U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Office of Nuclear Regulatory Research

The Atomic Energy Act of 1954 provided the framework for the widespread use of nuclear energy for peaceful purposes. The 1954 Act created the U.S. Atomic Energy Commission to both regulate nuclear power and to encourage the use of nuclear energy.

In 1974, the Energy Reorganization Act split the two functions of the Atomic Energy Commission. The U.S. Nuclear Regulatory Commission (NRC) was created to regulate the safe operation of commercial nuclear power and began operation on January 19, 1975. Initially, the U.S. Energy Research and Development Administration (ERDA) was created to manage energy research and development, nuclear weapons, and naval reactors programs. In 1977, ERDA was combined with the Federal Energy Administration to form the U.S. Department of Energy.

Cover image: The Office of Nuclear Regulatory Research is located in a new, state-of-the-art facility in Rockville, MD.

What Does NRC Do To Keep the Public Safe?

The mission of NRC is to license and regulate the Nation's civilian use of byproduct, source, and special nuclear materials to ensure adequate protection of public health and safety, promote the common defense and security, and protect the environment.

NRC has 104 licensed nuclear power plants currently operating and providing electricity to communities. Most of the plants were built in the 1960s and 1970s, and NRC provides regular inspections to ensure that they continue to operate safely.

To support the mission, NRC is staffed by professionals with expertise in a variety of fields. Like other government agencies, NRC employs administrative staff, but has a particular need for nuclear physicists and engineers of all types. To maintain the highest safety standards, the agency conducts a wide array of research and simulates a variety of scenarios. To ensure a strong technical basis for NRC's regulatory requirements, the agency conducts an extensive research program.

The Commission

NRC is headed by five Commissioners appointed by the President and confirmed by the Senate for 5-year terms. The President designates one of them to be the Chairman and official spokesperson of the Commission.

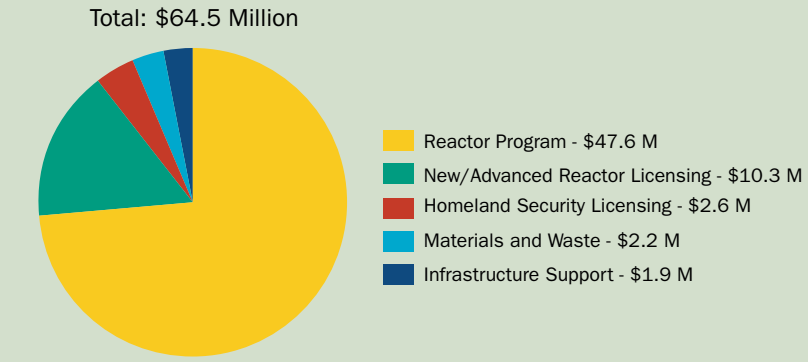
NRC Chairman Gregory B. Jaczko and Executive Director for Operations R.W. Borchardt holds a plaque that distinguishes NRC as the best place to work in the Federal Government.

According to NRC Chairman Gregory B. Jaczko, one of the main reasons NRC is ranked as the best place to work in the Federal Government is the agency's emphasis on effective communication. RES supports that goal through regular seminars and is always looking for opportunities to share information with staff in a timely and engaging manner.

What Does the Office of Nuclear Regulatory Research Do?

The Office of Nuclear Regulatory Research (RES) is the research arm of NRC. The office was created at the same time as NRC through the Energy Reorganization Act of 1974 and is one of the three statutory offices in the agency. RES currently has about 260 staff and close to $70 million in funding to pursue its programs. The office employs engineers, scientists, and other professionals who are experts in their field, and their work directly supports NRC's mission to protect people and the environment.

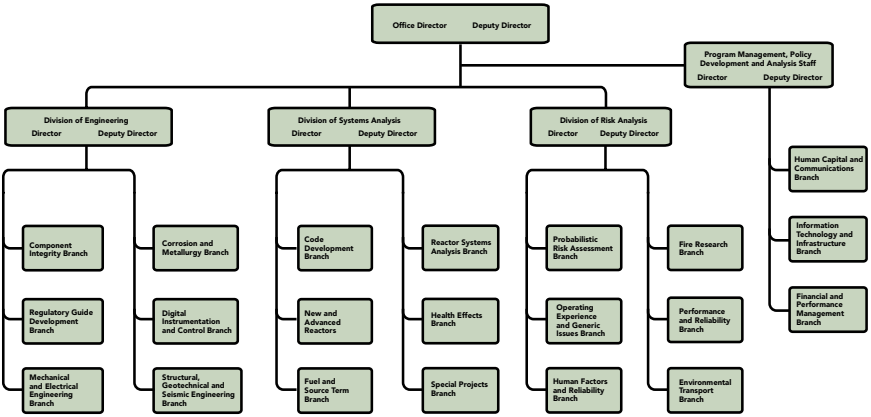
NRC Research Funding, FY 2009



Note: Totals may not equal the sum of components because of independent rounding.
Source: U.S. Nuclear Regulatory Commission

RES is organized into three research divisions: Engineering, Systems Analysis, and Risk Analysis. Administrative support is provided by the Program Management, Policy Development, and Analysis staff.

RES supports NRC's regulatory offices by conducting indepth confirmatory research on a variety of safety topics. For example, if the Office of New Reactors is considering a new reactor design, it may ask RES to conduct experiments to independently confirm licensee information or conduct analytical calculations to confirm the design complies with NRC regulations. Although NRC does not develop new technologies, the agency does stay abreast of emerging technologies to identify potential safety concerns and ensure they are acceptably resolved before the technology is implemented.



What Improvements Will We See In New Reactors?

NRC must thoroughly review and approve proposed new reactor designs before it will certify these designs for construction. Currently, NRC is certifying several new reactor designs and reviewing applications to build plants using these new designs. The agency also is expecting to receive additional applications in the future.

The proposed designs include significant safety improvements. Some of the new reactors are designed to respond to abnormal conditions and accidents with little or no powered equipment and require fewer operator actions.

Plant operators have begun replacing analog equipment in existing reactors with new digital systems to improve operational performance and safety. RES is conducting research to address the complex and unique issues associated with implementing digital control systems.

The nuclear industry is also developing advanced reactor designs that utilize coolants other than water. These advanced designs could be used for specialized uses like providing electricity for remote towns, generating steam for chemical plants, or producing hydrogen for fuel. RES is performing research to better understand the performance and potential safety issues associated with these designs to help NRC develop regulatory requirements for these reactors.

What is a Next Generation Nuclear Power Plant?

The Next Generation Nuclear Power (NGNP) is an advanced reactor concept for generating electricity and producing hydrogen using process heat. The Energy Policy Act of 2005 (EPAct) mandates the U.S. Department of Energy (DOE) to develop an NGNP prototype for operation by 2021, and gives NRC the authority to license the prototype.

How Long Can a Power Plant Operate?

The Atomic Energy Act limits an initial license for a nuclear power plant to 40 years. However, NRC has recently issued a rule (license-renewal rule) that allows licensees to apply for a license extension of up to 20 years. Before granting a license extension, NRC confirms that the plant meets all of the requirements of the license renewal rule and can operate safely for the longer period of time. NRC expects that some plants will request a second 20 year extension.

RES is conducting confirmatory research associated with extended operation. This includes research on materials and concrete structures to understand potential degradation mechanisms resulting from long-term exposure to high temperature, pressure, radiation, and water chemistry. RES is investigating improved inspection techniques for these items, as well as improved welding repair techniques and monitoring.

What About the Risk of Earthquakes Damaging Plants?

NRC has considered the hazard and risk posed by earthquakes in the design of nuclear power plants for decades. This topic is often broadly referred to as "seismic safety." NRC evaluates new plants and sites with the same rigor as the operating plants.

To ensure that new plants are designed with the best information available, NRC is participating with other experts in an extensive update to the characterization of seismic sources in the central and eastern United States.

The Sumatran earthquake in December 2004 (about magnitude 9 on the Richter scale) and the associated devastating tsunami in the Indian Ocean have focused considerable attention on structures and facilities that are located on or adjacent to the coastline. RES is working with other agencies to improve tsunami hazard assessment information and techniques and expects to update NRC's regulatory guidance as a direct result of this research.

What is Long-Term Research?

RES sponsors long-term research to provide fundamental insights and technical information that support anticipated future (> 5 years) NRC needs.

Ms. Rosemary Hogan has over 25 years of experience in the nuclear field and has been a supervisor for 8 years overseeing a variety of nuclear research including earthquake research. Rosemary received her bachelor's degree in chemistry from Nazareth College in Kalamazoo, MI.

"Nuclear plants are designed to robust requirements and include margin for error so that plants can withstand known earthquake levels. RES reviews updated earthquake information and the impact of the new information on the existing nuclear plants."
–Rosemary Hogan

What Does RES Do Regarding the Effects of Radiation on People and the Environment?

RES collects radiation exposure information on people who work at or visit NRC-licensed facilities including medical facilities, power plants, fuel facilities, and research facilities. RES monitors scientific literature for cancer rates and is performing an indepth analysis to confirm that cancer rates around nuclear power plants are not above average. RES also collaborates with national and international experts in the field of radiation protection on basic research and new guidance for acceptable radiation exposure.

In addition, nuclear facilities may release small amounts of radioactive materials (gaseous and liquid effluents) to the environment under certain conditions specified in their licenses, or inadvertently through deviations from normal operating conditions. Residual contamination occasionally remains after a facility has been permanently shut down and its license has been terminated. RES provides information and analytical tools (such as predictive models) to assess the public health consequences of both planned and unplanned releases. RES also assesses contamination that may remain after decommissioning and the effectiveness of remediation methods.

Moreover, because many Federal agencies are concerned with environmental contamination, NRC cooperates on research and development in this area with other agencies.

What are the Possible Public Health and Safety Consequences in the Unlikely Event of a Nuclear Power Plant Accident?

RES is conducting the State-of-the-Art Reactor Consequence Analysis (SOARCA) to estimate the most probable consequences in the unlikely event of a commercial nuclear power plant accident releasing radioactive material into the environment. The project is updating a 1982 study and takes maximum advantage of hundreds of millions of dollars of national and international reactor safety research to reflect improved plant design, operation, and accident management implemented over the past 25 years. Using computer models and simulation tools, SOARCA develops a set of realistic consequence estimates of very unlikely accidents at several U.S. reactor sites representative of reactor and containment designs in use in the United States.

The SOARCA Steering Committee meets regularly to discuss the project.

How is RES Examining Power Plants' Ability to Withstand Attacks?

Since 9/11, changes in the threat environment indicated that we should review potential threats to our nuclear facilities.

For example, NRC initiated a security and engineering review based on potential terrorist attacks. Research indicated that licensees could take additional measures to enhance the plant's capability to withstand large fires and explosions. NRC required power plant operators to implement those measures. In addition, structural analyses of new reactor designs led to the creation of new requirements for the design stage of new reactors. New reactor designers must assess the effects of an aircraft impact and, if needed, incorporate additional design features to show, with reduced operator actions, that the reactor and spent fuel pool are maintained in a cooled state.

Although the details are classified, the studies confirm that the plants are robust and the likelihood of a radioactive release affecting public health and safety is low.

What Kind of International Activities Does RES Participate In?

RES participates in over 100 international agreements that give NRC staff access to international subject matter experts and an extensive body of knowledge.

NRC participates in a wide range of mutually beneficial programs to exchange information with the international community and to enhance the safety and security of peaceful nuclear activities worldwide. These programs allow NRC to access test facilities that are not available domestically and to leverage its research expenditures. RES also assists other countries in developing and improving their regulatory organizations and provides them with important information on safety issues.

Does RES Have Cooperative Agreements with Other Organizations?

Yes, RES has cooperative agreements with universities and nonprofit organizations to conduct research in specific areas of interest to the agency. These cooperative agreements and grants include the following organizations:

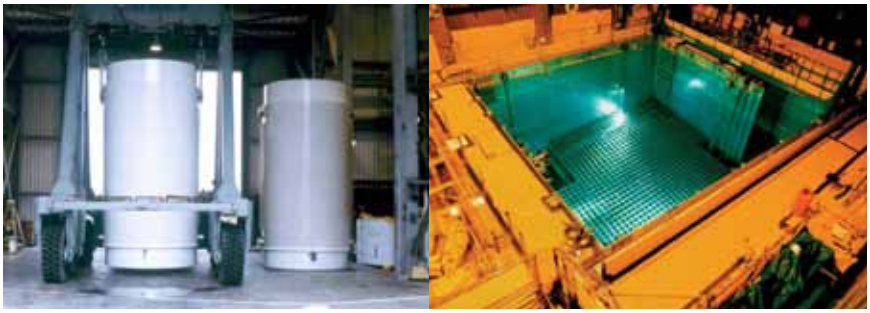
- Electric Power Research Institute for work on fire risk, materials research, and advancing probabilistic risk assessments.
- Pennsylvania State University for research on spacer grid thermal hydraulics and nuclear fuel cladding behavior.
- University of Tennessee for work on sparse survey data.
- Ohio State University for research on the risk importance of digital systems.
- Massachusetts Institute of Technology for work on advanced nuclear technology.
- University of Maryland for work on fire risk and uncertainties.
- National Institute for Standards and Technology for testing to improve mathematical fire modeling.

RES staff and NRC Chairman Gregory B. Jaczko observe cable tray fire testing at the National Institute of Standards and Technology.

What About the Storage of Spent Fuel and Waste?

Currently, used fuel from a nuclear power plant (also known as spent fuel) is stored at the power plant. Occasionally, the spent fuel needs to be moved and eventually there is expected to be a long-term storage facility built to store the spent fuel. RES does research to ensure that spent fuel is transported safely. Current research includes fire testing of the storage casks and evaluation of the possibility of cracking in a cask exposed to a marine environment.

NRC is examining applications for improved storage and transportation of spent nuclear fuel. Applying this research will assist NRC in approving license proposals to load more spent nuclear fuel assemblies in a single cask thereby reducing both the number of casks that need to be transported and the associated worker exposure.



The waste that nuclear power plants produce is known as "spent fuel." It is stored in casks (left) and spent fuel pools (right).

I Have Heard the Acronym PRA. What Is That?

Probabilistic risk assessment (PRA) is an important tool in NRC's regulatory process for nuclear power plants. A PRA assesses plant safety by examining the following three questions regarding plant design and operation:

- What can go wrong?
- How likely is it?
- What are its consequences?

The results of the assessments provide insights regarding the relative strengths and weaknesses of the plant's design and operation. NRC uses these insights to focus its reviews and attention on aspects of plant design and operation that are most risk-important.

Dr. Erasmia Lois has been with NRC for about 25 years working in areas related to probabilistic risk assessment with a focus on human reliability analysis. Erasmia has received a bachelor's degree in mathematics from the University of Athens, Greece and a doctorate in nuclear engineering from the University of Maryland.

"Human performance can significantly influence the reliability and safety of nuclear power plant operations. Adequate treatment of human interactions is key to understanding accident sequences and appropriately representing their relative importance to overall risk. RES continues to study human performance in nuclear plants and improve the methods for assessing human reliability."
–Erasmia Lois

How Does RES Account for Human Performance in Nuclear Plant Operations?

RES conducts research on the interaction of humans with systems and the environment in which they work. This research varies from assessing human reliability, evaluating fitness-for-duty programs, gauging safety culture, and identifying the implications of system automation. This research is used by the regulatory staff to determine the acceptability of both new designs and modifications to existing designs.

What Kind of Research Is Being Conducted at Decommissioning Sites that Previously Dealt with Nuclear Materials?

Research is being conducted to assess radioactive contamination at decommissioning sites. These sites were previously licensed sites that dealt with nuclear materials. Residual radioactive contamination at such sites can pose a risk to the public and must be assessed. The potential for movement of the contamination through the environment to humans is modeled with complex mathematical methods. Research leads to a better understanding and assessment of all aspects of the residual contamination including: (1) the form and extent of the radiation source, (2) the performance of engineered covers used to protect public health and safety, (3) the effectiveness of monitoring and remediation methods, and (4) the complex ways that radioactive contaminants travel through the environment.

Dr. Stephanie Bush-Goddard has more than 20 years experience in radiation protection and has been a supervisor of the Health Effects Branch for more than 5 years. Stephanie received her bachelor's degree in mechanical engineering from the University of Memphis and her masters and doctoral degrees in environmental health science from the University of Michigan.

"NRC's motto is 'Protecting People and the Environment.' RES continues to monitor and conduct radiation protection and health effects projects in the reactor, radioactive materials, and security areas to ensure that the agency fulfills its motto."
–Stephanie Bush-Goddard

Knowledge Management

Knowledge management is the process organizations use to collect and preserve important institutional knowledge and make it easily accessible to staff. Nurturing employees through effective knowledge management is a top priority at NRC because of the influx of new employees and ongoing retirements.

RES supports the agency's knowledge management goals through frequent RES Seminars featuring speakers who give presentations on technical topics. In addition, RES periodically hosts large events to recognize anniversaries of important occurrences in the nuclear industry. For example, RES recognized the 30th anniversary of the accident at Three Mile Island (TMI) Unit 2 by arranging a seminar with notable guests, video, and exhibits. These unique educational opportunities are provided for employees only and are designed to foster a well-informed workforce.

The office also develops publications and other educational tools (e.g., models) to ensure that important information is consolidated and available to staff and the public. Examples include a publication on the history of fire regulation as well as a scale model and lessons-learned brochure on the 2001 Davis-Besse reactor pressure vessel head degradation event.

Dick Thornburgh was Governor of Pennsylvania during the accident at TMI. RES organizes and sponsors educational seminars, and this photograph was taken at "The Accident at Three Mile Island – 30th Anniversary, A Look Back: Preserving the Institutional Memory."

Harold Denton was the President's Representative for TMI & Director of the Office of Nuclear Reactor Regulation during the accident.

In this picture, Office of Nuclear Regulatory Research Nuclear Safety Professional Development Program (NSPDP) participants visit TMI nuclear power plant. The NSPDP is a 2-year program to develop the next generation of nuclear safety professionals.

For more information about RES, please visit:
http://www.nrc.gov/about-nrc/organization/resfuncdesc.html

Or, access the latest version of the Research Activities publication, NUREG-1925, which is available online in pdf format:
http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/

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