



For Fiscal Years
2022–2024

RESEARCH PROSPECTUS

Office of Nuclear Regulatory Research

Leads the development of technical bases for risk-informed, performance-based regulations in all areas regulated by the NRC.

SYSTEMS ANALYSIS

ENGINEERING

RISK ANALYSIS

Supporting Decision-Making with Modeling and Simulation

Performing Comprehensive Technical Analysis

Advancing Probabilistic Risk Assessment

Foreword

#NuclearResearch

We invite you to explore the U.S. Nuclear Regulatory Commission's Research Prospectus for Fiscal Years 2022 through 2024.

THESE ARE EXCITING TIMES FOR RESEARCH. Our research results support the safety decisions our agency is making today. We are also preparing the agency for the future through our research of new and emerging technologies and technical advances. Such technologies and advances include accident tolerant fuels, advanced reactor designs, artificial intelligence, human-machine interface, advanced manufacturing techniques, to name but a few. To conduct our research activities, the Office of Nuclear Regulatory Research maintains an expert staff and collaborates with many domestic and international partners. We appreciate your interest and welcome your feedback on our research program.

**“ No research without action,
no action without research. ”**

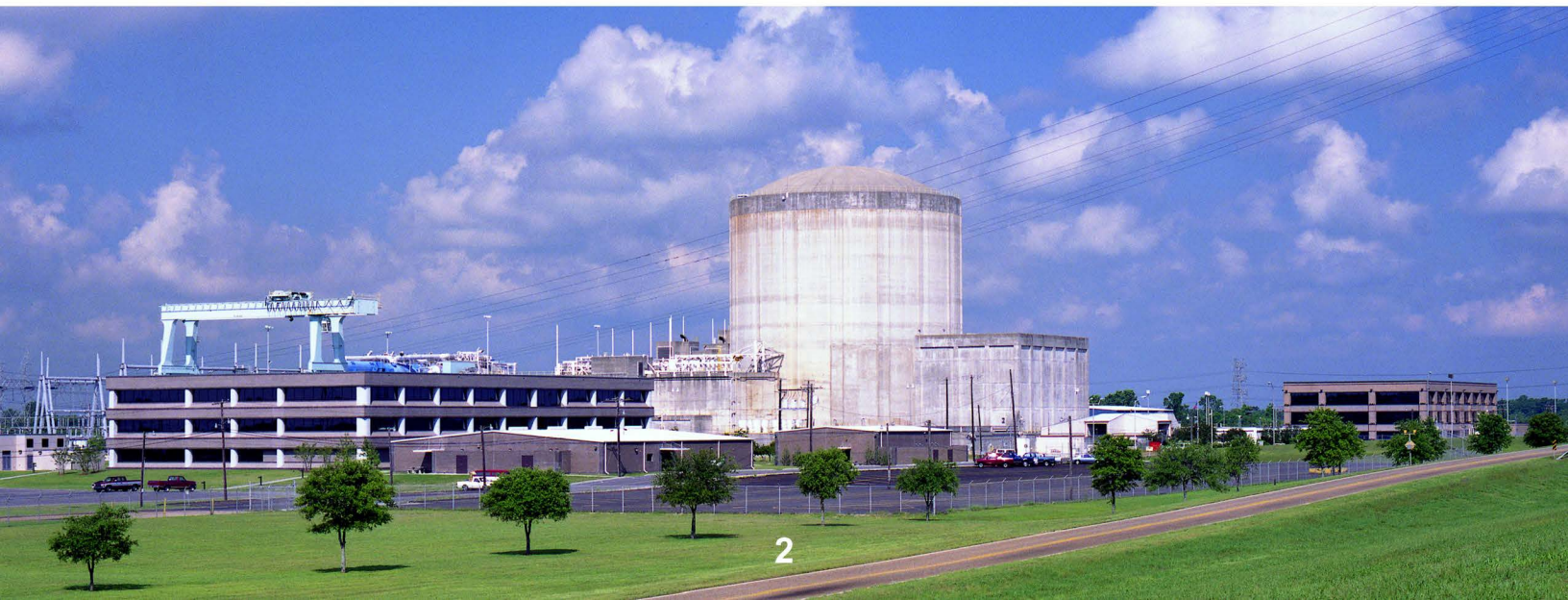
— Dr. Kurt Lewin, Founder of
Modern Social Psychology



Ray Furstenau
Director



Stephanie Coffin
Deputy Director



Office of Nuclear Regulatory Research

Current
FY 2022

\$85M

RESEARCH
BUDGET

203

FULL-TIME EQUIVALENT
STAFF

Research by the Numbers
FY 2021

42

MAJOR RESEARCH
PROGRAMS

>100

INTERNATIONAL
AGREEMENTS

29

RECENT NUREGS

>10,000

COMPUTER CODE
USERS

20

NEW AND REVISED
REGULATORY GUIDES

26

UNIVERSITY-LED, MISSION-
RELATED GRANTS

Abbreviated Terms

AI	artificial intelligence
ASP	accident sequence precursor
ATF	accident-tolerant fuel
FAST	Fuel Analysis under Steady-state and Transients
FFR	future focused research
FY	fiscal year
HEAF	high energy arcing fault
HRA	human reliability analysis
IDHEAS	Integrated Human Event Analysis System
LWR	light-water reactor
M	million
MACCS	MELCOR Accident Sequence Code System
ML	machine learning
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC technical report designation
OECD/NEA	Organisation for Economic Co-Operation and Development, Nuclear Energy Agency
OpE	operating experience
PARCS	Purdue Advanced Reactor Core Simulator
PRA	probabilistic risk assessment
RAMP	Radiation Protection Computer Code Analysis and Maintenance Program
REIRS	Radiation Exposure Information and Reporting System
RG	regulatory guide
SAPHIRE	Systems Analysis Programs for Hands-on Integrated Reliability Evaluations
SCALE	Standardized Computer Analyses Licensing Evaluation
SPAR	standardized plant analysis risk
TRACE	TRAC/RELAP Advanced Computational Engine
UNLP	University Nuclear Leadership Program

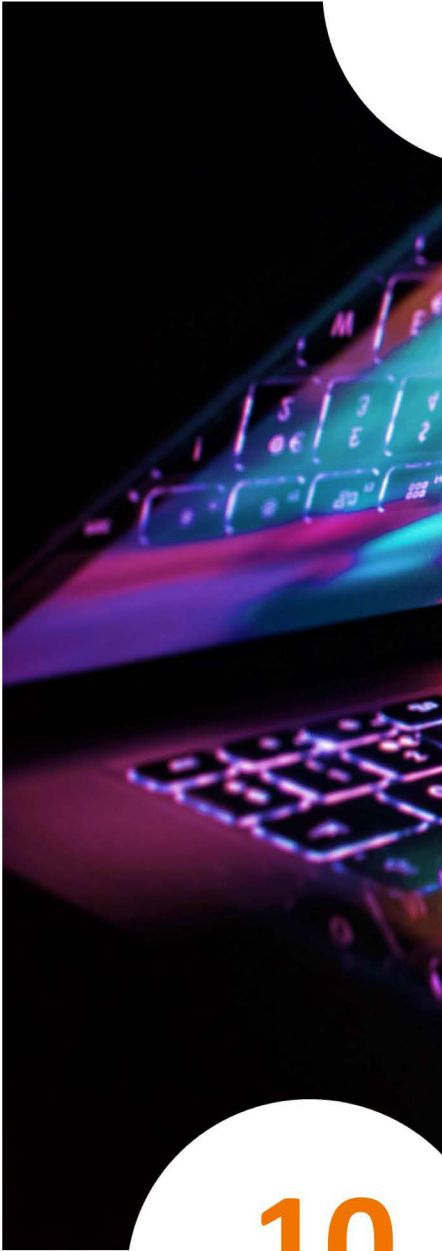
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FUTURE FOCUSED
RESEARCH

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ADVANCED REACTORS
RESEARCH

p8



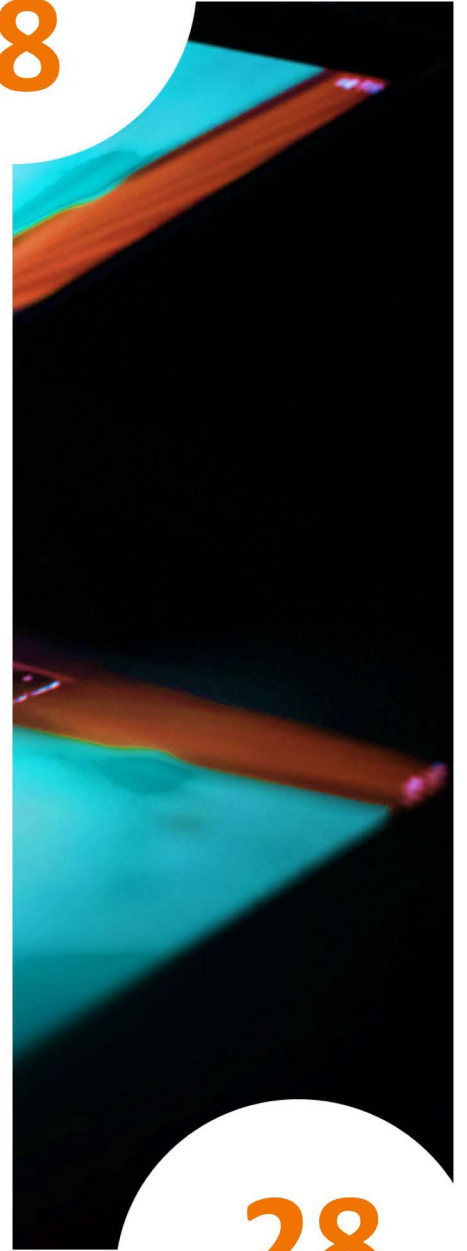
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SYSTEMS ANALYSIS
RESEARCH



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ENGINEERING
RESEARCH



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RISK ANALYSIS
RESEARCH

Looking Ahead



FFR & UNLP PROGRAMS

#NuclearResearch

The FFR Program provides a vehicle to position the NRC to be ready for future state-of-the-art technologies and their potential regulatory impacts. It **opens new areas of foundational knowledge** on key topics.

The UNLP inspires researchers at U.S. institutions to develop innovative ideas that benefit the NRC mission and the broader nuclear community.



FFR PROGRAM

Increasing Interest

NRC staff participation and interest has increased each year of the program. 18 of 78 proposals have been accepted for initiation since FY 2020.



UNLP PROGRAM

Positive Feedback

The first 2 years of the program have had an overwhelmingly positive response.

FFR Program Highlights



- › In the first 3 years of the FFR program, **\$1.8M** has been awarded for external support services. Sustained interest in the program may mean an increased allocation in the budgeted amount for FY 2023.
- › FFR projects are generally completed in 3 years or less.
- › Example projects that are at or nearing completion include Dynamic Probabilistic Analysis, Systems-Theoretic Accident Model and Processes-Based Methods for Digital Nuclear Safety System Evaluation, Digital Twins—Regulatory Viability, and Automation Tool Mapping.

UNLP Highlights



- › In FY 2020, the first year of the program, 54 institutions submitted over **160 proposals**. In a highly competitive review process, the NRC selected **15 proposals** to receive research and development grants totaling **\$7.3M**.
- › In FY 2021, nearly **100 proposals** were submitted, and the NRC selected **11 proposals** to receive research and development grants totaling **\$4.5M**.

Looking Ahead



ADVANCED REACTORS

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Research on advanced reactors facilitates the NRC's readiness for non-LWR licensing reviews.

The Near-Term Implementation Action Plan is the vehicle to execute the NRC's vision to safely achieve effective and efficient non-LWR mission readiness. Research efforts support development of computer codes and knowledge, guidance, and industry codes and standards for regulatory reviews.

SOFTWARE



Analytical Tools

Developing analytical tools and methods by executing computer code development plans and preparing reference plant models from public information. Also developing staff expertise to support future confirmatory analyses.

GUIDANCE



Risk-Informed

Preparing licensing safety guidance for seismic, materials, and human factors. Focusing on technology-inclusive, risk-informed, and performance-based approaches.

STANDARDS



Stakeholder Engagement

Engaging standards development organizations, designers, U.S. Department of Energy, and others to identify and facilitate development of new industry codes and standards.



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Advanced Reactors

Products and Budget

FY22

- › Develop two demonstration plant models for system and source term analysis for non-LWRs
- › Complete MACCS radionuclide properties on atmospheric transport and dosimetry
- › Issue trial-use RG 1.247
- › Complete final RG endorsing American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Division 5, including Alloy 617



\$6.2M

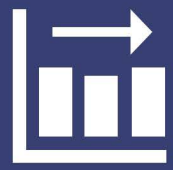
FY23

- › Complete review of MACCS capabilities for reviewing tritium releases to the environment
- › Complete scalable reactor operator licensing review guidance
- › Complete computational tool for confirmatory analyses of graphite component integrity
- › Complete trial RGs for risk-informed, performance-based seismic design and seismic isolation

\$6.4M

FY24

- › Update two demonstration plant models for system analysis
- › Develop risk-informed decision-making guidance for non-LWRs
- › Develop scalable human factors engineering and reactor operator licensing guidance
- › Develop methodology and evaluation tools for digital twin applications and enabling technologies



Systems Analysis Research

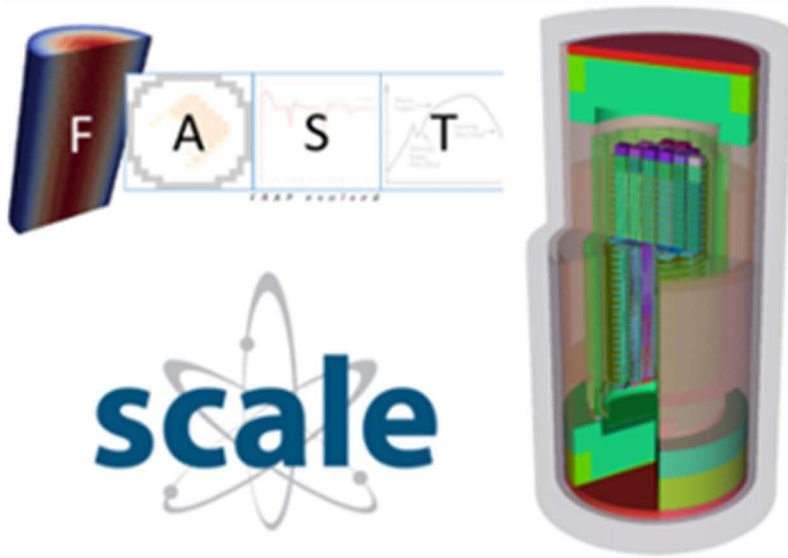
Building the NRC's
analytical capability
and **expertise**

#NuclearResearch

FOCUS AREAS

- > Fuels and Neutronics Analysis
- > Thermal Hydraulics Analysis
- > Accident Progression and Source Term Analysis
- > Consequence Analysis
- > Radiation Protection Research

Systems Analysis Research



FUELS & NEUTRONICS ANALYSIS

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Fuels and neutronics research provides the **technical bases for risk-informed regulatory decision-making.**

The FAST code enables confirmatory studies for new fuel designs, including ATF and high burnup fuels. The SCALE code can analyze neutronics-related phenomena (e.g., nuclear data libraries, depletion and activation, criticality and shielding, and sensitivity and uncertainty analysis) and is used to initialize other NRC safety codes.



ADVANCED

Nuclear Technologies

Code development to support advanced nuclear technologies, including ATF, high burnup and high-assay low-enriched uranium fuels and non-LWRs, in addition to code enhancements for LWRs.



INTERNATIONAL

Cooperation

Participation in various OECD/NEA projects to obtain data and investigate fuel and cladding behavior.



SOFTWARE

Analytical Tools

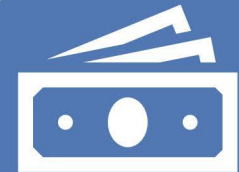
Development of staff expertise in reactor physics phenomena, including criticality and shielding, and analyses of advanced fuel designs.

Fuels and Neutronics Analysis

Products and Budget

FY22

- › Annual release of computer codes for LWR and non-LWR applications
- › Workshops for molten salt and sodium reactors
- › Issuance of research information letter on fuel fragmentation, relocation, and dispersal
- › Spent fuel storage and transportation for ATF



\$7.5M

FY23

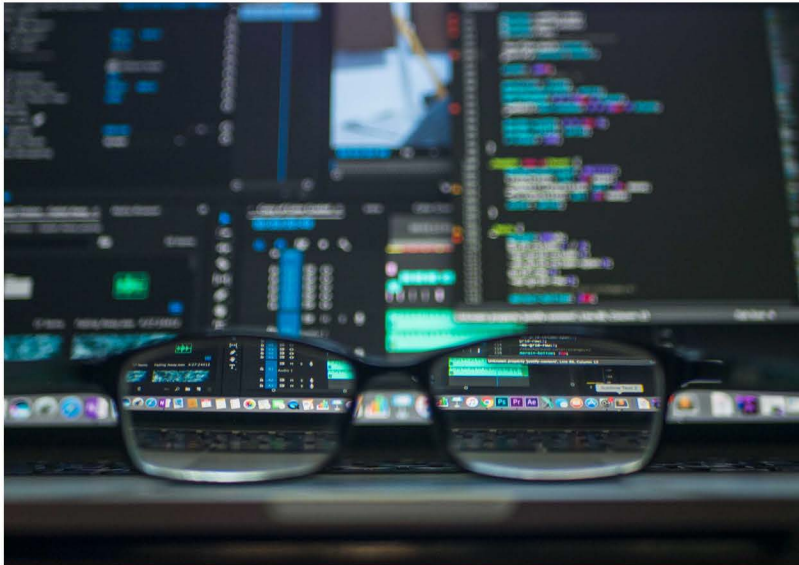
- › Annual release of computer codes for LWR and non-LWR applications
- › Completion of the first phase of the OECD/NEA Framework for Irradiation Experiments (four joint experimental programs)
- › In-house familiarity with U.S. Department of Energy computer codes

\$6.8M

FY24

- › Annual release of computer codes for LWR and non-LWR applications
- › Studsvik Cladding Integrity Program experiments
- › SCALE bundle experiments studying ATF cladding materials at the QUENCH facility in Germany
- › Spent fuel storage and transportation phenomena identification and ranking tables for ATF





THERMAL HYDRAULICS ANALYSIS

#NuclearResearch

Thermal hydraulics research leads to the development of computer codes that can **simulate** the behavior of **nuclear reactors**.

The TRACE and PARCS computer codes are used for confirmatory analyses of existing and new reactor designs to support regulatory decision-making. Like other modern reactor system codes, they depend upon empirical correlations that have been developed from detailed experiments over decades of domestic and international research.



SOFTWARE

Development

The TRACE and PARCS computer codes are maintained, developed, and distributed for performing best estimate thermal hydraulic and neutronics reactor systems analysis.



EXPERIMENTS

Model Validation

Participation in international experimental programs enables the NRC to obtain validation data at low cost. These data are then assessed to enhance code predictions.



INDEPENDENT

Analysis Tools

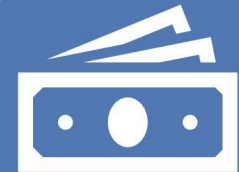
The TRACE and PARCS computer codes support independent technical basis development. They are used for confirmatory analyses to support safety and security regulatory decision-making.

Thermal Hydraulics Analysis

Products and Budget

FY22

- › Complete TRACE Version 5, Patch 7
- › Complete the ARTHUR experimental program
- › Complete two plant models to be ready for emergent licensing needs



\$6.7M

FY23

- › Complete TRACE Version 5, Patch 8
- › Complete TRACE assessment cases for the ATLAS-3 experimental program
- › Continue to provide regulatory support for the review of research reactors and a radioisotope production facility
- › Complete two plant models to be ready for emergent licensing needs

\$6.1M

FY24

- › Complete TRACE Version 5, Patch 9
- › Complete the ETHARINUS experimental program
- › Continue to provide regulatory support for the review of research reactors and a radioisotope production facility
- › Complete two plant models to be ready for emergent licensing needs



Systems Analysis Research



ACCIDENT PROGRESSION & SOURCE TERM ANALYSIS

#NuclearResearch

Research to develop, validate, and maintain state-of-the-art tools for severe accident and source term analysis.

The MELCOR computer code is used to support safety issue resolution and risk-informed decision-making. MELCOR is a system-level code that simulates the entire spectrum of accidents and phenomena from initiation to core degradation and fission product release from the fuel and transport to the containment and the outside environment.



SOFTWARE

Development

Code modernization and readiness for advanced nuclear technology applications, including ATF, high burnup and high-assay low-enriched uranium fuels, non-LWRs, and small modular reactors.



INTERNATIONAL

Cooperation

Participation in various OECD/NEA projects to obtain data for code verification and validation.



SOFTWARE

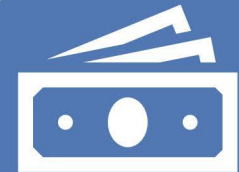
Applications

Using MELCOR to maintain staff expertise in new technologies.

Accident Progression and Source Term Analysis Products and Budget

FY22

- › Annual release of MELCOR for LWR and non-LWR applications
- › Annual technical meetings on Cooperative Severe Accident Research Program
- › Workshops for molten salt and sodium reactors
- › Source term analysis for chromium-coated ATF
- › Non-LWR fuel cycle demonstration calculations



\$2.3M

FY23

- › Annual release of MELCOR for LWR and non-LWR applications
- › Annual technical meetings on Cooperative Severe Accident Research Program
- › Modernization of the core code models
- › OECD/NEA experimental programs and data analysis
- › Fusion reactor demonstration project

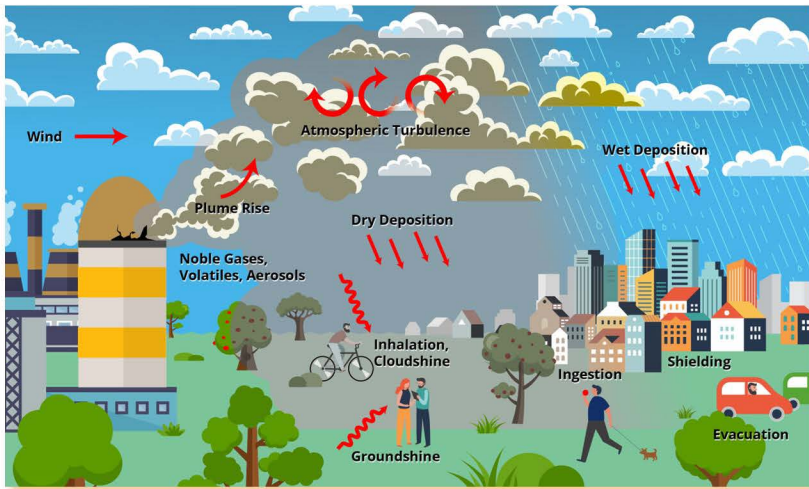
\$2.5M

FY24

- › Annual release of MELCOR for LWR and non-LWR applications
- › Annual technical meetings on Cooperative Severe Accident Research Program
- › Modernization of the radionuclide and transport code models
- › OECD/NEA experimental programs and data analysis



Systems Analysis Research



CONSEQUENCE ANALYSIS

#NuclearResearch

Research to develop and apply accident consequence codes to **evaluate** offsite consequences from hypothetical **severe accidents**.

Consequence analysis supports risk-informed decision-making by evaluating the public health effects and economic costs of mitigation actions for severe accidents and assists in emergency planning. The analyses also provide input to cost-benefit studies and support plant-specific evaluations of severe accident mitigation alternatives required for environmental assessments.



SOFTWARE

Analytical Tools

Develop and apply the MACCS computer code to model the offsite consequences from hypothetical severe accidents at nuclear power plants.



INTERNATIONAL

Cooperation

Leverage research from international organizations and other Federal agencies to continually improve the MACCS code.



EMERGENCY

Planning

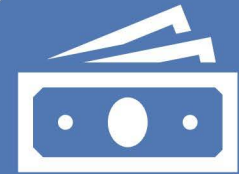
Provide insights to support methodology and guidance for determining emergency planning zone sizes for nuclear power plants.

Consequence Analysis

Products and Budget

FY22

- › Issue protective action recommendations scoping study report
- › Complete MACCS radionuclide properties on atmospheric transport and dosimetry
- › Complete initial evaluation of consequences from non-LWR source term demonstration calculations using MACCS



\$2.6M

FY23

- › Continue the evaluation of consequences from non-LWR source term demonstration calculations using MACCS
- › Develop screening analysis to inform the level of detail needed for severe accident mitigation design alternative and severe accident mitigation alternative analyses for new and non-LWR applications
- › Complete Level 3 PRA consequence analysis reports for the remaining reactor accident analyses

\$2.5M

FY24

- › Complete review of MACCS capabilities for reviewing tritium releases to the environment
- › Continue the evaluation of consequences from non-LWR source term demonstration calculations using MACCS
- › Address WinMACCS graphical user interface obsolescence





RADIATION PROTECTION RESEARCH

#NuclearResearch

Research for radiation protection, dose assessment, emergency response, and monitoring of radiation exposures for occupational safety.

This research promotes computer code development under RAMP. It also supports regulatory decisions affecting radiation protection through development of the abnormal occurrence report for Congress, REIRS, and occupational health RGs.



SOFTWARE

Development

Develop and maintain RAMP computer codes in the areas of nuclear power plant licensing and siting, decommissioning, atmospheric transport and dispersion, and emergency response.



CONSOLIDATION

Efficiency and Effectiveness

Gain RAMP computer code flexibility, efficiencies, and increased user-friendliness by consolidating similar dose assessment codes.



INTERNATIONAL

Cooperation

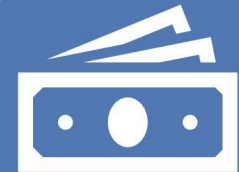
Leverage global expertise and research results to improve the RAMP computer codes.

Radiation Protection Research

Products and Budget

FY22

- › Issue annual abnormal occurrence report for Congress
- › Issue annual REIRS report
- › Complete atmospheric transport and dispersion module for the RAMP consolidated computer code



\$3.0M

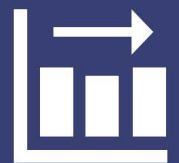
FY23

- › Issue annual abnormal occurrence report for Congress
- › Issue annual REIRS report
- › Issue RG 8.39, Revision 2, "Release of Patients Administered Radioactive Material"

\$4.3M

FY24

- › Issue annual abnormal occurrence report for Congress
- › Issue annual REIRS report
- › Complete consolidated RAMP computer code including the consolidated control room habitability, source term, and environmental pathways modules and user interface





Engineering Research

Delivering
**technology and
engineering
solutions** to make
the NRC a modern,
risk-informed
regulator

#NuclearResearch

F O C U S A R E A S

- > Seismic, Geotechnical, and Structural
- > Instrumentation, Electrical, and Cybersecurity
- > Materials Performance



SEISMIC, GEOTECHNICAL, & STRUCTURAL

#NuclearResearch

Performance assessment
of nuclear power plant
structures.

The performance of structures in nuclear installations is an essential aspect of their safety and security. Safety-related systems, structures, and components must be designed to ensure performance of their intended safety functions under design-basis events as required by NRC regulations.



SEISMIC

Hazard Analysis

Investigate enhanced seismic analysis and design approaches for operating, new, and advanced reactor technologies.



GEOTECHNICAL

Data Analysis

Address updated geotechnical, liquefaction, paleoliquefaction, and foundation stability data and analysis methods.



STRUCTURAL

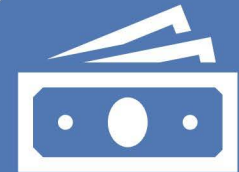
Long-Term Operation

Analyze nuclear power plant structural integrity, potential degradation mechanisms, and design and construction issues for long-term reactor operation.

Seismic, Geotechnical, and Structural Products and Budget

FY22

- › Seismic site response—Senior Seismic Hazard Analysis Committee Level 2 study
- › Research information letter on aging of posttensioned concrete containment vessels with emphasis on concrete creep and creep rupture



\$4.9M

FY23

- › Risk-informed, performance-based seismic safety and seismic isolation for advanced reactors
- › Seismic source characterization and ground-motion model updates
- › Three-dimensional physics-based ground motion study

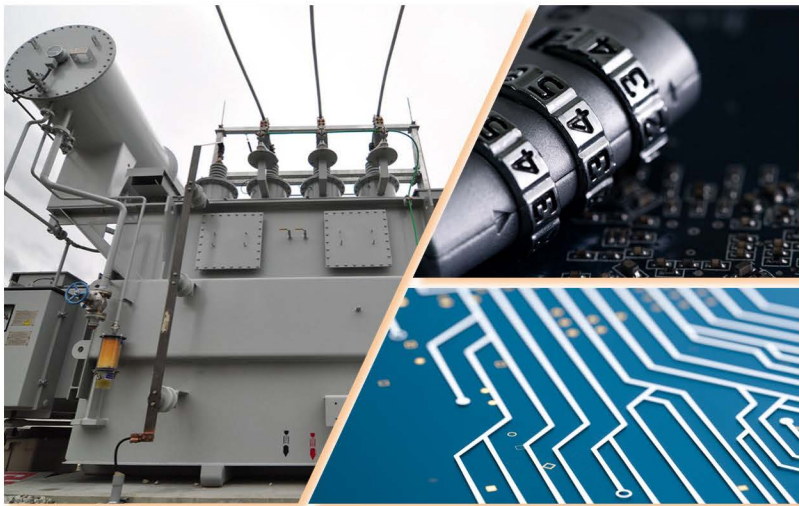
\$4.3M

FY24

- › Irradiation-assisted concrete degradation
- › Harvesting irradiated concrete materials
- › Prestressed concrete containment aging
- › Probabilistic liquefaction model development



Engineering Research



INSTRUMENTATION, ELECTRICAL, & CYBERSECURITY

#NuclearResearch

Research into **digital instrumentation** and control systems, **cybersecurity**, and electrical engineering.

Enables the safe use of new technologies in nuclear facilities, while also ensuring system security and data integrity. Also evaluates the potential degradation of electrical components and aging of cables in the existing fleet of nuclear power plants.

1010
1010

DIGITAL

Instrumentation & Control

Evaluate the safety and security implications of new technologies and designs. Provide technical information to support licensing decisions.



ELECTRICAL

Engineering

Issue assessments consistent with OpE and licensing and inspection activities, and evaluate cable condition monitoring methods.



CYBERSECURITY

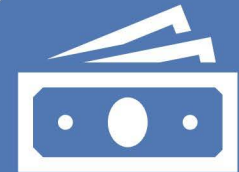
Safety

Ensure that digital instrumentation and control systems can maintain safe operating environments in nuclear facilities.

Instrumentation, Electrical, and Cybersecurity Products and Budget

FY22

- › Research on potential cyber risks from wireless technologies in risk-significant networks
- › Regulatory assessment of attack surface definitions, characterizations, and tools to assist cybersecurity
- › Evaluation of the effectiveness of systems-theoretic accident model and processes-based methods for system hazard identification



\$5.1M

FY23

- › Evaluation of methodologies and results of hazard analyses for digital instrumentation and control systems
- › Cybersecurity-focused overview of novel technology implementations in nuclear power plants
- › Electrical cable condition monitoring assessment reports
- › Criteria for determining the safety of wireless technologies at nuclear power plants

\$3.8M

FY24

- › Zero trust paradigm for cybersecurity in nuclear power plants
- › Characterizing cybersecurity using AI/ML for safety, control, and cyber protection systems
- › Contributions to Institute of Electrical and Electronics Engineers and International Electrotechnical Commission standards (all FYs)
- › Ongoing research regarding condition monitoring of cables at nuclear power plants



Engineering Research



MATERIALS PERFORMANCE

#NuclearResearch

Assessment of materials performance for manufacturing and long-term plant operations to **ensure component integrity.**

Preparing for review of advanced manufacturing technology applications and industry proposals related to nondestructive examination. Also facilitates risk-informed decision-making for component integrity assessments and addresses the impacts of material degradation for long-term operation.



ADVANCED MANUFACTURING

Emerging Applications

Assess high-interest technologies being used in the nuclear industry.



NONDESTRUCTIVE EXAMINATION

Defense In Depth

Evaluate effectiveness of nondestructive examination techniques for detecting and characterizing flaws in components.



INTEGRITY ANALYSIS

Software Tools

Maintain and develop deterministic and probabilistic codes to assess potential failures of aging components.



MATERIALS DEGRADATION

Testing and Evaluation

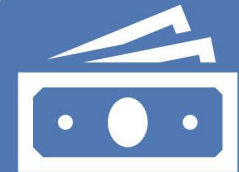
Investigate materials degradation phenomena like radiation embrittlement and cracking to ensure component integrity.

Materials Performance

Products and Budget

FY22

- › Assessment of electron beam welding and powder metallurgy hot isostatic pressing
- › Evaluation of modeling and simulation for ultrasonic examination predictions
- › Issuance of probabilistic fracture mechanics RG
- › Assessment of irradiated materials test results
- › Release of flaw evaluation software



\$9.0M

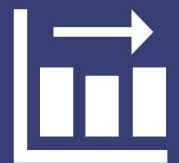
FY23

- › Evaluation of advanced phased array ultrasonic techniques
- › New release of the Fracture Analysis of Vessels— Probabilistic code and upgrades to the Extremely Low Probability of Rupture code
- › Assessment of primary water stress corrosion cracking initiation testing of Alloy 690/52/152 materials

\$9.0M

FY24

- › Assessment of automated data analysis and ML for nondestructive examination
- › Benchmarking of the Fracture Analysis of Vessels— Probabilistic code and the Extremely Low Probability of Rupture code
- › Assessment of primary water stress corrosion cracking initiation testing of Alloy 690/52/152 weld dilution zones, heat affected zones, and weld defects





Risk Analysis Research

Developing
risk-informed
solutions to
current and
anticipated
regulatory challenges

#NuclearResearch

FOCUS AREAS

- > Human Reliability and Organizational Factors
- > Operating Experience
- > Risk Tools and Studies
- > Fire Research and External Hazards Analysis

HUMAN RELIABILITY & ORGANIZATIONAL FACTORS

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Provides safety perspectives on the **impact of human performance** on nuclear power plants and other NRC-licensed facilities.

Improves understanding of complex human, organizational, and system interactions, which will help to ensure the continued safety of nuclear operations with novel technologies and advanced concepts of operation.

“

Virtually every system...places “operator error” high on its list of causal factors—generally about 60 to 80 percent of accidents are attributed to this factor.

Charles Perrow
in *Normal Accidents*

”



Use state-of-the-art principles to develop human and organizational factors guidance



Apply robust scientific basis to develop and improve HRA methods for risk analyses



Leverage domestic and international programs to gain data and insights

Human Reliability and Organizational Factors Products and Budget

FY22

- › Enhance HRA method for all nuclear applications: IDHEAS for Event and Condition Assessment
- › Develop new method for performing dependency analysis in HRA applications: IDHEAS-Dependency
- › Provide update on the human factors challenges associated with the incorporation of adaptive automation
- › Report on the use of cognitive task analysis for human factors engineering reviews
- › Complete human factors engineering training program



\$3.5M

FY23

- › Update human factors engineering program review model based on lessons learned from new and advanced reactor reviews
- › Develop new method for calculating the effects of time on human error: IDHEAS-Time
- › Publish research information letters on the results of the NRC's human performance test facility experiments
- › Enhance guidance for performing expert elicitations
- › Enrich database on human error to support HRA method development: IDHEAS-Data

\$3.5M

FY24

- › Update Human-System Interface Design Review Guidelines based on lessons learned from new and advanced reactor reviews
- › Develop new method for crediting recovery actions in HRA: IDHEAS-Recovery
- › Enhance technical bases for minimum joint human error probabilities
- › Issue guidance for the use of independent safety culture assessments in the nuclear industry



Risk Analysis Research



OPERATING EXPERIENCE

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Evaluation of OpE to gain risk insights, **understand industry performance**, and inform NRC risk models.

The ASP Program evaluates OpE to identify precursors to potential core damage. OpE data collection and analysis looks for long-term component and system performance trends and is used for initiating event frequencies and failure parameters in the NRC's plant risk models.



RISK INSIGHTS

ASP Program

Evaluates U.S. nuclear power plant OpE to identify, document, and rank operational events by core damage probability parameters.



PUBLIC WEBPAGE

Trending Events

Displays on the NRC's public webpage trends and insights from initiating events, system and component failures, and common-cause failures.



DATA ANALYTICS

AI/ML

Collaboration with the U.S. Department of Energy to evaluate data analytics and AI/ML for use to increase the effectiveness of NRC OpE evaluations.

Risk Analysis Research

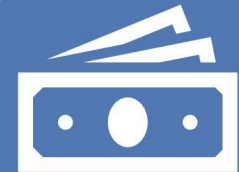
#NuclearResearch

Operating Experience

Products and Budget

FY22

- › Calendar year 2021 ASP analyses and issuance of annual ASP report
- › SPAR model data parameters update
- › Evaluation of initiating and loss of offsite power events
- › System and component reliability studies update
- › Development and evaluation of component-specific priors for common-cause failures



\$3.1M

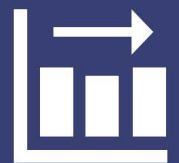
FY23

- › Calendar year 2022 ASP analyses and issuance of annual ASP report
- › Evaluation of initiating and loss of offsite power events
- › Collection, coding, and provide quality assurance of reactor operating data
- › Maintenance and enhancement of the database that houses the long-term OpE data and licensee event reports

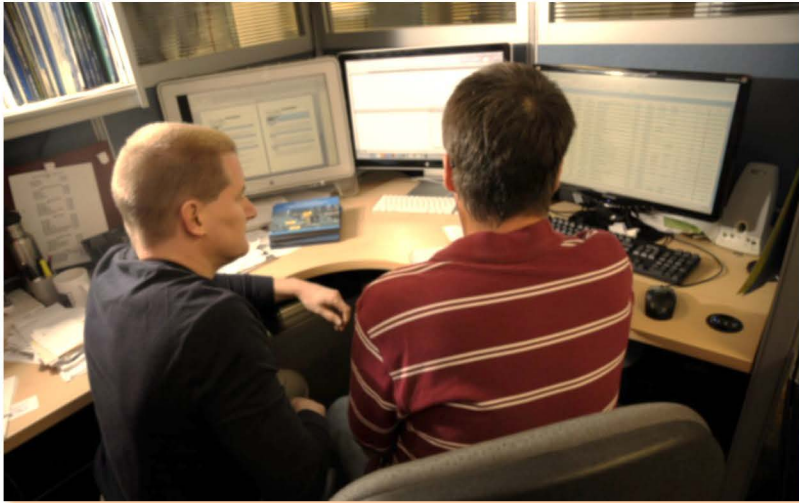
\$4.0M

FY24

- › Calendar year 2023 ASP analyses and issuance of annual ASP report
- › Evaluation of initiating and loss of offsite power events
- › Collection, coding, and provide quality assurance of reactor operating data
- › Maintenance and enhancement of the database that houses the long-term OpE data and licensee event reports



Risk Analysis Research



RISK TOOLS & STUDIES

#NuclearResearch

Timely, realistic, and repeatable risk assessments to support NRC licensing, rulemaking, oversight, and OpE evaluation activities.

Risk tools support projects such as Level 3 PRA, which is a sitewide, full-scope PRA that includes all radioactive sources for a two-unit reference pressurized-water reactor. This project is advancing the state of practice in areas such as human reliability, multiunit risk, severe accidents, and more.

RISK MODELS



SPAR

Maintain the NRC's SPAR models for all operating nuclear power plants with the goal of reflecting current designs and operations.



SOFTWARE

SAPHIRE

Use the SAPHIRE computer code to support the development of the agency's SPAR models.



RISK ASSESSMENT

Level 3 PRA

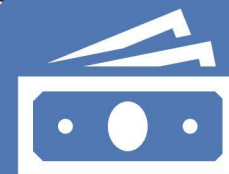
Provide living Level 1, 2, and 3 PRA models to support enhanced risk-informed decision-making and analyses of emerging technologies.

Risk Tools and Studies

Products and Budget

FY22

- › SAPHIRE updates to add user-requested features
- › Hundreds of requested SPAR model changes to support event and condition assessments
- › SPAR dashboard for expanded access to risk insights from SPAR models for nonrisk experts
- › Level 3 PRA project internal reports for reactor low power and shutdown, spent fuel pool, and dry cask storage
- › Draft NUREGs for comment on reactor, at-power, internal events and internal floods, and dry cask storage



\$4.5M

FY23

- › SAPHIRE Version 9.0 with cloud-based capabilities
- › Hundreds of requested SPAR model changes to support event and condition assessments
- › Expanded SPAR model capabilities in external hazards, diverse and flexible coping strategies, and HRA
- › Level 3 PRA project internal report for integrated site risk
- › Draft NUREGs for comment on reactor, at-power, internal fires, seismic and high winds; reactor, low power and shutdown; and spent fuel pools

\$4.4M

FY24

- › Integration of IDHEAS for Event and Condition Assessment into SAPHIRE as a replacement for SPAR-H
- › Hundreds of requested SPAR model changes to support event and condition assessments
- › Enhancements to SAPHIRE and SPAR models to assess time-sensitive and quickly changing conditions
- › Draft Level 3 PRA NUREGs for comment on integrated site risk and project summary



FIRE RESEARCH & EXTERNAL HAZARDS ANALYSIS

#NuclearResearch

Research to develop the tools, methods, and data for analyzing risks from fire and external hazards.

NRC regulations require each operating nuclear unit to be capable of performing safe shutdown and maintenance of the reactor when challenged by a fire or other natural hazards.

Research enhances realism in fire and other external hazard PRAs to support risk-informed decision-making.

“

We learn from every natural disaster. Whether it's a fire or a flood, we learn something from it so we can respond to the next one better.

Malcolm Turnbull,
Former Prime Minister
of Australia

”



Analyze fire hazards and the impact on reactor safety in a probabilistic framework



Assess potential risk of external flooding and the impact on reactor safety in a probabilistic framework

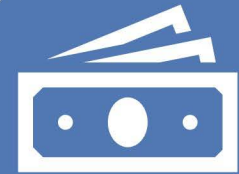


Systematically assess new natural hazard information and its impacts on existing estimates

Fire Research and External Hazards Analysis Products and Budget

FY22

- › In cooperation with the Electric Power Research Institute, develop an improved methodology for assessing fire risk including HEAFs
- › Lead the OECD/NEA testing program for HEAF
- › Perform fire PRA model refinements to improve PRA realism; update methods in NUREG/CR-6850
- › Develop draft probabilistic flood hazard assessment guidance
- › Maintain the NRC's Natural Hazard Information Digest
- › Host annual workshops and knowledge management training



\$3.1M

FY23

- › Complete testing and publish results from the OECD/NEA HEAF testing program
- › Perform fire PRA model refinements to improve PRA realism; update methods in NUREG/CR-6850, including the development of low power and shutdown risk for fire PRAs
- › Publish draft probabilistic flood hazard assessment regulatory guidance for public comment
- › Maintain and expand the NRC's Natural Hazard Information Digest
- › Host annual workshops and knowledge management training

\$2.4M

FY24

- › Continue to develop tools, methods, and data to improve realism in fire PRAs, including updates based on fire frequency and OpE
- › Publish final probabilistic flood hazard assessment regulatory guidance
- › Maintain and expand the NRC's Natural Hazard Information Digest
- › Research extreme weather events, such as cold-air outbreaks and high winds, in the context of climate change and their potential hazards for nuclear power plants
- › Host annual workshops and knowledge management training



Our

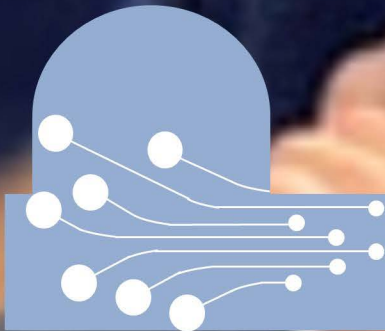
Research Supports

#NuclearResearch

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Reactors**



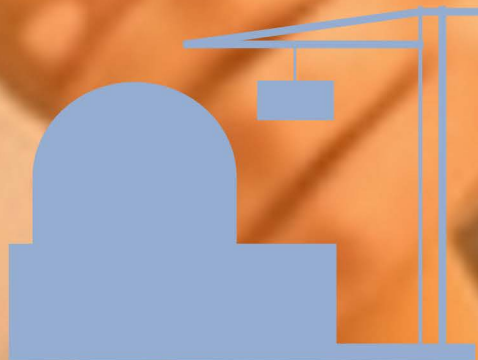
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