

ARTIFICIAL INTELLIGENCE STRATEGIC PLAN

Fiscal Years 2023-2027

AVAILABILITY OF REFERENCE MATERIALS IN NRC PUBLICATIONS

NRC Reference Material

As of November 1999, you may electronically access NUREG-series publications and other NRC records at the NRC's Library at www.nrc.gov/reading-rm.html. Publicly released records include, to name a few, NUREG-series publications; *Federal Register* notices; applicant, licensee, and vendor documents and correspondence; NRC correspondence and internal memoranda; bulletins and information notices; inspection and investigative reports; licensee event reports; and Commission papers and their attachments.

NRC publications in the NUREG series, NRC regulations, and Title 10, "Energy," in the *Code of Federal Regulations* may also be purchased from one of these two sources:

1. The Superintendent of Documents

U.S. Government Publishing Office
Washington, DC 20402-0001
Internet: <https://bookstore.gpo.gov/>
Telephone: (202) 512-1800
Fax: (202) 512-2104

2. The National Technical Information Service

5301 Shawnee Road
Alexandria, VA 22312-0002
Internet: <https://www.ntis.gov/>
1-800-553-6847 or, locally, (703) 605-6000

A single copy of each NRC draft report for comment is available free, to the extent of supply, upon written request as follows:

Address: **U.S. Nuclear Regulatory Commission**
Office of Administration
Digital Communications and Administrative
Services Branch
Washington, DC 20555-0001
E-mail: Reproduction.Resource@nrc.gov
Facsimile: (301) 415-2289

Some publications in the NUREG series that are posted at the NRC's Web site address www.nrc.gov/reading-rm/doc-collections/nuregs are updated periodically and may differ from the last printed version. Although references to material found on a Web site bear the date the material was accessed, the material available on the date cited may subsequently be removed from the site.

Non-NRC Reference Material

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, transactions, *Federal Register* notices, Federal and State legislation, and congressional reports. Such documents as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings may be purchased from their sponsoring organization.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at—

The NRC Technical Library

Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

These standards are available in the library for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from—

American National Standards Institute

11 West 42nd Street
New York, NY 10036-8002
Internet: www.ansi.org
(212) 642-4900

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

The NUREG series comprises (1) technical and administrative reports and books prepared by the staff (NUREG-XXXX) or agency contractors (NUREG/CR-XXXX), (2) proceedings of conferences (NUREG/CP-XXXX), (3) reports resulting from international agreements (NUREG/IA-XXXX), (4) brochures (NUREG/BR-XXXX), and (5) compilations of legal decisions and orders of the Commission and the Atomic and Safety Licensing Boards and of Directors' decisions under Section 2.206 of the NRC's regulations (NUREG-0750), (6) Knowledge Management prepared by NRC staff or agency contractors (NUREG/KM-XXXX).

DISCLAIMER: This report was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any employee, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for any third party's use, or the results of such use, of any information, apparatus, product, or process disclosed in this publication, or represents that its use by such third party would not infringe privately owned rights.



NRC headquarters in Rockville, Maryland

ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) recognizes that interest in artificial intelligence (AI) is growing rapidly in both the public and private sectors and anticipates increased use of AI in NRC-regulated activities. For the purposes of this document, AI refers to a machine-based system that can go beyond defined results and scenarios and has the ability to emulate human-like perception, cognition, planning, learning, communication, or physical action. For a given set of human-defined objectives, AI can make predictions, recommendations, or decisions influencing real or virtual environments. This strategic plan focuses on a broad spectrum of AI sub-specialties (e.g., natural language processing, machine learning, deep learning, etc.) which could encompass various algorithms and application examples which the NRC has not previously reviewed and evaluated. Anticipating the industry's potential application of AI to NRC-regulated activities, the NRC has developed this strategic plan to ensure the agency's readiness to review such uses. The strategic plan includes five goals: (1) ensure NRC readiness for regulatory decision-making, (2) establish an organizational framework to review AI applications, (3) strengthen and expand AI partnerships, (4) cultivate an AI-proficient workforce, and (5) pursue use cases to build an AI foundation across the NRC. The overall goal of this strategic plan is to ensure continued staff readiness to review and evaluate AI applications effectively and efficiently.

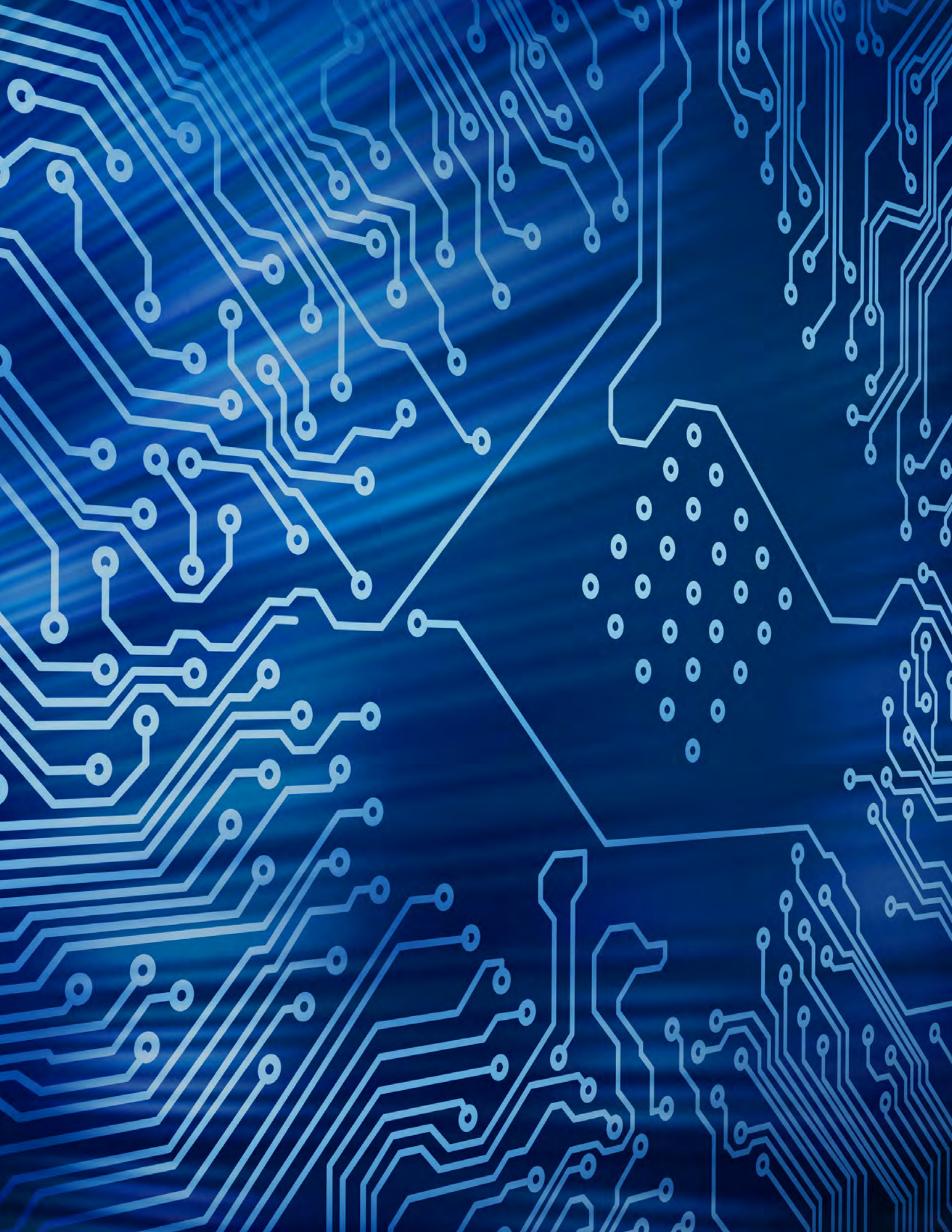


TABLE OF CONTENTS

ABSTRACT.....	iii
LIST OF FIGURES.....	vii
LIST OF TABLES.....	vii
EXECUTIVE SUMMARY.....	ix
FOREWORD.....	xi
ABBREVIATIONS AND ACRONYMS.....	xiii
INTRODUCTION.....	1-1
VISION.....	2-1
PURPOSE AND DRIVERS.....	3-1
STRATEGIC GOALS.....	4-1
4.1 Strategic Goal 1: Ensure NRC Readiness for Regulatory Decision-Making.....	4-2
4.2 Strategic Goal 2: Establish an Organizational Framework to Review AI Applications.....	4-4
4.3 Strategic Goal 3: Strengthen and Expand AI Partnerships.....	4-4
4.4 Strategic Goal 4: Cultivate an AI-Proficient Workforce.....	4-5
4.5 Strategic Goal 5: Pursue Use Cases to Build an AI Foundation Across the NRC.....	4-6
CONCLUSION.....	5-1
REFERENCES.....	6-1
APPENDIX A	
GLOSSARY.....	A-1
APPENDIX B	
USING ARTIFICIAL INTELLIGENCE TOOLS TO ENHANCE NRC ACTIVITIES.....	B-1





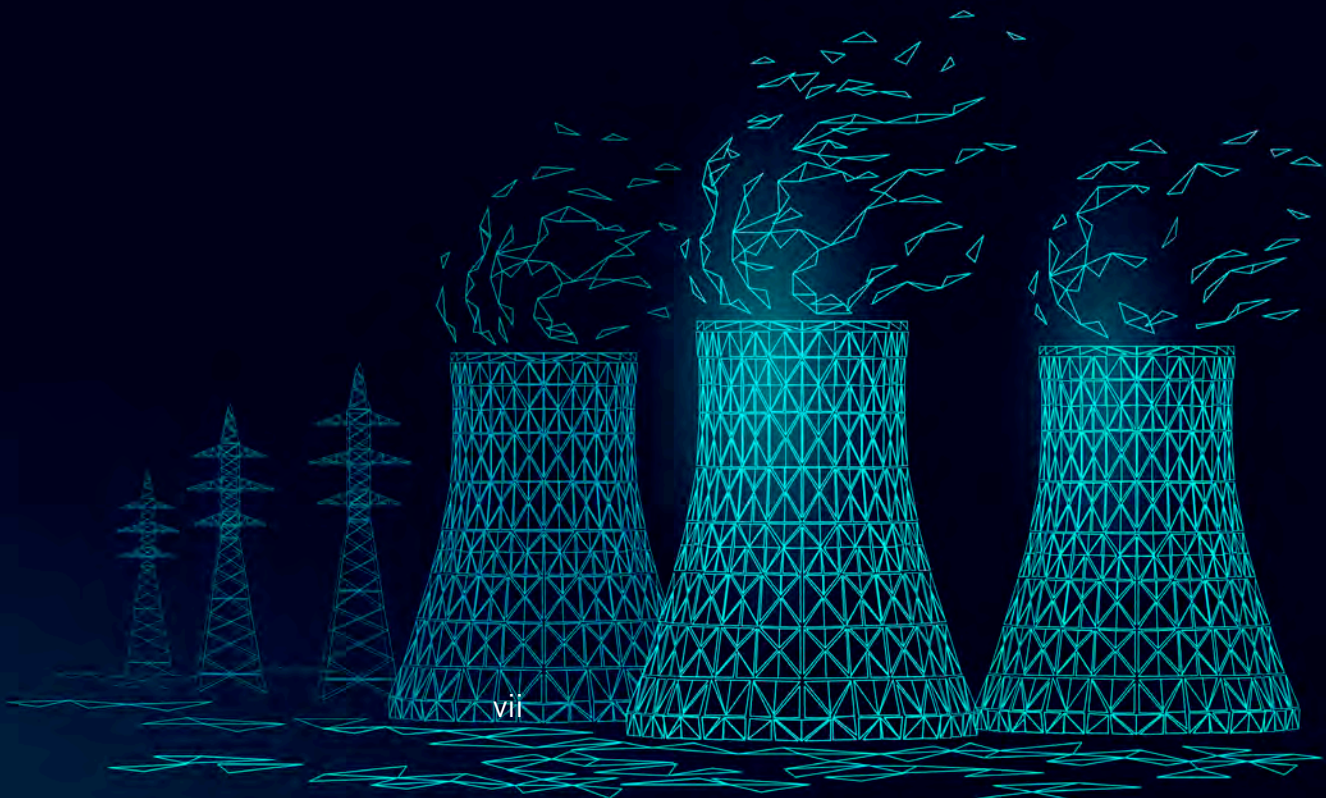
NRC staff observe advanced reactor vendor X-energy's simulator for their proposed high-temperature gas-cooled reactor facility

LIST OF FIGURES

Figure 1	Artificial Intelligence Hierarchy and Relationship with the NRC AI Strategic Plan (adapted from [5] and [6]).....	1-3
Figure 2	Overview of Strategic Goals.....	4-1

LIST OF TABLES

Table 1	Notional AI and Autonomy Levels in Commercial Nuclear Activities.....	1-4
Table 2	Potential AI Technical Considerations for Regulatory Decision-Making.....	4-3





Limerick Generating Station, Units 1 and 2

EXECUTIVE SUMMARY

For the purposes of this document, artificial intelligence (AI) refers to a machine-based system that can go beyond defined results and scenarios and has the ability to emulate human-like perception, cognition, planning, learning, communication, or physical action. For a given set of human-defined objectives, AI can make predictions, recommendations, or decisions influencing real or virtual environments. AI is one of the fastest-growing technologies globally and has the potential to enhance decision-making processes for the nuclear industry by providing insights into vast amounts of data generated during the design and operation of nuclear facilities. As a result, the nuclear industry has expressed a growing interest in researching and using AI technologies to improve operational performance and mitigate operational risk. The AI Strategic Plan focuses on a broad spectrum of AI sub-specialties (e.g., natural language processing, machine learning, deep learning, etc.) which could encompass various algorithms and application examples which the U.S. Nuclear Regulatory Commission (NRC) has not previously reviewed and evaluated. The NRC is committed to continue to keep pace with technological innovations to ensure the safe and secure use of AI in NRC-regulated activities. The NRC has developed the AI Strategic Plan to plan and prepare for new technologies involving AI.

The NRC's AI Strategic Plan, covering fiscal years (FY) 2023–2027, establishes the vision and goals for the NRC to continue to improve its skills and capabilities to review and evaluate the application of AI to NRC-regulated activities, maintain awareness of technological innovations, and ensure the safe and secure use of AI in NRC-regulated activities. The AI Strategic Plan includes five goals: (1) ensure NRC readiness for regulatory decision-making, (2) establish an organizational framework to review AI applications, (3) strengthen and expand AI partnerships, (4) cultivate an AI-proficient workforce, and (5) pursue use cases to build an AI foundation across the NRC.

The AI Strategic Plan supports the NRC's mission, broadly aligns with the agency's Principles of Good Regulation, and is tied to multiple NRC FY 2022–2026 Strategic Plan safety, security, and openness strategies [1]. The overall goal of the AI Strategic Plan is to ensure the staff's readiness to effectively and efficiently review and evaluate the use of AI in NRC-regulated activities. Any future guidance or rulemaking, if needed, will follow the agency's typical processes. In part, the AI Strategic Plan's success will depend on early and frequent industry stakeholder engagement on envisioned AI applications and partnering with domestic and international counterparts to gain valuable information to benchmark the agency's AI activities.



Comanche Peak Nuclear Power Plant, Units 1 and 2

FOREWORD

MESSAGE FROM THE DIRECTOR OF THE OFFICE OF NUCLEAR REGULATORY RESEARCH



RAYMOND FURSTENAU

I am pleased to present the U.S. Nuclear Regulatory Commission's (NRC's) Artificial Intelligence (AI) Strategic Plan for Fiscal Years 2023-2027. The objective of the NRC's AI Strategic Plan is to ensure continued staff readiness to review and evaluate future AI applications effectively and efficiently. We recognize that interest in AI is growing rapidly in both, the public and private sectors. As such, I think it is important to lay the groundwork needed to ensure the safe and secure use of AI in NRC-regulated activities.

The AI Strategic Plan illuminates our path forward for the NRC to continue to improve its skills and capabilities to review and evaluate the application of AI to NRC-regulated activities, maintain awareness of technological innovations, and ensure the safe and secure use of AI in NRC-regulated activities. This strategy is a critical step in our journey to continue to keep pace with technological innovations such as AI and furthers the agency's commitment to being a transparent, modern, risk-informed regulator.

Lastly, I believe in the power of collaboration, especially when trying to develop a strategy to resolve complex technical challenges. Moving forward, we are committed to continuing to engage the public and external stakeholders and strengthening and expanding partnerships with domestic and international counterparts. I have great confidence, that working together, we will accomplish the goals of this strategic plan.



Palo Verde Generating Station spray pond



NRC Chairman Hanson receives a demonstration of a robot used for limited-access area inspections.

ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
AICoP	Artificial Intelligence Community of Practice
AISC	Artificial Intelligence Steering Committee
FR	Federal Register
FY	Fiscal Year
NRC	U.S. Nuclear Regulatory Commission



INTRODUCTION

For the purposes of this document, artificial intelligence (AI) refers to a machine-based system that can go beyond defined results and scenarios and has the ability to emulate human-like perception, cognition, planning, learning, communication, or physical action. For a given set of human-defined objectives, AI can make predictions, recommendations, or decisions influencing real or virtual environments. These systems use machine- and human-based inputs to perceive real and virtual environments, abstract such perceptions into models through analysis in an automated manner, and use model inference to formulate options for information or action [2]. The AI Strategic Plan focuses on a broad spectrum of AI sub-specialties (e.g., natural language processing, machine learning, deep learning, etc.) which could encompass various algorithms and application examples which the U.S. Nuclear Regulatory Commission (NRC) has not previously reviewed and evaluated. The NRC has developed the AI Strategic Plan to plan and prepare for new technologies involving AI. Any future guidance or rulemaking, if needed, will follow the agency's routine processes.

An AI algorithm is a computer program that has been trained on a set of data to recognize certain types of patterns. AI uses various types of algorithms to reason over and learn from this data, with the overarching goal of providing solutions that mimic human-based decisions and predictions for problems. Unlike developing and coding a traditional software program with specific instructions to complete a task, AI seeks to learn to recognize patterns and make predictions. This AI Strategic Plan considers an evolving landscape where computers use data and unseen behavior to construct the underlying algorithmic model, draw inferences, and define the rules to achieve a task. Advances in computing technologies have led to the expanded use of AI across multiple disciplines in the public and private sectors, both domestically and internationally. AI provides new opportunities for organizations to enhance safety and security, improve processes, leverage historical and current data, identify research needs, and even explore autonomous control and operation. As a result, the nuclear industry has expressed interest in deploying these technologies. The NRC remains committed to enabling the safe and secure use of new technologies, especially those that can enhance the safety and security of nuclear facilities. The NRC is committed to keeping pace with technological innovations to effectively and efficiently carry out its safety and security mission.

The AI Strategic Plan was developed considering a variety of ongoing and future regulatory actions, and this strategy and its implementation will support those other activities. Thus, this strategy supports the NRC’s mission,¹ broadly aligns with the agency’s Principles of Good Regulation,² and is tied to the following:

- NUREG-1614, Volume 8, “U.S. Nuclear Regulatory Commission Strategic Plan: Fiscal Years 2022-2026,” issued April 2022 [1]
- NRC, “International Strategy: 2021-2025,” issued August 2021 [3]
- NUREG-1908, Volume 4, “Information Technology Information Management Strategic Plan: Fiscal Years 2020-2024,” issued November 2019 [4]

AI encompasses numerous technical disciplines involving data and foundational concepts (e.g., data analysis, statistics, computer programming, engineering), many of which the NRC already has experience with to conduct its regulatory mission. However, given major advancements in AI, it is critical to establish how AI builds upon and relates to other data fields to understand the potential uses of AI in NRC-regulated activities. Figure 1 illustrates these relationships in two different ways. On the left is a pyramid representing the increasing levels of complexity and maturity needed to implement AI within an organization. The foundation of this pyramid is data collection, which establishes the databases from which the AI is developed. Next is data infrastructure, which includes tools to organize and transform the collected data, make it available, and govern its use. From this point, the data may be used in data analytics, which provides plots and descriptive statistics that can be used in decision-making. Once the organization is capable of data analytics, it can pursue data science, which entails predictive modeling using data. Lastly, AI is at the apex of the pyramid with the supporting foundational fields underneath. As shown Figure 1, this AI Strategic Plan primarily covers AI and data science applications.

1 The NRC’s mission can be found at <https://www.nrc.gov/about-nrc/values.html>.

2 The NRC’s Principles of Good Regulation and other values can be found at <https://www.nrc.gov/about-nrc/values.html#principles>.

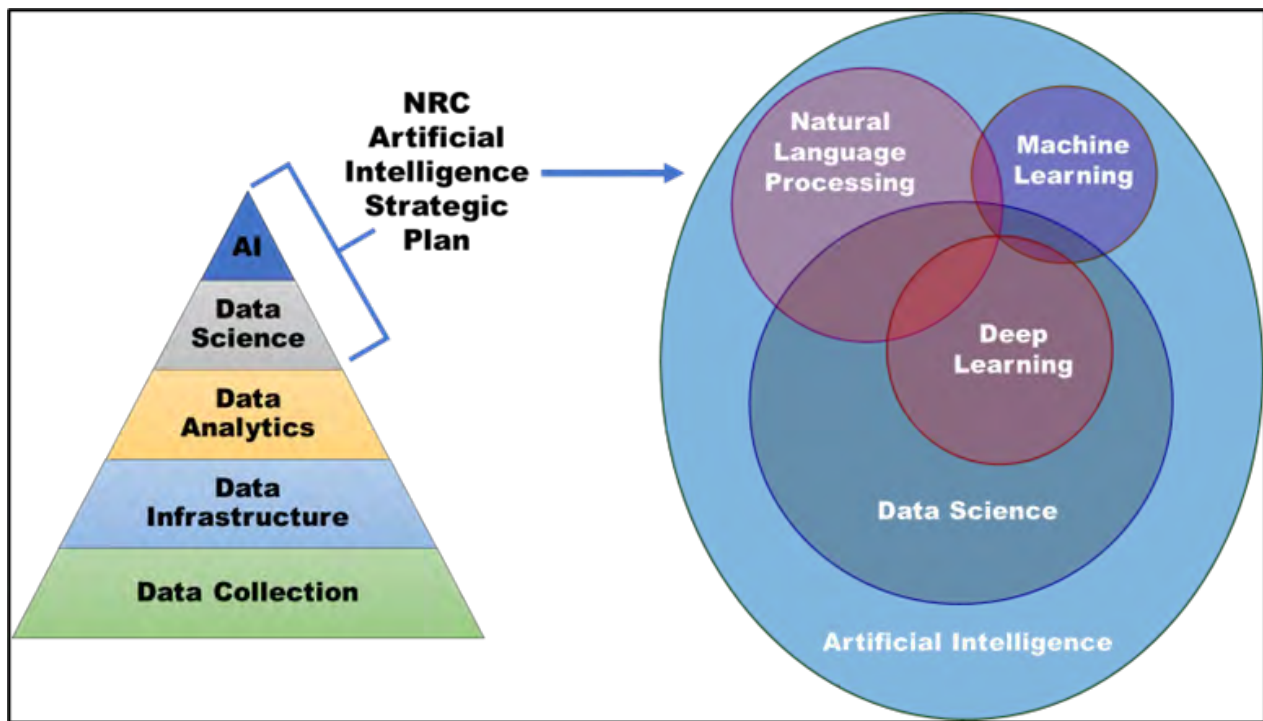


Figure 1 Artificial Intelligence Hierarchy and Relationship with the NRC AI Strategic Plan (adapted from [5] and [6])

The right side of Figure 1 illustrates an overview of major fields within the scope of the AI Strategic Plan. As shown in the figure, this AI Strategic Plan considers machine learning, deep learning, and natural language processing to be subsets of AI with data science being a foundational discipline.

AI technologies provide the underlying capability for autonomous systems. While AI enables autonomy, not all uses of AI are autonomous. For example, many AI capabilities may be used to augment human decision-making rather than replace it. Table 1 provides notional AI and autonomy levels in potential commercial nuclear activities. Higher autonomy levels indicate less reliance on human intervention or oversight and, therefore, may require greater regulatory scrutiny of the AI system. AI Strategic Goal 1, discussed further in Section 4.1, will assess the current regulatory framework and establish the appropriate regulatory requirements for varying degrees of AI and autonomy. Lastly, the NRC recognizes that there are differences between automation³ and autonomy in potential uses of AI in NRC-regulated applications. As such, the NRC will treat these differences with the appropriate level of regulatory scrutiny and consider the multiple criteria necessary to determine the appropriate regulatory involvement for each level.

³ *Automation is considered to be a system that automatically takes action on a specific task according to pre-defined, prescriptive rules. For example, reactor protection systems are automatically actuated when process parameters exceed certain defined limits. In an autonomous system, both the point at which action is taken and the action that is taken are the result of training an algorithm on data collected about the system.*

Table 1 Notional AI and Autonomy Levels in Commercial Nuclear Activities

Notional AI and Autonomy Levels	Potential Uses of AI and Autonomy in Commercial Nuclear Activities
Level 0: AI Not Used	No AI or autonomy integration in systems or processes
Level 1: Insight (Human decision-making assisted by a machine)	AI integration in systems is used for optimization, operational guidance, or business process automation that would not affect plant safety/security and control
Level 2: Collaboration (Human decision-making augmented by a machine)	AI integration in systems where algorithms make recommendations that could affect plant safety/security and control are vetted and carried out by a human decisionmaker
Level 3: Operation (Machine decision-making supervised by a human)	AI and autonomy integration in systems where algorithms make decisions and conduct operations with human oversight that could affect plant safety/security and control
Level 4: Fully Autonomous (Machine decision-making with no human intervention)	Fully autonomous AI in systems where the algorithm is responsible for operation, control, and intelligent adaptation without reliance on human intervention or oversight that could affect plant safety/security and control

The NRC recognizes the output of this AI Strategic Plan may also support agency use of AI tools to enhance internal NRC activities. For example, the NRC will gain additional knowledge and expertise in AI and data literacy to potentially support expanding use for decision-making across the agency. Further discussion related to considerations on internal agency use of AI can be found in Appendix B.

VISION

The NRC's vision is to continue to keep pace with technological innovations to allow for the safe and secure use of AI in NRC-regulated activities, when appropriate.





Palo Verde Nuclear Generating Station control room

PURPOSE AND DRIVERS

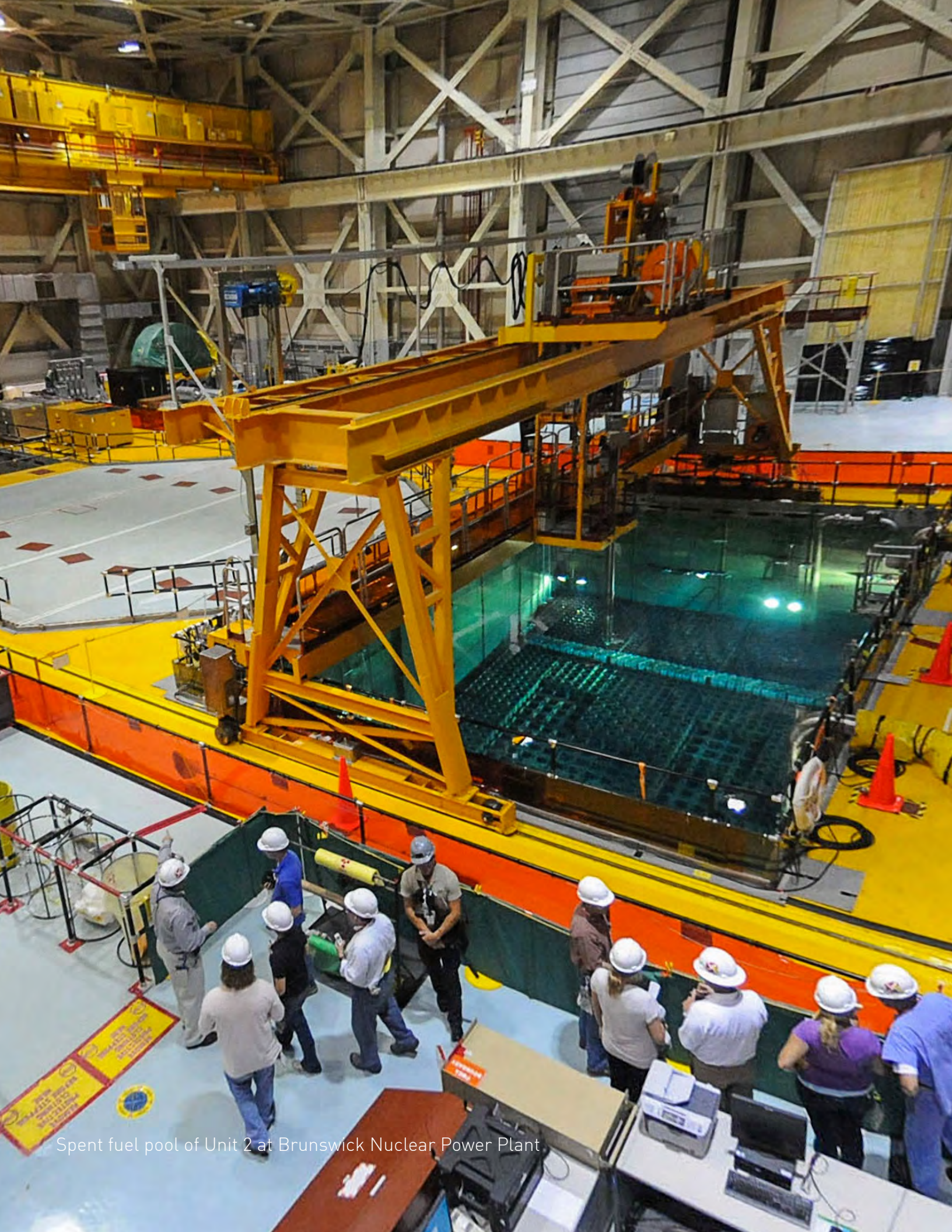
The purpose of the AI Strategic Plan is to ensure the staff's readiness to review the use of AI in NRC-regulated activities as the nuclear industry has expressed interest in deploying AI applications. Based on feedback from the NRC's Data Science and AI Regulatory Applications Public Workshops,⁴ the nuclear industry could start deploying AI technologies in the near future and has already begun investigating, developing, and assessing how such technologies can be used. Licensing applications that include the use of AI technologies may be submitted to the NRC for review and approval in the next few years.

In fiscal year (FY) 2021, the NRC began actively coordinating within the agency and across the nuclear industry to better understand activities and plans for AI by (1) conducting an internal scan to ascertain the scope of existing NRC projects that may fall within the technical area of AI, (2) issuing a Federal Register (FR) notice⁵ to solicit feedback on the nuclear industry's AI readiness and applications, and (3) hosting a series of Data Science and AI Regulatory Applications Public Workshops to provide a forum for the NRC, nuclear industry, and relevant stakeholders to discuss the state of knowledge and research activities related to data science and AI and their application in the nuclear industry. In February 2022, the NRC issued NUREG/CR-7294, "Exploring Advanced Computational Tools and Techniques with Artificial Intelligence and Machine Learning in Operating Nuclear Plants" [7], documenting the current state of practice of AI tools in the nuclear industry. In July 2022, the NRC issued an FR notice⁶ to solicit feedback on the draft AI Strategic Plan. The staff used these insights in the development of this AI Strategic Plan. The NRC has also learned from nuclear industry, U.S. Government agencies, nonprofit organizations, academia, international counterparts with mature or developing AI programs, and the public to gain valuable insights to inform the development of this AI Strategic Plan.

4 *The NRC hosted a series of Data Science and AI Regulatory Applications Public Workshops in June, August, and November 2021 to provide a forum for the NRC, nuclear industry, and stakeholders to discuss the state of knowledge and research activities related to data science and AI and their application in the nuclear industry. At these workshops, the NRC worked with internal and external stakeholders to identify the benefits and risks associated with the use of AI in regulatory activities and discussed ongoing and planned projects in the nuclear industry. For more details, see the NRC public Web site at <https://www.nrc.gov/public-involve/conference-symposia/data-science-ai-reg-workshops.html>.*

5 *See 86 FR 20744, "Role of Artificial Intelligence Tools in U.S. Commercial Nuclear Power Operations," at <https://www.federalregister.gov/documents/2021/04/21/2021-08177/role-of-artificial-intelligence-tools-in-us-commercial-nuclear-power-operations>.*

6 *See 87 FR 39874, "NRC's Fiscal Years 2023-2027 Artificial Intelligence Strategic Plan," at <https://www.federalregister.gov/documents/2022/07/05/2022-14239/nrcs-fiscal-years-2023-2027-artificial-intelligence-strategic-plan>.*



Spent fuel pool of Unit 2 at Brunswick Nuclear Power Plant

STRATEGIC GOALS

The AI Strategic Plan sets out the five strategic goals shown in Figure 2 to ensure readiness for reviewing the use of AI in NRC-regulated activities.

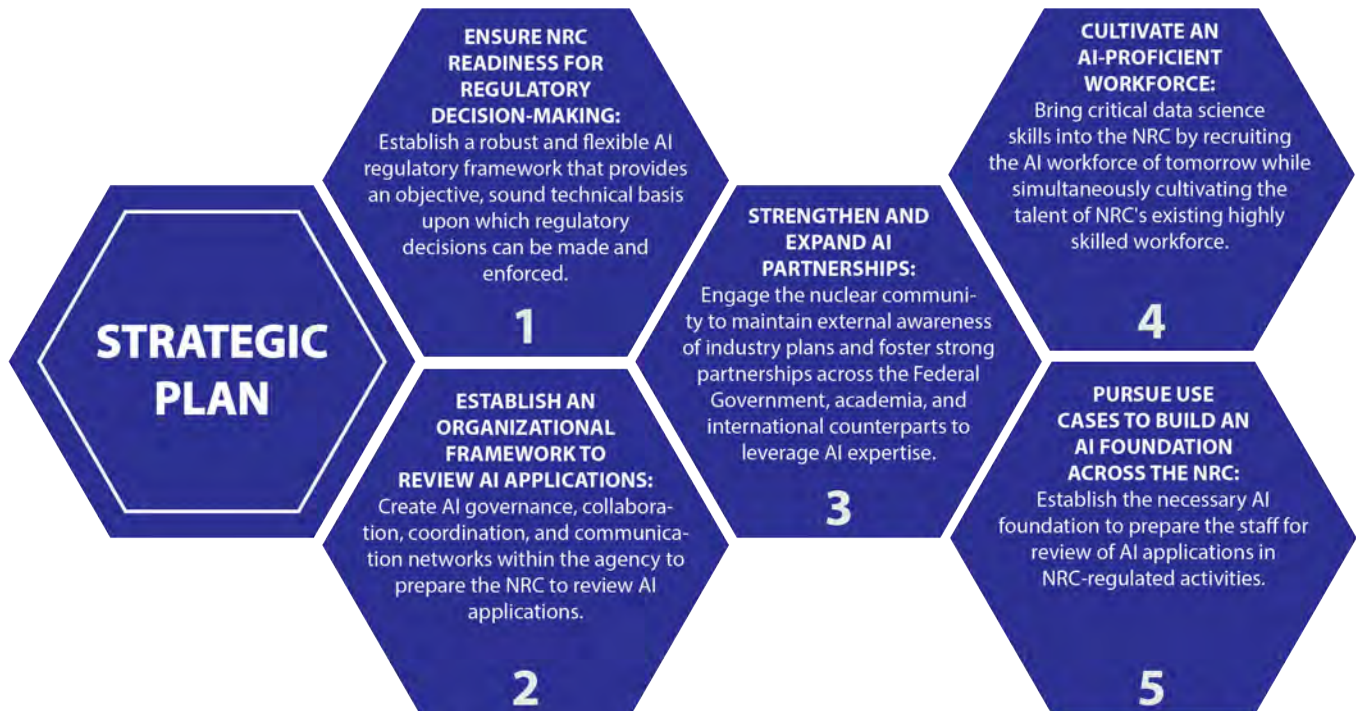


Figure 2 Overview of Strategic Goals

As shown above, the first strategic goal is the ultimate outcome of the implementation of this strategic plan, which is to continue to keep pace with technological innovations to allow for the safe and secure use of AI in NRC-regulated activities, when appropriate, through existing or new regulatory guidance, rules, inspection procedures, or oversight activities (AI Strategic Goal 1). AI Strategic Goals 2 through 5 directly support preparatory activities that culminate in successfully supporting technical readiness for regulatory decision-making activities desired in AI Strategic Goal 1. The establishment of the organizational framework (AI Strategic Goal 2) ensures all aspects of the NRC are represented in the preparations for reviewing AI in NRC-regulated activities. Strong partnerships are essential to ensuring the safe and secure use of AI in the nuclear industry. As such, the NRC is committed to engaging the industry and relevant stakeholders to maintain awareness of industry efforts (AI Strategic Goal 3) and prepare for regulatory reviews. The NRC will also engage in workforce development and acquisition to ensure that the NRC staff and contractors have the critical skills required (AI Strategic Goal 4) to evaluate the use of AI in NRC-regulated activities. The NRC recognizes the establishment of a foundation in data science as a fundamental requirement for evaluating AI applications. Therefore, the NRC will build the necessary AI foundation to pursue use cases across the NRC (AI Strategic Goal 5), which will foster organizational experience that supports future regulatory reviews and oversight activities.

The AI Strategic Goals are listed in order of priority and are expected to be initiated during different timeframes. Several organizations within the NRC play a significant role in achieving the strategic goals, and the successful implementation of activities necessary to achieve the goals outlined in this AI Strategic Plan will involve NRC staff members with varied expertise. The NRC will also continue to monitor external factors that may influence the ability to achieve these strategic goals.

The NRC developed an agency evidence-building plan [8], as required by the Foundations for Evidence-Based Policymaking Act of 2018 [9], for identifying and addressing priority questions relevant to the agency's programs, policies, and regulations. The NRC will leverage the resulting evidence gathered through the execution of the agency evidence-building plan to support the AI strategic goals. Furthermore, the AI strategic goals may inform the use of AI tools within the agency and enhance select activities, as discussed in Appendix B of this AI Strategic Plan.

4.1 Strategic Goal 1: Ensure NRC Readiness for Regulatory Decision-Making



The deployment of AI technologies by the nuclear industry is on the horizon. The NRC anticipates that within the next few years an existing licensee, new, or advanced nuclear technology applicant may employ AI in such a manner that it requires NRC regulatory approval or oversight. Guided by the agency's Principles of Good Regulation,⁷ the NRC will continue to be effective and efficient as it conducts its safety and security mission.

This goal focuses on developing the regulatory guidance and tools to prepare the staff to assess AI as part of NRC regulatory activities. The NRC recognizes that the nuclear industry is likely to use AI in applications (e.g., notional AI and autonomy adoption levels in Table 1) for the design and operation of nuclear facilities that may require regulatory approval or oversight. Therefore, the NRC will assess whether any regulatory guidance (e.g., regulatory guides or standard review plan sections) or inspection procedures need to be updated or created to clarify the process and procedure for the licensing and oversight of AI in NRC-regulated activities. The need for revision will be based on the information gathered through the execution of this AI Strategic Plan, engagement with external stakeholders (AI Strategic Goal 3), and experience obtained through pursuing internal use cases and their impact on the agency's regulatory framework (AI Strategic Goal 5). For example, the NRC will leverage its experience reviewing relevant historical

⁷ The NRC's Principles of Good Regulation and other values can be found at <https://www.nrc.gov/about-nrc/values.html#principles>.

models as it determines the requirements for new, more detailed models. Additionally, the NRC will leverage lessons learned from previous new technology applications in NRC-regulated activities to inform the development of the AI framework. Lastly, additional options for long-range changes for AI regulatory reviews and oversight that might require rulemaking will also be considered.

The NRC will undertake research to develop an AI framework to determine the approach to assess technical areas such as, but not limited to, topics shown in Table 2. The NRC will also work with agency stakeholders and the international regulatory community to determine the currently available AI standards and identify the technical areas where gaps may exist. In addition, the NRC will participate with standards development organizations and work with Federal agencies and the international regulatory community (AI Strategic Goal 3) to offer critical expertise and perspectives to inform the drafting and revision of AI standards and guidance documents.

Table 2 Potential AI Technical Considerations for Regulatory Decision-Making

Explainability	Trustworthiness	Bias
Robustness	Ethics	Security
Risk Analysis	Test, Evaluation, Verification and Validation	Assurance Processes
Model Maintenance	Domain Adaptation	Data Drift
Fielded Performance Degradation	Life Cycle Management	Data Quality, Quantity, Applicability, and Uncertainty

The development of the AI framework will be communicated with agency stakeholders and the public to maintain transparency and clearly communicate regulatory guidance to the nuclear industry as early as possible in the process (AI Strategic Goal 3). For this goal, a successful outcome is providing, as needed, the regulatory guidance and tools to ensure readiness for reviewing the use of AI in NRC-regulated activities.

4.2 Strategic Goal 2: Establish an Organizational Framework to Review AI Applications



The successful implementation of the AI Strategic Plan requires effective coordination and collaboration across the NRC, at both the management and staff levels. The NRC will establish an internal Artificial Intelligence Steering Committee (AISC) to provide cross-office coordination and direction to ensure readiness for regulatory decision-making and develop AI governance. The AISC will include senior management with responsibility for AI technology across the agency. The AISC may engage external subject-matter experts with AI expertise to assist with specific issues, as needed. The AISC will also leverage existing information technology, data, and security communities and expertise. They will coordinate with the Information Technology and Information Management Portfolio Executive Council to ensure direct prioritization of the activities that will enable the achievement of the strategic goals outlined in this document.

To support staff engagement and collaboration, the NRC will need to establish an internal AI Community of Practice (AICoP) to provide a forum for the NRC staff to (1) discuss best practices and lessons learned for reviewing requests that include the use of AI technologies, (2) provide agencywide awareness on active and potential use cases, and (3) facilitate the sharing of best practices and lessons learned. The AICoP will be comprised of NRC staff members from across the agency who are active in or interested in AI policy, technology, standards, and programs. In addition, AI working groups will support the AISC's efforts as needed to execute the AI Strategic Plan, such as prioritization of AI research, technical workshops, and specific subject-matter tasks as assigned. Membership for the AI working groups to support relevant subject matter expertise can be drawn from the AICoP.

A successful outcome of this goal is an organization that facilitates effective coordination and collaboration across the NRC to ensure readiness for reviewing the use of AI in NRC-regulated activities.

4.3 Strategic Goal 3: Strengthen and Expand AI Partnerships



Strong partnerships across the Federal Government, with the nuclear industry, and with international counterparts are essential in order to gain valuable information to benchmark the agency's AI activities and serve as force multipliers to optimize resources and effort. Scientific and technological exchange ensures the NRC remains current in the rapidly evolving AI field.

The NRC will continue to strengthen and expand strong AI working partnerships with domestic and international counterparts within the nuclear industry to stay abreast of industry interests, activities, and plans to deploy AI. For domestic AI activities, the NRC will continue to engage with stakeholders, including the public, nongovernmental organizations, and regulated entities through existing and new memoranda of understanding, public meetings, and workshops. For international AI activities, the NRC will continue to engage with international counterparts and multilateral organizations to collaborate in sharing information on the use of AI in NRC-regulated activities, conduct cooperative research, and influence the development of international standards and guidance.

The NRC is aware that other Federal agencies and industry sectors are faced with the potential challenges of safely and securely deploying, overseeing, and evaluating AI technologies. In some cases, other Government agencies have more experience with assessment and implementation of AI. Their experience and lessons learned provide the NRC with a unique opportunity to engage in intergovernmental information sharing, collaboration, and potential technology transfer from those agencies. The NRC will continue to build partnerships with other Government agencies to facilitate the exchange of ideas, practices, and procedures.

Incorporating the information and knowledge gathered from external organizations, including regulatory research, industry, Federal partners, standards, and international bodies, into the NRC staff knowledge base will allow for timely and informed regulatory decision-making. The NRC will coordinate external interactions, disseminate information from these interactions to the appropriate NRC staff, and support technical training and workshops to build AI awareness across the NRC offices. When achieved, this goal will provide established mechanisms to (1) maintain awareness of industry plans, (2) establish communication forums to discuss future plans and regulatory needs, and (3) effectively partner with other agencies on AI topics of mutual benefit.

4.4 Strategic Goal 4: Cultivate an AI-Proficient Workforce



The NRC recognizes the value of acquiring, developing, and retaining a skilled workforce in the area of AI. The term AI is often used generically to encompass a wide range of applications, from data analysis to fully autonomous systems. The NRC will develop a common understanding of AI by providing the NRC staff with seminars, workshops, and training.

This goal focuses on developing the technical information, knowledge, and tools to prepare the staff to review AI applications. The NRC must have the right number of people with the right skills at the right time to conduct effective and efficient regulatory

reviews and oversight activities to accomplish its safety and security mission. Given the competitive marketplace for AI talent, the NRC will establish and stabilize a pipeline for AI talent by using the Strategic Workforce Planning and Competency Models to meet this strategic goal and support NRC needs. A primary mechanism for building this pipeline is leveraging existing hiring processes (e.g., NRC Integrated University Program, internships and cooperative education programs, the Nuclear Regulator Apprenticeship Network program, and the Information Technology Fellows or Graduate Fellows programs). In addition, the NRC will fully use Federal retention authorities to maintain a skilled AI workforce and allow talented experts to contribute to AI research and development activities.

The NRC will cultivate the talent of its existing highly skilled workforce by investing in comprehensive training for NRC staff and managers working on use cases (AI Strategic Goal 5). The NRC AI training program will use a tiered approach, providing training ranging from basic to advanced concepts, applications, and AI tools tailored to the needs of the agency and staff development objectives.

The goal is to adopt the appropriate training programs and tools to develop the requisite skills in the NRC workforce. A successful outcome of this goal is to ensure appropriate qualifications, training, expertise, and access to tools exist for the workforce to review and evaluate AI usage in NRC-regulated activities effectively, efficiently and in a timely manner.

4.5 Strategic Goal 5: Pursue Use Cases to Build an AI Foundation Across the NRC



AI technologies may pose novel challenges for the NRC regulatory framework. As the NRC prepares for regulatory decision-making, internal uses of AI tools will increase staff knowledge and experience for future regulatory reviews and oversight, especially when those same tools may be used in external AI applications.

This goal focuses on developing and pursuing use cases, consistent with priority question two of the agency evidence-building plan (as discussed in Appendix B of this AI Strategic Plan), to build technical expertise for reviewing the use of AI in NRC-regulated activities. To build this expertise, the NRC needs to create an ecosystem that supports data science, assessment and integration of emerging AI tools, and hands-on talent development for reviewing the use of AI in NRC-regulated activities. To better understand how AI algorithms, models, and claims are validated and tested, the NRC needs to undertake research to develop use cases with data from various sources and in multiple forms. These use cases will help the staff gain AI expertise that could be used in performing regulatory reviews or assessments for a wide range of potential AI

applications. In addition, the NRC is planning to investigate engaging collaboratively with the nuclear industry to pursue potential pilot studies and proofs of concept to serve as a foundation for reviewing the use of AI in NRC-regulated activities. These pilots and proofs of concept, which would rely on industry feedback and engagement, may help in identifying challenges associated with getting the AI applications through the AI framework.

Lastly, the NRC will investigate improving staff access to software-based AI tools as part of the AI ecosystem which may be required to review and evaluate AI applications in NRC-regulated activities. Additionally, providing access to training and development with respect to the tools under the AI ecosystem facilitates staff engagement in training exercises that may mimic future regulatory reviews using such tools. This will allow staff to develop expertise and identify and address potential gaps in future regulatory reviews.

For this goal, a successful outcome is one in which the NRC staff possesses an ecosystem that supports AI analysis, integration of emerging AI tools, and hands-on talent development for reviewing AI applications from the nuclear industry.



McGuire Nuclear Station, Units 1 and 2

CONCLUSION

The NRC remains committed to ensuring that the use of new technologies is safe and secure. New technologies, like AI, have the potential to enhance the safety and security of nuclear facilities. This AI Strategic Plan presents the vision and goals for the NRC to cultivate an AI-proficient workforce, keep pace with AI technological innovations, and ensure the safe and secure use of AI in NRC-regulated activities.





REFERENCES

1. NRC, "U.S. Nuclear Regulatory Commission Strategic Plan: Fiscal Years 2022-2026," Washington, DC, NUREG-1614, Vol. 8, ML22067A170, 2022.
2. 116th U.S. Congress, "H.R.6395 - National Defense Authorization Act for Fiscal Year 2021: National Artificial Intelligence Initiative Act of 2020," 2021. [Online]. Available: <https://www.congress.gov/bill/116th-congress/house-bill/6395/text>.
3. NRC, "International Strategy: 2021-2025," Washington, DC, ML21236A120, <https://www.nrc.gov/docs/ML2123/ML21236A120.pdf>, 2021.
4. NRC, "Information Technology and Information Management Strategic Plan: Fiscal Years 2020-2024," U.S. Nuclear Regulatory Commission, Washington, DC, NUREG-1908, Vol. 4, ML19323D858, <https://www.nrc.gov/docs/ML1932/ML19323D858.pdf>, 2019.
5. O. Osagie, "medium.com," Medium, 21 February 2021. [Online]. Available: <https://medium.com/swlh/the-ai-hierarchy-of-needs-9b015d061f29>. [Accessed January 2022].
6. A. N. J. P. a. R. S. Andy Ho, "A Data Science Approach to Defining a Data Scientist," SMU Data Science Review, vol. 2, no. 3, 2019.
7. NRC, "Exploring Advanced Computational Tools and Techniques with Artificial Intelligence and Machine Learning in Operating Nuclear Plants," U.S. Nuclear Regulatory Commission, Washington, DC, NUREG/CR-7294, ML22042A662, <https://www.nrc.gov/docs/ML2204/ML22042A662.pdf>, 2022.
8. NRC, "Evidence Building Plan, Fiscal Year 2022," U.S. Nuclear Regulatory Commission, Rockville, MD, <https://www.nrc.gov/docs/ML2206/ML22066B056.pdf>, ML22066B056, 2022.
9. 115th U.S. Congress, "H.R.4174 - Foundations for Evidence-Based Policymaking Act of 2018," 2021. [Online]. Available: <https://www.congress.gov/bill/115th-congress/house-bill/4174/text>.



Calvert Cliffs Nuclear Power Plant, Units 1 and 2

APPENDIX A GLOSSARY

- **ARTIFICIAL INTELLIGENCE (AI):** The term AI refers to a machine-based system that can go beyond defined results and scenarios and has the ability to emulate human-like perception, cognition, planning, learning, communication, or physical action. For a given set of human-defined objectives, AI can make predictions, recommendations, or decisions influencing real or virtual environments. AI systems use machine- and human-based inputs to perceive real and virtual environments, abstract such perceptions into models through analysis in an automated manner, and use model inference to formulate options for information or action (adapted from [1]).
- **AI APPLICATION:** An AI application represents a use case, project, plan, or other topic area that uses various AI technology and tools to conduct research and development or create a production product, service, or goal.
- **AI TECHNOLOGY:** AI technology represents the algorithms and methods that are used within the available machine learning and AI software tool sets.
- **AI TOOLS:** AI tools represent the computer software, code, information technology infrastructure, and service provider utilities (e.g., Azure Cognitive Service, IBM Watson Studio) that are used to facilitate AI applications.
- **DATA ARCHITECTURE:** Data architecture is defined by where the data resides; how it is collected, managed, secured, and accessed; and who has access to it. This architecture is constructed using purpose-built repositories, tools, and techniques, and it is controlled through the implementation of governance standards and policies.

- **DATA SCIENCE:** Data science is a multidisciplinary field that involves computer programming codes, such as Python and R; collaboration with other technical disciplines; and communication using charts, graphs, or dashboards and by transforming data into insights using techniques in statistics, analytics, and machine learning [2]. Data scientists use computer programming languages, such as Python, to develop algorithms that classify, predict, and suggest outcomes from data. In comparison, data analysts use historical data to create visualizations and predictions using dashboard development tools, such as Tableau and PowerBI.
- **DATA ANALYTICS:** The goal of data analytics is to derive and effectively communicate actionable insights from a vast quantity and variety of data. It covers a broad spectrum of activities, including data management and quality, mathematical and statistical methods for data modeling, and techniques for visualizing data in support of enterprise-wide decision-making [2]. Data analysts use historical data to create visualizations and predictions using dashboard development tools, such as Tableau and PowerBI. In comparison, data scientists use computer programming languages, such as Python, to develop algorithms that classify, predict, and suggest outcomes from data.
- **DEEP LEARNING:** Deep learning is a subset of machine learning in which multilayered neural networks, modeled to work like the human brain, “learn” from large amounts of data. Within each layer of the neural network, deep learning algorithms perform calculations and make predictions repeatedly, progressively “learning” and gradually improving the accuracy of the outcome over time. Deep learning is differentiated in that it can ingest and process unstructured, unlabeled data [3].
- **MACHINE LEARNING:** Machine learning means an application of AI that is characterized by providing systems with the ability to automatically learn and improve on the basis of data or experience, without being explicitly programmed [1].

- **NATURAL LANGUAGE PROCESSING:** Natural language processing is the use of algorithms to determine properties of natural, human language so that computers can understand what humans have written or said. It includes teaching computer systems how to extract data from bodies of written text, translate from one language to another, and recognize printed or handwritten words [4].
- **USE CASE:** A use case is a specific situation in which a product or service could potentially be used.

REFERENCES

1. 116th U.S. Congress, "H.R.6395 - National Defense Authorization Act for Fiscal Year 2021: National Artificial Intelligence Initiative Act of 2020," 2021. [Online]. Available: <https://www.congress.gov/bill/116th-congress/house-bill/6395/text>.
2. North Carolina State University, "Institute for Advanced Analytics," [Online]. Available: https://analytics.ncsu.edu/?page_id=2. [Accessed May 2022].
3. IBM, "What is Deep Learning?," [Online]. Available: <https://www.ibm.com/cloud/learn/deep-learning>. [Accessed May 2022].
4. DeepAI, "Machine Learning Glossary and Terms," [Online]. Available: <https://deepai.org/machine-learning-glossary-and-terms/natural-language-processing>. [Accessed May 2022].

APPENDIX B USING ARTIFICIAL INTELLIGENCE TOOLS TO ENHANCE NRC ACTIVITIES

The U.S. Nuclear Regulatory Commission (NRC) may pursue internal opportunities for the use of artificial intelligence (AI) tools for business process automation and knowledge mining. The NRC continues to build a flexible, agile, and innovative information technology and information management environment that is prepared for the rapid development of new technologies and changes in the nuclear industry. Technological advances continue to change the way the agency works and interacts with stakeholders. The increased use of data analytics, cloud computing, and AI may improve efficiency and provide support for the workforce. These activities increase dependency on a robust and resilient network and information technology infrastructure. While AI Strategic Goals 4 and 5 principally support agency preparation for external AI usage in NRC-regulated activities, they may also benefit the agency in preparing for internal agency AI usage. In conjunction with AI Strategic Goals 4 and 5, the NRC will gain knowledge and expertise in a wide range of skills and capabilities such as artificial intelligence and data literacy, that could support expanding the use of data for decision-making in the agency.

Several actions taken by Congress or executive branch agencies are prompting the NRC to further consider the best way to strategically integrate AI technology into agency internal processes and work products in addition to the regulatory oversight functions discussed in the AI Strategic Plan. The AI Strategic Plan aligns with and supports the provisions of the following:

- Administrative Conference of the United States, Statement #20, “Agency Use of Artificial Intelligence” [1]
- Foundations for Evidence-Based Policymaking Act of 2018 (Evidence Act) [2]
- National Artificial Intelligence Initiative Act of 2020 [3]
- Office of Management and Budget M-21-06, “Guidance for Regulation of Artificial Intelligence Applications” [4]

AI tools may be used to enhance internal NRC activities, which could better allocate agency resources to higher value activities and emerging mission priorities. However, AI tools are highly dependent on the quantity and quality of the data that support them. In carrying out the agency’s mission, the NRC captures, creates, manages, and uses data from a variety of sources and in a variety of forms. These data inform the

agency's operational and regulatory decision-making and support all Federal reporting requirements. As part of the NRC's Information Technology/Information Management Strategic Plan, the agency will provide future enhancements to identify and collect data more effectively and efficiently [5].

The NRC has also developed an agency evidence-building plan, as required by the Evidence Act, for identifying and addressing priority questions relevant to the agency's programs, policies, and regulations [6]. As part of the evidence-building plan, the agency may identify what NRC decision-making processes could benefit from AI tools and prioritize the data collections that would have the most significant impact on agency decision-making, AI tool use, and stakeholder use to improve efficiency. The evidence-building plan also discusses how processes and procedures are vital to ensure consistency, clear expectations, performance measurement, and established roles and responsibilities consistent with established policy. As part of the evidence-building plan, the NRC will assess the agency's processes to determine what improvements can be implemented to continue our journey to become a more modern, risk informed regulator. When assessing processes for improvement, the NRC will include in its assessment, potential ways AI tools could be incorporated into processes, as well as for continuous process monitoring and optimization.

REFERENCES

1. Administrative Conference of the United States, “Agency Use of Artificial Intelligence,” 2021. [Online]. Available: <https://www.acus.gov/research-projects/agency-use-artificial-intelligence>.
2. 115th U.S. Congress, “H.R.4174 - Foundations for Evidence-Based Policymaking Act of 2018,” 2021. [Online]. Available: <https://www.congress.gov/bill/115th-congress/house-bill/4174/text>.
3. 116th U.S. Congress, “H.R.6395 - National Defense Authorization Act for Fiscal Year 2021: National Artificial Intelligence Initiative Act of 2020,” 2021. [Online]. Available: <https://www.congress.gov/bill/116th-congress/house-bill/6395/text>.
4. OMB, “Guidance for Regulation of Artificial Intelligence Applications,” Office of Management and Budget, Washington, DC, <https://www.whitehouse.gov/wp-content/uploads/2020/11/M-21-06.pdf>, 2020.
5. NRC, “Information Technology and Information Management Strategic Plan: Fiscal Years 2020-2024,” U.S. Nuclear Regulatory Commission, Washington, DC, NUREG-1908, Vol. 4, ML19323D858, <https://www.nrc.gov/docs/ML1932/ML19323D858.pdf>, 2019.
6. NRC, “Evidence Building Plan, Fiscal Year 2022,” U.S. Nuclear Regulatory Commission, Rockville, MD, <https://www.nrc.gov/docs/ML2206/ML22066B056.pdf>, ML22066B056, 2022.



NRC staff demonstrate X-energy's reactor facility virtual reality mockup

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

NUREG-2261

2. TITLE AND SUBTITLE

Artificial Intelligence Strategic Plan

Fiscal Years 2023–2027

3. DATE REPORT PUBLISHED

MONTH

May

YEAR

2023

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

M. Dennis, T. Lalain, L. Betancourt, A. Hathaway, R. Anzalone

6. TYPE OF REPORT

Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

Division of System Analysis
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)

Division of System Analysis
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission (NRC) recognizes that interest in artificial intelligence (AI) is growing rapidly in both the public and private sectors and anticipates increased use of AI in NRC-regulated activities. AI generally refers to a machine-based system that can and has the ability to emulate human-like perception, cognition, planning, learning, communication, or physical action. For a given set of human-defined objectives, AI can make predictions, recommendations, or decisions influencing real or virtual environments. The AI Strategic Plan focuses on a broad spectrum of sub-specialties (e.g., natural language processing, machine learning, deep learning, etc.) which could encompass various algorithms and application examples which the NRC has not previously reviewed and evaluated. Anticipating the industry's potential application of AI to NRC-regulated activities, the NRC has developed an AI Strategic Plan to ensure the agency's readiness to review such uses. The AI Strategic Plan includes five goals: (1) ensure NRC readiness for regulatory decision-making, (2) establish an organizational framework to review AI applications, (3) strengthen and expand AI partnerships, (4) cultivate an AI proficient workforce, and (5) pursue use cases to build an AI foundation across the NRC. The overall goal of this AI Strategic Plan is to ensure continued staff readiness to review and evaluate AI applications effectively and efficiently.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Artificial Intelligence, AI, Machine Learning, ML, Natural Language Processing, NLP, Strategic Plan

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)

unclassified

(This Report)

unclassified

15. NUMBER OF PAGES

16. PRICE



U.S. Nuclear Regulatory Commission

NUREG-2261

May 2023

www.nrc.gov

STAY CONNECTED

