NRC's Digital I&C Research for Application in Nuclear Power Plants – Status Update

Ismael L. Garcia

Senior Technical Advisor

Cybersecurity and Digital Instrumentation and Control

Office of Nuclear Security and Incident Response

Email: Ismael.Garcia@nrc.gov

Christopher B. Cook

Branch Chief

Instrumentation, Controls, and Electrical Engineering Branch

Office of Nuclear Regulatory Research

Email: Christopher.Cook@nrc.gov

Key Messages

- The Office of Nuclear Regulatory Research (RES) supports current and future NRC activities related to Instrumentation and Controls (I&C)
- Novel techs are applicable to both operating and advanced reactors
- RES is proactively looking at these technologies to be ready for the future
- Selected projects discussed herein are a subset of active research

Research Drivers

- Licensees are considering digital I&C technology implementations
  - NRC staff needs to understand associated safety and cybersecurity issues
  - Need to develop technical basis for licensing, guidance, and oversight
  - Help maintain the infrastructure of NRC staff expertise and competence
  - Need for inspection tools or similar

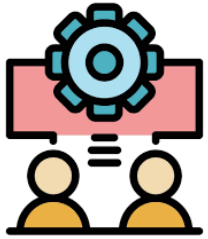
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

Digital I&C - Safety-Related Research

- Systems Engineering Assessment Approaches

- Technical Basis for Acceptance Criteria of Software Intensive Model Based Engineering Environments



- Technical Basis for Evaluating Operating Experience

- Evaluate adequacy of Systems Theoretic Process Analysis (STPA) for identifying common causes of systematic failures for digital I&C systems

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

Systems Engineering Assessment Approaches

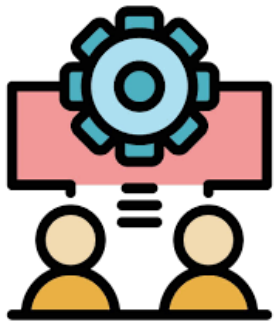
- Identify any changes needed in the existing review guidance infrastructure to avail of the systems engineering approach, under the core or integrated team approach
- Develop a plan of follow-on work (if any) needed to implement improvements in the applicable review guidance infrastructure

Technical Basis for Acceptance Criteria of Software Intensive Model Based Engineering Environments

- Develop a technical basis to enable consistent evaluation of submittals that use Software Intensive Model Based Engineering Environments and Correct-by-Construction (CbyC) Methods

- Research will include evaluation of other's methods or guidance in regard to the review of systems developed using Model Based Engineering Environments or CbyC techniques

Technical Basis for Evaluating Operating Experience

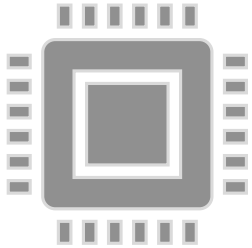


- Improve staff's I&C regulatory reviews and system inspections by supporting staff in verifying industry's claims regarding equipment reliability using available operating experience
- Develop or grade the current methods and/or tools for evaluating reliability claims
- Investigate the technical bases for quantitative or qualitative methods or practices that rely on operating experience to ensure reliability

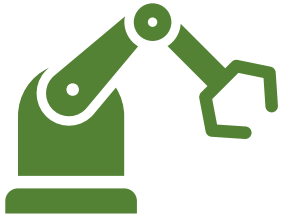
Evaluate adequacy of STPA for identifying common causes of systematic failures for digital I&C systems

- Assess the feasibility and limits of accepting STPA-informed evidence as a substitute for traditional diversity within a design (point 2 of SRM to SECY 93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs”)
- Develop NUREG that includes the technical basis for guidance to evaluate future license applications using STPA methods

Digital I&C - Cybersecurity-Related Research



- Field Programmable Gate Arrays (FPGAs)



- Autonomous Control

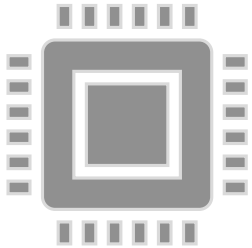
- Artificial Intelligence (AI)/Machine Learning (ML) – Future Focused Research (FFR)

- Wireless

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

FPGAs

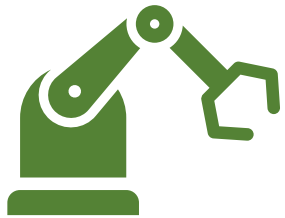


- Part of a research effort associated with a cybersecurity-focused overview of novel technology implementations in Nuclear Power Plants (NPPs)
- Identify potential cybersecurity concerns with FPGAs for future nuclear applications
- Investigate whether FPGAs:
  - Are inherently cyber secure
  - Are not vulnerable to Internet cyber-attacks
- Assist NRC staff

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

Autonomous Control



- Part of a research effort associated with a cybersecurity-focused overview of novel technology implementations in nuclear power plants
- Vendor/applicant interest in autonomous controls for NPPs
- Identify potential cybersecurity concerns with autonomous controls for NPPs
- Understand cyber implications of the enabling technologies:
  - Remote Monitoring and Operations
  - Digital Twins
  - AI/ML

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

AI/ML - FFR

- Prepare the NRC to regulate licensee cyber security AI/ML implementations by developing basic knowledge of the technologies and their applications
- This research effort includes:
  - Identify Nuclear AI-Cybersecurity Use Case
  - Develop Technical Approach
  - Gather Experimental Data
  - Develop and Document Insights

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

Wireless

- Perform research on use and application of secure wireless technologies in other industries

- Research motivation/purpose included:
  - Potential expanded use of wireless in nuclear power plants for monitoring and control
  - Cybersecurity insights from other safety-critical applications

Conclusion

- RES works closely with the NRC staff to produce **timely and useful** research
- RES work factors in the licensees' plans associated with digital I&C technology implementations
- RES work complements DOE-related research
- RES work leverages MOU and International research work to ensure that the NRC is ready for timely review future submittals

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ANS