Artificial Intelligence Project Plan

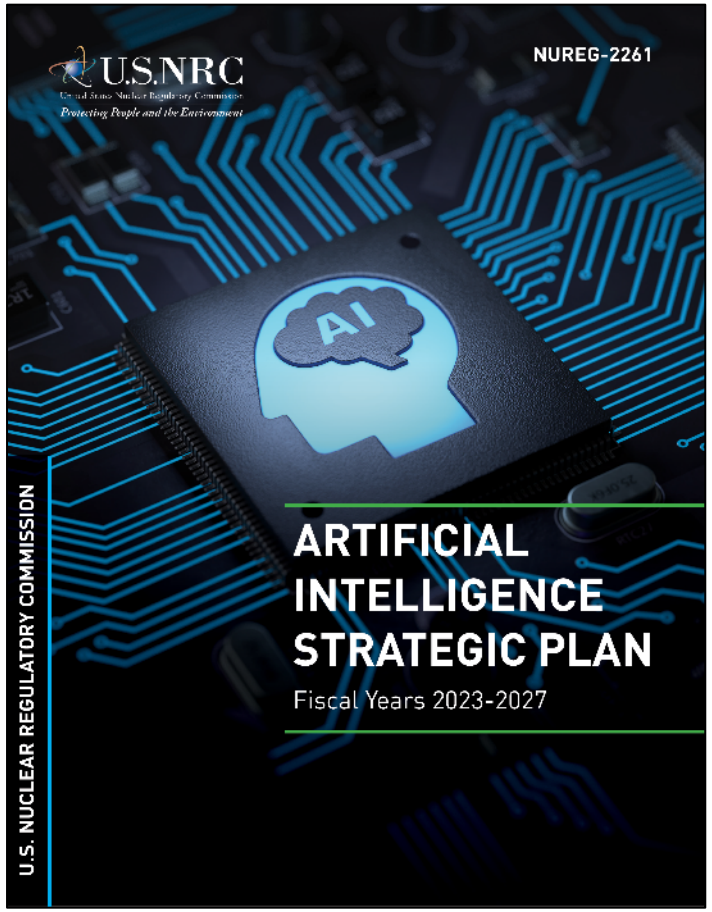
ACRS Subcommittee Meeting

Taylor Lamb

Senior Reactor Systems Engineer (Data Scientist)

November 20, 2024

Artificial Intelligence Strategic Plan Overview



Available at ML23132A305

Vision and Outcomes

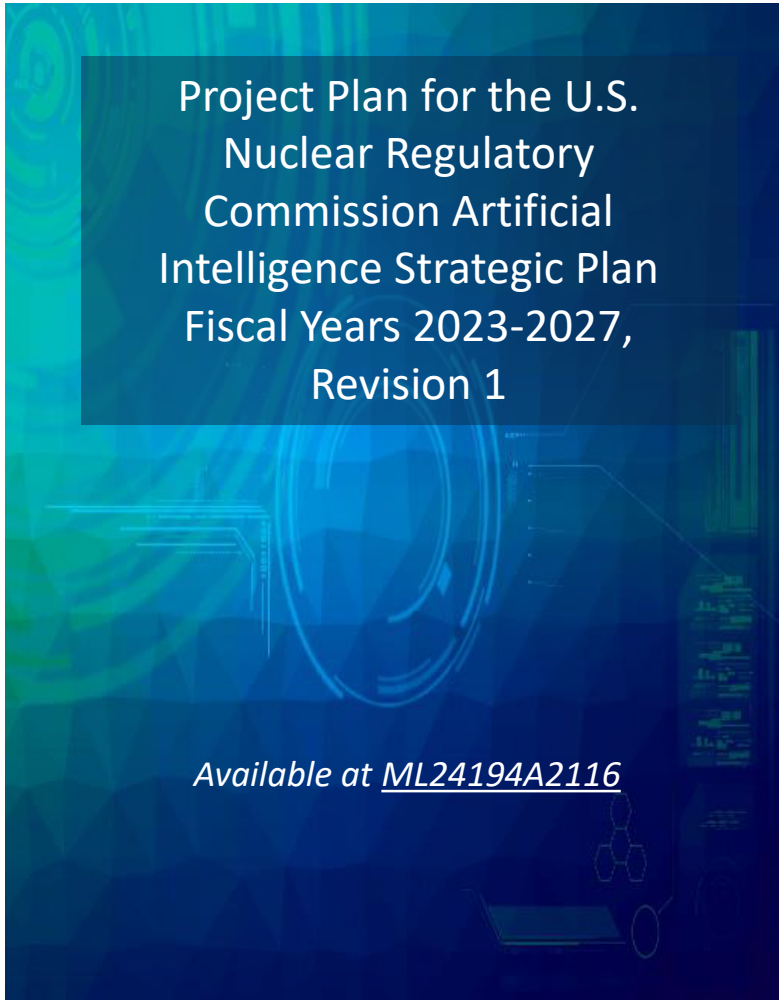
- Continue to keep pace with technological innovations to ensure the safe and secure use of AI in NRC-regulated activities
- Establish an AI framework and cultivate a skilled workforce to review and evaluate the use of AI in NRC-regulated activities

The AI Strategic Plan consists of five strategic goals:

- Goal 1: Ensure NRC Readiness for Regulatory Decisionmaking
- Goal 2: Establish an Organizational Framework to Review AI Applications
- Goal 3: Strengthen and Expand AI Partnerships
- Goal 4: Cultivate an AI-Proficient Workforce
- Goal 5: Pursue Use Cases to Build an AI Foundation Across the NRC

Artificial Intelligence Project Plan Overview

- The AI Project Plan describes how the agency will execute the five strategic goals from the AI Strategic Plan
- Provides estimated timelines for various task completions within each Strategic Goal
- Communicates NRC priorities to internal and external stakeholders



GOAL 1: Ensure NRC Readiness for Regulatory Decisionmaking

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

NUREG-0800

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

Regulatory Gap Analysis

- Assess regulations and guidance as it applies to gaps
- Identify usable standards and gaps

Planning for AI Submittals

- Collect industry AI plans
- Develop scheduling for resource allocation on AI applications

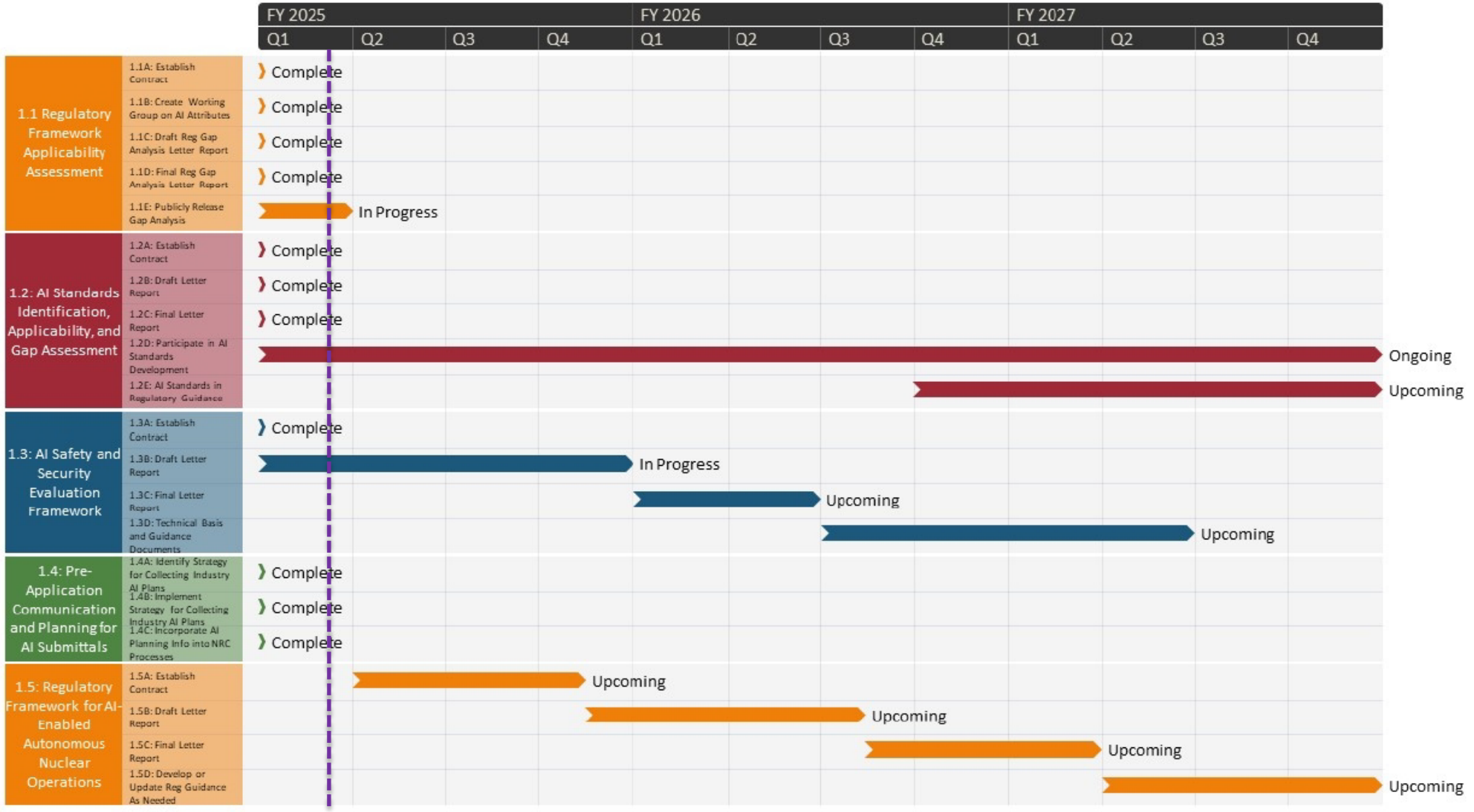
Goal 1

IEC/ SC45A/ WGA12

- Interdisciplinary team for the development of AI standards at nuclear facilities
- Applicable to entire nuclear fuel cycle
- Provides life cycle guidance on AI

Outcome: Develop an AI framework to review the use of AI in NRC-regulated activities

Goal 1: Ensure NRC Readiness for Regulatory Decision-Making



GOAL 2: Establish an Organizational Framework

NRC AI Steering Committee

Cross-agency strategic alignment and direction

Centralized coordination of resources, priorities, and use case analyses

NRC AI Community of Practice

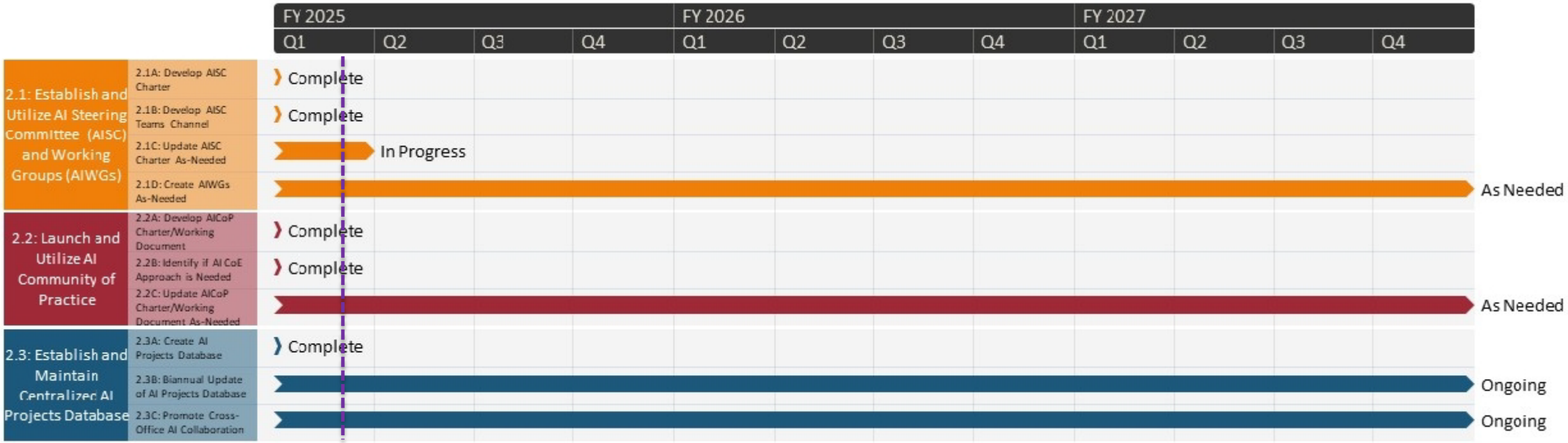
Lead best practices for reviewing requests that use AI technologies

Provide agencywide awareness on active and potential use cases

Facilitate the sharing of knowledge and lessons learned

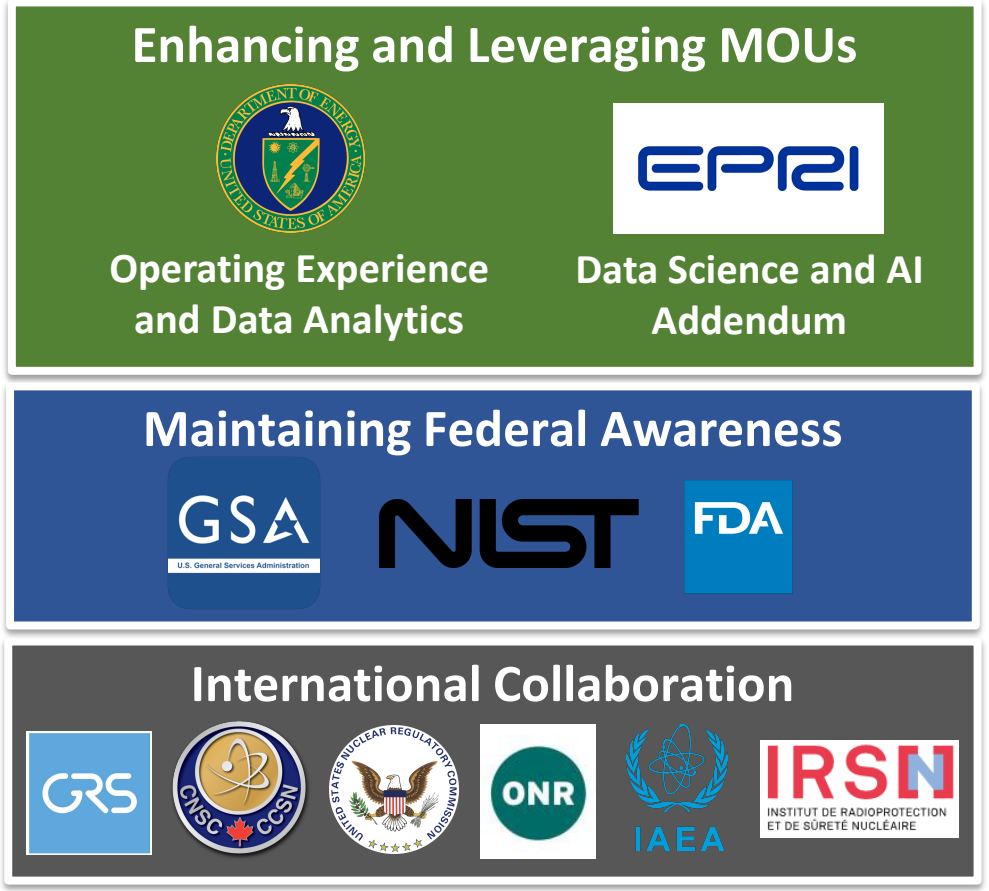
Outcome: An organization that facilitates effective coordination and collaboration across the NRC to ensure readiness for reviewing the use of AI in NRC-regulated activities

Goal 2: Establish an Organizational Framework to Review AI Applications



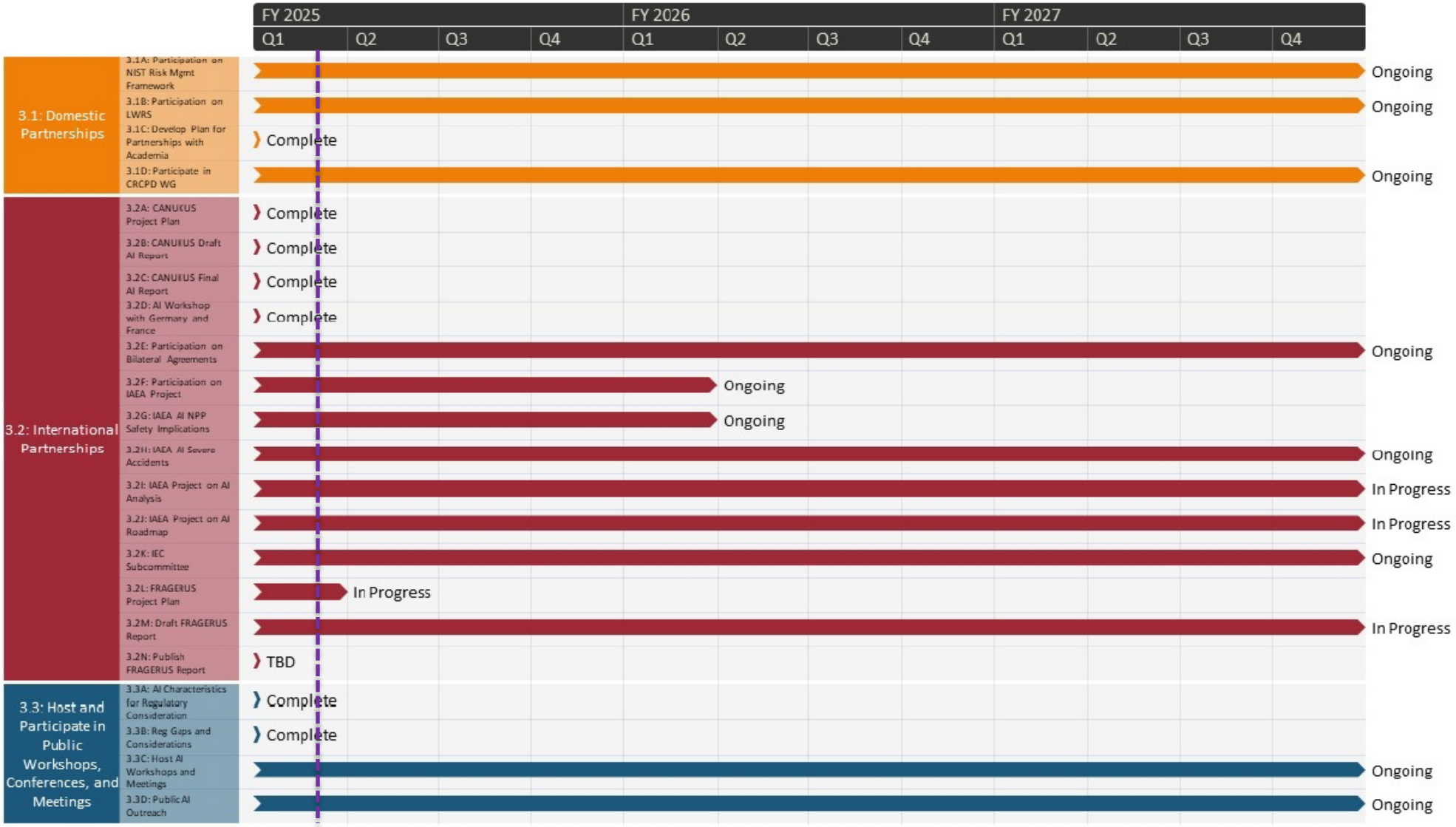
GOAL 3: Strengthening and Expanding AI Partnerships

- Enhancing and leveraging existing Memoranda of Understanding (MOU)
- Participating in federal AI working groups and maintaining awareness of other AI regulatory activities
- Engaging with international counterparts interested in AI for nuclear
- Maintaining continual engagement on state-of-the-art research



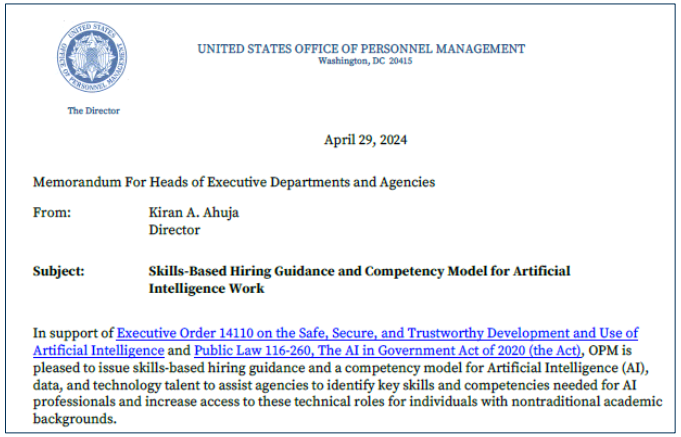
GAINING VALUABLE INFORMATION TO BENCHMARK AI ACTIVITIES

Goal 3: Strengthen and Expand AI Partnerships



GOAL 4: Cultivate an AI Proficient Workforce

- Focused on developing the critical skills for the AI workforce of tomorrow
- Staffing
  - Targeted staffing to review AI applications
  - Provide opportunities for all to learn
- Training
  - Develop qualifications and up-skilling opportunities
- Workforce Planning
  - Perform gap analysis, assess position descriptions and review hiring needs



UNITED STATES OFFICE OF PERSONNEL MANAGEMENT
Washington, DC 20415

The Director

April 29, 2024

Memorandum For Heads of Executive Departments and Agencies

From: Kiran A. Ahuja
Director

Subject: Skills-Based Hiring Guidance and Competency Model for Artificial Intelligence Work

In support of Executive Order 14110 on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence and Public Law 116-260, The AI in Government Act of 2020 (the Act), OPM is pleased to issue skills-based hiring guidance and a competency model for Artificial Intelligence (AI), data, and technology talent to assist agencies to identify key skills and competencies needed for AI professionals and increase access to these technical roles for individuals with nontraditional academic backgrounds.

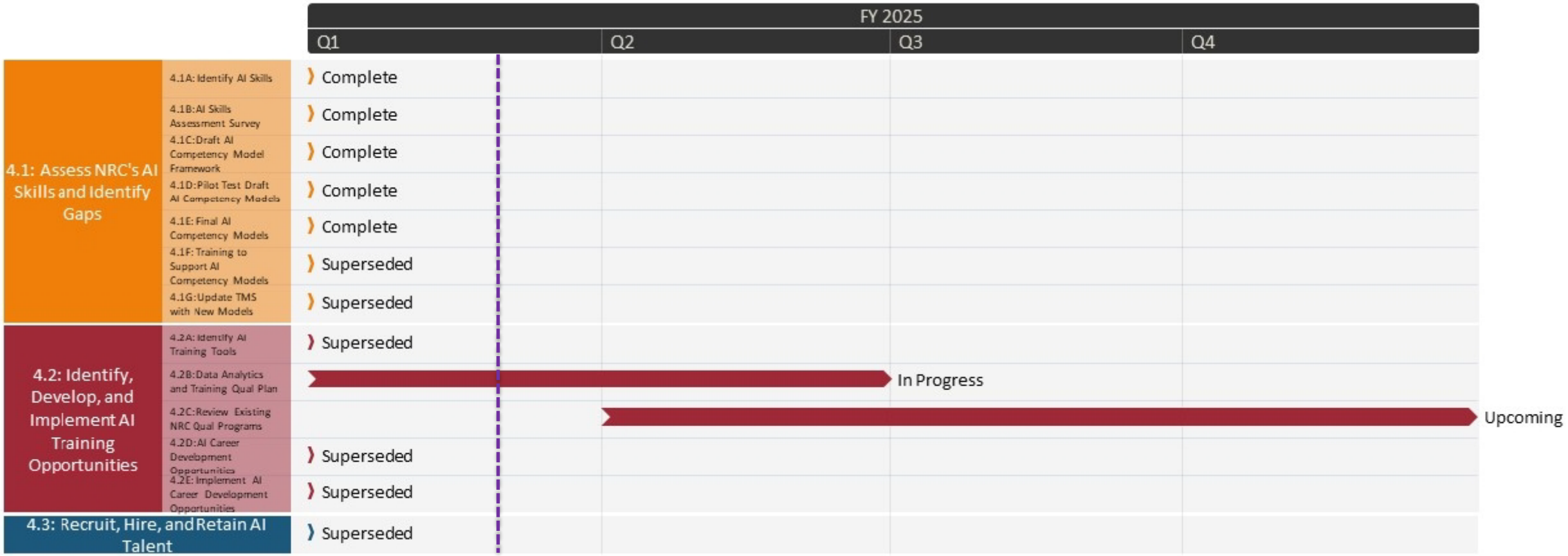
OCTOBER 30, 2023

Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence

BRIEFING ROOM • PRESIDENTIAL ACTIONS

Recruiting AI Talent on USAJOBS

Goal 4: Cultivate an AI Proficient Workforce



GOAL 5: Pursue Use Cases to Build AI Foundation Across the NRC

Pilot Studies

- Learn, measure, and evaluate readiness to implement regulatory framework
- Public workshops have shown industry interest to pursue pilot studies and proofs of concepts

AI Safety Insights

- Survey industrial safety evaluation methods and tools
- Utilize AI partnerships and engagement strategies

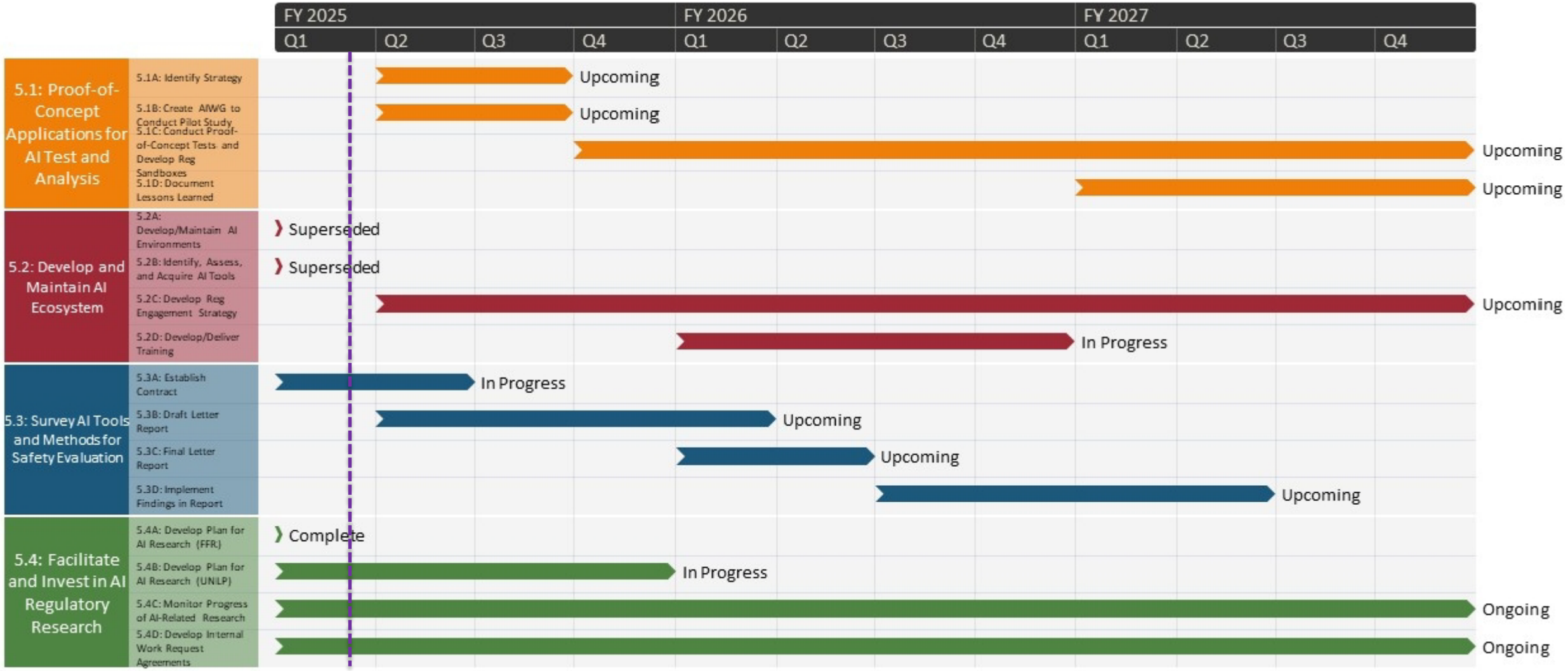
AI Ecosystem

- Establish integrated development environments and provide training
- Acquire common data science tools
- Develop regulatory sandboxes for supporting use-cases

AI R&D Research

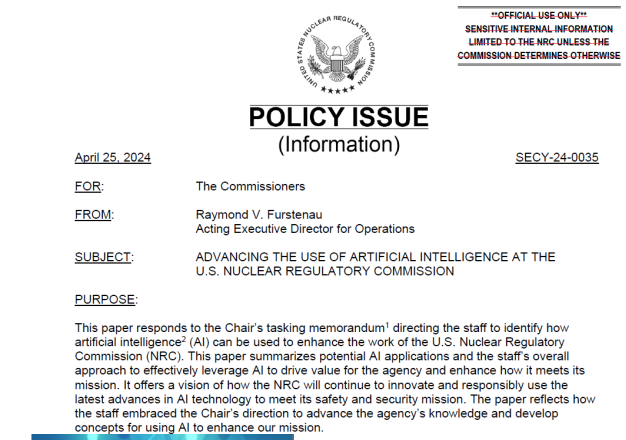
- Continue supporting University grants and research into AI systems
- Building AI foundation through the NRC's Future Focused Research initiative

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



Accomplishments

- Completed **one-third** of the actions in the Project Plan.
- Created an **AI Steering Committee** to promote cross-office coordination and direction to prepare the agency for the future use of AI in NRC-regulated activities.
- Issued **SECY-24-0035**, “Advancing the Use of Artificial Intelligence at the U.S. Nuclear Regulatory Commission” on April 25, 2024 (ML24086A001).
- Published an **AI principles paper with Canada and the United Kingdom** on September 5, 2024 (ML24241A252), outlining guiding principles for the safe and secure use of AI in nuclear applications.
- Issued the final report from SwRI supporting Task 1.1, “**Regulatory Framework Gap Assessment** for the Use of Artificial Intelligence in Nuclear Applications” (ML24290A059).



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LIMITED TO THE NRC UNLESS THE
COMMISSION DETERMINES OTHERWISE

POLICY ISSUE
(Information)

April 25, 2024 SECY-24-0035

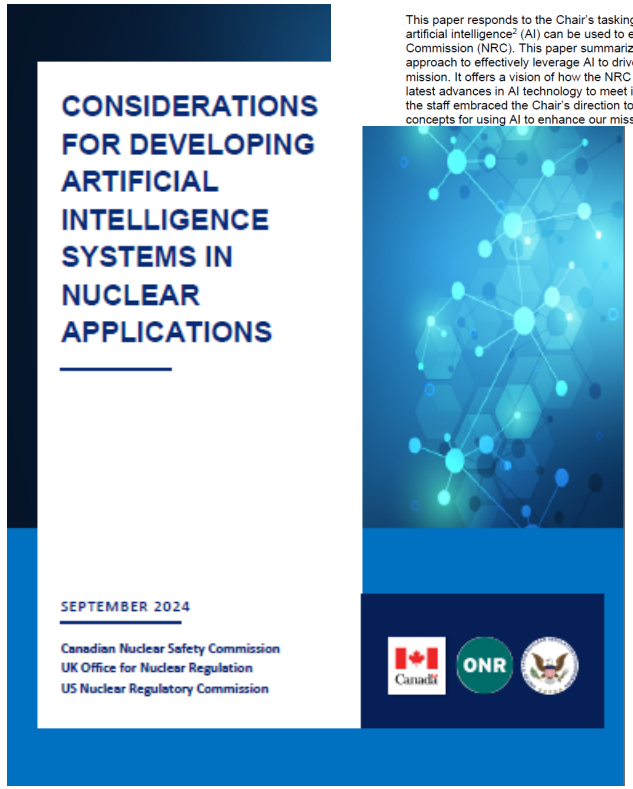
FOR: The Commissioners

FROM: Raymond V. Furstenau
Acting Executive Director for Operations

SUBJECT: ADVANCING THE USE OF ARTIFICIAL INTELLIGENCE AT THE U.S. NUCLEAR REGULATORY COMMISSION

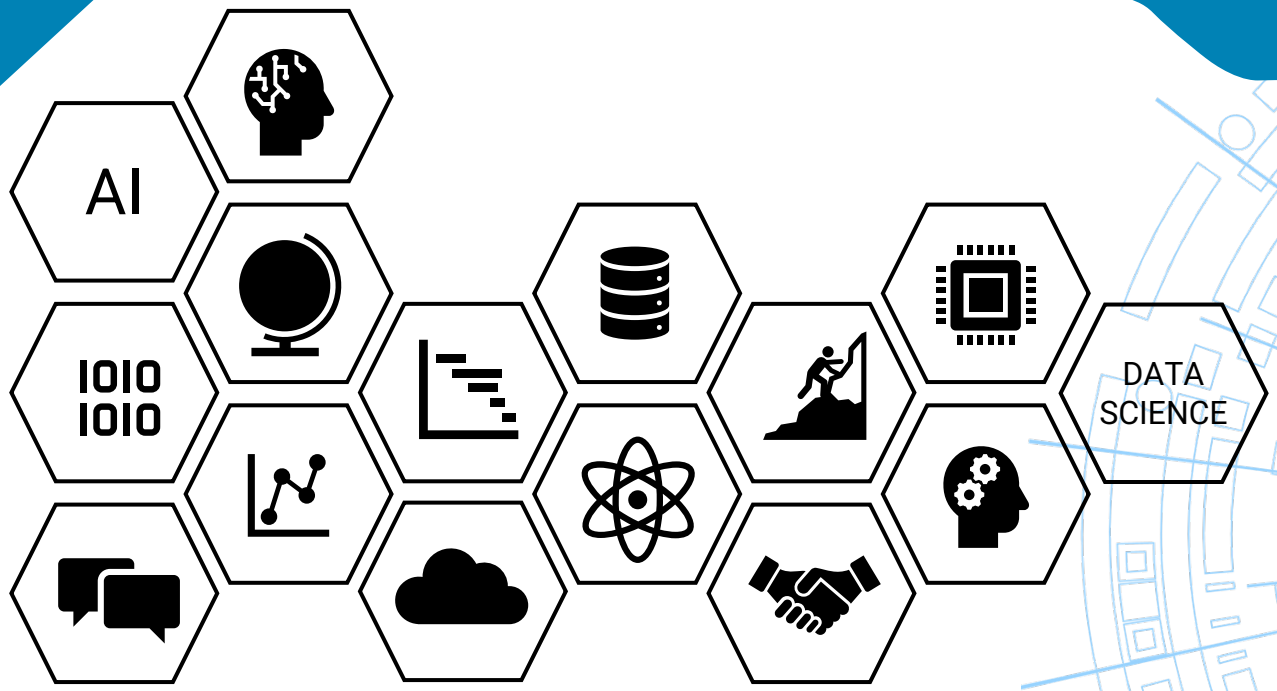
PURPOSE:

This paper responds to the Chair’s tasking memorandum[1] directing the staff to identify how artificial intelligence[2] (AI) can be used to enhance the work of the U.S. Nuclear Regulatory Commission (NRC). This paper summarizes potential AI applications and the staff’s overall approach to effectively leverage AI to drive value for the agency and enhance how it meets its mission. It offers a vision of how the NRC will continue to innovate and responsibly use the latest advances in AI technology to meet its safety and security mission. The paper reflects how the staff embraced the Chair’s direction to advance the agency’s knowledge and develop concepts for using AI to enhance our mission.



Focus for FY25

- Publish a strategy for identifying and removing barriers to the responsible use of AI and achieving enterprisewide improvements in **AI maturity**.
- Broaden the scope of **generative AI training to agency staff** and contractors and the development of the rules of behavior for the use of generative AI tools.
- Continue to engage with the inspection community across all regions and inspection types in **Future Focused Research** outreach sessions.
- Further develop the **regulatory framework** to support the use of AI in NRC-regulated activities.
- Continue **communication** with industry stakeholders to ensure preparedness for future uses of AI in NRC-regulated activities.



DATA SCIENCE & AI

REGULATORY APPLICATIONS PUBLIC WORKSHOP

Matthew Homiack

Reactor Systems Engineer (Data Scientist)

The NRC staff hosts public workshops to provide a forum to discuss the state of knowledge and research activities related to data science and AI applications in the nuclear industry.

GOAL 01

Establish consistent AI **terminology** and understand the availability and development of both NRC and industry **datasets**

GOAL 02

Explore and leverage **collaborative activities** with other U.S. government agencies, national laboratories, and industry organizations

GOAL 03

Identify and develop future **use cases** and collaborations where early intervention can provide high-yield resource investment

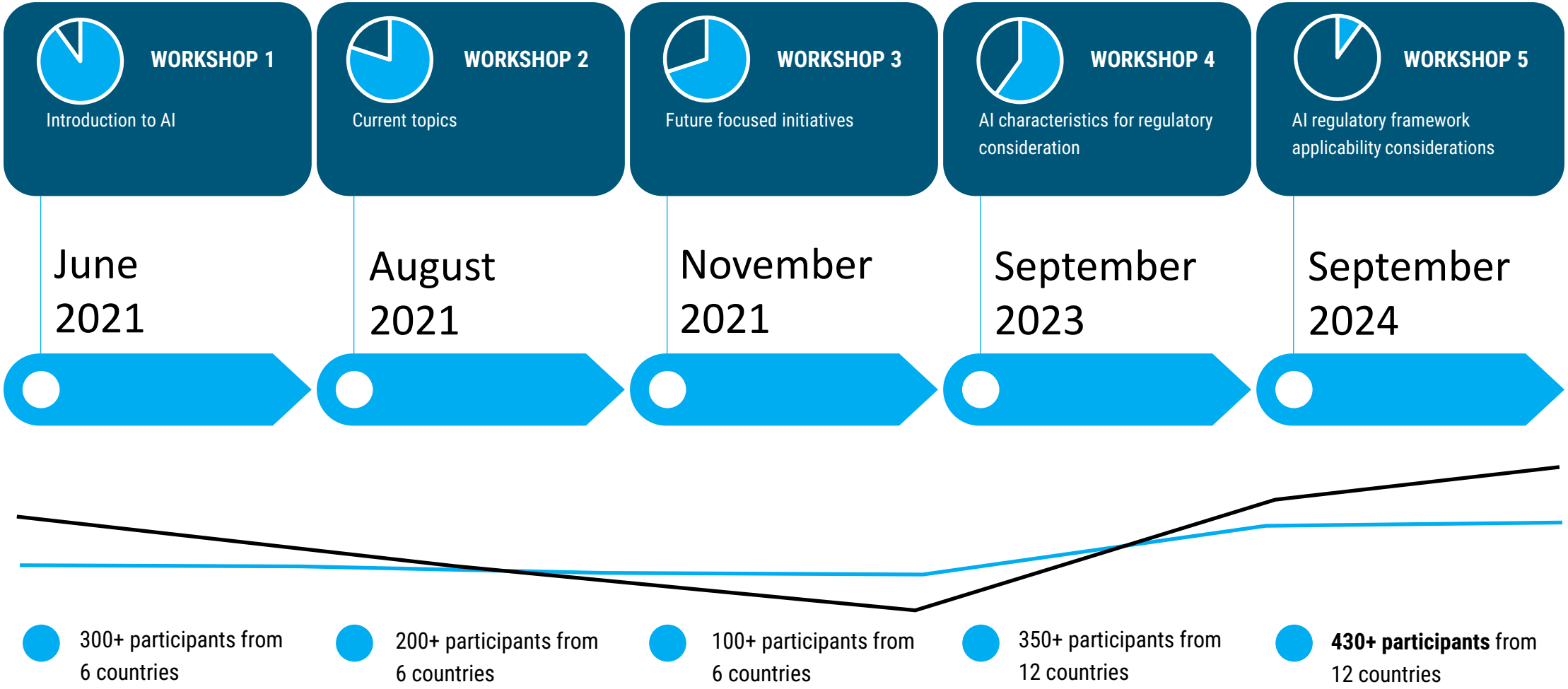
GOAL 04

Engage with industry and public stakeholders on areas where NRC could enhance information sharing, data access, or AI development that could **improve agency efficiency and effectiveness**

GOAL 05

Share industry and NRC **lessons learned** from ongoing data science and AI-related projects

The focus of the latest public workshop was on AI regulatory framework applicability considerations.



The 3 workshop panel sessions highlighted AI uses in NRC research projects, the industry, and the areas of nuclear materials, waste, and permitting.

AGENCY AI RESEARCH ACTIVITIES

01

NUCLEAR INDUSTRY AI

02

AI INNOVATIONS FOR NUCLEAR MATERIALS, RADIOACTIVE WASTE, AND PERMITTING

03

NRC AI RESEARCH ACTIVITIES

- Characterizing Nuclear Cybersecurity States with AI/ML
- Autonomous Control Algorithms to Simulate Boiling Water Reactor Cycle Depletion Using the Boiling Water Reactor Autonomous Learning Tasks Optimizer (BALTO)
- Engagement with the Regions

NUCLEAR INDUSTRY AI

- Nuclear Energy Industry (NEI) View on AI
- Pressurized Water Reactor Owners Group (PWROG) Insights on AI
- Blue Wave AI Labs Applications
- X-energy Applications

MATERIALS, WASTE, & PERMITTING

- Florida International University (FIU) Advanced Technologies for Characterization, Decommissioning, and Remediation of Contaminated Sites
- Microsoft AI for Nuclear Licensing
- Pacific Northwest National Laboratories (PNNL) PolicyAI
- Commonwealth Fusion AI/ML in Fusion Energy

There are 5 key takeaways from the 5th public workshop.

01 The workshop confirmed that the NRC remains well informed on the status of international AI regulation and domestic projects in the nuclear industry.

02 Industry representatives encouraged continued collaboration to pursue pilot studies and proofs of concept as a foundation for reviewing the use of AI in NRC-regulated activities.

03 AI regulatory sandboxes provide a unique opportunity for industry and the NRC to collaboratively explore the potential hurdles and benefits from using AI in safety-related nuclear applications.

04 The NRC plans to establish a working group to address the 8 potential AI regulatory gap categories and develop recommendations for the next steps based on feedback from the AI workshop and this subcommittee meeting.

05 Stakeholders are interested in leveraging NRC's public data set. Other Federal agencies are faced with similar challenges in implementing AI tools and features while ensuring privacy and responsible use.

CAN-UK-US Trilateral Collaboration: Considerations for Developing Artificial Intelligence Systems in Nuclear Applications

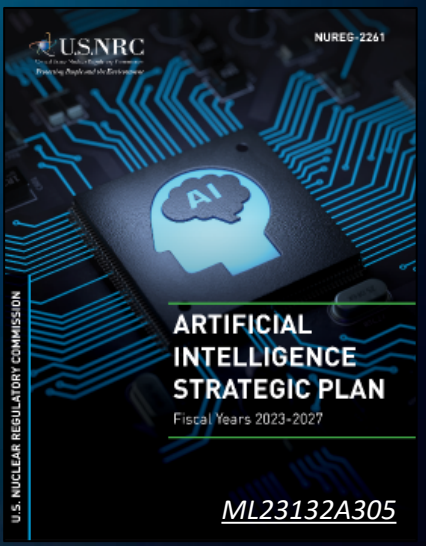
ACRS Briefing
November 20, 2024

Matt Dennis
Senior Data Scientist
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

OUTLINE

- Background on Individual Agency AI Activities
- Canada-UK-US (CANUKUS) AI Trilateral Background
- CANUKUS AI Paper Overview
- Path Forward

US NRC AI Activities



AI Research Priorities

- Regulatory framework applicability assessment
- Survey AI tools and methods for safety evaluation
- AI use cases for regulatory framework
- AI standards identification
- AI partnerships

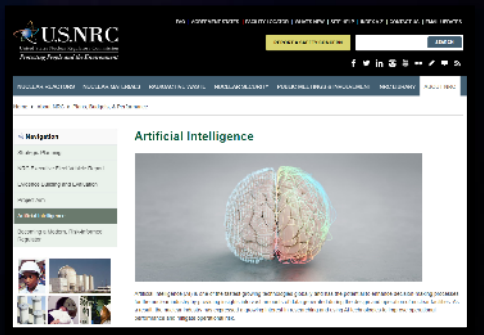
AI Regulatory Workshops*

- Scoping AI characteristics and regulatory considerations (2023.09.19)
- Regulatory gaps and considerations (2024.09.17)

AI Organizational Framework

- Internal NRC AI Steering Committee
- Internal NRC AI Community of Practice

NRC AI Webpage



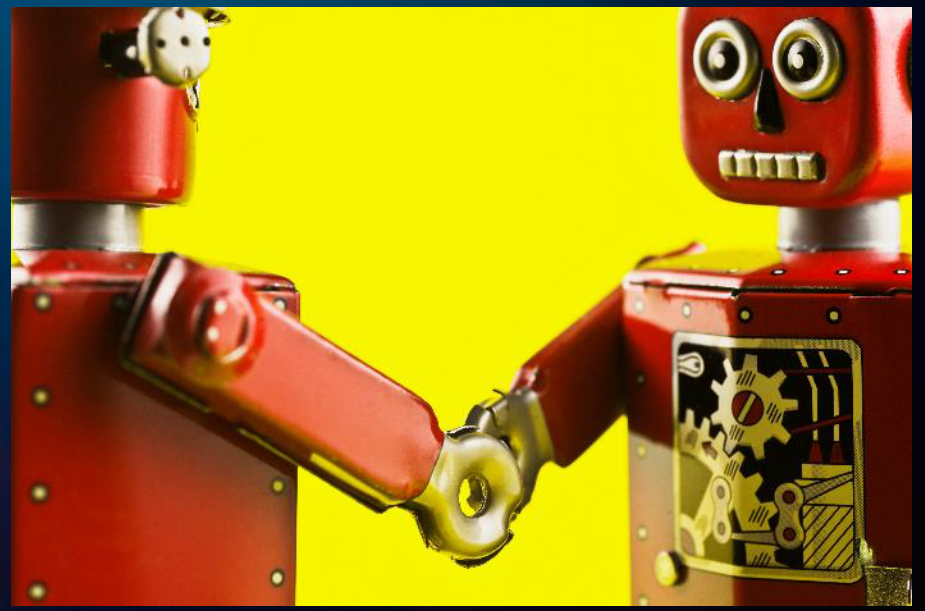
*https://www.nrc.gov/public-involve/conference-symposia/data-science-ai-reg-workshops.html

CANUKUS Trilateral Background

- CNSC/UK ONR/US NRC established a trilateral relationship in March 2022 to share knowledge and discuss disruptive, innovative and emerging technology (DIET)
- Three regulators agreed to work together to develop and publish a trilateral AI considerations paper
- Working group organized in November 2022
  - CNSC: Kevin Lee, Senior Regulatory Policy Officer
  - UK ONR: Andy White, Superintending Nuclear Inspector, Electrical and Control & Instrumentation
  - US NRC: Matt Dennis, Data Scientist

CANUKUS AI Paper Overview

- Purpose: Collaborate on a joint AI paper to establish a common set of overarching considerations for the use of AI technologies in nuclear activities
- Outcome: The AI considerations paper describes important topics that should be considered when deploying AI to ensure continued safe and secure operation of nuclear activities



Considerations for Developing AI Systems in Nuclear Applications

1. Introduction
2. Country-specific regulatory philosophies and perspectives
3. High level categories for AI use cases in nuclear applications
4. Use of existing safety and security systems engineering principles
5. Human and organisational factors
6. AI architecture in nuclear applications
7. AI lifecycle management
8. Documenting AI safety and security
9. Conclusion
10. Further reading (links to useful documents, etc.)
11. Annex (relevant standards and guidance across regulatory areas)

ML24241A252

Trilateral AI Publication

- Trilateral social media announcement occurred on September 5, 2024 (ML24241A252)
- Trilateral AI principles paper published on respective agency websites:
  - CNSC
  - ONR
  - NRC

Proposed Future CANUKUS AI Activities

- Trilateral working group determined the preferred future collaboration would focus on AI assurance and a literature review of near-term AI use cases across the three countries.
- The group plans to collaborate on another discussion paper with a target publication date of Fall 2025.

Conclusion

- Observations from fruitful and productive trilateral engagement
  - Recognition that AI is similar to other previous innovations
  - We have faced innovative technologies in the past and integrated those into suitable engineered systems to manage risks
  - Recognition that we are grappling with areas of uncertainty
- Maintaining adequate safety and security is fundamental
- Global cooperation among entities is paramount to ensure efficient, safe, and secure adoption of this emerging technology

BACKUP SLIDES

CNSC AI Activities

- Disruptive, Innovative, Emerging Technologies (DIET)
  - Canadian Nuclear Safety Commission (CNSC) DIET Working Group and its Innovation Hub enables greater sharing of innovation, internally and externally
  - Topics include AI, fusion, digital twins, drones, robotics, additive manufacturing
- Collaboration
  - Seminars from external presenters, internal communication, and DIET sub-groups
  - Engagement with IAEA, NEA, Canadian Standards Association, labs and Canadian Nuclear Society (CNS DIET2024 Conference, Oct. 28-30, 2024)
- Research on AI regulation
  - R760.1 A Study for the CNSC on AI Applications and Implications for the Nuclear Industry (April 2023)
- Future activities
  - Gathering intelligence, assessing DIET readiness, build innovative culture, ensure knowledge management, and continue external engagement (IAEA, NEA, regulatory counterparts, etc.)
  - Developing an AI roadmap for licensees as they consider deployment of AI

UK ONR AI Activities

- UK government – National AI Strategy 2022
  - Public sector leadership in safe and ethical deployment of AI
  - Incubator for Artificial Intelligence (i.AI) - Government team of technical specialists
- UK Office for Nuclear Regulation (ONR) research on AI regulation
  - ONR-RRR-121 (June 2021)
  - New research (commencing October 2024)
- Collaboration
  - Other UK regulators, licensees, internal specialisms, academia
  - Chair IAEA AI Safety Working Group, Alan Turing AI Standards
- Innovation Hub and Sandboxing
  - Test realistic applications against ONR regulation, test ability of AI to be used in nuclear safety applications, and pilot use of regulatory sandbox
  - Outcomes of nuclear AI regulatory sandbox pilot (November 2023)
- ONR future activities
  - IAEA participation, sandboxing, guidance, and growing skilled inspectors
  - Modernisation of ONR - data rich/data driven organisation, create an ecosystem of safe experimentation, think big/start small/learn fast, ‘Thought Group’

Regulatory Framework Applicability Assessment of Artificial Intelligence in Nuclear Applications (AIRGA: AI Regulatory Gap Analysis)

SOUTHWEST RESEARCH INSTITUTE®

O. Pensado, P. LaPlante, M. Hartnett, K. Holladay

Advisory Committee on Reactor Safeguards (ACRS)

Joint Human Factors Reliability & PRA, and Digital I&C Subcommittee Meeting Information Briefing: Implementing the NRC's Artificial Intelligence (AI) Strategic Plan Fiscal Years 2023-2027

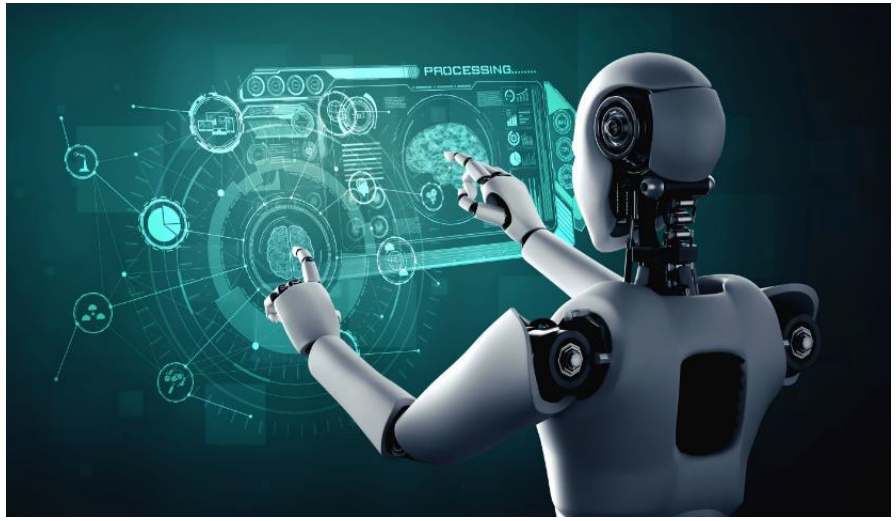
November 20, 2024

Acknowledgments

- This project benefitted from discussions with M. Dennis, L. Betancourt, A. Hathaway, N. Tehrani, A. Valiaveedu, and S. Haq of the NRC Office of Nuclear Regulatory Research
- This project was sponsored by the NRC Office of Nuclear Regulatory Research, Division of Systems Analysis
- The work is an independent product of SwRI and it does not necessarily reflect the views of the NRC
- Report: O. Pensado, P. LaPlante, M. Hartnett, K. Holladay. “Regulatory Framework Gap Assessment for the Use of Artificial Intelligence in Nuclear Applications.” San Antonio, TX: Southwest Research Institute, October 2024. ADAMS Accession Number ML24290A059

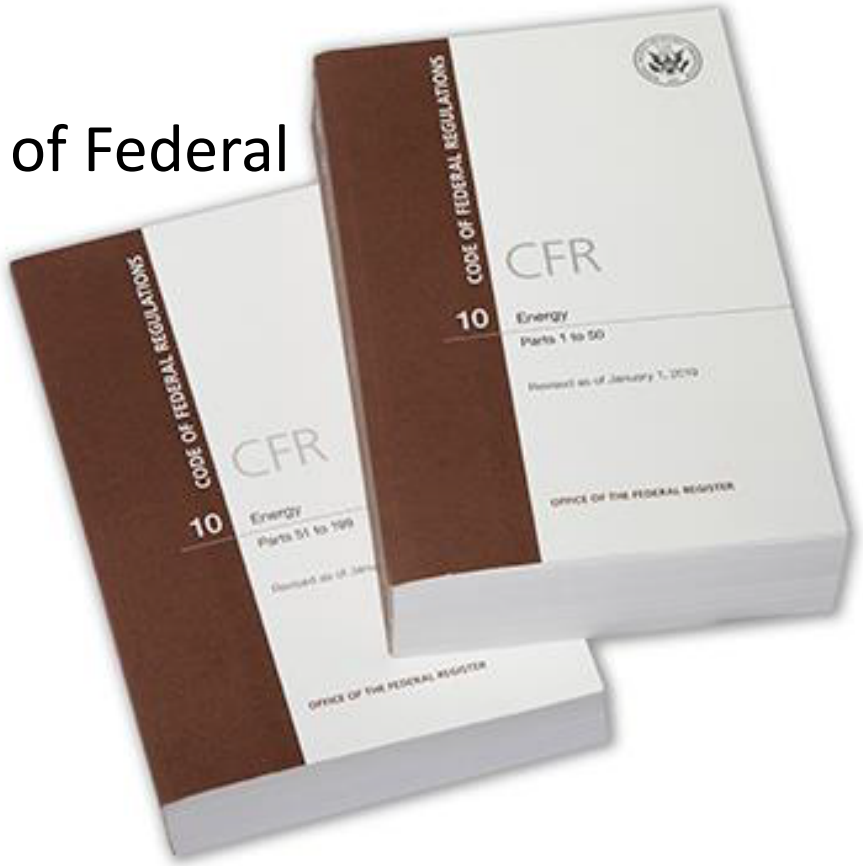
Project Objective

- Support NRC's readiness to evaluate uses of AI technologies in NRC-regulated activities
- Main task: conduct an AI regulatory gap analysis (AIRGA)
  - Identify types of AI technologies to be potentially used in the nuclear industry
  - Identify potential AI uses in NRC-regulated activities
  - Examine whether the existing regulatory framework is appropriate for AI technologies

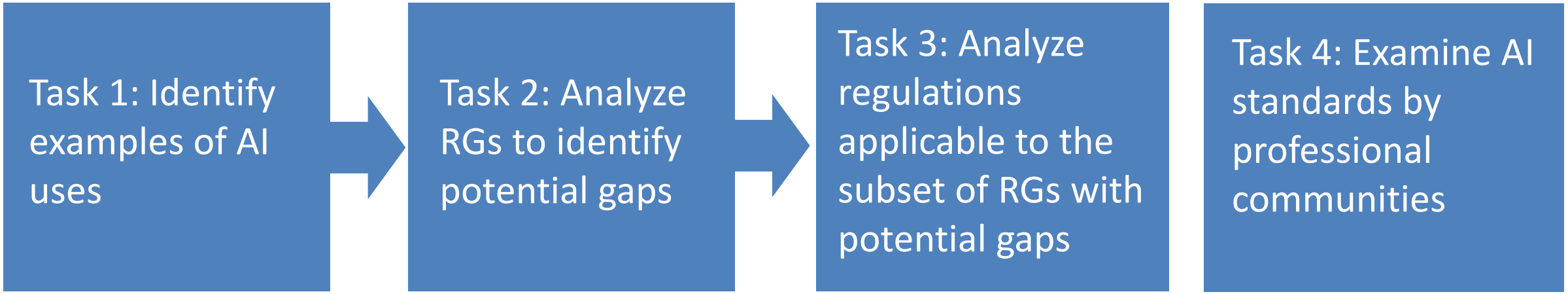


Project Scope

- Regulatory framework considered
  - NRC's regulations, Title 10, Chapter I, of the Code of Federal Regulations, Parts 1 – 171
  - 517 regulatory guides (RGs)
- Out of scope guidance documents:
  - NUREGs, Interim Staff Guidance (ISG)
  - Standard Review Plans (SRPs)
  - Inspection Procedures
  - Standards cited in regulations



Main Project Tasks



- Considered examples of AI uses based on known applications and R&D activities
- Examples discussed in past Data Science and AI Regulatory Applications Workshops
- Examples in NUREG/CR-7294

Analysis Approach for Regulatory Guides

Q0: Could AI technologies be used within the scope of the RG?

NO → RG is excluded from further analysis. No gap in the RG

YES

Q1: Is the regulatory guide flexible to allow use of AI?
Q2: Does the regulatory guide provide adequate guidance to evaluate the use of AI?

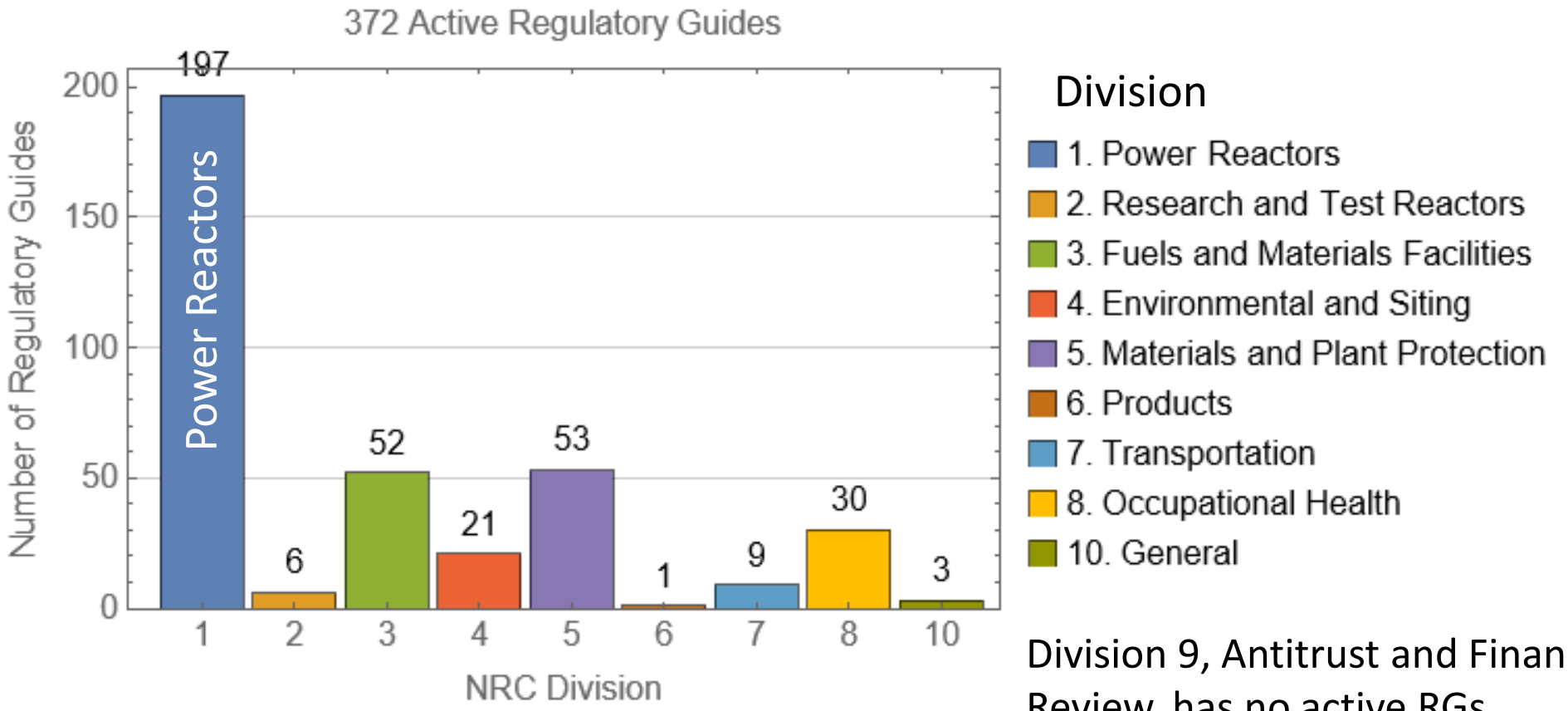
Answer to Q1 or Q2 is NO → The RG has a potential gap: detailed notes are recorded in report appendices

YES

Answer to both Q1 and Q2 is YES

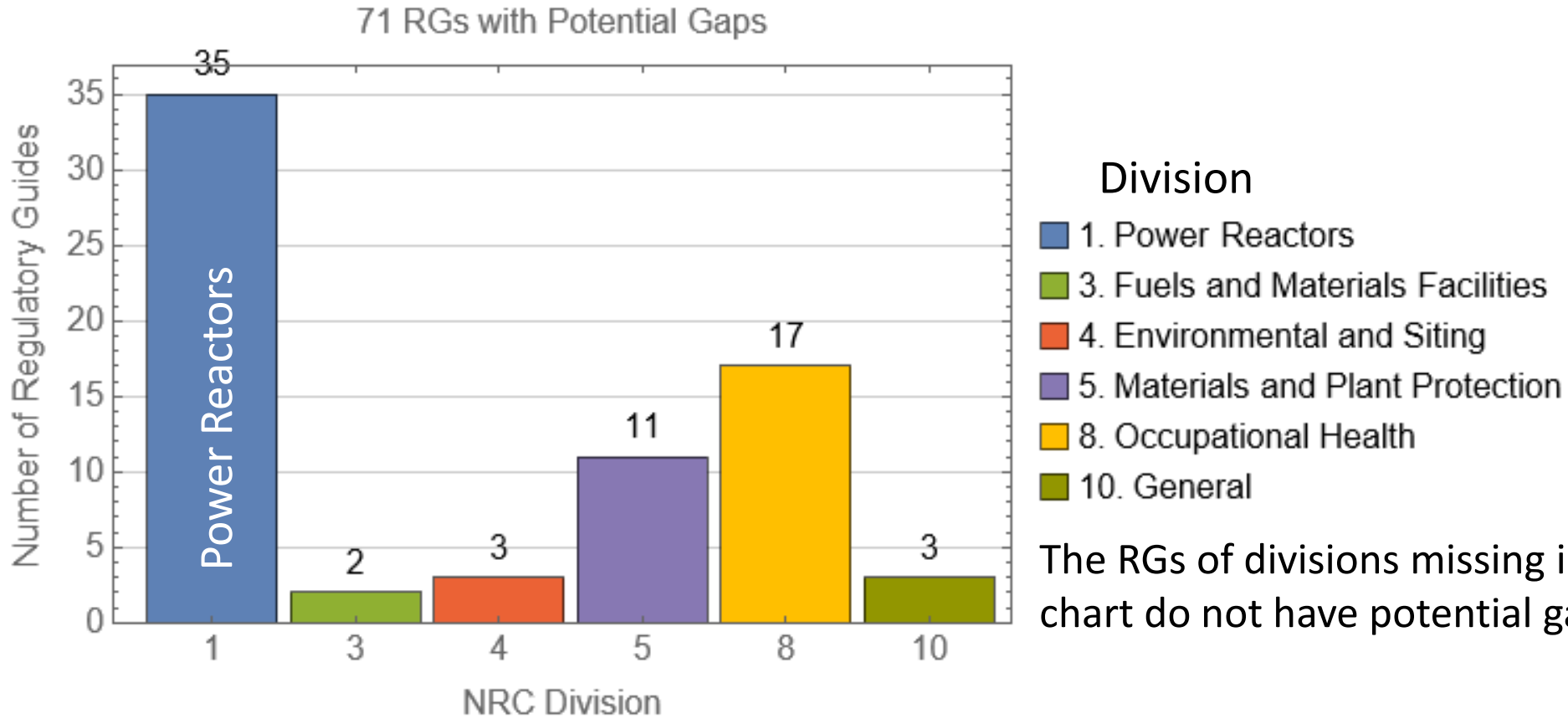
No gap in the RG

Regulatory Guides: 372 active RGs



Division 9, Antitrust and Financial Review, has no active RGs

Regulatory Guides with Potential Gaps



The RGs of divisions missing in the chart do not have potential gaps

- 71 RGs with potential gaps after applying the process from previous slide
  - Questions Q0, Q1, and Q2

Categories of Potential Gaps

- Gap 1: Implied Manual Actions
- Gap 2: Special Computations
- Gap 3: Preoperational and Initial Testing Programs May Omit AI
- Gap 4: Habitability Conditions under Autonomous Operations
- Gap 5: Periodic Testing, Monitoring, and Reporting
- Gap 6: Software for Safety Critical Applications
- Gap 7: Radiation Safety Support
- Gap 8: Miscellaneous: Training and Human Factors Engineering

Gap 1: Guides call for human manual actions; AI systems may offer different alternatives to execute those actions

Table 3-1. Regulatory guides related to Gap 1: Implied Manual Actions	
1.7	Control of Combustible Gas Concentrations in Containment
1.114	Guidance to Operators at the Controls and to Senior Operators in the Control Room of a Nuclear Power Unit
1.141	Containment Isolation Provisions for Fluid Systems
1.147	Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1
1.149	Nuclear Power Plant Simulation Facilities for Use in Operator Training, License Examinations, and Applicant Experience Requirements
1.189	Fire Protection for Nuclear Power Plants
1.205	Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants
5.7	Entry/Exit Control for Protected Areas, Vital Areas, and Material Access Areas
5.44	Perimeter Intrusion Alarm Systems

Gap 2: AI techniques may be used in special computations; guidance may be needed on documentation and verification

Table 3-2. Regulatory guides related to Gap 2: Special Computations	
1.59	Design Basis Floods for Nuclear Power Plants
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants
1.76	Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants
1.157	Best-Estimate Calculations of Emergency Core Cooling System Performance
1.198	Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites
1.200	Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities
1.203	Transient and Accident Analysis Methods
1.245	Preparing Probabilistic Fracture Mechanics (PFM) Submittals
1.247	TRIAL - Acceptability of Probabilistic Risk Assessment Results for Non-Light Water Reactor Risk-Informed Activities
3.27	Nondestructive Examination of Welds in the Liners of Concrete Barriers in Fuel Reprocessing Plants
3.76	Implementation of Aging Management Requirements for Spent Fuel Storage Renewals
5.11	Nondestructive Assay of Special Nuclear Material Contained in Scrap and Waste
5.21	Nondestructive Uranium-235 Enrichment Assay by Gamma Ray Spectrometry
5.23	In Situ Assay of Plutonium Residual Holdup
5.37	In Situ Assay of Enriched Uranium Residual Holdup
5.38	Nondestructive Assay of High-Enrichment Uranium Fuel Plates by Gamma Ray Spectrometry
10.4	Guide for the Preparation of Applications for Licenses to Process Source Material

Gap 3: Critical AI systems may need to be explicitly included in preoperational and initial testing programs

Table 3-3. Regulatory guides related to Gap 3: Preoperational and Initial Testing Programs May Omit AI	
1.68	Initial Test Programs for Water-Cooled Nuclear Power Plants
1.68.2	Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants
1.79	Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors
1.79.1	Initial Test Program of Emergency Core Cooling Systems for New Boiling-Water Reactors

Gap 4: Habitability conditions under autonomous operations; variable role of operators

Table 3-4. Regulatory guides related to Gap 4: Habitability Conditions Under Autonomous Operations	
1.78	Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release
1.189	Fire Protection for Nuclear Power Plants
1.196	Control Room Habitability at Light-Water Nuclear Power Reactors

Gap 5: Periodic testing, monitoring, surveillance, and reporting; AI systems may offer different strategies for those activities

- RGs related to testing and monitoring deemed with potential gaps:

1.7	1.205	5.11	**5.71**	8.22	8.38
1.9	1.246	5.21	8.8	8.25	10.2
1.21	3.27	5.23	8.1	8.26	10.3
1.9	3.76	5.27	8.11	8.31	10.4
1.118	4.1	5.37	8.15	8.32	
1.129	4.14	5.38	8.18	8.34	
1.141	4.16	5.41	8.19	8.36	
1.147	5.7	5.44	8.2	8.37	

- RG 5.71 Cyber Security Programs for Nuclear Power Plants: AI may be used as monitoring tool to detect anomalies as indicators of cyber attacks
  - Cybersecurity of AI and AI for cybersecurity

Gap 6: Software guides may need to be updated to address special features and risks of AI systems

Table 3-6. Regulatory guides related to Gap 6: Software for Critical Applications	
1.168	Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants
1.169	Configuration Management Plans for Digital Computer Software Used in Safety Systems of Nuclear Power Plants
1.171	Software Unit Testing for Digital Computer Software Used in Safety Systems of Nuclear Power Plants
1.172	Software Requirement Specifications for Digital Computer Software and Complex Electronics Used in Safety Systems of Nuclear Power Plants
1.173	Developing Software Life Cycle Processes for Digital Computer Software Used in Safety Systems of Nuclear Power Plants
1.231	Acceptance of Commercial-Grade Design and Analysis Computer Programs Used in Safety-Related Applications for Nuclear Power Plants
5.71	Cyber Security Programs for Nuclear Power Reactors

Gap 7: Radiation safety support; AI may be used for tasks and functions of radiation safety professionals

Table 3-7. Regulatory guides related to Gap 7: Radiation Safety Support	
8.8	Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable
8.10	Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable
8.11	Applications of Bioassay for Uranium
8.15	Acceptable Programs for Respiratory Protection
8.18	Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be as Low as Reasonably Achievable
8.20	Applications of Bioassay for Radioiodine
8.22	Bioassay at Uranium Mills
8.25	Air Sampling in the Workplace
8.26	Applications of Bioassay for Fission and Activation Products
8.31	Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable
8.32	Criteria for Establishing a Tritium Bioassay Program
8.34	Monitoring Criteria and Methods to Calculate Occupational Radiation Doses
8.35	Planned Special Exposures
8.36	Radiation Dose to the Embryo/Fetus
8.38	Control of Access to High and Very High Radiation Areas of Nuclear Plants
10.4	Guide for the Preparation of Applications for Licenses to Process Source Material

Gap 8: Miscellaneous: Training and Human Factors Engineering

Table 3-8. Regulatory guides related to Gap 8: Miscellaneous: Training, Human Factors Engineering, and AI Introduced as Changes	
1.149	Nuclear Power Plant Simulation Facilities for Use in Operator Training, License Examinations, and Applicant Experience Requirements
1.206	Applications for Nuclear Power Plants

The analysis identified only few gaps in applicable regulations

- Regulations applicable to the RGs deemed with potential gaps were examined
  - Not all the regulations were examined in detail
- In general, the applicable regulations (10 CFR 1 to 171) were high level and adequate for AI technologies, with a few exceptions
- The exceptions are related to regulatory statements calling for actions by humans when those actions could also be executed by AI systems
  - Surveillance using computer vision
  - Searches of people and vehicles
  - Escorting people in facilities
- Some regulations should be examined in light of questions related to autonomous operation and control room habitability
  - Role of operators, protection of equipment in the control room, constraints on autonomous operation

Recommendations

- Develop few general guides addressing cross-cutting issues associated with potential gaps, such as software development with AI systems and use of AI in special computations
  - More efficient to develop few guides rather than inserting explicit AI considerations in many RGs
- Existing AI standards by professional societies do not readily address the identified potential gaps

Potential cross-cutting guides

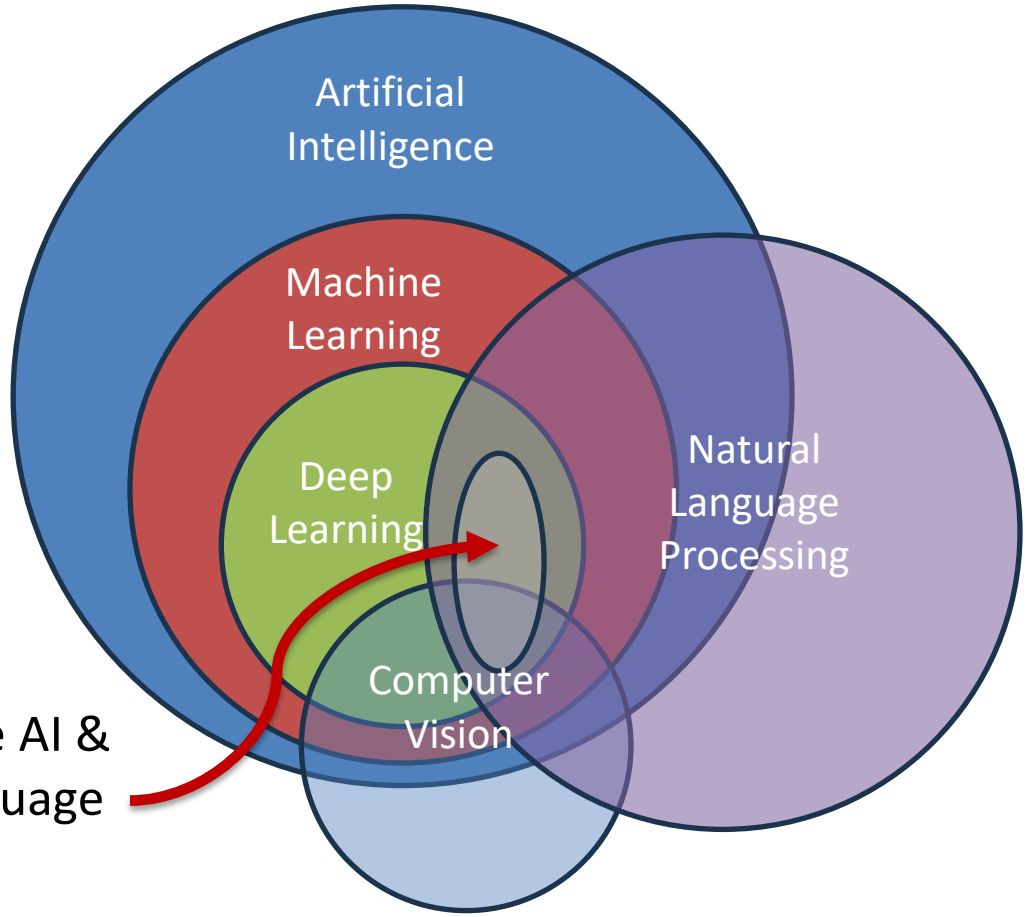
1. Data quality for machine learning (ML) purposes, including aspects of accuracy, context, data management, data variety, and data quantity.
2. Type of systematic testing and documentation needed to enhance confidence in outputs by AI systems, with special attention on responses to rare and extreme inputs.
3. Systematic fail-safe design, including active detection of inputs different than in the ML database, active detection of anomalous responses by AI systems, and mitigation of errors by AI systems.
4. Types of testing and documentation needed to enhance confidence in computations and predictions that use AI techniques.

Backup Slides

Abbreviations and acronyms

AI	Artificial intelligence
AIRGA	AI regulatory gap analysis
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
FAA	U.S. Federal Aviation Administration
FDA	U.S. Food and Drug Administration
HFE	Human factors engineering
IEEE	Institute of Electical and Electronics Engineers
ISG	Interim Staff Guidance
LLM	Large language model
ML	machine learning
NRC	U.S. Nuclear Regulatory Commission
PFM	Probabilistic fracture mechanics
R&D	Research and development
RG	Regulatory Guide
SRP	Standard Review Plan
SwRI	Southwest Research Institute

Terminology



- AI includes a range of technologies
- Deep neural networks and machine learning methods are notable because of their broad range of applicability