Meeting with NRC to Discuss Kewaunee Internal Flooding License Amendment Request

Location: NRC Headquarters
Date: December 6, 2007

Enclosure 2

Dominion Energy Kewaunee Attendees

Lori Armstrong

Tom Webb

Dave Lippard

Dave Sommers

Tom Breene

Jim Gausman

Craig Sly

Keshab Dwivedy

Tom Hook

Dominion

Meeting Agenda

- ❑ Introduction & Agenda
- ❑ Risk Informed Actions
- ❑ History & Background
- ❑ Proposed Criteria
- ❑ Criteria Application
- ❑ Closing Comments
- ❑ Questions

Dominion

Major Goals of License Amendment Request 215

- **Clarify design criteria for internal flooding:**
  - Design criteria are based on 1972 vintage design and licensing basis of the plant.
  - LAR reconstructs licensing basis in the absence of NRC or KPS docketed information.
  - Focused on the available design and licensing criteria and correspondence during and after plant was licensed.
  - Design Criteria do not supersede risk reduction activities.

Dominion

Actions to Reduce Internal Flooding and Plant Risk

- **Completed actions**
  - Installed flood barriers between Turbine Bldg and Safeguards Alley.
  - Installed flood sensors and alarms for Safeguards Alley.
  - Installed circulating water pump trip on high Turbine Bldg level.
  - Included new operator actions to address loss of battery room, AFW pump room or safeguards bus ventilation during safeguards flooding.
  - Implemented procedure changes enhancing service water isolation.
- **Scheduled to complete by 5/2008**
  - Install watertight door between Aux Bldg and Safeguards Alley (Door 8).
  - Raise cables for Turbine Building basement Fan Coil Unit B (cooling for AFW pump B room).
  - Raise 480V breaker associated with battery charger.
  - Spray shields around SW piping in safeguards alley.

After all scheduled modifications complete, 92% reduction in CDF since 12/2004. Kewaunee continues to evaluate additional modifications that will reduce flooding risk.

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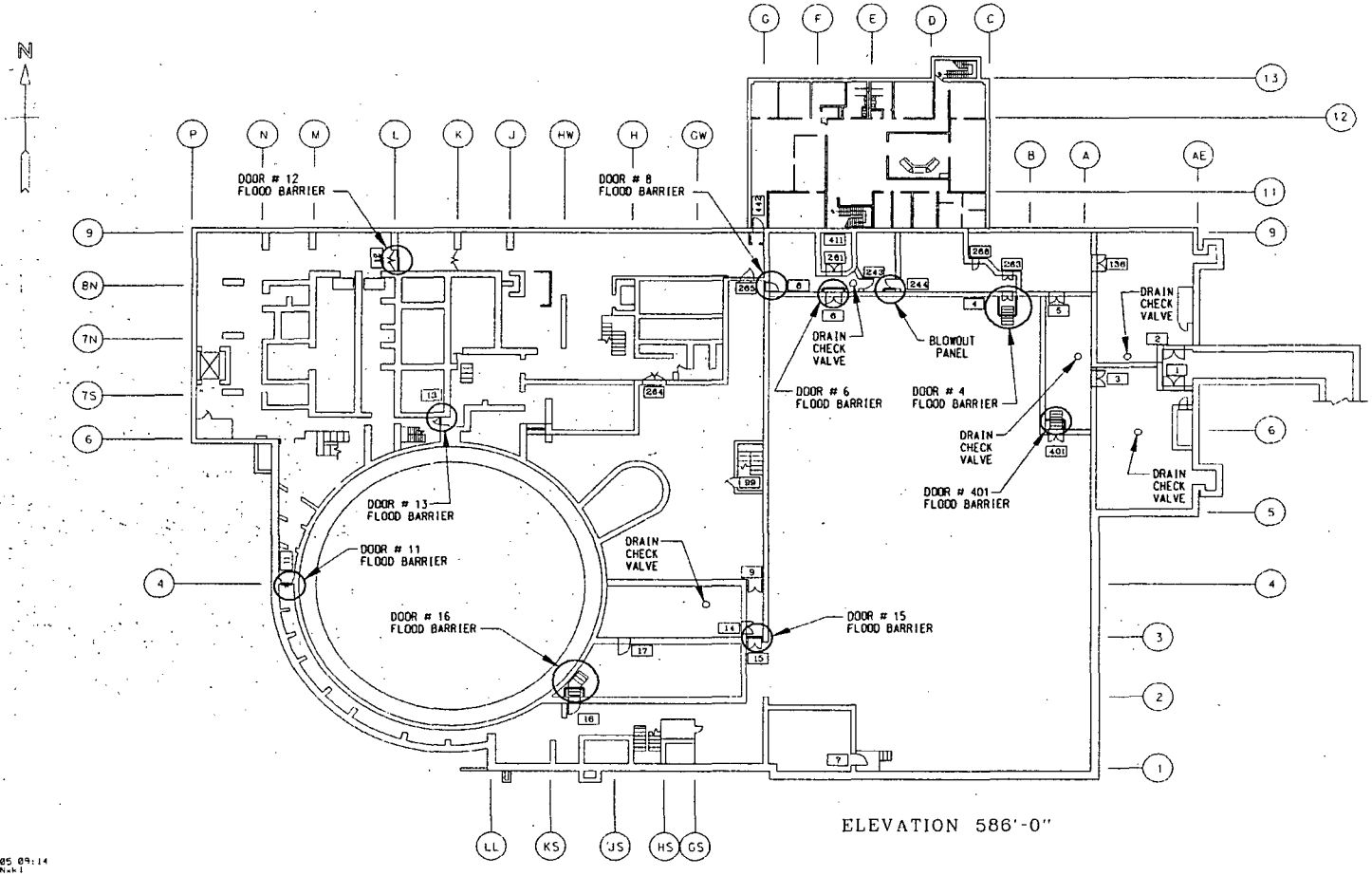
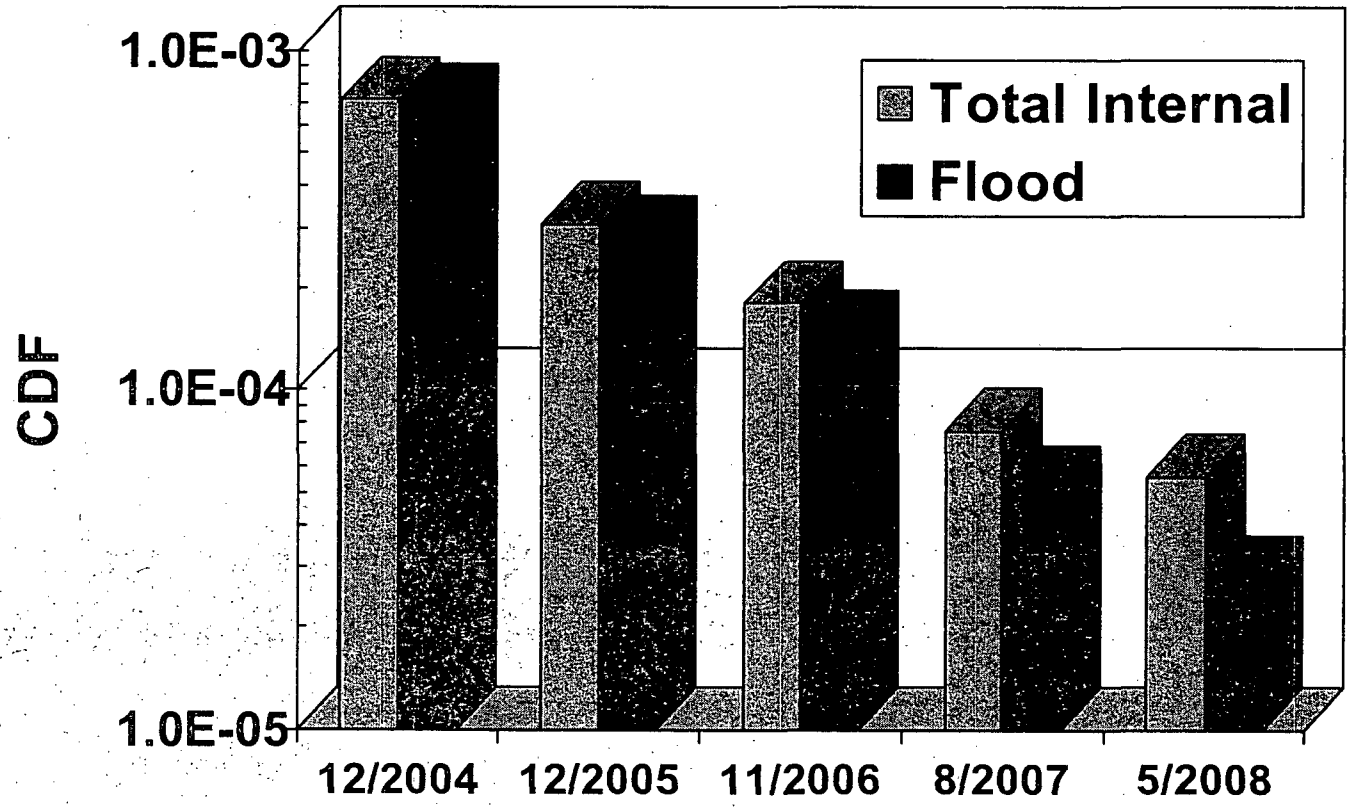
Actions to Reduce Internal Flooding and Plant Risk



Kewaunee Core Damage Frequency Reduction



Dominion

KPS Limited Flooding Licensing Basis History

- **September 23, 1971: AEC Letter (FSAR question 8.16)**
  - Postulated failure of safety-related SW line inside EDG room.
  - Application of December 15, 1971 response limited to specific case.
- **June 9, 1972**
  - Quad Cities flooding event / CW expansion joint failure.
- **July 24, 1972**
  - AEC issues KPS Safety evaluation report with no reference to internal flooding.
- **August 10-12, 1972 - ACRS meeting**
  - ACRS was informed that, "*staff review of Kewaunee TB drawings failed to disclose potential for repetition of Quad Cities flooding incident.*"

Dominion

KPS Limited Flooding Licensing Basis History

- **September 26, 1972 - AEC letter**
  - Requested licensees, *"to determine whether the failure of any non-category I (seismic) equipment ... could result in a condition, such as flooding ..."*
- **October 31, 1972 KPS response**
  - Kewaunee reviewed non-category I equipment.
  - No concerns identified based on "safety equipment redundancy and design arrangement."
  - No action items or modifications were proposed.
  - Established CLB that alarms in conjunction with operator action would be used to terminate flood.
  - No additional correspondence to or from NRC on this issue.

Dominion

KPS Limited Flooding Licensing Basis History

- December 18, 1972
  - AEC issues KPS SE Supplement 1.
  - No mention of internal flooding.
- May 10, 1973
  - AEC issues KPS SE Supplement 2, addressing HELB.
  - No mention of internal flooding.
- December 21, 1973
  - Kewaunee OL issued.
- 1973/1974
  - NRC issues itemized flooding guidelines to licensees (re: MPA B-11).
  - Guidelines not issued to Kewaunee.
- April 6, 1987
  - TI 2515 issued to verify licensee actions in implementing itemized flooding guidelines.
  - No record of TI being performed at Kewaunee.

Dominion

Separate KPS High Energy Line Break Licensing Basis

- HELB specific design criteria separately addressed.
  - November 7, 1972 – KPS response to verbal request for information.
  - December 15, 1972 – Giambusso HELB letter.
  - Protection Criteria established and plant modifications approved in KPS SER, Supplement 2.
  - AEC completed evaluation December 10, 1973 as presented in FSAR Amendment 24.
  - Current USAR Appendix 10A addresses HELB, including HELB related flooding.

Dominion

KPS Conformance to AEC General Design Criteria

- KPS was designed and constructed to "*generally conform*" with the intent of the AEC GDC is as proposed on July 10, 1967.
- Construction was about 50% complete when App A GDCs were published, February 20, 1971.
- The AEC did not require KPS to reanalyze the plant design. AEC was, *"satisfied that the plant design generally conforms to the intent of these criteria"* (KPS SE, July 24, 1972).

Dominion

Original FSAR Criterion

FSAR Section B.5 - Protection of Class I Items

"The 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.*
b. *Pipe whip and steam/water jets following a pipe rupture of an adjacent pipe.*
c. *Etc. ...*

No protection is required if the factors described under a, b, f and g cannot affect any Class I systems, or if redundant systems are provided and the physical separation of these systems is sufficient to prevent these factors from damaging both systems. Under c and d, redundancy and physical separation may decrease the requirement for protection. If redundancy and physical separation are not used, and if the surrounding building is not designed as a missile barrier, missile protection by shielding is necessary, either by shielding the source itself or by shielding the system." [emphasis added]

Dominion

Current USAR Criterion

KPS USAR Section B.5 - Protection of Class I Items

"Criterion: No single event will cause failure of redundant circuits or Engineered Safety Feature components in a manner such that a single failure after the event could prevent the protective functions of the associated Engineered Safety Features.

The 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.*
b. *Pipe whip and steam/water jets following a pipe rupture of an adjacent pipe."*
c. Etc. …

Dominion

Pending USAR Criterion

USAR Section B.5 - Protection of Class I Items

"The 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.*

b. *Pipe whip and steam/water jets following a pipe rupture of an adjacent pipe.**

c. Etc. ...

Original FSAR Text (Emphasis Added)

No protection is required if the factors described under a, b, f and g cannot affect any Class I systems, or if redundant systems are provided and the physical separation of these systems is sufficient to prevent these factors from damaging both systems. Under c and d, redundancy and physical separation may decrease the requirements for protection. If redundancy and physical separation are not used, and if the surrounding building is not designed as a missile barrier, missile protection by shielding is necessary, either by shielding the source itself or by shielding the system." (RAI Set 1, No. 2)

Re-Located

**No single event will cause failure of redundant circuits or Engineered Safety Feature components in a manner such that a single failure after the event could prevent the protective functions of the associated Engineered Safety Features.* (RAI Set 1, No. 3)

Dominion

Flooding Scenarios and Mitigation

Agenda Items

1. Proposed criteria.
2. Extent of consideration of ruptures in non-seismic piping and spray/minor leaks in safety system piping.
3. Scope of protected systems.
4. End state for flooding initiated events.
5. Mitigation factors.

Dominion

Proposed Criteria
New USAR Section B.11.2 – Internal Flooding Design Criteria

"The plant must withstand the consequences of an internal flooding event in such a manner that it retains the capability to achieve and maintain the reactor in a safe shutdown condition. Toward this end, the design criteria for internal flooding evaluations are:

a. *Only non-class I/I* piping or tanks are considered to fail unless specifically evaluated to withstand the Design Basis Event (DBE).*

b. *Only failures in piping and branch runs exceeding 1 inch are considered.*

c. *Pipe and tank failures assume a single most limiting failure in an area, as determined by maximum flood level calculated in an area.*

d. *Operator actions and design features are considered, but an additional single failure is not.*

e. *Flooding is assumed coincident with a loss of offsite power if it increases the consequences of a flood.*

f. *The effects of water spraying, dripping, or splashing on sensitive equipment are to be considered in the assessment of available equipment."*

Dominion

Proposed Criteria
New USAR Section B.11.3 – Class I Equipment Protection

(NOTE: Revised from RAI Set 2 Responses)

The following criteria specify the design considerations for the protection of necessary Class I equipment from internal flooding events:

- Separation for Redundancy: A single failure of any postulated internal flooding source, as defined in B.11.2, shall not result in loss of a function important to the safe shutdown of the plant. Redundant safety equipment shall be separated or protected to assure safe shutdown capability in the event an internal flooding event.
- Access Doors and Alarms: Watertight barriers credited for protection from flooding of equipment important to the safe shutdown of the plant shall have all access doors or hatches fitted with reliable switches and circuits that provide an alarm in the Control Room when the access is open.
- Sealed Water Passages: Passages or piping and other penetrations through walls of a flood zone containing equipment requiring protection to assure to the safe shutdown of the plant shall be sealed against water leakage from any postulated internal flooding source, as defined in B.11.2. Credited seals shall maintain their integrity during a Design Basis Earthquake.

Dominion

Proposed Criteria
New USAR Section B.11.3 – Class I Equipment Protection

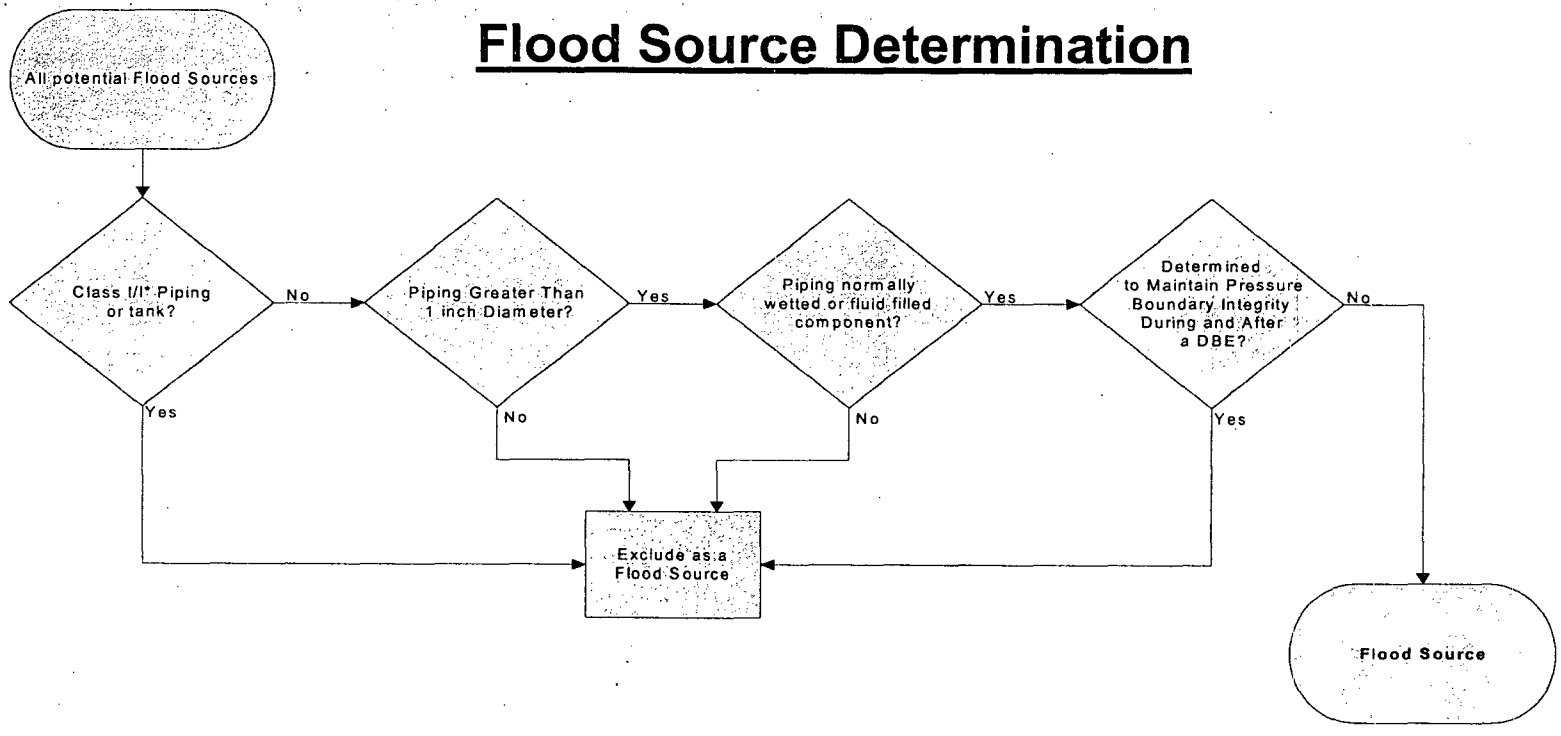
(Criteria Continued)

- Class I Watertight Structures: Walls, doors, panels, or other compartment closures credited to protect equipment important to the safe shutdown of the plant from damage due to flooding from any postulated internal flooding source, as defined in B.11.2, will maintain their integrity during a Design Basis Earthquake.
- Water Level Alarms and Trips: Plant areas containing a postulated internal flooding source, as defined in B.11.2 whose rupture could result in flood damage to equipment important to the safe shutdown of the plant shall have level alarms and pump trips (where necessary) that alarm in the Control Room. Redundancy of switches is required. Critical pump (i.e., high volume flow, such as condenser circulating water pumps) trip circuits should meet the IEEE 279 criteria to the extent practical.

Flooding Scenarios and Mitigation

2. Extent of consideration of ruptures in non-seismic piping and spray/minor leaks in safety system piping

Flood Source Determination



Dominion

Flooding Scenarios and Mitigation

2. Extent of consideration of ruptures in non-seismic piping and spray/minor leaks in safety system piping

Proposed Criteria (f):

"The effects of water spraying, dripping, or splashing on sensitive equipment are to be considered in the assessment of available equipment."

- Spray and minor leaks are considered from flood sources only.
- Spray/minor leaks addressed by zone approach (RAI Set 1, No. 4).
- Zone approach assumes that no flood/spray scenario can do more damage than a fire in the same zone.
- No flood zone involves multiple fire zones. Water moving between zones is bounded by flood level calculations.

Dominion

Flooding Scenarios and Mitigation

3. Scope of protected systems

Proposed B11.3 Text:

"Consistent with the AEC flooding guidelines, the Class I functions required following the rupture of a pipe or tank which results in internal flooding are those functions necessary to achieve and maintain safe shutdown of the reactor."

- Scope of protected SSCs includes only SSCs needed for the safe shutdown of the plant. It does not consider the protection of all Class 1 components.
- Safe Shutdown Equipment List (SSEL) for flooding was developed.
  - Based on Appendix R SSEL (RAI Set 1, No. 4).
  - The Appendix R SSEL was used as a starting point for the development of the Internal Flood SSEL due to the similarity in assumed initial conditions and single failure requirements.

Dominion

Flooding Scenarios and Mitigation

3. Scope of protected systems (Cont.)

- The protection of only needed equipment is consistent with the safe shutdown basis for HELB in USAR Section 10A.
  - Primary difference in safe shutdown approach between internal flooding and HELB is the requirement for consideration of an additional single failure.
  - Unlike HELB, internal flooding scenarios do not have any direct core reactivity effects (i.e., cooldown).
  - The AEC itemized flooding guidelines, specifically "Separation for Redundancy," implies no additional single active failure is considered for flood scenarios. Otherwise, redundancy would not be an acceptable design basis. From AEC Guidelines:

"Separation for Redundancy: A single failure of non-Class I system components or pipes shall not result in loss of a system important to safety. Redundant safety equipment shall be separated and protected to assure operability in the event a non-Class I system or component fails."

Dominion

Flooding Scenarios and Mitigation

3. Scope of protected systems (Cont.)

- USAR Section B.5.a protection requirement refers to "*the extent that the Class I function is impaired.*"
- The internal flooding criteria approach to "*Class I function*" is consistent with the HELB approach. It includes only necessary functions.
- Any SSEL equipment lost due to internal flooding was evaluated for redundancy to ensure that the function of the component was not compromised.
- Redundancy of function is consistent with our response to the September 26, 1972 Quad Cities letter and by the final paragraph in original Section B.5 of the FSAR.
- Consistent with Kewaunee TIA 2005-10 (May 5, 2006).

Dominion

Flooding Scenarios and Mitigation

4. End state for flooding initiated events

Proposed B11.2 Text:

"Safe shutdown following an internal flood is defined as hot shutdown. The reactor can be maintained in the hot shutdown condition for an extended period of time, if necessary, for cold shutdown equipment repairs."

- **The end state for an internal flooding event is safe shutdown. Kewaunee is a hot shutdown plant, so safe shutdown is hot shutdown.**
- **No specific criteria exist for taking KPS to cold shutdown, however, the equipment needed to achieve cold shutdown was included in the Safe Shutdown Equipment List for conservatism.**

Dominion

Flooding Scenarios and Mitigation

4. End state for flooding initiated events (Cont.)

- The HELB requirement stated in USAR Section 10A for shutdown following a pipe rupture is:

  "The capability to mitigate the consequences of an accident and bring the reactor to the hot shutdown condition, and ultimately a cold shutdown condition, is assured."

- Hot shutdown is the HELB requirement. Cold shutdown must be achievable, but no time frame is specified.

Dominion

Flooding Scenarios and Mitigation

5. Mitigation factors

Break Sizes:

- Breaks were always considered double-ended guillotine ruptures.
- Piping 1-inch diameter or less not considered. Consistent with current SRP BTP 3-3, Revision 3.
- Worst-case determined by resulting level (transient or steady-state).
  - Largest pipe or tank not always worst case.
  - Flow rates and volume limitations considered.

Dominion

Flooding Scenarios and Mitigation

5. Mitigation factors (Cont.)

Operator Actions:

- Pump trip or system isolation requiring response in less than 30 minutes.
  - Circulating Water (CW) pump trip: CW pump trip response time validated in simulator. Although a pump trip circuit has been installed the operator action is the credited response consistent with the original licensing basis.
  - Service Water (SW) header isolation: The response time to identify and isolate the SW header supply valves was validated in simulator.
- Sump level annunciator response: All other flood sources activate sump alarms in Control Room. Annunciator response procedures dispatch operators into the plant to identify source. Thirty (30) minutes assumed to identify and isolate. Generally, significantly more time than 30 minutes is available before safe shutdown equipment is impacted.
- Proposed LAR text in B.11.2 needs revision to include the SW header isolation.

Dominion

Flooding Scenarios and Mitigation

5. Mitigation factors (Cont.)

Holdup Volumes:

- Modeling of flood zones would account for trenches, pits, curbs, or low areas that would trap water. Other than these physical structures, no holdup volume is assumed to minimize flood levels.
- Sump pumps not credited (loss of offsite power per AEC itemized flooding guidelines).

Dominion

Flooding Scenarios and Mitigation

5. Mitigation factors (Cont.)

Drain Paths:

- Flow through floor drains to other areas were evaluated. Limiting case was used.
- Floor drains were blocked to maximize levels inside a flood zone. One exception made. The drains in the exception area were added to site PM program to ensure flow.
- Check valves credited to prevent backflow to Safeguards Alley and Auxiliary Building from Turbine Building sump.
- Closed doors are modeled with flow through door threshold gap unless sealed with a flood barrier. Measured gaps were used in the evaluation.
- Some cases run with doors open to maximize flood levels in areas with safe shutdown equipment.

Dominion

Application of Internal Flooding Criteria

Agenda Items

1. Threshold for consideration as a potential flooding source.
2. Need to evaluate non-seismic Class I systems.
3. Qualification of Class II and III* piping to OBE.
4. Use of Uniform Building Code Zone 1 Criteria as meeting OBE loading.
5. Sample analysis to cover full scope of pipe configurations.

Dominion

Application of Internal Flooding Criteria

Agenda Items (continued)

6. Analysis considers inspection frequency and uncertainties in corrosion effects.
7. Class III piping as a flooding source.
8. Cast iron piping.
9. Safety factor for anchors.
10. Factoring in buckling.

Dominion

Application of Internal Flooding Criteria

1. Threshold for consideration as a potential flooding source

   - A flooding source must be connected to large fluid filled components.
   - Steam only, air & gas lines, or lines that are normally isolated from a flood source are not considered as flood sources.
   - Piping systems such as floor drains are not considered flood sources. They are not connected to fluid filled components and consideration of their failure coincident with an internal flooding event involves multiple breaks.
   - Roof drains are not considered as flood sources. This water source is external.

<u>If a pipe is a flood source, then proposed Criteria (a) applies.</u>

Dominion

Application of Internal Flooding Criteria

1. Threshold for consideration as a potential flooding source (Cont.)

Proposed Criteria (a):

"Only non-Class I/I pipe or tanks are considered to fail unless specifically evaluated to withstand a Design Basis Earthquake (DBE)."*

- Original intent of LAR 215 was straight-forward. If a flood source was a Class I/I* pipe, it was excluded. If the pipe was not Class I/I* but had been determined by calculation to be capable of maintaining its pressure boundary integrity during and after a DBE, it was also excluded.
- Additional calculations supported the fact that Class II and III* piping is rugged and capable of maintaining its pressure boundary integrity during and after a DBE.

Dominion

Application of Internal Flooding Criteria

1. Threshold for consideration as a potential flooding source (Cont.)

   - Review of the original Pioneer piping installation specification (K204) verified that:
     - Piping specification incorporated USAS B31.1–1967.
     - Seismic parameters were in excess of the UBC Zone 1 criteria.
     - The installation specification was used for Class II, III, and III* piping systems in seismic areas of the plant.
   - Our conclusion is that a piping system installed to the original Pioneer installation specification (K204) would be able to maintain its pressure boundary integrity during and after a DBE and, therefore, could be excluded as a flood source.
   - Prairie Island TIA 2001-02 regarding seismic qualification with UBC Zone 1 design parameters supports this conclusion. (RAI Set 1, No. 8)

Dominion

Application of Internal Flooding Criteria

2. Need to evaluate non-seismic Class I systems

- Any piping not installed by the Class II, III, or III* installation specifications, K204, is considered as a potential flooding source (e.g., plant plumbing) unless it has been analyzed to maintain its pressure boundary integrity during and after a DBE .
- The evaluation methodology detailed in our RAI responses applies to the analysis of Class II, III, III* or non-Class piping segments. (RAI Set 2, No. 4 and No. 5)
- Expansion joints are flooding sources.
- The only tanks that have been excluded to-date are Class I/I* tanks.

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Application of Internal Flooding Criteria

3. Qualification of Class II and III* piping to OBE
   - Prairie Island TIA 2001-02, Issue 2 specifically discusses the seismic qualification associated with the UBC Zone 1 criteria.
   - Prairie Island and Kewaunee were designed by the same architect engineering firm (Pioneer), licensed to similar design basis, and built at the same time with similar piping installation standards.
   - Prairie Island TIA 2001- 02 (Issue 2) states that piping designed to the UBC Zone 1 loadings are essentially designed for the Operational Basis Earthquake (OBE).
   - Prairie Island TIA 2001-02 also states the seismic qualification to the OBE is adequate to demonstrate that non-safety will not affect safety-related SSCs.

Application of Internal Flooding Criteria

4. Use of UBC Zone 1 Criteria as meeting OBE loading

   – UBC Zone 1 criteria is explicitly stated as the OBE loading for KPS per USAR Table B.7-1.

Dominion

Classification of Potential Flooding Sources

5. Sample analysis to cover full scope of pipe configurations

- KPS has evaluated certain non-Class I/I* piping configurations for DBE loads.
- Evaluations performed:
  - Residual Heat Removal pump pit flood zone
  - Safeguards Alley piping
  - Emergency Diesel Generator room fire piping
  - Miscellaneous Auxiliary Building piping
- Evaluations determined that analyzed piping would maintain its pressure boundary integrity during and after a DBE.

Dominion

Classification of Potential Flooding Sources

5. Sample analysis to cover full scope of pipe configurations (cont)
   - Evaluated pipes ranged from 0.75-inch to 10-inch in diameter.
   - 100% of Safeguards Alley piping that was not Class I/I* or dry was evaluated.
   - Safeguards Alley and EDG room fire piping calculations covered 31 small-bore and 9 large-bore pipe segments involving 7 systems.
   - RHR Pit evaluations covered 10 pipe segments in the Auxiliary Building involving 3 systems.
   - Two additional Auxiliary Building piping segments were evaluated involving 2 systems.

Dominion

Classification of Potential Flooding Sources

5. Sample analysis to cover full scope of pipe configurations (cont)
   - Evaluations used response spectra that enveloped all floors from the base mat to the highest Auxiliary Building floor elevations.
   - Used operability criteria for allowable stresses.

<u>Summary</u>

- Total of 52 piping segments were analyzed including 9 large-bore pipes involving 10 separate systems.
- Evaluated piping segments represent a substantive cross-section of non-Class I/I* flood sources.
- Evaluations provide evidence that piping installed per Pioneer installation specification K204 will maintain pressure boundary integrity during and after a DBE.

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Application of Internal Flooding Criteria

6. Analysis considers inspection frequency and uncertainties in corrosion effects

   - Code specified corrosion allowance is used for deterministic basis.
   - Corrosion beyond Code allowance is addressed in PRA approach as discussed in EPRI reports TR-1013141 and TR-102266.

Dominion

Application of Internal Flooding Criteria

7. Class III piping as a flooding source

- Class II, Class III, and Class III* piping systems were installed to the same installation specification (K204).
- Class II and III* were installed to the seismic loading criteria for UBC, Zone 1 (OBE) per USAR Section B.7.
- As expected, all evaluations of various Class II, Class III and Class III* piping systems to-date demonstrate no discernable differences in results. All would maintain their pressure boundary integrity during and after a DBE.
- KPS proposed criteria to require evaluation to DBE is conservative with respect to the original (1973) licensing basis for KPS.
  - Prairie Island TIA 2001-02 indicates evaluation to OBE criteria would be sufficient to maintain the integrity of the Class II, III, and III* piping and comply with the original licensing basis.

Dominion

Application of Internal Flooding Criteria

8. Cast iron piping
   - Cast iron in pressure retaining components is permitted in ASME/ANSI Code as long as the brittle behavior is accounted for in analysis.
   - In ANSI B31.1 Code, the basic allowable is limited to 10% of Ultimate Tensile Stress (UTS) up to a temperature of 400° F.
   - In DBE loading condition, stress is limited to 20% of UTS, which is only two times the allowable stress in deadweight and pressure loading condition.
   - A conservative limit of 15% of UTS was also placed on DBE anchor movement as shown in our submittal.
   - Cast iron piping was not used in the process piping.
   - Cast iron valves identified during plant walk-downs were qualified to criteria above.

Application of Internal Flooding Criteria

9. Safety factor for anchors

   - When anchor bolts of unknown strength were identified, the capacity was estimated based upon SQUG criteria and a safety factor of 3 was used as recommended.
   - When anchors were identified with vendor tested ultimate capacity, a safety factor of 2 was used, taking guidance from EPRI sponsored research (TR-101968, Volume 3)

Dominion

Application of Internal Flooding Criteria

10. Factoring in buckling

- Buckling in pipe support components are accounted for in pipe support verification.
  - Per ASME Code, compressive stress in members is limited based upon kl/r ratio.
  - When stability is identified as a concern, the stress is limited to 2/3 of critical buckling stress for linear components and 1/2 of critical buckling stress for plate and shell type components.

Dominion

Questions

Dominion