Fleet Fire Protection Program

Calculation of Risk for Fire Areas Crediting Control Room Abandonment

H. B. Robinson Steam Electric Plant

Catawba Nuclear Station

McGuire Nuclear Station

April 14, 2015

Agenda

- Purpose
- Fleet NFPA 805 Transition Status
- Robinson Discussion
- Catawba/McGuire Discussion
- Comparison to FAQ 08-0054

Purpose

The purpose of this presentation is to explain the analysis used to develop the delta risk estimates for the Robinson, Catawba, and McGuire Plant fire scenarios that may lead to abandonment of the control room due to loss of control.

Duke Energy Nuclear Generation
NFPA 805
Fire Protection Program

Duke Fleet NFPA 805 Transition Status

Harris, Oconee and Brunswick: Received NFPA 805 Safety Evaluations

- Brunswick is in the Fire Protection Program Implementation window

McGuire, Robinson, Catawba: NFPA 805 License Amendment Request (LAR) Request for Additional Information (RAI) phase

- LAR Audits are complete
- Current focus is primarily PRA 3, aggregate risk impacts
- Potential additional clarification requests on submitted RAI responses

Duke Fleet NFPA 805 Transition Status

NFPA 805 Processes Established Across the Duke Fleet include:

- Fire Protection Change Process
- Fire Protection Impact Screening for Plant Design Changes
- NFPA 805 Monitoring
- Transient Combustible Control
- Hot Work Permits
- Fire Brigade Training

Robinson

Control Room Abandonment Calculation of Risk Robinson

As part of transition to NFPA 805, the fire areas previously utilizing an exit the control room Self-Induced Station Blackout (SISBO) strategy under Appendix R were re-analyzed for a shutdown from the Main Control Room (MCR)

- A3: Ground Floor Auxiliary Building Hallway
- A5: Auxiliary Building Second Level
- A13: Battery Room
- A14: HVAC Equipment Room for Control Room
- A15: Unit 2 Cable Spreading Room
- A16: Emergency Switchgear Room and Electrical Equipment Area
- A17: Rod Control Room
- A19: Component Cooling Water Surge Tank Room
- F: Containment

Control Room Abandonment Calculation of Risk Robinson

Shutdown at the Primary Control Stations (PCS) is credited in the NSCA only for Fire Area A18

- This fire area includes the Control Room and the Analog Instrumentation Rack Room ("Hagan Room")
- Previously Evaluated as Dedicated Shutdown Area per Appendix R
- Under NFPA 805, Fire Area A18 will no longer utilize a SISBO strategy

Control Room Abandonment Calculation of Risk Robinson

For a fire in Fire Area A18, the VFDRs are the dedicated shutdown recovery actions

- These are actions taken at a plant location that do not meet the definition of a PCS

For fire areas other than Fire Area A18, VFDRs were identified against a safe shutdown strategy with control from the MCR

Calculation of Delta Risk
Robinson

Delta risk is the difference between the variant and compliant cases

Risk reduction plant modifications are included in both the variant and compliant cases

Abandonment is not credited for loss of control

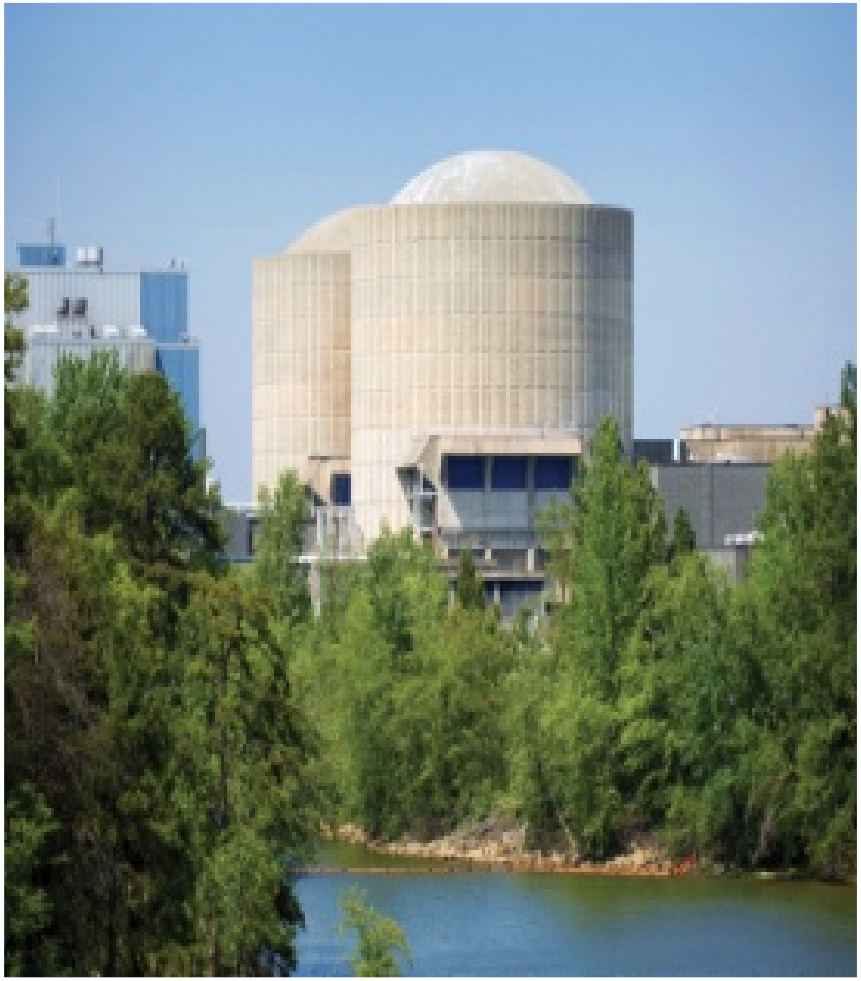
Actions outside the control room associated with VFDRs are identified as Recovery Actions

To evaluate delta risk for the compliant case, cable VFDRs are assumed to be protected and recovery actions are assumed to be successful – maximizes the delta risk

Control Room Abandonment Calculation of Risk Robinson

Questions regarding the Robinson Treatment?

Catawba and McGuire



Standby Shutdown System Compliance Strategy
Catawba and McGuire

Fire Areas where Control Room Abandonment/Alternate Shutdown is credited (other than postulated control room fire)

Catawba (CNS)

1: ND & NS Pump Room 522'
2: U2 CA Pump Room 543'
3: U1 CA Pump Room 543'
4: Aux Bldg Gen Area & NV Pump 543'
9: U2 Battery Room 554'
10: U1 Battery Room 554'
11: Aux Bldg Gen Area & U1 KC Pump Room 560'
16: U2 Cable Room 574'
17: U1 Cable Room 574'
18: Aux Bldg Gen Area & U2 KC Pump Room 577'
22: Aux Bldg Gen Area 594'

McGuire (CNS)

1: Aux Bldg Common 695' and Pipe
2: U1 MD Aux Feed Pump Room
3: U2 MD Aux Feed Pump Room
4: Aux Bldg. Common 716'
13: Battery Rooms Common
14: Aux Bldg Common 733'
19: U1 Cable Room
20: U2 Cable Room
21: Aux Bldg Common 750'
25: Aux Bldg Common 768'

Standby Shutdown Facility (SSF)
Catawba and McGuire

Alternate Safe Shutdown method at CNS and MNS

- SSF is essentially a third train
  - "Miniature Control Room" located away from the TB, AB and RB
  - This is the reason why a large number of fire areas at CNS and MNS are designated as SSF fire areas
- Features:
  - Full HVAC
  - Emergency diesel generator as well as off site power feed
  - Batteries for I&C support
  - Plant wide communications setup
- Functions include:
  - Establish Reactor Coolant Pump Seal Injection
  - Control Reactor Coolant System pressure and volume
  - Remove decay heat via the steam generators
  - Monitoring key plant parameters

Alternate Safe Shutdown Design
Catawba and McGuire

The SSF design addresses potential fire impacts

- Before Leaving MCR
  - Reactor, Turbine, Feedwater Pumps, and Reactor Coolant Pumps tripped
  - select actions based on the unique station design
- MCC containing needed SSF components is swapped to SSF power
  - aligns many valves to SSF position or
  - transfers control of valves to separate SSF circuitry operated from the SSF
  - TDCAP control power is transferred to SSF power
- The SSF AOVs are put in their failed position by the use of Transfer Plugs (valves automatically position contrary to hot shorts)
- Normal charging pumps and Motor Driven Aux Feedwater pumps are tripped
- Since SSF design disables MCR fire affected circuits (MSOs, manipulation of MCR controls), MCR actions/circuits cannot impact SSF activation/operation

Alternate Safe Shutdown Design
Catawba and McGuire

Once SSF transfer actions are complete, the plant is separated from fire spurious operation

- SSF operators have positive plant control
- SSF design presents an ultimate means of mitigating the fire effects on plant equipment
- Provides operators with positive means of maintaining NFPA 805 Performance Goals
- This is why a large number of fire areas at CNS and MNS are designated as SSF fire areas

Alternate Safe Shutdown Operation
Catawba and McGuire

Plant Response Overview

- Fire reported and Brigade dispatched
- Operators use AP/45 as a reference with OPs, APs, and EPs
  - APs and EPs are designed to use “A” and/or “B” Train plant equipment to maintain the Performance Goals
- Operating crew makes decision to enter AP/17 (CNS) or AP/24 (MNS) to activate SSF
- An operator will perform the MCR actions while typically another operator would be dispatched to the SSF to activate it
- Once AP/17(24) is entered, operators complete the procedure establishing control of the plant at the SSF
- The only true abandonment of the MCR is when operators cannot physically be in the MCR

MCR/SSF Fire Response Operation
Catawba and McGuire

Summary of SSF Operations

- SSF provides a conservative response to fires, providing the ultimate protection in SSF fire areas
- For a fire, operations will maintain plant control from the MCR for as long as they can.
  - If not successful, plant control can be regained from the SSF anytime into the event for SSF fire areas
- CNS and MNS are designed such that the MCR and SSF can be manned at the same time in the event of a fire
- Command and Control for PCS as described in RG-1.205 is moved from the MCR to the SSF as AP/17 (CNS) / AP/24 (MNS) is executed

Alternate Safe Shutdown Analysis
Catawba and McGuire

Success Path Determination

- Deterministic Analysis is performed, different success paths are analyzed
- In most SSF Fire Areas, there were a significant number of locations where Train “A” and Train “B” components were encountered
- Due to plant design, there were a minimal number of locations where the SSF components/cables were encountered
- This was the success path that was selected
- This presented an elegant solution for the SSF fire areas to achieve the NFPA 805 Performance Goals

PRA Discussion Overview
Catawba and McGuire

- SSF Modeling in Fire PRA
- Calculation of Variant Case CDF/LERF
- Calculation of Compliant Case CDF/LERF
- Delta Risk Calculation
- CNS PRA RAI 12 and MNS PRA RAI 13

Modeling SSF in the PRA
Catawba and McGuire

- The SSF is modeled directly in the FPRA
  - SSF functions are included in FPRA fault tree logic
  - HRA for SSF operator actions
  - SSF equipment failures

- FPRA logic is consistent with plant design and operating procedures

Duke Energy Nuclear Generation
NFPA 805
Fire Protection Program

Comparison of Variant Case to Compliant Case
Catawba and McGuire

	Variant Case	Compliant Case
CCDP/CLERP	Base FPRA (as built as operated, NFPA 805 projected)	Base FPRA (same as variant case) with VFDRs removed
Ignition Frequency	EPRI Frequency	EPRI Frequency (same as variant case)
NSP/SF	Scenario specific	Scenario specific (same as variant case)
SSF	Functions explicitly modeled	Functions explicitly modeled (same as variant case)
Modifications	Committed NFPA 805 Mods	Committed NFPA 805 Mods (same as variant case)
VFDR Impact	Includes impact of VFDR	Removes impact of VFDR from model

Calculation of Variant Case CDF/LERF
Catawba and McGuire

- Total variant case CDF/LERF calculated for each fire area
- Fire PRA includes variant conditions directly in the model
  - Fire impacts are mapped to cables which are mapped to components
- CCDPs are calculated directly from the FPRA model

Calculation of Compliant Case CDF/LERF
Catawba and McGuire

- The FPRA shows most fires have multiple success paths available
  - These success paths are included in both the compliant and variant cases
  - This eliminates over-stating the compliant case risk and under-stating delta risk
- Total compliant case CDF/LERF calculated for each fire area
- Fire impacts on the components which create the VFDR are removed from the model (Basic Event Toggling)

Calculation of Delta Risk
Catawba and McGuire

- Delta risk is calculated on a fire area basis
- The change in risk estimates are reasonable; no underestimation of delta risk since all conditions are the same except the VFDR impacts
  - No additional equipment is assumed failed in the compliant case
  - Risk reductions modifications accounted for in both cases
  - Same ignition frequencies and NSPs in both cases
  - Credit for SSF is the same in both cases

Treatment of Risk in PRA RAIs CNS-12 & MNS-13
Catawba and McGuire

RAI Response Summary:

Request:

Provide the risk of ex-control room* actions performed at the PCS while command and control is maintained in the control room.

Response:

Determined the risk of ex-control room actions contained in the PRA that mitigate fire induced failures.

Evaluation Process:

- For SSF Fire Areas (excluding MCR)
- Identified sequences containing ex-control room actions
- Excluded sequences associated with actions previously contained in the LAR
- Removed sequences that contain random failures

* Actions taken external to control room

Treatment of Risk in PRA RAIs CNS-12 & MNS-13 (Continued) Catawba and McGuire

Evaluation Process Continued:

- Examples of ex-control room operator actions include
  - recover main feedwater
  - start SSF SBMUP
  - start diesel driven instrument air compressor
- The total CDF associated with these sequences is in the low E-7 range (per unit)
  - Using the total sequence risk maximizes the estimate of the ex-control room action risk

Control Room Abandonment Calculation of Risk
Catawba and McGuire

Questions regarding the Catawba/McGuire Treatments?

Comparison to FAQ 08-0054
Robinson, Catawba and McGuire

Duke Energy meets the guidance in FAQ 08-0054

- B.2.2.4.2.a Variant vs. Compliant Condition
  - Cases are defined per the FAQ guidance
- B.2.2.4.2.b Fire Risk Evaluation
  - This analysis compares the risk of the variant case with the complaint case per the guidance in the FAQ
- B.2.2.4.2c Review of Acceptance Criteria
  - Evaluation of the VFDRs meets the acceptance criteria

Closing

The treatment of the variant and compliant case with the resulting delta risk calculation for control room abandonment fire scenarios relating to possible loss of control provides a reasonable estimate of the delta risk for transition to NFPA 805 and meets the guidance in FAQ 08-0054.

Questions?

Appendix
Related RAI Responses Previously Submitted - RNP

Some aspects addressed in this presentation are discussed in greater detail in the Robinson RAI responses for:

- PRA 01.f - MCR abandonment is only credited for loss of habitability in the FPRA
- PRA 23 - Determination of the change-in-risk and the additional risk of recovery actions associated with VFDRs
- PRA 24.01 - Clarification of actions taken at the remote shutdown locations not associated with MCR abandonment that are credited in the FPRA

Appendix
Related RAI Responses Previously Submitted - CNS

Some aspects addressed in this presentation are discussed in greater detail in the Catawba RAI responses for:

- PRA 11 - Control Room Abandonment for Main Control Room fires
- PRA 12 - Operator Actions at the PCS when Command and Control is at the MCR
- PRA 13 - Methods used to determine the change in risk values reported in LAR Tables W-3 and W-4

Appendix
Related RAI Responses Previously Submitted - MNS

Some aspects addressed in this presentation are discussed in greater detail in the McGuire RAI responses for:

- PRA 12 - Control Room Abandonment for Main Control Room fires
- PRA 13 - Operator Actions at the PCS when Command and Control is at the MCR
- PRA 14 - Methods used to determine the change in risk values reported in LAR Tables W-3 and W-4

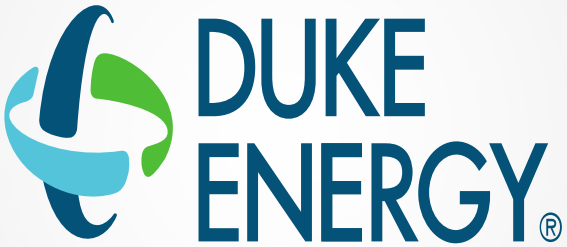
Acronyms

- AB - Auxiliary Building
- AP - Abnormal Procedure
- CCDP - Conditional Core Damage Probability
- CDF - Core Damage Frequency
- CLERP - Combined Large Early Release Probability
- CNS - Catawba Nuclear Station
- EP - Emergency Procedure
- EPRI - Electric Power Research Institute
- FAQ - Frequently Asked Question
- FPRA - Fire Probabilistic Risk Assessment
- HRA - Human Reliability Analysis
- HVAC - Heating Ventilation Air Conditioning
- I&C - Instrumentation and Control
- LAR - License Amendment Request
- LERF - Large Early Release Frequency
- MCC - Motor Control Center
- MCR - Main Control Room
- MNS - McGuire Nuclear Station
- MSO - Multiple Spurious Operations
- NFPA - National Fire Protection Association
- NRC - Nuclear Regulatory Commission
- NSCA - Nuclear Safety Capability Assessment
- NSP - Non-Suppression Probabilities
- OP - Operational Procedure
- PCS - Primary Control Station
- PRA - Probabilistic Risk Assessment
- RAI - Request for Additional Information
- RB - Reactor Building
- RG - Regulatory Guide
- RNP - Robinson Nuclear Plant
- SBMUP - Standby Makeup Pump
- SISBO - Self-Induced Station Blackout
- SSA - Safe Shutdown Analysis
- SF - Severity Factor
- SSF - Standby Shutdown Facility
- TDCAP - Turbine Driven Auxiliary Feedwater Pump
- TB - Turbine Building
- U1/U2 - Unit 1/Unit 2
- VFDR - Variance From Deterministic Requirements

Duke Energy Nuclear Generation
NFPA 805
Fire Protection Program

Duke Energy Participants

- **Jeffery Ertman** – Mgr, Nuclear Engineering, NFPA 805/Fleet Fire Protection
- **David Goforth** – NFPA 805 Technical Manager
- **Brandi Weaver** – Sr Nuclear Engineer, PRA Plant Support
- **Cathy Chan** – Nuclear Engineer, NFPA 805/Fire Protection
- **Harold Stiles** – Lead Nuclear Engineer, Probabilistic Safety Assessment
- **Stephen Kimbrough**– Lead Nuclear Engineer, Probabilistic Safety Assessment
- **Bryan Carroll** – Mgr, Nuclear Engineering, PRA Plant Support
- **Bruce Morgen** – Mgr, Nuclear Engineering, Probabilistic Safety Assessment
- **Kelly Lavin** – Site Fire Protection Program Transition Project Lead (Robinson)
- **Jeffrey Robertson** – Mgr, Nuclear Regulatory Affairs (McGuire)
- **Arthur Zaremba** – Mgr, Nuclear Fleet Licensing Regulatory Affairs


DUKE
ENERGY®