Nuclear Energy
($K)

FY 2021 Enacted[1,2]	FY 2022 Annualized CR[3]	FY 2023 Request
1,507,600	1,507,600	1,675,060

Overview

Nuclear energy is a key element of the President's plan to put the United States (U.S.) on a path to net-zero emissions by 2050. America's nuclear energy sector provides approximately 55 percent of the nation's annual clean electricity production and generates about 20 percent of U.S. electricity from a fleet of 93 operating units in 28 states. America's nuclear energy sector also plays key national security and global strategic roles for the U.S., including nuclear nonproliferation.

The U.S. pioneered the development and peaceful use of nuclear power to produce around-the-clock, emission-free baseload electricity generation as well as the development of the civilian nuclear fuel cycle. The Office of Nuclear Energy (NE) is now leading the effort to move new and innovative advanced reactors, small modular reactors, and microreactors from the conceptual and development stages into the commercial energy sector. NE executes its mission through investments in early-stage research and development efforts with the national laboratories, U.S. universities, and industry technical organizations, as well as through partnerships with the U.S. industry and commercial stakeholders to develop and demonstrate advanced reactor technologies and designs.

The FY 2023 Request helps to advance U.S. leadership in critical technologies, invest in our workforce, and upgrade America's research infrastructure. U.S. leadership in new nuclear technologies is critical to both our future economic competitiveness and our national security.

The Office of Nuclear Energy (NE) focuses on three major mission area: the nation's existing nuclear fleet, the development of advanced nuclear reactor concepts, and fuel cycle technologies. Investments in these areas leverage the tremendous innovation capacity of the United States' National Laboratories, universities, and advanced reactor developers to transform America's power sector. NE is also responsible for ensuring the secure operational availability of the Idaho National Laboratory (INL) as a national asset supporting a broad range of civilian and national security research.

The NE FY 2023 Request will extend the impact of our RD&D (Research, Development, & Demonstration) funding by leveraging creative funding mechanisms - such as prizes, competitions, technical assistance, and programs targeted to small businesses. The goal is to enable the commercialization of climate change and clean energy innovations that will activate job creation, expand other public impact outcomes, and yield a more geographically diverse and impactful research portfolio.

[1] Funding does not reflect the transfer of SBIR/STTR to the Office of Science.
[2] Funding does not reflect the mandatory transfer of $91.0M from Naval Reactors for operation of the Advanced Test Reactor.
[3] Funding does not reflect the mandatory transfer of $91.0M from Naval Reactors for operation of the Advanced Test Reactor.

Highlights and Major Changes in the FY 2023 Budget Request

Supporting the President's commitment to put America on a path to achieve net-zero emissions no later than 2050 by investing in resilience, clean energy innovation and U.S. competitiveness, the NE budget request provides a $167.5M increase (+11%) above the FY 2021 appropriation. These investments will leverage the tremendous innovation capacity of the National Laboratories, universities, and advanced reactor developers to transform America's power sector.

- A new element, **Directed R&D and University Programs**, requests $161.0M to consolidate and focus support to universities and small businesses in areas relevant to NE's mission. Most of this support will be awarded through competitive opportunities for researchers, students, faculty, and small businesses. Additionally, the program will continue to provide fuel services and support maintenance and safety upgrades of fuel fabrication equipment and facilities for U.S. university research reactors. This program also seeks to ensure that access to these opportunities and benefits are equitably provided, specifically seeking ways to include communities that have historically faced limits in access to such capabilities, such as students and faculty at Minority Serving Institutions (MSIs). These efforts will include initiating a competitively awarded, consortium-led project to establish an advanced research reactor at a U.S. university, potentially along with additional, complementary research infrastructure at additional locations.
- **High-Assay, Low Enriched Uranium (HALEU) Availability**, requests $95M to make available small quantities of HALEU from limited DOE uranium inventories and HALEU production in the short term and will work with the private sector in its design and establishment of commercial U.S. HALEU production capability in the long term.
- The **Advanced Reactor Demonstration Program** is requesting $230.2M to focus Departmental and non-federal resources on supporting the development of advanced reactors that have the potential for near and mid-term demonstration and commercial deployment and addressing challenges hindering their deployment. In the FY 2022 Bipartisan Infrastructure Law (BIL) (Infrastructure Investment and Jobs Act, P.L. 117-58, November 15, 2021, multi-year funding for the advanced reactor demonstration elements of this program was provided under the new Office of Clean Energy Demonstrations (OCED) and as such no FY 2023 funding is requested within NE.
- $53M is requested to support the implementation of a consent-based siting process for an **interim storage** facility to address the near-term requirements for storage of commercial used fuel. These funds are included within the Integrated Waste Management System subprogram within the Fuel Cycle R&D program.
- Acknowledging the tremendous recent advances that have been made in microreactor research and development, the **Transformational Challenge Reactor** effort is ended in FY 2023. The associated crosscutting research, particularly in areas such as advanced manufacturing, are integrated into the base NE R&D programs.
- Within its **Infrastructure Program**, NE is requesting $326M for INL Facilities Operations and Maintenance (IFM) subprogram. The request will focus on maintaining mission critical facilities to support technical advancements in existing nuclear fleet, reactors, and nuclear fuel cycle. It will also focus on investing in the Advanced Test Reactor (ATR) Complex and the Materials and Fuels Complex to improve reliability and modernize capabilities in support of nuclear energy R&D objectives. Additionally, within the Construction subprogram, NE is requesting $7.3M to complete the Sample Preparation Laboratory (SPL) at INL, which will provide world-class capability to conduct post-irradiation examinations at micro/nano scale of existing and advanced nuclear fuels and materials.

Nuclear Energy
Funding by Congressional Control ($K)

	FY 2021 Enacted[1,2]	FY 2022 Annualized CR[1,3]	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Directed R&D and University Programs					
Directed Research and Development	0	0	137,029	+137,029	+100%
University Nuclear Leadership Program	0	0	6,500	+6,500	+100%
University Fuel Services	0	0	17,500	+17,500	+100%
Directed R&D and University Programs	**0**	**0**	**161,029**	**+161,029**	**+100%**
Integrated University Program	**5,000**	**5,000**	**0**	**+0**	**+0%**
STEP Research & Development (R&D)	**5,000**	**5,000**	**0**	**+0**	**+0%**
Reactor Concepts Research, Development & Demonstration (RD&D)					
Advanced SMR RD&D	115,000	115,000	40,000	-75,000	-65%
Light Water Reactor Sustainability	47,000	47,000	45,000	-2,000	-4%
Advanced Reactor Technologies	46,000	46,000	50,000	+4,000	+9%
Reactor Concepts RD&D	**208,000**	**208,000**	**135,000**	**-73,000**	**-35%**
Fuel Cycle Research and Development					
Mining, Conversion and Transportation	2,000	2,000	1,500	-500	-25%
Civil Nuclear Enrichment	40,000	40,000	0	-40,000	-100%
Materials Recovery and Waste Form Development	25,000	25,000	38,000	+13,000	+52%
Accident Tolerant Fuels	105,800	105,800	113,900	+8,100	+8%
TRISO and Graphite Qualification	36,000	36,000	27,000	-9,000	-25%
Fuel Cycle Core R&D	20,000	20,000	46,500	+26,500	+133%
High Assay Low Enriched Uranium Availability	0	0	95,000	+95,000	+100%
Used Nuclear Fuel Disposition R&D	62,500	62,500	46,875	-15,625	-25%
Integrated Waste Management System	18,000	18,000	53,000	+35,000	+194%
Fuel Cycle R&D	**309,300**	**309,300**	**421,775**	**+112,475**	**+36%**

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	FY 2021 Enacted[1,2]	FY 2022 Annualized CR[1,3]	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Nuclear Energy Enabling Technologies					
Crosscutting Technology Development	28,000	28,000	35,250	+7,250	+26%
Joint Modeling and Simulation Program	35,000	35,000	28,327	-6,673	-19%
Nuclear Science User Facilities	30,000	30,000	39,160	+9,160	+31%
Transformational Challenge Reactor	29,869	29,869	0	-29,869	-100%
Nuclear Energy Enabling Technologies	**122,869**	**122,869**	**102,737**	**-20,132**	**-16%**
Advanced Reactor Demonstration Program					
National Reactor Innovation Center	30,000	30,000	75,000	+45,000	+150%
Demonstration 1	80,000	80,000	0	-80,000	-100%
Demonstration 2	80,000	80,000	0	-80,000	-100%
Risk Reduction for Future Demonstrations	40,000	40,000	140,238	+100,238	+251%
Regulatory Development	15,000	15,000	10,250	-4,750	-32%
Advanced Reactor Safeguards	5,000	5,000	4,750	-250	-5%
Subtotal, Advanced Reactors Demonstration Program	**250,000**	**250,000**	**230,238**	**-19,762**	**-8%**
Versatile Test Reactor Project					
Other Project Costs	43,000	43,000	45,000	+2,000	+5%
21-E-200, Versatile Test Reactor	2,000	2,000	0	-2,000	-100%
Versatile Test Reactor Project	**45,000**	**45,000**	**45,000**	**+0**	**+0%**
Infrastructure					
INL Facilities Operations & Maintenance	280,000	280,000	326,924	+46,924	+17%
ORNL Infrastructure Facilities O&M	20,000	20,000	0	-20,000	-100%
Research Reactor Infrastructure	11,500	11,500	0	-11,500	-100%
Construction					
16-E-200, Sample Preparation Laboratory	26,000	26,000	7,300	-18,700	-72%
Subtotal, Infrastructure	**337,500**	**337,500**	**334,224**	**-3,276**	**-1%**

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[3] Funding does not reflect the mandatory transfer of $91.0M from Naval Reactors for operation of the Advanced Test Reactor.

	FY 2021 Enacted[1,2]	FY 2022 Annualized CR[1,3]	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Idaho Sitewide Safeguards and Security	**149,800**	**149,800**	**156,600**	**+6,800**	**+5%**
International Nuclear Energy Cooperation	**0**	**0**	**3,000**	**+3,000**	**+100%**
Program Direction	**75,131**	**75,131**	**85,457**	**+10,326**	**+14%**
Total, Nuclear Energy R&D	**1,507,600**	**1,507,600**	**1,675,060**	**+167,460**	**+11%**
Federal FTEs	256	283	356	+100	+39%

SBIR/STTR:

- FY 2021 Transferred: SBIR $16,564; STTR $2,329
- FY 2022 Projected: SBIR $25,636; STTR $3,605
- FY 2023 Request: SBIR $22,513; STTR $3,166

Future Year Energy Program

($K)					
	FY 2023 Request	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**
Nuclear Energy (Non 050)	1,518,460	1,553,000	1,589,000	1,625,000	1,663,000
Nuclear Energy (050) S&S	156,600	161,000	164,000	168,000	172,000

Outyear Priorities and Assumptions

In the FY 2012 Consolidated Appropriations Act (P.L. 112-74), Congress directed the Department to include a future-years energy program (FYEP) in subsequent requests that reflects the proposed appropriations for five years. This FYEP shows outyear funding for each account for FY 2024 - FY 2027. The outyear funding levels use the growth rates from and match the outyear account totals published in the FY 2023 President's Budget for both the 050 and non-050 accounts. Actual future budget request levels will be determined as part of the annual budget process.

Nuclear Energy priorities in the outyears include the following:

- Supporting the five Risk Reduction for Future Demonstration awards and the National Reactor Innovation Center under the Advanced Reactor Demonstration Program.

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[3] Funding does not reflect the mandatory transfer of $91.0M from Naval Reactors for operation of the Advanced Test Reactor.

- Providing limited quantities of HALEU for NE research and demonstration requirements.
- Providing for the secure availability of the Idaho National Laboratory for NE, DOE and other U.S. government requirements.
- Expanding access to university based nuclear energy science and engineering opportunities.

Bipartisan Infrastructure Law (BIL) Investments

NE was appropriated funds through the Bipartisan Infrastructure Law (BIL) (P.L. 117-58). Not all BIL activities will be managed by the organization to which funds were appropriated. Activities that will be managed by other organizations are discussed below.

($K)

Nuclear Energy	FY 2022 BIL Appropriation	FY 2023 BIL Appropriation	Managing Organization
Civil Nuclear Credit Program	1,200,000	1,200,000	GDO
Total, Nuclear Energy	**1,200,000**	**1,200,000**	

- **Civil Nuclear Credit Program:** The goal of this investment is to help preserve the existing U.S. reactor fleet and save thousands of high-paying jobs across the country. Under the new program, owners or operators of commercial U.S. reactors can apply for certification to bid on credits to support their continued operations. An application must demonstrate the reactor is projected to close for economic reasons and that closure will lead to a rise in air pollutants and carbon emissions. The program is available for plants that are certified as safe to continue operations and prioritizes plants that use domestically produced fuel. Although funds were appropriated to NE, the Grid Deployment Office (GDO) will continue to execute the Civil Nuclear Credit Program in FY 2023.

Directed R&D and University Programs

Overview

The Office of Nuclear Energy (NE) Directed Research & Development (R&D) and University Programs is a new program that consolidates and focuses support to universities and small businesses in areas relevant to NE's mission. This program will fund university research, infrastructure, workforce development, and commercialization efforts for nuclear energy. Most of this support will be awarded through competitive opportunities for researchers, students, faculty, and small businesses. Additionally, the program will continue to provide fuel services and support maintenance and safety upgrades of fuel fabrication equipment and facilities for U.S. university research reactors. This program also seeks to ensure that access to these opportunities and benefits are equitably provided, specifically seeking ways to include communities that have historically faced limits in access to such capabilities, such as students and faculty at minority-serving institutions (MSI). These efforts will include initiating competitively awarded, consortium-led activities to establish one or more advanced research reactor(s) and related capabilities at U.S. universities.

Highlights of the FY 2023 Budget Request

The Directed R&D and University Programs will be implemented by consolidating the following programs: Small Business Innovation Research and Small Business Technology Transfer Program (SBIR/STTR), the Technology Commercialization Fund (TCF) program, the Nuclear Energy University Program (NEUP), the University Nuclear Leadership Program (UNLP), and University Fuel Services (UFS). SBIR/STTR, TCF, and NEUP were previously funded through allocated charges from other NE research, development, and demonstration programs. UNLP, formerly the Integrated University Program (IUP) and UFS, formerly Research Reactor Infrastructure (RRI), were funded as separate line items.

The Directed R&D subprogram will encompass the program's competitive awarded opportunities including SBIR/STTR, TCF, and competitively awarded, university-led R&D and infrastructure (NEUP).

The reorganization of these efforts into a new program in FY 2023 provides a more flexible, streamlined, and transparent approach for NE to support universities, small businesses, and researchers moving nuclear energy technology forward. The Advanced Reactor Infrastructure element under the Directed Research and Development subprogram initiates competitively awarded, consortium-led efforts to establish one or more advanced research reactor(s) and related capabilities at U.S. universities. These activities will help U.S. universities (1) develop a workforce with hands-on experience with commercially relevant advanced reactor concepts, reflective of those being deployed by industry; (2) offer research capabilities that address emerging technical challenges; and (3) ensure that access to the opportunities and benefits of these facilities are equitably provided, specifically seeking ways to include communities that have historically faced limits in access to such capabilities.

Directed R&D and University Programs
Funding ($K) (Non-Comparable)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Directed R&D and University Programs					
Directed Research and Development	0	0	137,029	+137,029	+100%
University Nuclear Leadership Program	0	0	6,500	+6,500	+100%
University Fuel Services	0	0	17,500	+17,500	+100%
Total, Directed R&D and University Programs	**0**	**0**	**161,029**	**+161,029**	**+100%**

Directed R&D and University Programs
Funding ($K) (Comparable)

	FY 2021 Enacted	FY 2022 Enacted	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Directed R&D and University Programs					
Directed Research and Development	90,417[1]	100,000[2]	137,029	+46,612	+51.6%
University Nuclear Leadership Program	5,000	6,000	6,500	+1,500	+30.0%
University Fuel Services	11,500	15,000	17,500	+6,000	+52.2%
Total, University Programs and Directed Research	**106,917**	**121,000**	**161,029**	**+54,112**	**+50.6%**

SBIR/STTR:

- FY 2021 Transferred: SBIR $16,093; STTR $2,800
- FY 2022 Enacted: SBIR $25,636; STTR $3,605[3]
- FY 2023 Request: SBIR $22,513; STTR $3,166

[1] Funding for SBIR/STTR transferred to the Office of Science from NE R&D programs (STEP R&D, Reactor Concepts RD&D, Fuel Cycle Research and Development, Nuclear Energy Enabling Technologies, and Advanced Reactors Demonstration Program).
[2] FY 2022 funding for Directed Research and Development reflects actual appropriated amount for "NEUP, SBIR/STTR, and TCF".
[3] FY 2022 Funding for SBIR and STTR reflects estimates based on actual FY 2022 enacted appropriations.

Directed R&D and University Programs
Proposed Budget Structure Changes

The reorganization of these efforts into a new program in FY 2023 provides a more consistent approach for NE to support universities, small businesses, and researchers moving nuclear energy technology forward.

	Directed R&D and University Programs			
	Directed Research & Development	**University Nuclear Leadership Program**	**University Fuel Services**	**Total**
FY 2022 Enacted Budget Structure				
Integrated University Program		6,500		6,500
Infrastructure				
Research Reactor Infrastructure			17,500	17,500
NEUP, SBIR/STTR, and TCF	137,029			137,029
Total, Directed R&D and University Programs	**137,029**	**6,500**	**17,500**	**161,029**

Directed R&D and University Programs
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Directed Research & Development:	
The increase from $0 to $137,029,000 reflects consolidation of funding for:	
• Small Business Innovation Research and Small Business Technology Transfer	**+25,679**
• Technology Commercialization Fund	**+6,692**
• University-Led Research and Development	**+59,658**
• University Infrastructure	**+45,000**
University Nuclear Leadership Program:	**+6,500**
Of the increase from $0 to $6,500,000, $5,000,000 reflects the transfer of scholarships and fellowships previously funded under the Integrated University Program; the additional increase supports $1,000,000 for a scholarship opportunity targeting 2-year applied technical degree programs focused on nuclear energy-related topics, with priority funding set-aside specifically to support Historically Black Colleges and Universities (HBCUs), MSIs, and institutions in disadvantaged communities; and $500,000 for the OMNI internship program that will help build careers for talented cybersecurity and information technology professionals who are often from disadvantaged communities.	
University Fuel Services:	**+17,500**
Of the increase from $0 to $17,500,000, $11,000,000 reflects the transfer of fuel services previously funded under Research Reactor Infrastructure. An additional $5,000,000 ensures a maximum number of orders for fresh TRIGA fuel elements per year can be purchased to minimize overall cost. An additional increase of $1,500,000 reflects support to the North Carolina State University Pulstar reactor, including new fuel assembly boxes and end fittings, neutronic and thermal-hydraulic modeling of a fuel package, safety analysis, licensing support and fuel design and engineering studies.	
Total, University Programs and Directed Research	**+161,029**

Directed Research & Development

Description

The Directed Research and Development subprogram includes competitive awarded opportunities for small businesses and universities. Establishing a single program funding line provides more flexibility to NE's competitive award process; streamlines program execution; and provide enhanced transparency for small businesses, universities, and other stakeholders.

The principal focus areas for FY 2023 include four elements: (1) Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR); (2) Technology Commercialization Fund (TCF); (3) University-led Research and Development; and (4) University Infrastructure.

1. **SBIR/STTR** – NE supports small business through the Department's SBIR/STTR program. The SBIR/STTR reauthorizing language (Reauthorization Act of 2011 (P.L. 112-81, 125 STAT 1822)) directs the Department to spend not less than 3.2 percent of its extramural research and development (R&D) budget for SBIR and not less than 0.45 percent of its extramural R&D budget for STTR. NE's contribution supports scope relevant to NE's R&D mission, for example technologies for improvements of existing reactors, advanced reactors, and fuel cycle systems.
2. **TCF** – NE supports the transfer of promising nuclear energy technologies developed at the Department's national laboratories to the nuclear industry for commercialization through TCF. The TCF was established under 42 U.S. Code § 16391, which directed the Secretary to "establish an Energy Technology Commercialization Fund, using 0.9 percent of the amount made available to the Department for applied energy research, development, demonstration, and commercial application for each fiscal year based on future planned activities and the amount of the appropriations for the fiscal year, to be used to provide matching funds with private partners to promote promising energy technologies for commercial purposes."
3. **University-led Research and Development** – NE supports the U.S. university community with competitive research and development through yearly competitive solicitations. The program's goal is to support outstanding, cutting-edge, and innovative research at U.S. universities, including minority-serving institutions (MSIs) and historically black colleges and universities (HBCUs), in the areas of nuclear energy science, technology and social impacts including Health Physics, Nuclear Materials Science, Radiochemistry, Applied Nuclear Physics, and intergenerational knowledge transfer through the following funding opportunities:
    a. **Consolidated Innovative Nuclear Research (CINR):** NE plans to continue to utilize the CINR funding opportunity to align nuclear energy research being conducted at U.S. colleges and universities with DOE's mission and goals, focusing on the needs and priorities of key NE programs including fuel cycle, reactor concepts, and mission supporting research. This opportunity will also include Integrated Research Projects (IRPs), which are multi-disciplinary and multi-institutional projects that address near-term, specific needs, problems, or capability gaps, including workforce development, related to nuclear energy. IRPs are intended to integrate several disciplinary skills to present solutions to complex systems design problems that cannot be addressed by a less comprehensive team.
    b. **Distinguished Early Career Program (DECP):** NE plans to continue to utilize its most prestigious opportunity for faculty members, DECP. This program will focus on faculty conducting transformative research, education, and leadership aligned with the Office of Nuclear Energy's mission. It will provide stable support to enable awardees to develop careers in nuclear energy relevant areas, not only as outstanding researchers but also as educators demonstrating commitment to teaching, learning, and dissemination of knowledge. This opportunity will support the development of faculty members to advance their research focus while training the next generation of nuclear energy professionals. DECP aims to recognize distinguished researchers at the pivotal initial stage of their careers and to support high-impact contributions to nuclear energy research, innovation, discovery, leadership, and dissemination of knowledge.

4. **University Infrastructure** – NE supports the infrastructure needed at universities to conduct cutting edge research and to educate and train the next generation nuclear workforce. It has been organized into the following elements:
    a. **Advanced Reactor Infrastructure**: This element initiates competitively awarded, consortium-led efforts to establish one or more advanced research reactor(s) and related capabilities at U.S. universities. These activities will help U.S. universities (1) develop a workforce with hands-on experience with commercially relevant advanced reactor concepts, reflective of those being deployed by industry; (2) offer research capabilities that address emerging technical challenges; and (3) ensure that access to the opportunities and benefits of these facilities are equitably provided, specifically seeking ways to include communities that have historically faced limits in access to such capabilities. These activities are expected to be led by one or more diverse consortia with appropriate expertise to ensure that the new capabilities will support these goals. This scope may include one or more research reactors and complementary infrastructure projects at different locations. A goal is to maximize the research and educational value and the broad accessibility of these resources in support of the administration's Justice40 Initiative.
    b. **Scientific Infrastructure Support:** This element provides competitively-awarded improvements to existing university infrastructure in the areas of general scientific infrastructure and reactor upgrades through NE's Scientific Infrastructure Support funding opportunity. General scientific infrastructure is focused on equipment, instrumentation, and associated non-reactor upgrades that significantly improve or expand research, instruction, and training capabilities. Reactor upgrades are focused on upgrades and improvements to existing nuclear research and training reactors. It includes purchase and maintenance of equipment to enhance the safety, security, performance, control, or operational reliability of the research reactor.

Directed Research & Development

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
SBIR/STTR $0	**$25,679,000**	**+$25,679,000**
• In FY 2021, NE provided $18,893,000 for SBIR/STTR through allocated charges to other R&D programs. Awards were made in areas such as advanced technologies for nuclear energy and used fuel.	• Support competitively awarded nuclear science and engineering small business and technology awards focusing in the areas of advanced technologies for nuclear energy and used fuel.	• The increase is due to increased Nuclear Energy research and development funding.
Technology Commercialization Fund $0	**$6,692,000**	**+$6,692,000**
• In FY 2021, NE provided $7,516,000 for the TCF through allocated charges to other R&D programs. Awards were made in areas such as advanced technologies for nuclear energy and used fuel.	• Supports competitive laboratory funding opportunity designed to help commercialize promising nuclear energy related technologies developed at the national laboratories.	• No significant change.
University Led Research & Development $0	**$59,658,000**	**+$59,658,000**
• In FY 2021, NE provided $58,259,000 for university led R&D through allocated charges to other R&D programs. Awards were made for research in areas such as fuel cycle, reactor concepts, and mission supporting research.	• Supports competitively awarded, university-led nuclear energy R&D that focus on the priorities of NE programs, including fuel cycle, reactor concepts, and mission supporting research. • Supports early career awards focused on faculty conducting transformative research, education, and leadership aligned with the NE mission.	• The increase is due to increased Nuclear Energy research and development funding.
University Infrastructure $0	**$45,000,000**	**+$45,000,000**
• In FY 2021, NE provided $5,749,000 for university infrastructure through allocated charges to other R&D programs. Awards supported general scientific infrastructure and reactor upgrades at U.S. universities.	• General scientific infrastructure and reactor upgrades are supported through the Scientific Infrastructure Support for Consolidated Innovative Nuclear Research funding opportunity. • Initiates competitively awarded, consortium-led activities to establish one or more advanced research reactor(s) and related capabilities at one or more U.S. universities.	• The increase is to initiate a competitively awarded, consortium-led project to establish an advanced research reactor at a U.S. university and provide competitively awarded general scientific and reactor upgrade support to U.S. universities.

University Nuclear Leadership Program

Description

The University Nuclear Leadership Program (UNLP) provides scholarships and fellowship to two and four-year college students and supports other internship programs that support disadvantaged communities.

The Office of Nuclear Energy (NE) UNLP subprogram supports the next generation of the nuclear energy workforce. The subprogram provides important educational support to bolster scientific discovery and innovation in nuclear science and engineering (NS&E) at U.S. universities and colleges.

The subprogram in intended to attract qualified students to nuclear energy professions by providing single-year undergraduate scholarships and multi-year graduate fellowships. Scholarships are awarded for undergraduate study at two- and four-year institutions leading to a major or minor degree or certificate and fellowships are awarded for graduate level work leading to a masters or doctoral degree in the fields or disciplines of NS&E relevant to the NE mission. NS&E disciplines of interest include nuclear engineering, mechanical engineering, electrical engineering, chemistry, health physics, nuclear materials science, radiochemistry, applied nuclear physics, nuclear policy, radiation protection technology, nuclear power technology, nuclear maintenance technology, and nuclear engineering technology.

NE has awarded more than $55 million for 929 nuclear energy-related scholarships and fellowships at 75 universities and colleges—including 11 minority-serving institutions (MSI) and two Historically Black Colleges and Universities (HBCU)—in 32 states since the program was initiated in 2009 under the Integrated University Program. Currently, scholarships are offered at $10,000 for one year to students attending four-year institutions and $5,000 to students attending two-year trade schools and community colleges. The maximum award for a fellowship is $52,000 per year for three years, with an additional one-time $5,000 allotment to fund a minimum 10-week internship at a Department of Energy (DOE) national laboratory or other designated facility.

All scholarship and fellowship awards are competitively awarded to students attending U.S. institutions of higher education offering NS&E educational programs, including MSIs and HBCUs. Emphasis is placed on increasing the involvement of HBCUs/MSIs, resulting in direct and meaningful investments in the areas of clean energy training and workforce development in support of the administration's Justice40 Initiative.

<u>OMNI Internships</u>

A new focus area is the OMNI Internships, a DOE Office of the Chief Information Officer-led effort to help build careers for talented cybersecurity and information technology professionals to strengthen the security of the Department, the national laboratories, and the nuclear industry.

University Nuclear Leadership Program
Funding ($K)

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
University Nuclear Leadership Program $0	**$6,500,000**	**+$6,500,000**
• In FY 2021 NE provided $5,000,000 under the Integrated University Program. • Support nuclear science and engineering study and research by fully funding approximately 30 or more multi-year student fellowships and 45 or more single-year scholarships in the nuclear energy field of study.	• Support nuclear science and engineering study and research by fully funding approximately 30 or more multi-year student fellowships and 45 or more single-year scholarships in the nuclear energy field of study. • Support a new scholarship program opportunity that targets two-year applied technical degree programs focused on nuclear energy-related topics, all with an increased emphasis on capacity-building and education at HBCUs, MSIs, and institutions in disadvantaged communities. This opportunity will focus on workforce development for nuclear relevant technician training, including nuclear operations, mechanical maintenance, electrical maintenance, chemistry, health physics and other nuclear energy-related topics. • Bolster outreach efforts focused on increasing HBCU/MSI involvement to include website resources, conference promotion, and university visits. • Support an OMNI internship program that will help build careers for talented cybersecurity and information technology professionals to strengthen the security of the Department, the national laboratories, and the nuclear industry.	• The increase reflects fully funding single-year scholarships and multi-year fellowships and maintaining or increasing the number of such awards via the UNLP and initiating a new scholarship opportunity that targets two-year applied technical degree programs focused on nuclear energy related topics, all with an increased emphasis on capacity-building and education at HBCUs, MSIs, and institutions in disadvantaged communities. The increase includes support for an OMNI internship program geared toward cybersecurity and information technologies professionals primarily from disadvantaged communities.

University Fuel Services

Description

University Fuel Services (UFS) provides fuel services for U.S. university research reactors. These activities were previously funded within the Research Reactor Infrastructure (RRI) subprogram.

UFS provides fresh reactor fuel to, and removes used fuel from, 25 operating university research reactors to support their continued operation. This provides continued research and training reactor capability to U.S. universities to ensure their continued ability to support U.S. nuclear energy initiatives in the areas of research, development, and educational opportunities.

The continued operation of U.S. university research reactors directly supports the successful execution of the nuclear energy research mission and plays an important role in developing future scientists and engineers in the U.S. These research reactors provide irreplaceable training, education and research support to hundreds of students annually, and many hosting universities expand access to these reactors through partnerships with minority serving institutions in underserved or disadvantaged communities, including innovative online opportunities providing direct access to reactor operating data. RRI support ensures continued reactor operations that directly expand diversity of Science, Technology, Engineering and Math (STEM) opportunities. This subprogram sustains unique capabilities for research and development and educational opportunities supporting U.S. energy initiatives. Used nuclear fuel shipments support U.S. and Department of Energy non-proliferation and national security objectives.

UFS provides project management, technical support, quality engineering and inspection, and nuclear material support to 25 research reactors located at 24 U.S. universities. Major program deliverables include procuring new plate fuel elements and shipping them to select universities; transporting used fuels from U.S. universities to a DOE site; procuring High Assay Low Enriched Uranium (HALEU) and shipping it to the Training, Research, Isotopes, General Atomics (TRIGA) Fuel Fabrication Facility (TFFF) in Romans, France, for fabrication of TRIGA fuel and procuring new TRIGA fuel elements from the TFFF; and reusing lightly-irradiated TRIGA fuel currently in inventory at Idaho National Laboratory (INL) by retrieving, inspecting and shipping it to universities with the most urgent need.

Major equipment and safety process upgrades to the TFFF, required by French safety authority, were completed and commercial production started in FY 2022, resulting in the initial procurement of 55 TRIGA fuel elements. In FY 2023, UFS will provide $7.3 million for the second procurement of TRIGA fresh fuel elements, to meet the increased fresh fuel requests from the 12 TRIGA research reactors located at U.S. universities, and to take advantage of the significant fuel cost discount provided to the Department if full orders are placed annually. UFS will also continue to ship used plate and TRIGA reactor fuel elements from supported universities to DOE used fuel receipt facilities. The Department will continue its policy, initiated in FY 2017, of reusing lightly-irradiated TRIGA fuel in the DOE inventory and will evaluate additional alternative sources.

The existing North Carolina State University Pulstar reactor fuel is reaching end of life. It is estimated that a new fuel core and fuel boxes will be needed by the end of FY 2025 for this reactor to remain operational. FY 2023 funding will be used to initiate design and fabrication activities.

University Fuel Services
Funding ($K)

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
University Fuel Services $0	**$17,500,000**	**+$17,500,000**
• In FY 2021 NE provided $11,500,000 under the Research Reactor Infrastructure program. • Procured 40 and delivered 33 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability. • Established the contract for the procurement of TRIGA fuel elements from the TRIGA Fuel Fabrication Facility (TFFF) in Romans, France upon resumption of operations. Due to COVID, there were delays in completing upgrades to the TFFF, gathering documentation from vendors to support the French regulator review, and significant increased time for the French regulator to complete their review. Therefore, fuel procurement will start in early FY 2022. • Procured and shipped HALEU metal to the TFFF in Romans, France, to support procurement of TRIGA fuel elements, and ship fuel elements to TRIGA reactor facilities as determined by need and fuel availability. • Completed 4 used fuel shipments to SRS and the INL, pending resolution of moratorium on such shipments to the INL. • Continued RRI project management, quality assurance, nuclear material accountability, and transportation cask maintenance.	• Procure 40 and deliver between 33 and 36 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability. • As needed, ship up to two cask loads of lightly-irradiated 8.5 wt% standard TRIGA fuel elements from the Irradiated Fuel Storage Facility at INL to select U.S. university research reactor facilities. • Procure up to 90 TRIGA fuel elements annually after the first year from TFFF. As needed, procure and ship HALEU metal to the TFFF in Romans, France, to support procurement of TRIGA fuel elements, and ship fuel elements to TRIGA reactor facilities as determined by need and fuel availability. • Complete up to 5 used fuel shipments to SRS and the INL, pending resolution of moratorium on such shipments to the INL. • Initiate fuel design and engineering studies; modeling, design and licensing of a shipment package, and procurement of fuel assembly boxes and end fittings for the North Carolina State University (NCSU) Pulstar reactor. • Continue UFS project management, quality assurance, nuclear material accountability, and transportation cask maintenance.	• Reflects additional TRIGA fresh fuel orders to ensure a maximum number of fuel elements per year can be purchased, resulting in the lowest average price per element to obtain the 668 fuel elements identified as the lifetime required fuel supply for the 12 U.S. university TRIGA research reactors within 10 years. • The existing NCSU Pulstar reactor fuel is reaching end of life. It is estimated that a new fuel core and fuel boxes will be needed by the end of FY 2025 to remain operational. FY 2023 funding will be used to initiate design and fabrication activities. Additional funding will be required in FY 2024 and FY 2025 to procure the required fuel.

Integrated University Program

Overview

The Office of Nuclear Energy (NE) Integrated University Program (IUP) supports the next generation of the nuclear energy workforce. The program provides important educational support to bolster scientific discovery and innovation in nuclear science and engineering (NS&E) programs at U.S. universities and colleges. This program is now requested under Directed R&D and University Program with new name of University Nuclear Leadership Program.

Integrated University Program
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Integrated University Program					
Integrated University Program	5,000	5,000	0	-5,000	-100%
Total, Integrated University Program	**5,000**	**5,000**	**0**	**-5,000**	**-100%**

Integrated University Program
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Integrated University Program:	
The decrease reflects funding requested under Directed R&D and University Program for the University Nuclear Leadership Program.	-5,000
Total, Integrated University Program	**-5,000**

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Integrated University Program $5,000,000	**$0**	**-$5,000,000**
• Support nuclear science and engineering study and research by fully funding approximately 30 or more multi-year student fellowships and 45 or more single-year scholarships in the nuclear energy field of study. • Support a new scholarship program opportunity that targets two-year applied technical degree programs focused on nuclear energy-related topics, all with an increased emphasis on capacity-building and education at HBCUs, MSIs, and institutions in disadvantaged communities. This opportunity will focus on workforce development for nuclear relevant technician training, including nuclear operations, mechanical maintenance, electrical maintenance, chemistry, health physics and other nuclear energy-related topics. • Bolster outreach efforts focused on increasing HBCU/MSI involvement to include website resources, conference promotion, and university visits.	• Funding is now requested under Directed R&D and University Programs for the University Nuclear Leadership Program.	• This funding is now requested under Directed R&D and University Programs for the University Nuclear Leadership Program.

Reactor Concepts Research, Development, and Demonstration

Overview

The Reactor Concepts Research, Development, and Demonstration (RD&D) program supports conducting RD&D on existing and advanced reactor designs and technologies to enable industry to address technical and regulatory challenges associated with maintaining the existing fleet of nuclear reactors, promoting the development of a robust pipeline of advanced reactor designs and technologies and associated supply chains, and progressing these advanced reactor designs and technologies towards demonstration when deemed appropriate. Program activities are focused on addressing technical, economic, safety, and security enhancement challenges associated with the existing commercial light water reactor fleet and advanced reactor technologies, covering large, small, and micro-sized designs and an array of reactor types including fast reactors using liquid metal coolants and high temperature reactors using gas or molten salt coolants.

In maximizing the benefits of nuclear power, work must be done to address the following challenges:

- improving affordability of nuclear energy technologies;
- enhancing safety and reducing technical and regulatory risk;
- minimizing proliferation risks of nuclear materials; and
- improving the economic outlook for the United States (U.S.) nuclear industry.

Reactor Concepts RD&D is key to enabling the industry to reverse the downward market trajectory of our nation's nuclear energy sector by regaining a technological and market leadership role. Through cost-shared RD&D activities, related technical assistance, and cross-cutting innovative research and development (R&D), the Department will enable industry to accelerate the timeline for commercialization of new, advanced, and more economic reactor technologies that will help revive and expand the domestic nuclear industry while advancing America's leadership role in the global nuclear sector and meeting our nation's clean energy goals.

The Reactor Concepts RD&D program continues to support RD&D efforts focused on small modular reactors (SMR) in FY 2023. The Advanced SMR RD&D subprogram supports cost-shared RD&D activities for the purpose of accelerating the development of U.S. SMR technologies for domestic and international markets, including countries that have expressed interest in near-term SMR deployment. In FY 2023, the program will support funding awards to U.S. recipients to encourage domestic SMR technology development and to produce results that are widely applicable across the spectrum of emerging reactor concepts.

The Light Water Reactor Sustainability (LWRS) subprogram conducts research in support of light water reactor (LWR) technologies so that LWR-based commercial nuclear power plants can continue to provide safe, clean, and reliable energy. The goal is to enable industry to enhance the efficient and economic performance of current nuclear power plants while enabling their extended operation. The primary focus of the subprogram is on cost-shared, private-public partnerships to help industry resolve its highest priority and highest uncertainty technical issues where U.S. government partnership is appropriate. Examples of such partnerships are the R&D on methods of control room and plant modernization to address aging and obsolescence of existing analog instrumentation and controls to improve plant efficiency and increasing revenue opportunities through the demonstration of non-electric applications such as hydrogen production.

The Advanced Reactor Technologies (ART) subprogram conducts targeted R&D on advanced reactor technologies, including molten salt reactors, fast reactors, high temperature gas-cooled reactors, and microreactors. The subprogram also supports work on cross-cutting R&D that can be applied to multiple advanced reactor concepts, including non-light water reactor SMRs. This subprogram focuses on efforts in the following areas: fundamental technologies and design methods for advanced reactors, interactions of diverse reactor coolants with materials and components, advanced energy conversion, analysis of reactor response to severe accidents, research to enhance safety and reduce regulatory risk, experimental validation of models, advanced materials development and codification, and continued international collaborations. Funding will also support competitively awarded projects to assist the progression of emerging advanced reactor designs and technologies.

Highlights of the FY 2023 Budget Request

The Advanced SMR RD&D subprogram will successfully finalize support for the NuScale SMR First-of-a-Kind Nuclear Demonstration Readiness Project, which supports development of a U.S. SMR technology for deployment in domestic and international markets. Domestic SMR demonstration activities are not funded.

The Reactor Concepts RD&D program will continue to conduct RD&D activities to address technical, cost, safety, and security enhancement challenges associated with the existing commercial light water reactor fleet and advanced reactor technologies.

Reactor Concepts Research, Development, and Demonstration
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Reactor Concepts Research, Development and Demonstration					
Advanced Small Modular Reactor RD&D	115,000	115,000	40,000	-75,000	-65%
Light Water Reactor Sustainability	47,000	47,000	45,000	-2,000	-4%
Advanced Reactor Technologies	46,000	46,000	50,000	+4,000	+9%
Total, Reactor Concepts Research, Development and Demonstration	**208,000**	**208,000**	**135,000**	**-73,000**	**-35%**

SBIR/STTR:

- FY 2021 Enacted: SBIR $2,814; STTR $490
- FY 2022 Annualized CR: SBIR $2,814; STTR $490
- FY 2023 Request: Funding provided in the Directed R&D and Universities Program line.

Reactor Concepts Research, Development and Demonstration
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Advanced Small Modular Reactor RD&D: The decrease from $115,000,000 to $40,000,000 successfully finalizes support for the development of a U.S. SMR technology for deployment in domestic and international markets. Domestic SMR demonstration activities are not funded.	**-75,000**
Light Water Reactor Sustainability: The decrease from $47,000,000 to $45,000,000 reflects $2,000,000 partially associated with funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line.	**-2,000**
Advanced Reactor Technologies: The increase from $46,000,000 to $50,000,000 reflects a greater emphasis on essential research and development activities to address high priority technical challenges and reduce the technical risks associated with advanced reactor technologies and systems.	**+4,000**
Total, Reactor Concepts Research, Development & Demonstration	**-73,000**

Reactor Concepts Research, Development and Demonstration
Advanced Small Modular Reactor RD&D

Description

The Advanced Small Modular Reactor (SMR) Research, Development and Demonstration (RD&D) subprogram supports enabling industry to reverse the downward market trajectory of our nation's nuclear energy sector, reestablishing U.S. leadership in the nuclear technology development arena, and meeting our nation's climate change and clean energy goals. A range of significant technological challenges remain in developing advanced SMR designs. The Department intends to leverage its appropriate federal role and notable expertise to facilitate industry's development of advanced SMR designs that have the potential to provide safe, clean, and affordable energy generation options.

The Advanced SMR RD&D subprogram will support RD&D to assist in maturing concepts toward commercial readiness. Results are generally intended to be widely applicable and adopted by domestic nuclear reactor vendors for the purpose of accelerating the development of their technologies. In so doing, the Advanced SMR RD&D subprogram will help address the climate crisis and achieve 100% carbon-free electricity by 2035. Funding will support ongoing awards, including the final year of funding for the NuScale First-of-a-Kind Demonstration Readiness Project, and will leverage ongoing and planned R&D activities supported by the related Advanced Reactor Technologies subprogram.

The subprogram will support industry awards that have high potential to accelerate the development of more mature SMR designs.

Advanced Small Modular Reactor RD&D

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Advanced Small Modular Reactor RD&D **$115,000,000**	**$40,000,000**	**-$75,000,000**
• Supported targeted research and development (R&D) to further advance small modular reactors (SMR). • Awarded one project under the Industry Funding Opportunity Announcement (Industry FOA) to complete a study on the effort required to repurpose a southern Ohio site for deployment of an SMR. The award also included the development of an Early Site Permit (ESP) template that has broad applicability to many advanced SMR technologies. • Provided funding to support the NuScale SMR design development project that was originally selected competitively. • Supported the reduction of first-mover's risk to deploy an advanced SMR by cost-sharing site-specific characterization, licensing, and planning efforts needed to demonstrate a NuScale SMR.	• Supports successful finalization of a cost-shared industry partnership award that has high potential to accelerate the development of both emerging and more mature SMR designs.	• The decrease finalizes support for the development of a U.S. SMR technology for deployment in domestic and international markets. Domestic SMR demonstration activities are not funded.

Reactor Concepts Research, Development and Demonstration
Light Water Reactor Sustainability

Description

The Light Water Reactor Sustainability (LWRS) subprogram conducts research and development (R&D) on technologies and other solutions that can improve economics, sustain safety, and maintain the technical reliability of the current domestic fleet of commercial nuclear power plants.

With the initial success of the lead plants' Subsequent License Renewal submittals in FY 2018, the focus for sustaining the existing fleet has shifted from enabling industry's effort to extend their operational licenses to conducting R&D to address technical questions that affect the industry's economic challenges leading to premature shutdowns. LWRS will continue to collaborate with nuclear power plant owner-operators, vendors, suppliers, industry support organizations, other research organizations, and the Nuclear Regulatory Commission (NRC) to closely coordinate research that both supports industry needs and maximizes taxpayer benefit.

Currently, the LWRS subprogram consists of the following primary technical areas of R&D:

- Plant Modernization: R&D to address nuclear power plant economic viability in current and future energy markets by increasing efficiency through the implementation of digital technologies. The R&D products will enable modernization of plant systems and processes across the industry by enabling a shift from a labor centric to a technology-centric business model platform that supports improved performance at a lower cost.
- Flexible Plant Operations and Generation: R&D to establish the technical feasibility and economic potential of dispatching thermal and electrical energy to diversify and increase revenue of light water reactors in the U.S. The R&D products, including hydrogen production demonstration activities, will allow the existing fleet of nuclear reactors to readily respond to rapid changes in electricity supply due to the widespread adoption of variable renewable energy resources and demonstrate the ability to repurpose nuclear power reactors into flexible energy sources for low-carbon industrial commodity production.
- Risk-Informed Systems Analysis: R&D to support decision-making related to the economics, reliability, and safety of the existing fleet by providing analysis solutions for integrated plant systems. In addition, the R&D products in this area will be used to optimize plant economic performance and safety by incorporating the impacts of physical aging and degradation processes.
- Physical Security Research: R&D that will validate methods and tools which can be used to implement an updated, cost-effective physical security regime. The R&D products are expected to enable companies across the industry to reduce excessive conservatisms in security modeling, leverage automation as force multipliers, optimize security postures, and develop additional means to risk-inform approaches to evaluate security changes.
- Materials Research: R&D to develop the scientific basis for understanding and predicting long-term environmental degradation behavior of materials in nuclear power plants. The R&D products will be used to define operational limits and aging mitigation approaches for materials in nuclear power plant systems, structures and components (SSC) subject to long-term operating conditions, providing key input to both regulators and industry.

In FY 2023, the LWRS subprogram continues to leverage cost-shared, private-public partnerships and our national laboratory system to conduct R&D to resolve industry's highest priority and highest uncertainty challenges where U.S. government partnership is appropriate. These high priority areas include providing science and technology-based solutions to improve the current business model and associated practices of the current fleet and develop the scientific bases for managing the aging of SSCs to allow existing nuclear power plants to continue to operate safely and cost-effectively.

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Light Water Reactor Sustainability **$47,000,000**	**$45,000,000**	**-$2,000,000**
• Materials Research – Completed environmental fatigue assessment of stainless steel and dissimilar metal weldments under relevant light water reactor conditions. Continued development of a predictive model for cable degradation. • Risk-Informed Systems Analysis – Completed human-reliability analysis to credit Diverse and Flexible Coping Strategies (FLEX) in accident management and perform risk-informed analysis of a passive-cooling design. Developed the strategy to extend the implementation of fire Probabilistic Risk Assessment (PRA) tools for the existing fleet. • Plant Modernization – Completed development of asset risk models that will be applicable to a variety of existing reactor designs and will be made widely available to the industry to enable adoption of predictive maintenance strategies to replace time-based maintenance activities of plant equipment. Conducted targeted research and development (R&D) on technologies that can enable online monitoring of plant equipment to replace labor-based approaches to equipment condition assessment at commercial nuclear power plants to reduce operating costs and improve equipment availability and reliability. • Flexible Plant Operations and Generation – Working with other applied energy offices, competitively selected one industry-led project	• Materials Research - Implement the reactor pressure vessel predictive embrittlement model through American Society for Testing and Materials (ASTM) and American Society of Mechanical Engineers (ASME) for code acceptance and wide industry use. Publish a methodological guideline on concrete degradation for industry and accompany with the public release of Microstructure Oriented Scientific Analysis of Irradiated Concrete (MOSAIC) for industry use. • Risk-Informed Systems Analysis – Enhance the algorithm used to optimize the reactor core reload process and enable crediting Terry Turbines for extended operation, which will expand the mitigation options available to operators under both normal and emergency conditions. • Plant Modernization - Complete development of the Integrated Operations for Nuclear business operating model and demonstrate its use with an operating nuclear power plant which will allow utilities to shift their operations from a labor centric to a technology centric business model. Produce an Artificial Intelligence/Machine Learning methodology to achieve a fully automated risk-informed predictive maintenance strategy. • Flexible Plant Operation and Generation - Develop the methods and licensing approach for thermal extraction, thermal energy storage, and	The decrease from $47,000,000 to $45,000,000 reflects $2,000,000 partially associated with funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
for grid-integration with hydrogen technologies to enhance the stability of the power grid through responsive load and energy storage, in support of H2@Scale. • Physical Security – Developed the technical basis for potential future, industry-funded pilots of remote operated weaponry, increasing the operating fleet's security posture and allowing for the first implementation of automated weapons at an operating commercial nuclear power plant.	distribution. Engineer and simulate operations and control systems for direct use of heat generated from the existing light water reactor fleet. Develop architectural and engineering models, and investor-grade reports to detail the opportunities for providing clean thermal and electrical energy for industrial applications (e.g., hydrogen, ammonia, metals, chemicals, and fuels production). • Physical Security - Deliver guidance to industry on the use and implementation of dynamic risk analysis tools to support dynamic physical security risk assessments, reducing utility security cost burdens and improving market competitiveness.	

Reactor Concepts Research, Development and Demonstration
Advanced Reactor Technologies

Description

The Advanced Reactor Technologies (ART) subprogram conducts essential research and development (R&D) activities to reduce technical risks associated with advanced reactor technologies and systems. The subprogram R&D scope reflects input from advanced reactor stakeholders with a goal of enabling industry to mature and ultimately demonstrate advanced reactor technologies by the 2030s. Innovative advanced reactor concepts have the potential to offer significant benefits versus existing technologies, including possible lower costs, enhanced safety and security, greater resource utilization, and simpler operating regimes. Such advantages could allow nuclear energy to increase its contributions to domestic clean and resilient energy sources and to support the growth of high-paying U.S. jobs. The ART subprogram conducts R&D that can help reduce long-term technical barriers for multiple reactor technology concepts with a focus on innovative technologies. This subprogram will address the full range of high-value R&D to enable advancement of innovative technologies that benefit multiple advanced reactor concepts, including microreactor designs, and stimulation of new ideas for transformational future concepts.

ART R&D efforts support innovative reactor concepts, including high temperature gas-cooled reactors (HTGR), fast reactors, and molten salt reactors (MSR) using liquid salt coolants and/or fuels. The ART subprogram focuses on industry-informed R&D priorities that could provide widely-applicable benefits across many different advanced reactor concepts including: fundamental technologies and design methods for advanced reactors; interactions of advanced reactor coolants with materials and components; advanced systems and components that can operate in extreme high temperature environments; research to enhance safety; advanced materials development and codification; cross-cutting areas of support in advanced energy conversion technologies; and research to support microreactors for remote and micro-grid commercial applications. The ART subprogram conducts R&D to mature emergent advanced reactor technologies to enhance the likelihood of future demonstration and commercialization of these technologies. The ART subprogram continues support for international collaborations on advanced materials, advanced reactor operations, and safety that will promote the development of advanced reactors in the United States (U.S.) and support deployment of U.S. technologies in the global marketplace.

Industry-led, innovative cost-shared R&D activities are supported through competitively selected industry awards to reduce technical and regulatory risks associated with advanced reactor designs. Specifically, in FY2021, DOE announced the selection of three awards to support the development of designs that could have significant impact on the energy market in the mid-2030s or later. The three concepts selected for award were:

- Development of a conceptual design of a seismically isolated advanced sodium-cooled reactor facility - Advanced Reactor Concepts, LLC;
- Development of a fast modular reactor conceptual design with verifications of key metrics in fuel, safety, and operational performance - General Atomics; and
- Maturing the Modular Integrated Gas-Cooled High Temperature Reactor (MIGHTR) concept from a pre-conceptual stage to a conceptual stage - Massachusetts Institute of Technology (MIT).

FY2023 activities for the ART subprogram will focus on essential research to address the highest priority challenges facing advanced reactor technologies and continued support for innovation through cost-shared partnerships with industry.

Advanced Reactor Technologies

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Advanced Reactor Technologies $46,000,000	**$50,000,000**	**+$4,000,000**
• Fast Reactor Technologies – Maintained Mechanisms Engineering Test Loop (METL) facility operational readiness to support industry-identified fast reactor component experiments. Qualified historical fast reactor data sets targeted by U.S. vendors using the Nuclear Regulatory Commission (NRC)-approved Quality Assurance (QA) methodology. Qualified Grade 91 sodium in support of NRC licensing by fast reactor developers. • Gas Reactor Technologies – Performed experimental validation of normal operation and transient conditions and support modeling and simulation using the water-based reactor cavity cooling system at the Natural Convection Shutdown Heat Removal Test Facility (NSTF) at the Argonne National Laboratory (ANL). Continued American Society of Mechanical Engineers (ASME) code qualification of Alloy 617 and resolved issues necessary to achieve endorsement by the NRC. • Molten Salt Reactor Technologies – Developed chemical monitoring requirements, methods, and instrumentation. Continued development of a modeling framework for salt characterization. Continued to collect and analyze fundamental data to understand fission product behavior in salt-fueled systems. • Microreactor Technologies – Performed nonnuclear testing and validation of high priority components. Continued code case	• Fast Reactor Technologies – Perform additional testing of the Thermal Hydraulic Experiment Test Article (THETA) in METL to generate data for fast reactor design and safety code validation and commission the gripper test article to demonstrate key aspects of an under-sodium fuel handling machinery. Perform model development and experimental validation activities to support development and licensing activities for fast reactors. • Gas Reactor Technologies – Perform additional experimental validation of normal operation and transient conditions and support modeling and simulation activities using the water-based reactor cavity cooling system at the NSTF at ANL. Support long term testing to characterize creep behaviors of high temperature alloys. • Molten Salt Reactor (MSR) Technologies – Maintain and expand the molten salt thermal properties database to aid in the design and licensing of MSRs. Investigate salt/graphite interactions and conduct corrosion tests at high temperatures to demonstrate the performance of materials under prototypic MSR conditions. • Microreactor Technologies – Continue qualification and testing of high temperature moderator materials that have the broadest potential application for microreactor applications. Begin nonnuclear integrated testing and validation of microreactor systems and operational regimes. Complete installation of the Microreactor Applications, Research,	• The increase reflects a greater emphasis on essential research to address the highest priority industry identified challenges associated with advanced reactor technologies and systems, including a ramp-up in testing at the METL facility, increased research to reduce the technical risks associated with MSRs, increased activities to support completing installation of MARVEL, increased support for materials development, and increased efforts for experimentally validating advanced reactor modeling and simulation capabilities.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
development for Grade 91 steel as an improved structural material for microreactors. • Cross-Cutting Technologies – Continued cross-cutting research and development for advanced reactor designs. Continued work on printed circuit heat exchangers, intermediate heat exchanger alloys and Brayton cycle plant analysis codes. • Industry Awards – Selected U.S. based teams to receive funding through the Advanced Reactor Concepts (ARC)–20 program. Finalized the work-scopes and milestones to be supported through the ARC-20 program and initiated execution of project activities.	Validation and Evaluation (MARVEL) test platform (nuclear microreactor test platform to demonstrate the integration of commercial end-user applications). • Industry Awards (ARC-20) – Support execution of the three ARC-20 projects per established project plans and using current and prior year carryover funds. Specific project activities include: o For the Advanced Reactor Concepts, LLC award: Conduct further pre-application engagement with the NRC and complete conceptual design report. o For the General Atomics award: Conduct further pre-application engagement with the NRC, complete report documenting analysis of reactor passive safety, and initiate irradiation testing of fuel in INL's Advanced Test Reactor (ATR). o For the MIT award: Complete the design of the reactor building to include consideration of radiation shielding, equipment support, safety and seismic response.	

Fuel Cycle Research and Development

Overview

The Fuel Cycle Research and Development (FCR&D) program conducts applied research and development (R&D) on advanced fuel cycle technologies that have the potential to accelerate progress on managing and disposing of the nation's spent fuel and high-level waste, improve resource utilization and energy generation, reduce waste generation, and limit proliferation risk. Advancements in fuel cycle technologies support the enhanced availability, economics, and security of nuclear-generated electricity in the United States (U.S.), further enhancing U.S. energy independence and economic competitiveness. The FCR&D program also contributes to the Department's policies and programs for ensuring a reliable and economic nuclear fuel supply.

The FCR&D program participates in world-class R&D and employs internationally renowned technical experts. FCR&D subprograms leverage their technical expertise by participating in international collaborations through bilateral and multilateral technical agreements. The program also participates in projects sponsored by the International Atomic Energy Agency and the Organization for Economic Co-operation and Development/Nuclear Energy Agency which provides further leverage in key technical areas.

The program supports R&D and evaluation of spent fuel and high-level waste disposition pathways, covering storage, transportation, and disposal technologies. The program also supports R&D on multiple advanced fuel technologies that hold promise for reduced risks and improved economics or are an important element in the development of the next generation of reactor designs; exploring the feasibility of reprocessing highly enriched uranium to produce high-assay, low-enriched uranium (HALEU); and providing fuel to support demonstration of advanced reactor technologies. These activities provide valuable information that will inform industry's decisions on the commercialization and deployment of advanced reactors, including micro reactors.

Highlights of the FY 2023 Budget Request

Continue the HALEU Availability subprogram to support civilian domestic demonstration and commercial use. This subprogram will work to make available small quantities of HALEU from limited DOE uranium inventories and HALEU production in the short term and will work with the private sector in its design and build out of commercial U.S. HALEU production capability in the long term.

Within the Accident Tolerant Fuel subprogram, the Request includes increased irradiation testing and examination at the national laboratories and in commercial reactors as industry nears its objective to install the first reload quantities of accident tolerant fuel in pilot plants by the mid-2020s and qualify the fuel for use at higher burnup levels. This irradiation testing and examination involves accident tolerant fuel concepts and fuel previously irradiated to higher burnup levels. Testing and examination will take place at the Idaho National Laboratory and Oak Ridge National Laboratory and be guided by the examination test plan being coordinated with industry and the U.S. Nuclear Regulatory Commission. The plan calls for more tests and examinations than experienced to date in the commissioning tests.

Within the Fuel Cycle Core R&D subprogram, a new metallic fuel qualification effort is initiated, building upon recent R&D on accelerated testing and qualification of new fuels to support advanced reactor developers. To ensure a robust pipeline of advanced in-core and fuel cladding materials, research activities are included to discover and develop innovative alloys and composites. The innovative process control activities will continue to support advanced reactor fuel preparation and treatment capabilities using molten salt technologies at national laboratories.

The Integrated Waste Management System (IWMS) subprogram includes working collaboratively with the public, communities, stakeholders, and governments at the Tribal, state, and local levels to lay the groundwork for effective implementation of consolidated interim storage for the nation's nuclear waste. In FY 2021, funding for related activities was appropriated within the Interim Storage and Nuclear Waste Fund Oversight program (Nuclear Waste Disposal account).

Fuel Cycle Research and Development
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Fuel Cycle Research and Development					
Material Recovery and Waste Form Development	25,000	25,000	38,000	+13,000	+52%
Mining, Conversion, and Transportation	2,000	2,000	1,500	-500	-25%
Civil Nuclear Enrichment	40,000	0	0	-40,000	-100%
Accident Tolerant Fuels	105,800	105,800	113,900	+8,100	+8%
TRISO Fuel and Graphite Qualification	36,000	36,000	27,000	-9,000	-25%
Fuel Cycle Core R&D	20,000	20,000	46,500	+26,500	+133%
High-Assay, Low-Enriched Uranium Availability	0	0	95,000	+95,000	+100%
Used Nuclear Fuel Disposition R&D	62,500	62,500	46,875	-15,625	-25%
Integrated Waste Management System	18,000	18,000	53,000	+35,000	+194%
Total, Fuel Cycle Research and Development	**309,300**	**309,300**	**421,775**	**+112,475**	**+36%**

SBIR/STTR:

- FY 2021 Enacted: SBIR $7,034; STTR $1,224
- FY 2022 Annualized CR: SBIR $7,034; STTR $1,224
- FY 2023 Request: Funding provided in the Directed R&D and Universities Program line.

Fuel Cycle Research and Development
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Material Recovery and Waste Form Development: Funding increase from $25,000,000 to $38,000,000 reflects increased staffing needs and facility operation costs associated with accelerating Experimental Breeder Reactor-II (EBR-II) activities from 7 days/week, 12 hours/day to 7 days/week, 24 hours/day.	**+13,000**
Mining, Conversion, and Transportation Funding decrease from $2,000,000 to $1,500,000 reflects that funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line.	**-500**
Civil Nuclear Enrichment Funding decrease from $40,000,000 to $0 reflects that FY 2021 was the final year of funding for this initiative. Completion of the HALEU Enrichment Demonstration and one year of limited operation to produce HALEU will be included under the HALEU Availability subprogram.	**-40,000**
Accident Tolerant Fuels: Funding increase from $105,800,000 to $113,900,000 reflects increased irradiation testing and examination at the national laboratories and in commercial reactors as industry nears its near-term objective to install the first reload quantities of accident tolerant fuel in pilot plants and qualify the fuel for use at higher burnup levels.	**+8,100**
TRISO Fuel and Graphite Qualification Funding decrease from $36,000,000 to $27,000,000 reflects associated funding for SBIR, STTR, TCF, and NEUP awards being consolidated within the new Directed R&D and University Programs line and the TRISO fuel qualification program ramping down as it nears completion and high-cost activities such as irradiation experiments have been completed.	**-9,000**
Fuel Cycle Core R&D: Funding increase from $20,000,000 to $46,500,000 reflects the initiation of a metallic fuel qualification program that supports advanced reactor developers using metallic fuel and continuing advances in accelerated fuel qualification for advanced reactor fuel. The increase reflects the initiation of a process control program to accelerate the fuel preparation and treatment using molten salt technologies as well as investment in nuclear materials and molten salt fuels development capabilities at the national laboratories that necessary for molten salt reactor development.	**+26,500**

	FY 2023 Request vs FY 2021 Enacted
High-Assay, Low-Enriched Uranium Availability Funding increase from $0 to $95,000,000 for the HALEU availability program to make available small quantities of HALEU from limited DOE uranium inventories and HALEU production in the short term and support the private sector in its design and build out of commercial U.S. HALEU production capability in the long term.	**+95,000**
Used Nuclear Fuels Disposition R&D Funding decrease from $62,500,000 to $46,875,000 reflects associated funding for SBIR, STTR, TCF, and NEUP awards being consolidated within the new Directed R&D and University Programs line.	**-15,625**
Integrated Waste Management System Funding increase from $18,000,000 to $53,000,000 reflects a ramp up of activities to support effective implementation of consolidated interim storage for the nation's nuclear waste, including support for working collaboratively with the public, communities, stakeholders, and governments at the Tribal, state, and local levels. The funding increase also reflects funding for Interim Storage activities that were previously appropriated within the Interim Storage and Nuclear Waste Fund Oversight program (Nuclear Waste Disposal account), in the amount of $20,000,000 in FY 2021. The FY 2023 request for Interim Storage activities is instead included as part of the Office of Nuclear Energy's IWMS subprogram within Fuel Cycle R&D.	**+35,000**
Total, Fuel Cycle R&D	**+112,475**

Fuel Cycle Research and Development
Material Recovery and Waste Form Development

Description

The Material Recovery and Waste Form Development (MRWFD) subprogram conducts applied research and development (R&D) on advanced fuel recycle technologies that have the potential to improve resource utilization and energy generation, reduce waste generation, and limit proliferation risk. The subprogram focuses on developing advanced fuel cycle technologies and addressing fundamental materials separation and recovery challenges that present significant degrees of technical risks and financial uncertainties.

MRWFD provides unique nuclear chemistry expertise and technical capabilities in separation technologies to a broad range of applications by seeking a fundamental understanding of various chemical challenges related to civil nuclear applications. MRWFD stewards the capabilities and knowledge relied upon by policy makers to make informed decisions regarding nuclear fuel cycle options. Such decisions in turn rely on the development of efficient and economical separation methods that can accept the used nuclear fuel containing actinides and fission products to recycle selected actinides, recover valuable by-products, and deliver waste streams that are suitable for disposal. For example, MRWFD supports molten salt chemistry research to support advanced nuclear technologies using molten salts as electrolytes, fuel solvent and coolants. MRWFD funds research on integrated advanced technologies encompassing R&D on off gas capture, and waste form development. The subprogram employs a science-based approach to foster innovative and transformational technology solutions to achieve this objective. Specifically, MRWFD subprogram will continue to:

- Exploit principles of coordination chemistry to simplify actinide separations;
- Understand and manage radiation effects on materials and processes;
- Develop advanced salt waste forms to efficiently immobilize fission products;
- Design robust materials for separation of gas-phase species; and apply physical phenomena and gradients to intensify separations.

MRWFD subprogram also supports the development and demonstration of different recycling technologies to make available small quantities of high-assay low enriched uranium (HALEU) materials for advanced reactor fuel-fabrication R&D needs. HALEU can be recovered from feedstock that contains highly-enriched uranium (HEU) by using the molten salt and hybrid ZIRCEX processes. Specifically, the subprogram supports the accelerated treatment of irradiated Experimental Breeder Reactor-II (EBR-II) fuel to produce HALEU materials for fast spectrum advanced reactor fuels R&D needs. The accelerated EBR-II fuel activity will also support fulfilling a supplemental agreement between DOE and the State of Idaho to complete treatment of all sodium bonded EBR-II driver fuel by December 2028. In anticipation of expanding the runtime in FY 2024 from 7 days a week, 12 hours a day to 7 days a week, 24 hours a day, the EBR-II activities will continue in FY 2023 for training of qualified workers for hot cell and facility operations. The subprogram continues to evaluate the feasibility of recycling federally owned HEU fuels for HALEU production using a ¼-scale ZIRCEX pilot facility at the Idaho National Laboratory. In FY 2023, the hybrid ZIRCEX activity will continue demonstrating the feasibility of aluminum extraction using unirradiated fuel from the Advanced Test Reactor (ATR) and establish a back-end polishing process which is also capable of cleansing HALEU materials obtained from the EBR-II fuels treatment.

Material Recovery and Waste Form Development
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Material Recovery and Waste Form Development **$25,000,000**	**$38,000,000**	**+$13,000,000**
• Continued the acceleration of Experimental Breeder Reactor-II (EBR-II) used fuel treatment. • Continued Joint Fuel Cycle Study (JFCS) for its 10th and final year of collaboration with South Korea. • Continued hybrid ZIRCEX process focusing on cold pilot plant studies. • Supported fundamental aqueous and molten salt separation chemistries to address chemical challenges related to civil nuclear energy applications. • Explored next generation fuel cycle technologies targeting high-value used fuels.	• Develop innovative fuel recycling technologies targeting high-value used fuels. • Support fundamental aqueous and molten salt separation chemistries to address challenges related to civil nuclear energy applications. • Determine efficiency of advanced complexants for simplified uranium recovery. • Develop advanced salt waste form and off-gas technologies. • Continue the accelerated EBR-II fuel treatment to fully fund an anticipated expansion of fuel treatment operations starting in FY 2024.Complete processing demonstration of unirradiated Aluminum-clad fuel in the material recovery pilot plant.	• The increase reflects the increased staffing and facilities costs associated with the anticipated expansion of EBR-II fuel treatment facility operation from 7 days a week, 12 hours a day to 7 days a week, 24 hours a day in FY 2024.

Fuel Cycle Research and Development
Mining, Conversion, and Transportation

Description

This subprogram supports, cost-shared research and development (R&D) that enables technological advances in uranium mining, conversion, and transportation capabilities in the United States as well as the conducting evaluations and assessments related to these areas. This subprogram supports activities related to the front end of the nuclear fuel cycle and supply chain.

Mining sites are often located in underserved communities and locations with limited water resources. Improvements to mining technology spurred by R&D may enable local economic opportunities and include environmental justice equities while reducing the amount of water used during uranium production.

In FY 2023, this subprogram will continue to fund cost-shared R&D for uranium mining and processing technologies that reduce water usage and/or improve extraction efficiency and resource utilization for uranium production.

Mining, Conversion, and Transportation
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Mining, Conversion, and Transportation $2,000,000	**$1,500,000**	**-$500**
• Supported research and Development (R&D) for uranium mining and processing technologies that reduce water usage and/or improve extraction efficiency and resource utilization for uranium production.	• Continue R&D for uranium mining and processing technologies that reduce water usage and/or improve extraction efficiency and resource utilization for uranium production.	• The decrease reflects funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line.

Fuel Cycle Research and Development
Civil Nuclear Enrichment

Description

This subprogram executed a three-year, limited scope, demonstration of a U.S. origin, enrichment technology for producing high-assay, low enriched uranium (HALEU). FY 2021 was the final year of funding for this initiative.

Civil Nuclear Enrichment
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Civil Nuclear Enrichment $40,000,000	**$0**	**-$40,000**
• Completed cascade design work, install support equipment such as the inventory withdrawal station, restore the Piketon, OH facility for handling classified material/information, install centrifuge machinery, condition the system for operation, calibrate operations and operate a lead cascade of centrifuges. • Continued regulatory support related to demonstrating the production of high-assay, low-enriched uranium.	• FY 2021 was the final year of funding for this initiative.	• FY 2021 was the final year of funding for this initiative.

Fuel Cycle Research and Development
Accident Tolerant Fuels

Description

The subprogram mission is enabling industry's development of one or more light water reactor (LWR) fuel concepts with significantly enhanced accident tolerance through cost shared research and development (R&D).

Following the accident at Fukushima, Advanced Fuels initiated a program in collaboration with fuel suppliers, national laboratories, and universities to explore advanced LWR fuel with enhanced accident tolerance to benefit existing U.S. commercial nuclear power reactors. After five years of feasibility studies and assessments of potential fuel concepts, the program identified promising concepts that have the potential to significantly enhance accident tolerance.

The U.S. fuel suppliers are developing accident tolerant fuel concepts that the owner/operators of commercial U.S. reactors believe will provide substantial performance improvements during accidents and under normal operations. The greatest improvements will come with using the robust nature of the accident tolerant fuel to enable the fuel to operate for a longer period of time in the reactor. This would allow reactors to operate for a longer time between refueling outages. Many reactors would be able to increase their cycle lengths from 18 to 24 months and less fuel would be needed to generate the same amount of electricity resulting in substantially reduced spent nuclear fuel storage and disposal requirements.

This subprogram supports the industry's objective to install the first reload quantities of accident tolerant fuel in pilot plants by the mid-2020s and qualify the fuel for use at higher burnup levels. In FY 2023 this will involve cost-shared testing and examination of fuel and cladding material performance to generate data that can be used by industry partners to support their NRC licensing efforts, research and development of pilot fuel pellet and cladding manufacturing equipment, analysis and redesign of fuel fabrication processes, and revising fuel performance codes and methods.

This subprogram is using the experimental and analytical capabilities only found at the Department of Energy (DOE) National laboratories to provide the U.S. nuclear industry with the data needed to qualify the accident tolerant fuel concepts, including for use at higher burn up levels and to demonstrate the performance of the fuel to take advantage of the safety and economic benefits that come with these more robust fuel designs. In FY 2023, this includes continuing the modifications at Idaho National Laboratory to expand its experimental capabilities. This involves: (1) the design, fabrication, and testing of experimental capsules to house irradiated fuel samples to simulate loss of coolant accident conditions in the transient test reactor (TREAT) and (2) the design and installation of a new test loop in the Advanced Test Reactor (ATR) to provide experimental capabilities lost when the Halden test reactor in Norway shutdown. These capabilities are boiling water reactor conditions, highly-instrumented test trains, ramp testing, and dry out testing. Also, in FY 2023, the partnership with industry to implement the test plans needed to develop the data needed to qualify the Accident Tolerant Fuel concepts for higher burn up will continue.

Accident Tolerant Fuels
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Accident Tolerant Fuels $105,800,000	**$113,900,000**	**+$8,100,000**
• Continued irradiations of fuel rodlets in the central water loop of the Advanced Test Reactor (ATR). • In the Transient Reactor Test Facility (TREAT), performed reactivity insertion accident tests on irradiated fuel in static water capsules. • Continued investment in fuel development capabilities at the Department of Energy (DOE) National laboratories that are critical for accident tolerant fuel development. • Continued to advance the accident tolerant fuel concepts under development by the three fuel vendor teams under cooperative agreements with the Department.	• Continue irradiations of fuel rodlets in the central water loop of the ATR. Initiate advanced instrumented tests to expand data generation for real time fuel performance under irradiation. • Continue in partnership with industry to support the Fuel Performance and Testing Technical Experts Group for burn up extension. This includes examination of high burn up fuel rods, furnace testing, re-irradiation of test samples in ATR, and loss of coolant tests in TREAT. • Conduct advanced LWR fuel technology research on ceramic fuel and cladding concepts. This includes fabrication technology development, separate effects irradiation tests in HFIR and ATR, and advanced characterization of properties and irradiation performance. • Continue to advance the accident tolerant fuel concepts under development by the three fuel vendor teams under cooperative agreements with the Department. This involves cost-shared testing and examination of fuel and cladding material performance, research and development of pilot fuel pellet and cladding manufacturing equipment, analysis and redesign of fuel fabrication processes, and revising fuel performance codes and methods.	• The increase reflects acceleration of irradiation testing and examination at the national laboratories and in commercial reactors as we near industry's objective to install the first reload quantities of accident tolerant fuel in pilot plants by the mid-2020s and qualify the fuel for use at higher burnup levels.

Fuel Cycle Research and Development
TRISO Fuel and Graphite Qualification

Description

The Tristructural-isotropic (TRISO)-coated particle fuel and graphite subprogram includes activities for fuel and material irradiation, post-irradiation examination (PIE) and safety testing, fuel performance modeling, and fission product transport and source term research.

TRISO particle fuel development and qualification activities support prismatic and pebble-bed high temperature fuel designs. Since the onset of the TRISO Fuel Program in 2002, the program has focused on qualification of the fuel design for high temperature gas reactor concepts; however, TRISO fuel also has applications for other reactor concepts such as molten salt-cooled high temperature reactors. Irradiation, safety testing, and PIE of TRISO fuel will provide data for fuel development and qualification in support of industry efforts to eventually establish a domestic commercial TRISO fuel fabrication capability.

The graphite development and qualification efforts provide data to support the use of graphite in high temperature reactor environments. Since historical grades of graphite used in previous high temperature reactors are no longer available, graphite development includes efforts to characterize and irradiate new grades of graphite. These efforts provide non-irradiated and irradiated properties so that the thermomechanical design of the structural graphite in advanced high temperature reactors can be validated. The irradiation experiments span the proposed temperature and dose envelope for a prismatic high temperature gas reactor and is also applicable to pebble-bed and possibly molten salt-cooled high temperature reactors.

TRISO Fuel and Graphite Qualification
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
TRISO Fuel and Graphite Qualification $36,000,000	**$27,000,000**	**-$9,000,000**
• Continued post irradiation examination (PIE) of the AGR-3/4 TRISO fuel experiment. • Continued safety testing of TRISO fuel in elevated temperatures. • Commissioned the air and moisture ingress furnace to understand TRISO fuel performance in a transient scenario resulting in air or moisture ingress. • Began high dose graphite experiment irradiation in Idaho National Laboratory (INL)'s ATR. • Continued characterization and PIE of graphite specimens. • Continued to pursue addition of graphite to the American Society of Mechanical Engineers (ASME) code for use in high temperature reactors.	• Perform further PIE of the AGR-3/4 and AGR-5/6/7 TRISO fuel experiments to characterize fission product inventory and fuel performance in response to varying reactor fluence and temperature to support industry TRISO fuel qualification efforts. • Perform additional safety testing of TRISO fuel to characterize performance in elevated temperatures and fission product transport. • Begin testing of TRISO fuel in the air and moisture ingress furnace to understand performance in a transient scenario. • Further irradiate high dose graphite experiment in INL's ATR to subject graphite to doses that more closely reflect what would be experienced in pebble bed type reactors. • Perform additional characterization and PIE of graphite specimens to provide qualification data of various grades of graphite for use in high temperature reactors. • Enhance the American Society of Mechanical Engineers (ASME) code to extend the use of graphite in high temperature reactors.	• The decrease from $36,000,000 to $27,000,000 reflects associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line. • The decrease also reflects the fact that the TRISO fuel qualification program is ramping down as it nears completion and high-cost activities such as irradiation experiments have been completed.

Fuel Cycle Research and Development
Fuel Cycle Core R&D

Description

This subprogram supports research activities that advance the knowledge base for nuclear fuel cycles and provide transformative changes to accelerate development of civil nuclear technologies, including consideration of fuel cycle impacts from the potential deployment of advanced reactor technologies. It also includes activities in Materials Protection, Accounting and Control Technologies (MPACT), Systems Analysis and Integration (SAI), Innovative Nuclear Materials (INM), Innovative Process Control Capabilities (IPCC) and advanced reactor fuels research and development (R&D).

MPACT develops innovative technologies, analysis tools and advanced integration methods to enable U.S. domestic nuclear materials management and safeguards for emerging nuclear fuel cycles. It also includes assessing vulnerabilities in current nuclear systems while minimizing proliferation risks. Addressing U.S. energy security needs requires innovative approaches to material control and accounting to ensure that nuclear material is not misused, diverted, or stolen.

SAI activities include strategic planning and analysis, and integrated evaluation of program activities. It provides the critical capability needed to analyze complex fuel cycle system options, assess overall performance under various scenarios, and improve understanding of the interdependencies between various subsystems and associated technologies.

INM activities focus on longer-term materials discovery and development for advanced nuclear energy systems applications. It seeks to develop new tools, techniques, and capabilities at national laboratories. The goal is to accelerate the pace of new materials discovery, building on recent advances in artificial intelligence, machine learning, theory, modeling, and computing, and advanced characterizations. For example, innovative approaches are needed to develop advanced metallic alloys and composite materials that are optimized to meet new reactor performance targets within the reactor core and fuel cladding. It also includes recycling of zircaloy cladding material, which is the second largest mass in used fuel assemblies. Developing recovery process with sufficient Zr purity to permit re-use will reduce the waste quantity as well as enhance resource utilization. Similar recycling approaches will be developed for other high value nuclear materials.

IPCC activities include the development of innovative fuel cycle process control technologies to enhance process controllability and to enable predictive modeling capability in advanced nuclear separation systems. A significant fraction of the space in a nuclear fuel recycling plant is occupied by large tanks—used for surge capacity or system redundancy. Implementing advanced process control and modeling technologies into the recycling plant design will reduce the size of such tanks, or even eliminate the need for this tank space. This in turn would directly reduce the cost of plant construction. The activity also supports fuel development and capabilities using advanced processing control technologies in molten salt recycling at the national laboratories.

Advanced reactor fuels activities include continued advances in accelerated fuel qualification activities to support advanced reactor development. Conventional fuel qualification takes more than 20 years and costs hundreds of millions of dollars. Recent advances in modeling, examination and analysis techniques, irradiation testing techniques, and even artificial intelligence and machine learning can significantly reduce the time and expense of fuel qualification. In FY 2023 we propose to build upon the advanced irradiation testing techniques recently developed at the national labs. Those techniques are the Fission Accelerated Steady-State Testing (FAST) approach at INL and MiniFuel separate effects testing at ORNL. Both techniques allow for much shorter irradiation times to gather meaningful data on fuel performance. Also, in FY 2023 we propose to initiate a metallic fuel qualification program that supports advanced reactor developers using metallic fuel. Many advanced reactor developers are proposing metallic fuel for their reactors. Metallic fuel is a mature and may become a key strategic U.S. developed and owned technology. This program would establish a reference fuel performance baseline using legacy data and analyses, improve performance modeling capability in the BISON fuel performance code, and prepare for transient experiments in Transient Reactor Test Facility (TREAT) on legacy Experimental Breeder Reactor-II (EBR-II) reactor fuel.

Fuel Cycle Core Research & Development
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Fuel Cycle R&D $20,000,000	**$46,500,000**	**+$26,500,000**
• Continued the development of innovative technologies, analysis tools, and advanced integration methods for aqueous and molten salt separation process controls and nuclear materials management and other limited fuel cycle research and development activities. • Developed innovative on-line process monitoring capabilities for advanced reactors fuel recycling. • Developed advanced solvent extractants and complexation agents to improve the separation processes controllability. • Developed and maintained leading-edge analysis capabilities to ensure world-class analysis of complete nuclear energy systems. • Performed scenario analysis studies of fuel cycle facilities for promising advanced reactor technologies. • Supported advanced reactor developers with innovative fuel irradiation experiments that accelerate the qualification of fuel for their reactor concepts. • Collaborated with Japan on transient testing of advanced fuel concepts.	• Continue developing innovative technologies, analysis tools, and advanced integration methods for material control and accounting applications. • Continue innovative on-line process monitoring capabilities for advanced reactors fuel recycling. • Demonstrate high resolution microcalorimeter measurements at INL • Deploy an acoustic system to monitor uranium and plutonium mass values in aqueous processing. • Continue to conduct performance assessments and economic and market analyses of promising advanced nuclear energy systems and their role in achieving a net-zero economy by 2050. • Continue accelerated irradiation experiments using the ATR and HFIR using Fission -Accelerated Steady-State Testing (FAST) and Mini-fuel Testing, respectively. Continue U.S./Japan joint transient testing of advanced reactor fuel concepts in TREAT. • Initiate a metallic fuel qualification program that supports advanced reactor developers using metallic fuel. This includes establishing a reference fuel baseline, improving performance modeling capability, and preparing for future transient experiments. • Initiate molten salt recycling for salt fuels development capabilities at the national laboratories. • Support new and recycled materials development for fuel cladding, coating and in-core materials.	•The increase reflects the initiation of a metallic fuel qualification program that supports advanced reactor developers using metallic fuel and continuing advances in accelerated fuel qualification for advanced reactor fuel. •The increase reflects the initiation of an innovative process control program to accelerate the fuel preparation and treatment using molten salt technologies. • The increase reflects investment in innovative nuclear materials and molten salt fuels development capabilities at the national laboratories that are critical for advanced fuel cycle development.

Fuel Cycle Research and Development
High Assay, Low-Enriched Uranium Availability

Description

Advanced reactors are being developed for flexible baseload power generation, providing U.S. leadership in nuclear technology, enabling new markets for export, and reducing greenhouse gas emissions. Many of these reactors are expected to require high-assay, low-enriched uranium (HALEU) fuel. HALEU is uranium with the fissionable isotope U-235 enriched to between greater than 5 and less than 20 percent. Current commercial light water reactors use uranium enriched to up to 5 percent U-235. There are no commercial suppliers of HALEU in the U.S. and advanced reactor developers will need small quantities of HALEU in the near term to support the qualification of their fuel and larger quantities for the first demonstration reactors. Much larger quantities of HALEU would be needed when advanced reactors requiring HALEU fuel are commercialized. The Energy Policy Act of 2020 authorized DOE to begin working to address HALEU availability issues.[1]

This subprogram will work to make available small quantities of HALEU from limited DOE uranium inventories and leverage the HALEU enrichment demonstration capability in the short term, in coordination with the National Nuclear Security Administration (NNSA), and work with the private sector in its building out of commercial U.S. HALEU production and supply chain capability for the long term.

In FY 2022, the Department received many responses to its request regarding the establishment of a HALEU consortium, technical and regulatory barriers to licensing fuel cycle facilities, cost-sharing approaches or contracting vehicles, transportation capabilities, conversion capabilities, market-related barriers, financing. Human resources, and/or other topics. Responses to the RFI are informing the Department's planning for FY 2023 and beyond. In FY 2022, DOE will develop a cost recovery process in preparation for the supplying of HALEU to members of a consortium for commercial use in future years.

In FY 2023, subprogram activities include initiating the recovery and down-blending of limited excess quantities of DOE uranium inventories to HALEU for DOE's use in research, development, and demonstration programs. In coordination with NNSA, NE will recover and downblend highly-enriched uranium from existing inventories located at the Savannah River Site and NNSA will identify and repurpose unused or scrap material at Y-12 under their Convert subprogram. This is anticipated to be a three-year effort which will reduce the costs to store, process and dispose of this material under current plans. Under this NE subprogram, NE will initiate activities to support the production of 2.0-2.4 MT HALEU from existing HEU uranyl nitrate solution at Savannah River and prepare it for shipping and conversion to oxide. NNSA's Convert subprogram will produce an additional ~2.2 MT of HALEU.

In FY 2022, DOE will transition the HALEU enrichment activities in Piketon, Ohio to a new competitively awarded, cost-share program to complete the HALEU Enrichment Demonstration and operate the 16-centrifuge cascade to produce a limited quantity of HALEU for one year. Future options to continue the operation of the cascade beyond FY 2023 are subject to the annual budget process. In FY 2023, the private sector partner awarded the contract will staff and operate the enrichment facility to produce a limited quantity of HALEU for DOE's use in research, development, and demonstration programs. The facility may contribute to the long-term commercialization of HALEU supply by private industry beyond FY 2023.

DOE will also initiate efforts to address critical near-term supporting elements of the HALEU availability program: (1) developing and executing a strategy to address the National Environmental Policy Act requirements, (2) explore with industry the processes that would be needed to convert HALEU to the various fuel forms needed to fuel their advanced reactors, and (3) working with industry on HALEU transportation needs including criticality benchmark data needed to reduce conservatism in package designs and cost-shared competitive awards to support package development.

[1] The Energy Act of 2020 authorized a HALEU availability program, which authorized the Department perform activities regarding developing criticality benchmark data, supporting design and licensing of transportation packages, considering options for acquiring or providing HALEU to advanced reactor developers, surveying stakeholders, and establishing a HALEU consortium. The Act also directs DOE to be prepared to supply HALEU to commercial industry by January 1, 2026 and requires DOE to develop an associated cost recovery process.

High-Assay, Low-Enriched Uranium Availability
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
HALEU for R&D $0	**$95,000,000**	**+$95,000,000**
• Funding was not provided in FY 2021.	• Initiate the recovery and down-blending of limited excess quantities of DOE uranium inventories to HALEU. In coordination with NNSA, NE will recover and downblend highly-enriched uranium from existing inventories located at the Savannah River Site and NNSA will identify and repurpose unused or scrap material at Y-12 under their Convert subprogram. • Continue activities under a new competitively awarded cost share program to operate the 16-centrifuge cascade in Piketon to produce a limited quantity of HALEU for research, development, and demonstration use for one year, with the option to extend in future years. The private sector partner awarded the contract will operate the facility and produce HALEU for DOE's use. • Initiate efforts to address critical near-term supporting elements of the HALEU availability program: : (1) develop and execute a strategy to address the National Environmental Policy Act requirements, (2) explore with industry the processes that would be needed to convert HALEU to the various fuel forms needed to fuel their advanced reactors, and (3) work with industry on HALEU transportation needs including criticality benchmark data needed to reduce conservatism in package designs and research and development.	• Initiate a HALEU availability program as authorized by the Energy Act of 2020 in order to make available small quantities of HALEU from limited DOE Uranium inventories and HALEU production in the short term and support the private sector in its design and build out of commercial U.S. HALEU production capability in the long term.

Fuel Cycle Research and Development
Used Nuclear Fuel Disposition R&D

Description
The Used Nuclear Fuel Disposition Research and Development (R&D) subprogram conducts scientific research and technology development to enable long term storage, transportation, and disposal of spent nuclear fuel and wastes. The primary focus of this subprogram supports the development of disposition-path-neutral waste management systems and options in the context of the current inventory of spent nuclear fuel and waste.

Research and Development
Full-Scale Storage Cask Demonstration – Although the nuclear power industry has used dry storage for many years, this storage option has been for low-burnup fuel; therefore, there is limited data available on the degradation of more contemporary high-burnup fuels. To address this data gap, the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and nuclear industry are cooperating to investigate extended storage of high-burnup fuels (≥ 45 GWd/MTHM). DOE, in cooperation with the NRC and industry, is conducting a full-scale demonstration of storage for high-burnup fuel that will be beneficial by: 1) benchmarking the predictive models and empirical conclusions developed from short-term laboratory testing, and 2) building confidence in the ability to predict the performance of these systems over extended time periods.

Storage and Transportation R&D – In addition to the Full-Scale Storage Cask project, DOE will continue to support other lab testing, field studies, and modeling R&D related to the storage and transport of high-burnup fuel to include: testing of cladding response with hydride reorientation and embrittlement; the effects of atmospheric corrosion on storage welds; measuring the embrittlement of elastomer seals; determining thermomechanical degradation of bolts, welds, seals and poisons; analyzing thermal profiles of stored fuels; determining the stress profiles of fuels and casks; evaluating cask drying processes; laboratory post-irradiation examination and testing of the fuel from the cask demonstration project at the North Anna Generating Station in Mineral, Virginia; and the development of sensors for internal and external cask monitoring. R&D will focus on contributing to the technical knowledge to support long-term storage and eventual transportation of high-burn-up fuels. As the DOE continues to make progress on the accident tolerant fuels, research will be done to ensure that data are gathered on the new/modified cladding and fuel materials to ensure that they can be stored and transported in the future. Current work also indicates that burnup rates for accident tolerant fuels could go up to 75 to 80 GWD/MTU for which very little if any data exists, so additional R&D will be done to address this gap.

Disposal R&D – Activities continue to further the understanding of long-term performance of disposal systems in three main geologic rock types: clay/shale, salt, and crystalline rock. These activities include collaborations with international partners to leverage and integrate applicable R&D being conducted by other countries into the U.S. disposal R&D portfolio. Also, evaluations will continue to determine the feasibility of directly disposing existing single (storage only) and dual-purpose (storage and transportation) used-fuel canisters in a mined repository. Evaluate the disposal performance characteristics of new accident tolerant fuels and high-level radioactive waste glass compositions. Support a pilot program to increase participation of underrepresented groups in research activities related to management and disposal of radioactive wastes.

Used Nuclear Fuel Disposition Research & Development (R&D)
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Used Nuclear Fuel Disposition Research & Development $62,500,000	**$46,875,000**	**-$15,625,000**
• Completed non-destructive testing and continue destructive testing of fuel rods that were pulled from a commercial power station to establish the performance baseline of the stored used fuel. • Characterized external loadings on fuel rods during normal conditions of transport. • Developed an understanding of material degradation phenomena in safety components associated with long term storage and transportation systems. This work will support licensing applications for extended dry storage and subsequent retrieval and transport of high burnup used nuclear fuel. • Evaluated integration and implementation methodologies of process-level models with performance assessment tools relating to argillite and crystalline media disposal. Integrate developed modeling tools with analysis software for uncertainty quantification and sensitivity analysis. • Continued science and engineering technical basis for the disposal of heat generating waste in salt. • Continued research and development (R&D) activities associated with exploring potential disposal options for various waste and spent nuclear fuel forms, including collaboration with international partners to leverage R&D being conducted in various geologic media. • Issued evaluation of the technical feasibility of direct disposal of dual-purpose canisters to	• Continue ongoing disposal R&D. • Evaluate the storage, transportation, and disposal performance characteristics of new accident tolerant fuels and high-level radioactive waste glass compositions. • Support pilot program to increase participation of underrepresented groups in research activities related to management and disposal of radioactive wastes. • Consistent with the results of an Independent Technical Review continue evaluations to determine the feasibility of directly disposing existing single (storage only) and dual-purpose (storage and transportation) used-fuel canisters in a mined repository. • Continue destructive testing on sibling rods. • Work with SONGS to install instrumentation on typical canisters used by the nuclear power plant industry. • Continue work to clear hot cells and prepare for acceptance of new accident tolerant fuels.	• The decrease reflects funds for NE's Directed R&D and University Programs being requested outside of the UNFD program's budget.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
potentially eliminate the need for repackaging these canisters for disposal. • Prepare to begin testing and evaluation of the storage, transportation and disposal performance characteristics of the new accident tolerant fuels.		

Fuel Cycle Research and Development
Integrated Waste Management System

Description

The Nuclear Waste Policy Act of 1982 (NWPA) assigns the Department of Energy the responsibility for disposition of U.S. spent nuclear fuel (SNF) and high-level radioactive waste (HLW), and the Department remains committed to fulfilling the Federal Government's legal obligations to properly manage and dispose of that material. The Integrated Waste Management System (IWMS) subprogram supports efforts to develop and implement a Federal interim storage program that uses a consent-based approach to siting as part of an overarching waste management system, as well as storage, transportation, and system development and analysis activities. The activities of this subprogram include developing a consent-based siting process, preparing for large-scale transportation of spent nuclear fuel, and working with communities, stakeholders, and governmental entities including in the more than 30 states where SNF and HLW is currently stored.

The IWMS subprogram's FY 2023 Budget Request funds critical, foundational planning and development actions required to lay the groundwork for effective implementation of consolidated interim storage of the nation's nuclear waste. As part of its efforts, the Department will work collaboratively with the public, communities, stakeholders, and governments at the Tribal, state, and local levels. The Department will develop a consent-based approach to siting, engaging with potential host communities. These activities include:

- Initiate $10,000,0000 of early-phase grant funding for interested groups, communities, states, or Tribes to explore consent-based siting and interim storage, support mutual learning, and reduce barriers to participation in the consent-based siting process;
- Build public participation into the consent-based siting process, allowing opportunities for the public and stakeholders to engage with the Department;
- Develop communication plans, materials, and strategies to support strong public engagement and meaningful information sharing capabilities;
- Develop a waste management system that incorporates social equity and environmental justice;
- Conduct technical activities to develop facility design concept information to share and support interactions with stakeholders to better inform the consent-based siting process;
- Evaluate the costs and benefits of interim storage facility approaches;
- Analyze regulatory considerations applicable to interim storage facility design options and siting process;
- Analyze and update critical data needed to identify quantities of and collect detailed information on relevant nuclear waste inventories to inform options analyses and transportation planning;
- Continue funding engagement with State and Tribal partners to cooperatively plan for large-scale SNF transportation, including approaches to emergency response training and safety inspections;
- Begin acquisition of transportation casks for SNF, which may require moderate lead times to update cask certificates of compliance and initiate commercial fabrication capacity; and
- Begin planning for a full-scale package performance test of a rail-sized SNF cask to aid in building public trust and confidence in the safety of SNF transport.

As part of the subprogram, storage facility design and operations options are explored and evaluated. These activities include investigating methods to mitigate the possibility of stress corrosion cracking and advanced manufacturing techniques for spent fuel containers. Evaluations of storage system design alternatives conducted in this subprogram inform an understanding that will help guide future approaches as well as the development of system interface requirements. The IWMS subprogram's work to implement SNF storage facilities and transport SNF complements and builds on the Used Nuclear Fuel Disposition R&D subprogram's work to conduct research on SNF and HLW disposal options, high-burnup fuel storage, and impacts to fuel rods during transport.

Preparations for large-scale transportation of SNF and HLW includes development of purpose-built railcar equipment, design of a safety and security monitoring system for rail shipments, assessment of transportation infrastructure and transport options at nuclear power plant sites, employment of state-of-the-science data and software tools to support decision-making and communications, thorough analysis of transportation system operational elements and dependencies, active engagement with State and Tribal government representatives through the Department's National Transportation Stakeholders Forum and associated working groups, and coordination with appropriate Federal agencies on safety and security considerations. These efforts build on successes and lessons learned from previous DOE radioactive materials transportation programs and campaigns as identified through knowledge management activities.

Waste management system analysis capabilities will be maintained and enhanced as part of the IWMS subprogram. These analytical tools and database systems provide the ability to model various system architectures and configurations including options involving interim storage of SNF. Using these models and analytical tools, different system scenarios can be evaluated and the effect of varying input assumptions can be examined, including interim storage facility receipt rate and capacities. Other analytical tools provide the capability to explore SNF storage, transport, and disposal considerations. In FY 2023, work will focus on incorporating output from detailed system analysis tools into a prototype user-friendly siting analysis tool to assist interested communities in interactive exploration of consolidated interim storage.

Integrated Waste Management System
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Integrated Waste Management System $18,000,000	**$53,000,000**	**+$35,000,000**
• Investigated possible storage approaches and solutions using advanced analytical methods and techniques. • Continued development of computational systems analysis tools to support facility design analyses and transportation operational planning. • Issued an updated report on evaluations of transportation infrastructure at nuclear power plant sites. • Maintained spent nuclear fuel inventory data and system analysis modeling tools by incorporating enhancements into software. • Supported development of a prototype web-based application to streamline future collection, processing, and analysis of spent nuclear fuel data from U.S. nuclear power plants. • Continued testing and demonstration of the Atlas railcar consist. • Received approval for the Fortis railcar design and began procurement for a prototype Fortis railcar.	• Continue early-phase funding to interested groups, communities, States, or Tribes exploring the consent-based siting process and interim storage. • Develop a prototype siting analysis tool to assist interested communities in exploring interim storage. • Finalize the railcar safety inspection protocol developed in coordination with States and Tribes. • Update DOE's proposed Section 180(c) Policy to provide emergency response training funds and technical assistance to States and Tribes. • Conduct demonstration run and delivery of one Atlas 12-axle cask-carrying railcar, two buffer railcars, and one REV. • Provide one complete rail consist approved by the Association of American Railroads (AAR) and achieve ready to transport in accordance with AAR Standard S-2043. • Complete fabrication of one Fortis 8-axle cask-carrying railcar prototype and begin railcar performance testing. • Conduct integrated system analyses of interim storage options, factoring in early feedback from consent-based siting activities. • Develop an updated reference concept for a generic Federal Consolidated Interim Storage Facility (CISF). • Commence work on conceptual design options of interest for Federal CISFs to inform consent-based siting efforts.	• Funding increase reflects a ramp-up in activities to develop a consent-based process for siting interim storage facilities and identify one or more sites for an interim storage facility based on that process. • Funding increase reflects $10,000,000 of dedicated funding for communities and Tribes to participate in the consent-based siting process. • Funding increase reflects additional SNF transportation planning activities, including work to begin acquiring SNF transportation casks, and preparations for full-scale accident testing of a rail-sized transport cask. • Funding increase also reflects funding for interim storage activities that were previously appropriated within the Interim Storage and Nuclear Waste Fund Oversight program (Nuclear Waste Disposal account), in the amount of $20,000,000 in FY 2021. The FY 2023 request for Interim Storage activities is instead included as part of the Office of Nuclear Energy's IWMS subprogram within Fuel Cycle R&D.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
	• Continue and expand upon existing planning, analysis, and outreach work for large-scale SNF transportation.	

Nuclear Energy Enabling Technologies

Overview

The Nuclear Energy Enabling Technologies (NEET) program conducts research and development (R&D) and makes strategic investments in research capabilities to develop innovative and crosscutting nuclear energy technologies to resolve nuclear technology development issues. The Crosscutting Technology Development (CTD) subprogram focuses on innovative research that directly supports the existing fleet of nuclear reactors and enables the development of advanced reactors and fuel cycle technologies, including topical areas such as advanced sensors and instrumentation; nuclear cybersecurity; innovative materials and manufacturing technologies; and integrated energy systems. Also, NEET invests in modeling and simulation tools for existing and advanced reactors and fuel system technologies. The program also provides industry, universities, and national laboratories with access to unique nuclear energy research capabilities through the Nuclear Science User Facilities (NSUF) subprogram. Collectively, NEET-sponsored activities support the Department's priorities to combat the climate crisis, create clean energy jobs with the free and fair chance to join a union and bargain collectively, and promote equity and environmental justice by delivering innovative clean energy and advanced manufacturing technologies for nuclear energy systems. NEET also makes these technology advancements accessible to the U.S. industry through the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative and private-public partnerships.

Highlights of the FY 2023 Budget Request

Within CTD, the Advanced Materials and Manufacturing Technologies (AMMT) subprogram will continue to accelerate the development, qualification, and demonstration of innovative materials and manufacturing technologies to enable reliable and economical technologies for nuclear energy production. AMMT will work with a broad range of stakeholders to develop new materials and manufacturing technologies, establish a comprehensive framework for rapid qualification, and perform technology demonstrations.

The Nuclear Science User Facilities subprogram includes, within its request, funding for the High Performance Computing (HPC) nuclear energy computation system that provides scientific computing capabilities to NE's R&D programs, universities, industry, national laboratories, and federal agencies to support their research and development efforts.

Nuclear Energy Enabling Technologies
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Nuclear Energy Enabling Technologies					
Crosscutting Technology Development	28,000	28,000	35,250	+7,250	+26%
Joint Modeling and Simulation Program	35,000	35,000	28,327	-6,673	-19%
Nuclear Science User Facilities	30,000	30,000	39,160	+9,160	+31%
Transformational Challenge Reactor	29,869	29,869	0	-29,869	-100%
Total, Nuclear Energy Enabling Technologies	**122,869**	**122,869**	**102,737**	**-20,132**	**-16%**

SBIR/STTR:

- FY 2021 Enacted: SBIR $3,758; STTR $654
- FY 2022 Annualized CR: SBIR $3,758; STTR $654
- FY 2023 Request: Funding provided in the Directed R&D and Universities Program line.

Nuclear Energy Enabling Technologies
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Crosscutting Technology Development:	**+7,250**
The increase from $28,000,000 to $35,250,000 reflects support for the Advanced Materials and Manufacturing Technologies (AMMT) activity, which consolidates efforts from the Nuclear Materials Discovery and Qualification initiative, the crosscutting research previously conducted under the Transformational Challenge Reactor subprogram, and the Advanced Methods for Manufacturing area. This increase also provides support for the Integrated Energy Systems activity and additional support for research and development (R&D) in the areas of advanced sensors and instrumentation and cybersecurity.	
Joint Modeling and Simulation:	**-6,673**
The decrease from $35,000,000 to $28,327,000 reflects $8,592,500 in associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line, and additional funding in the amount of $1,919,500 to support industry needs for modeling fuel fragmentation, relocation, and dispersion at higher burnup.	
Nuclear Science User Facilities:	**+9,160**
The increase from $30,000,000 to $39,160,000 reflects additional support for industry, universities, and national laboratories access to unique nuclear energy research facilities and continued support for NE's High Performance Computing capability.	
Transformational Challenge Reactor:	**-29,869**
The decrease from $29,869,000 to $0 reflects the subprogram's transition to an R&D effort to be managed under the Crosscutting Technology Development (CTD) subprogram with other relevant R&D.	
Total, Nuclear Energy Enabling Technologies	**-20,132**

Crosscutting Technology Development

Description

The Crosscutting Technology Development (CTD) subprogram develops innovative solutions to crosscutting nuclear energy technology challenges. The CTD subprogram focuses on foundational research on transformative technologies to maintain the current fleet of nuclear reactors and support the development of advanced reactors and fuels. CTD research and development (R&D) projects include industry, universities, and national laboratory collaborations and it is closely coordinated with the Office of Nuclear Energy's other R&D programs to ensure that developed technologies and capabilities are part of an integrated investment strategy aimed at improving reliability and economics of U.S. nuclear technologies.

Activities within this subprogram include:

- developing new capabilities needed for domestic nuclear energy R&D, with focus on gaps to commercial deployment of advanced reactors;
- conducting high-risk research that could overcome current technological limitations;
- developing enabling technologies that have applicability across multiple technical areas; and
- conducting leading-edge R&D to improve the economics, quality, security, and efficiency of nuclear technologies.

The principal focus areas for FY 2023 include advanced sensors and instrumentation, nuclear cybersecurity research, advanced materials and manufacturing technologies, and integrated energy systems as follows:

- Advanced Sensors and Instrumentation supports R&D of unique sensor and instrumentation technologies that provides enhanced monitoring and control capabilities to the existing reactor fleet, adapts novel sensor types for advanced reactor development and demonstration, and provides expanded capability to fuel cycle and advanced materials development;
- Nuclear Cybersecurity Research develops technologies and methods to address cyber threats to the U.S. nuclear power infrastructure, in coordination with the Department's Cybersecurity, Energy Security, and Emergency Response office, and supports secure implementation of advanced technologies such as wireless control and remote or autonomous operations;
- Advanced Materials and Manufacturing Technologies supports the development of technology-based solutions for advanced materials and manufacturing technologies for use in the deployment of advanced nuclear reactors and sustainment of the existing fleet. This consolidated focus area integrates the cutting-edge research formerly pursued through the Advanced Methods for Manufacturing topic area, the Nuclear Materials Discovery and Qualification Initiative, and the crosscutting research previously performed under the Transformational Challenge Reactor subprogram; and
- Integrated Energy Systems supports the expansion of nuclear energy's role beyond supplying electricity to the grid, such that nuclear energy can also support various industrial, transportation, and energy storage applications, both electrical and thermal. The successful integration of energy systems will allow the electric grid to continue to rely on the economic benefits, reliability, and emissions-free electricity from nuclear energy while offering additional economic benefits from using high-grade process heat and providing flexible energy dispatch. Integrated nuclear systems will allow clean, affordable nuclear energy to decarbonize industrial, chemical, and transportation applications currently relying on other energy sources.

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Crosscutting Technology Development **$28,000,000**	**$35,250,000**	**+$7,250,000**

• Advanced Sensors and Instrumentation (ASI):
  ○ Completed a successful first-of-a-kind demonstration of optical-fiber based Distributed Temperature Sensing (DTS) in a nuclear fuel test. DTS provides mapping of temperature profiles instead of single point measurements, expanding the capabilities of current fuel cycle testing and support development of data-intensive algorithms for optimized control of advanced reactors.
  ○ Performed test of real-time, in-core neutron flux monitoring sensors at high temperature (up to 800 C) towards the qualification of temperature compensation techniques to inform advanced reactor design.
  ○ Procured a prototype system to demonstrate instrumentation of irradiated fuel elements by remote handled re-manufacturing, aiding in characterization of high burn-up fuel and acceleration of novel fuel form development for the existing fleet and advanced reactors.
• Cybersecurity:
  ○ Developed a unified process formally integrating nuclear and cybersecurity risk analysis methods and initiated a demonstration of the technique at a U.S. nuclear power plant.
  ○ Expanded programmatic efforts to support cybersecurity by design in advanced reactors, by initiating the documentation of postulated attack surfaces and advanced reactor architectures. These will be used to prioritize
	• Conduct research on Advanced Sensors and Instrumentation to address future capabilities needed for advanced reactor demonstrations, fuel cycle and materials testing, and modernization of the existing fleet. Program activities will include development of temperature compensated neutron flux sensors, radiation drift compensated thermocouples, linear variable differential transformer (LVDTs), acoustic-based structural health monitoring, and process control algorithm and instrumentation integration in nuclear digital twin (NDT) platforms.
	• Continue the development of cybersecurity standards and reference architectures for wireless communication and autonomous control and zero-trust implementation. Pursue additional real-world pilot opportunities for the application of cyber-informed engineering and advanced risk management techniques for advanced reactors under development.
	• Continue the Advanced Materials and Manufacturing Technologies (AMMT) program to accelerate materials and manufacturing technologies development to support the existing reactor fleet as well as the deployment of advanced reactors. Program activities will include improvement and optimization of existing materials with minor chemistry modifications to improve use for advanced reactors; development of technical basis for regulatory approval of additively-manufactured 316 SS; initiation of ASME
		• The increase reflects support for the Integrated Energy Systems subprogram and the Advanced Materials and Manufacturing Technologies (AMMT) subprogram, initiated in FY 2021, which consolidates efforts from the Nuclear Materials Discovery and Qualification initiative, the crosscutting research previously conducted under the Transformational Challenge Reactor subprogram, and the Advanced Methods for Manufacturing area.
		• This increase provides support for R&D in the areas of advanced sensors and instrumentation and cybersecurity. For advanced sensors and instrumentation, funding supports expediting sensor development towards commercialization, providing sensors to be available for upcoming advanced reactor demonstrations, and investigating integration of advanced instrumentation and control algorithms into nuclear digital twin (NDT) platforms. In the cybersecurity area, this funding supports advanced reactor control systems design, such as development of zero trust architectures, secure wireless architectures, and methods for applying consequence-driven, cyber-informed engineering techniques.
		• The request reflects associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
additional R&D needs, particularly in cyber-informed engineering, risk-informed cybersecurity management, wireless communications and autonomous control. ○ Supported international standards development for nuclear power plant cybersecurity. • Advanced Materials and Manufacturing Technologies (AMMT): ○ Initiated the consolidation of materials and manufacturing technologies performed within different programs to improve the efficiency of the similar efforts. ○ Competitively solicited and awarded a project to improve manufacturing techniques on oxide dispersion strengthened (ODS) ferritic alloys. ○ Initiated research on the positive effects of advanced manufacturing techniques to improve use of critical minerals for nuclear energy applications. • Integrated Energy Systems: ○ Released enhanced, open-source modules for the Framework for Optimization of Resources and Economics (FORCE) suite of tools used for optimizing flexible energy dispatch, and the economic benefits of integrated energy systems comprised of multiple energy sectors with several electricity generation types. ○ Completed the design and installation of a laboratory-scale thermal distribution system for testing the control and dynamic behavior of heat exchangers and control valves for advanced light water reactor technologies involving multiple thermal outputs.	Code case development for additively-manufactured 316 SS for elevated temperatures; and identification of specific reactor components with industry that could take advantage of new AM technologies. • Develop Integrated Energy Systems techno-economic assessments; thermal storage and distribution, dynamic controls, and site integration technology for using clean nuclear heat and electricity from advanced reactors to decarbonize distributed industrial applications. These applications may include refining and biorefining; hydrogen and synthetic fuels production; chemicals, minerals, metals, and biomass processing; material recycling; combined heat and power; and dedicated reliable power for data centers.	Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs Line.

Joint Modeling and Simulation

Description

The Joint Modeling and Simulation subprogram, as implemented through the Office of Nuclear Energy's Nuclear Energy Advanced Modeling and Simulation (NEAMS) program, develops and deploys a set of predictive modeling and simulation tools to support and, in some cases, enable improved operation of the current fleet and the development and deployment of advanced reactors. NEAMS engages scientists and engineers in developing state-of-the-art, multi-scale models of physics and chemistry that drive advanced computational methods for simulations of advanced nuclear energy systems. NEAMS empowers researchers and designers to gain fundamental insights that are unattainable through experiment alone and inform experiment selection and design to minimize cost of research and development. Advanced modeling and simulation capabilities also support the Office of Nuclear Energy (NE) program priorities, such as the development of fuels with enhanced accident tolerance.

The NEAMS program has developed a set of analytic modeling and simulation tools that is flexible and able to accommodate different reactor types and designs. Through an enhanced programmatic framework, NEAMS tools support NE's mission priority areas: continued operation of the existing fleet of U.S. nuclear reactors; enable deployment of advanced nuclear reactors; develop advanced nuclear fuel cycles; and maintain U.S. leadership in nuclear energy technology.

For the existing fleet, NEAMS tools address core performance optimization issues and accelerate development of fuels with enhanced accident tolerance to help assure the long-term availability and market competitiveness of nuclear energy. The Bison fuel performance code, and the lower-length scale work that underpins it, helps to provide fundamental insight into how nuclear fuel behaves under normal and extreme reactor conditions, as well as higher fuel "burnup." When coupled with experimental work performed under the Fuel Cycle Research & Development program, this has the potential to accelerate the design and licensing of new fuel forms that can improve or extend the operation of existing reactors.

For advanced reactor technologies, NEAMS tools help industry accelerate advanced reactor development and meet otherwise cost-prohibitive data needs and will support Nuclear Regulatory Commission (NRC) efforts to address its confirmatory analysis needs. While many existing industry codes are designed for specific reactor designs, primarily light-water reactors, NEAMS has developed and continues to add capabilities to a suite of tools for reactor physics, thermal hydraulics, fuel performance, materials, chemistry, and system modeling that are intentionally flexible to accommodate the range of reactor designs currently being considered by industry. Several of these tools are being used, adopted, and modified by industry and NRC to meet their needs, and NEAMS incorporates feedback and inputs from these stakeholders to ensure proper focus on relevant capabilities.

For fuel cycle technologies, continued modeling and simulation tool development provide capabilities that can support future used nuclear fuel research and development, including development of strategies to burn less fuel, and high-fidelity analysis and prediction of fuel and cladding performance through the storage cycle.

Joint Modeling and Simulation

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Joint Modeling and Simulation $35,000,000	**$28,327,000**	**-$6,673,000**

• Enabled and accelerated industry's advanced reactor deployment efforts through advanced multiscale and multi-physics modeling and simulation approaches.
  ○ Demonstrated fast reactor multi-physics modeling capability for core radial expansion as an important reactivity feedback mechanism taking structural and irradiation impacts into consideration.
  ○ Fully incorporated and updated existing tristructural-isotropic (TRISO) fuel models into fuels modeling capability and perform validation against historical Advanced Gas Reactor tests.
  ○ Simulated key molten salt properties and validate them with selected measured data.
• Performed initial validation of advanced modeling tools consistent with Nuclear Regulatory Commission-specified priorities for specific validation experiments and reactor types.
• Completed development and validation of fuel performance and cladding models for Accident Tolerant Fuels (ATF). Updated verification and validation plan with experimental data.
• Transitioned the VERA Users Group to a self-sustaining model for funding the development and maintenance of the VERA software.
• Continued and updated quality assurance (QA) assessments and documentation to meet stakeholder requirements, such as Nuclear QA-1 research level.
	• Enable and accelerate industry's advanced reactor deployment efforts through advanced multiscale and multi-physics modeling and simulation approaches.
	  ○ Develop fully coupled, full-core simulation of entire microreactor to demonstrate self-regulation and load-following, during transient scenarios.
	  ○ Conduct graphite structural analysis and behavior for gas-cooled reactors during steady-state and transient conditions including swelling and oxidization as well as multiscale structural materials modeling for metallic structures including piping, heat exchangers, and reactor vessel.
	  ○ Develop and assemble molten salt reactor modeling capability and data sufficient to support the development of a mechanistic source term to support data safety and licensing.
	• Implement and demonstrate use of mechanistic tools to assess high-burnup fuel pulverization and burst potential for Light Water Reactor fuels to support licensing process associated with extending fuel burnup limits.
	• Maintain software tools with strong software quality assurance such that the tools can be used by industry and research institutions in research, design, and ultimately commercial deployment.
		• The decrease reflects $8,592,500 associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line, and additional funding in the amount of $1,919,500 to support industry needs for modeling fuel fragmentation, relocation, and dispersion at higher burnup.

Nuclear Science User Facilities

Description

The Nuclear Science User Facilities (NSUF) subprogram is the Nation's designated program to gain access to user facilities for nuclear energy research. As a consortium of partner facilities, the NSUF connects a broad range of nuclear research capabilities, expert mentors, and experimenters. The NSUF represents a "prototype laboratory for the future," promoting the use of unique nuclear research facilities located at multiple sites across the Nation and encouraging active university, industry, and laboratory collaboration in relevant nuclear science research. The NSUF, through competitive solicitations, provides a mechanism for research organizations to collaborate, conduct experiments and post-experiment analysis, and utilize high performance computing at facilities not normally accessible to these organizations. On an annual basis, researchers propose projects to be conducted at these unique facilities, with timelines ranging from a few months to several years. When projects are awarded, the NSUF subprogram pays for experiment support and laboratory services at the partner user facilities. In this manner, researchers benefit from the introduction to new techniques, equipment, and personnel. In FY 2021, the NSUF program supported 136 researchers from 23 different States through awards and 766 researchers across 26 States and eight other countries through access to high performance computing capabilities. Moving forward, emphasis will be placed on increasing the involvement of Historically Black Colleges and Universities, Minority Serving Institutions, and institutions in underserved communities, resulting in direct and meaningful investments through project selection and NSUF partnership agreements in support of the Administration's Justice40 Initiative.

The principal focus areas in NSUF for FY 2023 includes irradiation and post-irradiation examination of fuels and materials, high performance computing, and maintenance of the Nuclear Fuels and Materials Library as follows:

- The NSUF program competitively supports all pertinent irradiation and post-irradiation examination activities by providing researchers with access to unique nuclear research facilities. Support includes access to research reactors, hot cells, beam-line capabilities, irradiation capabilities, and irradiation experiment design and fabrication support, expert support, and community outreach.
- High Performance Computing (HPC) supports INL scientific computing capabilities to enable advanced modeling and simulation. These resources support a wide range of research activities, including performance of materials in harsh environments (such as the effects of irradiation and high temperatures), performance of existing light water and advanced nuclear reactors, and multiscale multi-physics analysis of nuclear fuel performance. HPC capabilities are available to industry, universities, national laboratories, and federal agencies to support research and development. Three HPC supercomputers are currently in operation at the Idaho National Laboratory: Sawtooth, Hoodoo and Lemhi.
- The Nuclear Fuels and Materials Library (NFML) supports the maintenance of a collection of specialized information and material specimens from past and ongoing irradiation test campaigns, real-world components retrieved from decommissioned power reactors, and donations from other sources. Everything in NFML is available to the nuclear research community, either through a peer-reviewed proposal process or through direct programmatic request.

Nuclear Science User Facilities

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Nuclear Science User Facilities		
$30,000,000	**$39,160,000**	**+$9,160,000**
• Competitively solicited and awarded four new fully-funded facility access awards. • Awarded 29 new fully-funded Rapid Turnaround Experiment awards through one competitive proposal process. • Optimized the capabilities available through partnerships with universities, industry, and national laboratories to offer unparalleled research opportunities in a highly cost-effective manner by leveraging capabilities and investments at partner institutions. • Enhanced the research tools provided to the Nuclear Science User Facilities (NSUF) user community. These online tools include the Nuclear Energy Infrastructure Database, the Nuclear Fuels and Materials Library, and Combined Materials Experiment Toolkit which, in concert, provide access to information on scientific equipment, previously irradiated materials, irradiation dose predictions and subject matter experts. • Invested in select domestic scientific infrastructure capabilities to support the advancement of applied research and development (R&D) in support of the Office of Nuclear Energy (NE) mission. • Conducted a workshop on the current capability gaps in performing materials research on irradiated materials.	• Competitively solicit and award new fully-funded facility access awards. • Award more than 100 Rapid Turnaround Experiment projects through three competitive proposal periods. • Continue NSUF partnership agreements with universities, industry, and national laboratories to support ongoing irradiation experiments ranging from neutron, gamma and ion irradiation to post-irradiation examination and incorporate new irradiation capabilities as needs are identified. • Enhance the Nuclear Fuels and Materials Library through the addition of irradiated fuels and materials. • Operate three supercomputers totaling more than 120,000 processor cores and 7 Petaflops of computational performance. Support more than 800 users by providing training, user support, and code optimization. Ensure effective cybersecurity and user access controls.	• The increase reflects support for High Performance Computing activities and additional access for industry, universities, and national laboratories to unique nuclear energy research facilities and a restoration of three Rapid Turnaround Experiment award cycles. • Additionally, the NSUF FY 2023 request reflects not having to provide funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards, which is being consolidated within the new Directed R&D and University Programs line.

Transformational Challenge Reactor

Description

The Transformational Challenge Reactor (TCR) subprogram provided a revolutionary platform to help demonstrate the ability to reduce the deployment costs and timelines for nuclear energy systems and enhanced the development of breakthrough technologies that provided the ability to manufacture small/micro advanced reactor components using additive manufacturing techniques. A central goal of the TCR subprogram was to demonstrate the ability to exploit advanced manufacturing techniques and digital predictive analysis capabilities to deliver a new approach to nuclear design and qualification for advanced reactor technologies. TCR combined advanced manufacturing with materials and computational sciences to predict optimal performance of components to enable faster innovation and certification.

Highlights of the FY 2023 Budget Request

No funding is requested in the FY 2023 Budget for the Transformational Challenge Reactor subprogram. In FY 2023, crosscutting research initiated under the TCR subprogram will continue under the Crosscutting Technology Development subprogram to consolidate all relevant technologies under one program.

Transformational Challenge Reactor

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2022 Request vs FY 2021 Enacted
Transformational Challenge Reactor $29,869,000	**$0**	**-$29,869,000**
• Demonstrated application of Artificial Intelligence (AI) to perform multi-physics optimization of additively manufactured component and provided benchmark test data to verify the framework. • Demonstrated predictive capability of the Digital Platform to assess nuclear component quality with Software Quality Assurance. • Performed irradiation testing of additively manufactured structures with embedded sensors and collected in situ data. • Published handbook of properties for additively manufactured ceramic and metal materials including neutron irradiation data.	• No funding is requested to continue this program in FY 2023. Crosscutting research will continue under the Crosscutting Technology Development (CTD) subprogram.	• No funding is requested to continue this program in FY 2023.

Advanced Reactor Demonstration Program

Overview

The Advanced Reactor Demonstration Program (ARDP) focuses Departmental and non-federal resources on supporting the development of advanced reactors that have the potential for near and mid-term demonstration and commercial deployment and addressing challenges hindering their deployment.

In the FY 2020 Further Consolidated Appropriations Act, Congress established ARDP to demonstrate multiple advanced reactor designs. In the Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act, P.L. 117-58), multi-year funding for the reactor demonstration elements of this program was provided under the new Office of Clean Energy Demonstrations (OCED). The ARDP research and development elements leading to demonstration remain with Nuclear Energy and include these four major elements:

- National Reactor Innovation Center (NRIC) – Supports testing, demonstration, and performance assessment to accelerate deployment of advanced reactors through development of advanced nuclear energy technologies by utilizing the unique DOE national laboratory facilities and capabilities;
- Risk Reduction for Future Demonstrations – Supports f cost-shared (up to 80% government, not less than 20% industry) partnerships with U.S.-based teams to address technical, operational, and regulatory challenges to enable development of a diverse set of advanced nuclear reactor designs for future demonstration;
- Regulatory Development – Coordinates activities with the Nuclear Regulatory Commission (NRC) and U.S. industry to address and resolve key regulatory framework and licensing technical issues that directly impact the "critical path" to advanced reactor demonstration and deployment; and
- Advanced Reactor Safeguards – Evaluates safeguards and security issues that are unique to advanced reactors to help reduce roadblocks by solving regulatory challenges, reducing safeguards and security costs, and utilizing the latest technologies and approaches for plant monitoring and protection.

In FY 2023, the Department focuses on the execution of the Risk Reduction projects selected in FY 2021. For the Risk Reduction projects, funding supports five domestic advanced reactor development partners in resolving technical, operational, and regulatory challenges to enable future demonstration of their concepts. Efforts initiated under the NRIC, Regulatory Development, and Advanced Reactor Safeguards subprograms continue in FY 2023.

The ongoing ARDP demonstration projects, funded in OCED, and the risk reduction projects are working to overcome barriers to future demonstrations and have the potential to create substantial numbers of new short and long-term domestic jobs. For example, in the early stages of design development and licensing, the reactor demonstration vendors are adding many technical and professional employees to address design, engineering, testing, procurement, and licensing requirements. The construction phase is expected to result in hundreds of short-term construction jobs, many of which are expected to be union filled. The eventual operation of these reactors will require the creation of additional long-term operations, maintenance, and security positions with the utility owners. Overall, the deployment and operation of these reactors are expected to have significant positive, long-term economic impacts on the communities in which they are operated.

Highlights of the FY 2023 Budget Request

The primary focus of the FY 2023 request is supporting ongoing activities under the Risk Reduction projects selected in FY 2021, and the NRIC, Regulatory Development, and Advanced Reactor Safeguards subprogram areas.

Funding for the two advanced reactor demonstrations previously included in this budget are now funded, per the Bipartisan Infrastructure Law (BIL), within the Office of Clean Energy Demonstrations.

Advanced Reactor Demonstration Program
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Advanced Reactor Demonstration Program					
National Reactor Innovation Center	30,000	30,000	75,000	+45,000	+150%
Demonstration 1	80,000	80,000	0	-80,000	-100%
Demonstration 2	80,000	80,000	0	-80,000	-100%
Risk Reduction for Future Demonstrations	40,000	40,000	140,238	+100,238	+251%
Regulatory Development	15,000	15,000	10,250	-4,750	-32%
Advanced Reactor Safeguards	5,000	5,000	4,750	-250	-5%
Total, Advanced Reactor Demonstration Program	**250,000**	**250,000**	**230,238**	**-19,762**	**-8%**

SBIR/STTR:

- FY 2021 Enacted: SBIR $2,332; STTR $406
- FY 2022 Annualized CR: SBIR $2,332; STTR $406
- FY 2023 Request: Funding provided in the Direct R&D and Universities Program line.

Advanced Reactor Demonstration Program
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
National Reactor Innovation Center:	
The increase from $30,000,000 to $75,000,000 reflects a transition from design to refurbishment/construction activities to support the establishment of demonstration test beds as well as the transition from the development to demonstration phase of the Advanced Construction Technologies (ACT) Initiative.	**+45,000**
Demonstration 1:	**-80,000**
The decrease from $80,000,000 to $0 reflects multi-year funding provided by the Bipartisan Infrastructure Law (BIL) for the advanced reactor demonstrations provided under the Office of Clean Energy Demonstrations.	**-80,000**
Demonstration 2:	
The decrease from $80,000,000 to $0 reflects multi-year funding provided by BIL for the advanced reactor demonstrations provided under the Office of Clean Energy Demonstrations.	**+100,238**
Risk Reduction for Future Demonstration:	
The increase from $40,000,000 to $140,238,000 reflects a ramp up in activities to maintain the project schedules and increased funding required to fully fund the third budget year of the projects.	**-4,750**
Regulatory Development:	
The decrease from $15,000,000 to $10,250,000 reflects associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line.	**-250**
Advanced Reactor Safeguards:	
The decrease from $5,000,000 to $4,750,000 reflects $250,000 associated funding for SBIR, STTR, TCF, and NEUP awards being consolidated within the new Directed R&D and University Programs line.	
Total, Advanced Reactor Demonstration Program	**-19,762**

National Reactor Innovation Center

Description

The National Reactor Innovation Center (NRIC) mission is to enable and accelerate the testing and demonstration of advanced reactors by utilizing the unique capabilities of U.S. national laboratories. NRIC provides private sector technology developers with access to the strategic infrastructure and assets of the national laboratories to enable physical validation of advanced nuclear reactor concepts, resolve technical uncertainties, and generate data relevant to safety, resilience, security, and functionality of advanced nuclear reactor concepts. NRIC works closely with R&D programs within the Office of Nuclear Energy to avoid duplication. NRIC does not conduct R&D; it facilitates information sharing and connectivity necessary to enable the demonstration of selected nuclear reactor designs.

The NRIC subprogram activities include interactions with reactor developers who are considering options for demonstrating their reactor technologies as well as investigation and development of national laboratory capabilities for hosting advanced reactor demonstrations. Subprogram activities also include completing design and pre-construction activities and supporting construction/refurbishment activities to enable the development of infrastructure for the testing and demonstration of multiple advanced reactor concepts. While NRIC is led by the Idaho National Laboratory (INL) with significant activities at the INL Site, resources at other national laboratories and potential nuclear reactor demonstration sites will play an important role in achieving NRIC's objectives.

NRIC is expected to help accelerate technology readiness from proof of concept through proof of operations. Key support to be provided by NRIC includes:

- Facilitating industry access to key resources, such as materials needed for nuclear reactor fuel, facilities for fabrication of fuel for demonstrations, test reactors such as the Advanced Test Reactor and Transient Reactor Test Facility at the INL and High Flux Isotope Reactor at the Oak Ridge National Laboratory, characterization capabilities such as INL's Irradiated Materials Characterization Laboratory, and access to advanced modeling and simulation codes and high performance computers through the INL Collaborative Computing Center;
- Providing access to national laboratory experts to support technology development;
- Developing complementary technologies, in conjunction with relevant Nuclear Energy R&D programs, such as application of digital engineering philosophies and development and proof of concept of advanced construction technologies, to reduce the cost and schedule risks associated with the deployment of advanced reactors;
- Assisting with National Environmental Policy Act (NEPA) evaluations, Nuclear Regulatory Commission (NRC) licensing, and DOE authorization related to nuclear facility operations;
- Developing a resource network of sites, facilities, and capabilities suitable for performing key R&D, experiments, tests, or fabrications, and for hosting advanced reactor demonstrations; and
- Identifying and facilitating resolution of experimental capability gaps which are vital to advanced reactor development and demonstration.

National Reactor Innovation Center

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
National Reactor Innovation Center $30,000,000	**$75,000,000**	**+$45,000,000**
• Initiated siting and regulatory preparation for advanced reactors and identified siting strategies that are scalable and incorporate environmental justice principles. • Established a formal agreement with the NRC to facilitate the sharing of technical expertise and knowledge on advanced nuclear reactor technologies and nuclear energy innovation, including reactor concept demonstrations. • Continued activities to reduce the regulatory risks and costs associated with advanced reactor demonstration, including development of a plant parameter envelope approach for advanced reactors. • Commenced design activities to inform future decisions about the implementation of demonstration test beds and ensured that project management best practices were applied to these activities. • Procured equipment and designed laboratory spaces to close vital experimental gaps. • Issued an award to support design, development, and testing of advanced construction technologies that may reduce the cost and schedule risk associated with construction of advanced reactors.	• Continue support for establishment of the Molten Salt Thermophysical Examination Capability (MSTEC) at INL to close a vital experimental gap for molten salt reactors (MSRs). • Complete Phase I of the ACT Initiative to enable development of advanced construction technologies that may reduce the cost and schedule risks associated with advanced reactor construction. • Initiate Phase II of the ACT Initiative to support proof of concept of advanced construction technologies. • Further engage with key stakeholders such as the NRC, advanced reactor developers, and potential end-users. • Continue evaluating capabilities and gaps and working with R&D programs to facilitate coordinated actions to address critical needs. • Complete construction of the Demonstration and Operation of Microreactor Experiments (DOME) test bed to enable development and demonstration of microreactor technologies. • Complete design of a Safeguards Category I test bed to support development and demonstration of experimental reactors utilizing Category I materials for operation. • Provide support to advanced reactor developers to enable successful execution of development and demonstration activities.	• The increase reflects a transition from design to refurbishment/construction activities to support the establishment of advanced reactor test beds as well as the transition from the development to demonstration phase of the ACT Initiative

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
	• Help make available infrastructure, materials, and expertise to support advanced reactor demonstration.	

Demonstration 1

Description

This subprogram focused efforts on the execution of one of two cost-shared projects for the eventual construction of an advanced reactor demonstration.
In FY 2020, DOE announced an award to X-energy to design, license, construct, and start up an advanced nuclear reactor that can be operational within seven years. The award is a cost-shared partnership that will deliver a first-of-a-kind advanced reactor to be licensed for commercial operations. X-energy will cover at least 50 percent the costs of this program.

The Bipartisan Infrastructure Law provides multi-year funding for the X-energy demonstration under the Office of Clean Energy Demonstrations. As such, no FY 2023 funding is requested for this effort within Nuclear Energy.

Demonstration 1

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Demonstration 1 $80,000,000	**$0**	**-80,000,000**

• DOE completed award negotiations and formalized cooperative agreements with X-energy.
• X-energy completed and submitted several early-stage project deliverables to DOE for milestones consistent with their project applications in areas such as:
  ○ Establishing project management structure and execution planning.
  ○ Development of licensing application documents and conducting pre-application engagement with the regulator.
  ○ Reactor systems design development.
  ○ Procurement planning.
  ○ Fuel fabrication facility design and licensing document development per 10 CFR Part 70.
  ○ Site selection and characterization activities.
• Continued to execute project scope for both Demonstration projects per established project plans using current and prior year carryover funds.
	• No funding is requested for the X-energy advanced reactor demonstration within Nuclear Energy.	• The decrease reflects the transfer of the X-energy advanced reactor demonstration to the Office of Clean Energy Demonstrations.

Demonstration 2

Description

This subprogram focused efforts on the execution of one of two cost-shared projects for the eventual construction of advanced reactor demonstrations. In FY 2020, DOE announced an award to TerraPower LLC to design, license, construct, and start up an advanced nuclear reactor that can be operational within seven years. The award is a cost-shared partnership that will deliver a first-of-a-kind advanced reactor to be licensed for commercial operations. TerraPower will cover at least 50 percent the costs of this program.

The Bipartisan Infrastructure Law provided multi-year funding for the TerraPower demonstration under the Office of Clean Energy Demonstrations. As such, no FY 2023 funding is requested for this effort within Nuclear Energy.

Demonstration 2

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Demonstration 1 $80,000,000	**$0**	**-$80,000,000**
• TerraPower completed and submitted mid-stage project deliverables to DOE for project milestones consistent with their project applications in areas such as: o Establishing project management structure and execution planning. o Development of licensing application documents and conducting pre-application engagement with the regulator. o Reactor systems design development. o Procurement planning. o Fuel fabrication facility design and licensing document development per 10 CFR Part 70. o Site selection and characterization activities. • Continue to execute project scope for both Demonstration projects per established project plans using current and prior year carryover funds.	• No funding is requested for the TerraPower advanced reactor demonstration within Nuclear Energy.	• The decrease reflects the transfer of the TerraPower advanced reactor demonstration to the Office of Clean Energy Demonstrations

Risk Reduction for Future Demonstrations

Description

The Risk Reduction for Future Demonstrations subprogram supports advanced reactor concepts with the potential for future demonstration through cost-shared (up to 80% government, not less than 20% industry) competitively awarded (through a financial assistance solicitation) projects that are designed to maximize the utility of the results across the nuclear energy industry. The projects are aimed at reducing risk and technical uncertainty for a broad range of advanced reactor designs. Project activities may include R&D to address technical challenges associated with development of technologies and methods to improve the timelines for advanced reactor deployments, the cost and schedule for delivery of nuclear products, services, and capabilities supporting these nuclear technologies, design and engineering processes, and resolution of certification challenges potentially impeding the introduction of these technologies into the marketplace. This subprogram coordinates closely with the Reactor Concepts Research, Development & Demonstration program and other relevant programs to avoid duplication, leverage existing expertise, and maximize synergies.

In FY 2021, DOE announced the selection of five projects to aid advanced reactor developers in resolving technical, operational, and regulatory challenges to enable potential future demonstration of a diverse set of advanced reactor designs. The Risk Reduction projects support the development of safe and affordable advanced reactor technologies that can be licensed and deployed over the next 10 to 13 years. Industry partners will provide at least 20 percent in matching funds for their cost share of the program.

The five projects are:

- Kairos Power, LLC (Alameda, CA) will work to design, construct, and operate its Hermes reduced-scale test reactor. Hermes is intended to lead to the development of Kairos Power's commercial-scale fluoride salt-cooled high temperature reactor (FHR), a novel advanced nuclear reactor technology that leverages TRI-structural ISOtropic particle fuel (TRISO) fuel in pebble form combined with a low-pressure fluoride salt coolant;
- Westinghouse Electric Company, LLC (Cranberry Township, PA) will advance the design of a heat pipe-cooled microreactor;
- BWXT Advanced Technologies, LLC (Lynchburg, VA) will mature a commercially viable transportable microreactor conceptual design focused on using TRISO fuel particles to achieve higher uranium loading and an improved core design using a silicon carbide (SiC) matrix;
- Holtec Government Services, LLC (Camden, NJ) will focus on early-stage design, engineering, and licensing activities to accelerate the development of its light water-cooled small modular reactor (SMR); and
- Southern Company Services Inc. (Birmingham, AL) will lead a project to design, construct, and operate the Molten Chloride Reactor Experiment (MCRE), a critical nuclear test bed supporting molten salt reactor systems and components demonstrations.

FY 2023 activities focus on continuing design activities; supporting further interactions with the NRC on high impact regulatory related topics; conducting activities to resolve technical, operational and regulatory challenges; and developing and executing plans for establishing infrastructure and support capabilities to enable execution of the Risk Reduction projects and future commercialization activities.

Risk Reduction for Future Demonstrations

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Risk Reduction for Future Demonstrations **$40,000,000**	**$140,238,000**	**+$100,238,000**
• Finalized Risk Reduction project selections through a competitive merit review process. • Finalized scope and milestones for Risk Reduction projects. • Initiated execution of project activities.	• Support execution of the Risk Reduction projects per established project plans and using current and prior year carryover funds. Specific project activities include: o For the Kairos project: Conduct activities to support the design, licensing, construction, and operation of an FHR test reactor. o For the Westinghouse project: Scale-up and enhance heat pipe manufacturing operations to enable design, procurement, and manufacturing of a microreactor demonstration unit. o For the BWXT project: Complete fabrication of TRISO fuel specimens to support irradiation testing in INL's Advanced Test Reactor (ATR). o For the Holtec project: Initiate long lead procurement activities by selecting the Control Rod Drive Mechanism subcontract supplier which will demonstrate the capability of the existing supply chain. o For the Southern Company Services project: Complete design of the fuel salt synthesis line and build and operate a non-nuclear mock-up of MCRE to de-risk fabrication of major	• The increase reflects a ramp up in activities to maintain the project schedules and increased funding required to fully fund the third budget year of the projects.

	components and operation of the fueled reactor experiment.

Regulatory Development

Description

The Regulatory Development subprogram coordinates with the Nuclear Regulatory Commission (NRC) and industry to address and resolve key regulatory framework issues that directly impact the "critical path" to advanced reactor demonstration and deployment. Part of the subprogram focuses on regulatory modernization activities such as developing adaptations of light water reactor (LWR)-based regulations for non-LWR advanced reactors, finalizing the establishment of risk-informed and performance-based license application guidance, and establishing clear expectations for license application content and review criteria. Other regulatory development activities include resolving the technical basis to support NRC endorsement of codes and standards important for the manufacture of advanced reactor components and expanding access to priority material property data to be used in safety codes and models in support of licensing. The Regulatory Development subprogram supports limited R&D aimed at producing broadly applicable results than can be used by an array of private sector companies to inform their regulatory requirements. Design-specific regulatory gaps for advanced reactors, including fast reactors, gas-cooled reactors, and molten salt reactors, are also addressed.

Regulatory Development

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Regulatory Development $15,000,000	**$10,250,000**	**-$4,750,000**
• Coordinated with industry and the NRC to identify technology gaps and high impact challenges regarding advanced reactor regulation. • Continued efforts to establish a risk-informed, advanced reactor regulatory framework. • Supported the development and submittal of an industry-driven proposal to NRC for risk-informed and "right-sized" license application content for advanced reactors to reduce regulatory uncertainty and support near-term demonstrations and deployments. • Performed a broad scope phenomena, identification, and ranking table (PIRT) exercise on liquid-fueled molten salt reactors (MSR) to identify key licensing and research and development (R&D) needs for demonstration and deployment. • Conducted experimental validation to provide reactor response data during normal and transient scenarios for high temperature reactors. • Through industry and NRC engagement, continued efforts to resolve remaining high impact NRC regulatory policy issues impacting advanced reactor licensing.	• Provide support for industry and NRC interactions that are establishing the advanced non-light water reactor regulatory framework. • Continue efforts to address unresolved and high impact NRC regulatory policy issues impacting advanced reactor licensing. • Develop the technical basis for material surveillance technologies to be used by owner/operators to implement a materials degradation management program for MSRs. • Utilize the Liquid Salt Test Loop (LSTL) at the Oak Ridge National Laboratory to test sensors and demonstrate tools in support of MSR development and deployment. • Maintain and develop the fast reactor database to archive historical data for fast reactor fuels and materials to preserve data, knowledge and experience. • Support fast reactor code validation and verification tasks and develop international benchmarks to verify and validate fast reactor design and safety analysis tools used by industry and NRC. • Continue development and testing to support inclusion of Alloy 709 (alloy with increased materials performance in high temperature advanced reactor operating environments) in the American Society of Mechanical Engineers (ASME) Code.	• The decrease reflects associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line.

Advanced Reactor Safeguards

Description

The Advanced Reactor Safeguards (ARS) subprogram evaluates safeguards and security issues unique to advanced reactor designs and informs and improves advanced reactor designs by addressing issues such as diversion of advanced fuel forms, protection of remotely operated plants, and other proliferation and security concerns. Broadly, the ARS subprogram also helps to reduce security costs by utilizing the latest technologies and approaches for plant monitoring and protection.

The ARS subprogram focuses on five major elements: physical protection systems, pebble bed reactor material control and accountability (MC&A), microreactor physical protection systems and MC&A, liquid fueled reactor MC&A, and international cooperation.

- Physical Protection Systems (PPS) – targets issues such as reducing number of on-site responders and upfront costs and evaluating enhanced safety systems and unique sabotage targets.

- Pebble bed reactor MC&A – focuses on evaluating the regulatory approach and determining the driving requirements, as well as evaluating new monitoring technologies.

- Microreactor PPS and MC&A – works on developing a licensing framework, developing approaches appropriate to the very small scale, and evaluating new monitoring technologies.

- Liquid fueled MC&A – targets evaluating regulatory approach, developing baseline accountancy approaches, and evaluating new measurement and monitoring technologies.

- International Cooperation – focuses on considering and incorporating international safeguards requirements, interfacing with international safeguards and security programs, and supporting the Gen-IV Proliferation Resistance & Physical Protection (PR&PP) Working Group.

The ARS subprogram also coordinates with the Nuclear Regulatory Commission (NRC), the Department of Energy's National Nuclear Security Administration (NNSA), and the nuclear industry to avoid duplication of activity and leverage nationwide expertise. Together, these safeguards activities help further advanced reactors development and deployment.

Advanced Reactor Safeguards

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Change FY 2023 Request vs FY 2021 Enacted
Advanced Reactor Safeguards $5,000,000	**$4,750,000**	**-$250,000**
• Executed FY 2021 activities identified during Advanced Reactor Safeguards development planning and subprogram execution initiated during FY 2020. • Provided physical protection system design alternatives that significantly reduces cost or need for on-site responders for advanced reactors. • Provided recommendations to advanced reactor vendors on material control and accountancy approaches. • Designed, analyzed, and proved plant protection system generic design alternatives that significantly reduce or eliminate the need for on-site responders.	• Refine and expand physical protection design alternatives for a diverse set of advanced reactors, to support cost effective, market competitive designs • Develop pebble bed burnup measurement strategy and experimental plan to assist pebble bed reactor vendors to meet key monitoring and accountancy requirements. • Engage with advanced reactor vendors, in coordination with NNSA, to advance both domestic and international safeguards and security by design.	• The decrease reflects associated funding for Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), Technology Commercialization Fund (TCF), and Nuclear Energy University Program (NEUP) awards being consolidated within the new Directed R&D and University Programs line

Versatile Test Reactor Project

Overview

The Versatile Test Reactor (VTR) supports advancements in nuclear energy, particularly in the testing of advanced fuels, materials, and instruments and sensors in extreme environments necessary for the advanced reactor community in the U.S. to tackle the climate crisis. The VTR would help the U.S. to regain and strengthen its global technical leadership role in the development of the next generation of advanced reactors.

The Department has prepared a Final Environmental Impact Statement in accordance with National Environmental Policy Act requirements to ensure that all environmental factors are considered before the Department makes a final decision to move forward with the project.

The VTR will leverage synergies from TerraPower's Natrium project, a sodium-cooled fast reactor demonstration project selected under the Advanced Reactor Demonstration Program (ARDP), by taking advantage of design commonalities, component development and testing, supply chain development, and construction activities. This will allow optimized use of human resources/expertise and testing facilities, reduction in the overall development and testing costs for components that have similar features, and reduction in cost and schedule risk and uncertainty. To that effect a memorandum of understanding was signed with the Natrium team establishing a private public partnership encouraged by Congress.

Highlights of the FY 2023 Budget Request

In FY 2023, activities will focus on component risk reduction activities, including prototyping and testing, nuclear fuel feedstock sourcing and fabrication studies and experimental capabilities development and conceptual design optimization studies. FY 2023 activities will be prioritized and coordinated with TerraPower's Natrium project.

Versatile Test Reactor Project
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 request vs FY 2021 Enacted (%)
Versatile Test Reactor Project					
Versatile Test Reactor – Other Project Costs	43,000	43,000	45,000	+2,000	+5%
21-E-200 VTR Project	2,000	2,000	0	-2,000	-100%
Total, Versatile Test Reactor Project	**45,000**	**45,000**	**45,000**	**0**	**0%**

Versatile Test Reactor Project
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Versatile Test Reactor – Other Project Costs:	
The increase reflects focus on risk reduction studies and coordination with TerraPower's Natrium project.	**+2,000**
21-E-200 VTR Project	
The decrease from reflects deferral of construction line item activities and coordination with TerraPower's Natrium project.	**-2,000**
Total, Versatile Test Reactor Project	**0**

Versatile Test Reactor – Other Project Costs

Description

In February 2019, the Versatile Test Reactor (VTR) Project was formally initiated with Critical Decision (CD)-0, Approve Mission Need, in accordance with Department of Energy Order 413.3B requirements. CD-1, Approve Alternative Selection and Cost Range, was approved on September 11, 2020. The Department will make a final decision on the design, technology selection and location for VTR following the completion of the VTR Environmental Impact Statement and issuance of a Record of Decision.

This budget line, Versatile Test Reactor – Other Project Costs (VTROPC), will be used to fund VTR costs that are not included in the Versatile Test Reactor - Design and Construction (VTRDC), such as supporting research and development, pre-authorization costs prior to start of preliminary design, plant support costs during design, construction, activation, and startup. VTROPC will also include funding of those activities necessary to comply with National Environmental Policy Act requirements. Specific activities to be accomplished in FY 2023 are in the Activities and Explanation of Changes section.

Versatile Test Reactor – Other Project Costs
Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Versatile Test Reactor – Operating $43,000,000	**$45,000,000**	**+$2,000,000**
• Manage VTR Project in accordance with Department of Energy Order 413.3B. • Continue to mature cost estimate. • Initiate assembly of Driver Fuel Subassembly, using fuel simulants. • Plan heavy metal shipments to support feedstock preparation for first driver fuel core. • Initiate fabrication of first Experiment Cartridge prototype.	• Manage VTR Project in accordance with Department of Energy Order 413.3B. • Identify potential coordination opportunities with TerraPower's Natrium project. • Perform fuel feedstock supply studies with National Nuclear Security Administration (NNSA). • Perform risk reduction studies.	• Reflects an increased focus on risk reduction.

21-E-200 VTR Project

Description

In February 2019, the Versatile Test Reactor (VTR) Project was formally initiated with Critical Decision (CD)-0, Approve Mission Need, in accordance with Department of Energy Order 413.3B requirements. CD-1, Approve Alternative Selection and Cost Range, was approved on September 11, 2020. CD-1 approved the selection of a sodium-cooled fast spectrum test reactor with an estimated cost range of $2.6 to $5.8 billion. The Department will make a final decision on the design, technology selection and location for VTR following the completion of the VTR Environmental Impact Statement and issuance of a Record of Decision.

This budget line, Versatile Test Reactor – Design and Construction (VTRDC), will be used to fund VTR costs that are not included in the Versatile Test Reactor – Other Project Costs, such as all engineering design costs (preliminary and final design), facility construction costs, and other costs specifically related to those construction and the procurement of VTR components and hardware. As a part of the project's overall risk reduction efforts, digital requirements management and digital design control techniques will be utilized to maximize design process efficiency and to help achieve the goal of finalizing the design prior to the start of construction. VTR will also include funding of project and construction management during preliminary and final design and construction, and funds to provide for contingency and economic escalation.

Versatile Test Reactor – Design and Construction

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
21-E-200 VTR Project $2,000,000	**$0**	**-$2,000,000**
• Manage VTR Project in accordance with Department of Energy Order 413.3B. • Continue preliminary design and expand to all mechanical, electrical, instrumentation and controls, and civil and structural disciplines. • Initiate prototype & testing for key equipment. • Initiate all design documentation.	• No activities are planned in FY 2023.	• The decrease reflects deferral of line item construction activities.

Infrastructure

Overview

Infrastructure consists of the Idaho National Laboratory (INL) Facilities Operations and Maintenance (IFM), Oak Ridge National Laboratory (ORNL) Nuclear Facilities Operations & Maintenance (O&M), and Construction subprograms.

The mission of the IFM subprogram is to manage the planning, acquisition, operation, maintenance, and disposition of the Office of Nuclear Energy (NE) owned multi-program nuclear facilities and capabilities along with the supporting infrastructure at INL. The IFM subprogram maintains Department of Energy (DOE) mission-supporting facilities and capabilities at the INL in a safe, and compliant status (with DOE Orders, federal laws and regulations, and state agreements) to enable technological advancement in the existing nuclear fleet, advanced reactor pipeline, and fuel cycle mission. The availability of these key facilities and capabilities to support NE research and development (R&D) is critical to the ongoing effort to revitalize nuclear energy in the U.S. INL facilities and capabilities also support testing of naval reactor fuels, reactor core components and a diverse range of national security technology programs for the National Nuclear Security Administration (NNSA) and other federal agencies in the area of critical infrastructure protection, nuclear nonproliferation, and incident response. The IFM subprogram integrates and closely coordinates with research programs to ensure proper alignment and prioritization of infrastructure investments, as well as availability of infrastructure for programmatic work.

The Construction subprogram plays a critical role in revitalizing the NE infrastructure. The subprogram focuses on addressing identified gaps created by either deteriorating critical infrastructure or evolving NE missions.

Highlights of the FY 2023 Budget Request

The Research Reactor Infrastructure subprogram, which provides fuel services for university research reactors, is consolidated with other university support activities under the new Directed R&D and University Programs, renamed as "University Fuel Services". As such, no funding is requested for RRI within the Infrastructure program in FY 2023.

The focus of IFM subprogram remains on the safe and compliant operation of the INL's nuclear research reactors and non-reactor nuclear and radiological research facilities while continuing to realize improvements in the condition of aging INL infrastructure. In FY 2023, the increase in IFM subprogram budget funds:

- Reliability improvements to keep facilities at INL operational to support NE's research and advanced fuel development missions. This includes infrastructure investments in the Advanced Test Reactor (ATR) Complex and Materials and Fuels Complex (MFC). Funding will also support initiating major system replacements to operate ATR through 2040 and initiating evaluation of long-term thermal neutron irradiation needs.
- Increased labor costs tied to negotiated wage agreements at the ATR Complex and MFC.
- Environmental review and data collection activities to support future permits and NEPA documentation.
- Initial transition of the Sample Preparation Laboratory (SPL) to operations.

In FY 2023, ORNL Nuclear Facilities O&M is fully funded through associated program budgets.

In FY 2023, the Construction subprogram funds the SPL Project consistent with the approved project baseline. FY 2023 is the final funding year for construction activities, including installation of scientific equipment, hot cell interior and experiment spaces, manipulator repair space, glove box and other service areas.

Infrastructure
Funding ($K) (Non-Comparable)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Infrastructure					
INL Facilities Operations and Maintenance[1]	280,000	280,000	326,924	+46,924	+16.8%
ORNL Nuclear Facilities O&M	20,000	20,000	0	-20,000	-100%
Research Reactor Infrastructure[2]	11,500	11,500	0	-11,500	-100%
Construction: Sample Preparation Laboratory	26,000	26,000	7,300	-18,700	-71.9%
Total, Infrastructure	**337,500**	**337,500**	**334,224**	**-3,276**	**-1.0%**

Infrastructure
Funding ($K) (Comparable)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Infrastructure					
INL Facilities Operations and Maintenance[3]	280,000	280,000	326,924	+46,924	+16.8%
ORNL Nuclear Facilities O&M	20,000	20,000	0	-20,000	-100%
Construction: Sample Preparation Laboratory	26,000	26,000	7,300	-18,700	-71.9%
Total, Infrastructure	**326,000**	**326,000**	**334,224**	**+8,224**	**+2.5%**

[1] Funding does not reflect the transfer of approximately $91M in FY 2021 from Naval Reactors for maintenance and operation of the Advanced Test Reactor.
[2] In FY 2023, the Research Reactor Infrastructure subprogram is consolidated with other university support activities under the new Directed R&D and University Programs.
[3] Funding does not reflect the transfer of approximately $91M in FY 2021 from Naval Reactors for maintenance and operation of the Advanced Test Reactor.

Infrastructure
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
INL Facilities Operations and Maintenance:	
The increase from $280,000,000 to $326,924,000 fully funds the ongoing efforts to improve the reliability and availability of the Advanced Test Reactor (ATR) and key Materials and Fuels Complex (MFC) nuclear facilities through risk-informed investments in equipment and infrastructure, planned major maintenance and repair activities at the ATR, such as heat exchanger replacement; evaluation of long-term thermal neutron irradiation capability needs; support for increased labor costs tied to negotiated wage agreements; and initial transition to operations of the Sample Preparation Laboratory (SPL) project.	**+46,924**
ORNL Nuclear Facilities O&M:	
The decrease from $20,000,000 to $0 reflects completion of congressionally directed activities. In fiscal year 2023, the Office of Nuclear Energy use of these ORNL facilities is fully funded through associated program budgets.	**-20,000**
Research Reactor Infrastructure:	
The decrease from $11,500,000 to $0 reflects the transfer of fuel services previously funded under Research Reactor Infrastructure including additional TRIGA fresh fuel orders to ensure a maximum number of fuel elements per year can be purchased to minimize overall cost.	**-11,500**
Construction:	
The decrease from $26,000,000 to $7,300,000 reflects the final year of Sample Preparation Laboratory (SPL) project construction funding consistent with approved baselines. The Budget Request provides for the completion of the construction and installation of scientific equipment including interior of hot cell and experiment spaces, manipulator repair space, glove box and other service areas.	**-18,700**
Total, Infrastructure	**-3,276**

INL Facilities Operations and Maintenance

Description

INL Nuclear Research Reactor Operations and Maintenance

This subcategory supports nuclear research reactor operations and maintenance at the Advanced Test Reactor (ATR) Complex and the Materials and Fuels Complex (MFC) for the Idaho National Laboratory (INL), including the ATR, the ATR Critical Facility (ATRC), the Transient Reactor Test Facility (TREAT), and the Neutron Radiography Reactor (NRAD).

The ATR is the primary research reactor at the INL. The ATR supports the majority of the Office of Nuclear Energy (NE) research and development (R&D) programs, as well as Naval Reactors (NR) Program in support of the U.S. Navy nuclear fleet and National Nuclear Security Administration (NNSA) programs. The ATR is also used by universities, laboratories, and industry, and is the primary scientific capability of the Nuclear Science User Facilities (NSUF). R&D demand for thermal neutron irradiation at ATRC and neutron radiography and small component test irradiation at NRAD continues to be significant. The TREAT reactor, an air-cooled thermal spectrum test facility, continues to address technical challenges for reactor fuels related to nuclear-fuel performance and qualification. All programmatic work is funded by the sponsoring federal programs. The cost to other users is determined in accordance with DOE regulations and depends upon the demands on the reactor and the nature of the user.

To satisfy the irradiation needs of ATR users, efforts will continue in FY 2023 to improve the availability and reliability of the ATR. FY 2023 will be the first full year of ATR operations following the successful completion of the ATR Core Internals Change-out (CIC). The CIC was a major outage to replace all the components within the Beryllium reflector region of the core. These major outages occur every 10 to 20 years, based on the power history of the reactor. Continued investments in ATR infrastructure are still needed to sustain the improvements that have been made to date. Funding is identified in FY 2023 to begin planning for major maintenance and repair activities required to sustain ATR operations through 2040 such as the replacement of the primary heat exchangers. Additionally, work is planned in FY 2023 to evaluate the long-term capability needs for continued thermal neutron irradiation testing.

Operations at TREAT and NRAD will continue in FY 2023 to support a wide range of customers including NE R&D programs, commercial industry, and other Federal Agencies.

INL Non-Reactor Nuclear Research Facility Operations and Maintenance

This subcategory provides funding for operations, maintenance, and support for non-reactor nuclear and radiological research facilities primarily located at the Materials and Fuels Complex (MFC). Activities within this category support sustainment of unique nuclear and radiological capabilities that are required to support essential R&D programs of NE. This includes maintaining a safe operating envelope by conducting maintenance (preventative and corrective) and refurbishments to sustain or improve core infrastructure capabilities. The non-reactor nuclear research facilities support core programmatic research capabilities including:

- Post-Irradiation Examination (PIE) and Fresh Fuel Characterization – Receipt of irradiated fuels and materials, non-destructive examinations, destructive examinations and analyses, and mechanical testing of highly radioactive materials.
- Experimental Fuel Fabrication – R&D on multiple fuel types and hazard levels.
- Advanced Separation and Waste Forms – Separation and pre-treatment technology development and electrochemical separation and waste form development (engineering scale).

To enable R&D activities at the MFC, efforts will continue in FY 2023 to ensure facility availability and equipment reliability is as high as feasible. In FY 2021, cumulative facility availability for MFC was 90%. In FY 2023, MFC Plant Health investments will continue to focus on improving throughput in MFC mission facilities, such as hot cell window and manipulator replacements at Hot Fuels Examination Facility (HFEF), Fuel Conditioning Facility (FCF), and Analytical Laboratory (AL); roof repairs and lab space renovations; and control systems replacements at FCF.

This subprogram also provides funding for the management of NE-owned special nuclear material (SNM), operation and maintenance of the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility and the Radioactive Waste Scrap Facility (RSWF), support for Nuclear Regulatory Commission cask certifications and Other Project Costs (OPCs) for the Sample Preparation Laboratory (SPL) Project.

In FY 2023, funds are also provided to initiate activities needed to transition SPL to operations, including development of procedures for operational readiness, updates of nuclear safety basis documentation, and development of procedures for system operability testing.

INL Engineering and Support Facility Operations and Maintenance

This subcategory provides funds for the community and technical support activities including support for the Shoshone-Bannock Tribes, Idaho Department of Environment Quality, and environmental reviews and data collection to support future permits and NEPA reviews. It also supports environmental surveillance and monitoring activities in accordance with State and Federal regulations. This subcategory also funds Payment in Lieu of Taxes (PILT), Institute of Nuclear Power Operations, and other Departmental cross-cutting infrastructure reporting requirements.

DOE has had a formal relationship via an Agreement in Principle with the Shoshone-Bannock Tribes since 1992 in recognition of the Tribes' connection and vested interest in the land upon which INL is located. Support is provided to the Tribes to participate in the review of Environmental Impact Statement and Environmental Assessments, cultural resource surveys and protection, environmental surveillance, and emergency response and preparedness.

INL Regulatory Compliance

This subcategory supports activities for continual compliance with the State and Federal environmental laws and other regulations that are under the purview of the Office of Nuclear Energy (NE). Compliance activities focus on air, soil, and water monitoring and waste disposal consistent with Federal and State permit requirements and agreements such as the INL Site Treatment Plan. Regulatory activities also include efforts that support compliance with the 1995 Settlement Agreement with the State of Idaho, which governs management and disposition of spent nuclear fuel and transuranic wastes at the INL. In November 2019, DOE and the State of Idaho signed a Supplemental Agreement to the 1995 Idaho Settlement Agreement that reaffirms DOE's and Idaho's commitment to remove Cold War legacy waste and special nuclear materials from Idaho. In FY 2023, funds are provided to support material stabilization and legacy material packaging consistent with approved plans and negotiated labor wage agreements.

INL Facilities Operations and Maintenance
Funding ($K)

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
INL Nuclear Research Reactor Operations and Maintenance $116,900,000	**$130,537,000**	**+$13,637,000**
• Maintained Advanced Test Reactor (ATR) availability greater than 80% prior to beginning the core internals change-out (CIC). • Continued investments to improve ATR availability and reliability through refurbishments and replacements of reactor systems and components such as loop refurbishment, cold waste control system refurbishment, and console display system annunciator upgrades. • Initiated the ATR CIC to replace major internal components including Beryllium reflectors. • Completed ATR reactor inspections including the reactor vessel weld and tank chain. • Continued transient testing operations at the TREAT facility. • Continued operations of the NRAD.	• Maintain ATR availability greater than 80% with a target of 161 irradiation days in the first full year of operations following completion of the CIC in FY 2022. • Continue investments to improve ATR availability and reliability through refurbishments and replacements of reactor systems and components such as warm waste pond liner replacement, canal bulkhead replacements, and regulating rod control system upgrades. • Initiate planning for major maintenance and repair activities required to sustain ATR operations through 2040 such as replacement of the primary heat exchangers. • Continue to transfer ATR spent fuel into dry storage configuration consistent with State agreements. • Evaluate long-term capability needs for continued thermal neutron irradiation testing. • Continue transient testing operations at the TREAT facility. • Continue operations of the NRAD.	• The increase supports ongoing efforts to improve the reliability and availability of the ATR, initial planning efforts for the major maintenance and repair activities required to sustain ATR operations through 2040, and evaluation of long-term capability needs for continued thermal neutron irradiation testing.
INL Non-Reactor Nuclear Research Facility Operations and Maintenance $145,845,000	**$175,649,000**	**+$29,804,000**
• Operated and maintained the Materials and Fuels Complex (MFC) infrastructure, facilities, and equipment to support facility operations and programmatic work activities. • Performed maintenance and refurbishment activities within the MFC nuclear facilities and	• Operate and maintain MFC infrastructure, facilities, and equipment to support facility operations and programmatic work activities. • Perform maintenance and refurbishment activities within the MFC nuclear facilities and	• The increase supports full funding to initiate transition to operations for the Sample Preparation Laboratory; and improving reliability and availability of key MFC nuclear facilities through a risk-based prioritization of

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
infrastructure consistent with the approved safety basis. • Performed maintenance and refurbishment on the radiological and balance-of-plant facilities necessary to support the MFC nuclear facilities and core missions. • Continued off-site disposition of surplus NE-owned Special Nuclear Materials (SNM) consistent with programmatic needs and approved nuclear material allotment forecasts. • Operated and maintained the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility to provide legacy and newly - generated waste disposal capability. • Conducted construction oversight activities for the Sample Preparation Laboratory (SPL) Project. • Continued MFC infrastructure investments, such as hot cell window and manipulator replacements, criticality alarm replacements, and laboratory refurbishments.	infrastructure consistent with the approved safety basis. • Perform maintenance and refurbishment on the radiological and balance-of-plant facilities necessary to support the MFC nuclear facilities and core missions. • Continue off-site disposition of surplus NE-owned SNM consistent with programmatic needs and approved nuclear material allotment forecasts. • Operate and maintain the RHLLW Disposal Facility to provide legacy and newly - generated waste disposal capability. • Conduct construction oversight activities for the SPL Project. • Continue to support activities to maintain INL operations such as NRC certificates for cask. • Continue MFC infrastructure investments to improve reliability and availability of key facilities, such as hot cell window and manipulator replacements at HFEF, FCF, and AL; roof repairs and lab space renovations; and replace control systems at FCF. • Initiate transition to operations for SPL including procedures development, updating nuclear safety documentation and system operability testing.	plant and equipment investments, such as replacement of manipulators and windows at HFEF, FCF, and AL, replacement of hot cell HEPA filters and chiller at HFEF, and replacement of HVAC throughout MFC.
INL Engineering and Support Facility Operations and Maintenance $7,580,000	**$5,424,000**	**-$2,156,000**
• Continued to support Federally funded activities to maintain operations at the Idaho National Laboratory (INL) such as Nuclear Regulatory Commission (NRC) certificates for casks, Payment-in-Lieu of Taxes (PILT), and environmental monitoring to support State requirements.	• Continue to support federally funded activities to maintain operations at the INL such as PILT; environmental review and data collection to support future permits/NEPA assessments; and community support activities for local Shoshone-Bannock Tribes including review of Environmental Impact Statement and Environmental Assessments, cultural resource surveys and	• The decrease reflects transition of environmental surveillance activities from federal contracts to Idaho National Laboratory under INL Regulatory Compliance.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
	protection, environmental surveillance, and emergency response and preparedness.	
INL Regulatory Compliance $9,675,000	**$15,314,000**	**+$5,639,000**
• Continued regulatory compliance program management. • Met INL Site Treatment Plan milestones for treatment of two cubic meters of mixed low-level waste (MLLW) annually based on a three-year rolling average. • Completed a minimum of 10 transfers of used nuclear fuel from wet storage in accordance with the 1995 Idaho Settlement Agreement and consistent with material requirements for the treatment of Experimental Breeder Reactor (EBR)-II used nuclear fuel.	• Continue regulatory compliance program management. • Meet INL Site Treatment Plan milestones for treatment of two cubic meters of MLLW annually based on a three-year rolling average. • Complete receipt of minimum of 12 transfers of used nuclear fuel from wet storage at FCF in accordance with the 1995 Idaho Settlement Agreement and consistent with material requirements for the treatment of EBR-II used nuclear fuel. • Process a minimum of 8 treatment batches of EBR-II fuel through FCF pyro-processing. • Continue to coordinate activities and operations for the direct shipment of EBR-II fuel from the Idaho Nuclear Technology and Engineering Center to the Materials and Fuels Complex. • Conduct environmental surveillance and monitoring activities.	• The increase reflects labor wage agreements; activities associated with environmental surveillance and monitoring in accordance with State and Federal regulations; and increased support for activities associated with meeting the schedules and milestones under the Idaho Settlement Agreement.

ORNL Nuclear Facilities O&M

Description

Consistent with congressional direction, this program provided funds in FY 2021 to support Oak Ridge National Laboratory (ORNL) hot cells. In FY 2023, the Office of Nuclear Energy use of these ORNL facilities is fully funded through associated program budgets.

ORNL Nuclear Facilities O&M
Funding ($K)

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Oak Ridge Nuclear Infrastructure $20,000,000	**$0**	**-$20,000,000**
Congressionally directed activities conducted included: • maintenance and end-of-life replacement of critical hot cell equipment and infrastructure such as ventilation system monitoring equipment, manipulator repairs, installation of hot cell window and liquid waste tanks. • updated facility safety basis documentation and performed nuclear criticality safety analyses.	• No funding is requested.	• Funding is allocated through facility use charges applied to NE R&D programs utilizing ORNL hot cell capabilities.

Research Reactor Infrastructure

Description

Research Reactor Infrastructure provides fuel services for U.S. university research reactors. These activities are now funded within the University Fuel Services subprogram under Directed R&D and University Programs.

Research Reactor Infrastructure

Funding ($K)

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Research Reactor Infrastructure $11,500,000	**$0**	**-$11,500,000**
• Procured 40 and delivered 33 plate fuel elements required annually by MURR and MIT as determined by need and fuel availability. • Established the contract for the procurement of TRIGA fuel elements from the TRIGA Fuel Fabrication Facility (TFFF) in Romans, France upon resumption of operations. Due to COVID, there were delays in completing upgrades to the TFFF, gathering documentation from vendors to support the French regulator review, and significant increased time for the French regulator to complete their review. Therefore, fuel procurement will start in early FY 2022. • Procured and shipped HALEU metal to the TFFF in Romans, France, to support procurement of TRIGA fuel elements, and ship fuel elements to TRIGA reactor facilities as determined by need and fuel availability. • Completed four used fuel shipments to SRS and the INL, pending resolution of moratorium on such shipments to the INL. • Continued RRI project management, quality assurance, nuclear material accountability, and transportation cask maintenance.	• Funding is requested under University Fuel Services under Directed R&D and University Programs.	• The decrease reflects the transfer of fuel services previously funded under Research Reactor Infrastructure including additional TRIGA fresh fuel orders to ensure a maximum number of fuel elements per year can be purchased to minimize overall cost.

Construction

Description

Line-item capital projects are sometimes required at the Idaho National Laboratory (INL) to maintain its ability to support mission goals. These projects help achieve the Department's and the Office of Nuclear Energy's (NE) strategic objectives by maintaining site services and providing critical information for future decisions. This activity is focused on two primary objectives: (1) identification, planning, and prioritization of projects required to meet NE program objectives, and (2) development and execution of these projects within approved cost and schedule baselines as such projects are deemed necessary. While the Department's acquisition management process does not guarantee that a project will be completed once the initial information gathering and preliminary design phase are complete, it does provide an important decision-making framework that, when well executed, allows only the most critically necessary, cost-effective projects to proceed to construction.

The Sample Preparation Laboratory (SPL) project is a line-item capital project that will provide the capability for sample preparation to support micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. This capability will augment non-destructive examination, elemental analysis, and radiological capabilities already present or being developed at INL. The SPL will, when coupled with existing facilities and recapitalization efforts, fulfill near-term capabilities for conducting the advanced post-irradiation examination needed to improve understanding of nuclear fuels and material performance at the micro-, nano-, and atomic scales.

The most recent SPL Department of Energy Order (DOE O) 413.3B Critical Decision (CD), CD-1R/2/3 (Reaffirm Alternative Selection Process, Approve Performance Baseline, and Approve Start of Construction), was approved on January 31, 2020, with a Total Project Cost (TPC) of $166,000,000 and CD-4, Approve Project Completion, in FY 2027.

The FY 2023 Budget Request for the SPL project is $7,3000,000 to complete construction activities including installation of scientific equipment including hot cell and experiment spaces.

Construction
Funding ($K)

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Construction $26,000,000	**$7,300,000**	**-$18,700,000**
Sample Preparation Laboratory (16-E-200) ($26,000,000) • Continued SPL construction activities including equipment and hardware procurement; hot cell liner fabrication; concrete stair and elevator core construction; concrete shear wall construction; and hot cell window delivery.	*Sample Preparation Laboratory (16-E-200) ($7,300,000)* • Continue SPL construction activities consistent with approved baseline. The Budget Request reflects completion of the construction and installation of scientific equipment including interior of hot cell and experiment spaces, manipulator repair space, glove box and other service areas.	*Sample Preparation Laboratory (16-E-200) (-$18,700,000)* • The decrease reflects meeting established baseline funding requirements.

Infrastructure
Construction Projects Summary ($K)

	Total	Prior Years	FY 2021 Enacted	FY 2021 Actuals	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted
16-E-200, Sample Preparation Laboratory, INL							
Total Estimated Cost (TEC)	144,600	69,450	26,000	26,000	26,000	7,300	-18,700
Other Project Costs (OPC)	21,400	4,647	500	500	2,500	0	-500
Total Project Cost (TPC) Project Number 16-E-200	**166,000**	**74,097**	**26,500**	**26,500**	**28,500**	**7,300**	**-19,200**
Total All Construction Projects							
Total Estimated Cost (TEC)	144,600	69,450	26,000	26,000	26,000	7,300	-18,700
Total Other Project Costs (OPC)	21,400	4,647	500	500	2,500	0	-500
Total Project Cost (TPC) All Construction Projects	**166,000**	**74,097**	**26,500**	**26,500**	**28,500**	**7,300**	**-19,200**

16-E-200, Sample Preparation Laboratory
Idaho National Laboratory
Project is for Design and Construction

1. Summary, Significant Changes, and Schedule and Cost History

Summary

The FY 2023 Budget Request for the Sample Preparation Laboratory (SPL) project is $7,300,000. The most recent Department of Energy (DOE) Order 413.3 B Critical Decision (CD), CD-1R/2/3 (Reaffirm Alternative Selection Process, Approve Performance Baseline, and Approve Start of Construction), was approved on January 31, 2020, with a Total Project Cost (TPC) of $166,000,000 and CD-4, Approve Project Completion, in FY 2027.

FY 2021 and FY 2022 funding supported facility construction, which was initiated in FY 2020. Construction activities conducted include but were not limited to: completion of facility footings and slab; erection of stair and elevator cores; erection of structural steel; initiation of precast concrete exterior panels; subcontractor procurement of mechanical, plumbing, and electrical components; and initial fabrication of hot cell liners.

Capital funding requested in FY 2023 supports completion of project construction activities including completion of major building system installations, such as HVAC, hot cell, gloveboxes, and facility cranes. FY 2023 funding will also support receipt and installation of scientific facility equipment including X-ray Photoelectron Instrument, Focused Ion Beam, dual arm Robot for Mechanical Properties Test Cell, and digital microscopes.

Construction on the project began at the beginning of the COVID-19 pandemic, however, to this point, there have been no significant impacts to the cost or schedule baseline.

A Level II Federal Project Director (FPD) has been assigned to this project, and their Level III certification is in progress.

Significant Changes

The SPL project was initiated in FY 2011. The most recent DOE Order 413.3B approved Critical Decision CD-1R/2/3 was approved on January 31, 2020. This CD approval certified the continued need for the project despite escalating construction costs, approved the increase in TPC based on the actual construction bid for the project, and was agreed on by the Independent Cost Estimate. This Construction Project Data Sheet (CPDS) is an update of the FY 2022 CPDS and does not include a new start for FY 2023.

Critical Milestone History

(Fiscal Quarter or Date)

Fiscal Year	CD-0	Conceptual Design Complete	CD-1	Final Design Complete	CD-1R/2/3	D&D Complete	CD-4
FY 2016	1/31/2011	4Q FY2014	3Q FY2015	TBD	TBD	TBD	TBD
FY 2017	6/18/2015	1Q FY2016	1Q FY2016	TBD	TBD	N/A	TBD
FY 2018	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD
FY 2019	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD
FY 2020	6/18/2015	8/31/2016	9/30/2016	TBD	TBD	N/A	TBD
FY 2021	6/18/2015	8/31/2016	9/30/2016	10/24/2018	1/31/2020	N/A	1QFY2027
FY 2022	6/18/2015	8/31/2016	9/30/2016	10/24/2018	1/31/2020	N/A	1QFY2027
FY 2023	6/18/2015	8/31/2016	9/30/2016	10/24/2018	1/31/2020	N/A	1QFY2027

CD-0 – Approve Mission Need for a construction project with a conceptual scope and cost range
Conceptual Design Complete – Actual date the conceptual design was completed (if applicable)
CD-1 – Approve Alternative Selection and Cost Range
Final Design Complete – Estimated/Actual date the project design will be/was complete (d)
CD-1R/2/3 – Reaffirm Alternative Selection Process, Approve Performance Baseline, and Approve Start of Construction

D&D Complete – Completion of D&D work
CD-4 – Approve Start of Operations or Project Closeout

Fiscal Year	Performance Baseline Validation	CD-3A	CD-3B
FY 2016	N/A	N/A	N/A
FY 2017	N/A	N/A	N/A
FY 2018	N/A	N/A	N/A
FY 2019	N/A	N/A	N/A
FY 2020	N/A	N/A	N/A
FY 2021	1/31/2020	N/A	N/A
FY 2022	1/31/2020	N/A	N/A
FY 2023	1/31/2020	N/A	N/A

CD-3A – Approve Long-Lead Procurements, Original Scope
CD-3B – Approve Long-Lead Procurements, Revised Scope

Project Cost History

(dollars in thousands)

Fiscal Year	TEC, Design	TEC, Construction	TEC, Total	OPC, Except D&D	OPC, Total	TPC
FY 2016	10,000	68,000	78,000	17,000	17,000	95,000
FY 2017	10,000	73,000	83,000	12,000	12,000	95,000
FY 2018	13,385	72,615	86,000	12,200	12,200	98,200
FY 2019	13,385	72,615	86,000	12,200	12,200	98,200
FY 2020	13,385	72,615	86,000	12,200	12,200	98,200
FY 2021	9,998	134,602	144,600	21,400	21,400	166,000
FY 2022	9,998	134,602	144,600	21,400	21,400	166,000
FY 2023	9,998	134,602	144,600	21,400	21,400	166,000

2. Project Scope and Justification

Scope

The Sample Preparation Laboratory (SPL) will receive irradiated materials and prepare samples for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. The improved sample preparation and analytical capabilities provided by SPL will enhance non-destructive examination, elemental, and radiological capabilities already present at the Materials and Fuels Complex (MFC).

SPL will provide the required capabilities to allow high hazard materials to be routinely prepared and tested in a safe, secure, and environmentally controlled environment. To meet this objective, SPL was designed and will be constructed to include the following specific capabilities and characteristics:

- The facility will be a Hazard Category 3, non-reactor nuclear facility designed to meet Seismic Design Category 2, Limit State B requirements. The facility has been designed to meet stringent vibration, electrical and magnetic field, acoustic, and temperature fluctuation requirements for advanced analytical equipment with the ability to support development and deployment of equipment, instruments, and models to meet future nuclear fuel development R&D needs over a 40-year period.
- The facility will be a three-story structure encompassing approximately 49,000 ft^2, comprised of two main areas: the nuclear portion (typically referred to as the hot cell gallery) and the office/support area, constituting 35,000 ft^2 and 14,000 ft^2, respectively.

- The facility will provide a source material receiving and storage area to receive and store experiment subassemblies with lengths up to 48 inches and weighs up to 20 pounds; other source material with a diameter of less than 5 inches and weighs up to 20 pounds will be accommodated.
- The facility will include a library or prepared sample storage area with the capacity to store up to 1,800 samples.
- The facility will include a shielded cell for mechanical properties testing. The initial complement of mechanical properties testing equipment will include a mechanical property testing load frame, a Charpy impact tester, a hardness tester, and a digital microscope.
- The facility design allocated space for eight separate instrument enclosures for deployment of advanced post-irradiation examination instruments; three of which will be shielded enclosures constructed as part of the initial facility buildout. The remaining five enclosure spaces are designated for future expansion: one shielded enclosure and four non-shielded enclosures for contact-handled materials. The shielded enclosures are designed for regular manned access when radioactive samples are not present. The shielded enclosures will be flexible and reconfigurable to accommodate operational requirements for use with modern characterization instruments. The minimum initial complement of shielded examination instruments will include a scanning electron microscope, a surface science instrument, and an x-ray diffraction instrument. Additional scientific capability will be considered as risk is retired during construction.
- The facility will include space for research expansion, allowing future installation of non-shielded instrument enclosures and instruments.

The initial complement of scientific instruments will be procured, modified to operate remotely through hot cell walls via telemanipulators or robotics, and tested as part of the project prior to installation in the facility. The initial complement of scientific instruments includes a scanning electron microscope, a surface science instrument (such as x-ray photoelectron spectroscopy), and micro x-ray diffraction.

The Sample Preparation Laboratory (SPL) Facility will be operated to preclude or limit introduction of alpha-emitting radioisotopes. Limitation of alpha-emitting radioisotopes will be accomplished through limitation of the types of materials that will be studied. The SPL is a separate structure, limited to receiving, processing, handling, examining, testing, storing, and packaging irradiated beta-gamma emitting materials with limited amounts of alpha contamination. In some cases, very small quantities of alpha-emitting material (i.e., fuels) may be received in the form of metallurgical mounts for examination, using unique SPL examination instruments. The sectioning and mounting of these metallurgical mounts would be performed elsewhere. The SPL will operate in conjunction with the Hot Fuel Examination Facility (HFEF), Analytical Laboratory, and Irradiated Materials Characterization Laboratory (IMCL), and offsite facilities to provide the overall capability to analyze and characterize irradiated and non-irradiated nuclear material samples. The SPL facility will not replace these facilities; it will function synergistically with them. Having most of these facilities located within a single security-protected site (i.e., MFC) supports efficient nuclear material control, security, and management.

Facility operations will include cask receipt and unloading, experiment decontamination, sample preparation (e.g., machining, grinding, and polishing), sample storage, waste packaging, and various micro-structure and thermal examinations. Majority of these operations will take place within shielded cells and enclosures due to the radioactivity of the materials handled. These include the Sample Preparation Line, the Mechanical Properties Test Cell (MPTC), and the shielded instrument rooms.

Nuclear materials and samples will be handled in containers ranging from the Battelle Energy Alliance, LLC (BEA) research reactor cask to shielded/non-shielded 55-gallon drums, incorporating a truck lock for cask and related container handling. The principal feature of the SPL design is the shielded sample preparation hot cells that include four cells with five additional stations supporting experiment handling, sizing, and grinding (two stations), decontamination/waste handling, and sample storage. Materials will be transferred to the testing and examination areas throughout the facility using a pneumatic transfer system (PTS). Samples will also be transferred within the facility and to other facilities via small, shielded pigs or casks that mate to the outside of the hot cells. Samples will be appropriately shielded and confined to protect workers, equipment, and the facility.

The MPTC will be attached to the hot cells on the first floor. Material handling operations within the MPTC and enclosures will be done through robotics, rather than using traditional telemanipulators and shielded windows like the sample preparation line.

The remaining space on the first floor will consist of office and support areas. The second-floor design provides for an auxiliary equipment area to support the scientific instruments on the first floor. Additional research space and office areas comprise the remainder of the floor. The third floor will include the bulk of the facility service and support areas including rooms associated with equipment and instrument repair.

Key Performance Parameters (KPPs)

KPPs are defined as a vital characteristic, function, requirement, or design basis that, if changed, would have a major impact on the facility or system performance, scope, schedule, cost, risk, or the ability of an interfacing project to meet its mission requirements. The threshold KPPs represent the minimum acceptable scope for successful delivery of SPL. Achievement of KPPs will be a prerequisite for approval of CD-4. The project has identified Objective KPPs that will provide expanded capabilities to meet R&D objectives, if needed. If project performance warrants, management reserve and/or contingency funds can be allocated to Objective KPP scope or infrastructure enhancements to improve facility performance. As the project progresses, project status will be assessed, and recommendations made to the FPD regarding the potential execution of objective KPP scope. Such recommendations will consider remaining project risks and will include detailed cost and schedule performance information.

Threshold and Objective KPPs

Performance Measure	Threshold	Objective*
Construct a Hazard Category-3, non-reactor nuclear laboratory facility	Minimum of 40,000 gross square feet of laboratory/support space	N/A
Provide a shielded sample preparation capability designated for beta/gamma emitting irradiated materials	Shielded hot cell with five workstations/windows and associated equipment that support cask receipt, material handling, gross source material sizing, storage, decontamination, and fine sample preparation	N/A
Provide advanced post-irradiation examination capabilities for beta/gamma emitting irradiated materials	Three shielded scientific instrument enclosures Three advanced scientific instruments that support interior (crystal) phase characterization, fracture surface analysis, and surface science	Up to five additional advanced scientific instruments and associated facility infrastructure
Provide mechanical properties testing capabilities for beta/gamma emitting irradiated materials	Mechanical Properties Test Cell with capabilities for hardness, tensile strength, and impact testing	N/A

* SPL will be baselined to the Threshold Measure. Objective KPPs will be executed if funding is available after Threshold KPPs are achieved.

The SPL facility will be constructed using sustainable building considerations per Department of Energy Guide 413.3-6B, dated 4-5-2020, “High Performance Sustainable Buildings.” The facility design includes provisions for meeting the 2016 and 2020 Guiding Principles for Sustainable Federal Buildings. Design, construction, and documentation of the 2016 Guiding Principles ensure compliance with DOE Order 436.1, Departmental Sustainability.

Funds appropriated under this data sheet may be used to provide independent assessments related to project planning and execution.

Justification

The behavior of fuels and materials in a nuclear reactor irradiation environment is the limiting factor in nuclear plant safety, longevity, efficiency, and economics. During the last 15 years, nanoscale (i.e., 10^{-9} meter) characterization of nonnuclear materials has become routine, with capabilities for sub-angstrom (i.e., 10^{-10}meter) investigation becoming increasingly available to researchers in other fields. An understanding of nuclear fuel and material performance in the nuclear reactor

internal environment at this scale is critical to development of the innovative fuels and materials required for tomorrow's nuclear energy systems.

Existing post-irradiation examination (PIE) and thermal and mechanical properties testing capabilities at U.S. Department of Energy (DOE) laboratories, universities, and in the private sector are widely dispersed. Current PIE capabilities serve basic needs for fuel examination, material handling, and waste disposal, but are limited in their ability to function on the micro, nano, and atomic scale. Advanced characterization of radioactive samples at nanoscale to micro-scale length resolutions will support development of modern computer codes that could enable order-of-magnitude improvements in the time and cost of developing new fuels.

The SPL facility will support a variety of programs and users by receiving irradiated nuclear materials and by preparing samples for micro-/nano-scale structural, chemical, mechanical, and thermal properties analyses. This improved sample preparation capability will enhance non-destructive examination, elemental, and radiological capabilities already present at the Materials and Fuels Complex (MFC). The SPL may also provide source material and sample storage capability. The laboratory will, when coupled with existing facilities and recapitalization efforts, fulfill near-term advanced post-irradiation capabilities necessary for conducting the advanced post-irradiation examination needed to improve understanding of nuclear fuels and materials performance at the micro-, nano-, and atomic scales. This new understanding will allow for the development of innovative fuels and materials that can be used by the nuclear energy community. Irradiation-driven phenomena can only be understood through conducting a scientific program that includes experimental irradiation testing and post-irradiation examination, materials characterization, and testing coupled with modeling and simulation.

The project is being conducted in accordance with the project management requirements in DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*.

3. Financial Schedule

(Dollars in Thousands)

	Budget Authority (Appropriations)	Obligations	Costs
Total Estimated Cost (TEC)			
Design			
FY 2016	2,000	2,000	0
FY 2017	6,000	6,000	33
FY 2018	1,988	1,988	6,484
FY 2019	0	0	3,471
Total, Design (TEC)	**9,988**	**9,988**	**9,988**
Construction			
FY 2018	4,012	4,012	0
FY 2019	30,000	30,000	0
FY 2020	25,450	25,450	19,277
FY 2021	26,000	26,000	35,548
FY 2022	41,850	41,850	51,090
FY 2023	7,300	7,300	26,357
FY 2024	0	0	2,340
Total, Construction (TEC)	**134,612**	**134,612**	**134,612**
Total Estimated Costs (TEC)			
FY 2016	2,000	2,000	0

	Budget Authority (Appropriations)	Obligations	Costs
FY 2017	6,000	6,000	33
FY 2018	6,000	6,000	6,484
FY 2019	30,000	30,000	3,471
FY 2020	25,450	25,450	19,277
FY 2021	26,000	26,000	35,548
FY 2022	41,850	41,850	51,090
FY 2023	7,300	7,300	26,357
FY 2024	0	0	2,340
Total TEC	**144,600**	**144,600**	**144,600**

	Budget Authority (Appropriations)	Obligations	Costs
Other Project Costs			
FY 2012	43	43	43
FY 2013	164	164	164
FY 2014	158	158	158
FY 2015	434	434	434
FY 2016	1,072	1,072	1,072
FY 2017	408	408	408
FY 2018	2,368	2,368	477
FY 2019	0	0	1,139
FY 2020	0	0	740
FY 2021	500	500	1,308
FY 2022	2,500	2,500	2,250
FY 2023	6,903	6,903	6,132
FY 2024	6,000	6,000	5,441
FY 2025	850	850	1,634
Total OPC	**21,400**	**21,400**	**21,400**
Total Project Costs (TPC)			
FY 2012	43	43	43
FY 2013	164	164	164
FY 2014	158	158	158
FY 2015	434	434	434
FY 2016	3,072	3,072	1,072
FY 2017	6,408	6,408	441
FY 2018	8,368	8,368	6,961
FY 2019	30,000	30,000	4,610
FY 2020	25,450	25,450	20,017
FY 2021	26,500	26,500	36,856
FY 2022	44,350	44,350	53,340
FY 2023	14,203	14,203	32,489
FY 2024	6,000	6,000	7,781
FY 2025	850	850	1,634
Grand Total	**166,000**	**166,000**	**166,000**

4. Details of Project Cost Estimate

(Budget Authority in Thousands of Dollars)

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Total Estimated Cost (TEC)			

	Current Total Estimate	Previous Total Estimate	Original Validated Baseline
Design			
Design	9,998	10,785	9,998
Contingency	0	2,600	0
Total, Design	9,998	13,385	9,998
Construction			
Site Work	2,505	2,230	2,505
Equipment	17,878	8,545	17,878
Construction	94,237	56,840	94,237
Other, as needed	--	--	--
Contingency	19,982	5,000	19,982
Total, Construction	134,602	72,615	134,602
Other TEC (if any)			
Cold Startup	--	--	--
Contingency	--	--	--
Total, Other TEC	--	--	--
Total **Estimated Cost**	144,600	86,000	144,600
Contingency, TEC	19,982	7,600	19,982
Other Project Cost (OPC)			
OPC except D&D			
R&D	0	4,220	0
Conceptual Planning	1,310	1,310	1,310
Conceptual Design	821	821	821
Other OPC Costs	15,743	4,549	15,743
Contingency	3,526	1,300	3,526
Total, OPC	21,400	12,200	21,400
Contingency, OPC	3,526	1,300	3,526
Total Project Cost	166,000	98,200	166,000
Total Contingency (TEC+OPC)	23,508	8,900	23,508

5. Schedule of Appropriation Requests

(Dollars in Thousands)

Request Year	Type	Prior Years	FY 2020	FY 2021	FY 2022	FY 2023	Outyears	Total
FY 2016	TEC	2,000	TBD	TBD	TBD	0	0	78,000
	OPC	1,847	TBD	TBD	TBD	0	0	17,000
	TPC	3,847	TBD	TBD	TBD	0	0	95,000

Request Year	Type	Prior Years	FY 2020	FY 2021	FY 2022	FY 2023	Outyears	Total
FY 2017	TEC	8,000	TBD	TBD	TBD	TBD	TBD	83,000
	OPC	4,647	TBD	TBD	TBD	TBD	TBD	12,000
	TPC	12,647	TBD	TBD	TBD	TBD	TBD	95,000
FY 2018	TEC	14,000	TBD	TBD	TBD	TBD	TBD	86,000
	OPC	4,647	TBD	TBD	TBD	TBD	TBD	12,200
	TPC	18,647	TBD	TBD	TBD	TBD	TBD	98,200
FY 2019	TEC	14,000	TBD	TBD	TBD	TBD	TBD	86,000
	OPC	4,647	TBD	TBD	TBD	TBD	TBD	12,200
	TPC	18,647	TBD	TBD	TBD	TBD	TBD	98,200
FY 2020	TEC	44,000	5,242	TBD	TBD	TBD	TBD	86,000
	OPC	4,647	0	0	TBD	TBD	TBD	12,200
	TPC	48,647	5,242	TBD	TBD	TBD	TBD	98,200
FY 2021	TEC	44,000	25,450	18,000	41,850	TBD	TBD	144,600
	OPC	4,647	0	2,403	2,500	TBD	TBD	21,400
	TPC	48,647	25,450	20,403	44,350	TBD	TBD	166,000
FY 2022	TEC	44,000	25,450	26,000	41,850	7,300	0	144,600
	OPC	4,647	0	500	2,500	6,903	6,850	21,400
	TPC	48,647	25,450	26,500	44,350	14,203	6,850	166,000
FY 2023	TEC	44,000	25,450	26,000	41,850	7,300	0	144,600
	OPC	4,647	0	500	2,500	6,903	6,850	21,400
	TPC	48,647	25,450	26,500	44,350	14,203	6,850	166,000

6. Related Operations and Maintenance Funding Requirements

Start of Operation or Beneficial Occupancy (fiscal quarter or date)	1Q FY 2027
Expected Useful Life (number of years)	40
Expected Future Start of D&D of this capital asset (fiscal quarter)	1Q FY 2067

Related Funding Requirements
(Budget Authority in Thousands of Dollars)

	Annual Costs		Life Cycle Costs	
	Previous Total Estimate	Current Total Estimate	Previous Total Estimate	Current Total Estimate
Operations and Maintenance	9,926	9,926	1,675,000	1,675,000

Life-cycle operations and maintenance costs include annual escalation.

7. D&D Information

The new area being constructed in this project is not replacing existing facilities.

	Square Feet
New area being constructed by this project at Idaho National Laboratory	49,000
Area of D&D in this project at Idaho National Laboratory	0
Area at Idaho National Laboratory to be transferred, sold, and/or D&D outside the project, including area previously "banked"	0
Area of D&D in this project at other sites	0

Area at other sites to be transferred, sold, and/or D&D outside the project, including area previously “banked”	0
Total area eliminated	0

Site location, building name or numbers, and square footages of existing facilities to be replaced: N/A

As a new Laboratory facility, the proposed SPL is not subject to Freeze the Footprint (>50% lab space).

8. Acquisition Approach

As a Hazard Category 3 nuclear facility, design, and construction of the Sample Preparation Laboratory (SPL) must be integrated with ongoing nuclear operations activities. Design and construction must also be coordinated/integrated with nuclear research and development programs. A design-bid-build project delivery method managed by the Idaho National Laboratory management and operating contractor was used for the design and construction of the SPL. The SPL construction subcontract is a firm, fixed-price contract.

Idaho Sitewide Safeguards and Security

Overview

The Idaho Sitewide Safeguards and Security (S&S) program supports the Idaho National Laboratory (INL) complex nuclear facility infrastructure and enables the Office of Nuclear Energy (NE) to conduct research and development (R&D) in support of multiple program missions. The S&S program benefits the site infrastructure and users by providing the safeguards and security functions required at Department of Energy (DOE) sites to enable R&D utilizing nuclear materials and protected information. In addition to NE R&D activities, S&S enables a range of national security programs that support the National Nuclear Security Administration and other Federal agencies including the Department of Homeland Security in the areas of critical infrastructure protection, nuclear nonproliferation, and incident response.

The FY 2023 Budget Request provides direct funding for the INL S&S base program. Strategic Partnership Projects (SPP) will continue to fund an allocable share of the S&S program via full cost recovery. Extraordinary security requirements, such as dedicated security for special projects or exercises, will be a direct charge to DOE and SPP customers.

Highlights of the FY 2023 Budget Request

In FY 2023, the S&S program will sustain program functionality at the level necessary to assure high confidence in the protection of INL assets and a high degree of customer service by maintaining effective staffing levels, proactive preventive and corrective maintenance programs, and a robust cybersecurity program. The FY 2023 Budget Request will focus on continued implementation of physical security infrastructure investments, capital improvements, emerging security technology investments, and enhanced cybersecurity program capabilities to adequately secure site wide assets, including:

- Completing critical physical security infrastructure investments and maintaining protective force staff levels required to maintain an effective S&S program consistent with evolving Departmental requirements, including related analyses and modifications to enhance physical security infrastructure across several INL complexes;
- Supporting physical security systems life-cycle replacement including preventive and corrective maintenance on critical security systems, subsystems, and components;
- Supporting implementation of the Design Basis Threat, Departmental Orders, and force-on-force exercises and equipment required to analyze and validate changes to security models that provide data for risk-informed decision making, and directly test the efficacy of the protection methodology and security posture; and
- Maintaining an effective cybersecurity program through the addition of lifecycle hardware/software upgrades and replacements including continuous monitoring, maintaining Industrial Control Systems, essential cybersecurity positions, and associated training.

Idaho Sitewide Safeguards and Security
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted ($)	FY 2023 Request vs FY 2021 Enacted (%)
Idaho Sitewide Safeguards and Security					
Protective Forces	71,705	85,356	88,497	+16,792	+23.4%
Security Systems	10,075	11,575	12,203	+2,128	+21.1%
Security Infrastructure	16,618	5,618	4,100	-12,518	-75.3%
Information Security	4,674	6,174	5,016	+342	+7.3%
Personnel Security	9,554	4,714	5,593	-3,961	-41.5%
Material Control & Accountability	5,505	6,376	5,825	+320	+5.8%
Program Management	11,193	10,175	11,450	+257	+2.3%
Cybersecurity	20,476	19,812	23,916	+3,440	+16.8%
Total, Idaho Sitewide Safeguards and Security	**149,800**	**149,800**	**156,600**	**+6,800**	**+4.5%**

Idaho Sitewide Safeguards and Security
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Protective Forces: The increase from $71,705,000 to $88,497,000 includes costs to maintain the protective force personnel staffing levels consistent with Departmental requirements and existing labor wage agreements. Funding also supports protective force equipment, training, facilities, and management consistent with Departmental requirements and the site-wide protection strategy.	**+16,792**
Security Systems: The increase from $10,075,000 to $12,203,000 reflects funds for end-of-life equipment replacement to enable intrusion detection and assessment system effectiveness and ensure protection of assets.	**+2,128**
Security Infrastructure: The decrease from $16,618,000 to $4,100,00 reflects completion of Phase IIB activities and Congressional direction for the training facility at the Central Facilities Area. This funding level includes $4,100,000 to address Design Basis Threat implementation and operational modernization at INL complexes.	**-12,518**
Information Security: No significant change.	**+342**
Personnel Security: The decrease from $9,554,000 to $5,593,000 reflects implementation of full cost recovery for security clearance activities.	**-3,961**
Material Control & Accountability: No significant change.	**+320**
Program Management: No significant change.	**+257**
Cybersecurity: The increase from $20,476,000 to $23,916,000 funds computer network tools and associated staff to protect laboratory systems against dynamic cyber security threats and activities to implement Executive Order 14028, *Improving the Nation's Cybersecurity.*	**+3,440**
Total, Idaho Sitewide Safeguards and Security	**+6,800**

Idaho Sitewide Safeguards and Security

Description

The Idaho Sitewide Safeguards and Security (S&S) program funds Office of Nuclear Energy (NE) base physical and cybersecurity activities for the Idaho National Laboratory (INL), providing protection of the Department of Energy's (DOE) nuclear materials, classified and unclassified matter, government property, personnel, and other vital assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause adverse impacts on our national security; program continuity; or the health and safety of employees, the public, or the environment.

Protective Forces

Protective Forces provides security police officers and other specialized personnel, equipment, training, and management needed during normal and security emergency conditions for the adequate protection of site assets consistent with site security plans. Protective force personnel are deployed 24 hours a day, 7 days a week, across 890 square miles to deter, detect, delay, and respond to adversarial threats.

Security Systems

Physical Security Systems provides preventive and corrective maintenance and performance testing of intrusion detection and assessment systems, entry and search control equipment, barriers, secure storage, lighting, sensors, entry/access control devices, locks, explosives detection, and tamper-safe monitoring. Ensures operation of approximately 4,600 security alarms and 6,100 security locks at multiple security areas, 24 hours a day, 7 days a week.

Security Infrastructure

Security Infrastructure provides critical security infrastructure investments and protection enhancements necessary to ensure adequate protection of assets consistent with Departmental requirements. These include, but are not limited to, upgrades, refurbishments, or replacement of security facilities.

Information Security

Information Security provides for the protection and control of classified and sensitive matter that is generated, received, transmitted, used, stored, reproduced, and/or destroyed. Information Security subprogram includes the Technical Security Countermeasures program.

Personnel Security

Personnel Security provides access to classified and sensitive information and assignment of personnel in sensitive positions through the clearance program, adjudication, security awareness and education, U.S. citizen and foreign visitor control, Human Reliability Program, psychological/medical assessments, and administrative review costs.

Material Control and Accountability

Material Control & Accountability (MC&A) provides the personnel, equipment, and services required to account for and control special nuclear materials (SNM) from diversion.

Program Management

Program Management includes policy oversight, development, and update of site security plans; vulnerability assessments, and performance testing to ensure adequate protection of SNM; investigations into incidents of security concern; and issuance of security infractions. Program management also ensures activities are conducted to analyze and identify the impacts of changes to Departmental policies and requirements on the site-wide safeguards and security program.

Cybersecurity

Cybersecurity maintains the staffing, computing infrastructure, and network security configuration necessary to support classified and unclassified information and electronic operations. Cybersecurity uses a graduated risk approach based on data sensitivity and impact of loss/compromise to ensure that electronic or computer information systems are protected in a manner consistent with upholding key priorities, including importance to national security, support of DOE missions and programs, vulnerability to threats, and the magnitude of harm that would result from an information system and industrial control systems compromise.

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Protective Forces $71,705,000	**$88,497,000**	**+$16,792,000**
• Maintained protective force staff levels, including planned hires for Phase IIB Implementation Plan protective force staffing requirements. • Purchased Protective Force equipment, including ammunition, weapons, protective gear, and vehicles.	• Maintains protective force staffing levels, consistent with the Site Security Plan and approved site labor wage agreements. • Purchases Protective Force equipment such as ammunition, weapons, protective gear, and vehicles.	• Increase reflects funds to support protective force staffing levels consistent with Departmental security requirements and approved security strategy.
Security Systems $10,075,000	**$12,203,000**	**+$2,128,000**
• Planned and conducted preventive and corrective maintenance on physical security systems across multiple Idaho National Laboratory (INL) security areas. • Operated and maintained the INL central alarm stations, including life-cycle replacement of security alarm systems.	• Maintains preventive and corrective maintenance programs for physical security systems across INL multiple security areas. • Operates and maintains INL central alarm stations, including life-cycle replacement of security alarm systems.	• Increase reflects funds for end-of-life equipment replacement to enable intrusion detection and assessment system effectiveness and ensure protection of assets.
Security Infrastructure $16,618,000	**$4,100,000**	**-$12,518,000**
• Continued Implementation Plan Phase IIB activities, including the performance of design work, construction, and related analyses required by Departmental Orders.	• Supports pre-conceptual planning activities for Design Basis Threat requirements and modernization of personnel and vehicle inspection facilities at INL complexes.	• The decrease reflects completion of Phase IIB activities and congressional direction for the Central Facilities Area training facility , off-set by funding to address Design Basis Threat requirements and operational modernization at INL complexes.
Information Security $4,674,000	**$5,016,000**	**+$342,000**
• Operated information security activities to protect classified and sensitive unclassified matter including Classified Matter Protection and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security programs.	• Conducts information security activities to protect classified and sensitive unclassified matter including Classified Matter Protection and Control, Technical Surveillance Countermeasures, Classification/Declassification, and Operations Security programs.	• No significant change.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Personnel Security $9,554,000	**$5,593,000**	**-$3,961,000**
• Conducted federal contractor personnel security programs to process clearances; operated Idaho National Laboratory (INL) badging office; processed foreign visits and assignments; and managed human reliability program activities.	• Conducts federal and contractor personnel security programs to process clearances; operating INL badging office; coordinating foreign visits and assignments; and managing human reliability program activities.	• Decrease reflects implementation of full cost recovery for security clearance activities by requesting program organizations.
Material Control & Accountability (MC&A) $5,505,000	**$5,825,000**	**+$320,000**
• Maintained INL's nuclear material database and tracking systems, coordinated on-and off-site material movements, and conducted accountable special nuclear material inventories.	• Maintains INL's special nuclear material database and tracking systems, manages on-and off-site material movements, and conducts accountable special nuclear material inventories. • Procures and installs equipment to ensure accountability of special nuclear materials.	• No significant change.
Program Management $11,193,000	**$11,450,000**	**+$257,000**
• Updated INL security plans to meet Design Basis Threat and Departmental security requirement changes. • Assessed impacts due to COVID-19 and provided revised security plans to ensure continued operation of the INL.	• Conducts force-on-force exercises to verify the INL security posture. • Develops and maintains site security documentation, including vulnerability and risk assessments, to ensure alignment to Departmental requirements.	• No significant change.
Cybersecurity $20,476,000	**$23,916,000**	**+$3,440,000**
• Provided 24/7 intrusion detection and prevention monitoring to ensure incidents and breaches are discovered and remediated. • Implemented cybersecurity vulnerability management tools to monitor INL network systems. • Completed life-cycle replacement of network boundary protection firewalls.	• Provide 24/7 intrusion detection and prevention monitoring to ensure incidents and breaches are discovered and remediated. • Implement Executive Order (EO) 14028 requirements in privileged access management in support of moving towards Zero Trust principles. • Upgrade Industrial Control System (ICS) firewalls and internet routers for INL systems consistent with current threat environment.	• The increase funds computer network tools and associated staff to protect laboratory systems against dynamic cyber security threats and activities to implement Executive Order 14028, *Improving the Nation's Cybersecurity Activities.*

Idaho Sitewide Safeguards and Security
Capital Summary ($K)

	Total	Prior Years	FY 2021 Enacted	FY 2021 Actuals	FY 2022 Request	FY 2023 Request	FY 2023 Request vs FY 2021 Request ($)	FY 2023 Request vs FY 2021 Request (%)
Capital Operating Expenses Summary (including Major Items of Equipment)								
Minor Construction	n/a	26,377	16,618	16,618	5,618	0	-16,618	-75.3%
Total, Capital Operating Expenses	**n/a**	**26,377**	**16,618**	**16,618**	**5,618**	**0**	**-16,618**	**-75.3%**
Minor Construction Projects								
Internet Pipeline Monitoring Infrastructure	1,800	0	1,800	1,800	0	0	-1,8000	-100%
Materials and Fuels Complex Protective Forces Building	15,600	15,600	0	0	0	0	0	0%
Security Infrastructure Phase IIB	13,913	5,477	2,818	2,818	5,618	0	-2,818	-100%
Consolidated training facility at the Central Facilities Area	12,000	0	12,000	12,000	0	0	-12,000	-100%
Total, Minor Construction Projects	**70,613**	**26,377**	**16,618**	**16,618**	**5,618**	**0**	**-16,618**	**-75.3%**
Total, Capital Summary	**n/a**	**26,377**	**16,618**	**16,618**	**5,618**	**0**	**-16,618**	**-75.3%**

International Nuclear Energy Cooperation

Overview

The International Nuclear Energy Cooperation (INEC) program leads the Department's international engagement for civil nuclear energy, including analysis, development, coordination, and implementation of U.S. civil nuclear energy policy integrated with the Office of Nuclear Energy's (NE) international nuclear technical activities. INEC's strategic partnerships contribute to bilateral and multilateral civil nuclear research and development (R&D) with countries that have advanced nuclear programs, while providing the expertise to better inform emerging countries on safety and security issues that should be considered before developing a civilian nuclear program. INEC also contributes financial support and technical expertise to international organizations, including the Nuclear Energy Agency (NEA), International Framework for Nuclear Energy Cooperation (IFNEC), the Clean Energy Ministerial (CEM) and the International Atomic Energy Agency (IAEA) and its International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). INEC employs a suite of tools, including workshops and other expert-based exchanges to engage industry, stakeholders, and foreign governments on issues such as nuclear energy as an integral part of a climate change strategy, infrastructure development, financing for nuclear builds, nuclear safety and multinational cooperation on the back end of the nuclear fuel cycle, including disposal.

INEC's mission has expanded its focus to develop strategic partnerships which overlay commercial opportunities for the U.S. nuclear industry. INEC actively works with industry and international partners to consider how advanced U.S. reactor designs, including traditional large reactor designs and small modular reactors, might be incorporated into established and growing energy grids. INEC's efforts contribute to increased nuclear exports which support U.S. leadership in the global nuclear market and expand U.S. job creation.

In conclusion, INEC enables the Department to effectively engage with international partners on civil nuclear policy, research, development, and demonstration (RD&D) and advancing U.S. technology exports. In close coordination with the Office of International Affairs, INEC's bilateral and multilateral engagement addresses broader U.S. strategic interests that support U.S. nuclear industry in the safe and secure deployment of nuclear energy worldwide while remaining sensitive to nonproliferation policy. INEC executes its international mission in coordination with the National Nuclear Security Administration; the National Security Council; the Department of State; the Department of Commerce; and the Nuclear Regulatory Commission to better support U.S. nuclear energy RD&D, civil nuclear policy, and U.S. commercial interests internationally.

Highlights of the FY 2023 Budget Request

In FY 2023 the INEC budget will be transferred from the NE Program Direction Budget Request to a program level activity within the overall NE Congressional Budget Request. This change will enable NE to better focus financial and personnel resources toward international priorities while providing improved transparency to Congress.

International Nuclear Energy Cooperation
Funding ($K)

	FY 2021 Enacted	FY 2022 Full Year CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted
International Nuclear Energy Cooperation				
International Nuclear Energy Cooperation	0	0	$3,000	+$3,000
Total, International Nuclear Energy Cooperation	**0**	**0**	**$3,000**	**+$3,000**

International Nuclear Energy Cooperation
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
International Nuclear Energy Cooperation:	
• The increase from $0 to $3,000,000 reflects INEC's transfer from NE Program Direction to a program level activity within the FY 2023 NE Congressional Budget Request.	**+3,000**
Total, International Nuclear Energy Cooperation	**+3,000**

International Nuclear Energy Cooperation

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs. FY 2022 Full Year CR
International Nuclear Energy Cooperation **$0**	**$3,000,000**	**+$3,000,000**
• In FY 2021, INEC was funded within the NE Program Direction budget.	• Organize and host an INPRO Dialogue Forum on nuclear workforce development and deployment. • Host a course on planning methodologies for a civil nuclear program. • Organize a nuclear energy management school. • Expand collaboration with small and emerging nuclear states through internships, educational exchanges, professional technical exchanges and training, and feasibility studies. • Continue bilateral coordination of technical cooperation with France, India, and the United Kingdom through mechanisms such as R&D Agreements, implementing arrangements and Action Plans. • Initiate bilateral coordination of technical cooperation with small and emerging nuclear states in Africa, the Baltic states and Eastern Europe. • Coordinate Fukushima Forensics activities that support improved operation and safety of U.S. domestic nuclear power plants. • Coordinate with U.S. interagency to support increased U.S. civil nuclear exports. • Manage International Nuclear Research Initiatives (INERI) collaborative partnerships on RD&D projects with the EURATOM and Republic of Korea focusing on advanced nuclear technologies to improve cost, safety, and proliferation-resistance.	• The new activities for FY23 reflect INEC's transfer from NE Program Direction to a program level activity within the FY 2023 NE Congressional Budget Request.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs. FY 2022 Full Year CR
	• Leverage U.S. strategic policy goals in multilateral organizations by providing staff to support the mission of these agencies. • Leverage role of Chair of IFNEC to better promote the use of nuclear energy for peaceful purposes while ensuring the highest standards for safety, security, and nonproliferation. • Continue to support infrastructure development and safety culture in Armenia and Ukraine.	

Program Direction

Overview

Program Direction provides the federal staffing resources and associated costs required to support the overall direction and execution of the Office of Nuclear Energy (NE) programs. NE has staff strategically located in multiple locations: Washington, D.C. Headquarters, Nevada Field Office, and the Idaho Operations Office. Activities within the site offices support inherently federal functions that facilitate the efficient execution of Department of Energy (DOE) programs or directly execute DOE mandated safety, security, business functions, and public outreach. In addition to NE federal personnel, Program Direction supports select federal staff and support for the Office of Human Capital Service Center.

The Support Services subprogram allows the Department to cost-effectively hire the best available industry experts to support federal staff in managing the nuclear programs and complex activities. The ability to acquire expertise quickly and on an "as needed basis" provides flexibility in team composition as the needs of NE evolve. Program Direction also includes the Other Related Expenses subprogram, which provides NE's directed funding contribution to the Department's Working Capital Fund (WCF). The WCF supports specific Departmental services and activities that are shared across DOE including: employee health and testing services, and consolidated training and recruitment initiatives; all established in previous fiscal years and supported in FY 2023.

In addition to appropriated funds, NE also manages approximately $200 million annually from other activities including: Strategic Partnerships Program and reimbursable funding from the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD).

Over the last four years, NE's program direction funding has remained level and overall federal staffing levels have declined by more than a quarter. Over the same period, the size of NE's programs have doubled. NE is now at a critical moment where it must replace retiring staff, increase staffing in areas of priority, and support career enhancing opportunities that allow us to attract and retain new staff. As such the FY 2023 request reflects the first funding increase for program direction in 9 years to support a multiyear effort, started in FY 2021, to restore staffing levels to the 2016 level.

The FY 2023 Program Direction Budget Request reflects NE's continued effort to optimize support for its federal programs through continued efficiency and cost-effectiveness; and to ensure a measured and effective oversight of NE mission activities. Federal staff supported by the Program Direction account are responsible for ensuring the appropriate planning, oversight, and execution of all activities within NE. The Program Direction Budget Request also implements Executive Order 14035, *Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce (DEIA)*, through hiring and training new and existing staff.

Highlights of the FY 2023 Budget Request

The FY 2023 Program Direction Budget Request includes a transfer of the International Nuclear Energy Cooperation (INEC) program within the NE Program Direction Budget Request to a program level activity within the overall NE Congressional Budget Request.

The Request also includes funding to support an additional 83 federal staffing positions onboarding between FY 2021 and FY 2023. These positions will be allocated across NE's site office locations as appropriate. This increase will allow NE to rebuild its workforce to levels consistent with our FY 2017 profile, which is necessary to execute the robust Research and Development, and Infrastructure activities that NE is responsible for overseeing.

Program Direction
Funding ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted
Program Direction				
Salaries and Benefits	45,637	50,637	57,926	12,289
Travel	198	330	1,200	1,002
Support Services	11,029	8,529	12,431	1,402
Other Related Expenses	13,517	11,017	13,900	383
International Nuclear Energy Cooperation	4,750	4,618	0	-4,750
Total, Program Direction	**75,131**	**75,131**	**85,457**	**10,326**

Program Direction
Explanation of Major Changes ($K)

	FY 2023 Request vs FY 2021 Enacted
Salaries and Benefits: The increase from $45,637 to $57,926 reflects the funds necessary to support 27 new FTE positions that occurred in FY 2022 as well as an additional 56 new positions planned across the Headquarters and Idaho Operations Offices in FY 2023.	**12,289**
Travel: The increase from $198 to $1,200 reflects a return to normal travel spending levels post COVID-19 restrictions.	**1,002**
Support Services: The increase from $11,029 to $12,431 reflects additional funding allocated for contractual support as needed to aid and support the increased federal workforce responsible for executing NE's requirements.	**1,402**
Other Related Expenses: The increase from $13,517 to $13,900 reflects funding to support other expenses related to the increase of NE's workforce that occurred in FY 2022 and planned hires in FY 2023.	**383**
International Nuclear Energy Cooperation The decrease from $4,750 to $0 reflects the International Nuclear Energy Cooperation's transfer from Nuclear Energy (NE) Program Direction to a program level activity within the FY 2023 NE Congressional Budget Request.	**-4,750**
Total, Program Direction	**10,326**

Program Direction
Funding ($K)

	FY 2021 Enacted	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted
Program Direction Summary			
Washington Headquarters			
Salaries and Benefits	22,081	28,374	6,293
Travel	108	1,000	892
Support Services	6,944	8,346	1,402
Other Related Expenses	7,687	8,070	383
International Nuclear Energy Cooperation	4,750	0	-4,750
Total, Washington Headquarters	**41,570**	**45,790**	**4,220**
Nevada Field Office			
Salaries and Benefits	1,622	1,782	160
Travel	0	0	0
Support Services	0	0	0
Other Related Expenses	115	115	0
Total, Nevada Field Office	**1,737**	**1,897**	**160**
Idaho Operations Office			
Salaries and Benefits	21,934	27,770	5,836
Travel	90	200	110
Support Services	4,085	4,085	0
Other Related Expenses	5,715	5,715	0
Total, Idaho Operations Office	**31,824**	**37,770**	**5,946**
Total Program Direction			
Salaries and Benefits	45,637	57,926	12,289
Travel	198	1,200	1,002
Support Services	11,029	12,431	1,402
Other Related Expenses	13,517	13,900	383
International Nuclear Energy Cooperation	4,750	0	-4,750
Total, Program Direction	**75,131**	**85,457**	**10,326**
Federal FTEs	**256**	**283**	**356**

	FY 2021 Enacted	FY 2023 Request	FY 2023 Request vs FY 2021 Enacted
Support Services			
Technical Support			
Mission Related	661	746	85
Advisory and Assistance	1,544	1,740	196
Total, Technical Support	2,205	2,486	281
Management Support			
Administrative	2,647	2,984	337
IT	6,177	6,961	784
Total Management Support	8,824	9,945	1,121
Total, Support Services	**11,029**	**12,431**	**1,402**
Other Related Expenses			
Working Capital Fund	5,214	6,296	1,082
Training	115	150	35
Miscellaneous	6,151	5,417	-734
Rents and Utilities	2,037	2,037	0
Total, Other Related Expenses	**13,517**	**13,900**	**383**

Program Direction
Funding

Activities and Explanation of Changes

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
Program Direction $75,131,000	**$85,457,000**	**$10,326,000**
Salaries and Benefits $45,636,749	**$57,926,000**	**$12,289,251**
• Provides salaries and benefits for 256 FTEs.	• Provides salaries and benefits for 339 FTEs.	• The increase reflects 27 FTEs during FY 2022 as well as an additional 83 FTEs to be onboarded in FY 2023.
Travel $198,021	**$1,200,000**	**$1,001,979**
• Provides for travel of the federal staff including any necessary permanent change of duty status costs.	• Provides for travel of the federal staff including any necessary permanent change of duty status costs.	• The increase reflects a normalization of federal travel activities post COVID-19 restrictions.
Support Services $11,029,481	**$12,431,019**	**$1,401,538**
• Provides for technical and administrative support services for the Nuclear Energy (NE) federal staff.	• Provides for technical and administrative support services for the NE federal staff.	• The increase reflects additional funding allocated for contractual support as needed to aid and support the increased federal workforce responsible for executing NE's requirements.
Other Related Expenses $13,516,749	**$13,899,981**	**$383,232**
• Provides for NE's share of goods and services procured through the Department's Working Capital Fund (WCF); rents and utilities associated with the Idaho Operations Office; federal training expenses; and other miscellaneous expenses.	• Provides for NE's share of goods and services procured through the Department's WCF; rents and utilities associated with the Idaho Operations Office; federal training expenses; and other miscellaneous expenses.	• The increase reflects funding to support other expenses related to the increase of NE's workforce that occurred in FY 2021 and planned hires in FY 2022.
International Nuclear Energy Cooperation (INEC) $4,750,000	**$0**	**-$4,750,000**
• Plan and organize 2022 IAEA Nuclear Power Ministerial, including venue reservation, primary contractor selection and coordination between primary contractor, venue and IAEA, NEA co-sponsors. • Support the Secretary of Energy and NE leadership in all international nuclear events, including participation in bilateral meetings and	• This activity will be reestablished as its own program within the FY 2023 Congressional Budget Request.	• The decrease reflects INEC's transfer from Nuclear Energy (NE) Program Direction to a program level activity within the FY 2023 NE Congressional Budget Request.

FY 2021 Enacted	FY 2023 Request	Explanation of Changes FY 2023 Request vs FY 2021 Enacted
multilateral events such as the IAEA General Conference and Clean Energy Ministerial. • Expand collaboration with small and emerging nuclear states through internships, educational exchanges, professional technical exchanges and training, and feasibility studies. • Continue bilateral coordination of technical cooperation with France, India, and the United Kingdom through mechanisms such as R&D Agreements, implementing arrangements and Action Plans. • Coordinate Fukushima Forensics activities that support improved operation and safety of U.S. domestic nuclear power plants. • Coordinate with U.S. interagency to support increased U.S. civil nuclear exports. • Manage International Nuclear Research Initiatives (INERI) collaborative partnerships on RD&D projects with the EURATOM and Republic of Korea focusing on advanced nuclear technologies to improve cost, safety and proliferation-resistance. • Leverage U.S. strategic policy goals in multilateral organizations by providing staff to support the mission of these agencies. • Leverage role of Chair of IFNEC to better promote the use of nuclear energy for peaceful purposes while ensuring the highest standards for safety, security and nonproliferation. • Continue to support infrastructure development and safety culture in Armenia and Ukraine.		

Nuclear Energy
Research and Development ($K)

	FY 2021 Enacted	FY 2022 Annualized CR	FY 2023 Request
Basic	0	0	0
Applied	770,756	770,756	1,096,648
Development	258,926	258,926	338,365
Subtotal, R&D	**1,029,682**	**1,029,682**	**1,435,013**
Equipment	0	0	0
Construction	37,000	37,000	7,300
Total, R&D	**1,066,682**	**1,066,682**	**1,442,313**