Southern Nuclear Operating Company

Protection System Upgrades Analog vs. Digital

Ray Herb, Principal Engineer I&C, SNC Fleet Design
2015 NRC Regulatory Issues Conference, Washington DC

SOUTHERN COMPANY

1

Summary

- Protection System Overview
- Protection System Changes
- Benefits of Digital
- Why Use Analog?
- Barriers to Using Digital
- Addressing the Digital Barriers

2

Protection System Overview

- Health and safety of the public
  - Primary focus
- Part of the "Echelons of Defense" *(protection systems in red)*
  - Plant Controls: keeps the reactor operating within normal limits
  - Reactor Trip System: trips the reactor before exceeding any safety analysis limits
  - Engineered Safety Features Actuation Systems: protects the credited physical boundaries to radiation
  - Monitoring and Indication Systems: provides information to the operator to support all the preceding echelons including selected manual actions and post accident responses
- Protection system design objectives - safe and reliable
  - Redundancy: multiple channels available in case of a failures
  - Independence: failures cannot be allowed to propagate through system
  - Diversity: multiple ways to get to safe conditions
  - Reliability: actuate when needed (not too early or too late), fail safe, deterministic
  - Robustness: resist both environmental and operational extremes
  - Secure: physical and cyber

3

Protection System Changes

- Nothing lasts forever…
  - Change is inevitable, desirable to maintain plant safety, defensive measures
  - Analog or Digital?
- Changes are needed at all echelons
  - Maintenance and obsolescence issues are not specific to protection systems
  - Plant control systems are being replaced with digital systems
  - Analog components are becoming less common in all industries
  - Cumulative changes must be addressed
- Protection systems are special, more care needed to maintain
  - Many protection system vendors currently support the older analog systems
  - Newer digital systems provide additional functionality and capability not included in original systems
  - Must address all impacts on principle design objectives

4

Benefits of Digital

- Reliability
  - Engineered to be fault tolerant
  - Repeatable, Accurate and Precise
  - Software does not wear out
- Maintainability
  - Self test routines announce failures
  - Diagnostic routines monitor system health
  - Code can be portable
- Vendor support
  - New digital systems easier to support
- Digital is the future
  - Many previous analog components now contain digital embedded devices

5

Why use Analog?

- Easier to remain within licensing basis (50.59 based changes)
  - Hardware based only, no software to qualify or maintain
  - Easier to reverse engineer if existing vendors no longer support
- Familiarity
  - Most utilities have traditional "analog" systems
  - Designers and Engineers know the engineering basis
- Less regulatory risk
  - Independence and redundancies are more evident
  - Failure modes well known
  - Avoids the dilemma of software common cause failures
- Longer lifecycle than digital
  - Depending on the technology and vendor support

6

Barriers to Using Digital

- Regulatory uncertainty
  - Staff and Industry issues with NEI 01-01 application
  - 10 CFR 50.59 allowed changes uncertain
  - DI&C-ISG-06 process unproven
  - Regulatory uncertainty can impact system cost, outage schedules, availability
- Uncertainty on assuring digital reliability
  - Commercial Grade Dedication vs. Appendix B Development Process
  - New vs. Old committed standards
  - 100% testing requirements of BTP 7-19
- Diversity and Defense in Depth (D3) issues
  - Software common cause failure (SCCF)
  - Combinational impacts on failure modes
  - Addition of non-safety diverse actuation system

7

Addressing the Digital Barriers

- Eliminate uncertainty in approval process
  - Consistent, acceptable methods for establishing quality and assurance levels
- Understanding the digital scope
  - Agree on what is digital (not as simple as it seems)
  - Clear design criteria with a digital focus
  - Separate software issues from hardware issues
- Understanding failure modes and how they impact the safety and reliability of the digital system
  - Assuring independence, redundancy and diversity of protective functions equivalent or better than existing protection systems

8

Questions?

9