**To:** American Nuclear Society (ANS) Standards Board

**From**: ANS Large Light Water Reactor Consensus Committee (LLWRCC)

**Subject:** Establishment of Consensus Committee on Artificial Intelligence (AI) for Nuclear

**Objective:** To provide a comprehensive justification for the need for a new consensus committee on AI for Nuclear and propose its establishment

**Introduction and Background:** An ad hoc committee to explore AI standards was recommended by the LLWRCC as part of discussions on new standards, including digital twins and robotics. The LLWRCC, one of eight ANS consensus committees reporting to the ANS Standards Board, assigned this action item at their November 2023 meeting to LWRCC members Ahmad Al Rashdan and James August and asked them to lead the effort. The leads decided to tackle AI first, issuing a brief survey to the Standards Committee to gather feedback and interest. The survey was sent to over 950 members of the ANS Standards Committee; 85 participants responded. The survey results were discussed at the March 2024 LLWRCC meeting, leading to the decision to hold a meeting with interested parties to investigate existing or developing AI standards. The aim was to gather feedback to focus this effort and provide a suggestion back to the LLWRCC, which will then make a recommendation to the Standards Board.

**Survey Summary:**

Applications: Potential uses of AI in the nuclear industry were broken into various areas: In the design of nuclear systems, a wide range of applications were identified. In modeling and reactor design, AI can enhance the precision and efficiency of developing new reactors. Code development and conversion can benefit from AI’s ability to automate and optimize programming tasks. During accident development, AI can simulate scenarios to improve response strategies. Critical experimental development tools and nuclear data applications can leverage AI for more accurate data analysis and experimental planning. AI can streamline regulatory submissions for nuclear licensing and compliance, ensuring more thorough and efficient review processes. Risk analysis and optimization tasks are greatly improved by AI’s capacity to analyze large datasets and identify optimal solutions. In core design, AI can aid in creating more efficient and effective core configurations. Virtual testing using AI allows for comprehensive simulations without the need for physical prototypes. Lastly, AI has significant potential in advancing fusion research by optimizing the complex processes involved in achieving sustainable fusion reactions.

Applications of AI in construction include enhancing manufacturing and fabrication processes by increasing precision, reducing errors, and improving overall efficiency. In supply chain and logistics optimization, AI can streamline procurement, reduce costs, and ensure timely delivery of materials, thereby improving project timelines and resource management.

Applications of AI in operations include autonomous operations and control (such as demand following, startup processes, and pre-accident identification and action), as well as advanced control systems and diagnostics, and robot guidance. Monitoring and maintenance are enhanced through AI’s capabilities in facility monitoring, including anomaly detection, inspections, preventive maintenance, corrosion detection, image change detection, outage management, programmed sensors, and gauge reading. AI also significantly improves documentation and assistance by facilitating document creation and revisions, document ingestion and summary (e.g., corrective action program screening), providing digital assistance, and operating chatbots. Digital simulation and modeling benefit from AI through the use of digital twins. Additionally, AI optimizes various aspects of operations, including supply chain and logistics, fuel usage, and planning processes.

AI also plays a crucial role in supporting various domains, including cybersecurity of autonomous systems, nonproliferation efforts, waste management, fire monitoring, virtual simulation for training, safety compliance, and managing inventory. Safety compliance is ensured through AI detection of personal protective equipment usage and real-time identification of potential hazards, promoting workplace safety.

Existing Efforts for AI in Nuclear: In the context of existing standards and guidance for AI in the nuclear industry, several key initiatives are shaping best practices, ensuring safety, and fostering innovation.

* International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)activities within SC45A, Working Group 12, launched two standard efforts related to cybersecurity and AI explainability.
* The U.S. Nuclear Regulatory Commission (NRC) published the Artificial Intelligence Project Plan (Rev. 0, ML23236A279), a regulatory compliance and safety plan for AI use within the United States.
* The Nuclear Energy Institute (NEI) Innovation Task Force is collaborating with industry stakeholders to explore emerging technologies, including AI, and is currently working on Nuclear Industry Views on Artificial Intelligence.
* National Institute of Standards and Technology, through its standards and technology development efforts, developed the AI Risk Management Framework.
* The International Atomic Energy Agency’s (IAEA’s) guidance on the Deployment of Artificial Intelligence Applications for the Nuclear Power Industry.
* Idaho National Laboratory (INL) researched into considerations regarding the use of computer vision machine learning in safety-related or risk-significant applications in nuclear power plants

Collectively, these initiatives could contribute to the development of comprehensive standards and guidelines for the safe and effective integration of AI technologies in the nuclear industry.

Outside the nuclear realm, several standards development organizations (SDOs) such as Institute of Electrical and Electronics Engineers, SAE International, and the American Society of Mechanical Engineers have been working on standards for AI use in applications relevant to the standards scope.

**Kick-off Meeting (May 15, 2024):**

Summary:A meeting was held to discuss several key topics related to AI in nuclear standards. The meeting was attended by 39 participants and discussed topics including defining AI, understanding the need for AI, acknowledging industry efforts by organizations such as NEI, NRC, and the U.S. Department of Energy, and identifying where ANS can contribute. Participants began with brief introductions. Ahmad Al Rashdan then presented a high-level summary of survey data, revealing that just over half of the survey responders were aware of AI applications in the nuclear field. The survey feedback was largely positive regarding ANS’s initiative to develop AI standards. The survey highlighted many potential areas for AI standards. It was noted that the NRC supports the development of AI standards by SDOs. Additionally, some responders were aware of ongoing AI guidance, standards, and plans by organizations such as ISO/IEC, NRC, NEI, INL, and IAEA.

Feedback: Given the existing efforts, the comments highlighted the necessity of understanding available resources and developments to avoid redundancy and leverage existing tools. They emphasize the importance of establishing the benefits of an ANS standard for AI in the nuclear domain, specifically for high-level guidance on testing and evaluating AI models without delving into excessive detail. A timeline for developing AI guidance and standards is crucial, although a standard or NRC regulatory guide need not precede this process. The potential responsibility for negative consequences of AI use and addressing associated risks are also important considerations. Identifying users and stakeholders for AI standards and guidance is essential, and adopting agreed-upon practices could enhance regulatory efficiency. The next meeting was planned for June, with Ahmad Al Rashdan and James August using the group’s input to shape its focus.

**Second Meeting (June 12, 2024):**

Summary:In the second meeting, new members who were unable to attend the first session joined the call, while some others were absent. In total, 34 members attended this meeting. The meeting began with introductions, allowing first-time participants to introduce themselves. Following this, a brief review of the kick-off meeting, was provided, including a summary of survey results. This was done to ensure that all participants, especially the new ones, were up to speed. The presentation from the kick-off meeting was made available for reference.

A key part of the meeting was the review of an earlier version of this white paper on AI standards for nuclear. Participants had been asked to review this document prior to the meeting. During the discussion, several critical points emerged. There was a consensus that the ANS needs a focused approach and a clear problem statement specific to the nuclear domain. The importance of ANS’s involvement in AI standards to protect its interests was highlighted. The group discussed the necessity of considering regulations and distinguishing ANS’s work from that of the NRC. It was noted that ANS standards could potentially guide NRC regulatory documents and help licensees meet regulatory requirements. Upcoming NRC meetings and their efforts in AI guidance were also mentioned, highlighting the need for multiple AI standards. Awareness of ongoing initiatives by the IEC, NEI, the United Kingdom Office for Nuclear Regulation, and others is crucial to avoid duplication and complement existing standards.

Feedback: Feedback emphasized the importance of a clear focus and distinct approach for ANS, while also addressing regulatory considerations. The group recognized that the rapid development of software technology poses challenges for creating relevant standards. Similarity of AI and software and risk standards were discussed. There was also a suggestion to consider AI as software and apply nuclear quality assurance requirements. Distinctions were made. ANS’s role would be more aligned with the use of software rather than its development. Additionally, INL mentioned its effort to compare AI to the digital instrumentation and control framework, further emphasizing the unique nature of AI standards. The importance of having clear acceptance criteria for AI was underlined.

The meeting concluded with a discussion on the next steps. The ad hoc committee was tasked with proposing a new committee to the LLWRCC and the Standards Board. The consensus was that AI standards are unique and broad enough to warrant a new consensus committee. This new committee would need representation from existing committees and new members with AI expertise. To support this proposal, a survey was suggested to gather potential AI standards focus, strengthening the case for the formation of a dedicated consensus committee for AI. The survey aimed to acquire input on a list of AI standards that would benefit the industry and be appropriate for ANS to develop will be framed and issued once the question is finalized.

A discussion of the proposal from the AI Ad Hoc Committee was discussed at the January 20, 2025, LLWRCC meeting. This white paper was augmented to include a list of proposed standards needed by the industry and appropriate for ANS to develop. Below are some of the potentially needed standards identified at this stage, categorized into topical areas/potential subcommittees.

Operational Efficiency

* ANS-X, *Qualification and Commercial Grade Dedication of AI Methods for Operational Decision Making*: Establishing a standard for the qualification of AI methods ensures their reliability and effectiveness in making operational decisions in a modular manner.
* ANS-X, *Requalification of AI Methods to Replace Obsolescent Datasets and Tools*: Establish standards for the necessary validation and verification of applications that undergo model or dataset upgrades.
* ANS-X*, Risk-Informed Methods for Use of AI in Monitoring*: Develop risk-informed methods to manage and mitigate risks associated with AI in monitoring processes is crucial for critical applications.
* ANS-X, *Process for Efficient Human-AI Integration*: Establish standards for Human-AI integration to ensure broader human acceptance of AI tools and methods.

Design and Engineering of Reactors and Components

* ANS-X, *Process to Review and Evaluate AI-Generated Designs*: Establish standards for validating and verifying AI-generated designs to ensure they meet safety, reliability, and compliance requirements.
* ANS-X, *Requirements for Digital Twins’ Integration with AI*: Develop standard for systematic means of integrating digital twins with AI to optimize their use in AI applications.
* ANS-X*, Requirements for Fuel Optimization AI Methods*: Establish standards for fuel optimization using AI to ensure reliable and efficient use of AI.

Use Standardization

* ANS-X, *AI Definitions, Terminology, and Metrics*: Establish clear definitions, terminology, and metrics is fundamental for consistency and clarity in AI applications.
* ANS-X, *Model and Ontology for Nuclear Data*: Develop models and ontology framework to create a common framework, facilitating interoperability and integration.
* ANS-X, *Interface Requirements for Nuclear Tools*: Establish requirements to ensure that AI systems can communicate and work together effectively, which is vital for complex operations.

**Recommendation:**

Based on surveys of the ANS Standards Committee and the ad hoc committee members and received feedback, a dedicated consensus committee for AI in nuclear standards should be formed, incorporating expertise from existing committees and new AI specialists. The architecture, workgroups, and targeted standards will be decided by the consensus committee, if established.

The LLWRCC has concurred with this recommendation.