Monticello Nuclear Generating Plant

Pre-Application Meeting

November 17, 2016

Risk-Informed Exemption Request from Specific Requirement of 10 CFR 50 Appendix R Section III.G.2

Introductions

- Martin Murphy – Director of Nuclear Licensing and Regulatory Affairs
- Paul Young – Engineering Programs Manager
- James Zimmerman – Appendix R Program Engineer
- Shane Jurek – Licensing Engineer
- Adam Stein – PRA Engineer
- Greg Kvamme – PRA Engineer

Agenda

- Meeting Purpose
- Background Information
- Description of Installed Modification
- Three Options for Resolving Non-Conformance with Appendix R
  - Evaluation
  - Modification
  - Exemption
- Risk Analysis Supporting Exemption
- Feedback

Meeting Purpose

- Describe a future request for an exemption to specific requirements of 10 CFR 50 Appendix R Section III.G.2
- Establish a common understanding of the scope of the request
- Obtain NRC expectations for submittal content
- Obtain NRC feedback

Regulatory Requirements

10 CFR 50, Appendix R, Section III.G.2

Where cables or equipment. . . of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are located within the same fire area . . . one of the following means of ensuring that one of the redundant trains is free of fire damage shall be provided:

a. Separation by a 3 hour fire barrier

b. Separation by 20 feet with fire detection and suppression systems

c. Enclosed by a 1 hour fire barrier with fire detection and suppression systems

Issue Identification

- 2009 – MSO evaluation completed
- 2011 – MSO modifications installed
- 2012 – Thermal hydraulic analysis to bound MSO expert panel assumptions completed
  – Identified that the drywell spray paths could have an adverse impact on safe shutdown
- 2012 – Shorting switch installed on outboard DWS Valves' control circuitry
- 2014 – NRC Triennial Fire Protection Inspection; assessed a Green NCV

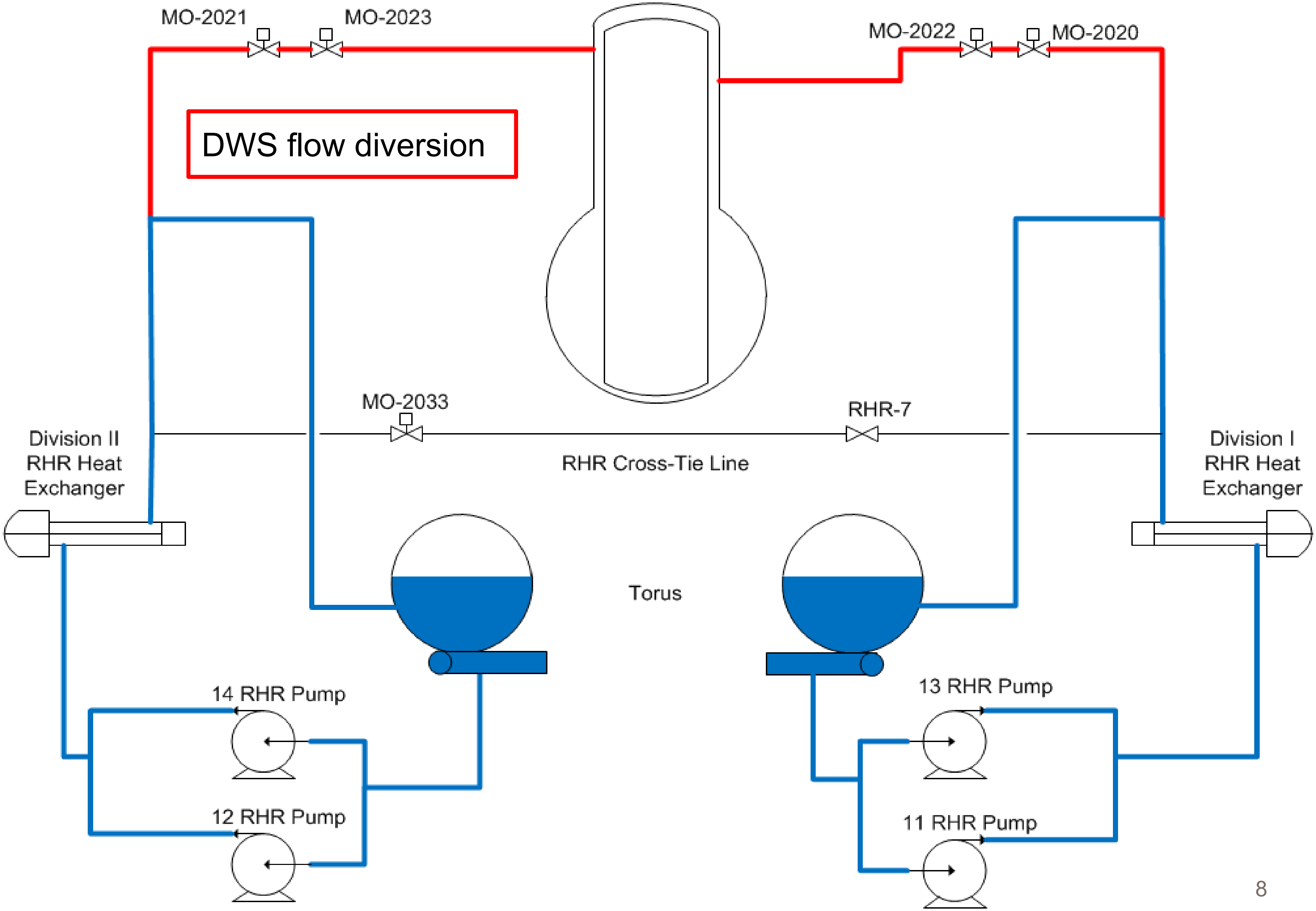
Non-Cited Violation

Green NCV of 10 CFR 50, Appendix R, Section III.G.2

- Specifically, the licensee failed to ensure that the Drywell Spray Motor Operated Valves MO-2020 and MO-2021 would not spuriously open due to fire induced failures (i.e., open circuit and hot shorts) when they installed shorting switch modifications for these valves.

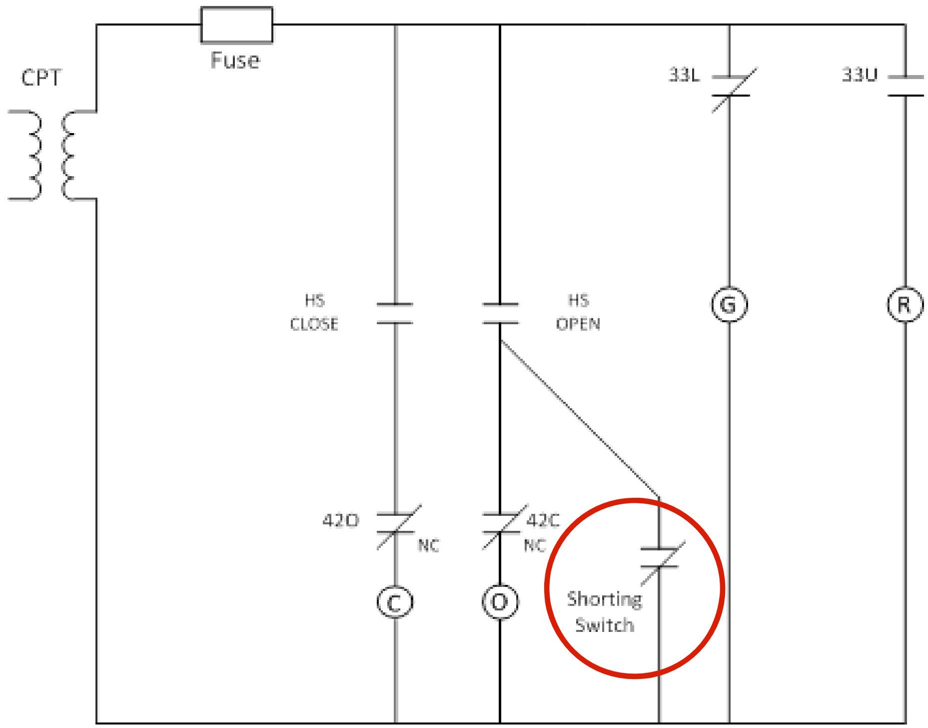
- The licensee performed a shorting switch considerations evaluation and determined that even after the implementation of the shorting switch modification; a multiple hot short scenario would still exist in theory which could spuriously open these RHR valves to their undesired position.

Residual Heat Removal System



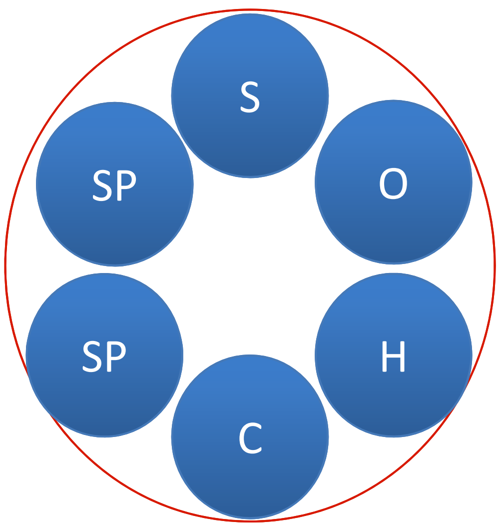
Shorting Switch

The MNGP shorting switch design utilizes a normally closed contact in the valve handswitch in the control room. When the handswitch is in the neutral position, the contact is closed. The switch shorts the open coil for the valves to prevent spurious opening.

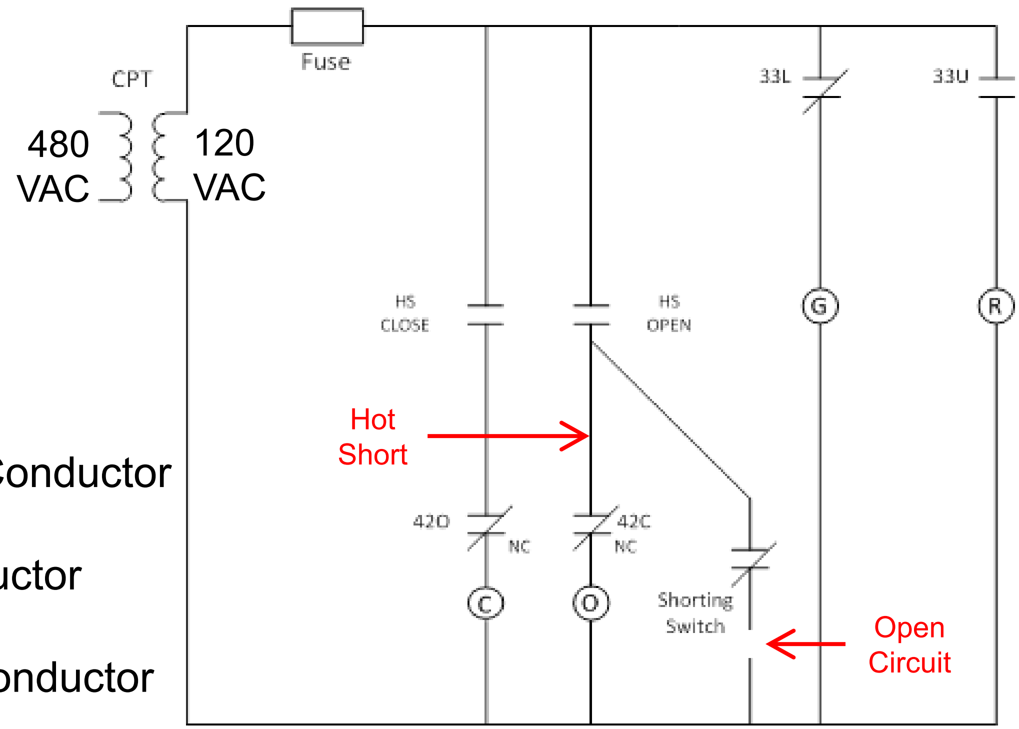


Shorting Switch Failure Mode

The shorting conductor is in the same field cable as the open conductor, so there is low possibility for the fire to defeat the shorting switch.



S = Shorting Conductor
O = Open Coil
H = Hot Conductor
C = Close Coil
SP = Spare Conductor



Possible Resolution Paths

1. Perform evaluation to demonstrate acceptable effects of flow diversion

2. Modify plant to comply with deterministic requirements

3. Receive an exemption from Appendix R

Option 1 - Evaluation

- Important to vs Required for Safe Shutdown
  - If the valves can be classified as Important to Safe Shutdown, shorting switches could potentially be credited for mitigation.
  - NEI 00-01 Revision 2 Appendix H
    - Can flow diversion be tolerated for one hour without mitigating action?

- Analysis did not support this option

Option 2 - Modification

- The compliant modification involves re-powering one drywell spray valve from each division from MCCs in different fire areas
- The target conductors in the control cable must be routed in dedicated conduit from the control room to the new MCC locations
  - Approximately 760 ft. of new conduit
  - Approximately 1070 ft. of new cable
- Risk associated with installing modification
  - Nuclear Risk
  - Radiological Risk
  - Industrial Risk
- Based on detailed walkdown and estimates
  - Approximately 12,500 person-hours to install
  - Approximately $2 Million

Option 3 - Exemption

The Commission may grant exemptions which:

- Are authorized by law
  – Atomic Energy Act of 1954 does not specify fire protection requirements
- Will not present an undue risk to the public health and safety
  – PRA section will show acceptably low risk
- Are consistent with the common defense and security
  – Not modifying the physical security plan in any way
- Include special circumstances, as defined in 10 CFR 50.12(a)(2)
  – 50.12(a)(2)(ii) Application of the regulation in the particular circumstances. . . is not necessary to achieve the underlying purpose of the rule
    - Underlying purpose of the rule is achieved by means of electrical protection provided by shorting switch

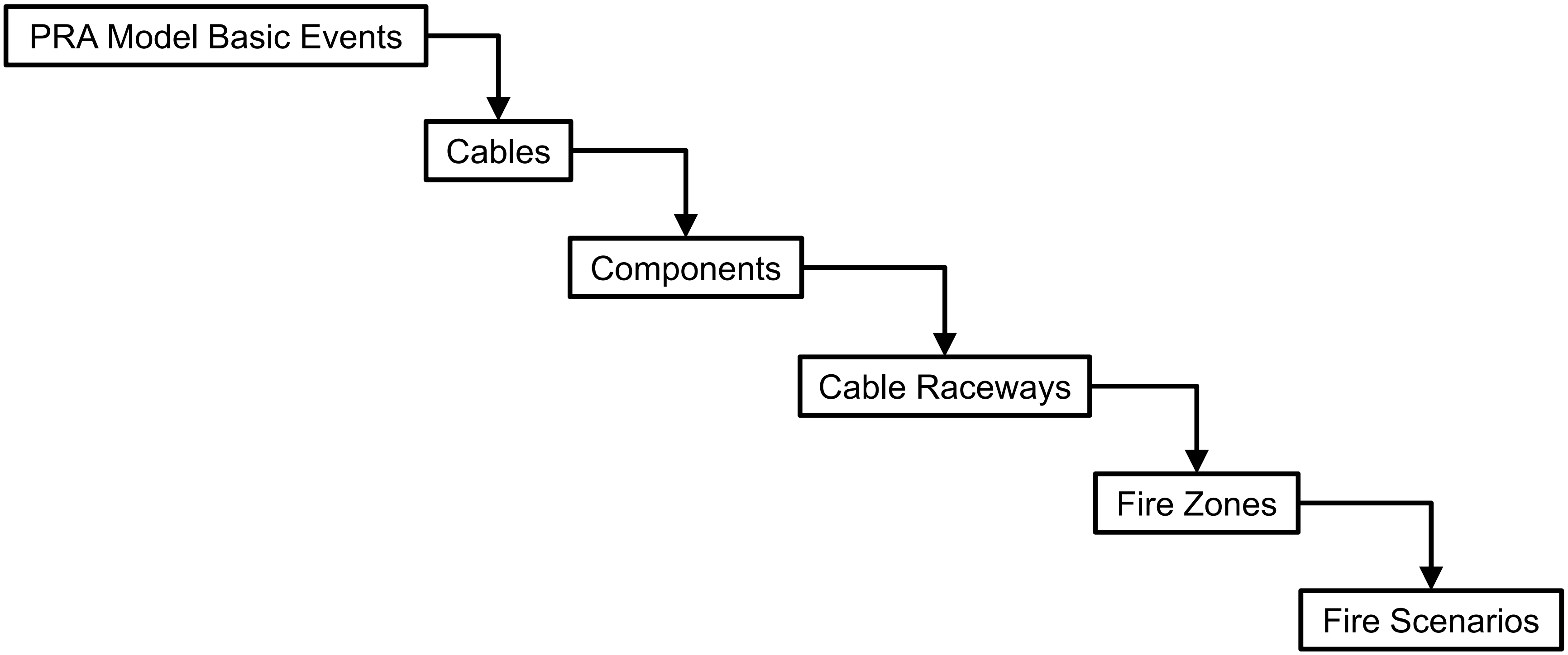
Option 3 - Exemption (cont.)

- Regulatory Guide 1.174 key principles for risk-informed application
  - Meets the current regulations or is related to an exemption
    - Request an exemption from 10 CFR 50, Appendix R, Section III.G.2
  - Consistent with a defense-in-depth philosophy
    - Fire protection program retains defense-in-depth philosophy
  - Maintains sufficient safety margins
    - No change to design or operation; therefore safety margins are maintained
  - Acceptably low increase in risk
    - The increase in risk is below the thresholds established in the RG
    - 1.0E-06 for ΔCDF and 1.0E-07 for ΔLERF
  - Monitored using performance measurement strategies
    - Post modification testing, MOV program, Maintenance Rule Program

Risk Analysis

- PRA model determined that there is a low risk benefit achieved by modifying the plant to meet the deterministic rules of Appendix R. To determine the risk benefit two PRA models were created:
  - Compliant Model
    - The unchanged most up-to-date Fire PRA model (Revision 3.0) was used where the drywell spray valve multiple spurious operation (DWS MOV MSO) is assumed to not occur in any fire
  - Variant Model
    - Created by modifying the most up-to-date Fire PRA model (Revision 3.0) to include the possibility of a DWS MOV MSO

Modeling of DWS MOV MSO



Functions Assumed Failed

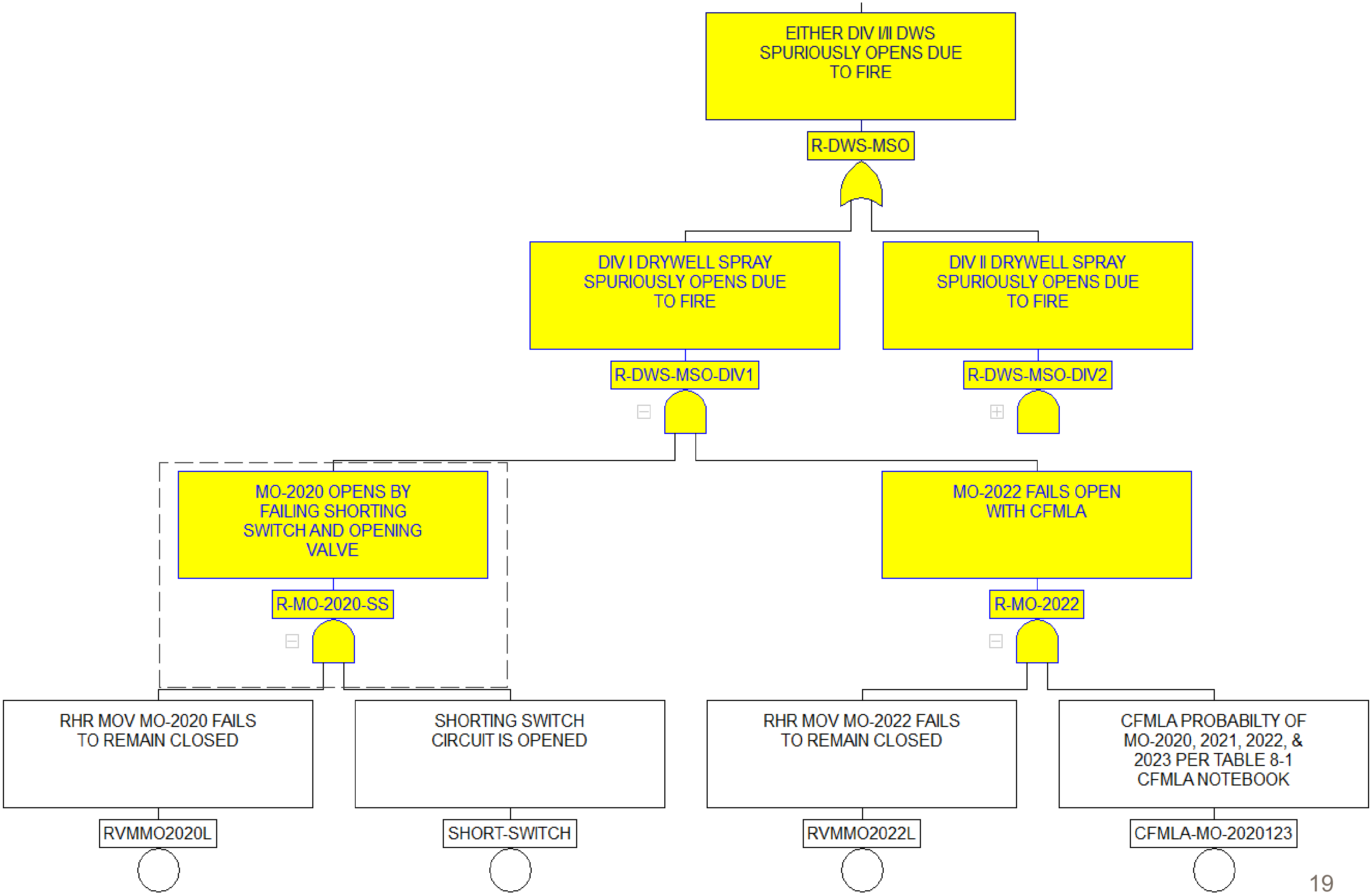
- All RHR functions assumed failed due to flow diversion except DWS
  - Torus Cooling (fails HPCI and RCIC suction from the torus due to long term NPSH concerns)
  - LPCI
  - Shutdown Cooling
  - Torus Spray (not credited in PRA)
  - RHR single pump run-out

- Core Spray - long term NPSH concerns

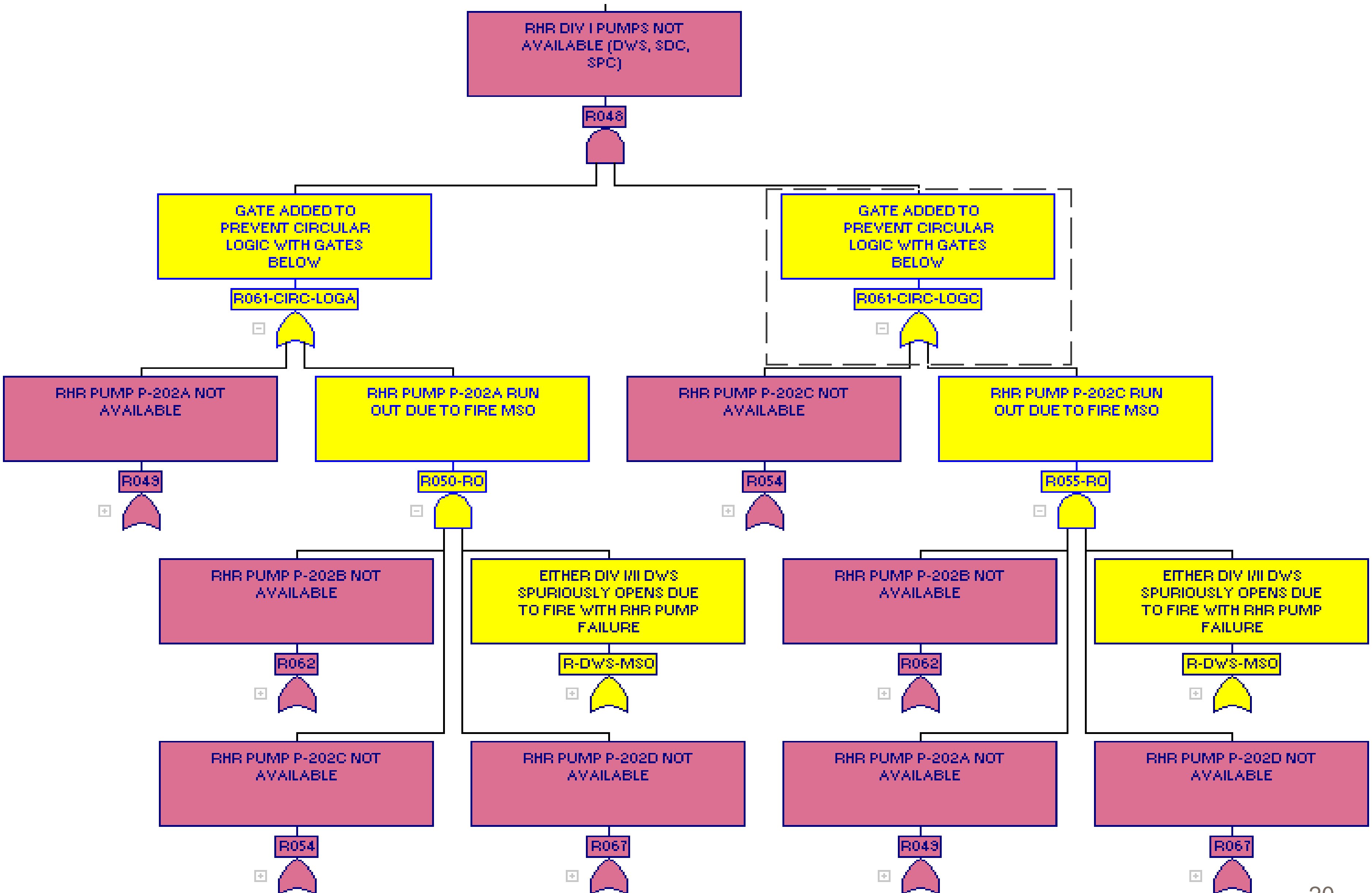
- Alternate injection with CSW, FPS, or RHRSW through the LPCI piping

- Primary Containment – negative pressure exceeds design if vacuum breakers also fail

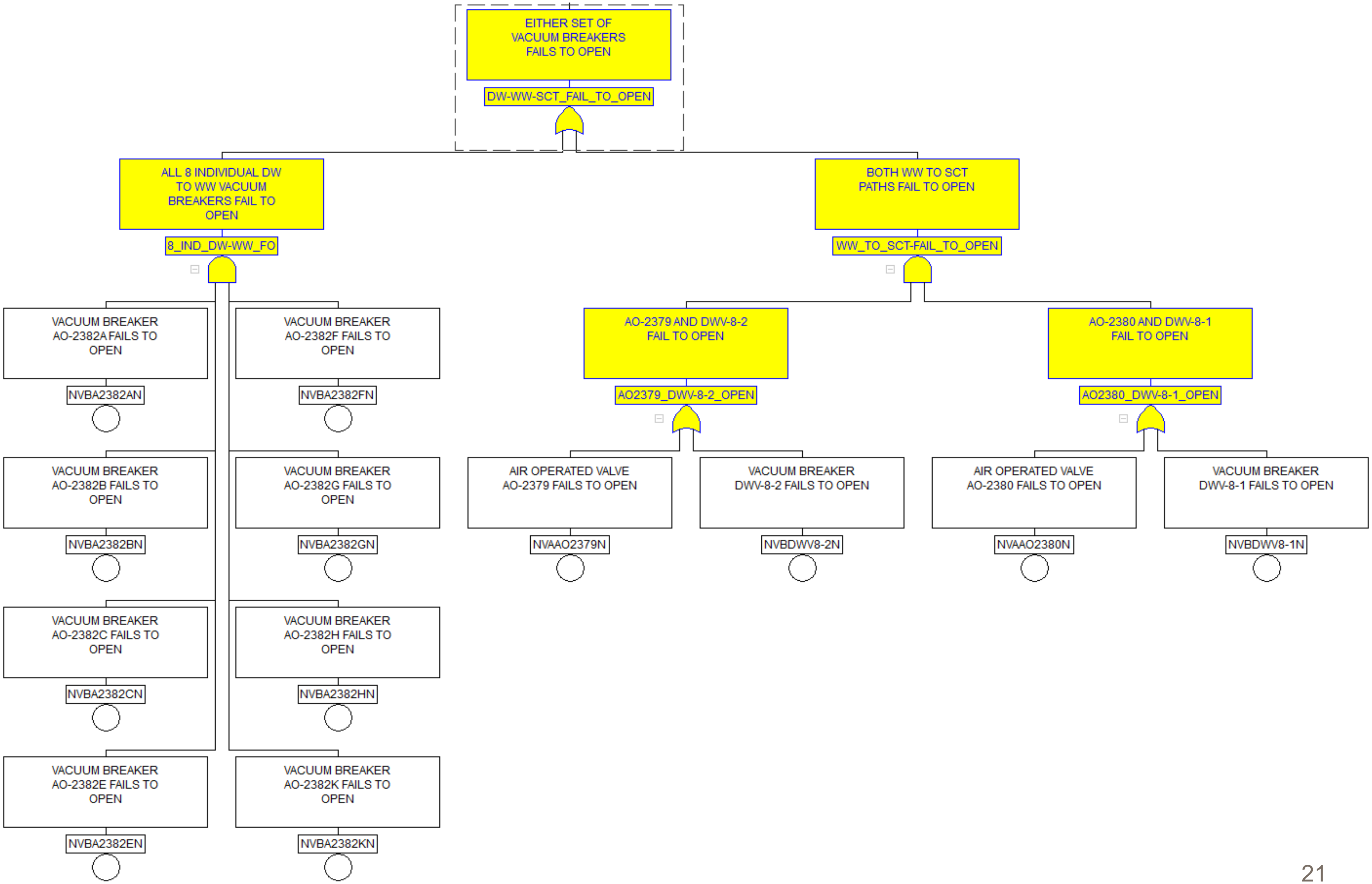
Modeling of DWS MOV MSO



Modeling of RHR Pump Run-Out



Modeling of Containment Failure



Model Results

- Fire scenarios comprising the entire plant were quantified for both models and compared in the following table.

	CDF	LERF
Compliant Model	4.109E-05	5.257E-06
Variant Model	4.112E-05	5.257E-06
Risk Change (Δ)	3.3E-08	4.0E-11
RG 1.174 Thresholds (Δ)	1.0E-06	1.0E-07

- Truncation at 1E-11 for CDF and 1E-12 for LERF based on convergence.

Model Conservatisms

- NUREG/CR-6850: Fire PRA Methodology for Nuclear Power Facilities states that open circuit failures are typically not considered since the fire would have to exceed the melting point of the conductor. Open circuits were conservatively considered in this analysis.

- Bounding probability of 1.0E-3 used for failure of the shorting switch based on the NRC's approval of amendments at Arkansas Nuclear One and Browns Ferry. This is considered bounding due to the unlikely combination and timing of concurrent failures required to fail a shorting switch.

- All control room fires were assumed to fail the shorting switches even though only 5 of the 180 fires directly affect the C-03 panel where the switches are located.

Model Conservatisms

- No credit was given for manually shutting the affected DWS MOV.
- No credit was given for stopping the RHR pumps from the control room.
- No credit was given for RHR pumps not running when the MSO occurs.
- DWS MOV MSO causing loss of NPSH is a long-term issue which could be mitigated by putting the RHR heat exchanger in service but was not credited. Instead all injection from the torus was assumed failed in a DWS MSO.
- If either division's DWS MOVs open, both divisions of RHR were assumed failed due to flow diversion. No credit was given for operators closing the RHR cross-tie valve from the control room.

Monticello PRA Model Rigor

- Internal Events and Fire PRA models were separately Peer Reviewed against RG 1.200, Rev. 2 and the ASME PRA Standard (ASME/ANS RA-Sa-2009) in April 2013 and March 2015, respectively.

- One Finding from the Peer Reviews remains open
  - Fire PRA model related
  - Sensitivity analysis confirmed this is a low risk issue

- The Fire PRA model has been updated twice (Revision 3.0) since the Peer Review to include more realistic fire modeling (1589 separate fire scenarios) and improved operator actions

Conclusion

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- Exemption to 10 CFR 50 Appendix R, Section III.G.2
- Very small safety benefit for installing compliant modification
- Meets the requirements of 10 CFR 50.12
- Meets the guidance and acceptance criteria for small changes in RG 1.174

Feedback

Acronyms

10 CFR 50 – Title 10 of the Code of Federal Regulations, Part 50

ASME – American Society of Mechanical Engineers

CDF – Core Damage Frequency

CSW – Condensate Service Water

DWS – Drywell Spray

FPS – Fire Protection System

HPCI – High Pressure Coolant Injection

LERF – Large Early Release Frequency

LPCI – Low Pressure Coolant Injection

MCC – Motor Control Center

MNGP – Monticello Nuclear Generating Plant

MOV – Motor Operated Valve

MSO – Multiple Spurious Operation

NCV – Non-Cited Violation

NEI – Nuclear Energy Institute

NPSH – Net Positive Suction Head

NRC – Nuclear Regulatory Commission

PRA – Probabilistic Risk Assessment

RCIC – Reactor Core Isolation Cooling

RG – Regulatory Guide

RHR – Residual Heat Removal

RHRSW – Residual Heat Removal Service Water