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

NRC

2021-2022 Information Digest

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NRC Reference Material

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1. **The Superintendent of Documents**
   U.S. Government Publishing Office
   Washington, DC 20402-0001
   Internet: www.bookstore.gpo.gov
   Telephone: (202) 512-1800
   Fax: (202) 512-2104

2. **The National Technical Information Service**
   5301 Shawnee Road
   Alexandria, VA 22312-0002
   Internet: www.ntis.gov
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Address: **U.S. Nuclear Regulatory Commission**
Office of Administration
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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
Internet: www.ansi.org
(212) 642-4900

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

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) has published the Information Digest annually since 1989. The Digest provides information about agency activities and licensees from the various 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 2021–2022 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) that were updated as of August 10, 2021, including data in maps and graphics. The Digest is an annual publication, with updates to certain non-NRC data every 2 years.

The next Information Digest containing updated data will be published in September 2022. The Information Digest will include links to the most current information.

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.

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NRC AT A GLANCE

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 Christopher T. Hanson	Term ends June 30, 2024
Commissioner Jeff Baran	Term ends June 30, 2023
Commissioner David A. Wright	Term ends June 30, 2025
Vacant	Term ends June 30, 2022
Vacant	Term ends June 30, 2026

Locations

Headquarters:

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

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	817-200-8100 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 assigned at each operating nuclear power plant site.

NRC Fiscal Year 2021 Budget

- *Total authority: $879 million ($844 million enacted budget and $35 million authorized carryover)*
- *Total authorized staff: 2,868 full-time equivalents*
- *Estimated fees to be recovered: $721.4 million*
- *Separate appropriation for the Office of the Inspector General: $13.5 million*
- *Total research budget: $77 million*
  - *Reactor Program: $55 million*
  - *New/Advanced Reactor Licensing: $18 million*
  - *Materials and Waste: $4 million*

What Does the NRC Do?

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

Nuclear 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 of 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 19 percent of U.S. gross electricity, or about 807 billion kilowatt-hours.

Nuclear Reactors

- *93 commercial nuclear power reactors operating in 28 States at 55 sites*
- *62 pressurized-water reactors and 31 boiling-water reactors*
- *Four reactor fuel vendors*
- *21 parent operating companies*
- *About 80 different designs*
- *About 5,530 total inspection and assessment hours at each operating reactor in 2020*
- *Licensees expected to shut down or not seek license renewal include the following:*
  - *Palisades (Entergy) will close by May 31, 2022*
  - *Diablo Canyon Units 1 and 2 (Pacific Gas and Electric) plan to close by November 2024 and August 2025, respectively*

Reactor License Renewal

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

- *94 reactors have been issued initial renewed licenses, including 9 reactors now permanently shut down.*
- *Eight reactors operate under their original licenses.*

Subsequent License Renewal

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

- *Six reactors at three sites have been issued subsequent renewed licenses.*
- *Seven reactors at three sites have subsequent license renewal applications under review.*
- *Two licensees with a total of five reactors have submitted letters of intent to request subsequent license renewals.*

Early Site Permits for New Reactors

- *Six early site permits have been issued:*
  - *System Energy Resources, Inc., for the Grand Gulf site in Mississippi*
  - *Exelon Generation Co., LLC, for the Clinton site in Illinois*
  - *Dominion Nuclear North Anna, LLC, for the North Anna site in Virginia*
  - *Southern Nuclear Operating Co., for the Vogtle site in Georgia*
  - *PSEG Power, LLC, and PSEG Nuclear, LLC, for a site in New Jersey*
  - *Tennessee Valley Authority for two or more small modular reactor modules at the Clinch River Nuclear Site in Tennessee*

Combined License — Construction and Operating License 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 has received and docketed a COL application for the Oklo advanced reactor.*
- *The NRC suspended or canceled 10 COL application reviews at the request of the applicants for 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.*
- *The NRC has issued COLs for 14 reactors at Fermi, MI; Levy County, FL; North Anna, VA; South Texas Project, TX; Turkey Point, FL; V.C. Summer, SC; Vogtle, GA; and W.S. Lee, SC.*
- *At the licensee's request, six COLs have been terminated at three sites: Levy County Units 1 and 2 (terminated on April 26, 2018); South Texas Project Units 3 and 4 (terminated on July 12, 2018); and V.C. Summer Units 2 and 3 (terminated on March 6, 2019).*

Reactor Design Certification

- *Six 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)*
  - *Korean Electric Power Corporation APR1400 (Advanced Power Reactor)*

- *One DC application review was completed by NRC staff for the NuScale small modular reactor design and issued a final safety evaluation report. The NRC staff published the proposed NuScale small modular reactor design certification rule for public comment on July 1, 2021.*
- *The NRC completed review of one DC renewal application for the ABWR design. The final rule for the ABWR design is effective September 29. 2021.*
- *Two DC applications for the U.S. EPR (Evolutionary Pressurized-Water Reactor) and US-APWR (Advanced Pressurized-Water Reactor) are suspended at the request of the applicants.*

Nonpower Production and Utilization Facilities

- *Research and Test Reactors*
  - *31 licensed research and test (nonpower) reactors operate in 21 States.*
- *Medical Radioisotope Facilities*
  - *Two construction permits have been issued to SHINE Medical Technologies, LLC, in Janesville, WI, and Northwest Medical Isotopes, LLC, in Columbia, MO.*
  - *One operating license application is under review (SHINE).*

NUCLEAR MATERIALS

Materials Licensing

- *The NRC and the Agreement States have more than 18,000 licensees for medical, academic, industrial, and general users of nuclear materials.*
  - *The NRC regulates nearly 2,200 licenses.*
  - *The 39 Agreement States regulate more than 16,000 licenses.*
- *Connecticut and Indiana have submitted letters of intent to become Agreement States, a process that takes about 5 years to complete, including legislative action within the States.*
- *The agency issues approximately 1,600 new licenses, renewals, or amendments for existing materials licenses annually. The NRC conducts approximately 600 to 800 safety, and security inspections of materials licensees each year.*

Nuclear Fuel Cycle

- *Three uranium recovery sites are licensed by the NRC.*
- *The NRC licenses nine active fuel cycle facilities:*
  - *One uranium hexafluoride conversion facility ("ready-idle" status)*
  - *Five uranium fuel fabrication facilities*
  - *Two gas centrifuge uranium enrichment facilities (one operating and one under construction)*
  - *One depleted uranium deconversion facility (construction decision pending)*
- *The NRC issues about 45 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 1,100 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 (DOE) use the Nuclear Materials Management and Safeguards System (NMMSS) to track transfers and inventories of source and special nuclear material. Licensees must report their inventories, transfers, purchases, and sales (including import and export) of these materials to the NMMSS. More than 300 licensees report to the NMMSS database, verifying their inventories at least annually by reconciling their transactions against the previous year's inventory. The database supports U.S. participation in the Treaty on the Non-Proliferation of Nuclear Weapons.

RADIOACTIVE WASTE

Low-Level Radioactive Waste

- *10 regional compacts*
- *Four State-licensed disposal facilities*

HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT

Spent Nuclear Fuel Storage

- *The NRC has issued 81 licenses for independent spent fuel storage installations in 35 States:*
  - *16 site-specific licenses (two of these facilities are licensed but were never built or operated) this includes the Interim Storage Partners CISF license that was issued September 13, 2021*
  - *65 general licenses*
- *An application is under review for consolidated interim storage facility for spent fuel in Lea County, NM.*

Transportation—Principal Licensing and Inspection Activities

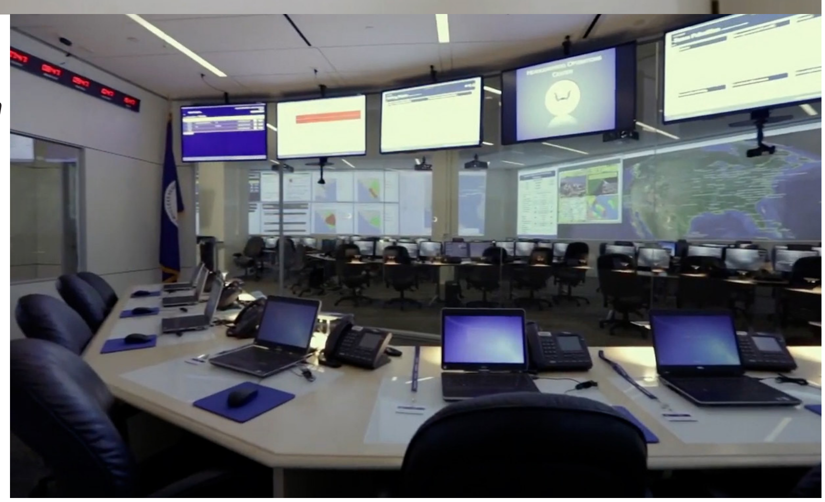
- *Approximately 1,000 safety inspections of fuel, reactor, and materials licensees are conducted annually.*
- *Annually, 50–70 new, renewed, or amended container-design applications for the transport of nuclear materials are reviewed.*
- *Approximately 150 license applications for the import and export 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 materials decommissioning program focuses on the termination of licenses that are not routine and that require complex activities.*
- *25 nuclear power reactors are in various stages of decommissioning (DECON or SAFSTOR).*
- *Three research and test reactors are permanently shut down and in various stages of decommissioning.*
- *11 complex materials sites are in various stages of decommissioning.*
- *Two fuel cycle facilities are in partial decommissioning, and one is undergoing decommissioning.*
- *Five NRC-licensed uranium recovery facilities are 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.*
- *Plants conduct additional emergency drills between full-scale exercises to maintain their preparedness and proficiency in responding to emergencies.*
- *The NRC spends about 15,000 hours a year scrutinizing security at nuclear power plants, including 8,000 hours of force-on-force inspections. These inspections include mock combat drills, which are conducted at each site every 3 years.*
- *The NRC has implemented a comprehensive cybersecurity oversight program for power reactors, which includes routine inspections and requires licensees to isolate critical systems from the Internet.*



The NRC Operations Center, located in the agency's Three White Flint North headquarters building, serves as the center when an emergency occurs or when the agency conducts exercises.

ACCOMPLISHMENTS AND HIGHLIGHTS 2020–2021

COVID-19

In March 2020, the NRC formed a task force to lead a coordinated agencywide response to the COVID-19 pandemic. The primary goals were to maintain the agency's important safety and security mission while also protecting employees and mitigating the spread of the virus at NRC worksites. By April 2020, approximately 98 percent of the agency workforce, including its inspectors, were successfully working remotely.

The task force oversaw the implementation of Federal requirements in response to the pandemic; engaged with other Federal agencies on their COVID response; developed agencywide guidance and protocols; and communicated on related NRC activities with internal and external stakeholders through virtual meetings, collaboration tools, social media, and dedicated internal and external Web pages.

Key NRC actions related to COVID-19 include the following:

- *Developing COVID-19 guidance for nuclear power plant licensees and nuclear materials licensees*
- *Communicating regularly with nuclear facilities to discuss current activities and future plans, including staffing, reactor operator licensing, reductions in nonessential maintenance, fire brigade staff requirements, and other matters*
- *Providing the nuclear industry with information to facilitate the expedited review of requests for temporary exemptions, such as to work-hour limits, to allow flexibility in maintaining an appropriate workforce to meet the NRC's minimum reactor operator and security staffing requirements*
- *Deferring licensee invoicing for annual fees (10 CFR Part 171) and user fees (10 CFR Part 170) normally due in the third quarter of Fiscal Year (FY) 2020*
- *Informing licensees how to request extensions to requirements to account for special nuclear materials and request temporary relief from some agency requirements while maintaining safety*
- *Providing information to NRC licensees to facilitate expedited review of requests for temporary exemptions from some biennial emergency preparedness exercise requirements*
- *Completing "full implementation" inspections and engaging stakeholders during development of a draft baseline cyber inspection procedure that will be used in CY 2022.*
- *Approving more than 250 licensing actions seeking temporary flexibilities to maintain the safe and secure operation of reactor licensees during the pandemic*
- *Issuing general enforcement guidance on how the agency will examine potential violations of NRC regulations related to COVID-19*
- *Adjusting inspection plans and schedules to safeguard the health and safety of NRC and licensee staff while effectively implementing the Reactor Oversight Program*
- *Adjusting security and emergency preparedness inspections schedules related to COVID-19*
- *Performing a lessons-learned and best practices review, resulting in recommendations to address information technology and changes to remote oversight when site access may be restricted*
- *Extending public comment deadlines to afford additional opportunities for public involvement during the pandemic*
- *Creating a new NRC eLearning initiative to help parents with children attending school virtually and for adults who want to know more about science, nuclear technology, and the NRC*

Power Reactors

- *Completed more than 1,350 licensing actions and other licensing tasks that support operating, new, and advanced reactors, including numerous actions related to the adoption of risk-informed initiatives, topical reports, and the safe transition of operating plants to decommissioning*
- *Provided a revision of NUREG-1409, "Backfitting Guidelines," to the Commission*
- *Issued a memorandum to the Commission describing the status of the NRC's review of construction tests and analysis, inspection, and licensing activities for Vogtle Unit 3*
- *Continued preparation for the end of Vogtle construction by risk-informing the baseline inspection program for AP1000 reactors and finalizing plans to transition Vogtle Units 3 and 4 from construction to the operating reactor oversight process*
- *Rolled out a new Web-based portal for licensee submission of proposed alternatives to codes and standards per 10 CFR 50.55a(z)*
- *Provided to the Commission several rulemakings such as the ABWR design certification (DC) renewal, NuScale small modular reactor DC, AP1000 DC extension*
- *Completed several key activities related to accident tolerant fuel (ATF) including issuance of a report by Energy Research, Inc. that covers the performance of the reactor during severe accidents for the current ATF concepts, higher burnup fuel, and fuel with enrichment above five weight percent; redesigning the ATF public Web site; and hosting two large workshops on licensing of higher burnup and increased enrichment fuel*
- *Granted subsequent license renewals for Surry Units 1 and 2, authorizing reactor operation from 60 to 80 years*
- *Accepted for review two subsequent license renewal applications for North Anna Units 1 and 2 and Point Beach Units 1 and 2*
- *Accepted for review the first digital instrumentation and control (DI&C) pilot application for Waterford using the new DI&C licensing process providing for an earlier licensing decision on the safety of the design*
- *Issued a revision to staff guidance regarding the evaluation of defense-in-depth and diversity to address a potential common-cause failure in digital safety systems*
- *Published technology-inclusive guidance for use by the NRC staff in reviewing the instrumentation and controls portions of non-light-water reactor applications*
- *Developed preliminary proposed rule language and held multiple public workshops regarding the safety and security requirements for the 10 CFR Part 53, "Licensing and regulation of advanced nuclear reactors," rulemaking on a risk-informed, technology-inclusive regulatory framework for advanced reactors, with a publication target of October 2024*
- *Completed reviews of several topical reports and continued various other preapplication engagement activities with reactor vendors and applicants, including those selected by the Department of Energy, to construct and operate advanced nuclear power reactors under the Advanced Reactor Demonstration Program*
- *Issued several guidance and policy documents to support future licensing of advanced reactors on topics such as fuel qualification methodology; policy, licensing, and environmental considerations associated with micro-reactors; and instrumentation and controls systems*
- *Finalized guidance on a risk-informed process for evaluations to establish a more efficient means to review licensing actions that address issues of low safety significance within the licensing basis*
- *Issued revised guidance to enhance regulatory efficiencies by enabling licensee peer review of newly developed methods for use in probabilistic risk assessments*
- *Completed reviews on all seismic probabilistic risk assessments and external flooding submittals in response to the agency's post-Fukushima actions resulting in safety enhancements and an improved ability to cope with the reevaluated hazards*

- *Approved multiple applications for the adoption of advanced risk management programs (such as 15 Risk-Informed Completion Times applications and the last National Fire Protection Agency 805 application)*
- *Completed 99 percent of calendar year 2020 required inspection and assessment activities of the Reactor Oversight Process, despite significant challenges due to COVID-19*
- *Issued a new Inspection Manual chapter to assist staff in reviewing licensee evaluations of changes to facility design, procedures, tests, or experiments in instances where a license amendment is not required to make the change*
- *Developed and began implementing an operating experience dashboard to provide staff with centralized access to information and ability to view, search, and use relevant operating experience data and trends*
- *Implemented various data analysis initiatives to enhance and modernize new and operating reactor workload and financial management across multiple business lines*
- *Prepared a rulemaking plan to update and transform the NRC's environmental review process*
- *Published an Advance Notice of Proposed Rulemaking for Alternatives to the Use of Credit Ratings*
- *Issued Interim Staff Guidance, "Micro-Reactor Applications, COL-ISG-029, Environmental Considerations Associated with Micro-Reactors"*
- *Published proposed rule for the NuScale small modular reactor DC*
- *Issued orders approving the transfers of Indian Point Units 1, 2, and 3 and Three Mile Island Unit 2 licenses for the purpose of decommissioning*
- *Provided technical expertise to the U.S. Navy for decommissioning of the Surface Ship Support Barge under an interagency agreement*
- *Completed 61 force-on-force inspections, testing licensees' abilities to protect against the Design Basis Threat during the COVID-19 public health emergency*
- *Reviewed and accepted three industry-proposed revisions to current cybersecurity guidance to enhance the identification and protection of the critical digital assets associated with the safety-related and emergency preparedness functions*
- *Conducted 154 baseline security inspections at operating power reactors and Category I fuel cycle facilities*
- *Issued Revision 6 of Regulatory Guide 1.101, "Emergency Planning and Preparedness for Nuclear Power Reactors," which describes and endorses acceptable methods for implementing the emergency preparedness regulations*
- *Issued Revision 1 of NUREG/CR-7002, "Criteria for Development of Evacuation Time Estimate Studies," resulting in significant enhancements for use by licensees when analyzing 2020 decennial census data*
- *Continued to synchronize physical security inspections of Vogtle Units 1 and 2 with Unit 3, improving efficiency in the oversight program*
- *Signed a memorandum of understanding with Cooper Nuclear Station to participate in the RAPBack Program, which allows both parties to receive notification of activity on individuals who hold positions of trust or who are under criminal justice supervision or investigation*

Nonpower Reactors

- *Granted SHINE Medical Technologies, LLC, an exemption that provides flexibility to procure facility-specific and other components for the construction of the SHINE medical isotope production facility*

Nuclear Materials and Waste

- *Completed approximately 1,400 radioactive materials licensing actions*
- *Transitioned inspection activities, Integrated Materials Performance Evaluation Program (IMPEP) activities, and public meetings to a remote environment in response to the COVID-19 pandemic to minimize impact to the agency's oversight programs and stakeholder engagement*
- *Completed six IMPEP reviews, including the first consolidated IMPEP of NRC licensing and oversight programs*
- *Issued a revision to Management Directive 5.1, "Consultation and Coordination with Governments and Indian Tribes," in July 2020 to ensure that written communications are provided to Federally recognized Indian Tribes for providing input on NRC regulatory actions after the agency's final decision*
- *Completed the revisions of 13 State Agreement procedures to implement the revised Management Directive 5.6, "Integrated Materials Performance Evaluation Program"*
- *Issued revisions to five State Agreement and State Liaison procedures to support NRC Agreement States and enhance joint oversight of the National Materials Program*
- *Issued a technical evaluation report for Exubrion Therapeutics' proposed license application template for the use by the NRC and Agreement States' applicants and licensees for use of a tin-117m colloid to treat osteoarthritis in large dogs*
- *Issued five Approved Spent Fuel Storage Casks Certificates of Compliance*
- *Issued Centrus Energy Corp./American Centrifuge Operating's license amendment for the High-Assay Low-Enriched Uranium Demonstration Program*
- *Issued reports for the fuel cycle smarter inspection program and the independent spent fuel storage installation (ISFSI) oversight enhancement initiatives to ensure safety as well as provide for a comprehensive and consistent inspection program*
- *Issued NUREG-2224, "Dry Storage and Transportation of High Burnup Spent Nuclear Fuel," which includes approaches for enhancing the effectiveness and efficiency of licensing and certification of high burnup spent nuclear fuel in transportation and dry storage*
- *Endorsed the "ISFSI License and Cask CoC Format Content, and Selection Criteria" document to improve the dry storage licensing process by applying risk insights to clarify the information required in certificates of compliance and technical specifications and removing or relocating details that are not risk significant*
- *Renewed the license for the Honeywell International uranium conversion plant in Metropolis, IL, after concluding that renewing the license will not pose an undue risk to public health and safety and will not significantly affect the quality of the environment*
- *Renewed the license for the Humboldt Bay ISFSI for an additional 40 years; the renewed license includes implementation of an aging management program to ensure that important-to-safety structures, systems, and components will continue to perform their intended functions during the extended storage period authorized by the renewal*
- *Terminated the materials license for the General Atomics facility in San Diego, CA*
- *Submitted a report to Congress identifying best practices for establishing and operating local community decommissioning advisory boards, as required by the Nuclear Energy Innovation and Modernization Act*
- *Signed a memorandum of understanding with the Environmental Protection Agency to improve coordination and cooperation in the regulation of the in situ recovery process of uranium extraction*

- *Used pre-recorded radio broadcasts both in English and the Navajo Diné language to communicate on NRC activities during the public comment period for the United Nuclear Corporation Church Rock Project Draft Environmental Impact Statement*
- *Issued a license on Sept. 13 to Interim Storage Partners LLC to construct and operate a consolidated interim storage facility for spent nuclear fuel in Andrews, Texas.*

Agencywide

- *Continued to oversee the safe and secure operation of nuclear power plants and fuel cycle facilities, as well as the possession and use of radioactive materials*
- *Made significant progress toward the transformation vision of being a modern, risk-informed regulator, particularly in the areas of innovation; employee retention, recruitment, and development; use of risk insights; and technology adoption*
- *Launched the internal agencywide "innovation platform," and collected more than 480 innovation success stories and hosted approximately 20 innovation challenge campaigns*
- *Established a framework to incorporate risk considerations across all business lines and platforms, which was used to help determine certain licensing actions in response to COVID-19 considerations*
- *Provided technology infrastructure and training to allow 98 percent of the NRC workforce to transition to mandatory telework within days due to the COVID-19 pandemic, and increased the use of dashboards to enhance the automated use of data for decisionmaking and data analysis*
- *Established two career development platforms for NRC employees*
- *Overall achievements that contributed to the agency's desired culture efforts:*
  - *Administered three Culture and Climate Surveys to 1,200 employees in March 2020, which created a baseline for culture improvement efforts*
  - *Developed an Agencywide Improvement Strategy and Implementation Plan and delivered presentations to staff.*
  - *Administered the Federal Employee Viewpoint Survey to all employees in September 2020 with 83 percent participation. The results showed 4 percent increase in employee engagement index (78 percent positive) and 3 percent increase in global satisfaction (75 percent positive).*
  - *Conducted discussions with management and champions in 22 offices and regions to review office/region-level culture improvement plans and identify best practices to share more broadly*
  - *Administered a culture pulse survey to all employees in April 2021 with 57 percent participation. The culture pulse survey showed a slight increase in constructive behavior; a significant decrease in defensive behavior; and increases in perceptions of employee involvement, communication, and adaptability.*
  - *Held three Executive Director for Operations Town Hall meetings to create a dialogue between staff and senior management about emergent topics of wide interest*
  - *Held 17 Leader Behavior Check-In sessions with groups of senior managers in June 2021 to create forums for leadership to model constructive behaviors in the agency's desired culture*
- *Continued implementing innovative solutions via EMBARK Venture Studio to enable and promote a risk-informed mindset within the nuclear reactor safety program and other business lines*
- *Pursued substantial rulemaking activities on topics including American Society of Mechanical Engineers codes and code cases; licensing of advanced reactors; categorical exclusions from environmental reviews; and petitions for rulemaking submitted by members of the public*
- *Implemented Fiscal Year (FY) 2020 eBilling, a public facing, Web-based application for use by NRC licensees, that provides immediate delivery of NRC invoices, customizable e-mail notifications, the capability to view and analyze invoice details, and the convenience to access U.S. Treasury systems to pay invoices*

- *Issued 61 escalated enforcement actions under traditional enforcement, the Reactor Oversight Process, and the Construction Reactor Oversight Process; processed 15 enforcement actions that involved civil penalties (14 proposed, 1 imposed) totaling $1,586,413 proposed and $606,942 imposed; 9 were enforcement orders without a proposed civil penalty, and 37 were escalated notices of violation without a proposed civil penalty*
- *Published research results on a variety of topics related to operating facility safety, safety analysis, severe accident analysis, improved methods for risk assessment, embedded digital devices, flood hazard assessment, advanced manufacturing, and fire modeling*
- *Continued collaboration with the DOE under the Nuclear Energy Innovation Capabilities Act through signing a technical addendum on light-water reactor sustainability and MELCOR source term evaluation, and through a separate agreement with DOE on operating experience and data analysis sharing*
- *Continued collaboration with the DOE under the Nuclear Energy Innovation Capabilities Act through signing technical addenda for the National Reactor Innovation Center, on light-water reactor sustainability, and MELCOR source term evaluation, and through a separate agreement with DOE on operating experience and data analysis sharing.*
- *Received 88 educational proposals and 160 research and development (R&D) proposals under the Integrated University Program Funding Opportunity Announcements, grants awarded included 45 educational grants and 15 R&D grants totaling $17.9 million in grants to 33 academic institutions.*

International Activities

- *Represented the NRC as part of U.S. delegations, negotiating agreements for civil nuclear cooperation (Section 123 Agreements) and participating in activities such as meetings of the Nuclear Suppliers Group, International Atomic Energy Agency (IAEA) Board of Governors, and Group of Seven Nuclear Safety and Security Group*
- *Issued 60 licenses to export nuclear materials and equipment*
- *Supported the development of enhanced regulatory infrastructure for radiological sources, research reactors, and nuclear power plant safety and security around the world through the provision of technical expertise and assistance funding thereby reinforcing U.S. Government national security and foreign policy objectives*
- *Participated in a U.S. Government delegation to international meetings addressing the implementation of treaties and conventions, including the Technical Meeting of Representatives to the Convention on the Physical Protection of Nuclear Materials (CPPNM) and its Amendment (A/CPPNM), and the meeting of the Preparatory Committee for the Conference of the Parties to the Amended CPPNM*
- *Participated in hundreds of virtual meetings with regulatory counterparts after international travel was suspended due to COVID-19*
- *Continued work under a first-of-a-kind memorandum of cooperation with the Canadian Nuclear Safety Commission to increase regulatory effectiveness through collaboration on the technical reviews of advanced reactors and small modular reactors*
- *Supported establishment of the Framework for Irradiation Experiments with the Organization for Economic Co-operation and Development/Nuclear Energy Agency to provide testing and examination capabilities for fuels and materials research to support new reactor technologies*

Administration

- *Processed 288 Freedom of Information Act (FOIA) requests and 24 appeals in FY 2020, with 81 FOIA requests and 3 FOIA appeals pending by the end of FY 2020*
- *Conducted 155 investigation cases by the Office of Investigations for FY 2020 including 110 investigations, 60 of which were carried over from FY 2019, and also 45 assists to staff, 5 of which were carried over from FY 2019*
- *Conducted agency outreach to audiences interested in NRC activities, including through the use of social media*
- *Awarded and administered the agency's acquisition portfolio with obligations estimated more over $255 million in FY 2020*

Public Meetings and Involvement

- *Revised the agency's public meeting policy and defined new public meeting categories to interact more effectively with stakeholders and the public*
- *During calendar year 2020 conducted approximately 639 open public meetings addressing a full range of NRC issues to support transparency with agency stakeholders and conducted 31 closed meetings*
- *Conducted 10 full committee meetings of the Advisory Committee on Reactor Safeguards and approximately 47 subcommittee meetings in fiscal year 2021; all of the ACRS meetings during the fiscal year were conducted virtually in response to COVID-19*
- *Held four public meetings of the Advisory Committee on the Medical Uses of Isotopes in calendar year 2020*
- *Hosted the first ever, all-virtual Regulatory Information Conference, which was also the highest attended to date with more than 4,300 people attending and 50 countries represented*
- *Created a new NRC eLearning initiative for children and adults who would like to know more about science, nuclear technology, and the NRC*

News and Information

- *Maintained the NRC Web site and free listserv subscription services at https://www.nrc.gov/public-involve/listserve.html to post and distribute NRC news releases*
- *Shared information with the public using social media through platforms that address the major categories of social communication, with a focus on social networking and microblogging (Facebook, LinkedIn and Twitter, respectively)*
- *In calendar year 2020, gained 960 followers on Twitter and sent 470 tweets; gained more than 880 page likes and published approximately 280 posts on Facebook; gained more than 3,000 followers and published approximately 100 posts on LinkedIn.*
- *Issued 146 news releases in FY 2020*

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

CONTACT US

U.S. Nuclear Regulatory Commission
800-368-5642
301-415-7000

Hearing Impaired Access TTY:
240-428-3217
https://www.nrc.gov

Public Affairs
301-415-8200
fax: 301-415-3716
e-mail: opa.resource@nrc.gov

Public Document Room
800-397-4209
fax: 301-415-3548

Employment
Human Resources: 301-415-7400

General Counsel Intern Program
Honor Law Graduate Program
or 2-Year Judicial Clerkship Program:
301-415-1515

Contracting Opportunities
Small Business:
800-903-7227

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 Boiling Brook Parkway
Rockville, MD 20852

REPORT A CONCERN

Emergency

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

- *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.

The NRC accepts collect calls. The agency records 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:

The 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, a list of 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

7 a.m. – 4 p.m. (eastern time)
After hours, please leave a message.

NRC inspectors keep a close eye on construction activities to ensure NRC regulations are being met at Vogtle Units 3 and 4, in Georgia.

NRC Office of Nuclear Security and Incident Response Director Mirela Gavrilas observes new construction activities at Vogtle Units 3 and 4, in Georgia.

PHOTOS:
NRC ON THE JOB

NRC inspectors (left to right) Katherine Warner, Liz Andrews and Mark Henrion observe workers preparing and pouring concrete for a dry cask storage pad on the Three Mile Island plant site in Pennsylvania.

Region IV Health Physicist Linda Gersey (right) conducts radiological surveys and collects soil samples at the Sequoyah Fuels plant near Gore, Oklahoma. This site is undergoing decommissioning.

Jared Nadel, NRC senior resident inspector at the Oconee Nuclear Station in South Carolina, tracks outage work on a licensee-provided iPad, checks work email on his NRC tablet, reviews his latest inspection report on his home computer and keeps his NRC laptop ready for the next virtual meeting.

Using Microsoft Teams, Ryan Craffey, a Region III materials inspector, successfully conducts a virtual inspection, observing in real-time the licensee's preparations and assessing the effectiveness of their safety practices.

Chairman Christopher T. Hanson (left) observes plant operations, including a stop in the control room during his visit to the Salem and Hope Creek nuclear power plants in New Jersey.

NRC Senior Instructor Jeff Griffis teaches a virtual class from the agency's Technical Training Center in Chattanooga, Tennessee.

NRC Division Director Chris Miller observes new construction activities at Vogtle Units 3 and 4, in Georgia.

Nuclear Regulator Apprenticeship Network participant Hayden Page visits the plant's condenser containment system at the Sequoyah nuclear power plant in Tennessee.

NRC Commissioner David Wright (purple shirt) tours Arkansas Nuclear One in Russellville, Arkansas, with Entergy and NRC staff before observing a security exercise. Photo courtesy of Entergy.

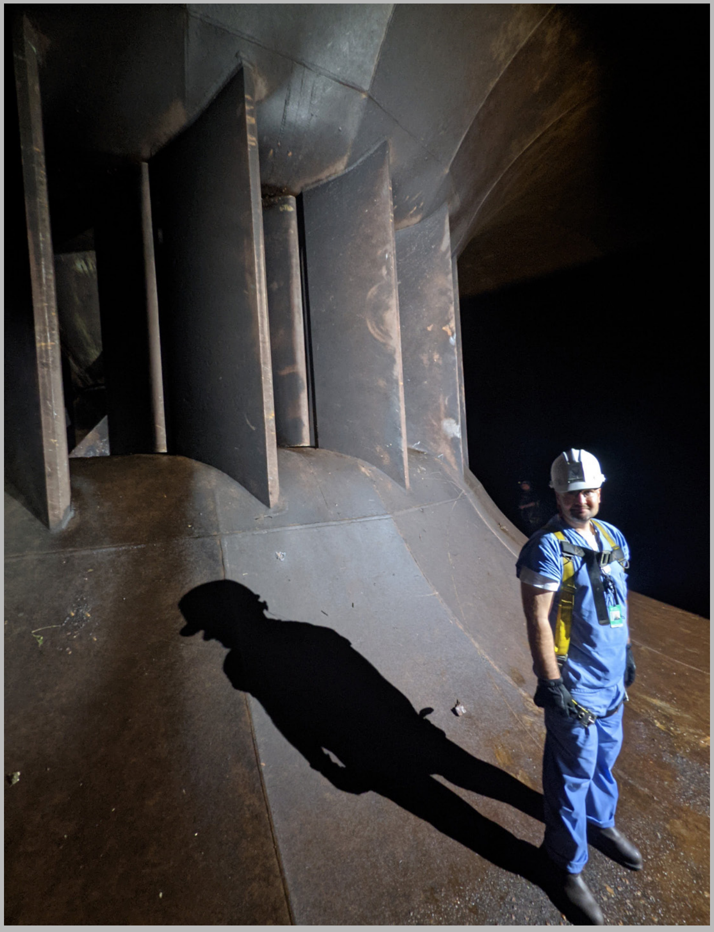
NRC Region I Inspector Juan Ayala in Wilmington, Delaware, conducts an inspection to ensure a nuclear gauge is being properly handled and secured.

Region IV health physicist Rob Evans completes his inspection at the 600-acre site in Gore, Oklahoma, where the Sequoyah Fuels Corporation operated a uranium conversion facility.

Indian Point nuclear power plant control room operators prepare for the final insertion of control rods in the Unit 3 reactor, part of the permanent shutdown of the site in New York. Not pictured NRC inspectors watching operations.

The reactor vessel and vessel head arrive at the V.C. Summer site South Carolina. The parts traveled by rail from the Port of Charleston by rail and on a Schnabel car—a specialized freight car designed to carry heavy and oversized loads. Courtesy of SCANA/SCE&G.

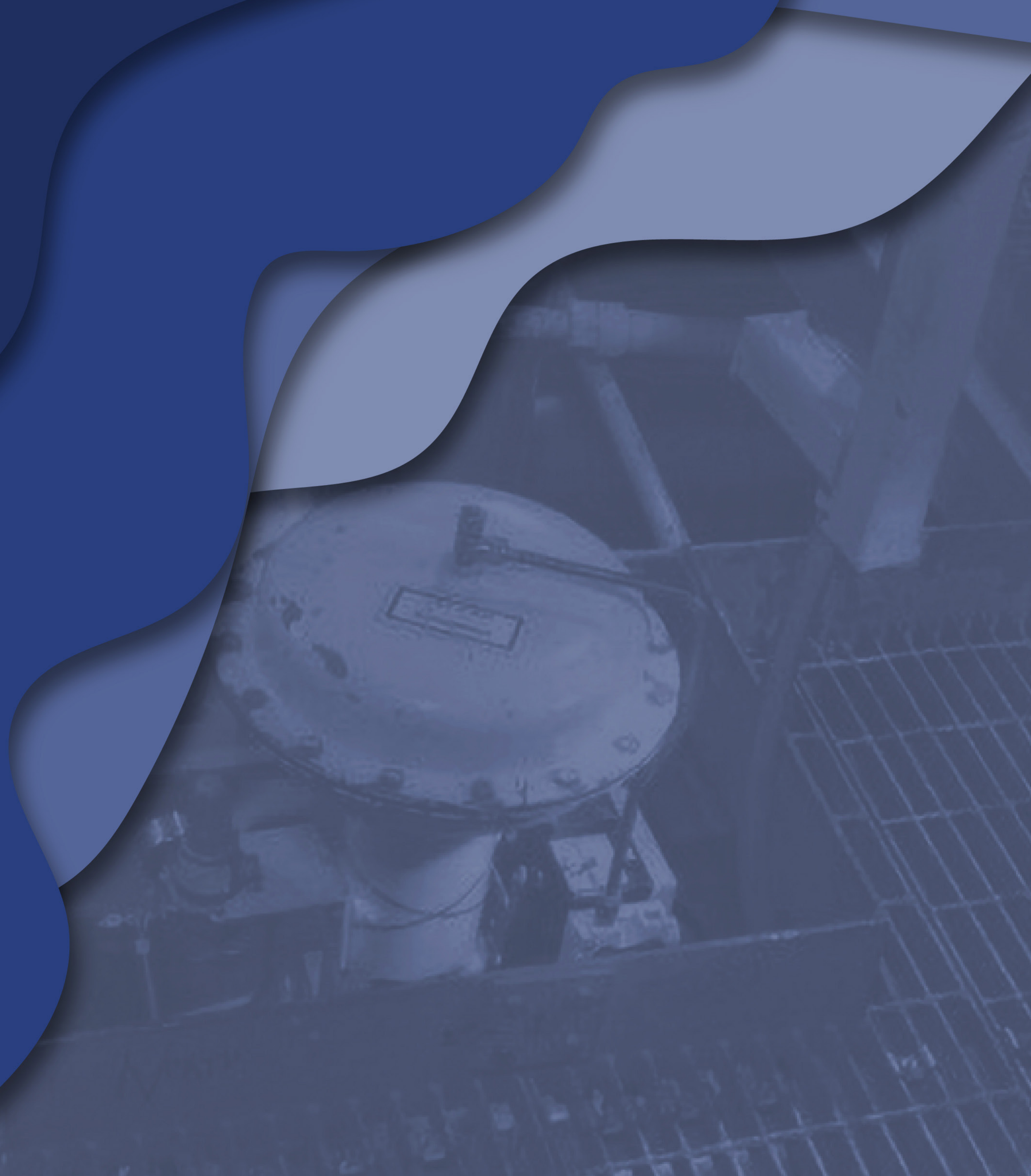
NRC Office of Nuclear Reactor Regulation Director Andrea Veil observes new construction activities at Vogtle Units 3 and 4, in Georgia.



NRC Region II Inspector Nick Peterka pauses for a moment during an inspection of the Keowee Hydro Station near the Oconee Nuclear Station in South Carolina.

Edison Fernandez (left), a Region III specialist in refueling outage activities and welding, makes an unannounced inspection at the Palisades nuclear power plant to observe some emergent repair work and conduct final examinations on a nozzle weld during a refueling outage.

NRC staff participate in a "hybrid" incident response exercise with some staff online and others working from the Headquarters Operations Center in Rockville, Maryland.



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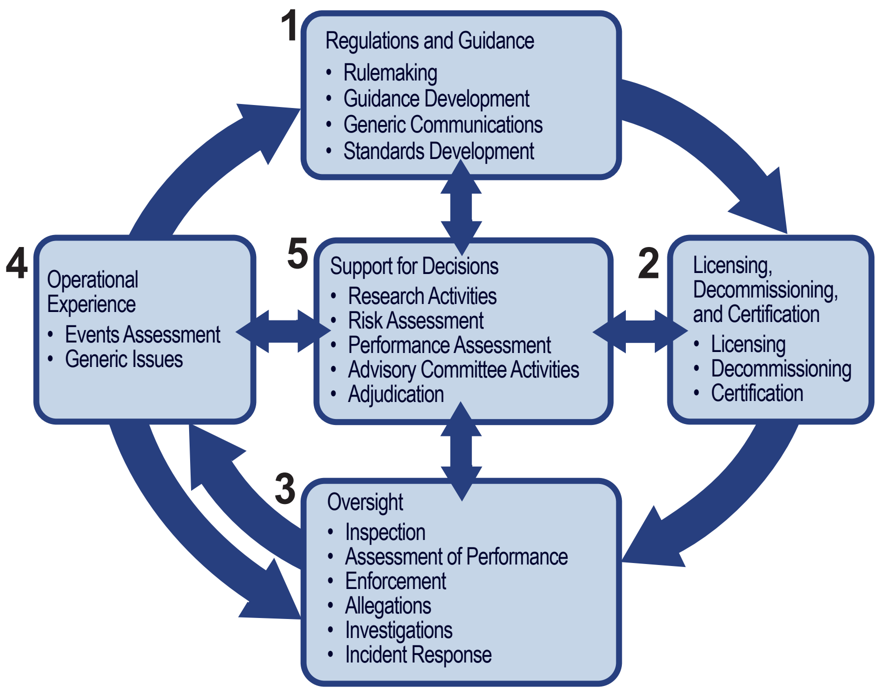
NRC: AN INDEPENDENT REGULATORY AGENCY

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; nonpower production and utilization facilities including research and test reactors (RTRs); 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 the NRC Regulates.

Figure 1. How the NRC Regulates



1. Develop regulations and guidance for applicants and licensees.
2. License or certify applicants to use nuclear materials, operate nuclear facilities, and decommission facilities.
3. Inspect and assess licensee operations and facilities to ensure licensees comply with NRC requirements, respond to incidents, investigate allegations of wrongdoing, and take appropriate followup or enforcement actions when necessary.
4. Evaluate operational experience of licensed facilities and activities.
5. Conduct research, hold hearings, and obtain independent reviews to support regulatory decisions.

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, to promote the common defense and security, and to protect the environment.

Vision

Demonstrate the Principles of Good Regulation in performing the agency's 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 with external stakeholders. By adhering to these principles, 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.*

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 its Web site (see the Web Link Index for more information).

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

APPENDIX

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.

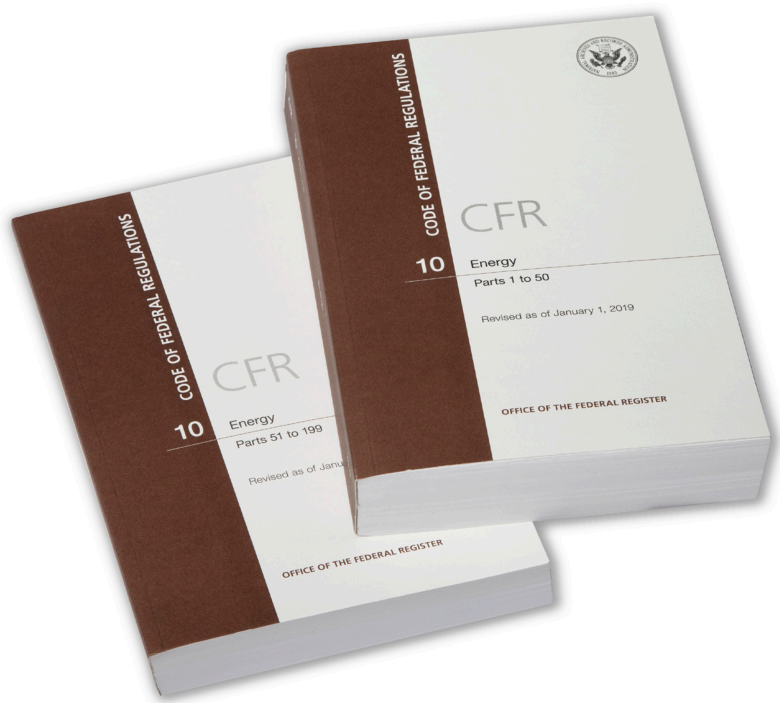
On September 28, 2018, the Nuclear Energy Innovation Capabilities Act of 2017 was signed into law. The Act requires the U.S. Department of Energy (DOE) and the NRC to enter into a memorandum of understanding (MOU) on certain topics related to advanced reactors and authorizes them to enter into an MOU on additional topics in this area. The NRC and DOE signed an MOU to implement provisions of the Act in October 2019.

On January 14, 2019, the Nuclear Energy Innovation and Modernization Act (NEIMA) was signed into law. NEIMA's provisions are varied and have impacts across the agency.

NEIMA has three stated objectives:

1. *To provide a revised framework for fee recovery by the NRC "to ensure the availability of resources to meet industry needs without burdening existing licensees unfairly for inaccurate workload projections or premature existing reactor closures."*
2. *To support the development of expertise and regulatory infrastructure necessary to allow innovation and the commercialization of advanced nuclear reactors.*
3. *To foster "more efficient regulation of uranium recovery."*

The NRC is in the process of implementing the various provisions of NEIMA. The agency has already submitted multiple reports to Congress establishing performance metrics and milestone schedules for "requested activities of the Commission." The NRC is also taking actions related to the licensing process for commercial advanced reactors and research and test reactors. The NRC is committed to meeting the requirements of NEIMA and is working diligently to do so.



NRC regulations are contained in Title 10, "Energy," of the *Code of Federal Regulations*, Chapter 1, Parts 1 to 199.

MAJOR ACTIVITIES

The NRC fulfills its responsibilities by doing the following:

- *licensing the design, and overseeing 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*
- *establishing national policy and standards for the safe disposal of low-level radioactive waste*
- *certifying the design, and overseeing construction, and operation of commercial transportation casks for radioactive materials and waste*
- *licensing the design, and overseeing 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 support regulatory framework and to address potential reactor and other nuclear facility safety issues*
- *collecting, analyzing, and disseminating information about the 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, security, and nonproliferation issues*
- *conducting investigations of alleged violations by NRC licensees that may result in criminal, civil, or administrative penalties*
- *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, security, and environmental concerns*
- *implementing international legal commitments made by the U.S. Government in treaties and conventions*
- *developing working relationships with State and Tribal governments*
- *maintaining an 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*
- *transforming the agency one decision at a time into a modern, risk-informed regulator that promotes and embraces innovative approaches to achieve the agency mission (see Figure 2. Transforming the NRC)*
- *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; offering multiple ways to report safety concerns; and providing documents under the Freedom of Information Act and through the NRC's Web site (see Figure 3. A Typical Rulemaking Process)*
- *engaging and informing the public through social media platforms and by providing interactive, high-value datasets (data in a form that allows members of the public to search, filter, or repackage information)*

TRANSFORMING THE NRC

Figure 2. Transforming the NRC

How is the NRC transforming into a modern, risk-informed regulator?

- *Be riskSMART—making sound decisions while accepting well-managed risks in decisionmaking.*
- *Focus on Our People—maintaining an engaged and highly skilled workforce now and in the future.*
- *Innovate—making timely decisions that take into account different viewpoints and fully explored options.*
- *Use Technology—working smarter, including using data analytics to highlight areas for regulatory attention and improvement.*

The NRC's Transformation Journey

Over the past several years, the NRC has been transforming to realize its vision of becoming a modern, risk-informed regulator and be in the best position to continue meeting its important safety and security mission well into the future. Transformation will help the agency keep pace with the highly dynamic, interconnected environment in which it operates and regulate an innovative industry that has new technologies. Transforming also provides the NRC an opportunity to re-evaluate the way it conducts business to streamline processes and procedures and maximize efficiencies to better serve the American public.

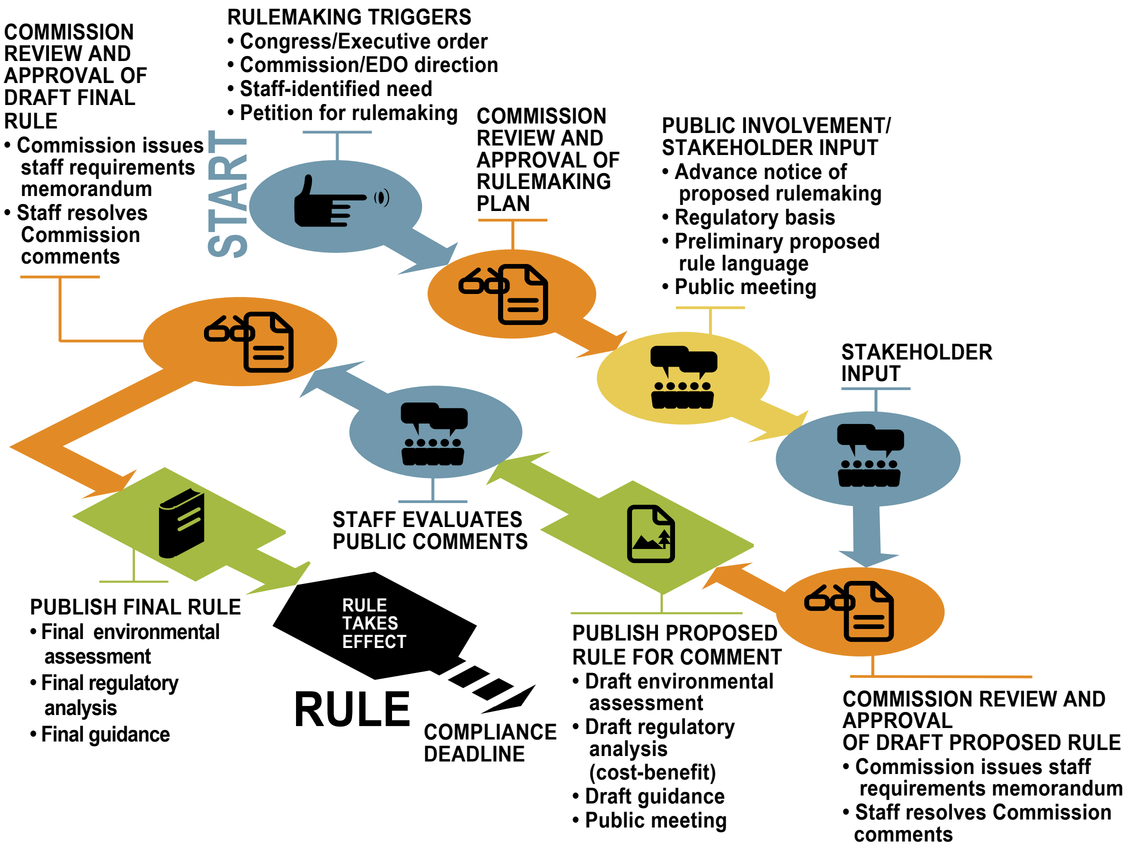
The NRC's transformation vision is supported by the four focus areas outlined above. Each of the four focus areas is supported by initiatives aimed at streamlining work processes, advancing the use of new information technology, systematizing the appropriate consideration of risk in decisionmaking and encouraging innovative solutions to agency challenges.

The NRC anticipates that the efficiencies gained by transformation will allow the staff to make more timely and better quality decisions vital for accomplishing the agency's safety and security mission. As the agency continues its transformation journey, stakeholder engagement is important, and the agency is communicating its progress through public meetings and conferences, as well as through the NRC Web site. For more information on the agency's transformation journey, visit https://www.nrc.gov/about-nrc/plans-performance/modern-risk-informed-reg.html.

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.

Figure 3. A Typical Rulemaking Process



Regulatory Basis

A regulatory basis document is an analysis that describes the technical, legal, and policy information that supports changes to the NRC's regulations. It describes why the current regulation needs to be updated, explains how a change in the regulations will resolve the problem, and discusses other regulatory options to potentially address the problem. It provides a high-level discussion of the costs and benefits of each option, and identifies any backfitting and forward fitting considerations. For each rulemaking, the NRC determines whether development of a regulatory basis is necessary based on the regulatory issues involved. If development of a regulatory basis is warranted, it is generally published for public comment. Any comments received on the regulatory basis would be considered in the development of the proposed rule.

Proposed Rules

Each proposed rule that involves significant matters of policy is sent to the NRC Commission for approval. Less significant rules may, with Commission approval, be signed by an NRC staff manager. If approved, the proposed rule is published in the *Federal Register* and usually contains the following items:

- *the background information about the proposed rule*
- *an address for submitting comments*
- *the date by which comments must be submitted to ensure consideration by the NRC*
- *an explanation indicating why the rule change is thought to be needed*
- *the proposed text to be changed*

Usually, the public is given 30 to 90 days to provide written comments, although not all rules are issued for public comment. Generally, the agency does not collect comments on rules that concern agency organization, procedure, practice, or rules for which delaying their publication to receive comments would be contrary to the public interest and not practical.

Final Rules

Once the public comment period has closed for the proposed rule, the staff analyzes the comments, makes any needed changes, and prepares a final rule for approval by the Commission or delegated NRC manager. Upon approval, 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 used only for regulatory changes that the NRC believes are noncontroversial. In a direct final rule, a companion proposed rule is published at the same time as the direct final rule. If there are no significant and adverse comments on the proposed rule, the direct final rule becomes effective. If there are significant and adverse comments, the direct final rule is withdrawn and the rulemaking proceeds as a typical final rule addressing public comment.

Advance Notice of Proposed Rulemaking

For especially important or complex rules, the NRC may engage the public at the earliest stages of rulemaking to define the scope and content of the rule. One way of doing this is through an Advance Notice of Proposed Rulemaking. 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. The NRC may also conduct public meetings at this stage to gather direct input on the rulemaking.

Rulemaking Information

The public can access a centralized, Web-based tracking and reporting system, which provides near-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 4. NRC Organizational Chart).

*Commissioner Term Expiration**

Christopher T. Hanson
Chairman
June 30, 2024

Jeff Baran
June 30, 2023

David A. Wright
June 30, 2025

Vacant
June 30, 2022

Vacant
June 30, 2026

* Commissioners listed by seniority.

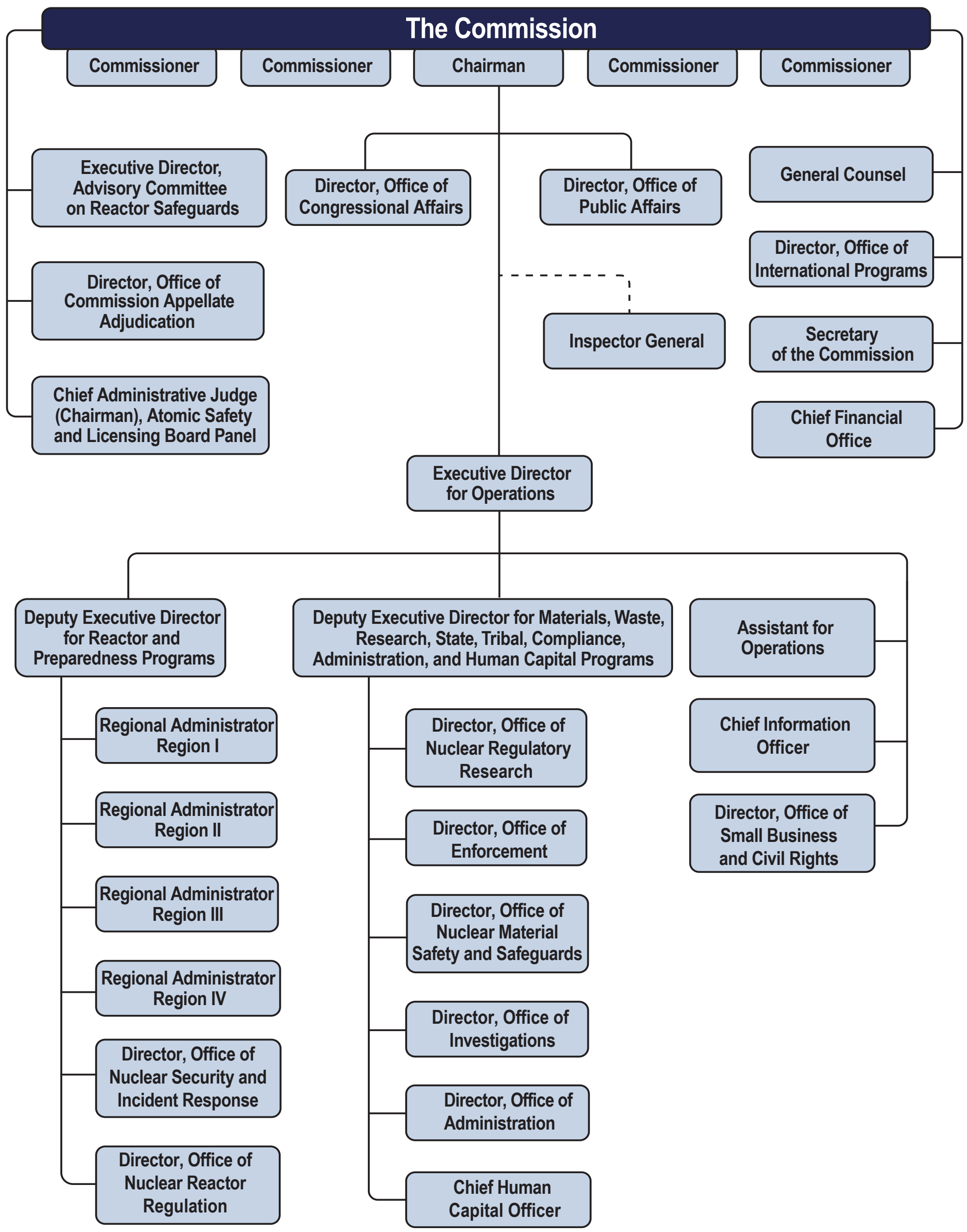
The NRC is headquartered in Rockville, MD, and has four regional offices. They are located in King of Prussia, PA; Atlanta, GA; Lisle, IL; and Arlington, TX.

The NRC's corporate offices provide centrally managed activities necessary for agency programs to operate and achieve goals. Corporate support is needed for a successful regulatory program that include such as Administration, Office of General Council and Office of Chief Information Officer et. al. 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. It also 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.*
- *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.*

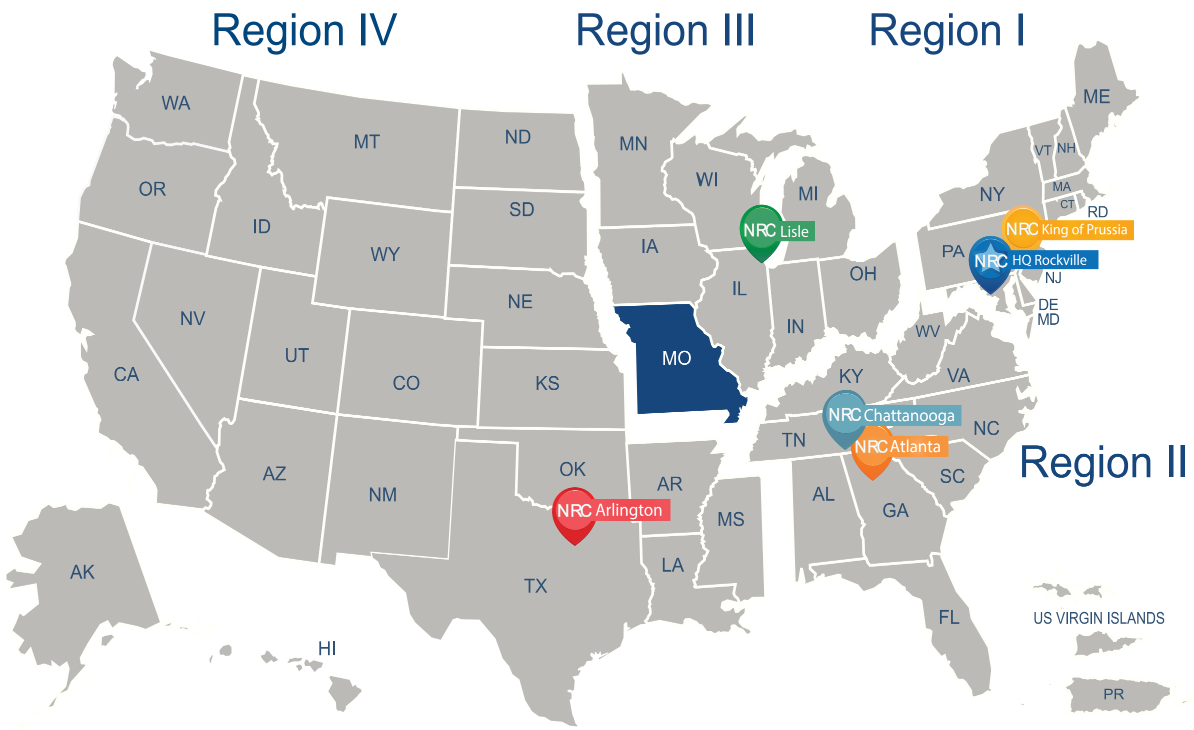
- The NRC **regional offices** conduct inspections and investigations; take enforcement actions (in coordination with the Office of Enforcement); and maintain incident response programs for nuclear reactors, fuel facilities, and materials licensees. In addition, the regional offices carry out licensing for certain materials licensees (see Figure 5. NRC Regions).
- The agency has two **advisory committees**, the Advisory Committee on Reactor Safeguards (ACRS) and the Advisory Committee on the Medical Uses of Isotopes (ACMUI), which 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.

Figure 4. NRC Organizational Chart



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

Figure 5. NRC Regions

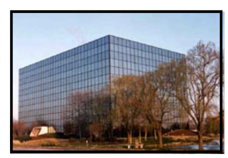


Region I
King of Prussia, PA

Region II
Atlanta, GA

Region III
Lisle, IL

Region IV
Arlington, TX



Technical Training Ctr.
Chattanooga, TN

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

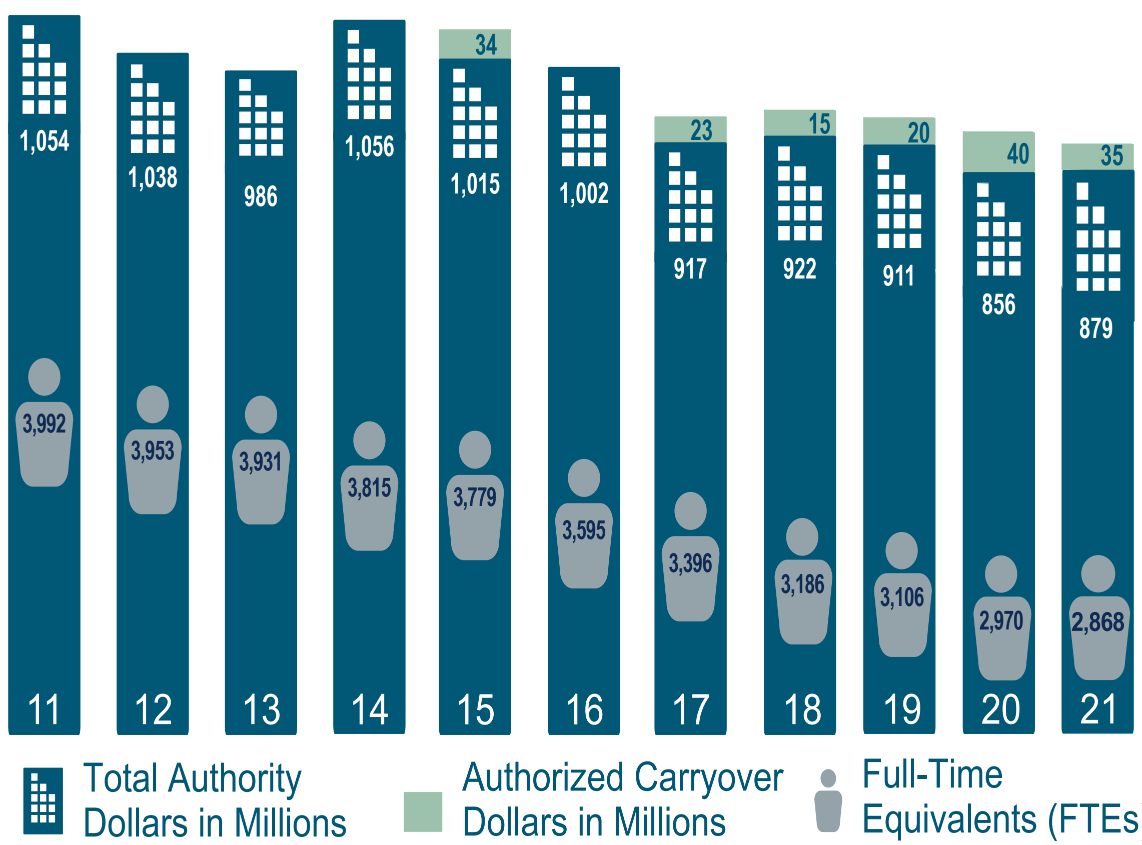
- Region II oversees all the fuel processing facilities in all regions.
- Region II also handles all construction inspection activities for new nuclear power plants and fuel cycle facilities in all regions.

FISCAL YEAR 2021 BUDGET

For fiscal year (FY) 2021 (October 1, 2020, through September 30, 2021), the NRC's budget is $879 million. The NRC has 2,868 full-time equivalents (FTEs) in FY 2021; including the Office of the Inspector General (see Figure 6. NRC Total Authority, FYs 2011–2021). The Office of the Inspector General received its own appropriation of $13.5 million, which is included in the total NRC budget.

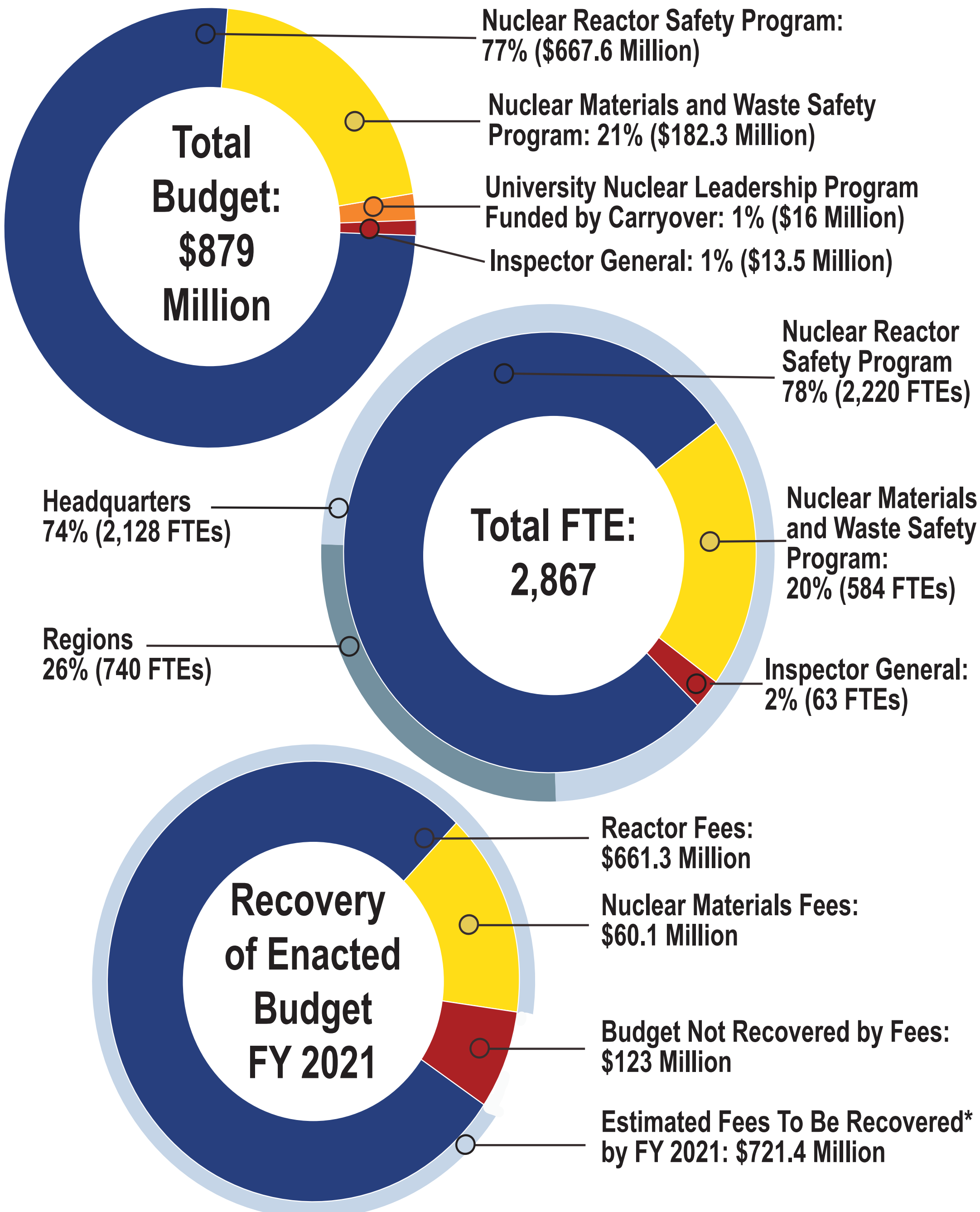
The breakdown of the budget is shown in Figure 7. NRC FY 2021 Distribution of Budget Authority; Recovery of Enacted NRC Budget. The Nuclear Energy Innovation and Modernization Act, known as NEIMA (Public Law 115-439), requires the NRC to recover, to the maximum extent practicable, approximately 100 percent of its total budget authority for a fiscal year, less the budget authority for "excluded 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 $721.4 million in fees in FY 2021.

Figure 6. NRC Total Authority, FYs 2011–2021



Note: Dollars are rounded to the nearest million.

Figure 7. NRC FY 2021 Distribution of Budget Authority; Recovery of Enacted Budget



* Recovered fees do not include the use of prior-year carryover where fees were previously collected. After Part 171 billing adjustments the amount to be recovered is $708 Million.

Notes: The NRC incorporates corporate and administrative costs proportionately within programs. Also, the spread of corporate FTE is included in Reactor and Material fees. Numbers may not add due to rounding. Enacted budget for FY 2021. More budget information available in the Congressional Budget Justification at https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1100.

2

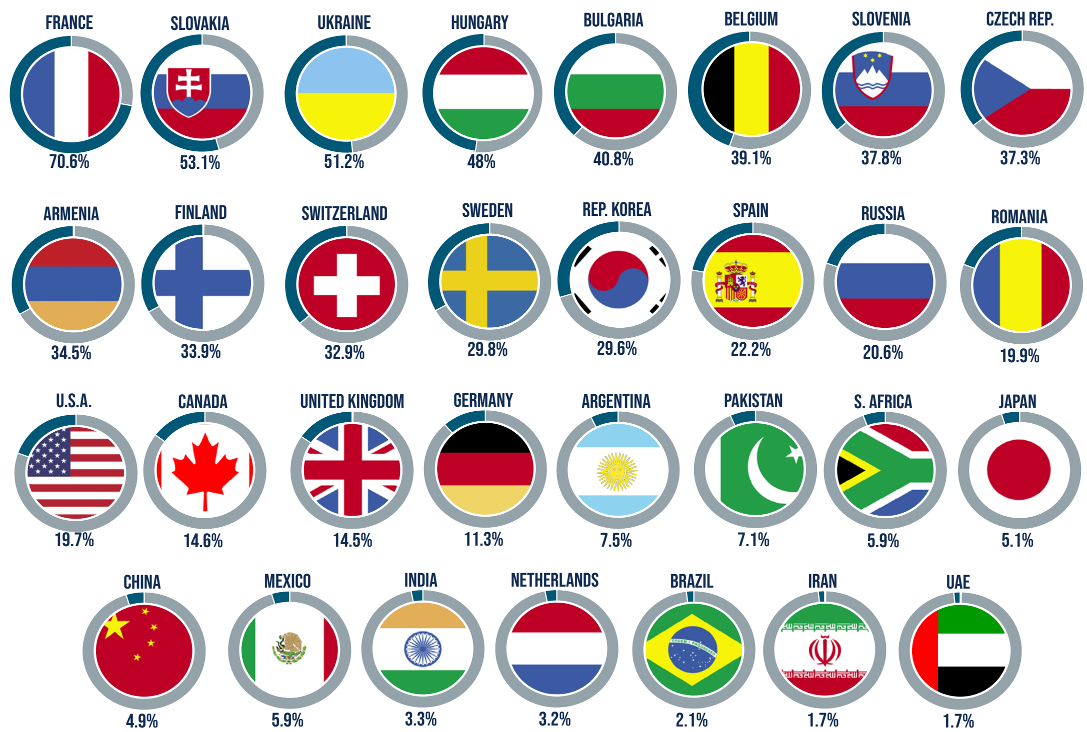
NUCLEAR ENERGY IN THE U.S. AND WORLDWIDE

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 June 2021, there were 444 operating reactors in 30 countries with a total net capacity of 394,229 megawatts electric (MWe). In addition, 51 reactors were under construction. Based on data from 2020, France had the highest portion (70.6 percent) of total domestic energy generated by nuclear power.

Figure 8. Nuclear Share of Electricity Generated by Country.



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

- *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 to enhance the safe and secure civilian use of nuclear materials and technologies.

APPENDIX

See Appendix R for the number of nuclear power reactor units by nation; Appendix S for nuclear power reactor units by reactor type, worldwide; and Appendices X, Y, and Z for lists of international activities, including conventions and treaties, bilateral information exchange and cooperation agreements, multilateral organizations in which the NRC participates, and list of export and import licenses.

INTERNATIONAL STRATEGY 2021–2025

The NRC is well-respected internationally in nuclear safety and security regulation. The agency's International Strategy builds directly on the Commission's 2014 International Policy Statement and has two primary aims:

- *Leverage this reputation to positively influence the development of new, and maintenance of existing, nuclear safety and security regimes around the world; and*
- *Target the staff's international engagement to opportunities that will directly inform the agency's domestic mission objectives.*

The strategy consists of five objectives to guide the agency's international engagement and ensure that the agency's activities positively influence global nuclear safety and security, align with U.S. Government policy priorities, and promote strong cooperation with international regulatory partners. The objectives are as follows:

EXCEL

Maintain excellence in executing the NRC's statutory and legally mandated activities.

- *Successfully execute the U.S. Government's export and import mandate for nuclear equipment, components, and materials and contribute to meeting U.S. obligations under nuclear safety, security, and nonproliferation conventions, treaties, and U.S. Government commitments.*

INTEGRATE

Integrate the agency's international activities with broader U.S. Government foreign policy and national security objectives.

- *Frequent engagement with the Executive Branch about how the NRC can complement U.S. foreign policy or national security objectives, recognizing the NRC's nonpromotional status and independence and areas where policy restrictions may influence the direction of the agency's work.*

PARTNER

Build and maintain partnerships in specific regions of strategic importance to the United States that will support governmentwide objectives and enable the agency to learn from its counterparts and advance its domestic mission.

- *Establish and maintain strategic global partnerships in all regions in targeted ways; promote domestic and global nuclear safety and security by creating and taking advantage of opportunities to increase cooperation; and gain valuable information to use as a benchmark for the agency's domestic activities.*

LEAD

Demonstrate leadership in the international community through involvement in key bilateral and multilateral forums in areas of strategic importance to the NRC and U.S. Government.

- *Positively influence the global nuclear safety and security regime to develop regulatory frameworks that emphasize safety and security as a foremost objective, in a manner that promotes or is consistent with the NRC's domestic regulatory approach.*

ASSIST

Advance nuclear safety and security worldwide by providing regulatory assistance to countries with emerging regulatory programs, with a focus on countries of strategic importance to the broader U.S. Government.

- *Countries receiving NRC capacity-building support will make advances in developing a sound, independent, technically competent, adequately resourced nuclear safety and security regulatory infrastructure that mirrors key tenets of the NRC's regulatory infrastructure and approach.*

INTERNATIONAL ACTIVITIES

The NRC's international activities support the agency's domestic mission, as well as broader U.S. domestic and international interests. The wide-ranging activities include the following:

- *convention and treaty implementation*
- *nuclear nonproliferation*
- *export and import licensing for nuclear materials and equipment*
- *international nuclear safety, security, and safeguards cooperation and assistance*
- *cooperative safety research*

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 acquire regulatory safety and security best practices. In addition, joint research projects give the NRC access to research facilities not available in the United States.

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. 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.

In addition, the NRC's international cooperation and assistance activities, as well as import and export licensing of nuclear materials and equipment, fulfill U.S. obligations undertaken under the treaty on the Non-Proliferation of Nuclear Weapons, which says that all parties to the Treaty have the right to participate in the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy, provided that they meet their nonproliferation obligations. The NRC therefore participates in review meetings and associated activities under this treaty.

The NRC also actively participates in meetings and activities for the following conventions:

- *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*
- *Convention on the Physical Protection of Nuclear Material and Its Amendment*
- *Convention on Early Notification of a Nuclear Accident*
- *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*

Export and Import Licensing

The NRC reviews applications to license exports and imports of nuclear materials and equipment to ensure that such exports and imports will not be inimical to the safety and security of the United States and will be consistent with applicable agreements for the peaceful use of nuclear materials. The NRC's export and import regulations are found in Title 10 of the *Code of Federal Regulations* 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 more than 45 countries, as well as Taiwan and the European Atomic Energy Community (see Appendix X for the list of the NRC's bilateral information exchange and cooperation agreements).

Cooperation

The NRC participates in 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.

Some of the benefits of consulting with mature regulatory programs include the following:

- *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 and vice versa*
- *sharing of safety and security information*

Assistance

The NRC provides bilateral and regional capacity-building support, training, workshops, and peer reviews to assist countries as they develop or enhance their national nuclear regulatory infrastructures and programs.

Foreign Assignee Program

The NRC provides long-term, on-the-job assignments to foreign regulators at the NRC through its Foreign Assignee Program. 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 the program's 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 and Professional Development Center.

Multilateral Cooperation and Assistance

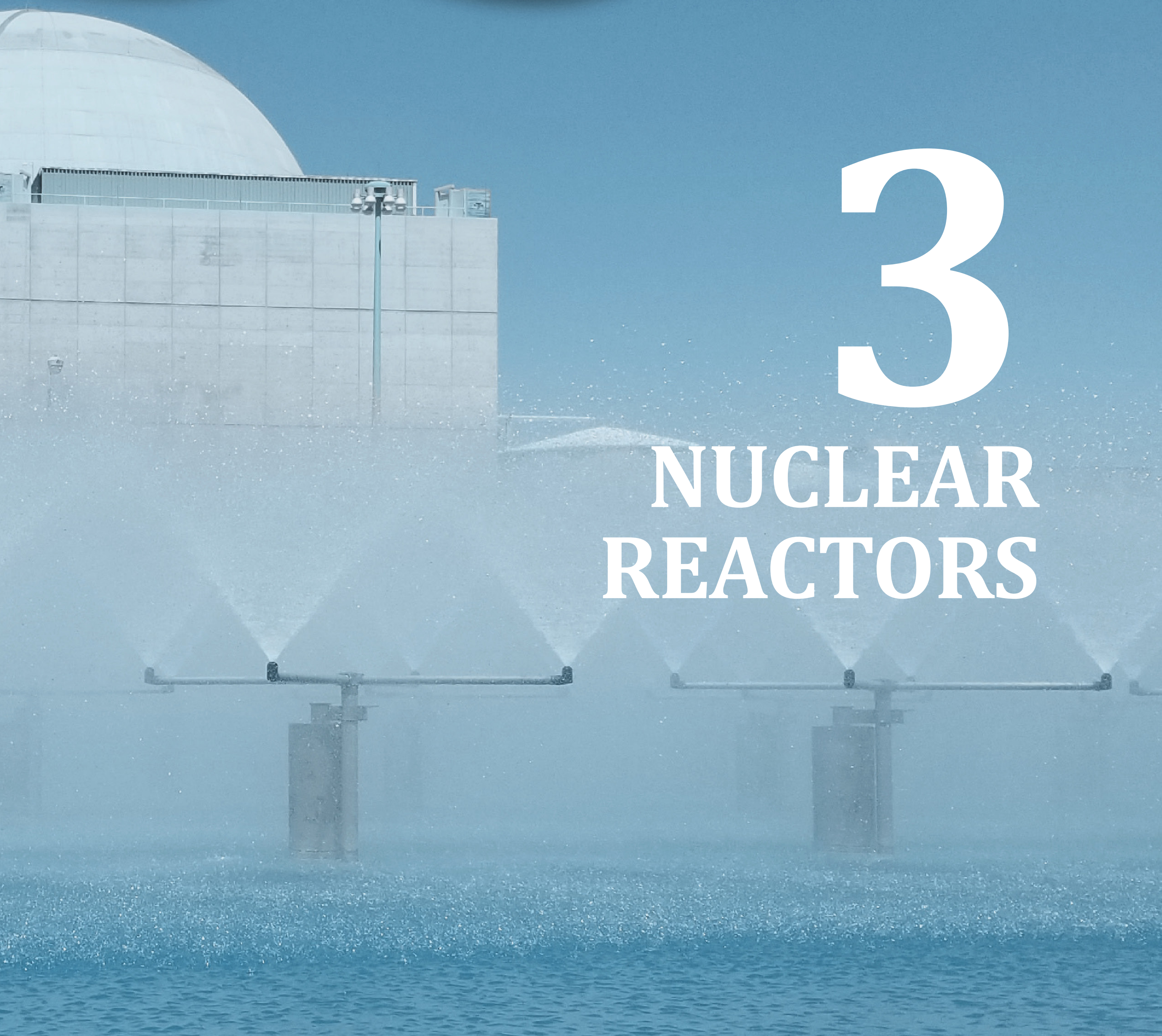
The NRC plays an active role in the different programs and committee work of multilateral organizations. The agency works with multiple regulatory counterparts through the IAEA, OECD/NEA, and other multilateral organizations on issues related to—

- *safety research and development of standards*
- *radiation protection*
- *risk assessment*
- *emergency preparedness*
- *waste management*
- *transportation*
- *safeguards, physical protection, and security*
- *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. This helps leverage access to foreign research data and test facilities otherwise unavailable to the United States.

3 NUCLEAR REACTORS



U.S. ELECTRICITY GENERATED BY COMMERCIAL NUCLEAR POWER

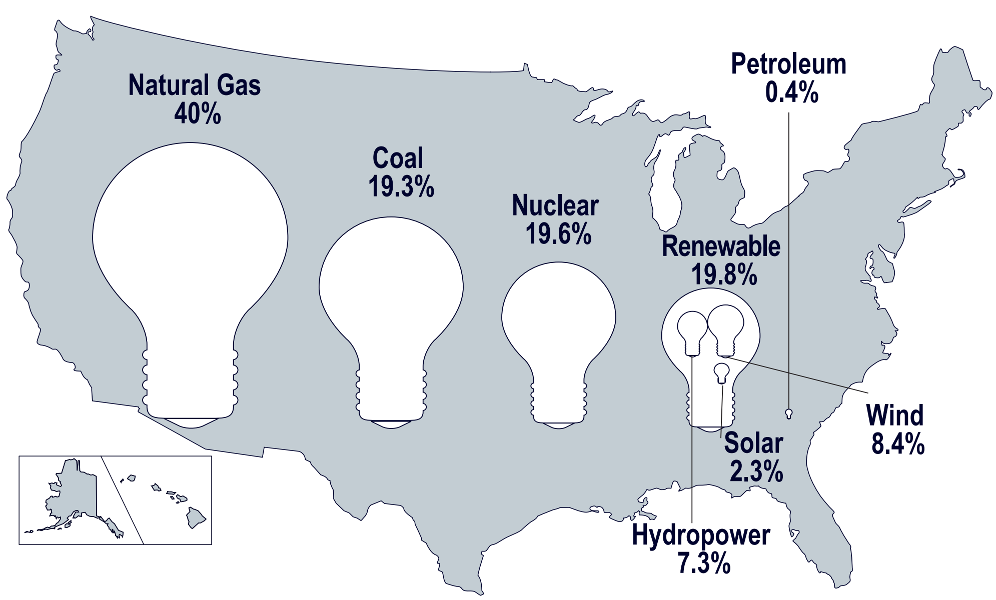
According to the U.S. Energy Information Administration (EIA), in 2020, preliminary estimates show that 4,009 billion kilowatt-hours (kWh) (or 4 trillion kWh) of electricity were generated at utility-scale electricity generation facilities in the United States. About 60.3 percent of this electricity generation was from fossil fuels (coal, natural gas, petroleum, and other gases). Nuclear energy provided 19.7 percent (790 billion kWh), and about 19.8 percent came from renewable energy sources (see Figure 9. U.S. Gross Electricity Share by Energy Source, 2020, and Figure 10. U.S. Electricity Generation by Energy Source, 2015–2020).

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 heat, or power level, is used with other data in many analyses that demonstrate the safety of the nuclear power plant. Because 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 it, as it would for any license or technical specification change. 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. See the Glossary for information on the electric power grid.

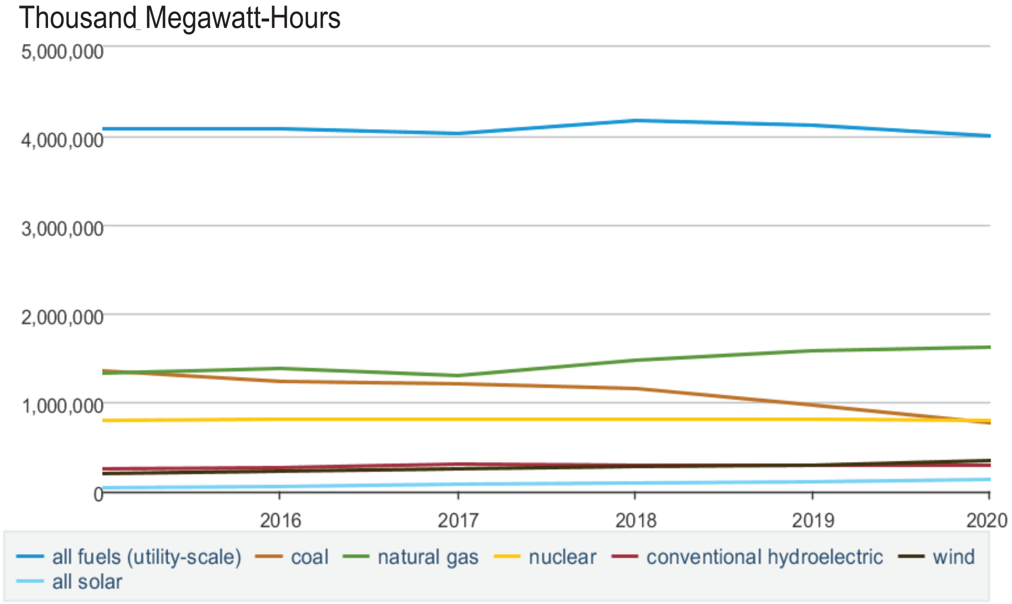
According to the EIA, in 2019, each of the following States generated more than 40,000 megawatt-hours of electricity from nuclear power: Illinois, Pennsylvania, South Carolina, New York, Alabama, North Carolina, and Texas. Illinois ranked first in the Nation in both generating capacity and net electricity generation from nuclear power. Illinois nuclear power plants accounted for 12 percent of the Nation's nuclear power generation. The 2019 data cited reflect the total net electricity generation from nuclear sources in each of these States. See Figure 11. Gross Electricity Generated in Each State by Nuclear Power. In 2019, 30 of the 50 States generated electricity from nuclear power plants.

Figure 9. U.S. Gross Electricity Share by Energy Source, 2020



Note: Figures are preliminary and rounded.
Source: DOE/EIA at https://www.eia.gov—Table 7.2a Electricity Net Generation: Total (All Sectors) data released as of June 24, 2021, annual total for 2020.

Figure 10. U.S. Electricity Generation by Energy Source, 2015–2020



***2020 data are preliminary. Note: Figures are rounded.**
Source: DOE/EIA, https://www.eia.gov—Electricity Data Browser; —Electricity Net Generation: Total (All Sectors—Annually 2015–2020) released as of June 2021 for 2020 data.

U.S. COMMERCIAL NUCLEAR POWER REACTORS

Power plants convert heat into electricity using steam. At nuclear power plants, the heat to boil water into 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 reaction's heat creates steam to turn a turbine. As the turbine spins, the generator turns, and its magnetic field produces electricity.

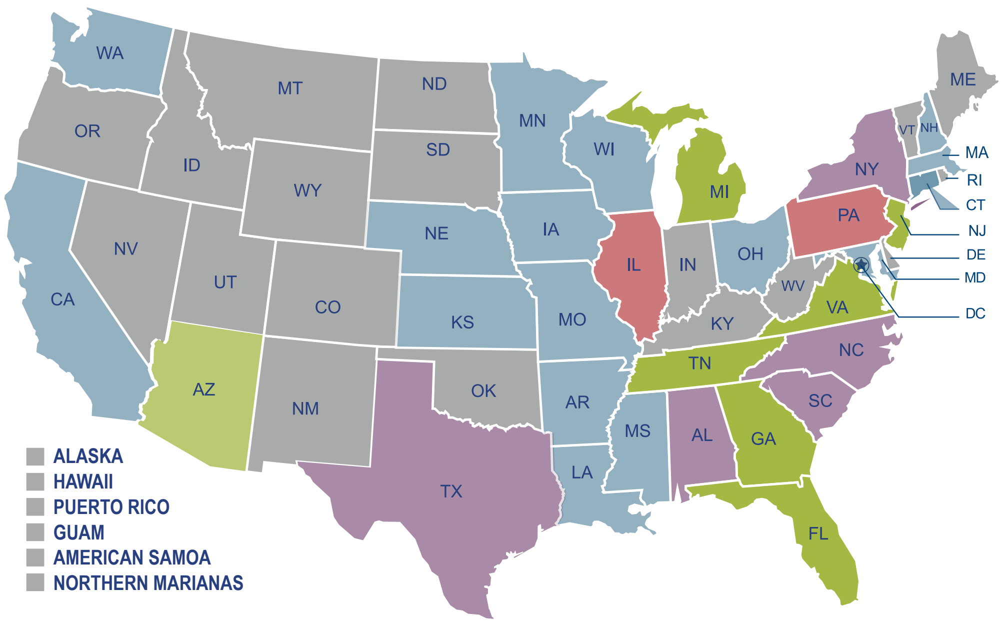
Nuclear power plants are very complex. There are many buildings at the site and many different systems. Some of the systems work directly to make electricity, while others keep the plant working correctly and safely. All nuclear power plants have a containment structure with reinforced concrete about 4 feet (1.2 meters) thick that houses the reactor. To keep reactors performing efficiently, operators remove about one-third of the fuel every year or two and replace it with fresh fuel. Used fuel is stored and cooled in deep pools of water located 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 nuclear reactors. Pressurized-water reactors are known as PWRs. They keep water in the reactor under pressure, so it heats to over 500 degrees Fahrenheit (260 degrees Celsius) 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,called BWRs, the water heated in the reactor actually boils and turns into steam, which then turns a turbine generator to produce electricity. In both types of plants, the steam is turned back into water and reused.

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. See Glossary for typical PWR and BWR designs. Although commercial U.S. reactors have many similarities, each one is considered unique (see Figure 12. U.S. Operating Commercial Nuclear Power Reactors).

Figure 11. 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+
0 States	16 States	8 States	4 States	2 States

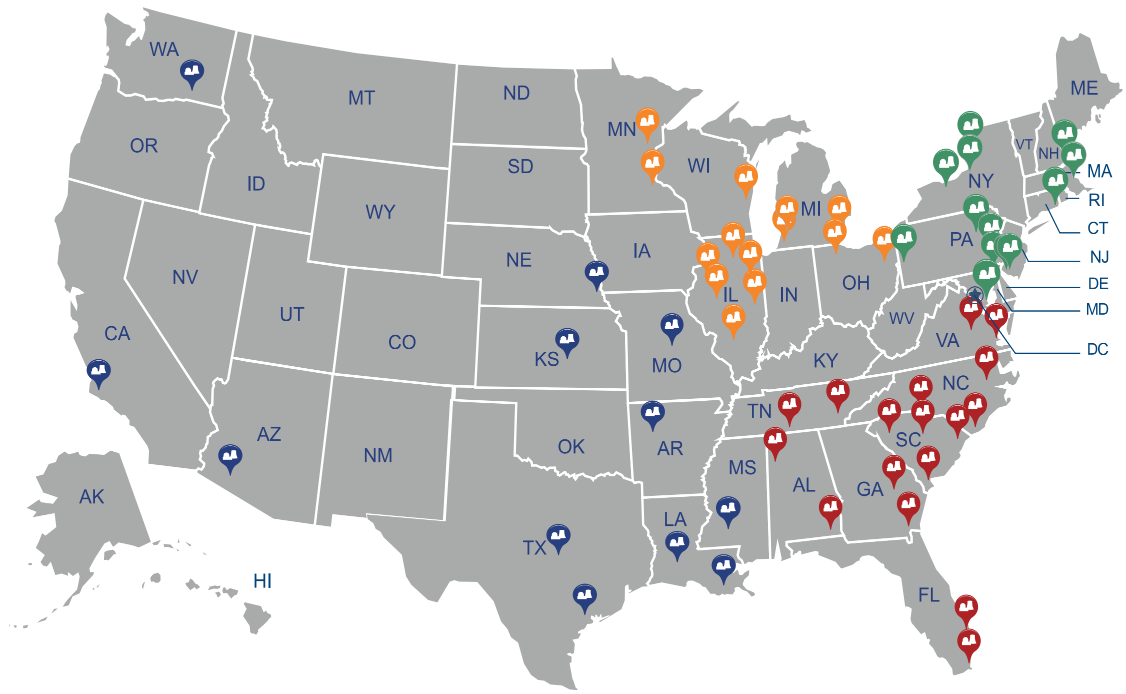
Total Nuclear Power Generated by State (in megawatt-hours)

State	Total Nuclear Generated	% of Nuclear Electricity
Illinois	98,735,488	53%
Pennsylvania	83,229,652	36%
S. Carolina	56,103,043	56%
New York	44,865,018	34%
Alabama	43,656,862	30%
N. Carolina	41,915,605	32%
Texas	41,298,007	8%
Tennessee	35,720,405	43%
Georgia	33,591,181	26%
Michigan	32,909,275	28%
Arizona	31,920,368	28%
Virginia	29,497,516	30%
Florida	29,108,066	12%
New Jersey	26,637,324	37%
Ohio	17,010,561	14%

State	Total Nuclear Generated	% of Nuclear Electricity
California	16,165,384	8%
Connecticut	16,733,398	42%
Maryland	15,012,922	38%
Minnesota	14,104,547	24%
Louisiana	13,981,335	14%
Arkansas	13,574,947	21%
Mississippi	11,032,514	17%
New Hampshire	10,906,923	60%
Wisconsin	10,030,305	16%
Kansas	9,247,734	18%
Missouri	9,189,863	12%
Washington	8,866,499	8%
Nebraska	6,951,600	19%
Iowa	5,235,716	8%
Massachusetts	2,177,204	10%

Source: DOE/EIA, State Historical Tables for 2019, Released September 2020, Revised February 2021, https://eia.gov/state.

Figure 12. U.S. Operating Commercial Nuclear Power Reactors



REGION I

CONNECTICUT
- Millstone 2 and 3

MARYLAND
- Calvert Cliffs 1 and 2

NEW HAMPSHIRE
- Seabrook

NEW JERSEY
- Hope Creek
- Salem 1 and 2

NEW YORK
- FitzPatrick
- Ginna
- 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

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
- 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

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

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

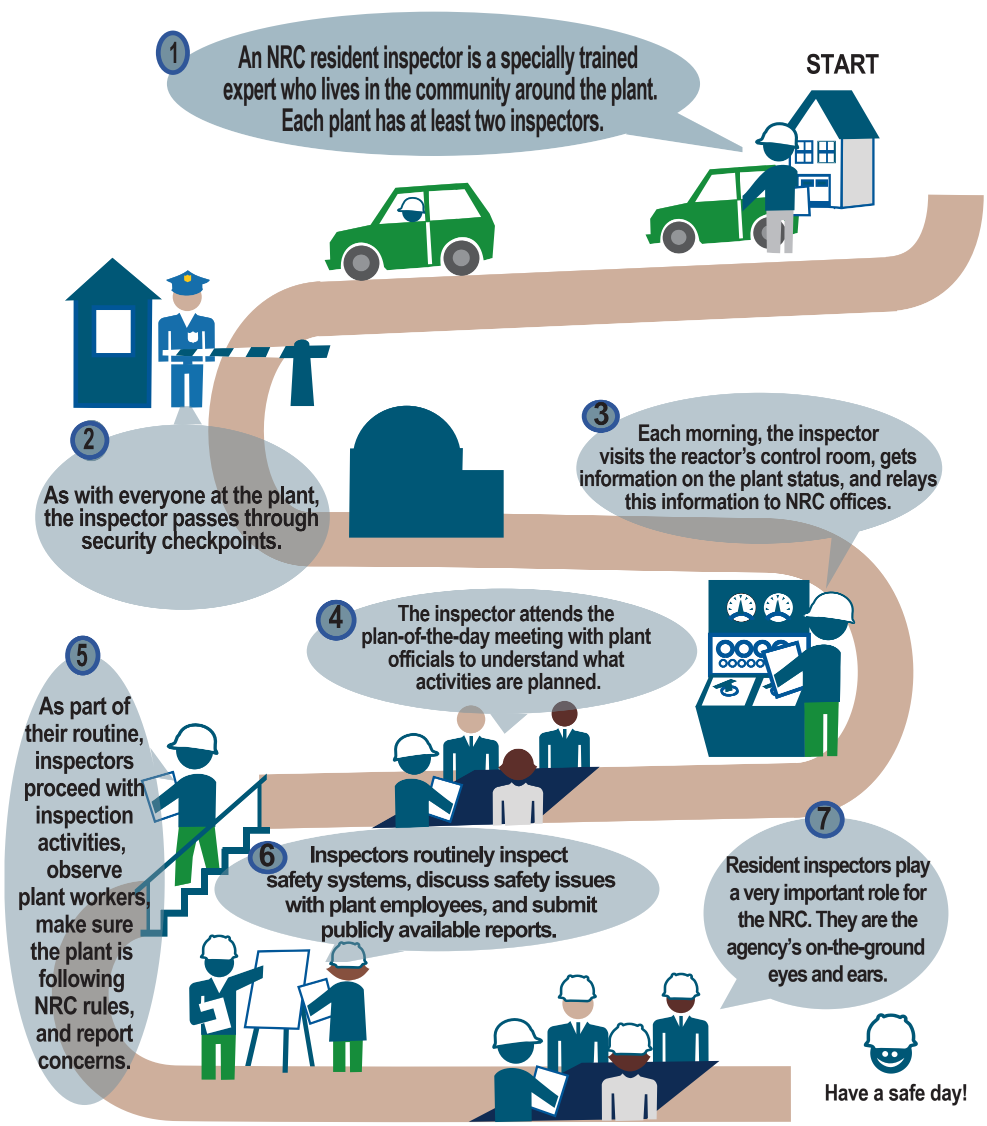
Note: NRC-abbreviated reactor names are listed. Data are current as of June 2021. For the most recent information, go to the NRC facility locator page at https://www.nrc.gov/info-finder/reactors/index.html.

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 personnel are referred to as "resident inspectors." Each plant has at least two resident inspectors, and their work is at the core of the agency's reactor inspection program. These highly trained and qualified professionals scrutinize activities at the plants and verify adherence to Federal safety requirements. The inspectors visit the control room and review operator logbook entries, visually assess areas of the plant, observe tests of (or repairs to) important systems or components, interact with plant employees, and check 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 they 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 13. Day in the Life of an NRC Resident Inspector).

Figure 13. Day in the Life of an NRC Resident Inspector



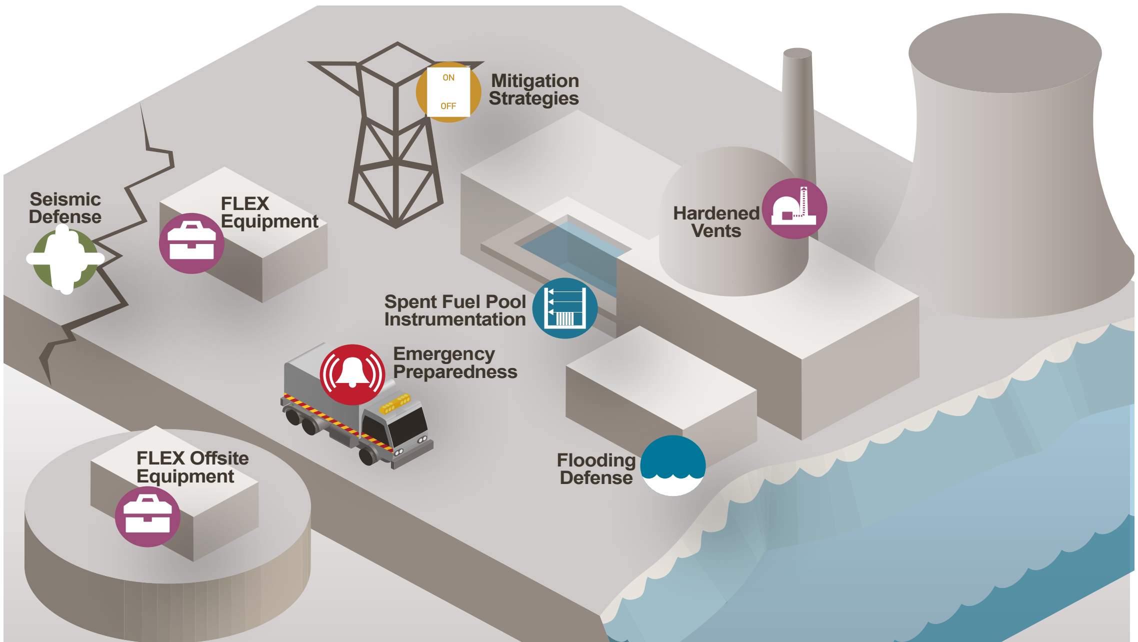
YouTube Learn more about resident inspectors. Watch the videos on the NRC YouTube Channel at https://www.youtube.com/user/NRCgov.

Post-Fukushima Safety Enhancements

On March 11, 2011, a 9.0-magnitude earthquake, followed by a 45-foot (13.7-meter) tsunami, heavily damaged the nuclear power reactors at Japan's Fukushima Dai-ichi facility. Following this accident, the NRC required significant enhancements to U.S. commercial nuclear power plants. At the front lines of this effort were the agency's resident inspectors and regional staff. They inspected and monitored U.S. reactors as the plants worked on these enhancements.

The enhancements included adding capabilities to maintain key plant safety functions following any kind of severe event, updating evaluations of potential impacts from seismic and flooding events, installing new equipment to better handle potential reactor core damage events, and strengthening emergency preparedness capabilities. These actions ensure the nuclear industry and the NRC are prepared for the unexpected. The NRC continues to inspect plants' efforts to ensure they have the required resources, plans, and training (see Figure 14. NRC Post-Fukushima Safety Enhancements and the Web Link Index).

Figure 14. NRC Post-Fukushima Safety Enhancements



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

Principal Licensing, Inspection, and Enforcement Activities

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

- *reviewing separate license change requests, called "amendments," from power reactor licensees*
- *performing inspections at each operating reactor site*
- *conducting initial reactor operator licensing examinations*
- *ensuring NRC-licensed reactor operators maintain their knowledge and skills current by passing rigorous requalification exams every 2 years and obtaining an NRC license renewal every 6 years*
- *reviewing applications for proposed new reactors*
- *inspecting construction activities*
- *reviewing operating experience items each year and sharing 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 safety and security regulations*

- *investigating allegations of inadequacy or impropriety associated with NRC-regulated activities*
- *incorporating independent advice from the Advisory Committee on Reactor Safeguards (ACRS), which holds both full committee meetings and subcommittee meetings each year to examine potential safety issues for existing or proposed reactors*

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 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 applies this information to assess the reactor's safety performance and security measures. Every 3 months, 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 15. 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," issued July 2016 (see Figure 16. Reactor Oversight Framework).

NRC Commissioner Jeff Baran observes the reactor vessel head inside Unit 4 containment, currently under construction at the Vogtle site in Georgia.

Figure 15. Reactor Oversight Action Matrix Performance Indicators

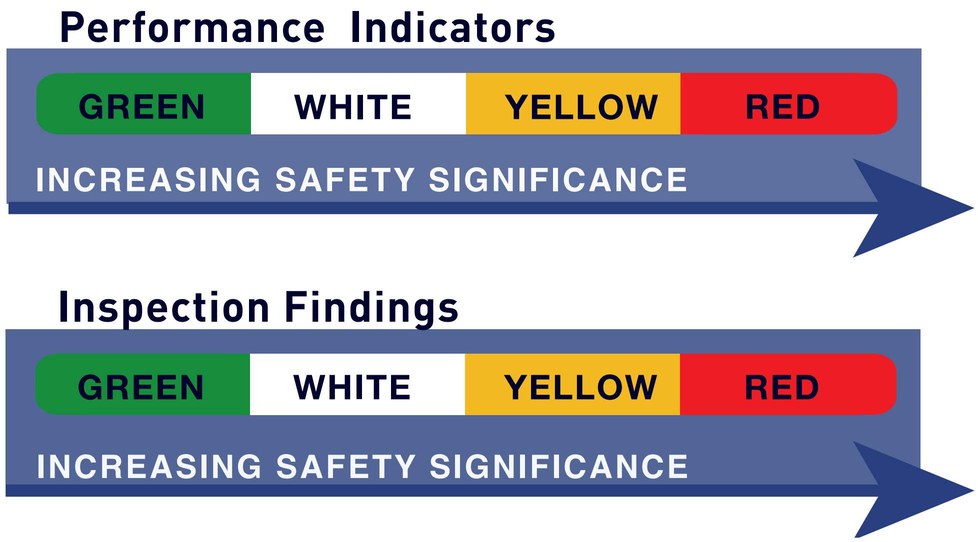
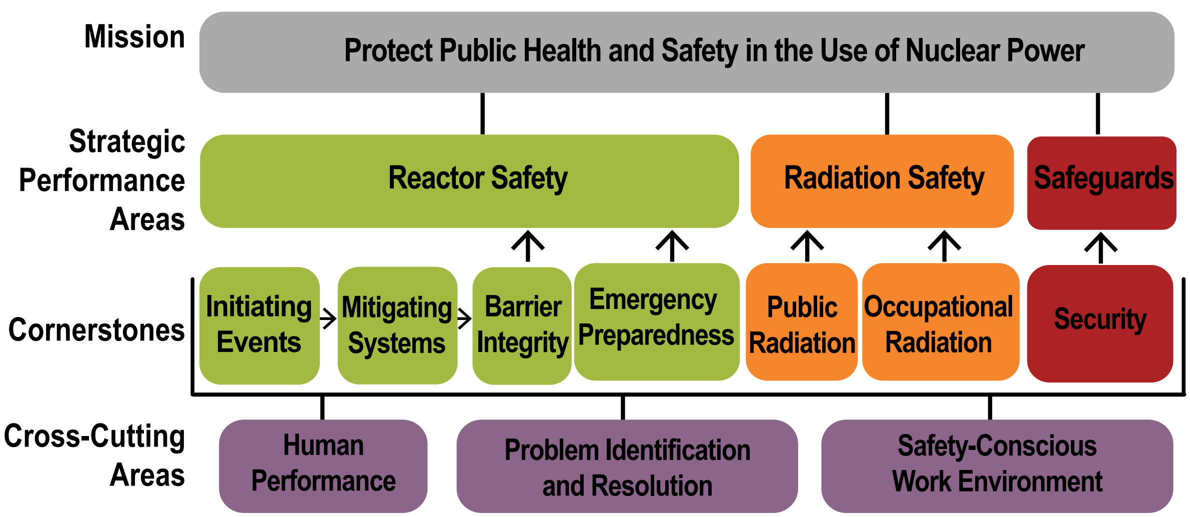


Figure 16. Reactor Oversight Framework



See Appendix C for a list of reactors undergoing decommissioning and permanently shutdowns; Appendix V for list of significant enforcement actions; and Appendices F and G for power reactor operating licenses issued and expiring by year.

APPENDIX

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 17. License Renewals Granted for Operating Nuclear Power Reactors). For current reactors grouped by how long they have operated, see Figure 18. U.S. Commercial Nuclear Power Reactors—Years of Operation by the End of 2020. 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 19. 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, Revision 1, issued June 2013) 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).

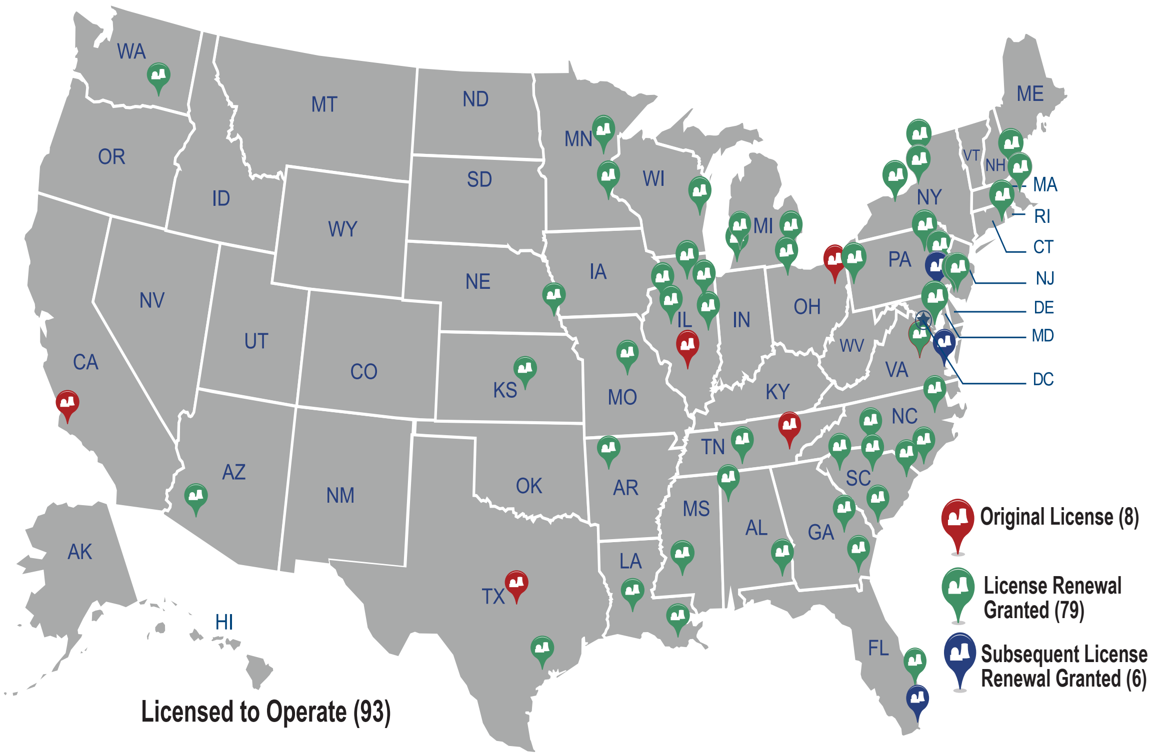
The Commission determined that the agency's existing regulations are adequate for subsequent license renewals. Nevertheless, the Commission asked the staff to develop new guidance to better help licensees develop aging management programs for the 60-year to 80-year period. The staff issued this guidance (NUREG-2191 and NUREG-2192) in July 2017.

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, holds public meetings, and publicly documents the results of its technical and environmental reviews. In addition, the ACRS reviews license renewal applications and discusses them at its meetings.

Individuals or groups can raise legal arguments against a license renewal application in an Atomic Safety and Licensing Board 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.)

Figure 17. License Renewals Granted for Operating Nuclear Power Reactors



Note: The NRC has issued a total of 94 initial license renewals: 9 of these units have permanently shut down.
Data are as of July 2021. For the most recent information, go to NRC Web page at *https://www.nrc.gov/info-finder.html*

Figure 18. U.S. Commercial Nuclear Power Reactors —Years of Operation by the End of 2020

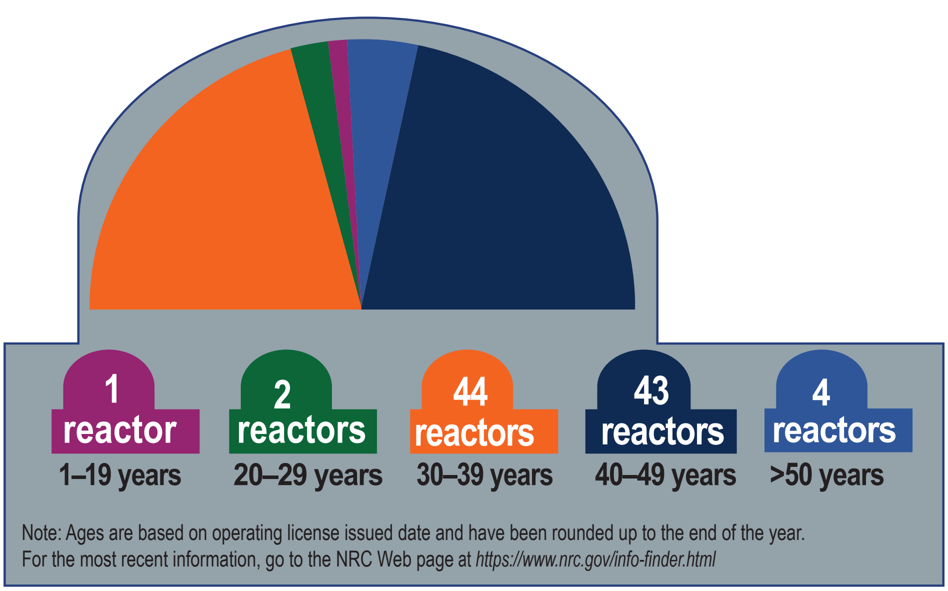
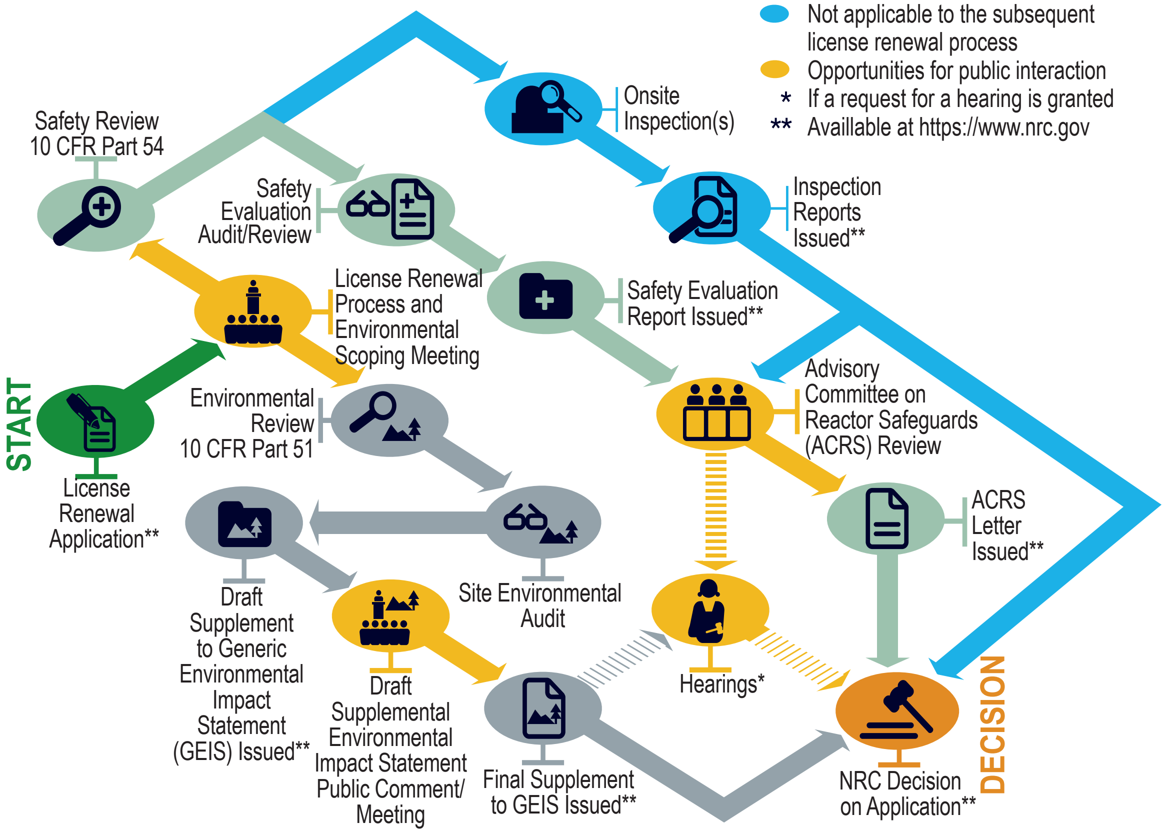


Figure 19. License Renewal Process



Turkey Point nuclear power plant in Florida was the first U.S. plant to be approved by the NRC for Subsequent License Renewal, or an additional 20 years of operation, for a total lifespan of 80 years.

NUCLEAR RESEARCH AND TEST REACTORS

Nuclear research and test reactors (RTRs), also called “nonpower” reactors, are a type of Nonpower Production and Utilization Facility (NPUF). RTRs 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 operates at 20 megawatts thermal (MWt) is approximately 80 times smaller than the smallest U.S. commercial power nuclear reactor (which operates at 1,677 MWt). The NRC regulates a wide variety of RTRs located across the country (see Figure 20. Size Comparison of Commercial and Research Reactors and Figure 21. U.S. Nuclear Research and Test Reactors). DOE also uses nonpower nuclear research reactors, but they are not regulated by the NRC.

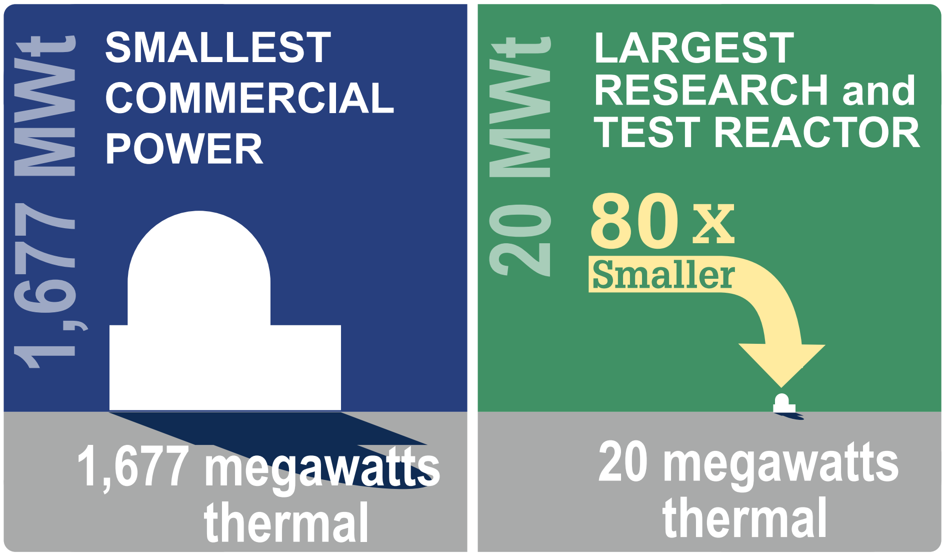
NRC inspectors visit each RTR facility about once a year to provide varying levels of oversight. RTRs licensed to operate at 2 MWt or more receive a full NRC inspection every year. Those licensed to operate at less than 2 MWt receive a full inspection every 2 years.

Principal Licensing and Inspection Activities

The NRC’s RTR licensing and inspection activities include:

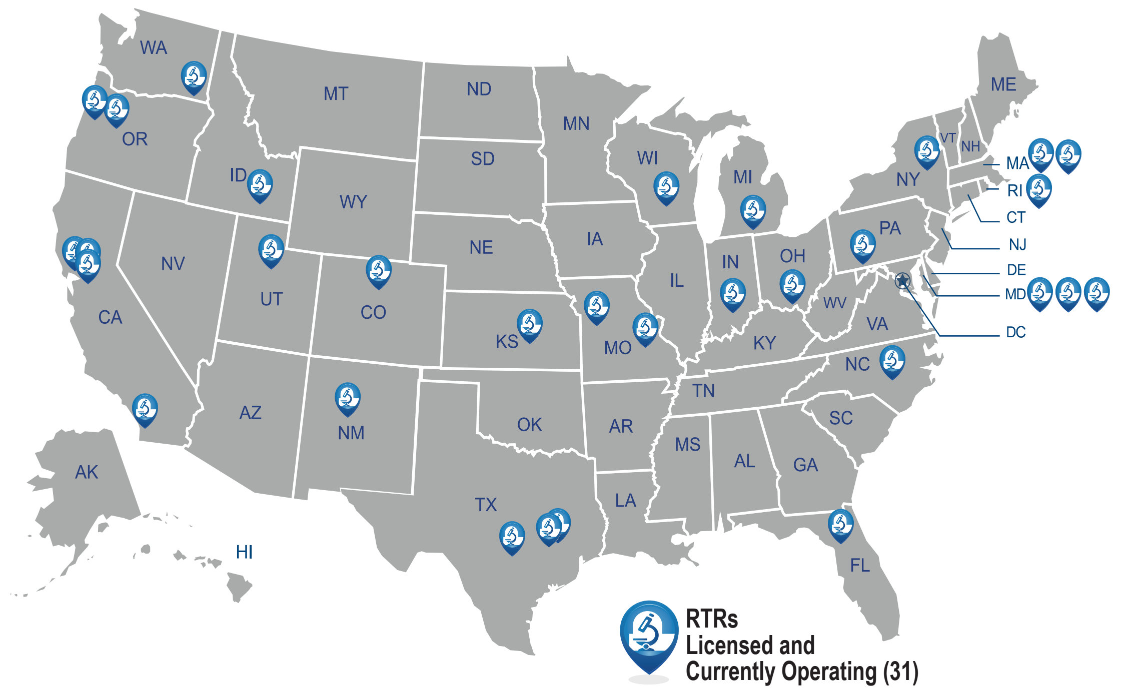
- *licensing new and current operating sites, including license renewals and license amendments*
- *overseeing decommissioning*
- *licensing operators*
- *overseeing operator relicensing programs*
- *conducting inspections each year, based on inspection frequency and procedures for operating RTRs*
-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

Figure 20. Size Comparison of Commercial and Research Reactors



For the most recent information, go to NRC Web page at *https://www.nrc.gov/info-finder.html*

Figure 21. U.S. Nuclear Research and Test Reactors



Note: RTRs are also referred to as "nonpower facilities." For the most recent information, go to NRC Web page at *https://www.nrc.gov/info-finder.html*

APPENDIX

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

NEW COMMERCIAL NUCLEAR POWER REACTOR LICENSING

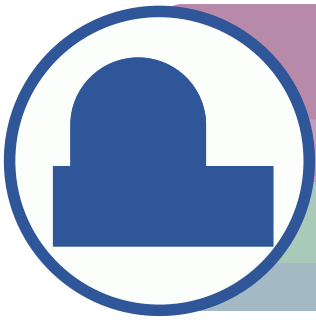
New reactors are any reactors proposed in addition to the current fleet of operating reactors (see Figure 22. The Different NRC Classifications for Types of Reactors).

The NRC's current review of new power reactor license applications improves on the process used through the 1990s (see Figure 23. 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 approvals, 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.

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.

Figure 22. 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 1,677 MWt (approximately 570 MWe) or higher.

Safety: These reactors have "active" safety systems powered by alternating current (ac) and require an operator to reach a safe shutdown state.

Fuel: These reactors require enriched uranium.

Advanced Reactors

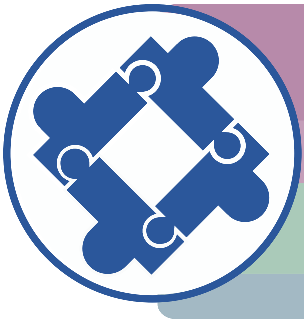
Design: Advanced reactors are a new generation of nonlight-water reactors.They use coolants including molten salts, liquid metals, and even gases such as helium.

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



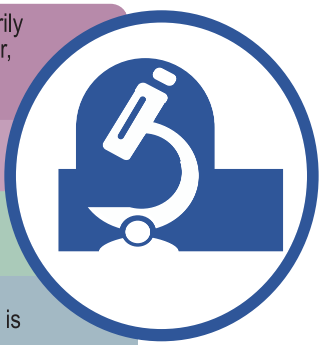
Design: Small modular reactors (SMRs) are similar to large light-water reactors but are smaller, compact designs. These factory-fabricated reactors can be transported by truck or rail to a nuclear power site. Additional SMRs can be installed on site to scale or to meet increased energy needs.

Capacity: These reactors are about one-third the size of typical reactors with a 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 (H2O), heavy water (D2O), polyethylene, and graphite.

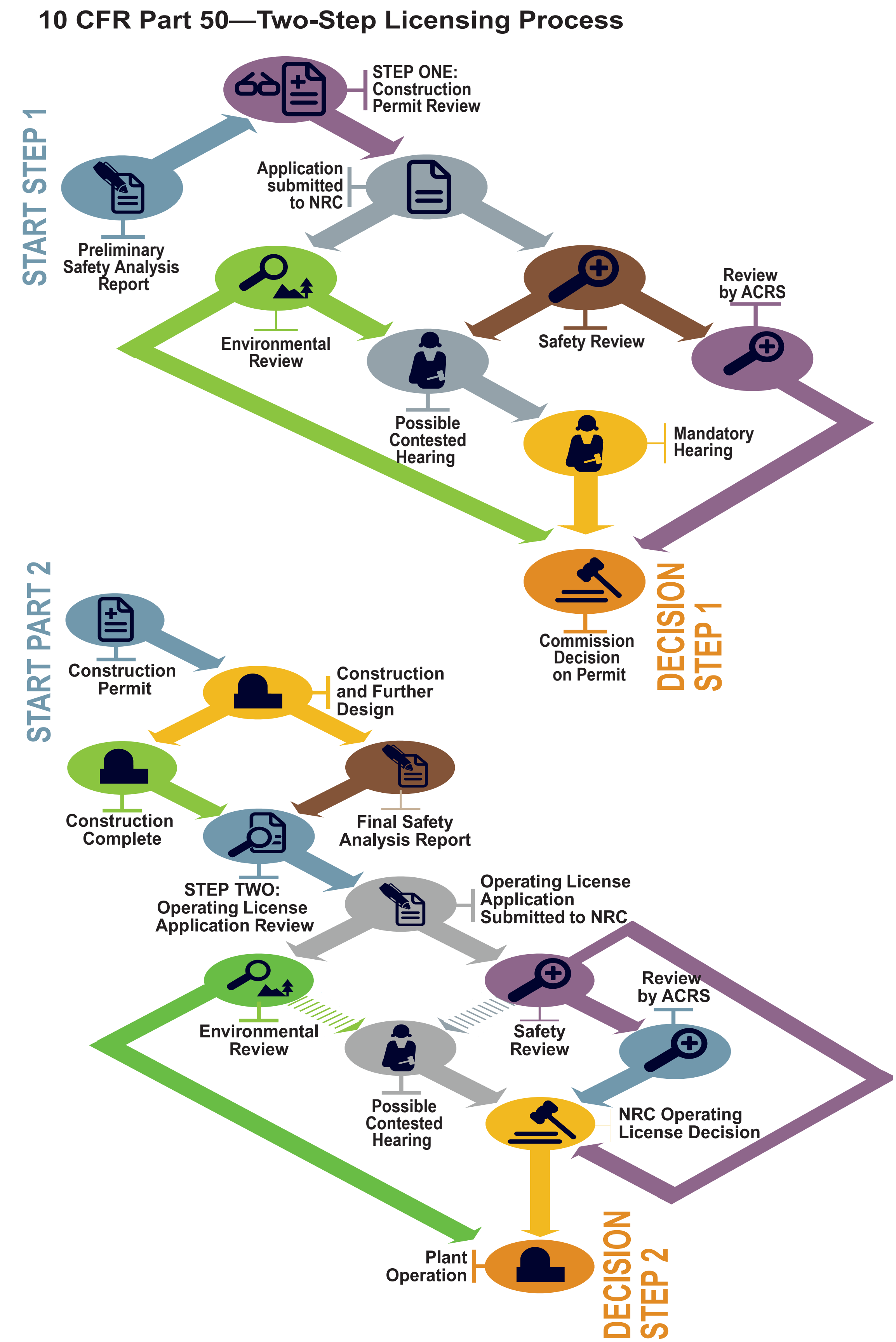
Capacity: These current licensed facilities range in size from 5 watts (less than a night light) to 20 MWt (equivalent to 20 standard medical x-ray machines).

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.

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

Figure 23. New Reactor Licensing Process



10 CFR Part 52—Combined License Application Review Process

Combined License Applications—Construction and Operating

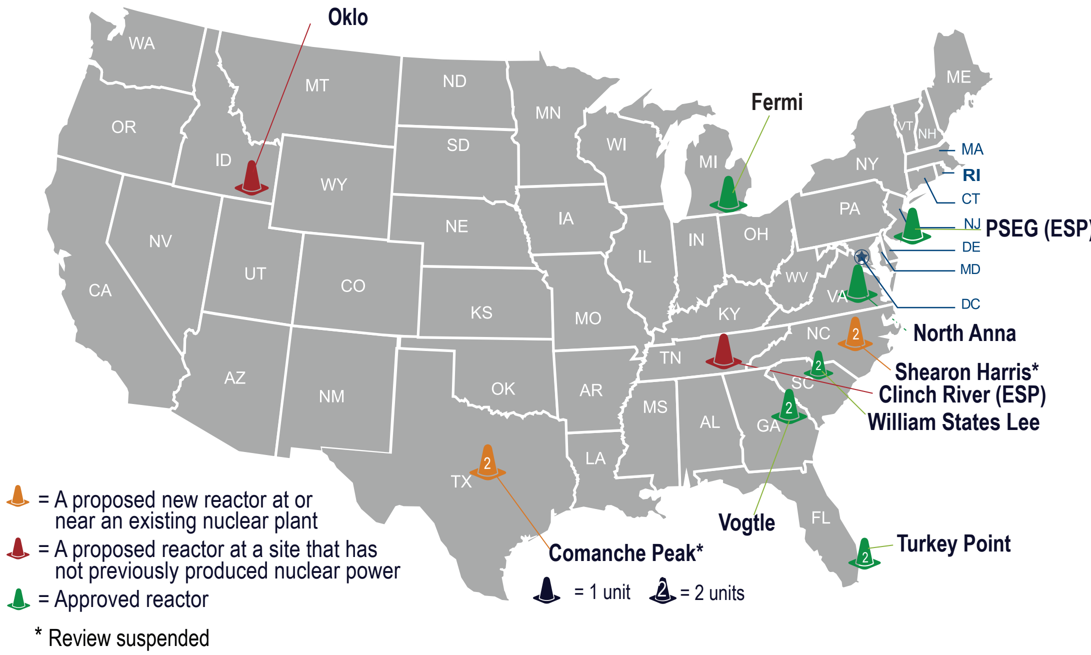
By issuing a COL, the NRC authorizes the licensee to construct and (with specified conditions) operate a nuclear power plant at a specific site, in accordance with established laws and regulations. If the Commission finds that the acceptance criteria are met, a COL is valid for 40 years. A COL can be renewed for additional 20-year terms (see Figure 24. 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).

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. 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 its 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 Atomic Safety and Licensing Board 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 news releases, in the *Federal Register,* and on its Web site.

Figure 24. Locations of New Nuclear Power Reactor Active Applications and Approved Licenses



Note: Alaska and Hawaii are not pictured, but have no sites. On July 31, 2017, South Carolina Electric and Gas announced its decision to cease construction on V.C. Summer 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 for South Texas Project Units 3 and 4 be withdrawn. NRC-abbreviated reactor names are listed. Data are current as of August 2021. For the most recent information, go to the NRC Web site at https://www.nrc.gov.

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 standard design certifications through rulemaking for reactor designs that meet basic requirements for ensuring safe operation. Utilities can cite a certified design when applying for a nuclear power plant construction permit, COL, ESP, or manufacturing license. The certification is valid for 15 years from the date issued and can be renewed for an additional 15 years. The NRC staff has also issued standard design approvals upon completion of the final SER for the design. Standard design approvals may be referenced by a construction permit, combined license, or manufacturing license. The new reactor designs under review incorporate new elements such as passive safety systems and simplified system designs. The six certified designs are—

- *GE-Hitachi Nuclear Energy's Advanced Boiling-Water Reactor (ABWR)*
- *Westinghouse Electric Company's System 80+*
- *Westinghouse Electric Company's AP600*
- *Westinghouse Electric Company's AP1000*
- *GE-Hitachi Economic Simplified Boiling-Water Reactor (ESBWR)*
- *Korean Electric Power Corporation APR 1400 (Advanced Power Reactor)*

Design Certification Renewals

The NRC staff has completed its review of GE-Hitachi's application to renew the ABWR design certification. The direct final rule renewing this design certification was published on July 1, 2021, and was effective September 29, 2021.

Advanced Reactor Designs

Several companies are considering advanced reactor designs and technologies and are conducting preapplication activities with the NRC. These reactors 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 (UO_2) 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. Each SMR module generates 300 megawatts electric (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 activities. 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 in NRC Region II's Division of Construction Oversight 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 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).

NRC senior leaders observe new construction activities to ensure NRC regulations are being met at Vogtle Units 3 and 4, in Georgia.

NEW LICENSING OF NONPOWER PRODUCTION AND UTILIZATION FACILITIES

Research reactors, testing facilities, and other nonpower facilities can be used to produce medical radioisotopes and demonstrate advanced reactor technologies. These research and test reactors are used to demonstrate new reactor technologies to meet future energy needs, promote training and education, and support needed medical care. To support these efforts, the NRC staff conducts safety and environmental reviews of construction permit and operating license applications, which are also subject to regulatory requirements for hearings and an independent review by the ACRS.

Doctors worldwide rely on a steady supply of molybdenum-99 (Mo-99) to produce technetium-99m in hospitals, which is used in a radiopharmaceutical applied 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 these facilities submitted in accordance with the provisions of 10 CFR Part 50. Since 2013, the NRC staff has received two construction permit applications and one operating license application for these facilities. The proposed facilities would irradiate low-enriched uranium targets in utilization facilities, then separate Mo-99 from other fission products in hot cells contained within a production facility. The NRC approved the construction permits for SHINE Medical Technologies, LLC (SHINE), in February 2016 and for Northwest Medical Isotopes, LLC, in May 2018. The staff is reviewing SHINE's application for a license to operate its facility.

The NRC is also engaged in pre-application topical report reviews for Atomic Alchemy and Abilene Christian University, which have proposed to construct nonpower reactors for radioisotope production and molten salt reactor technology demonstration, respectively.

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

The NRC continues to develop the 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 is produced by the decay of molybdenum-99 and is used in diagnostic nuclear medical imaging procedures

NUCLEAR REGULATORY RESEARCH

The NRC's Office of Nuclear Regulatory 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 the following:

- *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 reflects the challenges of an evolving industry. 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 advance 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 the following:

- *material performance (for example, environmentally assisted degradation and cracking of metallic alloys, aging management of reactor components and materials, boric-acid corrosion, radiation effects on concrete, 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, accident tolerant fuel, and advanced control and automation*
- *experience gained from operating reactors*
- *digital instrumentation and controls, including 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, flooding, and high-wind 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).

NRC Research Funding

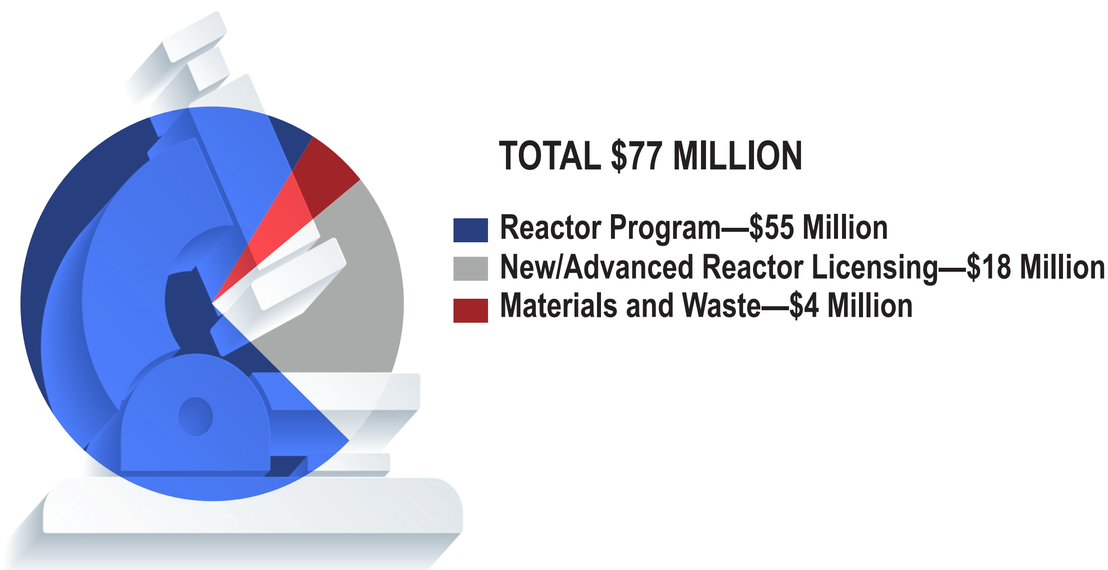
The NRC's research program involves about 5 percent of the agency's personnel and uses about 7 percent of its contracting funds. The NRC's $77 million research budget for Fiscal Year (FY) 2021 includes contracts with national laboratories, universities, research organizations, and other Federal agencies (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 25. NRC Research Funding, FY 2021, illustrates the primary areas of research.

The majority of the NRC's research budget supports maintaining operating reactor safety and security, while the remainder 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.

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 agency's leadership role in international organizations such as IAEA and OECD/NEA helps guide the agency's collaborations.

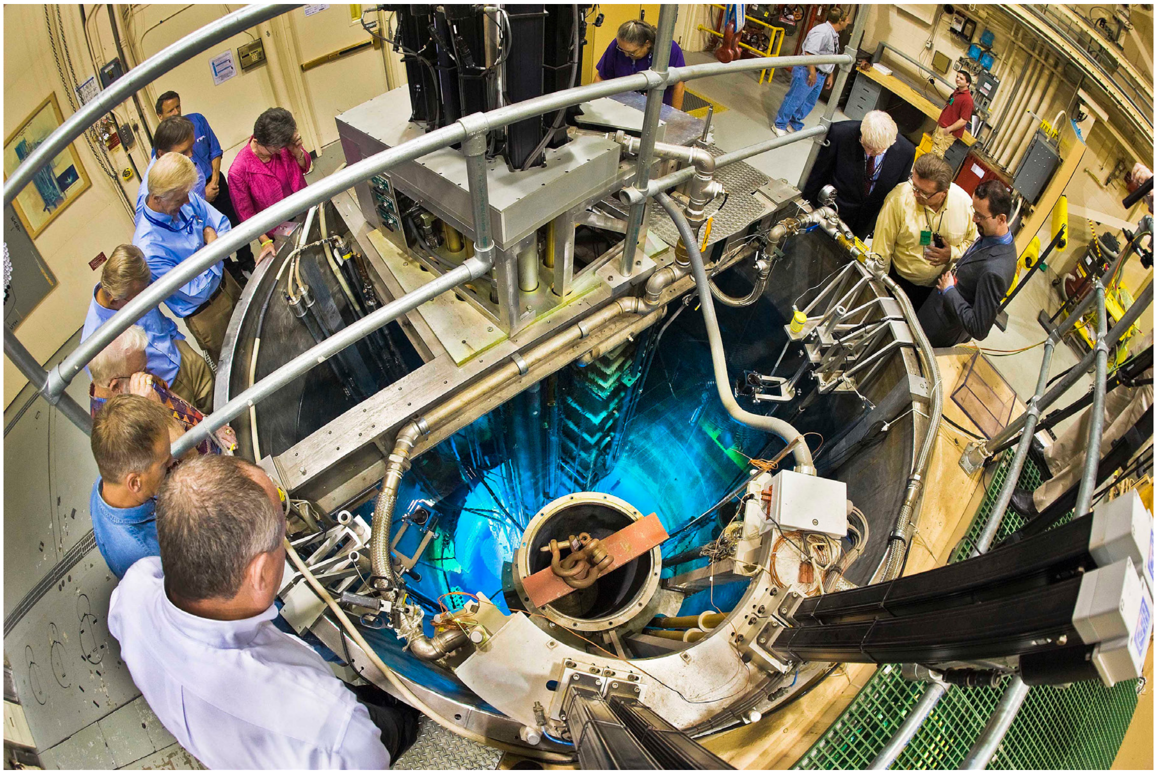
The NRC maintains international cooperative research agreements with more than two dozen foreign governments. This work covers technical areas from severe accident research and computer code development to materials degradation, nondestructive examination, fire risk, and human-factors research. Cooperation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

Figure 25. NRC Research Funding, Fiscal Year 2021

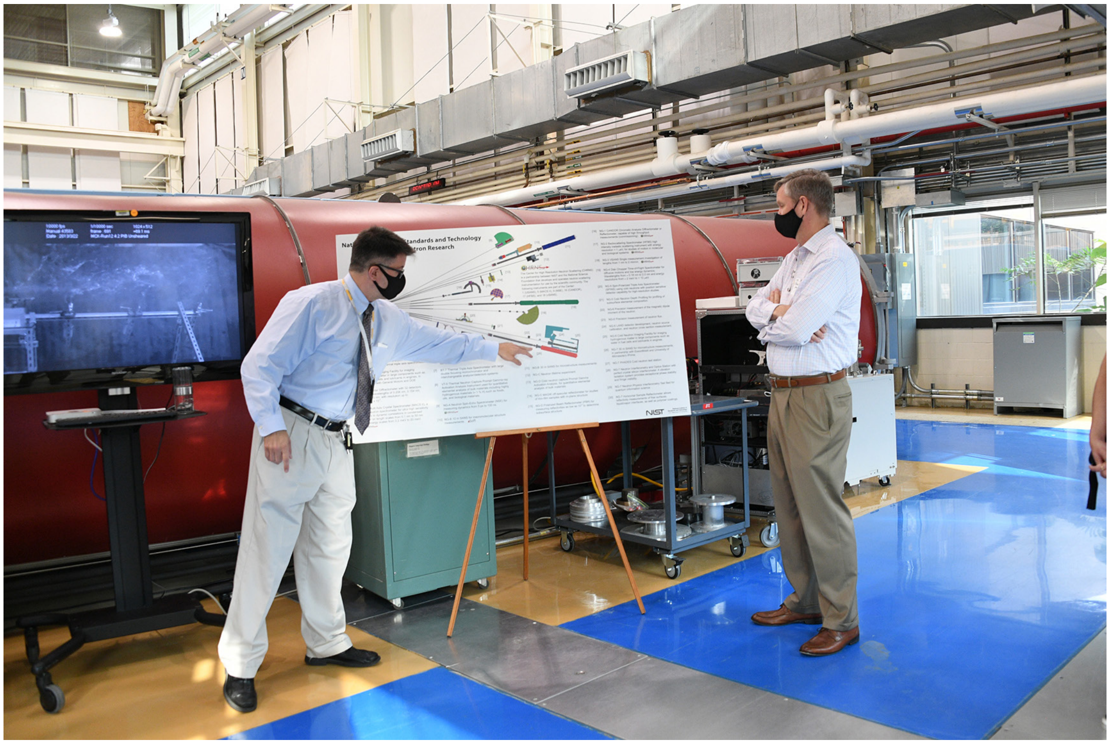


APPENDIX

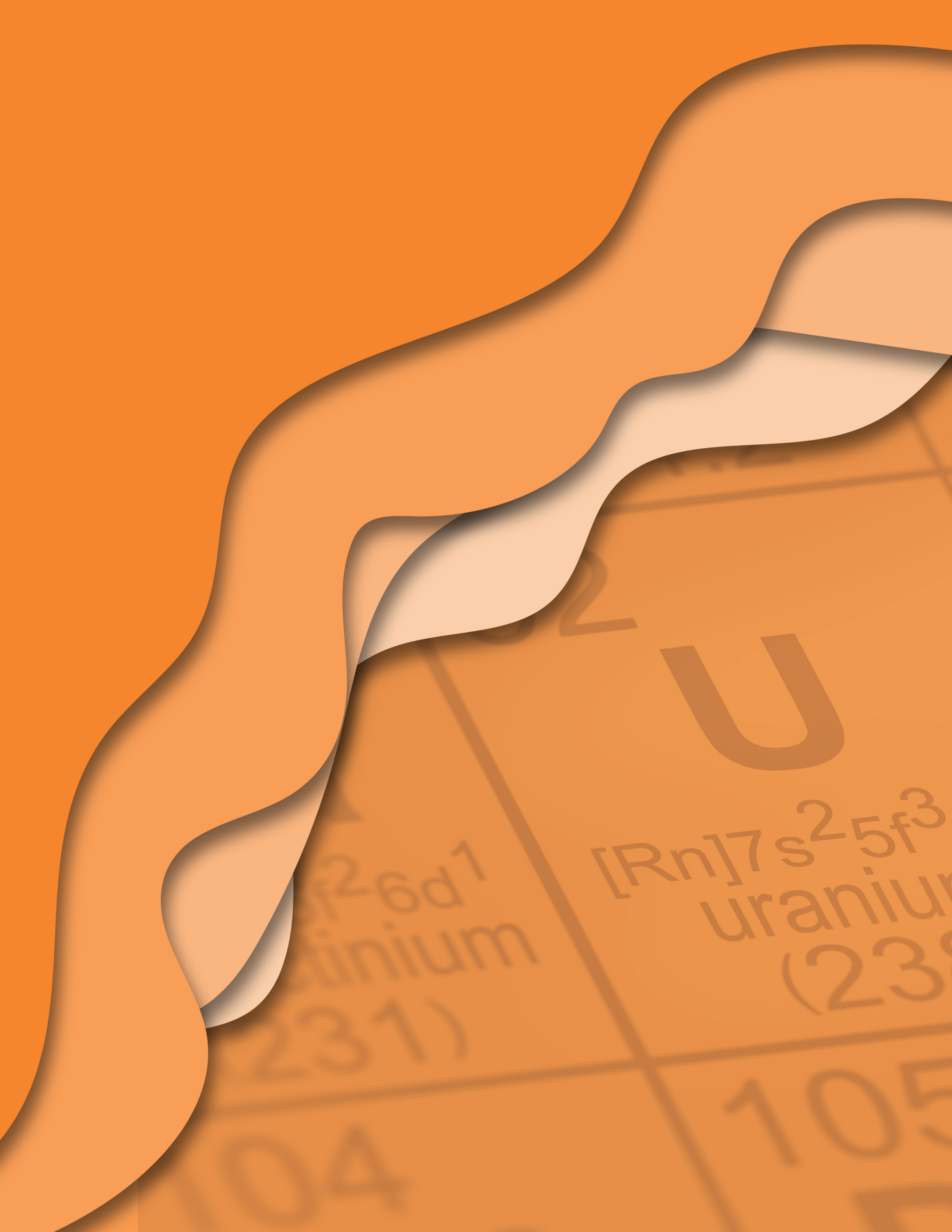
See Appendix U for States with NRC Grant Award Recipients in Fiscal Year 2020



A group observes the Annular Core Research Reactor. The reactor has been in operation since 1979 at Sandia National Laboratories in New Mexico.



NRC Chairman Christopher T. Hanson tours the NIST Center for Neutron Research in Maryland, learning about some of the research conducted using the largest NRC-regulated nonpower reactor in the U.S.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4
NUCLEAR MATERIALS

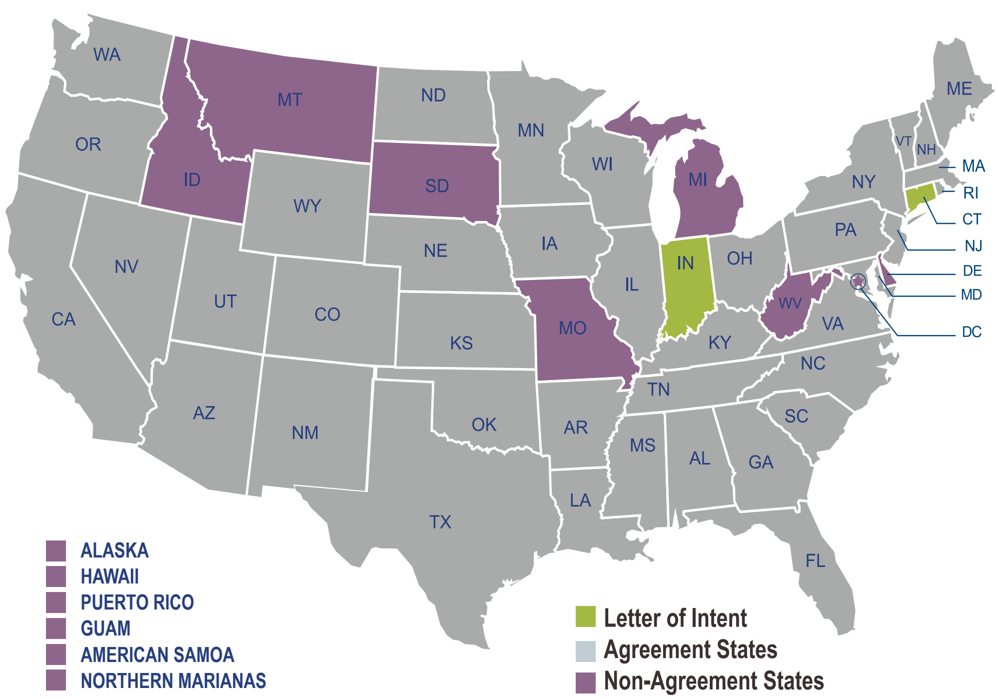
The NRC regulates each phase of the nuclear fuel cycle—the steps needed to turn uranium ore into fuel for nuclear power plants—as well as storing and disposing of the fuel after it is used in a reactor. In some States, the NRC also regulates nuclear materials used for medical, industrial, and academic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

MATERIALS LICENSES

States have the option to regulate certain radioactive materials under agreements with the NRC. Those that do are called “Agreement States” (see Figure 26. U.S. Agreement States). These Agreement States then develop regulations consistent with the NRC’s and appoint officials to ensure nuclear materials are used safely and securely. 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 26. U.S. Agreement States



Note: Data are current as of June 2021. For the most recent information, go to the NRC facility locator page https://www.nrc.gov/info-finder/reactors/index.html.

APPENDIX

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

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 it does not regulate x-ray machines or other devices that produce radiation without using radioactive materials.

Medical

The NRC and Agreement States license hospitals, physicians, veterinarians, health physicists, and radiopharmacists 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 Advisory Committee on the Medical Uses of Isotopes advises the NRC staff on policy and technical issues that arise in the regulation of the medical uses of radioactive material in diagnosis and therapy. 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.

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:

- *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.*
- *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 (2.54 centimeters) from the target area.*
- *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 and the Agreement States issue 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. For example, gas chromatography devices are used to analyze air pollutants, blood alcohol content, essential oils, and food products. They are also 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 within 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 materials at construction sites. Gauges may be fixed or portable.

A 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 density, flow rate, level, thickness, 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 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 is a portable device 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.

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, or an electron beam.

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 when not in use. 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.

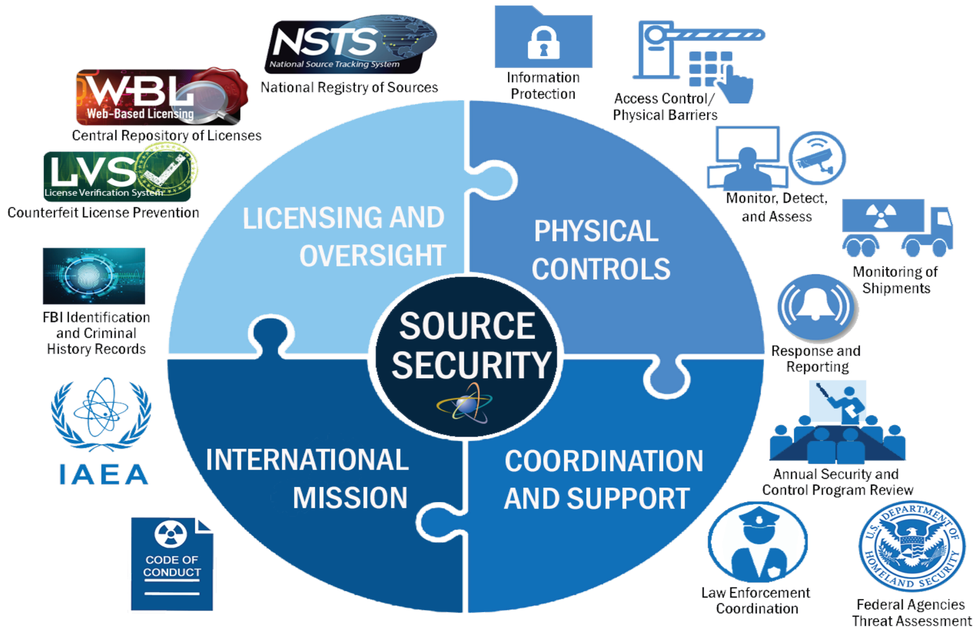
MATERIALS SECURITY

To monitor the manufacture, distribution, and possession of the most high-risk sources, the NRC set up the National Source Tracking System (NSTS) in January 2009. 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.

Licensees use this secure Web-based system to enter information on the receipt or transfer of tracked radioactive sources (see Figure 27. NRC Approach to Source Security). The NRC and the Agreement States use the system to monitor where high-risk sources are made, shipped, and used.

The NRC and the Agreement States have increased controls on the most safety-significant 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.

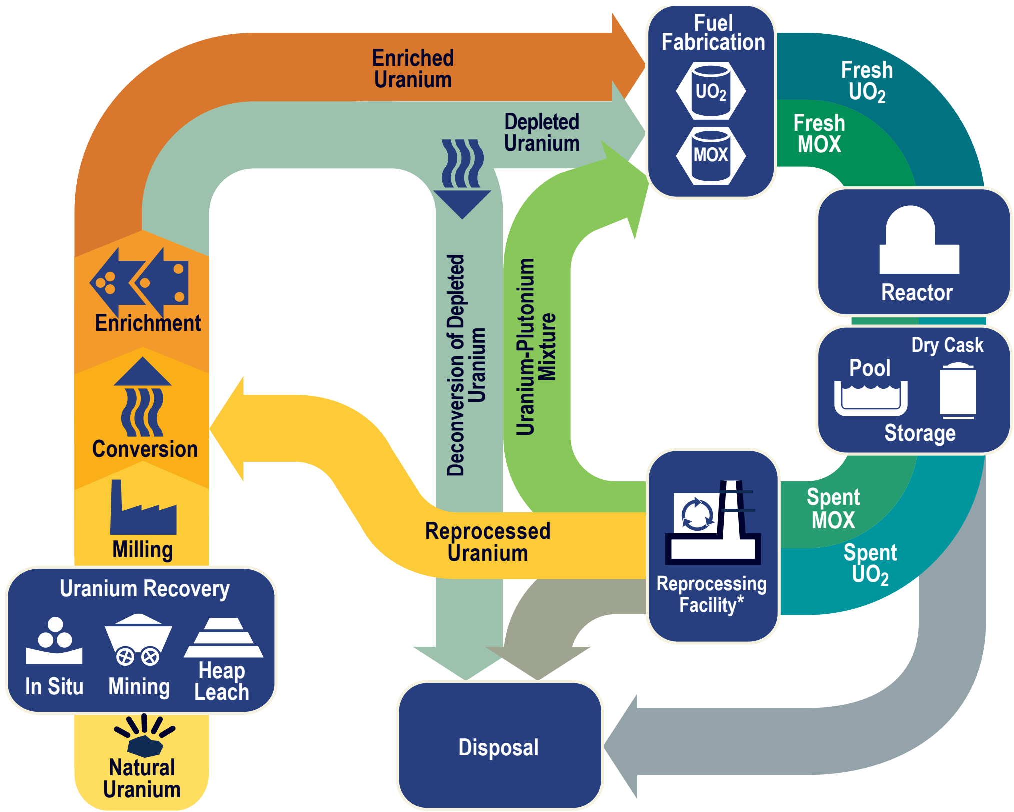
Figure 27. NRC Approach to Source Security



NUCLEAR FUEL CYCLE

The typical nuclear fuel cycle uses uranium in different chemical and physical forms. Figure 28. The Nuclear Fuel Cycle illustrates the stages, which include uranium recovery, conversion, enrichment, and fabrication, to produce fuel for nuclear reactors. Uranium is recovered or extracted from ore, converted, and enriched. Then the enriched uranium is manufactured into pellets, which are placed into fuel assemblies to power nuclear reactors.

Figure 28. 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.

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 the milling is completed, 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.

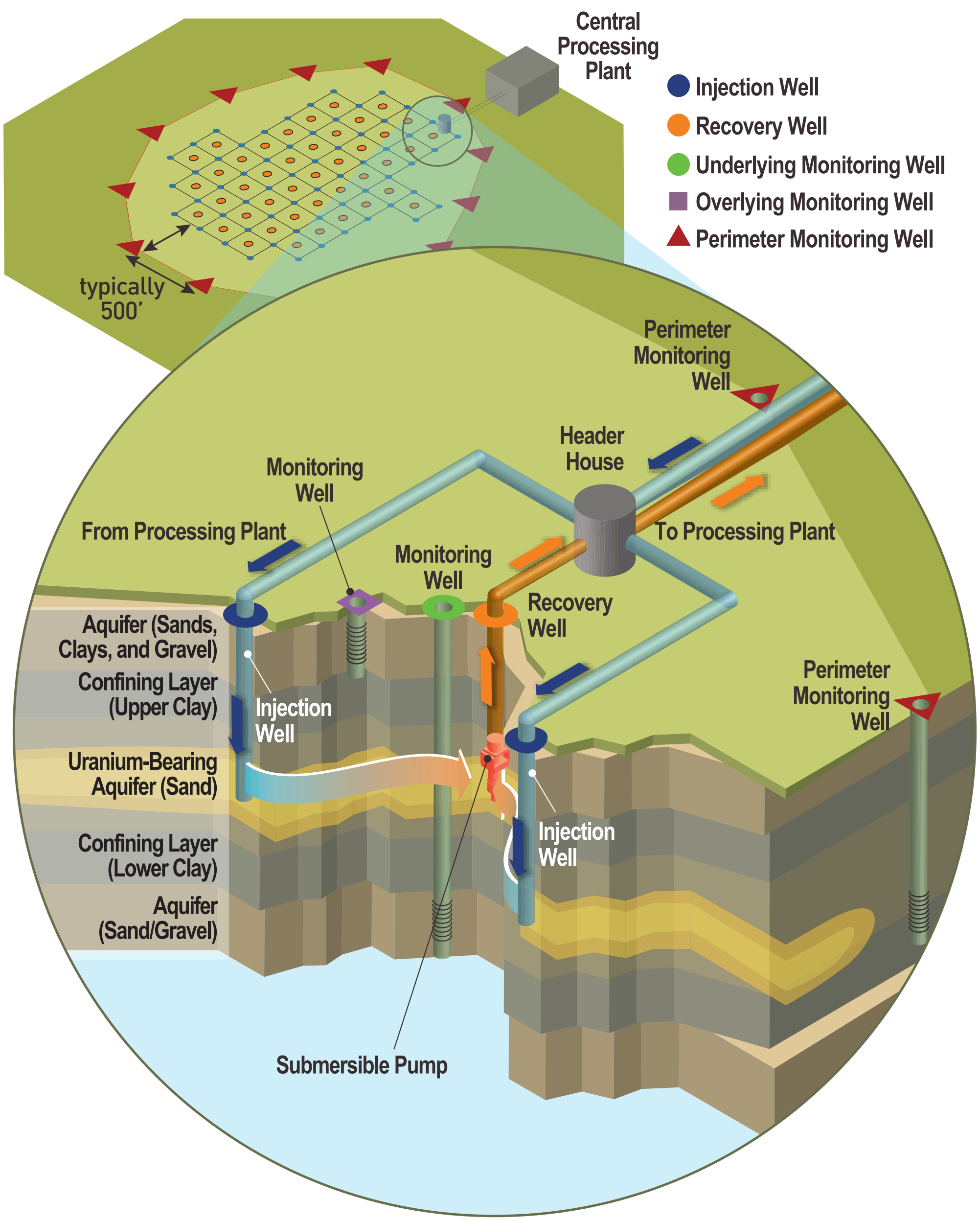
Conventional Uranium Mill

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 this process, a solution of 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 29. The In Situ Uranium Recovery Process).

Figure 29. 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 or 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.

Heap Leach Facility

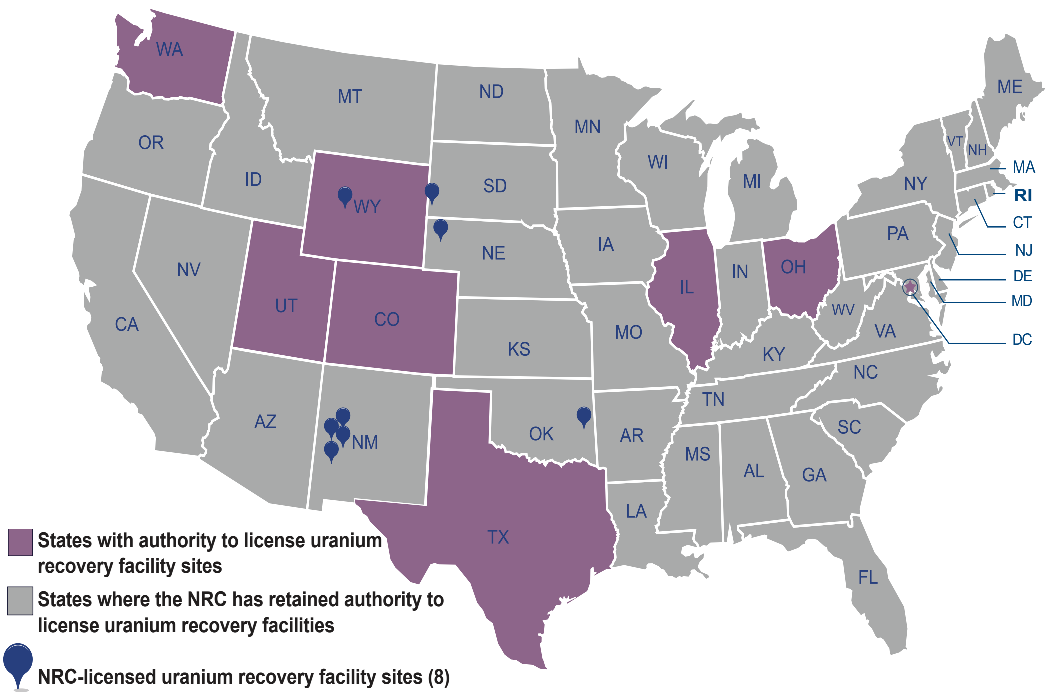
Heap leach facilities also extract uranium from ore. At these facilities, the ore is placed in piles or heaps on top of liners. The liners prevent uranium and other chemicals from moving into the ground. Sulfuric acid is dripped onto the heap and dissolves uranium as it moves through the ore. The uranium 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. There are no licensed uranium heap leach facilities in operation in the United States.

Licensing Uranium Recovery Facilities

The NRC currently regulates an in situ uranium recovery facility in Nebraska, which suspended operations in 2016. Two in situ recovery facilities, one in South Dakota and another in New Mexico, have been licensed but not constructed. Nine in situ recovery facilities are operating in Wyoming under State regulations, as Wyoming became an NRC Agreement State in 2018. The NRC considers the views of stakeholders, including Native American Tribal governments, to address their concerns with licensing new uranium recovery facilities. (See the Web Link Index for more information on uranium recovery and Agreement States. See the Glossary for the definition and an illustration of the heap leach recovery process.)

The NRC is also overseeing the decommissioning of five uranium recovery facilities: three in New Mexico, one in Oklahoma, and another in Wyoming that was not transferred to the State under its agreement with the NRC. See Figure 30. Locations of NRC-Licensed Uranium Recovery Facility Sites. See Glossary for information on mill tailings.

Figure 30. Locations of NRC-Licensed Uranium Recovery Facility Sites



Note: Alaska and Hawaii are not pictured here and do not have sites.
For the most recent information, go to the NRC facility locator page at https://www.nrc.gov/info-finder/reactors/index.html.

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*
- *ensuring licensees monitor ground water for contamination*
- *providing oversight of decommissioned uranium recovery facilities*

FUEL CYCLE FACILITIES

The NRC licenses all commercial fuel cycle facilities involved in conversion, enrichment, and fuel fabrication (see Figure 31. Locations of NRC-Licensed Fuel Cycle Facilities, and Figure 32. Simplified Fuel Fabrication Process).

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 UF_6 gas is then cooled back into solid UF_6 for shipment to a fuel fabrication facility.

Once at a fuel fabrication facility, the UF_6 is mechanically and chemically processed back into a solid 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.

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 these operations to ensure they are conducted safely.

Domestic Safeguards Program

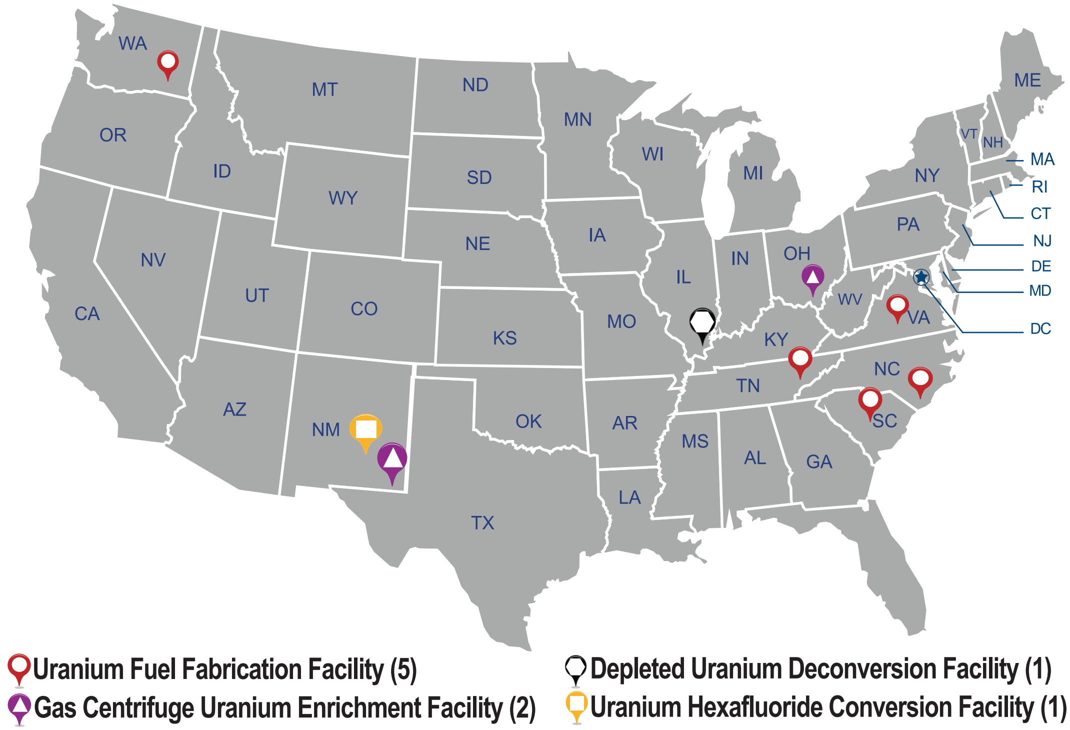
The NRC's domestic safeguards program for fuel cycle facilities and transportation is aimed at ensuring that special nuclear material (such as plutonium or enriched uranium) is not stolen and does not pose a risk to the public from sabotage or terrorism. Through licensing and inspections, the NRC verifies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

See Appendix M for major U.S. fuel cycle facility sites and Glossary for more information on the enrichment process.

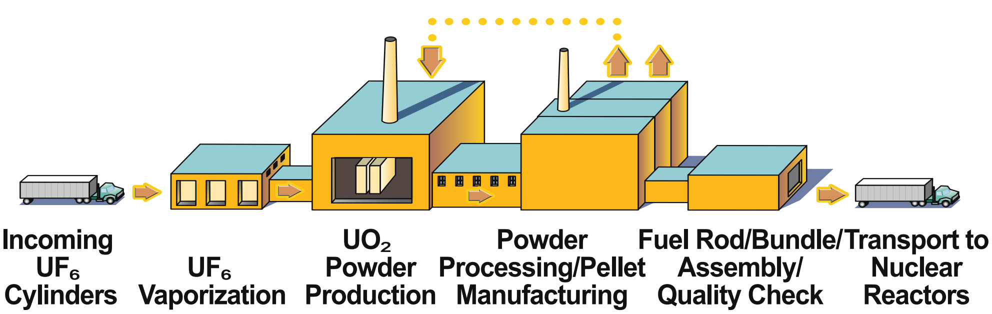
APPENDIX

Figure 31. Locations of NRC-Licensed Fuel Cycle Facilities



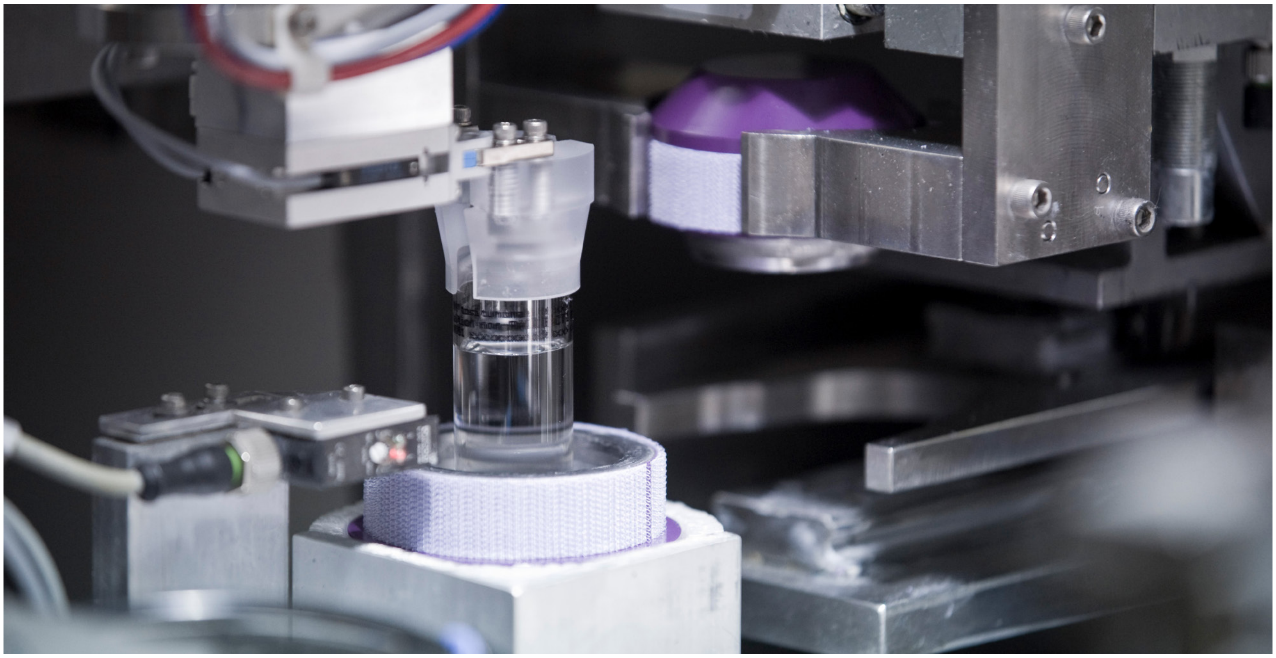
Note: Alaska and Hawaii are not pictured here and do not have sites. On January 5, 2021, the NRC issued a letter terminating the license for the GLE Laser Separation Enrichment Facility. For the most recent information, go to the NRC facility locator page at https://www.nrc.gov/info-finder/reactors/index.html.

Figure 32. Simplified Fuel Fabrication Process



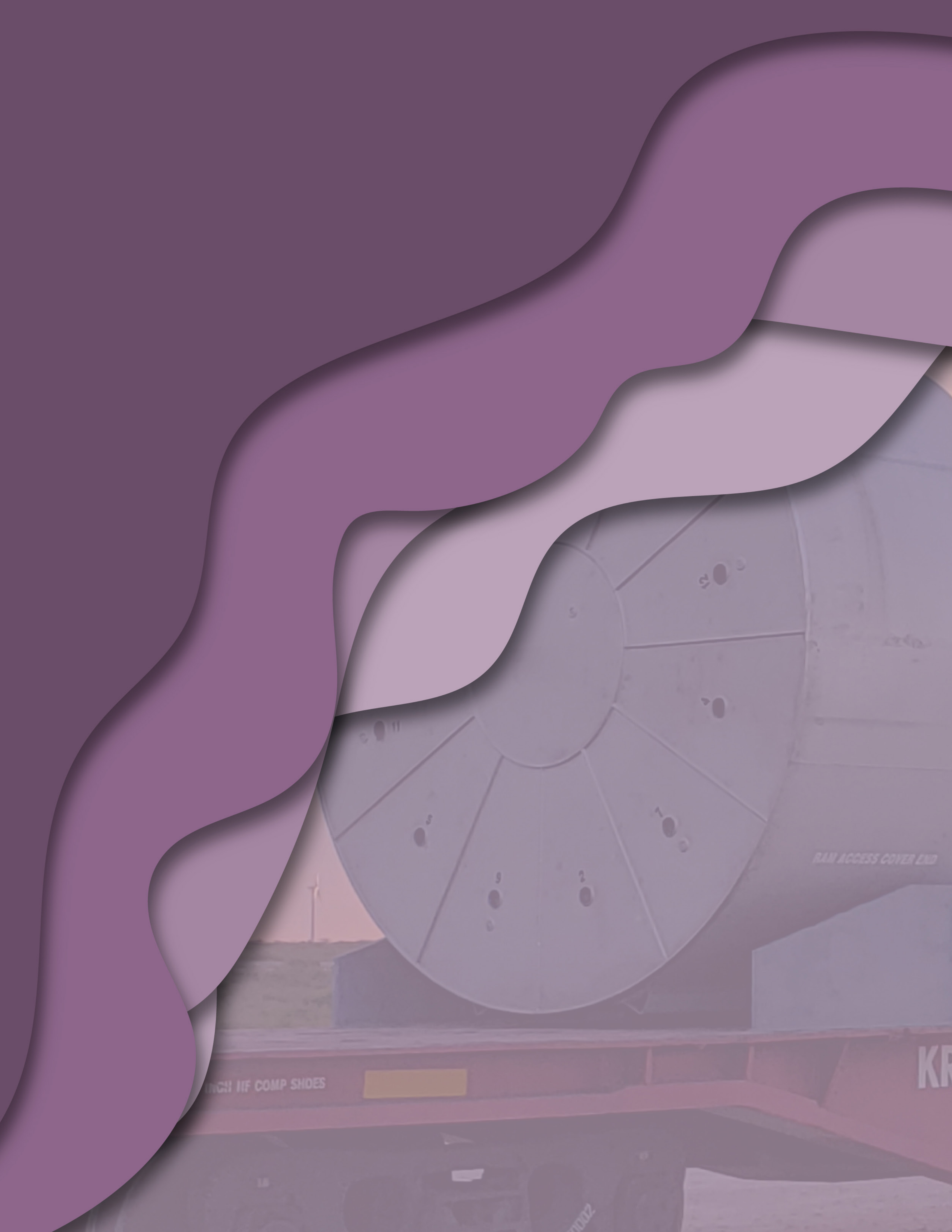
Fabrication of commercial light-water reactor fuel consists of the following three basic steps:

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**



A Bexxar Automated-Inspection unit placing a vial containing radiopharmaceutical into a lead pot. Courtesy of the Noridan Corporation.

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


RAM ACCESS COVER END

5 RADIOACTIVE WASTE

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 and State 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 33. Low-Level Radioactive Waste Disposal).

Determining the classification of waste can be 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," must be disposed of in a geological repository licensed by the NRC unless the Commission approves an alternative proposal. 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 vary 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.

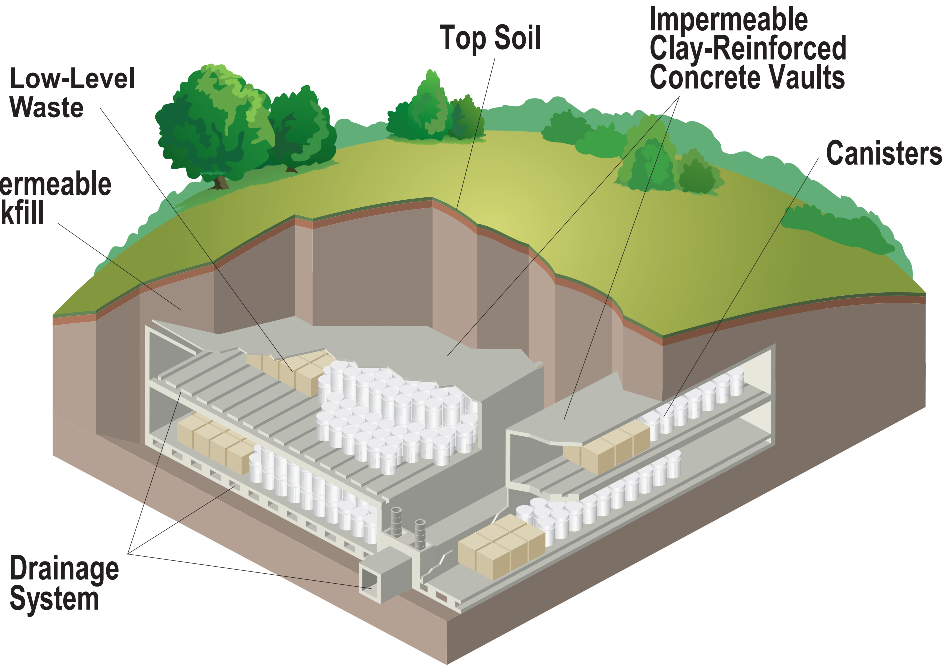
The Low-Level Radioactive Waste Policy Amendments Act gave the States responsibility for LLW disposal. The Act authorized States to do the following:

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

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 (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 States 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 Site—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 County, TX— Andrews accepts waste from the Texas Compact States (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.*

Figure 33. Low-Level Radioactive Waste Disposal



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

See Appendix P for regional compacts and closed LLW sites, Appendices N and O for information about dry spent fuel storage and licensees, and Glossary for information on fuel reprocessing (recycling).

APPENDIX

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, decommissioning or decommissioned reactors, and some other sites. 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.

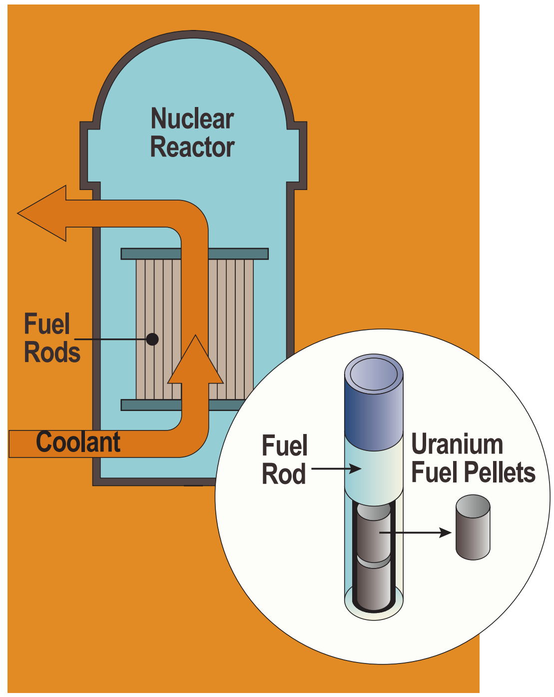
Most reactor facilities were not designed to store the full amount of spent fuel that the reactors would generate during their operational licenses. Originally planned to store spent fuel temporarily in deep pools of continuously circulating water, which cools the spent fuel assemblies. After a few years, they 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 Although the Government later lifted the restriction, reprocessing has not resumed in the United States.

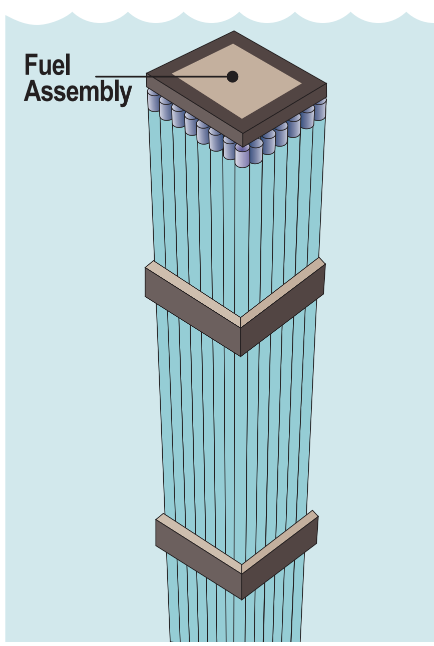
Facilities then expanded their storage capacity by using high-density storage racks in their spent fuel pools. For additional storage, some fuel assemblies are stored in dry casks on site (see Figure 34. Spent Fuel Generation and Storage after Use) in independent spent fuel storage installations (ISFSIs). These large casks are licensed by the NRC and 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 35. Dry Storage of Spent Nuclear Fuel). Another type of ISFSI is called a consolidated interim storage facility, which would store spent fuel from multiple commercial reactors, including those that have ceased operation, on an interim basis until a permanent disposal option is available. Additional information on consolidated interim storage is available on the NRC's Web site (see the Web Link Index).

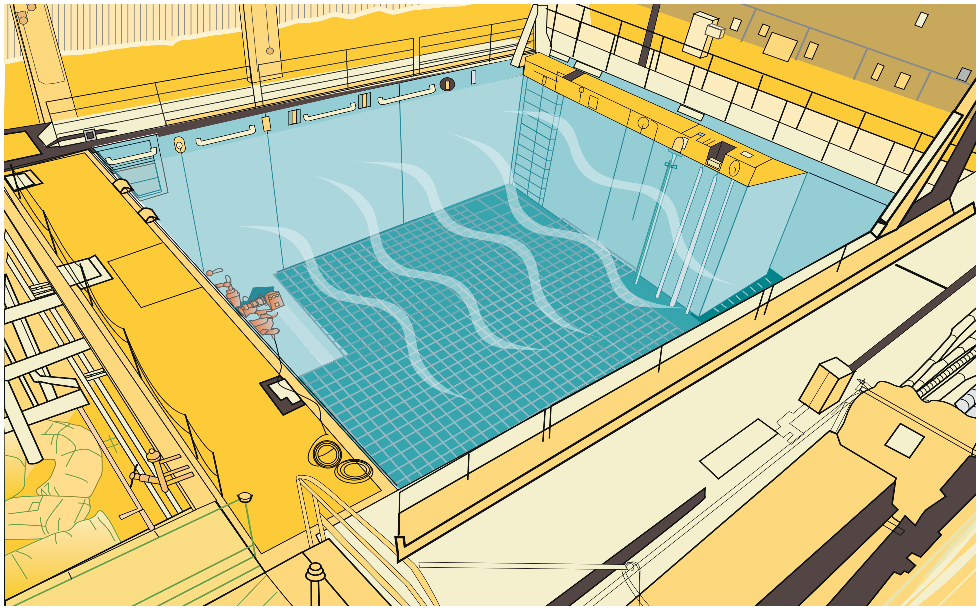
Figure 34. Spent Fuel Generation and Storage after Use

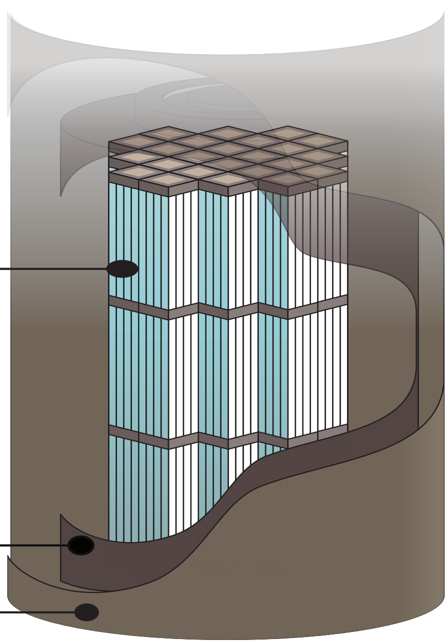
1 **A nuclear reactor is powered by enriched uranium-235 fuel. Fission (splitting of atoms) generates heat, which produces steam that turns turbines to produce electricity. A reactor rated at several hundred megawatts may contain 100 or more tons of fuel in the form of bullet-sized pellets loaded into 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.**





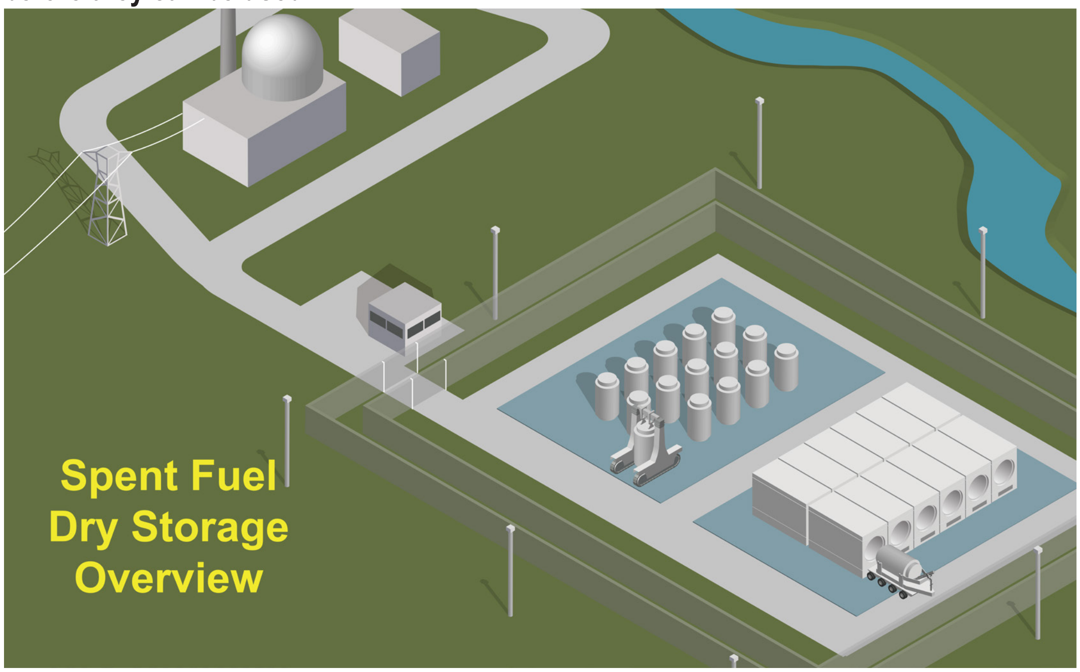
3 **Commercial light-water nuclear reactors store spent radioactive fuel in a steel-lined, seismically designed concrete pool under about 40 feet (12.2 meters) of water that provides shielding from radiation. Pumps supply continuously flowing water to cool the spent fuel. Extra water for the pool is 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 or transported off site for interim storage or disposal.**

The NRC regulates facilities that store spent fuel in two different ways, either through a specific or general license. Site-specific licenses are issued after a safety review of the technical requirements and operating conditions for an ISFSI.

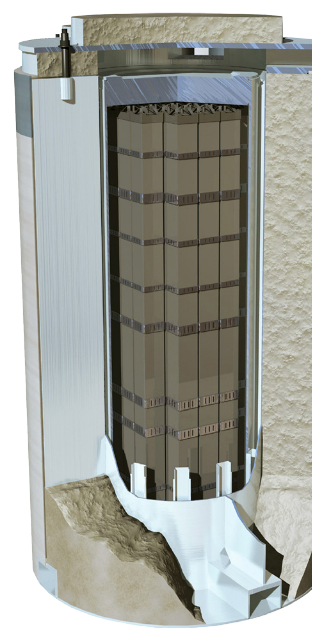
The agency has issued a general license authorizing nuclear power reactor licensees to store spent fuel on site in dry storage casks that the NRC has certified. Following a similar safety review, the NRC may issue a certificate of compliance and add the cask to a list of approved systems through a rulemaking. 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 36. Licensed and Operating Independent Spent Fuel Storage Installations by State).

Figure 35. 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.

Public Involvement

The public can participate in decisions about spent nuclear 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).

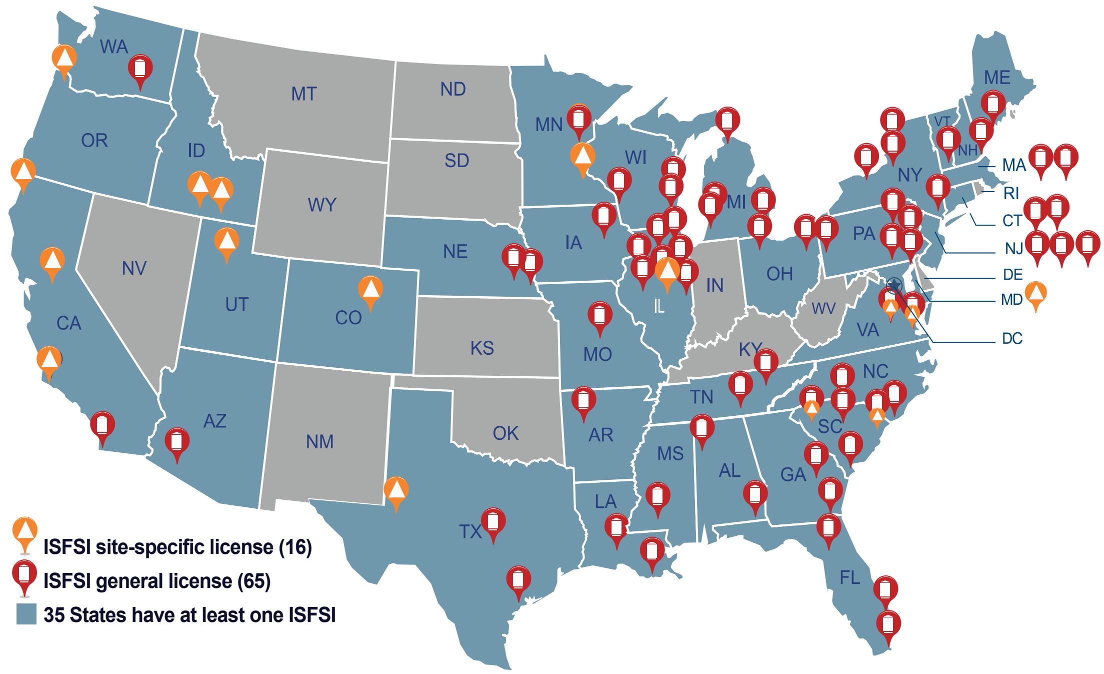
Spent Nuclear Fuel Disposal

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.

Massive containers hold spent nuclear fuel at safe and secure dry storage facilities. This photo shows, at right, dry cask recently loaded with spent fuel being lifted from a horizontal transporter to be placed vertically on a specially-designed storage pad. Courtesy of Sandia National Laboratories.

Figure 36. Licensed and Operating Independent Spent Fuel Storage Installations by State



ALABAMA
Browns Ferry
Farley

ARIZONA
Palo Verde

ARKANSAS
Arkansas Nuclear

CALIFORNIA
Diablo Canyon
Humboldt Bay
Rancho Seco
San Onofre

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
Dresden
GEH Morris (Wet)
LaSalle
Quad Cities
Zion

IOWA
Duane Arnold

LOUISIANA
River Bend
Waterford

MAINE
Maine Yankee

MARYLAND
Calvert Cliffs

MASSACHUSETTS
Pilgrim
Yankee Rowe

MICHIGAN
Big Rock Point
Cook
Fermi 2
Palisades

MINNESOTA
Monticello
Prairie Island

MISSISSIPPI
Grand Gulf

MISSOURI
Callaway

NEBRASKA
Cooper
Ft. Calhoun

NEW HAMPSHIRE
Seabrook

NEW JERSEY
Hope Creek
Oyster Creek
Salem

NEW YORK
FitzPatrick
Ginna
Indian Point
Nine Mile Point

NORTH CAROLINA
Brunswick
McGuire

OHIO
Davis-Besse
Perry

OREGON
Trojan

PENNSYLVANIA
Beaver Valley
Limerick
Peach Bottom
Susquehanna
Three Mile Island

SOUTH CAROLINA
Catawba
Oconee
Robinson
Summer

TENNESSEE
Sequoyah
Watts Bar

TEXAS
WCS Consolidated Interim Storage Facility (CISF)
Comanche Peak
South Texas Project

UTAH
Private Fuel Storage*

VERMONT
Vermont Yankee

VIRGINIA
North Anna
Surry

WASHINGTON
Columbia

WISCONSIN
Kewaunee
La Crosse
Point Beach

* Facility licensed only, never built or operated.

Note: Alaska and Hawaii are not pictured and have no sites. NRC-abbreviated reactor names are listed. Data are current as of Sept.13, 2021. For the most recent information, go to the NRC facility locator page at https://www.nrc.gov/info-finder/reactors/index.hml.

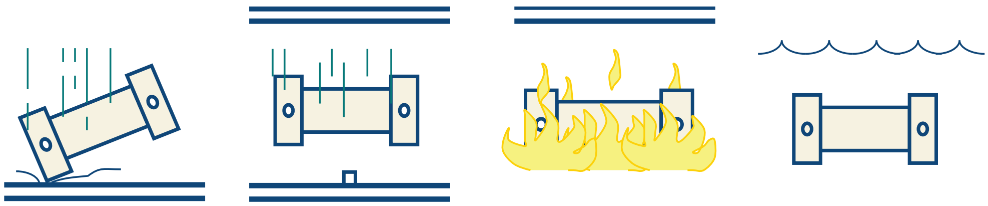
TRANSPORTATION

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

- *prevents the loss or dispersion of radioactive contents*
- *shields everything outside the cask from the radioactivity of the contents*
- *dissipates the heat from the contents*
- *prevents 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 (9.14-meter) drop onto an unyielding surface, a puncture test, a fully engulfing fire at 1,475 degrees Fahrenheit (800 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 37. Ensuring Safe Spent Fuel Shipping Containers).

Figure 37. 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 nuclear 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*
- *inspects cask vendors and manufacturers to ensure the quality of dry cask design and fabrication*

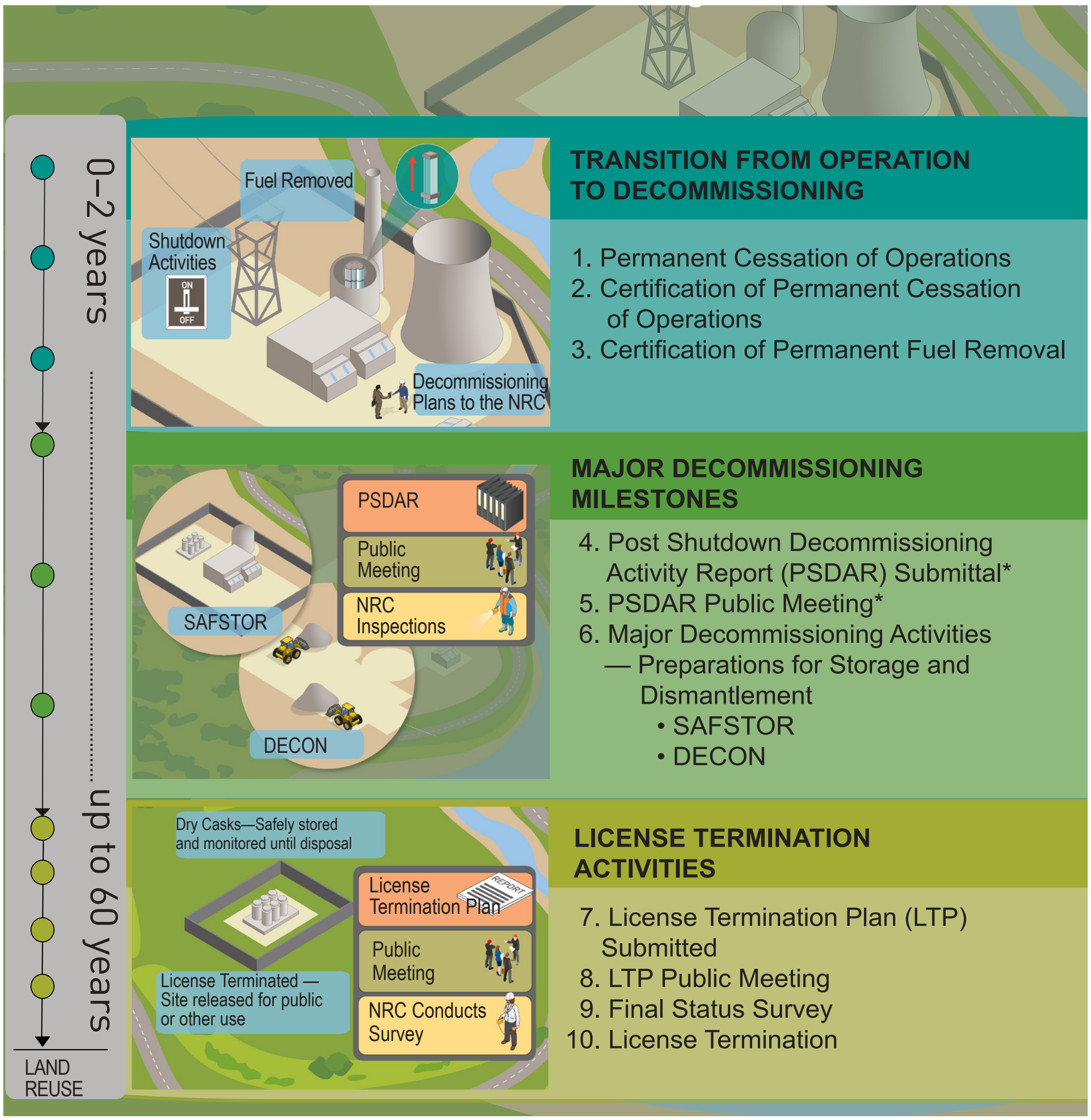
Additional information on materials transportation is available on the NRC's Web site (see the Web Link Index).

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 licensees to maintain financial assurance that funds will be available when needed for 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 38. Reactor Phases of Decommissioning, and Figure 39. Power Reactor Decommissioning Status).

Figure 38. Reactor Phases of Decommissioning

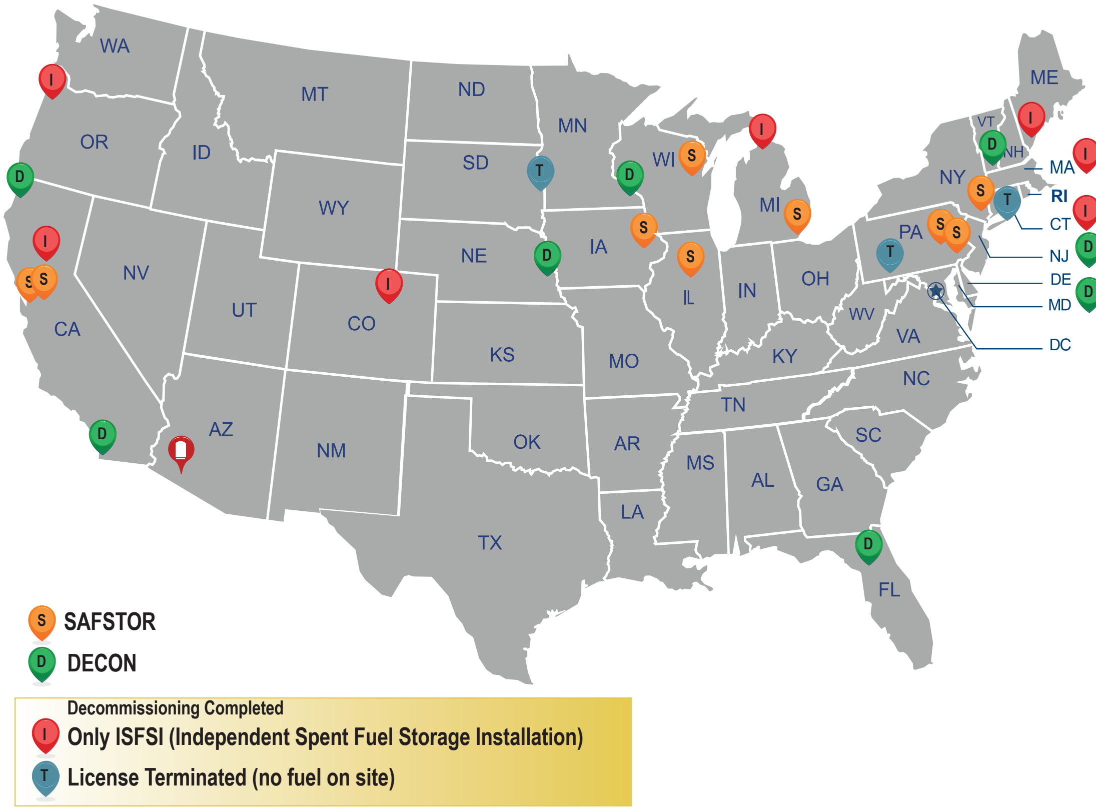


SAFSTOR — Under SAFSTOR, a nuclear power plant is maintained and monitored in a condition that allows the radioactivity to decay; afterwards, the plant shifts to DECON as the facility is dismantled and the property decontaminated.

DECON — Under DECON, equipment, structures, and portions of the facility containing radioactive contaminants are removed or decontaminated to a level that permits release of the property and termination of the NRC license.

*Under DECON, some licensees have submitted the PSDAR before shutdown (license transfer model).

Figure 39. Power Reactor Decommissioning Status



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

COLORADO
- I Fort St. Vrain

CONNECTICUT
- I Haddam Neck
- S Millstone

FLORIDA
- D Crystal River

ILLINOIS
- S Dresden
- D Zion 1 and 2*

IOWA
- S Duane Arnold

MAINE
- I Maine Yankee

MARYLAND
- D N.S. Savannah

MASSACHUSETTS
- D Pilgrim
- I Yankee Rowe

MICHIGAN
- I Big Rock Point
- S Fermi 2

NEBRASKA
- D Ft. Calhoun

NEW JERSEY
- D Oyster Creek

NEW YORK
- S Indian Point 1, 2, and 3
- T Shoreham

OREGON
- I Trojan

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

SOUTH DAKOTA
- T Pathfinder

VERMONT
- D Vermont Yankee

WISCONSIN
- S Kewaunee
- D La Crosse*

* The NRC is in the final stages of the license termination process with the reviews of the final status survey reports at Zion 1 and 2, La Crosse, and Humboldt Bay.

Notes: Fort St. Vrain ISFSI NRC SNM-2504 license was transferred to the DOE on June 4, 1999. 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 Sites Web page at https://www.energy.gov/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 Byron (2021), Dresden (2021), Palisades (2022), and Diablo Canyon (2024 and 2025). NRC-abbreviated reactor names are listed. Alaska and Hawaii are not pictured and have no sites.
For the most recent information, go to the NRC facility locator page at https://www.nrc.gov/info-finder/reactors/index.html.
Data are current as of August 2021.

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. It includes detailed plans for decommissioning the facility, as well as a cost estimate.

The first stage of decommissioning for a nuclear power plant is to transition from operating status to a permanently shutdown condition. The licensee must certify to the NRC that it has permanently ceased operation and that it has permanently removed the fuel from the reactor. At this point, the license no longer authorizes the plant to operate or load fuel in the reactor.

Licensees typically then apply for several exemptions from NRC requirements that apply to operating reactors but are no longer appropriate after permanent shutdown because a reactor accident can no longer occur. The exemptions are implemented through license amendments that change the plant's licensing basis to reflect its decommissioning status. These changes are in areas such as personnel, spent fuel management, physical and cybersecurity, emergency preparedness, and incident response. The NRC is developing new regulations to 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 are 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 cleanup 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.

Public Involvement

NEIMA required the NRC to provide a report to Congress identifying best practices for establishing and operating local community advisory boards, including lessons learned from existing boards. These boards try to foster communication and information exchange between NRC licensees and members of the communities around decommissioning nuclear power plants.

In developing the report, the NRC hosted 11 public meetings in the vicinity of reactors and two webinars to consult with host States, local government organizations, communities within the emergency planning zone of a nuclear power reactor, existing local community advisory boards associated with decommissioning nuclear power plants, and similar external stakeholders. The public meeting locations were selected to ensure geographic diversity across the United States, with priority given to States that have a nuclear power reactor undergoing the decommissioning process.

The report, issued to Congress in July 2020, includes a discussion of the composition of local community advisory boards and best practices, such as logistical considerations, frequency of meetings, and the selection of board members.

APPENDIX

See Appendices C, I and Q for licensees undergoing decommissioning

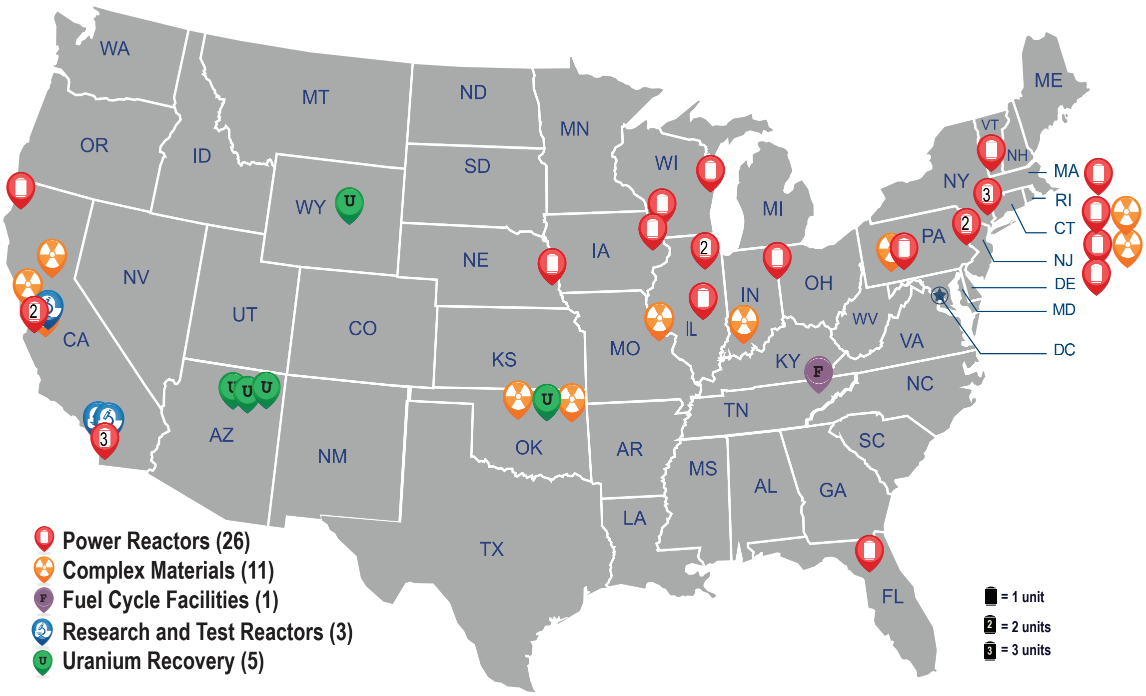
Decommissioning of Materials Licenses

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 40. Locations of NRC-Regulated Sites Undergoing Decommissioning.)

SECY-20-0108, "Status of the Decommissioning Program—2020 Annual Report," dated November 30, 2020, 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 40. Locations of NRC-Regulated Sites Undergoing Decommissioning



Note: Alaska and Hawaii are not pictured and have no sites. The NRC is in the final stages of the licensing termination process with the reviews of the final status survey results at Zion 1 and 2, La Crosse, and Humboldt Bay, and it expects to terminate the two research reactor licenses at General Atomics by the end of 2020. Data are current as of June 2021. For the most recent information, go to the NRC facility locator page at https://www.nrc.gov/info-finder/reactors/index.html.

6

SECURITY AND EMERGENCY PREPAREDNESS

Nuclear security and emergency preparedness and response are high priorities 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 and prepared 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 (see Figure 41. Security Components).

Since 9/11, the NRC has required many enhancements to the security of nuclear power plants. Because they are inherently robust structures, these additional security upgrades largely focus on the following:

- *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*
- *controls to protect physical security, emergency preparedness, and safety systems from a cyber attack*

The NRC also coordinates and shares threat information with the Department of Defense, DHS, the FBI, intelligence agencies, and local law enforcement.

The NRC is moving toward a risk-informed, performance-based, technology-inclusive regulatory framework for emergency preparedness. As with security, the NRC's approach to emergency preparedness is graded, using a risk-informed process in which the safety requirements and criteria are matched to the risk of the facility. This approach provides an appropriate level of protection to public health and safety without creating undue regulatory burden.

In 2020, the NRC published a proposed rule for emergency preparedness for small modular reactors and other new technologies. Major provisions of the proposed rule include the following:

- *an alternative performance-based framework for emergency preparedness*
- *a required hazard analysis of nearby facilities that would adversely impact emergency preparedness*
- *a scalable approach for determining the size of the emergency planning zone*
- *a requirement to describe ingestion response capabilities and resources*

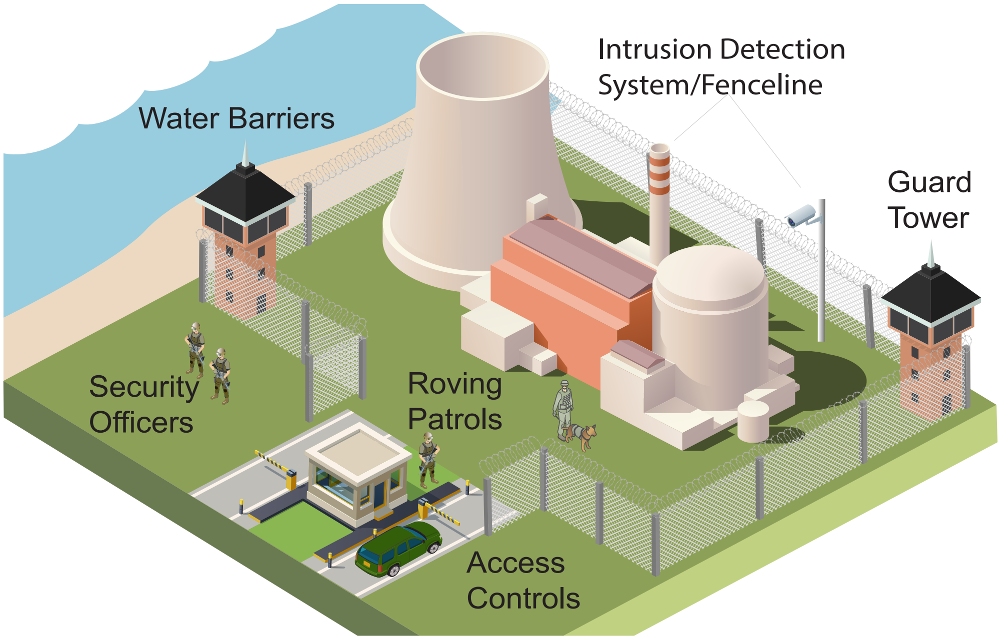
FACILITY SECURITY

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). The details of the DBT are not public because of security concerns, but it includes threats to a facility's physical security, personnel security, and cybersecurity and is based on realistic assessments of the tactics, techniques, and procedures used by terrorist groups. The NRC continually evaluates the threat environment and assesses the need to change the DBT.

The NRC verifies that licensees are complying with security requirements through its baseline inspection program. This includes force-on-force inspections designed to test a facility's defenses against the DBT. Force-on-force inspections are held at each nuclear power plant once every 3 years, employing a highly trained mock adversary force to "attack" a nuclear facility.

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 41. Security Components



CYBERSECURITY

Nuclear facilities use digital and analog systems to monitor and operate 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 "cybersecurity." All nuclear power plants licensed by the NRC must have an approved cybersecurity plan to guard against malevolent cyber acts against these facilities. For this reason, computer systems at nuclear power plants that monitor and operate safety and security systems are isolated from external communications, including the Internet.

In 2017, the NRC began inspections of nuclear power plants' full cybersecurity programs. The NRC's cybersecurity inspections provide reasonable assurance that nuclear power plant licensees adequately protect digital computers, communication systems, and networks associated with safety, security, and emergency preparedness. The experience that the NRC gained in developing the cybersecurity requirements for the current fleet of nuclear power plants provided a basis for developing cybersecurity requirements for nonreactor licensees and future advanced reactor licensees.

The NRC's cybersecurity oversight team includes technology and threat experts who evaluate and identify emerging cyber-related issues that could endanger plant systems. The team also makes recommendations to other NRC offices and programs on cybersecurity oversight issues. The NRC has established working relationships with Federal agencies such as the DHS's U.S. Cybersecurity and Infrastructure Security Agency; DOE's Office of Cybersecurity, Energy Security, and Emergency Response; and the FBI; as well as with international organizations such as the IAEA and the International Electrotechnical Commission. Such relationships are intended not only to promote information sharing but also to ensure effective coordination among Federal agencies if there were a cyber incident at a nuclear facility.

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 require the physical protection of certain types and quantities of radioactive material. Additionally, the NRC works with the Agreement States, other Federal agencies, the 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 conducts inspections and monitors performance indicators associated with emergency preparedness programs. At least once every 2 years, nuclear power plant operators must conduct full-scale exercises in coordination with State and local officials, under evaluation by the NRC and the Federal Emergency Management Agency. Once during every 8-year exercise cycle, these exercises include hostile-action-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 emergency response actions may be expanded during an emergency if circumstances warrant.

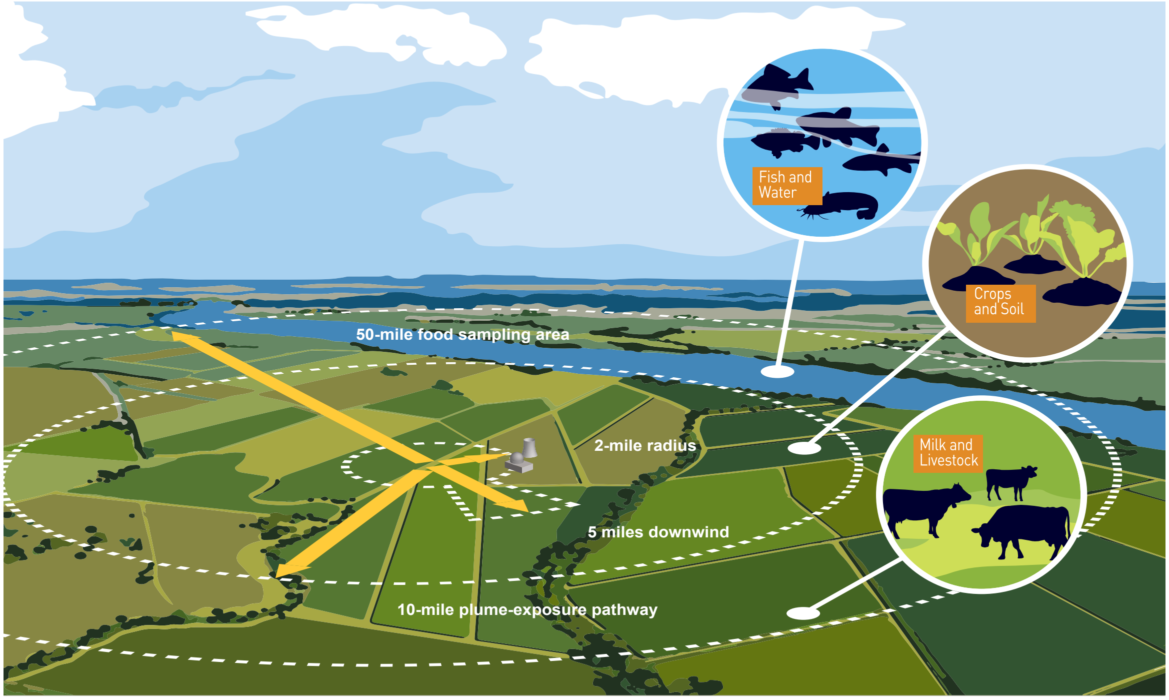
For a typical EPZ around a nuclear plant, see Figure 42. Emergency Planning Zones. The two types of EPZs are the plume-exposure pathway and the ingestion pathway.

- *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 that may be contaminated by radioactive material.*

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 whether to order evacuations, based on these and other assessments.

Figure 42. Emergency Planning Zones



Note: A 2-mile (3.2-kilometer) ring around the plant is identified for evacuation, along with a 5-mile (8-kilometer) 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 preventative 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. 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. In certain situations, KI may be used as a supplement to either sheltering in place or evacuation.

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. If the exemptions are granted, State and local agencies may apply their comprehensive emergency plans—known as "all-hazards 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 and accurate communication among the NRC, other Federal and State agencies, and the nuclear industry is critical when responding to any incident. 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.

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.

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 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 response 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 and provide licensee event information to the technical experts at the region and Headquarters.

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:

1. **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.*
2. **Alert:** *Events that involve an actual or potential substantial degradation in the level of plant safety or security events that involve 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).*
3. **Site Area Emergency:** *Events that may result in actual or likely major failures of plant functions needed to protect the public or hostile actions that result 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 by EPA except near the site boundary.*
4. **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 actions that result 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 EPA for more than the immediate site area.*

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

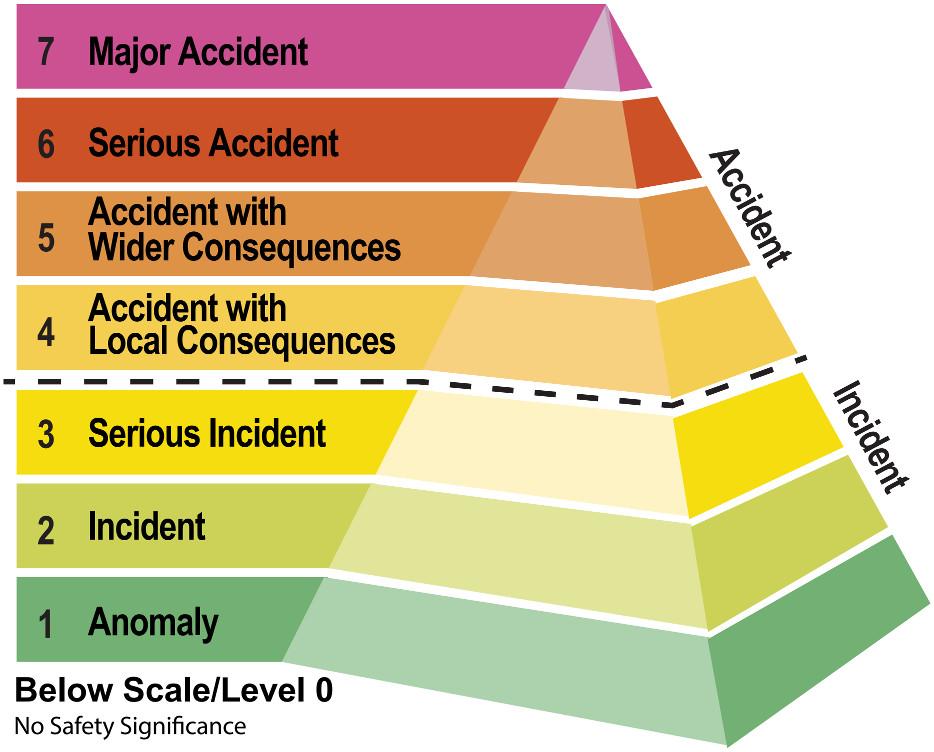
1. **Alert:** *Events that could lead to a release of radioactive materials are in progress or have occurred. The release is not expected to require a response by an offsite response organization to protect residents near the site.*
2. **Site Area Emergency:** *Events that could lead to a significant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

The 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 43. 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. However, the NRC has a commitment to transmit to the IAEA an INES-based rating for an applicable U.S. events rated at Level 2 or above, or for events attracting international public interest.

Figure 43. 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

7
APPENDICES

Abbreviations

ABWR	Advanced Boiling-Water Reactor
AC	Allis Chalmers
ac	alternating current
ACMUI	Advisory Committee on the Medical Uses of Isotopes
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Documents Access and Management System
ADR	alternative dispute resolution
AEC	Atomic Energy Commission (U.S.)
AEP	American Electric Power Company
AGN	Aerojet-General Nucleonics
AP1000	Advanced Passive 1000 Megawatt (Westinghouse pressurized-water reactor)
AP600	Advanced Passive 600 Megawatt (Westinghouse pressurized-water reactor)
APR1400	Advanced Power Reactor
ASLB	Atomic Safety and Licensing Board
AFT	accident tolerant fuel
B&R	Burns & Roe
B&W	Babcock & Wilcox
BALD	Baldwin Associates
BECH	Bechtel
BRRT	Brown & Root
BWR	boiling-water reactor
CE	Combustion Engineering
CFR	*Code of Federal Regulations*
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	construction permit
CP	civil penalty
CP Issued	date of construction permit issuance
CPPNM	Convention on the Physical Protection of Nuclear Material
CT	computerized tomography
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.)
DI&C	digital instrumentation and control
DOE	Department of Energy (U.S.)
DOT	Department of Transportation (U.S.)
DUKE	Duke Power Company
EDO	Executive Director for Operations
EBSO	Ebasco
EIA	Energy Information Administration (DOE)
EPA	Environmental Protection Agency (U.S.)
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
FDA	Food and Drug Administration
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 radioactive waste
HTG	high-temperature gas (reactor)

Abbreviations (continued)

HWR	heavy-water reactor
IAEA	International Atomic Energy Agency
IMPEP	Integrated Materials Performance Evaluation Program
INES	International Nuclear Event Scale
ISFSI	independent spent fuel storage installation
ISR	in situ recovery
KAIS	Kaiser Engineers
KI	potassium iodide
kW	kilowatt(s)
kWh	kilowatt-hour(s)
LLP	B&W lowered loop
LLW	low-level radioactive waste
LM	Legacy Management
LMFB	liquid metal fast breeder (reactor)
LOCA	loss-of-coolant accident
LR Issued	license renewal issued
LSN	Licensing Support Network
LTP	license termination plan
LWGR	light-water-cooled graphite-moderated reactor
Mo-99	molybdenum-99
MOU	memorandum of understanding
MOX	mixed oxide
MW	megawatt(s)
MWe	megawatt(s) electric
MWh	megawatt-hour(s)
MWt	megawatt(s) thermal
NARM	naturally occurring or accelerator-produced radioactive material
NEA	Nuclear Energy Agency
NEIMA	Nuclear Energy Innovation and Modernization Act
NEPA	National Environmental Policy Act
NINA	Nuclear Innovation North America
NMMSS	Nuclear Materials Management and Safeguards System
NNSA	National Nuclear Security Administration
NOV	notice of violation
NPUF	nonpower production and utilization facility
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	post-shutdown decommissioning activities report
PSEG	Public Service Electric and Gas Company
PWR	pressurized-water reactor
rad	radiation absorbed dose
RDD	radiological dispersal device
RIC	Regulatory Information Conference
RLP	B&W raised loop
ROP	Reactor Oversight Process
RSS	Really Simple Syndication
RTR	research and test reactor
S&L	Sargent & Lundy
S&W	Stone & Webster
SCF	sodium-cooled fast (reactor)
SHINE	SHINE Medical Technologies, LLC
SI	Système Internationale (d'unités) (International System of Units)
SL	severity level
SL	site-specific license
SMR	small modular reactor
SR	subsequent license renewal
SSI	Southern Services Incorporated
STP	South Texas Project
Sv	sievert

Abbreviations (continued)

TMI-2	Three Mile Island, Unit 2
TRIGA	Training Reactor and Isotopes Production, General Atomics
TVA	Tennessee Valley Authority
UE&C	United Engineers & Constructors
UF_6	uranium hexafluoride
U-235	uranium-235
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UO_2	uranium dioxide
US-APWR	U.S. [version of] Advanced Pressurized-Water Reactor
U.S. EPR	U.S. [version of] Evolutionary Pressurized-Water Reactor
VBWR	Vallecitos Boiling-Water Reactor
WEST	Westinghouse Electric
WNA	World Nuclear Association
Y-90	yttrium-90

State and Territory Abbreviations

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

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
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

QUICK-REFERENCE METRIC CONVERSION TABLES

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/ft^2	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 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, 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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015– 2020* Capacity Factor (Percent)
Arkansas Nuclear One, Unit 1	IV	PWR-DRYAMB	2,568	12/06/1968	82
Entergy Operations, Inc.		B&W LLP	833	05/21/1974	72
London, AR		BECH		12/19/1974	87
(6 miles WNW of Russellville, AR)		BECH	DPR-51	06/20/2001	76
05000313				N/A	87
https://www.nrc.gov/info-finder/reactors/ano1.html				05/20/2034	102
Arkansas Nuclear One, Unit 2	IV	PWR-DRYAMB	3,026	12/06/1972	89
Entergy Operations, Inc.		CE	985	09/01/1978	94
London, AR		BECH		03/26/1980	70
(6 miles WNW of Russellville, AR)		BECH	NPF-6	06/30/2005	82
05000368				N/A	82
https://www.nrc.gov/info-finder/reactors/ano2.html				07/17/2038	88
Beaver Valley Power Station, Unit 1	I	PWR-DRYAMB	2,900	06/26/1970	90
Energy Harbor Nuclear Generation LLC/		WEST 3LP	907	07/02/1976	91
Energy Harbor Nuclear Corp.		S&W		10/01/1976	99
Shippingport, PA		S&W	DPR-66	11/05/2009	92
(17 miles W of McCandless, PA)				N/A	91
05000334				01/29/2036	101
https://www.nrc.gov/info-finder/reactors/bv1.html					
Beaver Valley Power Station, Unit 2	I	PWR-DRYAMB	2,900	05/03/1974	90
Energy Harbor Nuclear Generation LLC/		WEST 3LP	901	08/14/1987	97
Energy Harbor Nuclear Corp.		S&W		11/17/1987	90
Shippingport, PA		S&W	NPF-73	11/05/2009	90
(17 miles W of McCandless, PA)				N/A	100
05000412				05/27/2047	93
https://www.nrc.gov/info-finder/reactors/bv2.html					
Braidwood Station, Unit 1	III	PWR-DRYAMB	3,645	12/31/1975	93
Exelon Generation Co., LLC		WEST 4LP	1,183	07/02/1987	90
Braceville, IL		S&L		07/29/1988	98
(20 miles SSW of Joliet, IL)		CWE	NPF-72	01/27/2016	93
05000456				N/A	94
https://www.nrc.gov/info-finder/reactors/brai1.html				10/17/2046	102
Braidwood Station, Unit 2	III	PWR-DRYAMB	3,645	12/31/1975	91
Exelon Generation Co., LLC		WEST 4LP	1,154	05/20/1988	95
Braceville, IL		S&L		10/17/1988	88
(20 miles SSW of Joliet, IL)		CWE	NPF-77	01/27/2016	92
05000457				N/A	100
https://www.nrc.gov/info-finder/reactors/brai2.html				12/18/2047	96

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015– 2020* Capacity Factor (Percent)
Browns Ferry Nuclear Plant, Unit 1	II	BWR-MARK 1	3,952	05/10/1967	94
Tennessee Valley Authority		GE 4	1,256	12/20/1973	83
Limestone County, AL		TVA		08/01/1974	97
(10 miles S of Athens, AL)		TVA	DPR-33	05/04/2006	82
05000259				N/A	99
https://www.nrc.gov/info-finder/reactors/bf1.html			12/20/2033	83	
Browns Ferry Nuclear Plant, Unit 2	II	BWR-MARK 1	3,952	05/10/1967	85
Tennessee Valley Authority		GE 4	1,259	06/28/1974	94
Limestone County, AL		TVA		03/01/1975	83
(10 miles S of Athens, AL)		TVA	DPR-52	05/04/2006	97
05000260				N/A	80
https://www.nrc.gov/info-finder/reactors/bf2.html				06/28/2034	91
Browns Ferry Nuclear Plant, Unit 3	II	BWR-MARK 1	3,952	07/31/1968	92
Tennessee Valley Authority		GE 4	1,260	07/02/1976	80
Limestone County, AL		TVA		03/01/1977	93
(10 miles S of Athens, AL)		TVA	DPR-68	05/04/2006	76
05000296				N/A	94
https://www.nrc.gov/info-finder/reactors/bf3.html				07/02/2036	86
Brunswick Steam Electric Plant, Unit 1	II	BWR-MARK 1	2,923	02/07/1970	93
Duke Energy Progress, LLC		GE 4	938	09/08/1976	83
Southport, NC		UE&C		03/18/1977	93
(20 miles S of Wilmington, NC)		BRRT	DPR-71	06/26/2006	85
05000325				N/A	92
https://www.nrc.gov/info-finder/reactors/bru1.html				09/08/2036	84
Brunswick Steam Electric Plant, Unit 2	II	BWR-MARK 1	2,923	02/07/1970	81
Duke Energy Progress, LLC		GE 4	932	12/27/1974	92
Southport, NC		UE&C		11/03/1975	82
(20 miles S of Wilmington, NC)		BRRT	DPR-62	06/26/2006	93
05000324				N/A	85
https://www.nrc.gov/info-finder/reactors/bru2.html				12/27/2034	99
Byron Station, Unit 1	III	PWR-DRYAMB	3,645	12/31/1975	88
Exelon Generation Co., LLC		WEST 4LP	1,164	02/14/1985	97
Byron, IL		S&L		09/16/1985	89
(17 miles SW of Rockford, IL)		CWE	NPF-37	11/19/2015	94
05000454				N/A	100
https://www.nrc.gov/info-finder/reactors/byro1.html				10/31/2044	96
Byron Station, Unit 2	III	PWR-DRYAMB	3,645	12/31/1975	94
Exelon Generation Co., LLC		WEST 4LP	1,136	01/30/1987	96
Byron, IL		S&L		08/02/1987	89
(17 miles SW of Rockford, IL)		CWE	NPF-66	11/19/2015	100
05000455				N/A	95
https://www.nrc.gov/info-finder/reactors/byro2.html				11/06/2046	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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
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 1190 NPF-30	04/16/1976 10/18/1984 12/19/1984 03/06/2015 N/A 10/18/2044	96 87 77 100 86 74
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	2,737 866 DPR-53	07/07/1969 07/31/1974 05/08/1975 03/23/2000 N/A 07/31/2034	97 89 97 92 100 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	2,737 842 DPR-69	07/07/1969 08/13/1976 04/01/1977 03/23/2000 N/A 08/13/2036	86 95 91 100 92 104
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	3,469 1,160 NPF-35	08/07/1975 01/17/1985 06/29/1985 12/05/2003 N/A 12/05/2043	88 97 90 93 100 91
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 1,150 NPF-52	08/07/1975 05/15/1986 08/19/1986 12/05/2003 N/A 12/05/2043	86 88 96 91 92 100
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 1,065 NPF-62	02/24/1976 04/17/1987 11/24/1987 N/A N/A 09/29/2026	87 89 84 88 87 101

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015– 2020* Capacity Factor (Percent)
Columbia Generating Station Energy Northwest Hanford Reservation in Benton County, WA (15 miles NNW of Richland , WA) 05000397 https://www.nrc.gov/info-finder/reactors/wash2.html	IV	BWR-MARK 2 GE 5 B&R BECH	3,544 1,163 NPF-21	03/19/1973 04/13/1984 12/13/1984 05/22/2012 N/A 12/20/2043	78 92 77 96 88 92
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 1,205 NPF-87	12/19/1974 04/17/1990 08/13/1990 N/A N/A 02/08/2030	100 92 91 100 89 92
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 1,195 NPF-89	12/19/1974 04/06/1993 08/03/1993 N/A N/A 02/02/2033	88 100 68 93 94 92
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	2,419 770 DPR-46	06/04/1968 01/18/1974 07/01/1974 11/29/2010 N/A 01/18/2034	97 84 99 81 100 92
Davis-Besse Nuclear Power Station, Unit 1 Energy Harbor Nuclear Generation LLC Energy Harbor Nuclear Corp. 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	2,817 894 NPF-3	03/24/1971 04/22/1977 07/31/1978 12/08/2015 N/A 04/22/2037	97 79 97 93 98 92
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 1,122 DPR-80	4/23/1968 11/02/1984 05/07/1985 Withdrawn N/A 11/02/2024	87 98 81 98 89 90

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
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 1,118 DPR-82	12/09/1970 08/26/1985 03/13/1986 Withdrawn N/A 08/26/2025	95 88 95 87 75 75
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 1,009 DPR-58	03/25/1969 10/25/1974 08/28/1975 08/30/2005 N/A 10/25/2034	78 82 72 100 79 94
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 1,168 DPR-74	03/25/1969 12/23/1977 07/01/1978 08/30/2005 N/A 12/23/2037	79 71 104 79 84 97
Dresden Nuclear Power Station, Unit 2 Exelon Generation Co., LLC Morris (Grundy County), 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	2,957 902 DPR-19	01/10/1966 02/20/1991[A] 06/09/1970 10/28/2004 N/A 12/22/2029	83 91 84 99 89 101
Dresden Nuclear Power Station, Unit 3 Exelon Generation Co., LLC Morris (Grundy County), 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	2,957 895 DPR-25	10/14/1966 01/12/1971 11/16/1971 10/28/2004 N/A 01/12/2031	89 84 91 94 99 96
Edwin I. Hatch Nuclear Plant, Unit 1 Southern Nuclear Operating Co., Inc. 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	2,804 876 DPR-57	09/30/1969 10/13/1974 12/31/1975 01/15/2002 N/A 08/06/2034	101 93 97 91 98 83

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.

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
Edwin I. Hatch Nuclear Plant, Unit 2	II	BWR-MARK 1	2,804	12/27/1972	91
Southern Nuclear Operating Co., Inc.		GE 4	883	06/13/1978	101
Baxley, GA		BECH		09/05/1979	95
(20 miles S of Vidalia, GA)		GPC	NPF-5	01/15/2002	95
05000366				N/A	82
https://www.nrc.gov/info-finder/reactors/hat2.html				06/13/2038	97
Fermi, Unit 2	III	BWR-MARK 1	3,486	09/26/1972	69
DTE Electric Company		GE 4	1,141	03/20/1985	86
Newport, MI		S&L		01/23/1988	82
(25 miles NE of Toledo, OH)		DANI	NPF-43	12/15/2016	75
05000341				N/A	99
https://www.nrc.gov/info-finder/reactors/ferm2.html				03/20/2045	61
Grand Gulf Nuclear Station, Unit 1	IV	BWR-MARK 3	4,408	09/04/1974	93
Entergy Operations, Inc.		GE 6	1,401	11/01/1984	47
Port Gibson, MS		BECH		07/01/1985	58
(20 miles S of Vicksburg, MS)		BECH	NPF-29	12/01/2016	57
05000416				N/A	88
https://www.nrc.gov/info-finder/reactors/gg1.html				11/01/2044	53
H.B. Robinson Steam Electric Plant, Unit 2	II	PWR-DRYAMB	2,339	04/13/1967	85
Duke Energy Progress, LLC		WEST 3LP	759	07/31/1970	95
Hartsville, SC		EBSO		03/07/1971	88
(26 miles NW of Florence, SC)		EBSO	DPR-23	04/19/2004	79
05000261				N/A	94
https://www.nrc.gov/info-finder/reactors/rob2.html				07/31/2030	92
Hope Creek Generating Station, Unit 1	I	BWR-MARK 1	3,902	11/04/1974	83
PSEG Nuclear, LLC		GE 4	1,172	07/25/1986	85
Hancocks Bridge, NJ		BECH		12/20/1986	94
(18 miles SE of Wilmington, DE)		BECH	NPF-57	07/20/2011	90
05000354				N/A	84
https://www.nrc.gov/info-finder/reactors/hope.html				04/11/2046	103
James A. FitzPatrick Nuclear Power Plant	I	BWR-MARK 1	2,536	05/20/1970	96
Exelon Generation Co., LLC		GE 4	848	10/17/1974	76
Scriba, NY		S&W		07/28/1975	80
(6 miles NE of Oswego, NY)		S&W	DPR-59	09/08/2008	89
05000333				N/A	100
https://www.nrc.gov/info-finder/reactors/fitz.html				10/17/2034	89
Joseph M. Farley Nuclear Plant, Unit 1	II	PWR-DRYAMB	2,775	08/16/1972	86
Southern Nuclear Operating Co., Inc.		WEST 3LP	874	06/25/1977	86
Columbia, AL		SSI		12/01/1977	100
(18 miles E of Dothan, AL)		DANI	NPF-2	05/12/2005	84
05000348				N/A	91
https://www.nrc.gov/info-finder/reactors/far1.html				06/25/2037	102

APPENDIX A
Commercial Nuclear Power Reactors
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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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
Joseph M. Farley Nuclear Plant, Unit 2 Southern Nuclear Operating Co., Inc. Columbia, AL (18 miles E of Dothan, AL) 05000364 https://www.nrc.gov/info-finder/reactors/far2.html	II	PWR-DRYAMB WEST 3LP SSI BECH	2,775 877 NPF-8	08/16/1972 03/31/1981 07/30/1981 05/12/2005 N/A 03/31/2041	98 90 91 99 92 91
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 1,131 NPF-11	09/10/1973 04/17/1982 01/01/1984 10/19/2016 N/A 04/17/2042	99 89 96 92 99 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 1,134 NPF-18	09/10/1973 12/16/1983 10/19/1984 10/19/2016 N/A 12/16/2043	83 95 88 98 92 102
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 1,120 NPF-39	06/19/1974 08/08/1985 02/01/1986 10/20/2014 N/A 10/26/2044	100 93 100 92 99 93
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 1,122 NPF-85	06/19/1974 08/25/1989 01/08/1990 10/20/2014 N/A 06/22/2049	89 101 86 99 91 104
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 1,158 NPF-9	02/23/1973 05/27/1981 12/01/1981 12/05/2003 N/A 06/12/2041	95 89 90 100 90 93

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015– 2020* Capacity Factor (Percent)
McGuire Nuclear Station, Unit 2	II	PWR-ICECND	3,411	02/23/1973	87
Duke Energy Carolinas, LLC		WEST 4LP	1,158	05/27/1983	97
Huntersville, NC		DUKE		03/01/1984	86
(17 miles N of Charlotte, NC)		DUKE	NPF-17	12/05/2003	92
05000370				N/A	100
https://www.nrc.gov/info-finder/reactors/mcg2.html				03/03/2043	95
Millstone Power Station, Unit 2	I	PWR-DRYAMB	2,700	12/11/1970	85
Dominion Energy Nuclear Connecticut, Inc.		CE	853	09/26/1975	93
Waterford, CT		BECH		12/26/1975	85
(3.2 miles WSW of New London, CT)		BECH	DPR-65	11/28/2005	82
05000336				N/A	97
https://www.nrc.gov/info-finder/reactors/mill2.html				07/31/2035	89
Millstone Power Station, Unit 3	I	PWR-DRYSUB	3,650	08/09/1974	97
Dominion Energy Nuclear Connecticut, Inc.		WEST 4LP	1,220	01/31/1986	83
Waterford, CT		S&W		04/23/1986	89
(3.2 miles WSW of New London, CT)		S&W	NPF-49	11/28/2005	100
05000423				N/A	89
https://www.nrc.gov/info-finder/reactors/mill3.html				11/25/2045	84
Monticello Nuclear Generating Plant, Unit 1	III	BWR-MARK 1	2,004	06/19/1967	78
Northern States Power Company-Minnesota		GE 3	617	01/09/1981[B]	93
Monticello, MN		BECH		06/30/1971	86
(30 miles NW of Minneapolis, MN)		BECH	DPR-22	11/08/2006	99
05000263				N/A	88
https://www.nrc.gov/info-finder/reactors/mont.html				09/08/2030	103
Nine Mile Point Nuclear Station, Unit 1	I	BWR-MARK 1	1,850	04/12/1965	88
Nine Mile Point Nuclear Station, LLC		GE 2	621	12/26/1974[C]	96
Scriba, NY		NIAG		12/01/1969	87
(6 miles NE of Oswego, NY)		S&W	DPR-63	10/31/2006	99
05000220				N/A	85
https://www.nrc.gov/info-finder/reactors/nmp1.html				08/22/2029	100
Nine Mile Point Nuclear Station, Unit 2	I	BWR-MARK 2	3,988	06/24/1974	100
Nine Mile Point Nuclear Station, LLC		GE 5	1,292	07/02/1987	92
Scriba, NY		S&W		03/11/1988	101
(6 miles NE of Oswego, NY)		S&W	NPF-69	10/31/2006	90
05000410				N/A	99
https://www.nrc.gov/info-finder/reactors/nmp2.html				10/31/2046	90

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.

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
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	2,940 948 NPF-4	02/19/1971 04/01/1978 06/06/1978 03/20/2003 N/A 04/01/2038	91 89 99 90 93 102
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	2,940 944 NPF-7	02/19/1971 08/21/1980 12/14/1980 03/20/2003 N/A 08/21/2040	99 87 89 99 88 88
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	2,610 847 DPR-38	11/06/1967 02/06/1973 07/15/1973 05/23/2000 N/A 02/06/2033	96 83 95 90 100 92
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	2,610 848 DPR-47	11/06/1967 10/06/1973 09/09/1974 05/23/2000 N/A 10/06/2033	89 98 88 100 90 103
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	2,610 859 DPR-55	11/06/1967 07/19/1974 12/16/1974 05/23/2000 N/A 07/19/2034	97 91 97 92 100 93
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	2,565.4 769 DPR-20	03/14/1967 02/21/1991[D] 12/31/1971 01/17/2007 N/A 03/24/2031	89 99 86 77 97 89

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

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
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 1,311 NPF-41	05/25/1976 06/01/1985 01/28/1986 04/21/2011 N/A 06/01/2045	94 83 85 97 90 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 1,314 NPF-51	05/25/1976 04/24/1986 09/19/1986 04/21/2011 N/A 04/24/2046	85 95 86 82 98 91
Palo Verde Nuclear Generating Station, Unit 3 Arizona Public Service Company Wintersburg, AZ (50 miles W of Phoenix, AZ) 05000530 https://www.nrc.gov/info-finder/reactors/palo3.html	IV	PWR-DRYAMB CE 80-2L BECH BECH	3,990 1,312 NPF-74	05/25/1976 11/25/1987 01/08/1988 04/21/2011 N/A 11/25/2047	85 85 92 90 87 98
Peach Bottom Atomic Power Station, Unit 2 Exelon Generation Co., LLC Delta, PA (17.9 miles S of Lancaster, PA) 05000277 https://www.nrc.gov/info-finder/reactors/pb2.html	I	BWR-MARK 1 GE 4 BECH BECH	4,016 1,265 DPR-44	01/31/1968 10/25/1973 07/05/1974 05/07/2003 03/05/2020 08/08/2053	99 96 92 94 100 92
Peach Bottom Atomic Power Station, Unit 3 Exelon Generation Co., LLC Delta, PA (17.9 miles S of Lancaster, PA) 05000278 https://www.nrc.gov/info-finder/reactors/pb3.html	I	BWR-MARK 1 GE 4 BECH BECH	4,016 1,285 DPR-56	01/31/1968 07/02/1974 12/23/1974 05/07/2003 03/05/2020 07/02/2054	75 95 86 94 93 103
Perry Nuclear Power Plant, Unit 1 Energy Harbor Nuclear Generation LLC/ Energy Harbor Nuclear Corp. Perry, OH (35 miles NE of Cleveland, OH) 05000440 https://www.nrc.gov/info-finder/reactors/perr1.html	III	BWR-MARK 3 GE 6 GIL KAIS	3,758 1,240 NPF-58	05/03/1977 11/13/1986 11/18/1987 N/A N/A 03/18/2026	83 91 85 99 83 101

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
Point Beach Nuclear Plant, Unit 1 NextEra Energy Point Beach, LLC Two Rivers, WI (13 miles NNW of Manitowoc, WI) 05000266 https://www.nrc.gov/info-finder/reactors/poin1.html	III	PWR-DRYAMB WEST 2LP BECH BECH	1,800 598 DPR-24	07/19/1967 10/05/1970 12/21/1970 12/22/2005 N/A 10/05/2030	92 86 86 99 91 92
Point Beach Nuclear Plant, Unit 2 NextEra Energy Point Beach, LLC Two Rivers, WI (13 miles NNW of Manitowoc, WI) 05000301 https://www.nrc.gov/info-finder/reactors/poin2.html	III	PWR-DRYAMB WEST 2LP BECH BECH	1,800 603 DPR-27	07/25/1968 03/08/1973[E] 10/01/1972 12/22/2005 N/A 03/08/2033	86 94 85 94 99 93
Prairie Island Nuclear Generating Plant, Unit 1 Northern States Power Co.—Minnesota Welch, MN (28 miles SE of Minneapolis, MN) 05000282 https://www.nrc.gov/info-finder/reactors/prai1.html	III	PWR-DRYAMB WEST 2LP FLUR NSP	1,677 521 DPR-42	06/25/1968 04/05/1974[F] 12/16/1973 06/27/2011 N/A 08/09/2033	77 81 88 89 99 95
Prairie Island Nuclear Generating Plant, Unit 2 Northern States Power Co.—Minnesota Welch, MN (28 miles SE of Minneapolis, MN) 05000306 https://www.nrc.gov/info-finder/reactors/prai2.html	III	PWR-DRYAMB WEST 2LP FLUR NSP	1,677 519 DPR-60	06/25/1968 10/29/1974 12/21/1974 06/27/2011 N/A 10/29/2034	65 78 80 100 91 104
Quad Cities Nuclear Power Station, Unit 1 Exelon Generation Co., LLC Cordova, IL (20 miles NE of Moline, IL) 05000254 https://www.nrc.gov/info-finder/reactors/quad1.html	III	BWR-MARK 1 GE 3 S&L UE&C	2,957 908 DPR-29	02/15/1967 12/14/1972 02/18/1973 10/28/2004 N/A 12/14/2032	83 92 85 99 91 101
Quad Cities Nuclear Power Station, Unit 2 Exelon Generation Co., LLC Cordova, IL (20 miles NE of Moline, IL) 05000265 https://www.nrc.gov/info-finder/reactors/quad2.html	III	BWR-MARK 1 GE 3 S&L UE&C	2,957 911 DPR-30	02/15/1967 12/14/1972 03/10/1973 10/28/2004 N/A 12/14/2032	95 85 89 92 99 95

E: The AEC issued a provisional OL on 11/18/1971. The NRC issued a full-term OL on 03/08/1973.
F: The AEC issued a provisional OL on 08/09/1973. The NRC issued a full-term OL on 04/05/1974.

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
R.E. Ginna Nuclear Power Plant R.E. Ginna Nuclear Power Plant, LLC Ontario, NY (20 miles NE of Rochester, NY) 05000244 https://www.nrc.gov/info-finder/reactors/ginn.html	I	PWR-DRYAMB WEST 2LP GIL BECH	1,775 581 DPR-18	04/25/1966 09/19/1969 07/01/1970 05/19/2004 N/A 09/18/2029	89 94 87 93 99 85
River Bend Station, Unit 1 Entergy Operations, Inc. St. Francisville, LA (24 miles NNW of Baton Rouge, LA) 05000458 https://www.nrc.gov/info-finder/reactors/rbs1.html	IV	BWR-MARK 3 GE 6 S&W S&W	3,091 968 NPF-47	03/25/1977 11/20/1985 06/16/1986 12/20/2018 N/A 08/29/2045	76 78 77 82 76 94
St. Lucie Plant, Unit 1 Florida Power & Light Co. Jensen Beach, FL (10 miles SE of Ft. Pierce, FL) 05000335 https://www.nrc.gov/info-finder/reactors/stl1.html	II	PWR-DRYAMB CE EBSO EBSO	3,020 981 DPR-67	07/01/1970 03/01/1976 12/21/1976 10/02/2003 N/A 03/01/2036	83 73 90 91 70 101
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	3,020 987 NPF-16	05/02/1977 04/06/1983 08/08/1983 10/02/2003 N/A 04/06/2043	77 92 84 87 100 93
Salem Nuclear Generating Station, Unit 1 PSEG 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 1,153 DPR-70	09/25/1968 12/01/1976 06/30/1977 06/30/2011 N/A 08/13/2036	95 68 90 100 79 71
Salem Nuclear Generating Station, Unit 2 PSEG 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 1,142 DPR-75	09/25/1968 05/20/1981 10/13/1981 06/30/2011 N/A 04/18/2040	85 85 85 87 99 90

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
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 1,250 NPF-86	07/07/1976 03/15/1990 08/19/1990 03/12/2019 N/A 03/15/2050	87 99 92 92 100 90
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 1,152 DPR-77	05/27/1970 09/17/1980 07/01/1981 09/24/2015 N/A 09/17/2040	87 71 88 89 82 97
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 1,126 DPR-79	05/27/1970 09/15/1981 06/01/1982 09/28/2015 N/A 09/15/2041	73 90 83 88 99 94
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	2,948 964 NPF-63	01/27/1978 10/24/1986 05/02/1987 12/17/2008 N/A 10/24/2046	87 90 99 89 89 98
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 1,280 NPF-76	12/22/1975 03/22/1988 08/25/1988 09/28/2017 N/A 08/20/2047	78 95 85 89 100 93
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 1,280 NPF-80	12/22/1975 03/28/1989 06/19/1989 09/28/2017 N/A 12/15/2048	85 88 97 90 91 103

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
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	2,587 838 DPR-32	06/25/1968 05/25/1972 12/22/1972 03/20/2003 05/04/2021 05/25/2052	76 96 101 87 88 103
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	2,587 838 DPR-37	06/25/1968 01/29/1973 05/01/1973 03/20/2003 05/04/2021 01/29/2053	82 101 93 88 100 92
Susquehanna Steam Electric Station, Unit 1 Susquehanna Nuclear, LLC Salem Township (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 1,247 NPF-14	11/03/1973 07/17/1982 06/08/1983 11/24/2009 N/A 07/17/2042	76 77 97 86 99 85
Susquehanna Steam Electric Station, Unit 2 Susquehanna Nuclear, LLC Salem Township (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 1,247 NPF-22	11/03/1973 03/23/1984 02/12/1985 11/24/2009 N/A 03/23/2044	82 93 86 99 89 97
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	2,644 837 DPR-31	04/27/1967 07/19/1972 12/14/1972 06/06/2002 12/04/2019 07/19/2052	78 93 80 89 99 89
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	2,644 861 DPR-41	04/27/1967 04/10/1973 09/07/1973 06/06/2002 12/04/2019 04/10/2053	106 99 98 100 91 80
Virgil C. Summer Nuclear Station, Unit 1 Dominion Energy South Carolina, Inc. 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	2,900 971 NPF-12	03/21/1973 11/12/1982 01/01/1984 04/23/2004 N/A 08/06/2042	79 96 77 85 95 91

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 MWe License Number	CP Issued OL Issued Comm. Op LR Issued SR Issued Exp. Date	2015–2020* Capacity Factor (Percent)
Vogtle Electric Generating Plant, Unit 1	II	PWR-DRYAMB	3,625.6	06/28/1974	91
Southern Nuclear Operating Co., Inc.		WEST 4LP	1,150	03/16/1987	101
Waynesboro, GA		SBEC		06/01/1987	93
(26 miles SE of Augusta, GA)		GPC	NPF-68	06/03/2009	93
05000424				N/A	100
https://www.nrc.gov/info-finder/reactors/vog1.html				01/16/2047	95
Vogtle Electric Generating Plant, Unit 2	II	PWR-DRYAMB	3,625.6	06/28/1974	100
Southern Nuclear Operating Co., Inc.		WEST 4LP	1,152	03/31/1989	94
Waynesboro, GA		SBEC		05/20/1989	96
(26 miles SE of Augusta, GA)		GPC	NPF-81	06/03/2009	100
05000425				N/A	92
https://www.nrc.gov/info-finder/reactors/vog2.html				02/09/2049	92
Waterford Steam Electric Station, Unit 3	IV	PWR-DRYAMB	3,716	11/14/1974	80
Entergy Operations, Inc.		COMB CE	1,165	03/16/1985	96
Killona, LA		EBSO		09/24/1985	80
(25 miles W of New Orleans, LA)		EBSO	NPF-38	12/27/2018	100
05000382				N/A	74
https://www.nrc.gov/info-finder/reactors/wat3.html				12/18/2044	88
Watts Bar Nuclear Plant, Unit 1	II	PWR-ICECND	3,459	01/23/1973	76
Tennessee Valley Authority		WEST 4LP	1,123	02/07/1996	85
Spring City, TN		TVA		05/27/1996	77
(60 miles SW of Knoxville, TN)		TVA	NPF-90	N/A	87
05000390				N/A	86
https://www.nrc.gov/info-finder/reactors/wb1.html				11/09/2035	92
Watts Bar Nuclear Plant, Unit 2	II	PWR-ICECND	3,411	01/24/1973	
Tennessee Valley Authority		WEST 4LP	1,122	10/22/2015	26
Spring City, TN		TVA		10/19/2016	45
(60 miles SW of Knoxville, TN)		TVA	NPF-96	N/A	95
05000391				N/A	88
https://www.nrc.gov/info-finder/reactors/wb2.html				10/22/2055	86
Wolf Creek Generating Station, Unit 1	IV	PWR-DRYAMB	3,565	05/17/1977	78
Wolf Creek Nuclear Operating Corp.		WEST 4LP		06/04/1985[G]	74
Burlington (Coffey County), KS		BECH		09/03/1985	96
(28 miles SE of Emporia, KS)		DANI	NPF-42	11/20/2008	86
05000482				N/A	87
https://www.nrc.gov/info-finder/reactors/wc.html				03/11/2045	98

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

APPENDIX A
Commercial Nuclear Power Reactors
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 MWe License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date
Bellefonte Nuclear Power Station, Unit 1** Tennessee Valley Authority (6 miles NE of Scottsboro, AL) 05000438 https://www.nrc.gov/reactors/new-reactors/bellefonte-constr-permits.html	II	PWR-DRYAMB B&W 205 TVA TVA	3,763	12/24/1974
Bellefonte Nuclear Power Station, Unit 2** Tennessee Valley Authority (6 miles NE of Scottsboro, AL) 05000439 https://www.nrc.gov/reactors/new-reactors/bellefonte-constr-permits.html	II	PWR-DRYAMB B&W 205 TVA TVA	3,763	12/24/1974
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	ESBWR4,500 GEH	 NPF-95	 05/01/2015
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 4,500 ESBWR GEH	 NPF-103	 06/02/2017
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 WEST 2LP	3,400 NPF-104	 04/12/2018
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 WEST 2LP	3,400 NPF-105	 04/12/2018
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

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 MWe License Number	CP Issued OL Issued Comm. Op. LR Issued Exp. Date
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
William States Lee III Nuclear Station, Unit 3[A] 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
William States Lee III Nuclear Station, Unit 4[A] 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

A: 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 2014.

** 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, combined licenses (COLs) be withdrawn.

Note: Plant names and data are as identified on the license as of August 2021; the next printed update will be in September 2022.

Source: NRC, with some data compiled from the 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 (NINA)	05200012 & 05200013	COL	09/20/07 9/20/2007	ABWR	South Texas Project, Units 3 and 4	TX	Yes	11/29/07	COL terminated 07/12/2018
Tennessee Valley Authority (TVA)	05200014 & 05200015	COL	10/30/07	AP1000	Bellefonte, Units 3 and 4	AL	No	01/18/08	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	02/25/08	COL Issued 12/19/2016
Progress Energy	05200022 & 05200023	COL	02/19/08	AP1000	Shearon Harris, Units 2 and 3	NC	Yes	04/17/08	Suspended–05/02/2013
Southern Nuclear Operating Co., Inc.	05200025 & 05200026	COL	03/28/08	AP1000	Vogtle, Units 3 and 4	GA	Yes	05/30/08	COL Issued 02/10/2012
AmerenUE	05200037	COL	07/24/08	U.S. EPR	Callaway, Unit 2	MO	Yes	12/12/08	Withdrawn–10/29/2015
DTE Electric Company	05200033	COL	09/18/08	ESBWR	Fermi, Unit 3	MI	Yes	11/25/08	COL Issued 05/01/2015
Luminant Generation Co.	05200034 & 05200035	COL	09/19/08	US-APWR	Comanche Peak, Units 3 and 4	TX	Yes	12/02/08	Suspended–03/31/2014
Entergy	05200036	COL	09/25/08	ESBWR	River Bend, Unit 3	LA	Yes	12/04/08	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	06/30/09	AP1000	Turkey Point, Units 6 and 7	FL	Yes	09/04/09	COL Issued 04/12/2018
Duke Energy Florida	05200029 & 05200030	COL	07/30/08	AP1000	Levy County, Units 1 and 2	FL	No	10/06/08	COL Terminated 04/26/2018
Oklo Power LLC	05200049	COL	03/11/20	Aurora	Idaho National Laboratory	ID	No	06/05/20	Scheduled

APPENDIX B
New Nuclear Power Plant Licensing Applications (continued)

Applicant	Docket Number	Type	Submittal Date	Design	Site	State	Existing Plant?	Date Accepted	Status
Design Certification									
AREVA NP	05200020	DC	12/11/07	U.S. EPR	N/A	N/A	N/A	02/25/08	Suspended–03/27/2015
Mitsubishi Heavy Industries	05200021	DC	12/31/07	US-APWR	N/A	N/A	N/A	02/29/08	Suspended–03/03/2020
Korea Electric Power Company and Korea Hydro and Nuclear Power	05200046	DC	12/23/14	APR 1400	N/A	N/A	N/A	03/04/15	Certified 09/19/2019
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	02/14/11	Scheduled
NuScale Power LLC	05200048	DC	01/6/17	NuScale	N/A	N/A	N/A	03/23/17	Scheduled
Early Site Permit									
PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG)	05200043	ESP	05/25/10	Not yet announced	PSEG Site	NJ	Yes	08/04/10	Issued 05/06/2016
Tennessee Valley Authority	05200047	ESP	05/12/16	Not yet announced	Clinch River Site	TN	No	12/30/16	Issued 12/19/2019

Notes: Withdrawal was requested for Calvert Cliffs, Grand Gulf, Nine Mile Point, Victoria County, Bellefonte, and Callaway combined license and early site permit (ESP). In September 2017, Duke Energy announced cancellation of William States Lee nuclear power plant Units 3 and 4.
Data are current as of June 2021 the next printed update will be in September 2022. NRC-abbreviated reactor names listed.

APPENDIX C

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

Unit Location Docket Number	Reactor Type MWt MWe	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
Duane Arnold Palo, IA 05000331	BWR-MARK 1 1,912	GE 4	06/22/1970 08/10/2020 2040	SAFSTOR SAFSTOR in Progress
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 2025	SAFSTOR SAFSTOR
GE VBWR (Vallecitos) Sunol, CA 05000018	BWR 50	GE	08/31/1957 12/09/1963 2025	SAFSTOR SAFSTOR
Haddam Neck Meriden, CT 05000213	PWR 1,825	WEST	12/27/1974 12/05/1996 11/26/2007	DECON DECON Completed

APPENDIX C

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

Unit Location Docket Number	Reactor Type MWt MWe	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 2036	DECON DECON in Progress
Indian Point 2 Buchanan, NY 05000247	PWR 3,216	WEST	09/28/1973 04/30/2020	DECON DECON in Progress
Indian Point 3 Buchanan, NY 05000286	PWR 3,216	WEST	12/12/1975 04/30/2021	DECON DECON in Progress
Kewaunee Carlton, WI 05000305	PWR 1,772	WEST 2LP	12/21/1973 05/07/2013 2073	SAFSTOR SAFSTOR
LaCrosse 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
Oyster Creek Forked River, NJ 05000219	BWR 1,930	GE	04/09/1969 09/17/2018 2078	SAFSTOR SAFSTOR
Pathfinder Sioux Falls, SD 05000130	BWR 190	AC	03/12/1964 09/16/1967 07/27/2007	DECON DECON Completed

APPENDIX C

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

Unit Location Docket Number	Reactor Type MWt MWe	NSSS Vendor	OL Issued Shut Down OL Terminated Closure Date Est.	Decommissioning Alternative Selected Current License Status
Peach Bottom 1 Delta, PA 05000171	HTG 115	GA	01/24/1966 10/31/1974 12/31/2034	SAFSTOR SAFSTOR
Pilgrim Plymouth, MA 05000293	BWR-MARK 1 2,028	GE 3	06/08/1972 05/31/2019 2064	SAFSTOR SAFSTOR
Rancho Seco Herald, CA 05000312	PWR 2,772	B&W	08/16/1974 06/07/1989 09/25/2009	DECON DECON Completed
San Onofre 1* San Clemente, CA 05000206	PWR 1,347	WEST	03/27/1967 11/30/1992 2030	DECON SAFSTOR
San Onofre 2 San Clemente, CA 05000361	PWR CE 3,438	CE	02/16/1982 06/12/2013 2030	DECON DECON in Progress
San Onofre 3 San Clemente, CA 05000362	PWR CE 3,438	CE	11/15/1982 06/12/2013 2030	DECON DECON in Progress
Savannah, N.S. Baltimore, MD 05000238	PWR 74	B&W	08/1965 11/1970 2031	DECON DECON in Progress
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 1 Middletown, PA 05000289	PWR 2,568	WEST	04/19/1974 09/20/2019 2079	SAFSTOR

APPENDIX C

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

Unit Location Docket Number	Reactor Type MWt MWe	NSSS Vendor	OL Issued Shut Down OL Terminated Closure Date Est.	Decommissioning Alternative Selected Current License Status
Three Mile Island 2** Middletown, PA 05000320	PWR 2,770	B&W	02/08/1978 03/28/1979 12/31/2036	DECON DECON in Progress
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 2030	DECON DECON in Progress
Zion 1 Zion, IL 05000295	PWR 3,250	WEST	10/19/1973 02/21/1997 2021	DECON DECON in Progress
Zion 2 Zion, IL 05000304	PWR 3,250	WEST	11/14/1973 09/19/1996 2021	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 post-defueling 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. N.S. = Nuclear Ship

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 August 2021. The next printed update will be in September 2022.

APPENDIX D

Canceled Commercial Nuclear Power Reactors

10 CFR 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

APPENDIX D

Canceled Commercial Nuclear Power Reactors

10 CFR Part 50—Domestic Licensing of Production and Utilization Facilities (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
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
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

APPENDIX D

Canceled Commercial Nuclear Power Reactors

10 CFR Part 50—Domestic Licensing of Production and Utilization Facilities (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number	
Hartsville A1 & A2	BWR	1984	
Tennessee Valley Authority	1,233	With CP	
5 miles SE of Hartsville, TN		05000518 & 519	
Hartsville B1 & B2	BWR	1982	
Tennessee Valley Authority	1,233	With CP	
5 miles SE of Hartsville, TN		05000520 & 521	
Haven 1 (formerly Koshkonong)	PWR	1980	
Wisconsin Electric Power Company	900	Under CP Review	
4.2 miles SSW of Fort Atkinson, WI		05000502	
Haven 2 (formerly Koshkonong)	PWR	1978	
Wisconsin Electric Power Company	900	Under CP Review	
4.2 miles SSW of Fort Atkinson, WI		05000503	
Hope Creek 2	BWR	1981	
Public Service Electric & Gas Company	1,067	With CP	
18 miles SE of Wilmington, DE		05000355	
Jamesport 1 & 2	PWR	1980	
Long Island Lighting Company	1,150	With CP	
65 miles E of New York City, NY		05000516 & 517	
Marble Hill 1 & 2	PWR	1985	
Public Service of Indiana	1,130	With CP	
6 miles NE of New Washington, IN		05000546 & 547	
Midland 1	PWR	1986	
Consumers Power Company	492	With CP	
S of City of Midland, MI		05000329	
Midland 2	PWR	1986	
Consumers Power Company	818	With CP	
S of City of Midland, MI		05000330	
Montague 1 & 2	BWR	1980	
Northeast Nuclear Energy Company	1,150	Under CP Review	
1.2 miles SSE of Turners Falls, MA		05000496 & 497	
New England 1 & 2		PWR	1979
New England Power Company		1,194	Under CP Review
8.5 miles E of Westerly, RI			05000568 & 569

APPENDIX D

Canceled Commercial Nuclear Power Reactors

10 CFR Part 50—Domestic Licensing of Production and Utilization Facilities (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
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
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

APPENDIX D

Canceled Commercial Nuclear Power Reactors

10 CFR Part 50—Domestic Licensing of Production and Utilization Facilities (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
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
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

APPENDIX D

Canceled Commercial Nuclear Power Reactors
10 CFR Part 50—Domestic Licensing of Production and Utilization Facilities (continued)

Unit Utility Location	Con Type MWe per Unit	Canceled Date Status Docket Number
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

10 CFR 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 3,763	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 1,594	July 17, 2015 With COL Review 05200016
Grand Gulf 3 Entergy Operations, Inc. Near Port Gibson in Claiborne County, MS	ESBWR 1,594	September 15, 2015 With COL Review 05200024
Levy 1 and 2 Duke Energy Florida 2 miles NE of Inglis, 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 1,594	March 31, 2014 With COL Review 05000038
River Bend 3 Entergy Operations, Inc. St. Francisville, LA	ESBWR 1,594	June 14, 2016 With COL Review 05200036
South Texas Project 3 and 4 Nuclear Innovation North America, LLC Bay City, TX	ABWR 3,926	July 12, 2018 With COL 05200012 & 05200013
V.C. Summer, Units 2 and 3 South Carolina Electric & Gas Co. Jenkinsville, SC	AP100 1,100	March 6, 2019 With COL 05200027 & 05200028
Victoria County Station 1 and 2 Exelon Nuclear Texas Holdings, LLC Near Victoria City in Victoria County, TX	ESBWR 4,500	July 20, 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. NRC actions are still pending. In September 2017, Duke Energy announced plans to cancel William States Lee III, Units 3 and 4.
Data are current as of August 2021; the next printed update will be in September 2022. 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, and 3*
Dominion Generation www.dom.com	Millstone 2 and 3 North Anna 1 and 2 Surry 1 and 2 Summer 1
DTE Electric Company www.dteenergy.com	Fermi 2
Duke Energy www.duke-energy.com	Brunswick 1 and 2 Catawba 1 and 2 Harris 1 McGuire 1 and 2 Oconee 1, 2, and 3 Robinson 2
Energy Harbor Corp. www.energyharbor.com	Beaver Valley 1 and 2 Davis-Besse 1 Perry 1
Energy Northwest www.energy-northwest.com	Columbia
Entergy Corporation, Inc. www.entergy-nuclear.com (formerly Entergy Nuclear Operations, Inc.)	Arkansas Nuclear One 1 and 2 Grand Gulf 1 Indian Point 2 and 3 Palisades River Bend 1 Waterford 3
Exelon Corporation, LLC www.exeloncorp.com	Braidwood 1 and 2 Byron 1 and 2 Calvert Cliffs 1 and 2 Clinton 1 Dresden 2 and 3 FitzPatrick Ginna LaSalle 1 and 2 Limerick 1 and 2 Nine Mile Point 1 and 2 Peach Bottom 2 and 3 Quad Cities 1 and 2

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 and 2
Nebraska Public Power District www.nppd.com	Cooper
NextEra Energy Inc. with principal subsidiaries Florida Power and Light Co. and NextEra Energy Resources, LLC www.fplgroup.com or nexteraenergy.com	Point Beach 1 and 2 Seabrook 1 St. Lucie 1 and 2 Turkey Point 3 and 4
Northern States Power Company Minnesota doing business as Xcel Energy www.xcelenergy.com	Monticello 1 Prairie Island 1 and 2
Pacific Gas and Electric Company www.pge.com	Diablo Canyon 1 and 2*
PSEG Nuclear, LLC www.pseg.com	Hope Creek 1 Salem 1 and 2
Southern Nuclear Operating Company www.southerncompany.com	Farley 1 and 2 Hatch 1 and 2 Vogtle 1 and 2
STP Nuclear Operating Company www.stpnoc.com	South Texas Project 1 and 2*
Talen Energy Corp. www.talenenergy.com	Susquehanna 1 and 2
Tennessee Valley Authority www.tva.gov	Browns Ferry 1, 2, and 3 Sequoyah 1 and 2 Watts Bar 1 and 2
Vistra Energy www.vistraenergy.com	Comanche Peak 1 and 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 August 2021; the next printed update will be in September 2022.

APPENDIX F

Commercial Nuclear Power Reactor Operating Licenses— Issued by Year

1969	Dresden 2* Ginna* Nine Mile Point 1* (1974)
1970	Point Beach 1* Robinson 2
1971	Dresden 3 Monticello 1* (1970)
1972	Palisades* (1971) Quad Cities 1 Quad Cities 2 Surry 1 Turkey Point 3
1973	Browns Ferry 1 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 D.C. Cook 1 FitzPatrick Hatch 1 Oconee 3 Peach Bottom 3 Prairie Island 1 Prairie Island 2
1975	Millstone 2
1976	Beaver Valley 1 Browns Ferry 3 Brunswick 1 Calvert Cliffs 2 Salem 1 St. Lucie 1
1977	Davis-Besse 1 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 1 Susquehanna 1
1983	McGuire 2 St. Lucie 2
1984	Callaway Columbia Diablo Canyon 1 Grand Gulf 1 LaSalle 2 (1983) 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 1 Harris 1(1986) 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

* The Atomic Energy Commission 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 are listed. Data are current as of August 2021; the next printed update will be in September 2022.

APPENDIX G

Commercial Nuclear Power Reactor Operating Licenses— Expiration by Year, 2024–2055

2024	Diablo Canyon 1
2025	Diablo Canyon 2
2026	Clinton 1 Perry 1
2029	Dresden 2 Ginna Nine Mile Point 1
2030	Comanche Peak 1 Monticello 1 Point Beach 1 Robinson 2
2031	Dresden 3 Palisades
2032	Quad Cities 1 Quad Cities 2
2033	Browns Ferry 1 Comanche Peak 2 Oconee 1 Oconee 2 Prairie Island 1 Point Beach 2
2034	Arkansas Nuclear 1 Browns Ferry 2 Brunswick 2 Calvert Cliffs 1 D.C. Cook 1 Cooper FitzPatrick Hatch 1 Oconee 3 Prairie Island 2
2035	Millstone 2 Watts Bar 1
2036	Beaver Valley 1 Browns Ferry 3 Brunswick 1 Calvert Cliffs 2 St. Lucie 1 Salem 1
2037	D.C. 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 1 Susquehanna 1
2043	Catawba 1 Catawba 2 Columbia LaSalle 2 McGuire 2 St. Lucie 2
2044	Byron 1 Callaway Grand Gulf 1 Limerick 1 Susquehanna 2 Waterford 3
2045	Fermi 2 Millstone 3 Palo Verde 1 River Bend 1 Wolf Creek 1
2046	Braidwood 1 Byron 2 Harris 1 Hope Creek 1 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
2050	Seabrook
	Turkey Point 3 Surry 1
2052	Peach Bottom 2
2053	Surry 2
	Turkey Point 4
2054	Peach Bottom 3
2055	Watts Bar 2

Notes: NRC-abbreviated reactor names are listed. Data are current as of August 2021; the next printed update will be in September 2022.

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 MARK I 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 MARK II 10/16/1962	1,250	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, MTR type fuel 11/21/1961	200	R-79 05000123
National Institute of Standards and 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
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

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
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 MARK II 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 August 2021; the next printed update will be in September 2022.

APPENDIX I

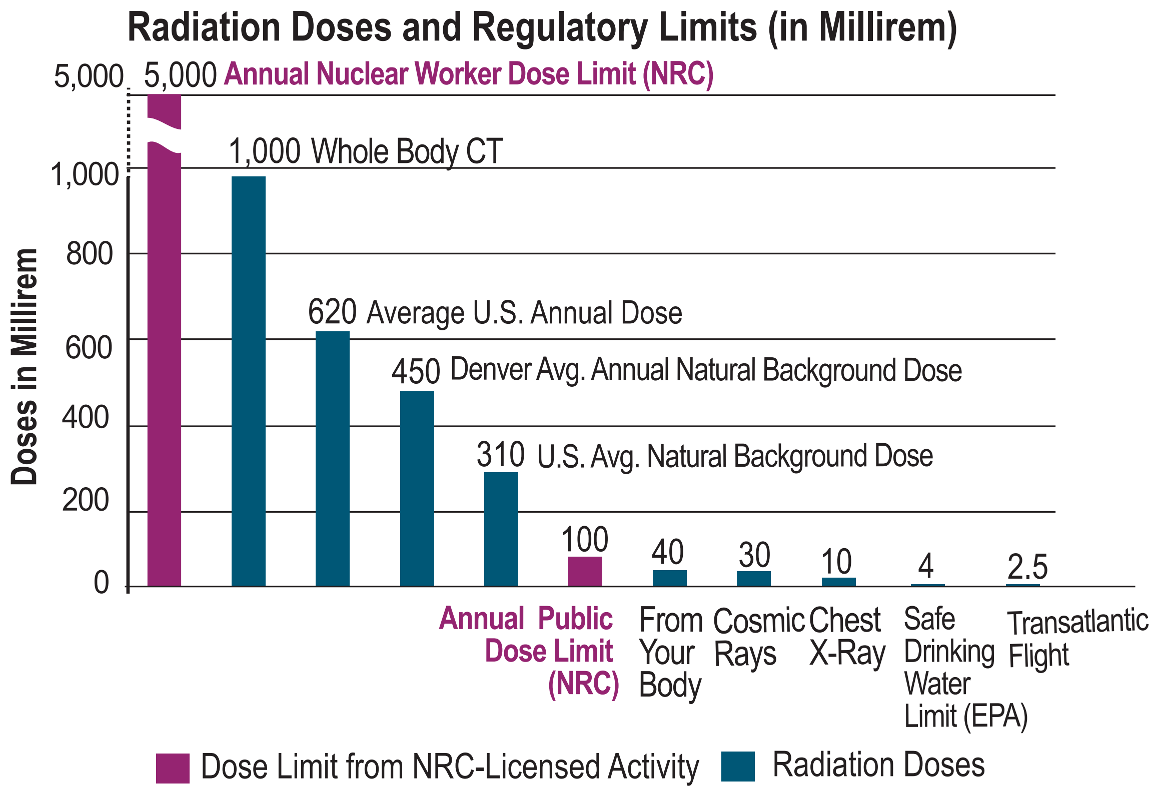
Nuclear Research and Test Reactors under Decommissioning Regulated by the NRC

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

Note: Data are current as of August 2021; the next printed update will be in September 2022.

APPENDIX J

Radiation Doses and Regulatory Limits



APPENDIX K
Commercial Nuclear Power Plant Licensing History 1955–2020

Year	Original Licensing Regulations (10 CFR Part 50)[1]		Alternative Licensing Regulations (10 CFR Part 52)[3]			
	CP Issued[2]	Full-Power OL Issued	COL Issued[4]	Operating COLs[5]	Permanent Shutdowns[6]	Operable Units
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	– –	– –	17	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

APPENDIX K
Commercial Nuclear Power Plant Licensing History 1955–2020 (continued)

Year	Original Licensing Regulations (10 CFR Part 50)[1]		Alternative Licensing Regulations (10 CFR Part 52)[3]			
	CP Issued[2]	Full-Power OL Issued	COL Issued[4]	Operating COLs[5]	Permanent Shutdowns[6]	Operable Units
1997	0	0	0	0	2	107
1998	0	0	0	0	1	104
1999–2011	0	0	0	0	0	104
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 unit	0	0	100
2016	0	0	6 units	0	1	99
2017	0	0	1 unit	0	0	99
2018	0	0	2 units	0	1	98
2019	0	0	0	0	2	96
2020	0	0	0	0	2	94
2021	0	0	0	0	1	93
Total	177	133	14 units	0	39	– –

U.S. Atomic Energy Commission was the regulatory authority.

– – Not applicable

[1] Data in columns 1–3 are based on 10 CFR Part 50. Numbers reflect permits or licenses issued in a given year, not extant permits or licenses.

[2] Issuance by regulatory authority of a permit, or equivalent permission, to begin construction. Under alternative licensing regulations in 10 CFR Part 52, a construction permit (CP) is not issued separately from the operating license.

[3] Data in columns 4–6 are based on 10 CFR Part 52. Numbers reflect permits or licenses issued in a given year, not extant permits or licenses.

[4] Number of combined licenses (COLs) issued in a given year, including six that were subsequently terminated. See Appendix A on status of plant construction and Appendix B for more information on withdrawn and suspended applications.

[5] Issuance by the NRC of a finding under 10 CFR 52.103(g), in a given year.

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

[7] These are DOE nuclear legacy sites: Hallam (1964), Piqua (1966), Elk River (1968), and Shippingport (1982). For more information, visit DOE's Legacy Management Web site at https://energy.gov/lm/sites/lm-sites and see the Glossary for definitions of decommissioning alternatives (DECON, SAFSTOR).

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

Data are current as of September 2022; the next printed update will be in August 2022.

APPENDIX L
Materials Licenses by State

State	NRC (Number of Licenses)	Agreement States (Number of Licenses)
Alabama	11	337
Alaska	58	0
Arizona	5	351
Arkansas	4	178
California	46	1,677
Colorado	16	311
Connecticut	118	0
Delaware	40	0
District of Columbia	33	0
Florida	16	1,538
Georgia	14	389
Hawaii	52	0
Idaho	67	0
Illinois	19	562
Indiana	199	0
Iowa	1	137
Kansas	13	255
Kentucky	6	339
Louisiana	12	440
Maine	2	91
Maryland	64	528
Massachusetts	17	401
Michigan	379	0
Minnesota	14	149
Mississippi	12	257
Missouri	223	0
Montana	75	0
Nebraska	4	130
Nevada	1	223

State	NRC (Number of Licenses)	Agreement States (Number of Licenses)
New Hampshire	2	71
New Jersey	21	523
New Mexico	9	204
New York	14	1,250
North Carolina	18	532
North Dakota	3	76
Ohio	40	534
Oklahoma	12	224
Oregon	3	304
Pennsylvania	42	539
Rhode Island	1	42
South Carolina	3	317
South Dakota	33	0
Tennessee	21	502
Texas	43	1,404
Utah	7	190
Vermont	1	33
Virginia	50	374
Washington	12	330
West Virginia	133	0
Wisconsin	6	284
Wyoming	73	14
Puerto Rico	102	0
Virgin Islands	9	0
Guam	5	0
American Samoa	2	0
Northern Marianas	1	0
Total number of materials licenses in Agreement State jurisdiction		16,040
Total number of materials licenses in NRC jurisdiction		2,186
Total number of materials licenses in the United States		18,226

Agreement State

Letter of Intent

Notes: The NRC and Agreement State data are current as of September 2022. 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 2022. The NRC licenses Federal agencies in Agreement States.

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	07001113
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
Framatome, Inc.	Richland, WA	active	07001257
Gas Centrifuge Uranium Enrichment Facilities			
Centrus Energy Corp American Centrifuge Plant	Piketon, OH	license issued, under construction	07007004
Centrus Energy Corp Lead Cascade	Piketon, OH	license active (facility decommissioned)	07007003
URENCO-USA (Louisiana Energy Services)	Eunice, NM	active	07003103
Uranium Enrichment Laser Separation Facility			
GE-Hitachi Global Laser Enrichment, LLC	Wilmington, NC	license terminated	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.
Notes: On February 8, 2018, the NRC issued a termination of the construction authorization (CAMOX-001) for the Mixed-Oxide Fuel Fabrication Facility (see ADAMS Accession No. ML18318A135). Centrus Energy Corp – American Centrifuge Plantis under construction for High Assay Low Enriched Uranium Demonstration Program. On January 5, 2021, the NRC issued a letter terminating the license for the GLE Laser Separation Enrichment Facility (see ADAMS Accession No. ML20293A175.
Data are current as of August 2021; the next printed update will be in September 2022.

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
Westinghouse Electric Co.	07201007	VSC-24
	07201026	Fuel Solutions™ (WSNF-220, -221, -223)
		W-150 Storage Cask
		W-100 Transfer Cask
		W-21, W-74 Canisters
TN Americas, LLC	07201005	TN-24 (expired)
(formerly Transnuclear, Inc.)	07201027	TN-68
	07201021	TN-32
	07201004	Standardized NUHOMS®-24P, -24PHB, 24PTH, -32PT, -32PTH1, -37PTH, -52B, -61BT DSC,-61BTH, -69BTH
	07201029	Standardized Advanced NUHOMS®-24PT1, -24PT4
	07201030	NUHOMS® HD-32PTH
	07201042	NUHOMS® EOS

Notes: Data are current as of August 2021; the next printed update will be in September 2022. (See the 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	Westinghouse Electric Co. Holtec International	VSC-24 HI-STORM 100	07200013
Beaver Valley FirstEnergy Nuclear Operating Company	GL	TN Americas, LLC	NUHOMS®-37PTH	07201043
Big Rock Point Entergy Nuclear Operations, Inc.	GL	Westinghouse Electric Co.	Fuel SolutionsTM 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	TN Americas, LLC	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	TN Americas, LLC	NUHOMS®-24P NUHOMS®-32P	07200008
Catawba Duke Energy Carolinas, LLC	GL	NAC International, Inc.	NAC-UMS® MAGNASTOR®	07200045
Clinton Exelon Generation Co., LLC	GL	Holtec International	HI-STORM FW	07201046
Columbia Generating Station Energy Northwest	GL	Holtec International	HI-STORM 100S	07200035
Comanche Peak Luminant Generation Company, LLC	GL	Holtec International	HI-STORM 100	07200074
Cooper Nuclear Station Nebraska Public Power District	GL	TN Americas, LLC	NUHOMS®-61BT	07200066
Crystal River Duke Energy Company	GL	TN Americas, LLC	NUHOMS®--32PT	07201035
Davis-Besse FirstEnergy Nuclear Operating Company	GL	TN Americas, LLC	NUHOMS®-24P NUHOMS®--32PTH	07200014
DC Cook Indiana/Michigan Power	GL	Holtec International	HI-STORM 100	07200072
Diablo Canyon Pacific Gas & Electric Co.	SL	Holtec International	HI-STORM 100	07200026
Dresden Exelon Generation Company, LLC	GL	Holtec International	HI-STAR 100 HI-STORM 100	07200037
Duane Arnold NextEra Energy Inc. Duane Arnold, LLC	GL	TN Americas, LLC	NUHOMS®-61BT	07200032

APPENDIX O

Dry Cask Spent Fuel Storage Licensees (continued)

Name Licensee	License Type	Vendor	Storage Model	Docket Number
Fermi DTE Electric Company	GL	Holtec International	HI-STORM 100	07200071
Fort Calhoun Omaha Public Power District	GL	TN Americas, LLC	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	TN Americas, LLC TN Americas, LLC	NUHOMS®-7P NUHOMS®-24P NUHOMS®-24PTH	07200003 07200060
Haddam Neck CT Yankee Atomic® Power	GL	NAC International, Inc.	NAC-MPC	07200039
Hatch Southern Nuclear Operating Co. Inc.	GL	Holtec International	HI-STORM100 HI-STAR100	07200036
Hope Creek PSEG Nuclear, LLC	GL	Holtec International	HI-STORM 100	07200048
Humboldt Bay Pacific Gas & Electric Co.	SL	Holtec International	HI-STAR 100HB	07200027
Idaho National Laboratory TMI-2 U.S. Department of Energy	SL	TN Americas, LLC	NUHOMS®-12T	07200020
Idaho Spent Fuel Facility U.S. Department of Energy	SL	Foster Wheeler	Concrete Vault	07200025
Indian Point Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100	07200051
James A. FitzPatrick Entergy Nuclear	GL	Holtec International Operations, Inc.	HI-STORM 100 HI-STORM 100S	07200012 07200013
Joseph M. Farley Southern Nuclear Operating Co.	GL	Holtec International	HI-STORM 100S	07200042
Kewaunee Dominion Energy	GL	TN Americas, LLC NAC International, Inc.	NUHOMS®-32PT MAGNASTOR®	07200064
Kewaunee, Inc. La Salle Exelon Generation Co., LLC	GL	Holtec International	HI-STORM 100S	07200070
LaCrosse Dairyland Power	GL	NAC International, Inc.	NAC-MPC	07200046
Limerick Exelon Generation Co., LLC	GL	TN Americas, LLC	NUHOMS®-61BT NUHOMS®-61BTH	07200065
Maine Yankee Maine Yankee Atomic Power Company	GL	NAC International, Inc.	NAC-UMS®	07200030
McGuire Duke Energy, LLC	GL	TN Americas, LLC NAC International, Inc.	TN-32 NAC-UMS® MAGNASTOR®	07200038
Millstone Dominion Generation	GL	TN Americas, LLC	NUHOMS®-32PT	07200047
Monticello Northern States Power Co., Minnesota	GL	TN Americas, LLC	NUHOMS®-61BT NUHOMS®-61BTH	07200058

APPENDIX O

Dry Cask Spent Fuel Storage Licensees (continued)

Name Licensee	License Type	Vendor	Storage Model	Docket Number
Nine Mile Point Constellation Energy	GL	TN Americas, LLC	NUHOMS®-61BT	07201036
North Anna Virginia Electric & Power Co. (Dominion Energy Virginia)	GL SL	TN Americas, LLC TN Americas, LLC	NUHOMS®32PTH1 TN-32 07200016	07200056
Oconee Duke Energy Company	SL GL	TN Americas, LLC TN Americas, LLC	NUHOMS®-24P NUHOMS®-24P	07200004 07200040
Oyster Creek Oyster Creek Environmental Protection, LLC	GL	TN Americas, LLC	NUHOMS®-61BT NUHOMS®-61BTH	07200015
Palisades Entergy Nuclear Operations, Inc.	GL	Westinghouse Electric Co TN Americas, LLC Holtec International	VSC-24 NUHOMS®-32PT NUHOMS®-24PT HI-STORM FW	07200007
Palo Verde Arizona Public Service Co.	GL	NAC International, Inc.	NAC-UMS®	07200044
Peach Bottom Exelon Generation Co., LLC	GL	TN Americas, LLC	TN-68 07200029	
Perry FirstEnergy	GL	Holtec International	HI-STORM 100	07200069
Pilgrim Holtec Pilgrim, LLC	GL	Holtec International	HI-STORM 100	07201044
Point Beach NextEra Energy	GL	Westinghouse Electric Co. TN Americas, LLC	VSC-24 07200005 NUHOMS®-32PT	
Prairie Island Northern States Power Co., Minnesota	SL	TN Americas, LLC	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	TN Americas, LLC	NUHOMS®-24PT	07200011
R.E. Ginna Constellation Energy	GL	TN Americas, LLC	NUHOMS®-32PT	07200067
River Bend Entergy Nuclear Operations, Inc.	GL	Holtec International	HI-STORM 100S	07200049
Salem PSEG Nuclear (Duplicate, see Hope Creek)	GL	Holtec International	HI-STORM 100	07200048
San Onofre Southern California Edison Co.	GL	TN Americas, LLC Holtec International	NUHOMS®-24PT4 NUHOMS®-24PT1 HI-STORM UMAX	07200041
Seabrook FPL Energy	GL	TN Americas, LLC	NUHOMS®-HD-32PTH	07200063
Sequoyah Tennessee Valley Authority	GL	Holtec International	HI-STORM 100 HI-STORM FW HI-STORM 100S	07200034

APPENDIX O

Dry Cask Spent Fuel Storage Licensees (continued)

Name Licensee	License Type	Vendor	Storage Model	Docket Number
South Texas Project STP Nuclear Operating Co.	GL	Holtec International	HI-STORM FW	07201041
St. Lucie Florida Power & Light Co.	GL	TN Americas, LLC	NUHOMS®-HD-32PTH	07200061
Surry Virginia Electric & Power Co. (Dominion Energy Virginia)	SL GL	TN Americas, LLC TN Americas, LLC Gesellschaft für Nuklear-Service NAC International, Inc. Westinghouse Electric Co	NUHOMS®HD NUHOMS®HD-32PTH Castor NAC-128 MC-10	07200002 07200055
Susquehanna Pennsylvania Power & Light Co.	GL	TN Americas, LLC	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	TN Americas, LLC	NUHOMS®-HD-32PTH	07200062
Vermont Yankee NorthStar Vermont Yankee, LLC	GL	Holtec International	HI-STORM 100	07200059
Virgil C. Summer South Carolina Electric & Gas	GL	Holtec International	HI-STORM FW	07201038
Vogtle Southern Nuclear Operating Co. Inc.	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
WCS Consolidated Interim Storage Facility, CISF Interim Storage Partners, LLC	SL	TN Americas, LLC NAC International, Inc.	NUHOMS®-MP187 NUHOMS 24PT1 NUHOMS 61BT NUHOMS 61BTH NAC-MPC NAC-UMS® MAGNASTOR®	07201050
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 ISFSI NRC SNM-2504 license was transferred to DOE on June 4, 1999.
Notes: NRC-abbreviated unit names. Data are current as of Sept. 2021; the next printed update will be in September 2022.
License Types: SL = site-specific license, GL = general license

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

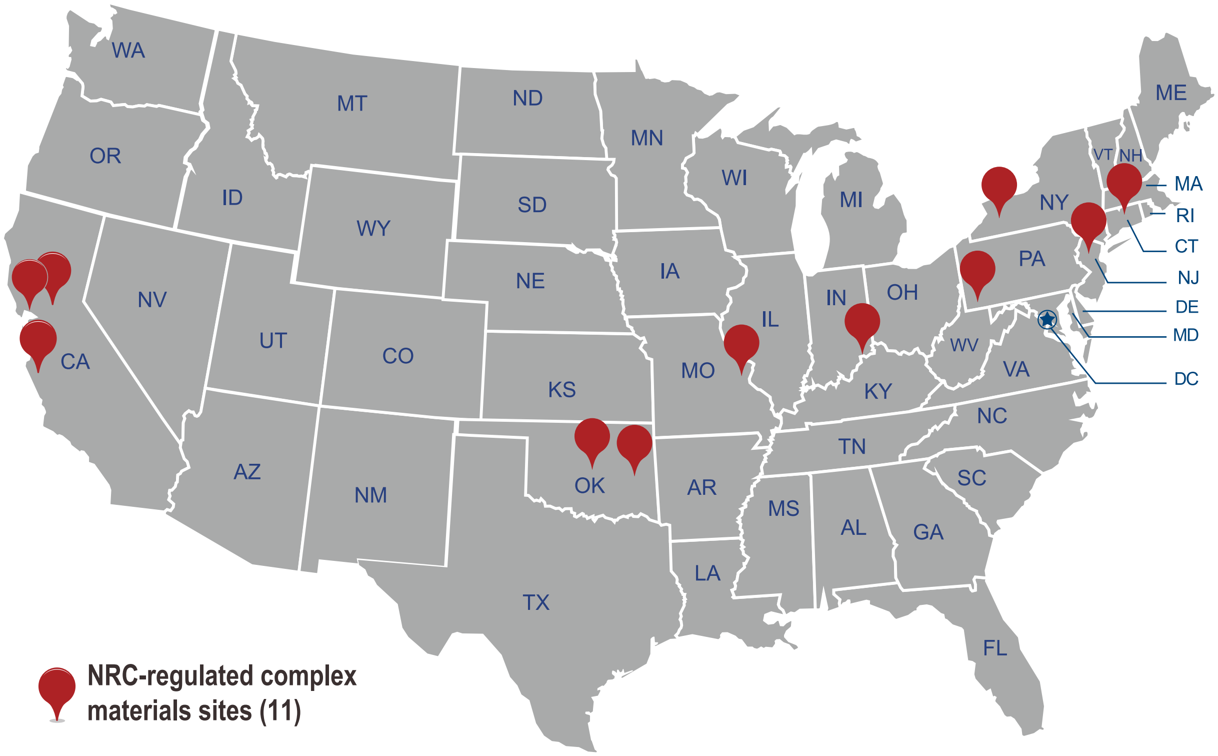
Beatty, NV, closed 1993
Sheffield, IL, closed 1978
Maxey Flats, KY, closed 1977
West Valley, NY, closed 1975

* Site of an active low-level waste disposal facility.

Note: Data are current as of August 2021; the next printed update will be in September 2022.

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 the Army, Jefferson Proving Ground	Madison, IN
Department of the Army, Picatinny Arsenal (ARDEC)	Picatinny, NJ
FMRI, Inc. (Fansteel)	Muskogee, OK
Hunter's Point Naval Shipyard	San Francisco, CA
McClellan Air Force Base	Sacramento, CA
Sigma Aldrich	Maryland Heights, MO
UNC Naval Products	New Haven, CT
West Valley Demonstration Project	West Valley, NY

Note: Data are current as of August 2021; the next printed update will be in September 2022.

APPENDIX R

Nuclear Power Units by Nation

Country	In Operation: Nuclear Power Production GWh*	In Operation: Number of Units	In Operation: Net MW(e) Electrical Capacity	Under Construction or on Order: Number of Units	Under Construction or on Order: Net MW(e) Electrical Capacity	Shutdown
Argentina	10,011	3	1,641	1	25	0
Armenia	2,552	1	415	0	0	1P
Bangladesh	0	0	0	2	2,160	0
Belarus	338	1	1,110	1	1,110	0
Belgium	32,606	7	5,942	0	0	1P
Brazil	14,053	2	1,884	1	1,340	0
Bulgaria	16,626	2	2,006	0	0	4P
Canada	92,652	19	13,624	0	0	6P
China	366,300	51	48,528	13	12,565	0
Czech Republic	28,372	6	3,934	0	0	0
Finland	22,358	4	2,794	1	1,600	0
France	379,500	56	61,370	1	1,630	14P
Germany	60,918	6	8,113	0	0	30P
Hungary	15,179	4	1,902	0	0	0
India	40,374	23	6,885	6	4,194	0
Iran	5,792	1	915	1	974	0
Italy	0	0	0	0	0	4P
Japan	43,000	33	31,679	2	2,653	27P
Kazakhstan	0	0	0	0	0	1P
Korea, Republic of	152,328	24	23,150	4	5,360	2P
Lithuania	0	0	0	0	0	2P
Mexico	10,864	2	1,552	0	0	0
Netherlands	3,865	1	482	0	0	1P
Pakistan	9,640	6	2,332	1	1,014	0
Romania	10,558	2	1,300	0	0	0
Russia	215,745	38	28,578	3	3,459	9P
Slovakia Republic	15,444	4	1,837	2	880	3P
Slovenia	6,041	1	688	0	0	0

APPENDIX R

Nuclear Power Units by Nation (continued)

	In Operation			Under Construction or on Order		
Country	Nuclear Power Production GWh*	Number of Units	Net MW(e) Electrical Capacity	Number of Units	Net MW(e) Electrical Capacity	Shutdown
South Africa	11,616	2	1,860	0	0	0
Spain	55,793	7	7,121	0	0	3P
Sweden	47,262	6	6,882	0	0	7P
Switzerland	22,990	4	2,960	0	0	2P
Turkey	0	0	0	3	3,242	0
Ukraine	76,202	15	13,107	2	2,070	4P
United Arab Emirates	1,562	1	0	3	4,035	0
United Kingdom	45,668	15	8,923	2	3,260	30P
United States	789,919	93	95,523	2	2,234	40P

Overview of Worldwide Nuclear Power Reactors—As of June 28, 2021

Nuclear Electricity Supplied (GWh)	2,553,208
Net Installed Capacity (MWe)	394,226
Nuclear Power Reactors in Operation	444
Nuclear Power Reactors in Long-Term Shutdown	0
Nuclear Power Reactors in Permanent Shutdown	193
Nuclear Power Reactors under Construction	51

* Annual electrical power production for 2018.

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. Source: 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 June 28, 2021. The next printed update will be in September 2022.

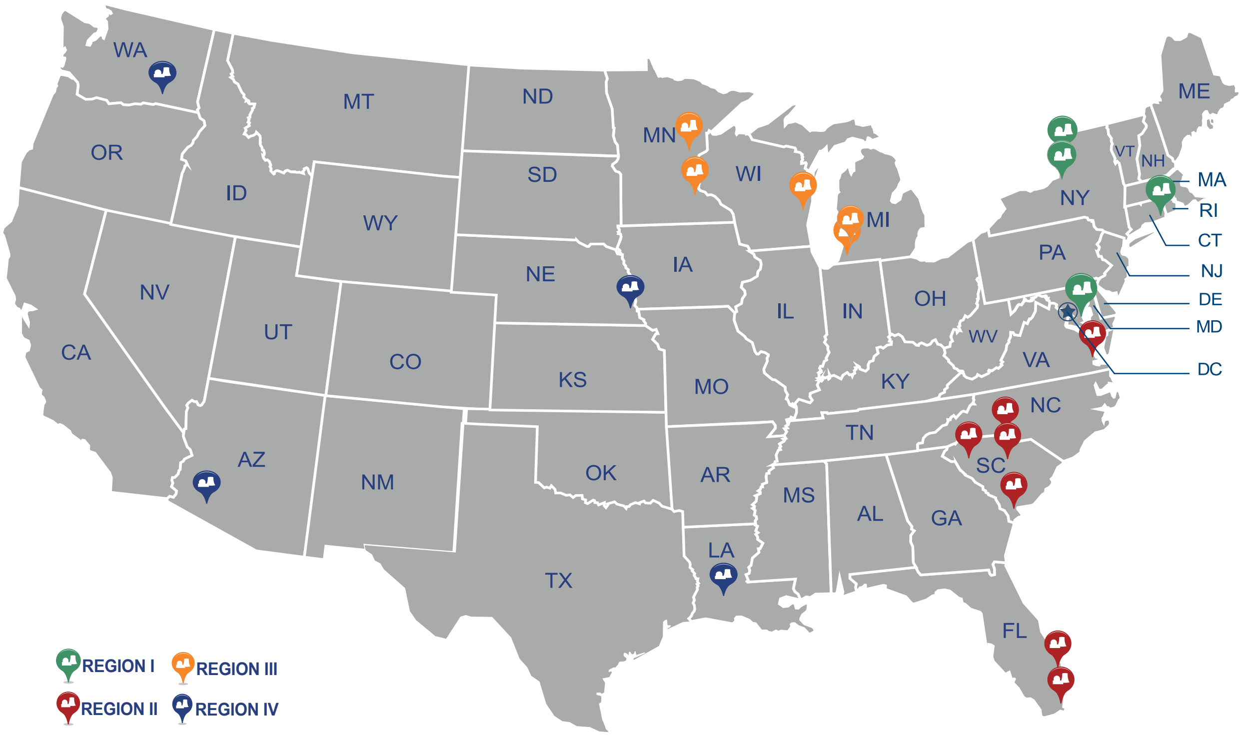
APPENDIX S

Nuclear Power Units by Reactor Type, Worldwide

	In Operation	
Reactor Type	Number of Units	Net MWe
Pressurized light-water reactors (PWR)	303	288,068
Boiling light-water reactors (BWR)	63	64,122
Heavy-water reactors, all types (HWR, PHWR)	49	24,553
Gas-cooled reactors, all types (GCR)	14	7,725
Light-water-cooled graphite-moderated reactor (LWGR)	12	8,358
Liquid-metal-cooled fast breeder reactors (FBR)	3	1,400
Total	**444**	**394,226**

Note: Megawatts electric (MWe) values are rounded to the nearest whole number.
Source: IAEA Power Reactor Information System Database, https://www.iaea.org/pris/ Compiled by the NRC from IAEA data.
Data are current as of June 28, 2021. The next printed update will be in September 2022..

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



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

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

LOUISIANA
River Bend
Tunica-Biloxi Reservation

MARYLAND
Calvert Cliffs
Rappahannock Tribe
Upper Mattaponi 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.**
Note: 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, Hawaii or U.S. Territories. For more information on other Tribal concerns, go to the NRC Web site at https://www.nrc.gov. NRC-abbreviated reactor names listed. Data as of July 2021, and the next printed update will be September 2022.

APPENDIX U
States with NRC Grant Award Recipients in Fiscal Year 2020

State	Amount Awarded	Type of Grant	Academic Institution	Title of Proposal
CA	$500,000	Research and Development Grant	University of Southern California	Risk-informed Condition Assessment of Spent Nuclear Fuel Canisters Using Experimental Measurements and High-fidelity Computational Models
CO	$400,000	Fellowship	Colorado State University	Colorado State University Health Physics Fellowship Program
FL	$450,000	Faculty Development	University of Florida	2020 NRC Nuclear Engineering Faculty Development Program
FL	$399,389	Fellowship	Florida International University	FIU Nuclear Fellowship Program: Expanding the Radiochemistry Ph.D. Track
FL	$395,277	Fellowship	University of Florida	2020 NRC Graduate Fellowship Program at the University of Florida
FL	$199,990	Scholarship	Florida Memorial University	Fostering Matriculation of Undergraduates in Nuclear Research and Collaboration
GA	$499,927	Research and Development Grant	Georgia Institute of Technology	Experimental Investigation of Heat Transfer and Pressure Drop Characteristics of AHTR Channels
ID	$398,050	Fellowship	Idaho State University	Idaho State University Nuclear Education Fellowship Program
ID	$399,332	Fellowship	University of Idaho	Graduate Fellowships in Nuclear Engineering at the University of Idaho
IL	$400,000	Fellowship	University of Illinois	University of Illinois at Urbana-Champaign Nuclear Engineering Education Fellowship Program
IL	$500,000	Research and Development Grant	University of Illinois	Advancing Uncertainty Analysis Processes in Risk-Informed Regulatory Framework to Support Simulation Approaches for Aging Plants and Advanced Reactors
IN	$450,000	Faculty Development	Purdue University	Purdue University Health Physics Faculty Development Plan
IN	$398,092	Fellowship	Purdue University	Graduate Fellowship Program in Nuclear Materials at Purdue
KS	$400,000	Fellowship	Kansas State University	Kansas State University (KSU) Nuclear Engineering Fellowship Program (NEFP)
KS	$418,161	Research and Development Grant	Kansas State University	Addressing Technical Knowledge Gaps for Concrete Creep, Creep Recovery, and Creep Fracture
MA	$450,000	Faculty Development	University of Massachusetts - Lowell	Faculty Development Program for Radiochemistry and Radiological Health Physics at the University of Massachusetts Lowell
MA	$450,000	Faculty Development	Worcester Polytechnic Institute	WPI Nuclear Science and Engineering (NSE) Faculty Development Program
MA	$400,000	Fellowship	University of Massachusetts - Lowell	Fellowship in Nuclear Engineering and Health Physics at the University of Massachusetts Lowell
MD	$500,000	Research and Development Grant	University of Maryland	Improving Foundational Knowledge of Dependency in Human Reliability Analysis
MD	$383,061	Research and Development Grant	University of Maryland	Application of Advanced and Hybrid Risk Tools in External Hazard PRA: Challenges and Opportunities
MI	$500,000	Research and Development Grant	University of Michigan	High fidelity modeling and experiments to inform safety analysis codes for heat pipe microreactors

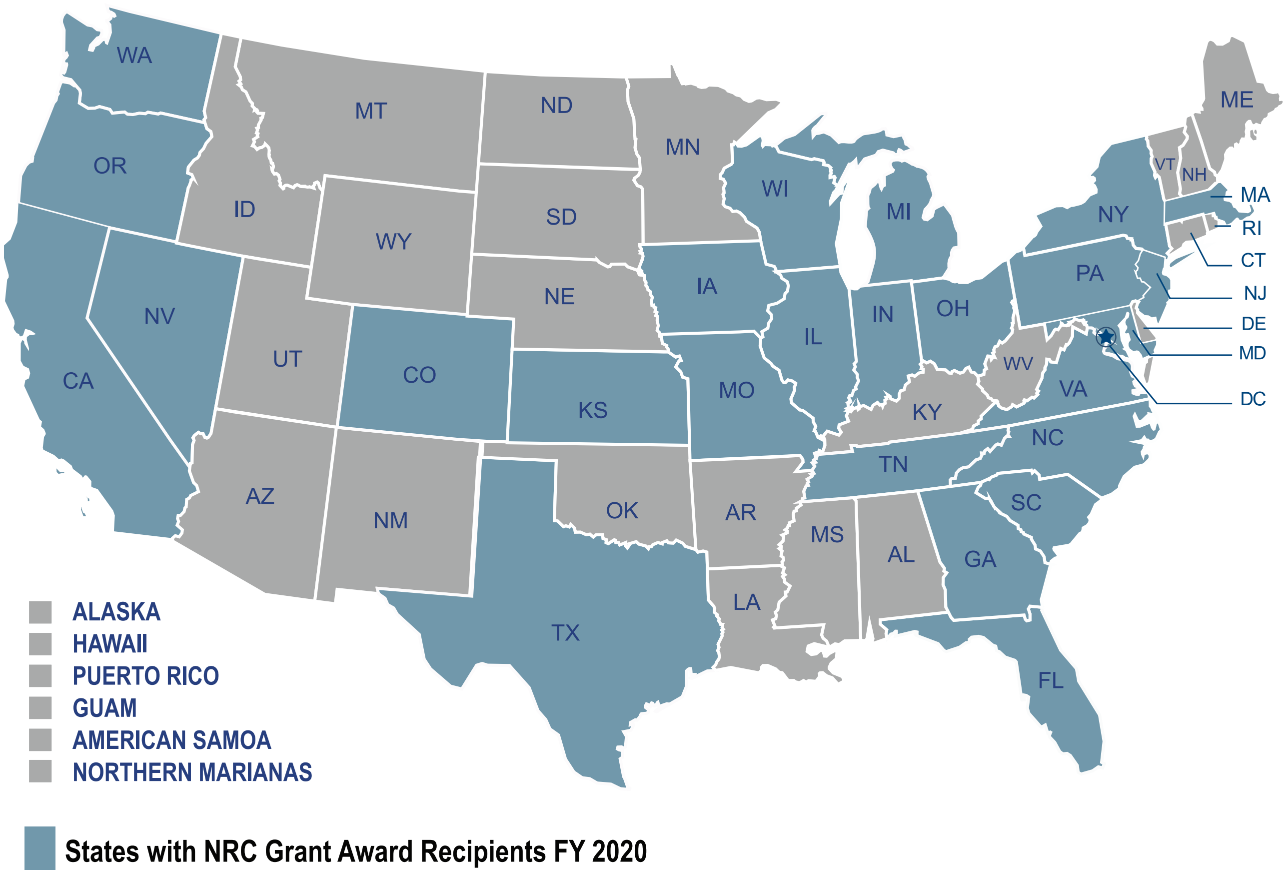
APPENDIX U
States with NRC Grant Award Recipients in Fiscal Year 2020 (continued)

State	Amount Awarded	Type of Grant	Academic Institution	Title of Proposal
MO	$450,000	Faculty Development	University of Missouri - Columbia	University of Missouri-Columbia Radiochemistry Faculty Development Program
MO	$200,000	Scholarship	Missouri University of Science and Technology	Undergraduate Scholarships in Nuclear Engineering at Missouri S&T (2020-2022)
NC	$500,000	Research and Development Grant	North Carolina State University	OECD/NRC Liquid Metal Fast Reactor (LMFR) Core Thermal-Hydraulic Benchmark for Verification, Validation, and Uncertainty Quantification(VVUQ) of Sub-Channel and Computational Fluid Dynamics (CFD) Codes
NJ	$199,396	Scholarship	Thomas Edison State University	Thomas Edison State University Scholarship Program for Qualified Students Matriculated in Nuclear Energy Engineering, Electronics Systems Engineering Technology, Radiation Protection, Cyber Security, and Information Technology Degree Programs
NV	$499,912	Research and Development Grant	University of Nevada – Reno	A Self-Powered Platform to Measure and Report Spent Nuclear Fuel Package Temperatures during Transport without Containment Boundary Penetrations
NY	$500,000	Research and Development Grant	Rensselaer Polytechnic Institute	Development of a Modular Paradigm to Enhance Monte Carlo Neutronics for NRC Comprehensive Reactor Analysis Bundle (CRAB)
NY	$200,000	Scholarship	Rensselaer Polytechnic Institute	Enabling Strong Growth of the Nuclear Engineering Undergraduate Scholarship Program
OH	$187,105	Scholarship	Case Western Reserve University	ThinkEnergy, ThinkNuclear: The Next Generation of ThinkEnergy Scholars
OR	$400,000	Fellowship	Oregon State University	Oregon State University Nuclear Science and Engineering Fellowship Program
OR	$500,000	Research and Development Grant	Oregon State University	Dynamic Risk Assessment for Nuclear Cybersecurity
PA	$450,000	Faculty Development	University of Pittsburgh	Pitt Nuclear Engineering Faculty Growth and Development
SC	$400,000	Fellowship	University of South Carolina	University of South Carolina Next Generation Nuclear Engineering Fellowship Program
TN	$450,000	Faculty Development	University of Tennessee	Faculty Development Program in Nuclear Data at the University of Tennessee
TX	$450,000	Faculty Development	Texas A&M University	Texas A&M Nuclear Engineering Faculty Development Program
TX	$300,000	Faculty Development	University of Texas at San Antonio	UTSA Faculty Development in Cybersecurity of Digital I&C in Nuclear Power Plants Research and Education
TX	$500,000	Research and Development Grant	Texas A&M University	Heat Transfer Experimental and Computational Data for Molten Salt Reactors Applications
TX	$450,000	Research and Development Grant	Texas A&M University	Assessment of TRACE Thermal-Hydraulic System Code for the Prediction of the Reactor Cavity Cooling System Behavior and Performance
TX	$158,040	Scholarship	University of Texas at Austin	NRC Scholarship at the University of Texas
VA	$450,000	Faculty Development	Virginia Commonwealth University	Virginia Commonwealth University Faculty Development Program in Advanced non-LWR Nuclear Reactor Design and Thermal Hydraulics

APPENDIX U

States with NRC Grant Award Recipients in Fiscal Year 2020 (continued)

State	Amount Awarded	Type of Grant	Academic Institution	Title of Proposal
VA	$499,517	Research and Development Grant	Virginia Polytechnic Institute	Non-dimensional Analysis of Density-Wave Instabilities and Dryout-Rewet Cycles during an ATWS
WA	$150,000	Trade & Community College	Columbia Basin College	Columbia Basin College Nuclear Scholarship Program
WI	$450,000	Faculty Development	University of Wisconsin - Madison	University of Wisconsin-Madison Faculty Development Program in Nuclear Engineering
WI	$499,991	Research and Development Grant	University of Wisconsin – Madison	Understanding Microstructure-Mechanical Behavior Relationships in Coated Cladding Accident Tolerant Fuel (ATF) Concepts for Used Fuel Storage and Transportation
WI	$200,000	Scholarship	University of Wisconsin - Madison	University of Wisconsin-Madison Undergraduate Scholarship Program in Nuclear Engineering



APPENDIX V
Significant Enforcement Actions Issued, 2020

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-19-079	Bittner Engineering, Inc.	Materials	02/12/2020	SLIII Problem/NOV
EA-19-127	Municipality of Anchorage	Materials	02/13/2020	SLIII/NOV
EA-19-141	Sanders Medical Products	Materials	03/03/2020	(2) SLIII/NOV
EA-19-025	Duke Energy (H.B. Robinson Steam Electric Plant)	Reactor	03/11/2020	Confirmatory Order result of an ADR mediation
EA-19-126	Avera St. Luke's Hospital	Materials	03/11/2020	SLIII Problem/NOV
IA-20-005	Mr. Stanley Schultz	Individual	03/11/2020	SLIII/NOV
EA-19-108	Schultz Surveying & Engineering Inc.	Materials	03/11/2020	SLIII Problem/NOV
IA-20-025	Mr. Michael Paul	Individual	03/12/2020	SLIII/NOV
EA-19-071	Reed College	Reactor	03/16/2020	Confirmatory Order result of an ADR mediation
IA-19-035	Dr. Melinda Krahenbuhl	Individual	03/16/2020	Order banning for three years; withdrawn following ADR mediation
EA-19-112	Southern Nuclear Operating Co. (Vogtle Electric Generating Plant)	Reactor	03/31/2020	White/NOV
EA-19-068	Lantheus Medical Imaging	Materials	04/23/2020	SLIII Problem/NOV; SLIII/NOV/CP-$7,500
IA-19-033	Mr. César Blanco	Individual	04/23/2020	SLIII Problem/NOV
EA-19-136	Thrasher Engineering	Materials	04/27/2020	SLIII/NOV/CP-$7,500
EA-20-014	Alt and Witzig Engineering, Inc.	Materials	05/13/2020	(2) SLIII/NOV/CP-$8,500
EA-20-047	Christian Wheeler Engineering	Materials	06/18/2020	SLIII/NOV
EA-20-046	Bayou Inspection Services, Inc.	Materials	06/22/2020	SLIII/NOV
EA-19-096	Hot Asphalt Paving, Inc.	Materials	06/24/2020	SLIII/NOV/CP-$7,500
EA-20-010	Centro Comprensivo de Cancer de la UPR	Materials	06/30/2020	SLIII Problem/NOV
IA-20-023	Mr. Dennis Bergmooser	Individual	07/15/2020	SLIII/NOV
IA-20-040	Dr. Melinda Krahenbuhl	Individual	07/27/2020	Confirmatory Order result of an ADR mediation; Order IA-19-035 withdrawn for three year ban on July 27, 2020
EA-20-057	Virginia Electric and Power Co. (Surry Power Station)	Reactor	07/30/2020	White/NOV
EA-20-003	Avera McKennan	Materials	08/12/2020	SLIII Problem/NOV/CP-$7,500
IA-20-008	Mr. Joseph Shea	Individual	08/24/2020	Order banning for five years; Order rescinded on January 22, 2021

APPENDIX V
Significant Enforcement Actions Issued, 2020 (continued)

Action #	Name	Type	Issue Date	Enforcement Action
IA-20-009	Ms. Erin Henderson	Individual	08/24/2020	SLII/NOV; NOV rescinded on January 22, 2021
EA-20-006 EA-20-007	Tennessee Valley Authority (Watts Bar Nuclear Plant)	Reactor	08/24/2020	SLI Problem/NOV; SLII Problem/NOV/CP-$606,942; Order Imposing CP issued October 29, 2020; Hearing requested by TVA on November 30, 2020
EA-20-065	St. Luke's Regional Medical Center	Materials	09/15/2020	SLIII Problem/NOV/CP-$7,500
EA-20-095	International Isotopes, Inc.	Materials	09/17/2020	SLIII/NOV
EA-20-018	Entergy Operations, Inc. (Arkansas Nuclear One)	Reactor	09/23/2020	SLIII/NOV
IA-20-027	Mr. Todd Hegeman	Individual	09/24/2020	SLIII/NOV
IA-20-028	Mr. James Johnson	Individual	09/24/2020	SLIII/NOV
IA-20-029	Mr. Thomas Spivey	Individual	09/24/2020	SLIII/NOV
IA-20-030	Mr. Denver Lee	Individual	09/24/2020	SLIII/NOV
EA-19-132	St. Joseph's Regional Medical Center	Materials	10/07/2020	SLIII Problem/NOV/CP-$7,500
EA-20-050	Sanford Medical Center	Materials	10/16/2020	SLIII Problem/NOV
EA-20-073	International Isotopes, Inc.	Materials	10/20/2020	SLII Problem/NOV
EA-20-051	The Queen's Medical Center	Materials	10/27/2020	SLIII Problem/NOV/CP-$7,500
EA-19-092	Tennessee Valley Authority (Watts Bar Nuclear Plant)	Reactor	11/06/2020	SLII/NOV; (2) SL III/NOV, SL II/NOV/CP $303,471
IA-20-017	Mr. Billy Johnson	Individual	11/06/2020	SLII/NOV; SLIII/NOV
IA-20-018	Mr. William Sprinkle	Individual	11/06/2020	SLIII/NOV; NOV withdrawn on July 23, 2021
IA-20-020	Mr. Todd Blakenship	Individual	11/06/2020	SLIII/NOV; NOV withdrawn on July 23, 2021
EA-20-054	Arizona Public Service Co. (Palo Verde Nuclear Generating Station)	Reactor	11/17/2020	Confirmatory Order result of an ADR mediation
EA-20-056	Armed Forces Radiobiological Research Institute	Reactor	11/19/2020	Confirmatory Order result of an ADR mediation
EA-20-110	TTL Associates	Materials	12/03/2020	(2) SLIII/NOV
EA-20-066	NAC International	Non-licensee	12/21/2020	SLIII/NOV/SLIV

APPENDIX W

FUNDAMENTAL 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. 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)
11. Nuclear Energy Innovation and Modernization Act (Pub. L. 115-439)

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, as amended

Nonproliferation

1. Nuclear Non-Proliferation Act of 1978

Fundamental Laws Governing the Processes of Regulatory Agencies

1. Administrative Procedure Act (5 U.S.C. Chapter 5, Subchapter II, and Chapter 7)
2. National Environmental Policy Act of 1969, as amended (42 U.S.C Chapter 55, Subchapters I and II)
3. National Historic Preservation Act as amended (54 U.S.C. Subtitle III, Division A)

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. Convention on Early Notification of a Nuclear Accident, entry into force October 27, 1986; the United States is a party
3. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, entry into force February 26, 1987; the United States is a party
4. Convention on Nuclear Safety, entry into force October 24, 1996; the United States is a party
5. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, entry into force June 18, 2001; the United States is a party
6. Convention on the Physical Protection of Nuclear Material (CPPNM), entry into force February 8, 1987; the United States is a party
7. Amendment to the CPPNM, entry into force May 8, 2016; the United States is a party
8. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, entry into force August 30, 1975; the United States 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)
9. Convention on Supplementary Compensation for Nuclear Damage; entry into force April 15, 2015
10. Agreement between the United States of America and the International Atomic Energy Agency for the Application of Safeguards in the United States of America (INFCIRC/288); entry into force December 9, 1980
11. Agreement Between the United States of America 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; the United States is a party
12. Protocol Additional to the Agreement between the United States of America and the International Atomic Energy 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 August 2021; the next printed update will be in September 2022.

APPENDIX Y
International Activities:

LIST OF MULTILATERAL ORGANIZATIONS, COMMITTEES, AND WORKING GROUPS IN WHICH THE NRC PARTICIPATES

International Commission on Radiological Protection (ICRP)

International Atomic Energy Agency (IAEA)
Commission on Safety Standards (CSS)
Emergency Preparedness and Response Standards Committee (EPReSC)
IAEA Global Nuclear Safety and Security Network Steering Committee (GNSSN)
International Nuclear and Radiological Event Scale (INES) Advisory Committee
Nuclear Safety Standards Committee (NUSSC)
Nuclear Security Guidance Committee (NSGC)
Radiation Safety Standards Committee (RASSC)
Regulatory Cooperation Forum Steering Committee (RCF)
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)
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 Decommissioning of Nuclear Installations and Legacy
Management (CDLM)
The Committee on Radiation Protection and Public Health (CRPPH)
The Nuclear Law Committee (NLC)
Multinational Design Evaluation Programme (MDEP)
Nuclear Science Committee (NSC)

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

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

Source: https://www.unscear.org/

APPENDIX Y
International Activities: (continued)

NRC'S BILATERAL INFORMATION EXCHANGE AND COOPERATION AGREEMENTS

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

Notes: The country's short-form name is used. The NRC's cooperation arrangements are initiated and renewed for 5-year terms.
Data are current as of August 2021; the next printed update will be in September 2022.
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 2020: APPENDIX P

License Number	Applicant	Docket Number
PXB11b.14	QSA Global, Inc.	11006092
PXB11a.04	QSA Global, Inc.	11006386
PXB12.04	QSA Global, Inc.	11006073
PXB139.05	Schlumberger Technology Corporation	11006082
PXB190a.02	International Isotopes Inc.	11006160
PXB217.01	Halliburton Energy Services, Inc.	11006287
PXB220.01	Baker Hughes Oilfield Operations, Inc.	11006304
PXB224.01	ISOFLEX Radioactive, LLC	11006318
PXB3.11	Nordion (Canada) Inc.	11006070
PXB6.30	Alpha-Omega Services, Inc.	11006027
PXB6.31	Alpha-Omega Services, Inc.	11006027
PXB6.32	Alpha-Omega Services, Inc.	11006027
PXB6.33	Alpha-Omega Services, Inc.	11006027
PXB6.34	Alpha-Omega Services, Inc.	11006027

Licenses under Appendix P to 10 CFR Part 110,"Export 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 and import of U.S-origin sources for return back to the U.S. supplier after the source has been used. These combined licenses are no longer being issued and can no longer be amended going forward, because such imports are authorized under a general license (see 10 CFR 110.27, "General license for imports," and paragraph (1) under the definition of "Radioactive Waste" in 10 CFR 110.2). 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.

APPENDIX Z
International Activities: (continued)
LIST OF IMPORT AND EXPORT LICENSES FOR 2020: NON-APPENDIX P

License Number	Applicant	Docket Number
XB1343	Sanders Medical Products, Inc.	11006364
XCOM1291/02	Eaton Corporation	11006180
XCOM1299/02	ATI Specialty Alloys %26 Components	11006218
XCOM1310/01	Curtiss-Wright Corporation, Curtiss-Wright Nuclear Division	11006263
XCOM1328/01	Mirion Technologies (IST) Corporation	11006346
XCOM1329	Curtiss-Wright Flow Control Services LLC	11006355
XCOM1332	Curtiss-Wright Electro-Mechanical Corp	11006370
XCOM1333	Curtiss-Wright Flow Control Corporation	11006374
XCOM1335	Materion Brush, Inc.	11006389
XMAT409/02	Cambridge Isotope Laboratories Inc.	11005753
XMAT418/03	Sigma Aldrich Co. LLC	11005977
XMAT427/03	Airgas Specialty Gases	11006088
XMAT429/03	Matheson Tri Gas, Inc.	11006116
XMAT433/03	Cambridge Isotope Laboratories, Inc.	11006181
XMAT433/04	Cambridge Isotope Laboratories Inc.	11006181
XMAT441/01	Cambridge Isotope Laboratories, Inc.	11006293
XMAT441/02	Cambridge Isotope Laboratories Inc.	11006293
XMAT448/01	Cambridge Isotope Laboratories, Inc.	11006349
XMAT448/02	Cambridge Isotope Laboratories Inc.	11006349
XMAT453	Cambridge Isotope Laboratories, Inc.	11006365
XMAT455	Cambridge Isotope Laboratories, Inc.	11006378
XSNM3398/06	Global Nuclaer Fuel - Americas, LLC	11005555
XSNM3702/01	Westinghouse Electric Company, LLC	11005968
XSNM3747/04	Framatome Inc.	11006110
XSNM3763/04	Edlow International Co. as Agent for ANSTO	11006195
XSNM3799/01	Exelon Generation Company, LLC	11006329
XSNM3809	TN Americas LLC	11006358
XSNM3810	U.S. Department of Energy, National Nuclear Security Administration	11006361
XSNM3811	TAM International Inc.	11006373
XSNM3812	Edlow International Co. as Agent for NNSA	11006376
XSNM3812/01	Edlow International Co..	11006376
XSNM3813	NBL Program Office, US Dept of Energy	11006379
XSNM3814	TN Americas LLC	11006385
XSNM3815	TAM International Inc.	11006392
XSNM3816	ALARA Logistics	11006393
XSNM3817	TAM International (US) Inc.	11006394
XSOU8707/07	MP Mine Operations LLC	11004455
XSOU8827/02	MP Mine Operations LLC	11005966

APPENDIX Z

International Activities: (continued)

LIST OF IMPORT AND EXPORT LICENSES FOR 2020: NON-APPENDIX P (continued)

License Number	Applicant	Docket Number
XSOU8838/01	TAM International Inc.	11006194
XSOU8840/01	Iluka Resources Inc.	11006220
XSOU8842/01	The Chemours Company FC, LLC. (Chemours)	11006256
XSOU8842/02	The Chemours Company FC, LLC. (Chemours)	11006256
XSOU8851/02	Honeywell International, Inc.	11006336
XSOU8852	Manufacturing Sciences Corp.	11006372
XSOU8853	Twin Pines Minerals; LLC	11006387
XSOU8854	Iluka Resources Inc.	11006399
XW027	Perma-Fix Northwest Richland, Inc.	11006380

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 10 CFR Part 110, 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 non-nuclear end use]).

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

(XR) denotes export of reactor equipment, refer to 10 CFR Part 110, Appendix A, Items (1)–(4).

(IW) denotes import of radioactive waste.

(XW) denotes export of radioactive waste.

APPENDIX AA

List of Some Major Uses of Radioisotopes in the United States

Radioisotope is an unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified. Radioisotopes come from three sources: from nature, such as radon in the air or radium in the soil; from machine-produced nuclear interactions in devices, such as linear accelerators and cyclotrons; or from nuclear reactors.

The licensing and regulation of radioisotopes in the United States are shared by the NRC, the U.S. Environmental Protection Agency (EPA), and many State governments. The EPA is also responsible for, among other things, setting air emission and drinking water standards for radionuclides. The States regulate radioactive substances that occur naturally or are produced by machines, such as linear accelerators or cyclotrons. The Food and Drug Administration (FDA) regulates the manufacture and use of linear accelerators; the States regulate their operation.

Americium-241
Used in many smoke detectors for homes and businesses; to measure levels of toxic lead in dried paint samples; to ensure uniform thickness in rolling processes like steel and paper production; and to help determine where oil wells should be drilled.

Cadmium-109
Used to analyze metal alloys for checking stock, scrap sorting.

Calcium-47
Important aid to biomedical researchers studying the cellular functions and bone formation in mammals

Californium-252
Used to inspect airline luggage for hidden explosives; to gauge the moisture content of soil in the road construction and building industries and to measure the moisture of materials stored in soils.

Carbon-14
Major research tool. Helps ensure potential new drugs are metabolized without forming harmful by-products. Used in biological research, agriculture, pollution control, and archeology.

Cesium-137
Used to measure correct patient dosages of radioactive pharmaceuticals; to measure and control the liquid flow in oil pipelines; to tell researchers whether oil wells are plugged by sand; and to ensure the right fill level for packages of food, drugs and other products. (The products in these packages do not become radioactive.)

Chromium-51
Used in research in red blood cell survival studies

Cobalt-57
Used as a tracer to diagnose pernicious anemia

Cobalt-60
Used to sterilize surgical instruments and to improve the safety and reliability of industrial fuel oil burners. Used in cancer treatment, food irradiation, gauges, and radiography.

Curium-244
Used in mining to analyze material excavated from pits and slurries from drilling operations.

Fluorine-18
Used for Positron Emission Imaging in medical diagnosis.

Gallium-68
Used for Positron Emission Imaging in medical diagnosis

Iodine-123
Widely used to diagnose thyroid disorders and other metabolic disorders including brain function.

Iodine-125
Major diagnostic tool used in clinical tests and to diagnose thyroid disorders. Also used in biomedical research.

Iodine-129
Used to check some radioactivity counters in vitro diagnostic testing laboratories.

Iodine-131
Used to treat thyroid disorders.

Iridium-192
Used to test the integrity of pipeline welds, boilers and aircraft parts and in brachytherapy/tumor irradiation.

Iron-55
Used to analyze electroplating solutions and to detect the presence of sulphur in the air. Used in metabolism research.

Krypton-85
Used in indicator lights in appliances such as clothes washers and dryers, stereos, and coffee makers; to gauge the thickness of thin plastics and sheet metal, rubber, textiles, and paper; and to measure dust and pollutant levels.

Lutecium-177
Used as part of radiopharmaceuticals for treatment of cancer.

Nickel-63
Used to detect explosives, and in voltage regulators and current surge protectors in electronic devices, and in electron capture detectors for gas chromatographs.

Phosphorus-32
Used in molecular biology and genetics research.

Phosphorus-33
Used in molecular biology and genetics research.

Plutonium-238
Has powered more than 20 NASA spacecraft since 1972. (The most common radioisotopes of plutonium are Pu-238, Pu-239, and Pu-240.)

Polonium-210
Reduces the static charge in production of photographic film and other materials.

Promethium-147
Used in electric blanket thermo-stats…and to gauge the thickness of thin plastics, thin sheet metal, rubber, textile, and paper.

Radium-226
Makes lighting rods more effective. (The most common isotopes of radium are Ra-226 and Ra-228. Radium-226 is part of the uranium decay series. Radium-228 and Ra-224 are part of the thorium decay series. All isotopes of radium are radioactive. Radium decays to produce radon gas)

Selenium-75
Used in protein studies in life science research.

Sodium-24
Used to locate leaks in industrial pipe lines; and in oil well studies.

Strontium-85
Used to study bone formation and metabolism.

Strontium-90
Used in survey meters by schools, the military and emergency management authorities. Also used in cigarette manufacturing sensors and medical treatment.

Sulphur-35
Used in genetics and molecular biology research.

Technetium-99m
The most widely used radioactive pharmaceutical for diagnostic studies in nuclear medicine. Different chemical forms are used for brain, bone, liver, spleen and kidney imaging and also for blood flow studies.

Thallium-201
Used in nuclear medicine for nuclear cardiology and tumor detection.

Thallium-204
Used to measure dust and pollutant levels on filter paper; and to gauge the thickness of plastics, sheet metal, rubber, textiles, and paper.

Thorium-229
Helps fluorescent lights last longer.

Thorium-232
As thoriated tungsten, used in electric arc welding rods in construction, aircraft, petrochemical and food processing equipment industries.

Thorium-230
Provides coloring and fluorescence in colored glazes and glassware.

Tritium
Major tool for biomedical research. Used for life science and drug metabolism studies to ensure the safety of potential new drugs; for luminous exit signs; for luminous dials, gauges and wrist watches; to produce luminous paint; and for geological prospecting and hydrology.

Uranium-235
Fuel for nuclear power plants and naval nuclear propulsion systems; previously used to produce fluorescent glassware, a variety of colored glazes and wall tiles.

Xenon-133
Used in nuclear medicine for lung ventilation and blood flow studies.

Yttrium-90
Used as microsphere brachytherapy for treatment of liver cancers.

Source: NUREG/BR-0217 Rev. 1 APRIL 2000,The Regulation and Use of Radioisotopes in Today's World For more information visit the following web pages:
EPA at *https://www.epa.gov/radiation/radionuclides*
FDA at *https://www.fda.gov radiation-emitting-products*
National Nuclear Data Center at *https://www.nndc.bnl.gov/*

PERIODIC TABLE OF ELEMENTS

RADIOACTIVE ELEMENTS
Radioactive elements have no stable isotopes.

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Caesium	56 Ba Barium	57 La* Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac** Actinium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

*	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
**	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

8

GLOSSARY

GLOSSARY

(Includes Abbreviations, Definitions, and illustrations)

Advanced reactors

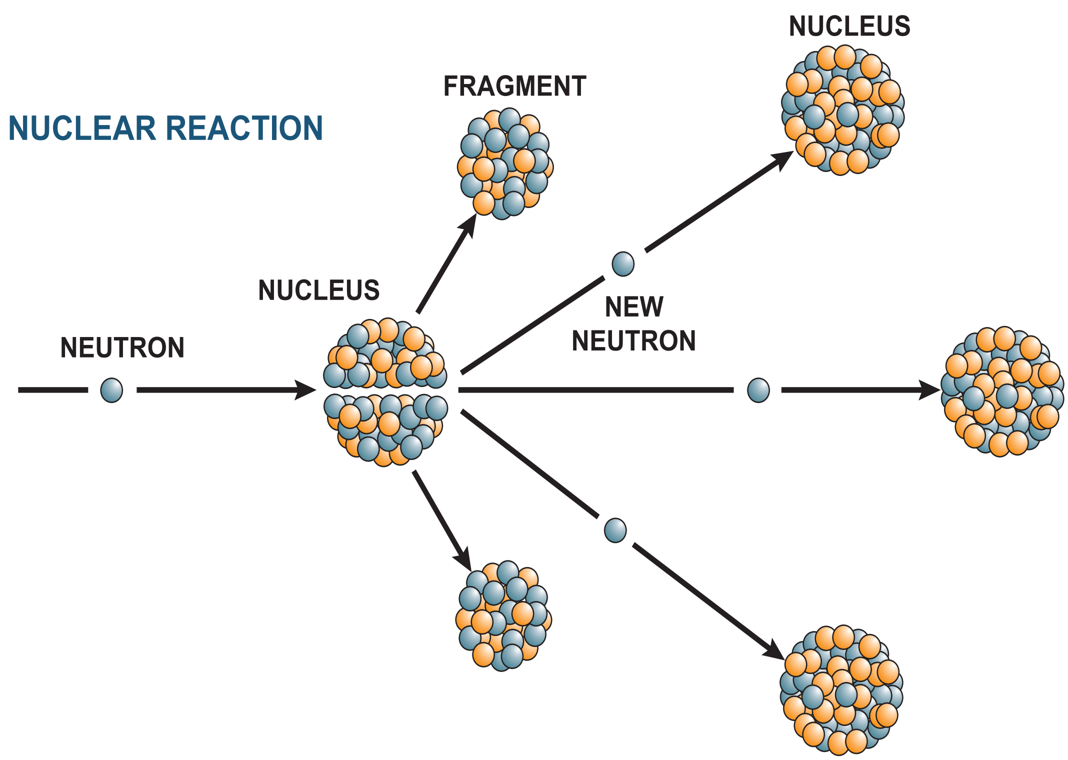
Reactors that differ from today's reactors primarily by their use of inert gases, molten salt mixtures, or liquid metals to cool the reactor core. Advanced reactors can also consider fuel materials and designs that differ radically from today's enriched-uranium-dioxide pellets within zirconium cladding.

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.

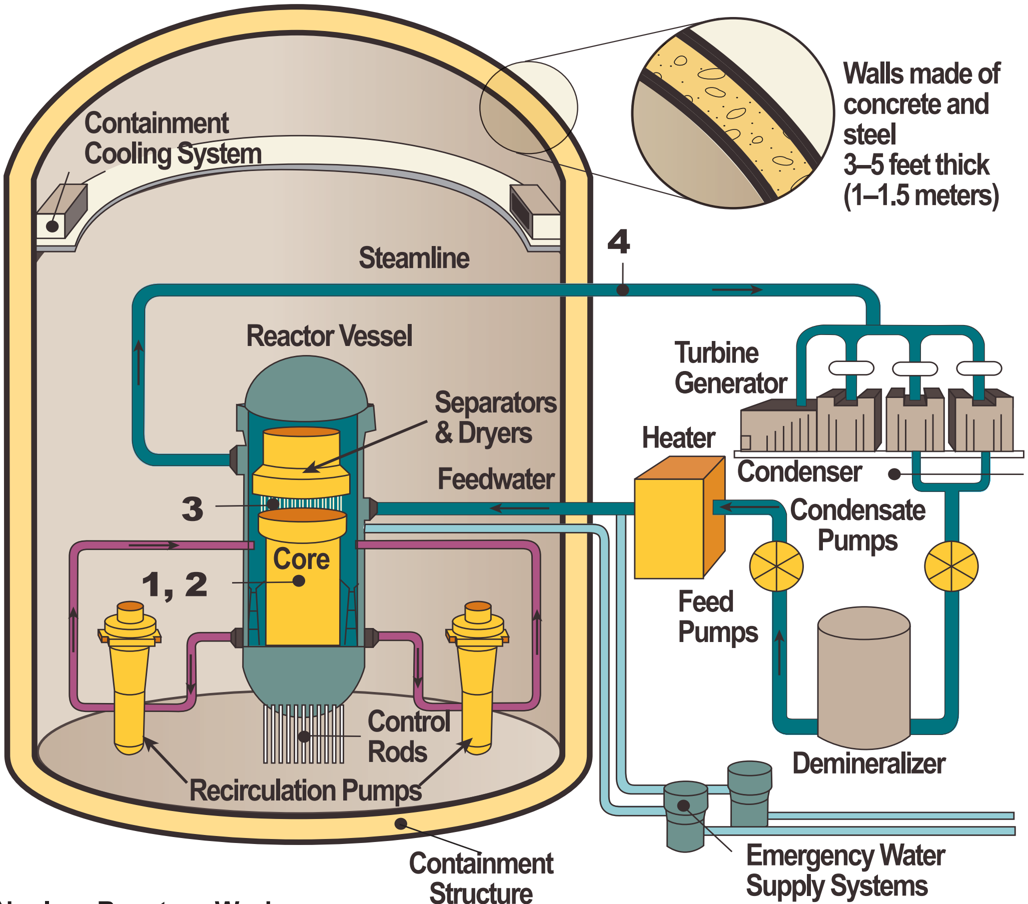


Background radiation

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 millisieverts) 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 electrical 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, U.S. Department of Energy (DOE), U.S. Department of Homeland Security, 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, 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 devices.
- 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 groups 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

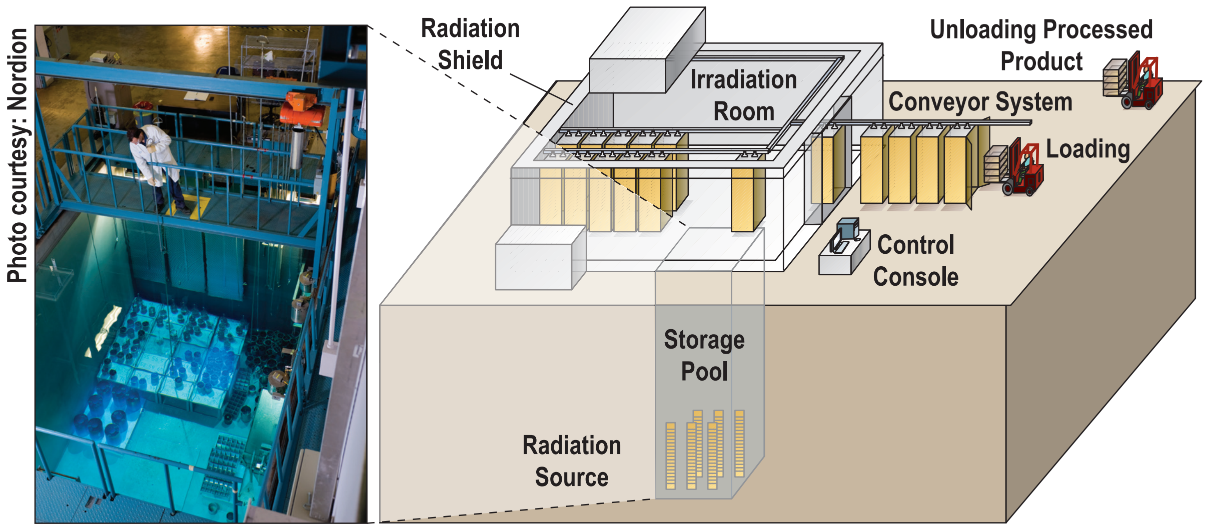
Information that has been determined pursuant to an Executive order to require protection against unauthorized disclosure and is marked to indicate its classified status when in documentary form. The NRC has two types of classified information. The first type, known as National Security Information, 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.



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 or mitigates accidents or attacks that could result in release of 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, against which a security system is designed to protect. 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 millisieverts) 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 millisieverts).

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.

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 of 1978 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. The four emergency classification levels used for commercial nuclear power plants, in ascending order of severity, are: Notification of Unusual Event, Alert, Site Area Emergency, and General Emergency.

Emergency Notification System

A telephone system used by the NRC to receive 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.

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 that 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 DOE 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 process.

Exposure (radiation)
Absorption of ionizing radiation or the amount of a hazardous substance that has been ingested, inhaled, or in contact with 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 2019 runs from October 1, 2018, through September 30, 2019.

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

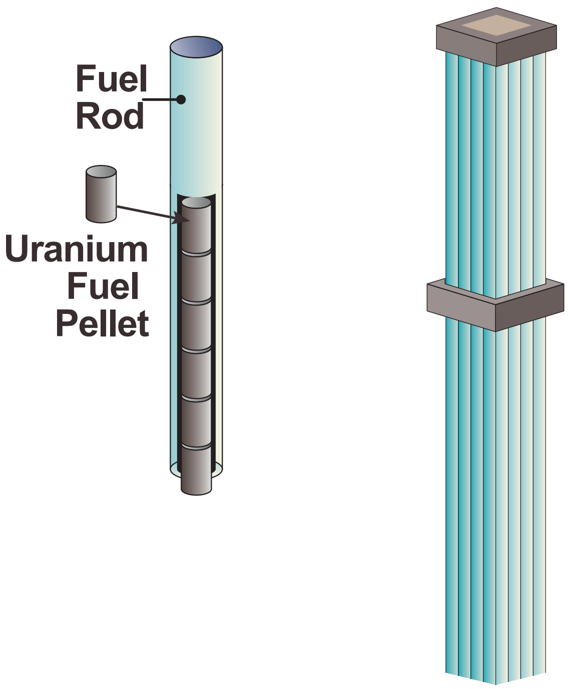
A personnel exchange program for foreign regulatory counterparts. This helps the NRC and partners better understand each other's regulatory programs, capabilities, and commitments and fosters relationships between the NRC and key officials in other countries. The assignees' regulatory authorities generally 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.



Fuel assembly

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 (HLW)
- transportation of the uranium in all forms, including spent fuel

The NRC regulates these processes.

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, DOE 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

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.

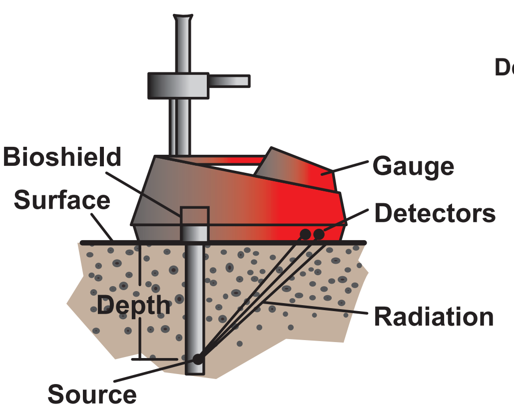
Gas chromatography

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.

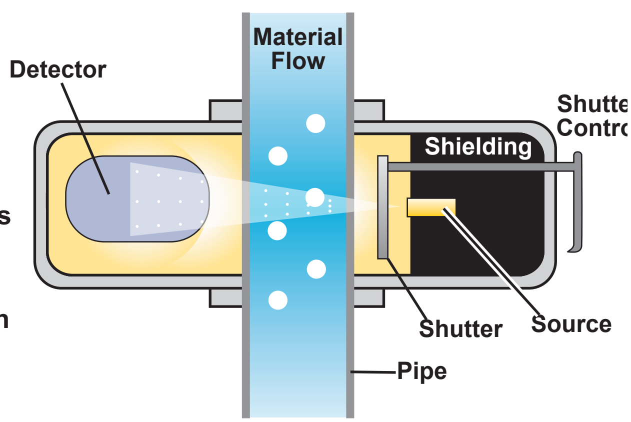
Gauging devices

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



Cross-Section of 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 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.

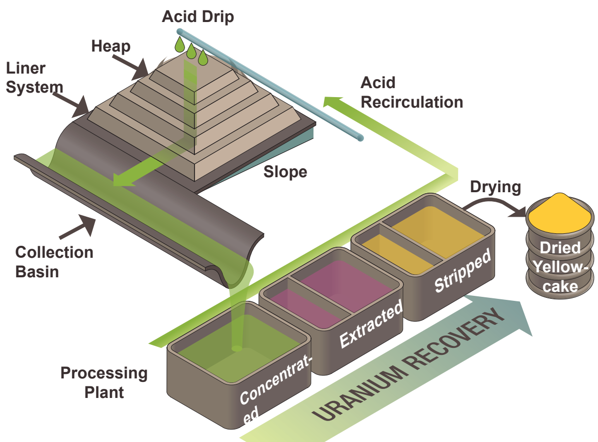
Gigawatt-hour (GWh)
One billion (1,000,000,000) watt-hours.

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. This technique 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 171 member States and multiple partners worldwide to promote safe, secure, and peaceful nuclear technology.

International Nuclear Regulators Association (INRA)

An association established in 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, the Republic of Korea, Spain, Sweden, the United Kingdom, and the United States 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 DOE's application for authorization to construct a high-level nuclear waste geologic repository at Yucca Mountain, NV. The LSN Library is affiliated with the 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
A unit of measurement equivalent to 1,000 kilograms or about 2,000 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. The U.S. Department of Energy program to produce an MOX fuel under an agreement with Russia was canceled in 2018. The NRC terminated the facility's construction authorization in February 2019.

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 Environmental Policy Act (NEPA)

A U.S. environmental law enacted on January 1, 1970. The NRC implements NEPA as part of its regulatory process by evaluating the relevant environmental effects for particular actions. A typical review will include an analysis of impacts to air, water, animal life, vegetation, natural resources, and resources of historical, archaeological, or architectural significance. The review will also evaluate cumulative economic, social, cultural, and other impacts affecting environmental justice.

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 fourth edition of the framework, which became effective in October 2019, is built on the scalable, flexible and adaptable concepts identified in the National Incident Management System to align key roles and responsibilities.

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.

Naturally Occurring and Accelerator-Produced Radioactive Material (NARM)

The Energy Policy Act of 2005 gives the NRC regulatory authority over NARM, which includes those materials that have been processed, or concentrated, for use in commercial, medical, or research activities, including contamination resulting from the use of these materials.

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, archaeology, 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 for 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 33 countries in Europe, North America, and the Asia-Pacific region, which account for about 85 percent of the world's installed nuclear capacity. The OECD is 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.

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 Materials 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/Radiological Incident Annex

An annex to the Response and Recovery Federal Interagency Operational Plans that provides for a timely, coordinated response by Federal agencies to nuclear or radiological accidents or incidents. This annex covers radiological dispersal devices and improvised nuclear devices, as well as incidents involving commercial reactors or weapons production facilities, lost radioactive sources, transportation accidents involving radioactive material, and international incidents 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 doses 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 millisieverts) 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.

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 (9.525 millimeter) in diameter and 5/8 inch (15.875 millimeter) 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

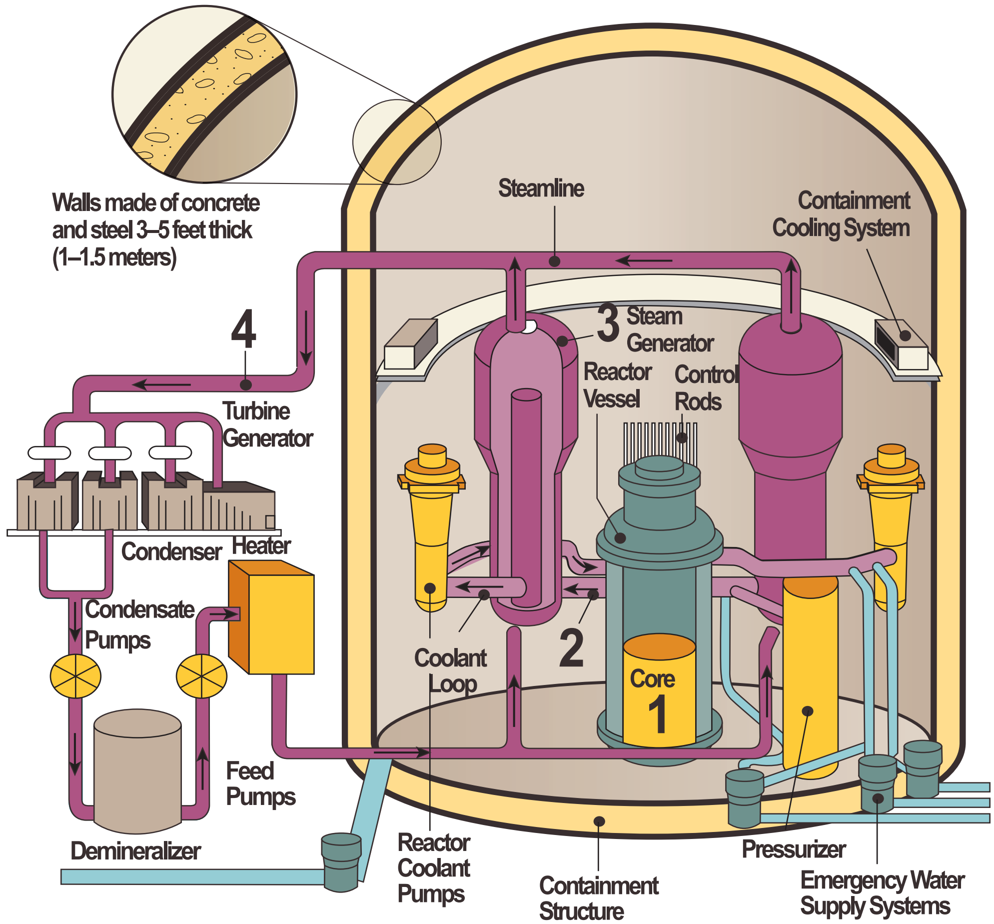
A license, issued by the NRC, that authorizes the licensee to possess specific nuclear material but does not authorize its use or the operation of a nuclear facility.

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.

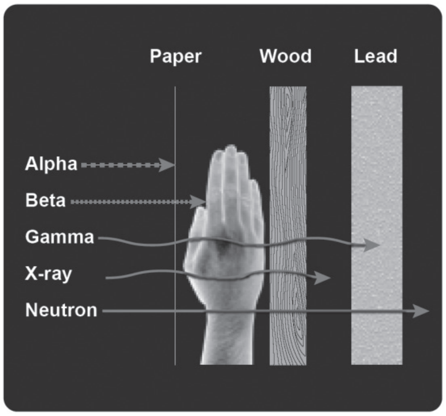
Production expense

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 human-made 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.

Radium

A radioactive substance found in nature. The Energy Policy Act of 2005 gives the NRC regulatory authority for the safe use of radium under certain conditions.

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.

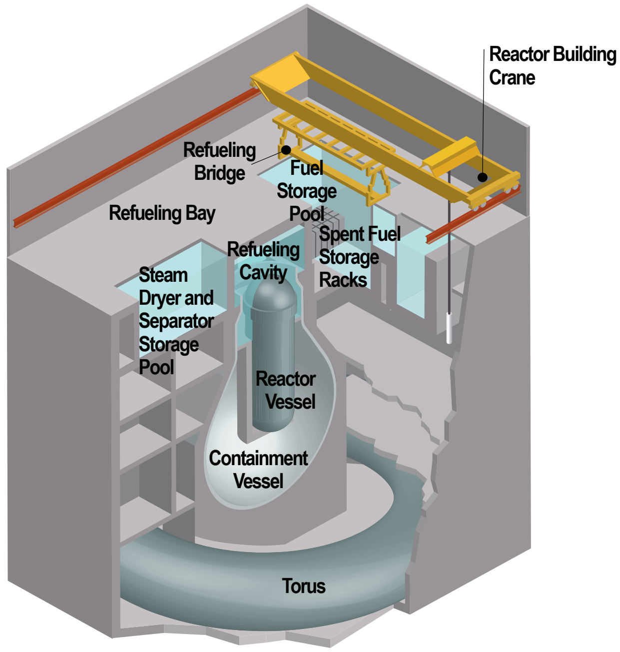
Reactor Oversight Process (ROP)

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

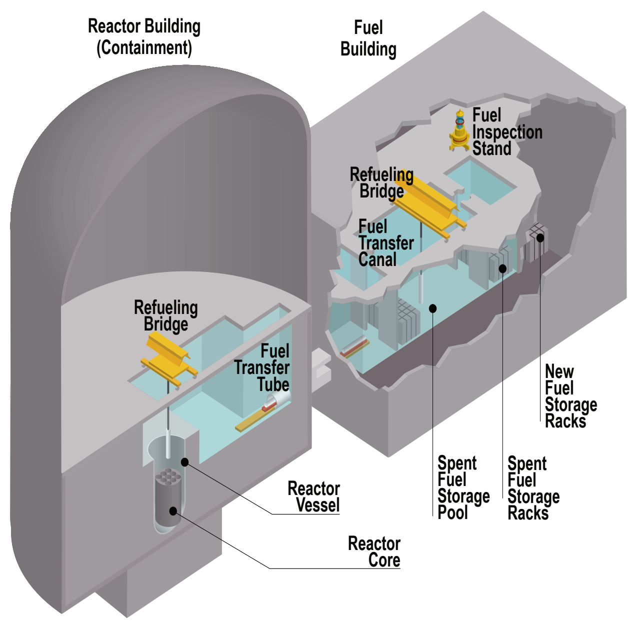
The process of removing older fuel and loading new fuel. These actions are all performed underwater to supply continuous cooling for the fuel and provide shielding from the radioactive spent fuel.

Refueling BWR



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 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.

Refueling PWR



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.

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

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) measures and security forces. As used by 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 LLW 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 non-safeguards 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)

Title 10 of 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.

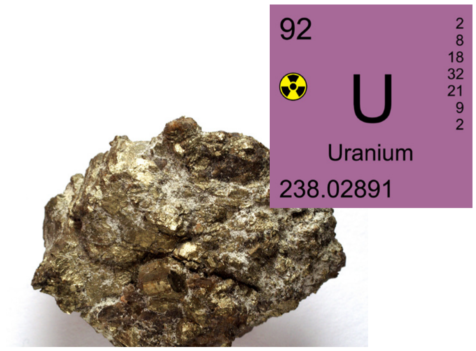
Tritium

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

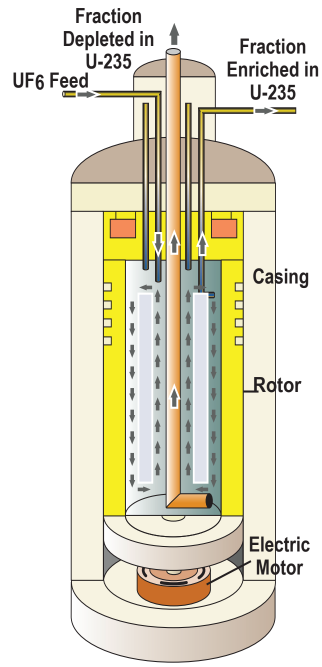


A radioactive element with the atomic number 92 and, as found in natural ores, an atomic weight of about 238. The two principal natural isotopes are uranium-235 and uranium-238. Uranium-235 is composed of 0.7 percent natural uranium and is fissile. Uranium-238 is composed of 99.3 percent natural uranium, 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.

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. In May 2013, the last remaining U.S. operating gaseous diffusion plant 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.

- **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 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 HLW 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 radioactive waste, Low-level radioactive waste, and Spent (depleted or used) 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 United States. 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).

Watt-hour

A unit of energy equal to 1 watt of power steadily supplied to, or taken from, an electrical circuit for 1 hour (or exactly 3.6×10^3 joules).

Yellowcake

The solid form of uranium oxide, which is produced from uranium ore in the uranium recovery (milling) process.

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WEB LINK INDEX

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 2020
https://www.nrc.gov/docs/ML2104/ML21048A429.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

Congressional Budget Justification: Fiscal Year 2021(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)
https://www.world-nuclear.org

World Nuclear Power Reactors and Uranium Requirements
https://www.world-nuclear.org/info/reactors.html

WNA Reactor Database
http://www.world-nuclear.org/nucleardatabase/default.aspx

NRC Regulatory Information Conference
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
https://www-ns.iaea.org/tech-areas/radiation-safety/code-of-conduct.asp

Radiation Sources Regulatory Partnership
https://rsrp-online.org

International Regulatory Development Partnership
https://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

Post-Fukushima Safety Enhancements
https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements.html

https://www.nrc.gov/docs/ML1835/ML18355A806

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

Status of Subsequent License Renewal Applications

https://www.nrc.gov/reactors/operating/licensing/renewal/subsequent-license-renewal.html

U.S. Nuclear Research and Test Reactors

Research and Test Reactors
https://www.nrc.gov/reactors/nonpower.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
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 Research
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

Office of Nuclear Regulatory Research-Planned Research Activities
https://www.nrc.gov/about-nrc/regulatory/research/activities.html

Nuclear Materials

Agreement States

Office of Nuclear Material Safety and Safeguards State Communication Portal
https://scp.nrc.gov

NRC Tribal Web site

Office of Nuclear Material Safety and Safeguards Tribal Web site
https://tribal.nrc.gov/

U.S. Fuel Cycle Facilities

Fuel Cycle Facilities
https://www.nrc.gov/materials/fuel-cycle-fac.html

Fuel Cycle Facilities Regulations, Guidance, Communications, and Cumulative Effects of Radiation
https://www.nrc.gov/materials/fuel-cycle-fac/regs-guides-comm.html

Uranium Recovery

Location of 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, Industrial, and Academic Uses of Nuclear Materials
https://www.nrc.gov/materials/medical.html

Medical Uses

Medical Uses of Nuclear Materials
https://www.nrc.gov/materials/miau/med-use.html

Nuclear Gauges and Commercial Product Irradiators

General License Uses of Nuclear Materials
https://www.nrc.gov/materials/miau/general-use.html

Industrial Applications

Industrial Uses of Nuclear Materials
https://www.nrc.gov/materials/miau/industrial.html

License-Exempt Consumer Product Uses of Radioactive Material
https://www.nrc.gov/materials/miau/consumer-pdts.html

Radioactive Waste

U.S. Low-Level Radioactive Waste Disposal

Low-Level Waste
https://www.nrc.gov/waste/low-level-waste.html

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

High-Level Waste
https://www.nrc.gov/waste/high-level-waste.html

Spent Nuclear Fuel Storage

Storage of Spent Nuclear Fuel
https://www.nrc.gov/waste/spent-fuel-storage.html

Consolidated Interim Storage Facility
https://www.nrc.gov/waste/spent-fuel-storage/cis.html

U.S. Nuclear Materials Transportation

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 of Nuclear Facilities
https://www.nrc.gov/waste/decommissioning.html

Status of the Decommissioning Program: 2020 Annual Report
https://www.nrc.gov/docs/ML2025/ML20259A506.pdf

Nuclear Security and Emergency Preparedness

Nuclear Security

Nuclear Security and Safeguards
https://www.nrc.gov/security.html

Research and Test Reactors Security
https://www.nrc.gov/reactors/non-power.html#security

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

Required Reporting for Clearance Holders
https://www.nrc.gov/security/required-reporting-for-clearance-holders.html

Insider Threat Program for Licensees
https:www.nrc.gov/security/insider-threat-program-for-licensees.html

Cybersecurity

Cybersecurity
https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/cyber-security-bg.html

Emergency Preparedness and Response

Emergency Preparedness and Response
https://www.nrc.gov/about-nrc/emerg-preparedness.html

Emergency Action Level Development
https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/emerg-action-level-dev.html

Emergency 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

Career Opportunities
https://www.nrc.gov/about-nrc/employment.html

Glossary

NRC Full-Text Glossary
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 Act
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

Information for Small Businesses
https://www.nrc.gov/about-nrc/contracting/small-business.html

Workplace Diversity
https://www.nrc.gov/about-nrc/employment/workingatnrc.html

Civil Rights
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

Social Media Platforms

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/

Linkedin
https://www.linkedin.com/company/u-s--nuclear-regulatory-commission

GovDelivery
https://www.nrc.gov/public-involve/listserver.html#gov

RSS
https://www.nrc.gov/public-involve/listserver.html#rss

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The U.S. Nuclear Regulatory Commission (NRC) has published the Information Digest annually since 1989. The Digest provides information about agency activities and licensees from the various 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 2021–2022 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) that were updated as of August 10, 2021, including data in maps and graphics. The Digest is an annual publication, with updates to certain non-NRC data every 2 years.

The next Information Digest containing updated data will be published in September 2022. The Information Digest will include links to the most current information.

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/.

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