Dominion®

Regulatory Conference

Safety Related Equipment
Susceptibility To Internal Flooding

November 8, 2005

Introduction

Mike Gaffney

Site Vice President

AGENDA

Introduction	Mike Gaffney – Site VP
Background	Tom Webb – Director S&L
Analysis	Tom Hook – Supv. PRA
Corrective Actions	Kyle Hoops – Site Director
Conclusion	Mike Gaffney – Site VP

Dominion

Background

Tom Webb

Station Director

Nuclear Safety and Licensing

Dominion

NRC Finding

The design of KPS did not ensure the AFW Pumps, EDGs, 480V and 4kV Safeguards Buses would be protected from random or seismically induced failures of non-class I systems in the Turbine Building

Dominion

Internal Flood Design Requirements

USAR Appendix B.5 - Protection of Class I Items

Class I items are protected against damage from: a) Rupture of a pipe or tank resulting in serious flooding or excessive steam release to the extent that the Class I function is impaired.

Systems, structures, and components designated Class I are so designed that there is no loss of function in the event of a Design Basis Earthquake (DBE) and all environmental factors (Ref.: USAR 1.3.1)

Dominion

Flood Areas

Analysis

Tom Hook

Supervisor PRA

Dominion

Internal Flood Risk Assessment

Topics

- Initiating Events Summary
- Analysis Methods
- Failure Assumptions
- Mitigation Assumptions
- Risk Results

Dominion

Flood Initiating Events

- Random pipe breaks
- Condenser expansion joint breaks
- Steam line break with fire water sprinkler actuation
- Feedwater line break with fire water sprinkler actuation
- Seismic induced pipe breaks
- Tornado induced pipe breaks
- Turbine induced pipe breaks

Dominion

Resolution of NRC Issues with Prior Draft Analysis

Credit for operator action to isolate firewater flow which required access through flooded Safeguards Alley compartments

Credit for operator detection and isolation of the breaks in the assume timeframes

Credit for connecting battery charger to TSC diesel

Critical flood height uncertainty

High energy line break initiating event frequency based on flow accelerated corrosion program

Dominion

Analysis Methods

- Surveyor measurements of flood area floor elevations
- Dynamic flood level analysis using GOTHIC
- Equipment survivability evaluations in flooded conditions
- Dynamic motor-driven auxiliary feedwater pump room heatup upon loss of ventilation
- Simulator scenario exercises
- Review of operator training materials
- 480V breakers tested in flooded conditions
- Developed seismic fragilities for flood sources
- Constructed event trees and fault trees for scenarios

Dominion

Flood Initiating Event Assumptions

Offsite power available unless event causes loss (e.g., flood level exceeds 18”, seismic, or tornado)

No credit taken for equipment in Turbine Building

- **Non-safety related buses**
- **Feedwater and condensate**
- **Sump pumps**
- **Auxiliaries for reserve auxiliary transformer**

Dominion

Flood Initiating Event Assumptions - Break Frequencies

Plant specific analysis using EPRI reports

- **High energy line breaks**
- **Random pipe breaks**
- **Condenser expansion joint breaks**
- **Seismic breaks**

Dominion

Flood Failure Assumptions

Critical flood heights in each compartment

- **Train A/B 480V switchgear (buses 51, 52, 61, 62)**
  - **@ 2.75” flood level trips bottom row of breakers**
  - **@ 4” flood level control power lost**
  - **@ 11” flood level bus stabs covered and bus failed**

- **Train A/B 4kV switchgear (buses 5 and 6 located in respective EDG rooms)**
  - **@ 4” flood level control power connections covered and breaker failed (applies to Train A, only applies to Train B room after 6” curb removal)**
  - **@ 18” flood level bus stabs covered and bus failed**

Dominion

Flood Failure Assumptions (cont.)

Critical flood heights in each compartment (cont.)

- **Turbine-driven AFW pump**
  - **@ 9” flood level auxiliary lube oil pump fails**
  - **@ 18” flood level pump fails**
- **Motor-driven AFW pumps**
  - **@ 9” flood level auxiliary lube oil pump fails**
  - **@ 13” flood level pump fails**
- **Instrument air compressors**
  - **@ 11” flood level compressor fails**
- **Emergency diesel generators and dedicated shutdown panel**
  - **Equipment above 6”, however 4kV buses fail @ 6” flood level**

Dominion

Flood Mitigation Assumptions

Operator action times

- Based on simulator exercise, table top exercises, and training
  - Isolation of circulating water and service water breaks
  - Isolation of firewater sprinklers and deluge valves
  - Establish alternate battery room cooling
  - Transfer inverter to alternate power supply
  - Establish long term power supply to DC chargers

Impact of flood on local operator actions

- No credit for operator passing through flooded safeguards areas to perform flood isolation actions in high energy line break events

Equipment operation

- Operation in flooded environment based on documented engineering assessments and testing

Dominion

Resolution of NRC Issues with Prior Draft Analysis

Credit for operator action to isolate firewater flow which required access through flooded Safeguards Alley compartments

- No longer credited in high energy line break events

Credit for operator detection and isolation of the breaks in the assumed timeframes

- Operator actions were time validated in simulator exercises performed, human error evaluations revised to be more conservative

Credit for connecting battery charger to TSC diesel

- Human error evaluations revised to be more conservative

Critical flood height uncertainty

- Performed definitive 480V breaker test (all 3 breakers performed same), surveyor measurements of room elevations

High energy line break initiating event frequency based on flow accelerated corrosion program

- Performed updated plant specific evaluation based on new EPRI report on pipe break frequencies

Dominion

Internal Flood Risk Results

Flood Scenario	Total CDP (per yr)
Random circulating water inlet expansion joint break	2.8E-5
Random circulating water outlet expansion joint break	4.3E-6
Random service water system break with equivalent diameter greater than four inches	1.2E-6
Random fire water line with equivalent diameter greater than four inches	2.3E-6
Random feedwater or condensate high-energy line break that actuates all turbine building fire sprinklers	8.7E-6
Random feedwater or condensate high-energy line break that actuates 100 turbine building fire sprinklers	6.1E-7
Random main steam high-energy line break that actuates all turbine building fire sprinklers	7.0E-6
Random main steam high-energy line break that actuates 100 turbine building fire sprinklers	4.2E-7
Tornado induced break of circulating water lines, firewater lines, service water lines, and condensate storage tanks	Negligible
Turbine missile induced break of circulating water lines, firewater lines, service water lines, and condensate storage tanks	Negligible
Seismic induced break of circulating water lines, firewater lines, service water lines, and condensate storage	6.6E-6
Total	5.9E-5

Dominion

Internal Flood Risk Results (cont.)

Large early release probability (LERP)

- No short term impact on Containment integrity assuming Containment initially intact
- Likelihood of intact Containment capable of causing large release less than 10%
- CDP impact dominates risk, LERP at least factor of 10 below CDP

Dominion

Sensitivity Analyses

Sensitivity Case	Total CDP (per year)	Percent Change
Best-Estimate Baseline	5.9E-5	n/a
HEPs for operator actions with less than 30 min time window increased by 100%	6.5E-5	+09%
HEPs for operator actions with less than 1 hour time window increased by 100%	8.2E-5	+39%
HEPs for unproceduralized operator actions increased by 100%	7.1E-5	+21%
High energy (main steam & feedwater) line break frequencies increased by 100%	7.6E-5	+28%
Circulating water expansion joint break frequencies increased by 100%	7.7E-5	+31%
Random pipe break frequencies increased by 100%	7.7E-5	+31%

Dominion

Summary

Overall delta core damage risk is 5.9E-05 per year (yellow)

Large, early release risk not a factor in overall SDP color

Additional conservatisms not quantified:

- **No credit for operators taking actions in Safeguards Alley to isolate floods following high energy line break events**
- **Additional mitigation from primary system feed & bleed cooling not credited**
- **Opening Safeguards Alley doors would hasten isolation of firewater pumps and eliminate need for local operator action to isolate flood**
- **Impact of operators tripping feedwater pumps before emptying hotwell not credited**

Consideration of uncertainties does not impact overall risk characterization

Dominion

Corrective Actions

Kyle Hoops

Site Director

Dominion

Corrective Actions

- **Organizational**

- **Modifications**
  - **- Barriers**
  - **- Check Valves**
  - **- Circulating Water Pump Trip**

Dominion

Conclusion

Mike Gaffney

Site Vice President

Dominion

Conclusions

Flooding Overall Delta Core Damage Risk 5.9E-05 per year (Yellow)

Modifications Resolved Turbine Building Flooding Issues

Dominion