U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Digital Instrumentation and Control

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Speakers

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Agenda

- **Background of Digital I&C and Lessons Learned**
- **Incorporation by Reference of IEEE 603-2009**
- **Other Key Regulatory Initiatives**

Background—Why is Digital Technology Unique?

- Different principles of operation
- Different hazards for digital vs. analog
- Communications independence challenges
- Increased potential for latent errors

Early Actions Taken to Address Digital

- Development of guidance to address unique aspects of digital
  - Regulatory guides on digital I&C system development
  - Standard review plan revision

Formation of the Digital I&C Steering Committee

- Task working groups initiated to address digital I&C licensing process
- Issuance of digital I&C interim staff guidance

What We Learned—Operating Reactors

- **Digital I&C licensing processes can be improved**
  - **Early communications and identification of required documentation works well**
  - **Graded review approach needs to be improved**

What We Learned—New Reactors

- Utilize highly integrated digital I&C systems
- Challenged in providing sufficient design information and analysis to demonstrate safety with initial designs
- Addressing requirements at architectural level was effective

What We Learned—Other Key Issues

- Current I&C requirements should be updated to address digital
- Ambiguities in 10 CFR 50.59 guidance need to be revised
- Diversity and defense-in-depth criteria need to be re-evaluated

The Role of IEEE 603

- Criteria for I&C safety systems
  - Technology neutral
  - Performance based
- Incorporated into regulation
  - Incorporated by reference
  - General Design Criteria

What Changed in the Standard

- New version of the standard adds:
  - Guidance for digital technology
  - Annex on electromagnetic compatibility
  - Guidance for connected equipment
  - Communication independence criteria

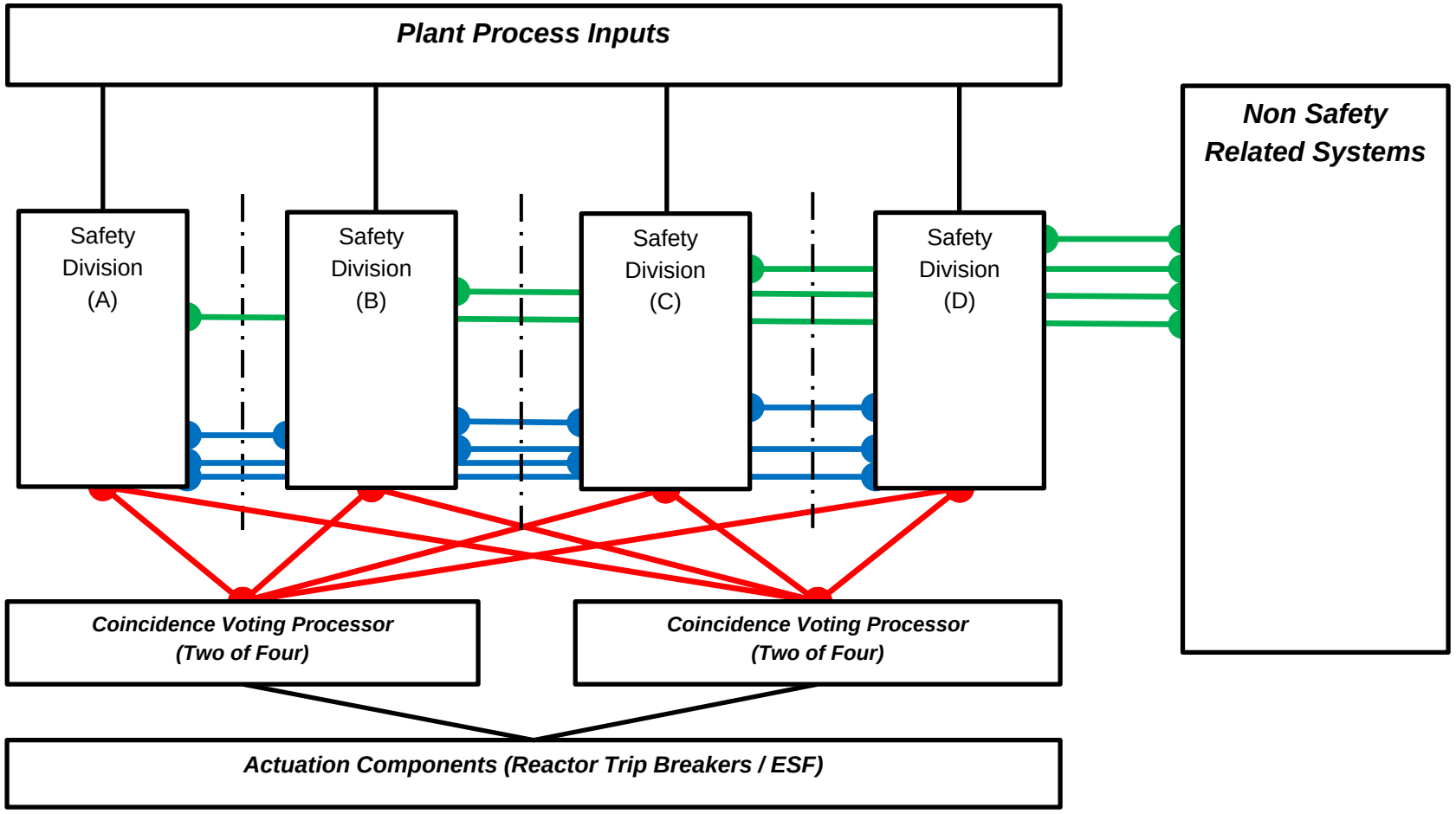
Applicability of New Standard

- **Conditions for applicability of the new and previously incorporated versions**
  - **New plant designs required to comply with IEEE 603-2009**
  - **Impacts operating plants and existing design certifications if changes meet threshold**

System Integrity

- **Amplify "System Integrity" requirements**
- **Condition added:**
  - **In order to assure the integrity and reliable operation of safety systems, safety functions shall be designed to operate in a predictable and repeatable manner.**

Example Reactor Protection System



Independence

- **Amplify "Independence" requirements**
  - **Between redundant portions of safety systems**
  - **Between safety systems and other systems**

Independence (cont.)

- **Amplify "Independence" requirements**
  - **A. Manner of processing data**
  - **B. Detection and mitigation capabilities**

Independence (cont.)

- **Amplify "Independence" requirements**

  C. For current reactors,

  Signals must support safety or provide a safety benefit.

Independence (cont.)

- **Amplify "Independence" requirements**

  D. For new reactors,

  (1) One-way—hardware enforced

  (2) Only signals to perform safety functions are allowed

Independence (cont.)

- **Amplify "Independence" requirements**

  (3) Signals to support diversity and automatic anticipatory reactor trip functions

  (4) Proposed alternatives requirements

Potential Impact on Operating Plants

- **Supports use of newer version of IEEE 603**
- **Applicants already perform hazard analysis**

Potential Impact on New Reactors

- **Communication independence demonstrated at higher level**
- **Limit failure modes and unexpected behaviors associated with communications**

Stakeholder Engagement

- **NRC staff participated in IEEE 603-2009 development**
- **ACRS recommended adding conditions**
- **Industry generally did not support added conditions**
- **NEI does not support issuance of proposed rule**

Benefits of Proposed Rule

- Facilitates use of IEEE 603-2009
  - Updates for new technology
  - More effective EMC
- Conditions provide improved consistency and predictability for licensing
- Issuing the proposed rule will facilitate external stakeholder feedback

Key Regulatory Initiatives—Develop a DI&C Action Plan

- Address lessons learned and stakeholder feedback
- Prioritize activities
- Coordinate with industry initiatives

DI&C Action Plan

10 CFR 50.59

- Review/Comment on NEI draft 50.59 guidance
- Identify impact on NRC policy/guidance documents
- Interface with industry stakeholders
- Revise regulatory guidance

Software CCF

- Evaluate assumptions in SECY-93-087
- Evaluate options for updating NRC policy
- Prepare technical basis
- Interface with industry stakeholders
- Prepare SECY paper

Licensing Process

- Evaluate guidance based on lessons learned
- Interface with industry stakeholders
- Revise regulatory guidance

Cyber Review in Design

- Develop options for reviewing cyber-related design information
- Draft SECY paper to propose options to Commission
- Revise appropriate documentation in accordance with Commission direction

Enhance 10 CFR 50.59 Guidance

- **Non-compliances identified when upgrades performed**
- **Ensure updated guidance is adequate**

How Software Common Cause Failure is Currently Addressed

- SRM-SECY-93-087 defines criteria for addressing software common cause failure
  - BTP 7-19: guidance for implementation
  - NUREG/CR-6303: guidance for performing diversity and defense-in-depth analysis

Improve Software Common Cause Failure Criteria

- Evaluate existing policy on software common cause failure
  - Incorporate advances in digital technology
  - Prepare a technical basis paper and a SECY paper
  - Maintain interfaces with industry stakeholders throughout effort

Improve Licensing Process for Digital I&C Systems

- Enhance licensing process in ISG-06 to include lessons from the pilot
- Improve guidance for new reactor licensing processes

Review Cyber Security Design Features During Licensing

- Cyber security design not currently reviewed as part of licensing
- Early consideration of cyber security in the design process is beneficial
- SECY paper under development

Digital I&C Action Plan

- **Additional activities:**
  - **Highly integrated systems**
  - **Regulatory infrastructure**
  - **Guidance for alternative evaluation**
  - **Consistency: licensing and inspections**
  - **Topical report process**

Summary

- **Publish proposed rule to obtain stakeholder feedback**
- **Ensure Digital I&C Action Plan includes key regulatory initiatives**
- **Coordinate with industry digital I&C working group**

Acronyms

ACRS – Advisory Committee on Reactor Safeguards
BTP – Branch Technical Position
CFR – Code of Federal Regulations
DI&C – Digital Instrumentation and Control
EMC – Electromagnetic Compatibility
ESF – Engineered Safety Feature
I&C – Instrumentation and Control
IEEE – Institute of Electrical and Electronics Engineers
ISG – Interim Staff Guidance
NEI – Nuclear Energy Institute
NRC – Nuclear Regulatory Commission
NRO – Office of New Reactors
NRR – Office of Nuclear Reactor Regulation
NUREG – NRC technical report
SECY paper – Commission Paper
SRM – Staff Requirements Memorandum