Open Phase Condition Industry Update

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OPC Industry Update

Agenda

- Industry's Regulatory Position
  - OPC Regulatory Requirements
  - OPC Industry Standards
  - OPC Regulatory Conclusion
- OPC Risk Informed Position
- Open Phase Condition Initiative

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OPC Regulatory Requirements

- **NRC Standard Review Plan (SRP) Appendix 7.1-B:** "Guidance for Evaluation of Conformance to IEEE Std. 279"
  - Reinforces the scope limitations of IEEE Std. 279-1971
    - "...systems that actuate a reactor trip..."

- **10 CFR 50.55a(h)(2):** "Protection systems"
  - Taken from the "Statements of Consideration" for the rule change to incorporate IEEE Std. 603-1991 into 10CFR50.55a(h)(2), dated April 13, 1999:

    "all electric and mechanical devices and circuitry (from sensors to actuation device input terminals) involved in generating those signals associated with the protective function. These signals include those that actuate reactor trip..."
  - Scope limited to protection systems
    - Protection systems only sense or command features of the reactor trip system
    - Protection Systems only generate signals, actuate, or power engineered safety features

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OPC Industry Standards (1 of 2)

- **IEEE Std. 279-1971:** "Criteria for Protection Systems for Nuclear Power Generating Stations"
  - Defines protection systems
    - Protection systems include all devices that generate signals and actuate to trip the reactor
    - Minimum criteria established for the safety-related functional performance and reliability of protection systems for nuclear reactors
  - Protection systems meet the criteria stated in either IEEE Std. 279, IEEE Std. 603-1991, or the plant-specific requirements
  - Open phase indication system (OPIS) designs are not protection systems

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OPC Industry Standards (2 of 2)

- **IEEE Std. 603-1991:** "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations"
  - Incorporation by reference approved as of May 13, 1999
  - Clarifies that power sources are considered auxiliary supporting features - power sources are not part of the reactor trip system and not an engineered safety feature
  - Open phase indication system (OPIS) designs are power source detection circuits

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OPC Regulatory Conclusion (1 of 2)

- **A typical OPIS solution:**
  - Is located on the offsite electric power system
  - Isolates an open phase condition (OPC) similar to other switchyard, transformer, and transmission network fault isolation circuits
  - Assures independence of the onsite power system
  - Allows the Class 1E ESF buses to be repowered by alternate GDC-17 sources preserving their designated safety functions
  - Restores compliance with GDC-17:
    - Addresses single passive component failures
    - Prevents the loss of power from the onsite electric power system as a result of, or coincident with, the loss of power from the transmission network

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OPC Regulatory Conclusion (2 of 2)

- **An OPIS should *not* be considered part of the protection system because:**
  - It does not sense or command features of the reactor trip system
  - It does not generate signals, actuate, or power the ESFAS
  - It is located on connections to the station switchyard, switchyard transmission lines, or the transmission network which, as discussed in IEEE-308-1974, are excluded from the Class 1E power systems

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Industry's Regulatory Position

Questions / Discussion

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Open Phase Condition
Risk Informed Position

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Risk Informed Bounding Analysis

- **OPC Bounding Analysis**
  - **Selected an Exelon unit with single off-site power supply to safety trains (worst case)**
  - **Risk informed analysis completed using**
    - Non-safety system Open Phase Indication System (OPIS) circuitry
    - No redundant circuits
    - Determination of affect on Core Damage Frequency (CDF)
  - **Results**
    - Calculation assumptions generic enough to apply to all plants
    - CDF impact from an open phase is approximately 1E-08
    - No safety improvement by adding redundant circuits

OPIS and Additional Equipment

- Adding a loss-of-single-phase event to the PRA would be expected to have the following effect

Condition	Failures Modeled	Approximate Increase in CDF	
Pre-Event	Operator action	3E-6	7.5%
Current Configuration	Alarm or operator action	6E-7	1.5%
Planned Configuration	Automatic actuation & operator backup	1E-8	0.03%

- Conclusion: No gain in safety by adding Class 1E or Non-Class 1E equipment

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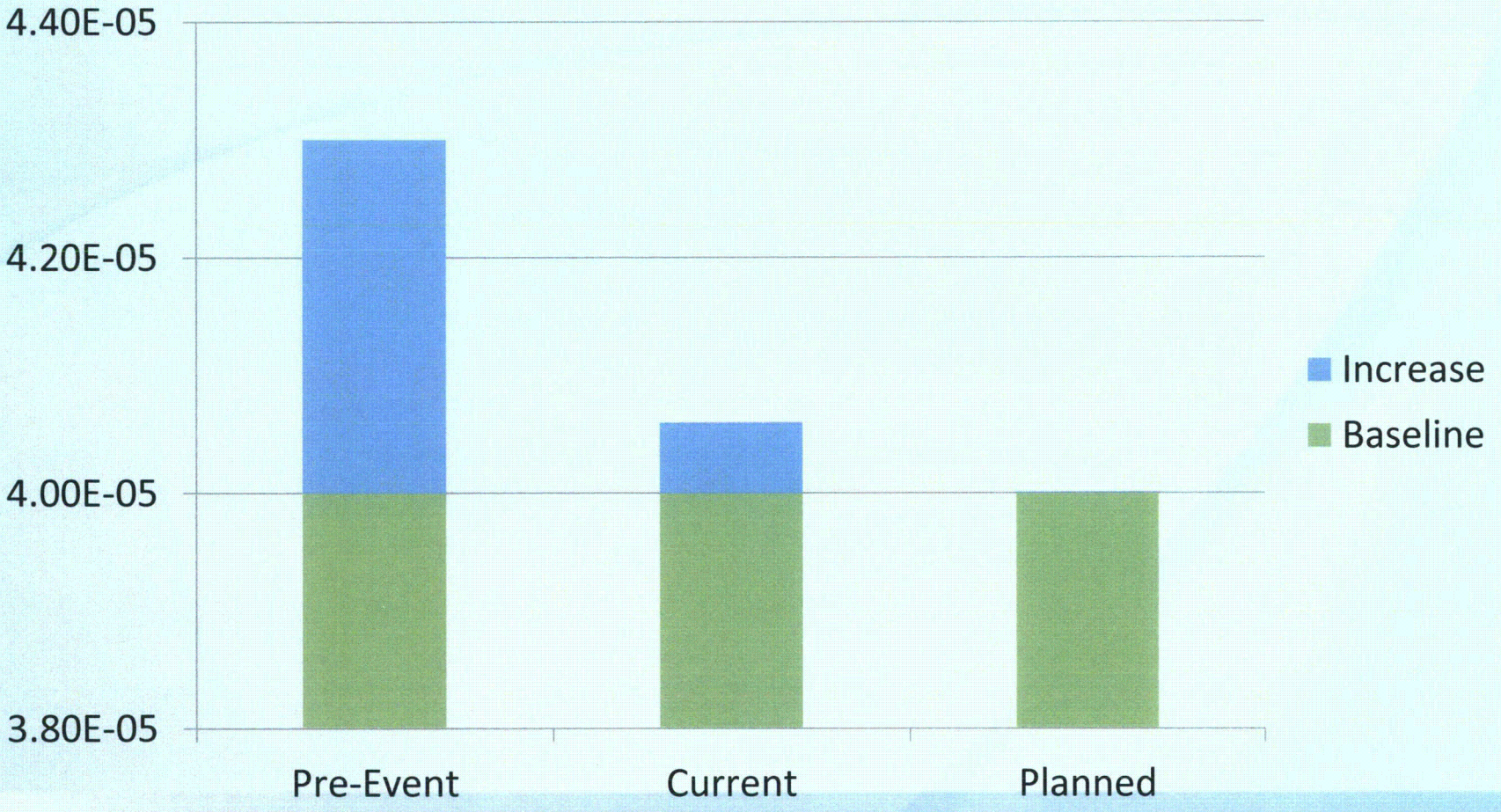
Core Damage Frequency



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Risk Informed Conclusion

- OPC Risk Informed Position
  - Additional equipment or compensatory actions beyond OPIS provides no measureable safety gain
  - Additionally, nothing in the current regulations would require additional circuitry
  - NRC should pursue rule making or a backfit review if additional work is deemed necessary beyond the industry initiative

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Open Phase Condition
Industry's Initiative

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Open Phase Condition Initiative

Goal

- An open phase condition will not prevent functioning of important to safety structures, systems, and components. An open phase condition is defined as an open phase, with or without a ground, which is located on the high voltage side of a transformer connecting a General Design Criterion (GDC) 17 offsite power circuit to the transmission system.

Objectives

- Operating nuclear power plant licensees demonstrate that important to safety functions remain available given an open phase condition or install plant modifications to detect and isolate from the open phase condition. If the open phase condition prevents the functioning of important to safety structures, systems, and components, the engineered safeguard buses should be transferred to an alternate source.

- New reactor licensees, Combined License (COL) applicants, and design centers for *active safety features plant designs* demonstrate that important to safety functions remain available given an open phase condition or install plant modifications to detect and isolate from the open phase condition. If the open phase condition prevents the functioning of important to safety structures, systems, and components, the engineered safeguard buses should be transferred to an alternate source.

Open Phase Condition Initiative

Industry Strategies

- Industry pro-active response
- Alignment between NRC & Industry strategies
- Plant specific strategy – including plant specific schedules, as needed, that may not meet the initiative timelines (deviation process being developed)

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Leading Nuclear OPC Industry Solutions

- Current detection
  - SEL relay (existing/new CTs & site-specific programming)
  - PCS2000 (custom CTs & site-specific programming)
  - Alstom (optical CTs & site-specific programming)
- Voltage unbalance detection
  - ABB 60Q Relay (solid state, not programmable)
- Current injection
  - EPRI Neutral Injection
- Hybrid (e.g., EPRI Injection + Voltage detection)

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Industry Research

(>20 OPC Detection Methods Under Investigation)

- IEEE Protective Relay Committee
- IEEE Nuclear Power Engineering Committee
- EPRI
- Universities
- Vendors
- Utilities / A&Es

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OPC Industry's Position

Questions / Discussion

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