DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-073

SECTION A. Project Title: Un-hackable Communications with Quantum Key Distribution for Secure Remote Operations – Purdue University

SECTION B. Project Description

Purdue University proposes to develop quantum-based secure communication architectures optimized for Quantum Key Distribution (QKD) protocols in advanced nuclear systems and demonstrate their use on Purdue's all digital University Reactor, PUR-1, the first reactor in the U.S. with fully digital instrumentation and control (I&C). Project specific objectives include: 1) Perform evaluation of recently licensed (e.g., NuScale) and future, (e.g., microreactors) advanced nuclear system architectures to identify which QKD solutions are most appropriate and where they should be implemented to address security vulnerabilities; 2) Development of a robust quantum communication modeling and simulation framework to support the analysis of QKD systems; 3) Perform STRIDE (Spoofing, Tampering, Repudiation, Information Disclosure, Denial of Service, and Elevation of Privilege) threat modelling to identify potential QKD vulnerabilities; and 4) Thorough testing of prototypic QKD equipment (provided by ORNL) under an actual nuclear environment on PUR-1 to evaluate QKD's performance with and without cyber attacks. The proposed research is aligned with the DOE-NE's objective to enable "secure communication solutions for future reactor technologies." It supports the program's efforts to develop and demonstrate secure communications for control and monitoring to enable remote operations.

SECTION C. Environmental Aspects / Potential Sources of Impact

The proposed project will involve the use of an "auxiliary control rod" placed in the periphery of the reactor core of the Purdue University Reactor (PUR-1). As a result, the "auxiliary control rod" will be irradiated with a low flux of neutrons (less than 10^10 n/cm^2 s) and may become slightly radioactive. The material composition (high purity aluminum) of the "auxiliary control rod" is selected to result in minimum activity. The total irradiation duration is expected to be short (a few weeks) and activation products will decay within a few days following irradiation (Mn-56 half-life: 2.85 hr; Al-28 half-life: 2.25 min). The "auxiliary control rod" will remain in the reactor pool under water until activation products have decayed below background levels. The "auxiliary control rod" will be handled by the PUR-1 NRC licensed reactor operators following standard experiment procedures. At the end of the project, the "auxiliary control rod" will be handled as low-level radioactive waste following standard procedures for handling low-level waste approved by the Purdue's Radiation Safety Committee. The Purdue Radioactive and Environmental Management (REM) office is responsible for handling and disposing radioactive waste. REM's trained technicians will store the "auxiliary control rod" in licensed storage facilities and handle eventual disposal per applicable regulations. No waste will be released to the environment in an uncontrolled manner.

SECTION D. Determine the Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 CFR 1021, Appendix B, give the appropriate justification, and the approval date.

Note: For Categorical Exclusions (CXs) the proposed action must not: 1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, including requirements of DOE orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) adversely affect environmentally sensitive resources. In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not "connected" nor "related" (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

References: B3.6 Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). For purposes of this category, "demonstration actions" means actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment. Demonstration actions frequently follow research and development and pilot projects that are directed at establishing proof of concept.

Justification: The activity consists of an investigation to demonstrate the first implementation of quantum cybersecurity in a nuclear system and provide a new approach toward secure communications for control and monitoring systems to enable remote operations.

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Jason Anderson, DOE-ID NEPA Compliance Officer, on 09/10/2021.