Waterford 3
Surge Line Leak-Before-Break
RCS Leakage Detection

NRC Presentation

November 10, 2010

Purpose

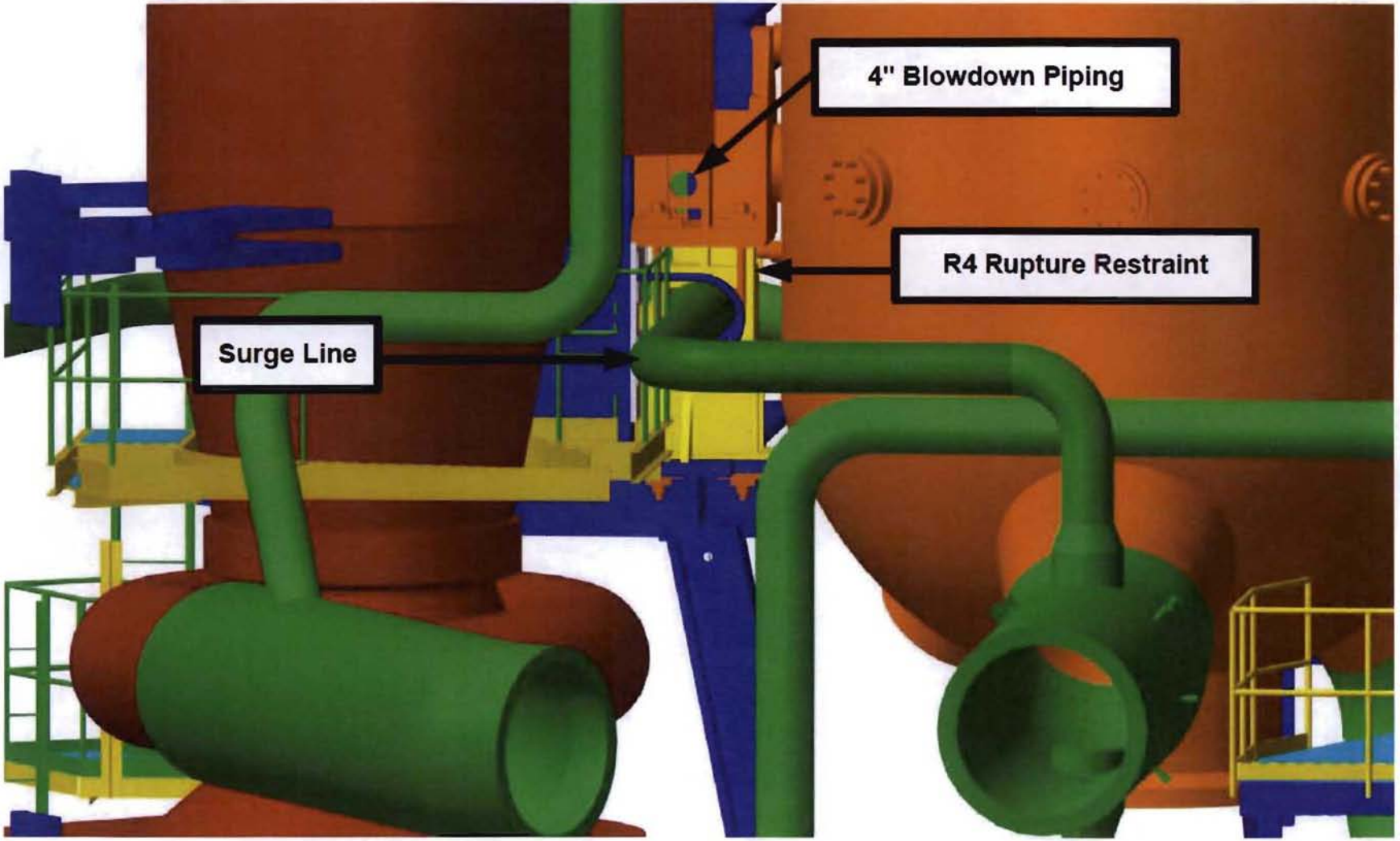
- Discuss LBB Request for Additional Information (RAI) regarding:
  - Acceptability of existing Waterford 3 RCS unidentified RCS leakage detection TSs for meeting 10 CFR 50.36(c)(2), Criterion 1 for Leak-Before-Break (LBB) analyses
  - Waterford 3's leakage detection capability for meeting SRP 3.6.3 and RG 1.45

Background

- Waterford 3 RSG tubesheet design has integral blowdown passage
  - Improves secondary chemistry and reduces sludge accumulation
- RSG blowdown nozzle is ~17 inches lower than OSG
  - Creates interference with existing surge line whip restraint
  - Whip restraint and blowdown line relocation not practical due to space limitations
  - Would restrict access for future Steam Generator inspections
- Surge line LBB approval provides ability to effectively route blowdown piping

Blowdown Line Routing Constraints

Entergy



Background

- February 22, 2010 license amendment application provided details of Waterford 3 RCS leakage detection capability for meeting SRP 3.6.3 and RG 1.45 guidance
- Additional leakage detection details provided in the NRC RAI response on August 12, 2010
- Additional NRC RAI 2:

> *These [RCS leak detection] capabilities were not proposed for inclusion as a Technical Specification LCO as required by Criterion 1 of 10 CFR 50.36(c)(2)*

Key Points

- **Entergy has concluded that the LBB leakage detection meets the regulatory requirements based upon the following:**
  - SRP 3.6.3 requirements are met for LBB analyzed leakage flaw of 2.5 gpm with a leakage detection sensitivity of 0.25 gpm (factor 10).
  - The SRP 3.6.3 and RG 1.45 guidance for the leakage detection sensitivity is a design requirement and does not require a Technical Specification limit.
  - W3 TS and STS do not have a TS limit for RCS leak detection sensitivity. The current RG 1.45 design requirement is contained in the TS bases.
  - Surge line piping flaws are very stable and a leakage flaw of 2.5 gpm provides substantial analytical margin against a critical flaw (factor >2).
  - The existing Waterford TS LCO of 1 gpm unidentified leakage provides margin with respect to the analysis value (2.5 gpm) and against a potential piping rupture.
  - 10 CFR 50.36(c)(2) Criterion 1 is met by W3 TS 3.4.5.1. 10 CFR 50.36 criteria are met with existing TS LCO limits.
  - NRC precedent does not support changing TS LCO limits.

NRC Regulatory Guidance

- **GDC 4 for LBB requires analyses to demonstrate that the probability of piping rupture is extremely low**
  - GDC 4 governs LBB analyses including design and uncertainty margins
  - Provides specific conclusions that piping systems do not approach rupture
  - Performed for specifically analyzed piping systems to ensure stability
- **GDC 30 requires that means shall be provided for detecting/ identifying RCS leakage**
  - GDC 30 governs leakage detection requirements
  - TS requirements under RG 1.45 are for complying with GDC 30
  - Assumes unanalyzed piping failures involving rapid propagation

NRC Regulatory Guidance

SRP 3.6.3 guidance:

- A piping system under pressure involves uncertainties and that margins are needed (§ III.4)
- Detection should be sufficiently reliable, redundant, and sensitive to support the fracture mechanics evaluation (§ III.4)
- The size of the flaw is 10 times greater than the minimum leakage the detection system is capable of sensing (§ III.11(C)(iii))
- References RG 1.45 for compliance

NRC Regulatory Guidance

RG 1.45 regarding LBB leakage detection:

- The overall response time should be based on the piping system to protect against a piping rupture
- Under certain circumstances leakage monitoring system specifications may need to exceed the quantitative criteria in this regulatory guide
- No mention of TS for reduced LBB leakage detection design capability

NRC Regulatory Guidance

- RG 1.45 does define what leakage detection limits should be provided in TSs
  - TSs should respond to a leakage increase of 1 gpm
  - Significant increases in the leakage rates below the TS limits, but above the baseline values, should be monitored in order to operate within acceptable limits
  - The rate of increase in leakage is needed to verify that actions can be taken before the plant exceeds TS limits
  - Plant procedures should specify operator actions in response to leakage rates less than the TS limits
- RG 1.45 only addresses TS limits for unidentified leakage for compliance with GDC 30

NRC Regulatory Guidance

- Summary for LBB leakage detection guidance:
  - It provides for uncertainty in analysis against leakage flaw for detection
  - The detection system must be reliable, redundant, and sensitive
  - It shows that the leakage detection system is capable of detecting to the specified margin of 10
  - The response time of system should be consistent with the analysis results
- LBB leakage detection guidance establishes new design requirements but not TS limits under GDC 30

LBB Licensing/Design Basis

- The analysis and margins performed in accordance with GDC 4 establish new design requirements to be reflected in the design and licensing basis
- The FSAR and TS Bases contain these assumptions and requirements that support design limits
- A change to the licensing / design basis does not constitute a need to change the TSs

LBB Licensing/Design Basis

- The new LBB RCS leakage detection requirements and sensitivity are being included in the Waterford UFSAR
- Similar to other design basis margins and requirements they will be controlled under 10 CFR 50.59 Review
- These limits cannot be changed unless the review passes 10 CFR 50.59 criteria
- LBB design basis is protected and governed in licensing basis documents

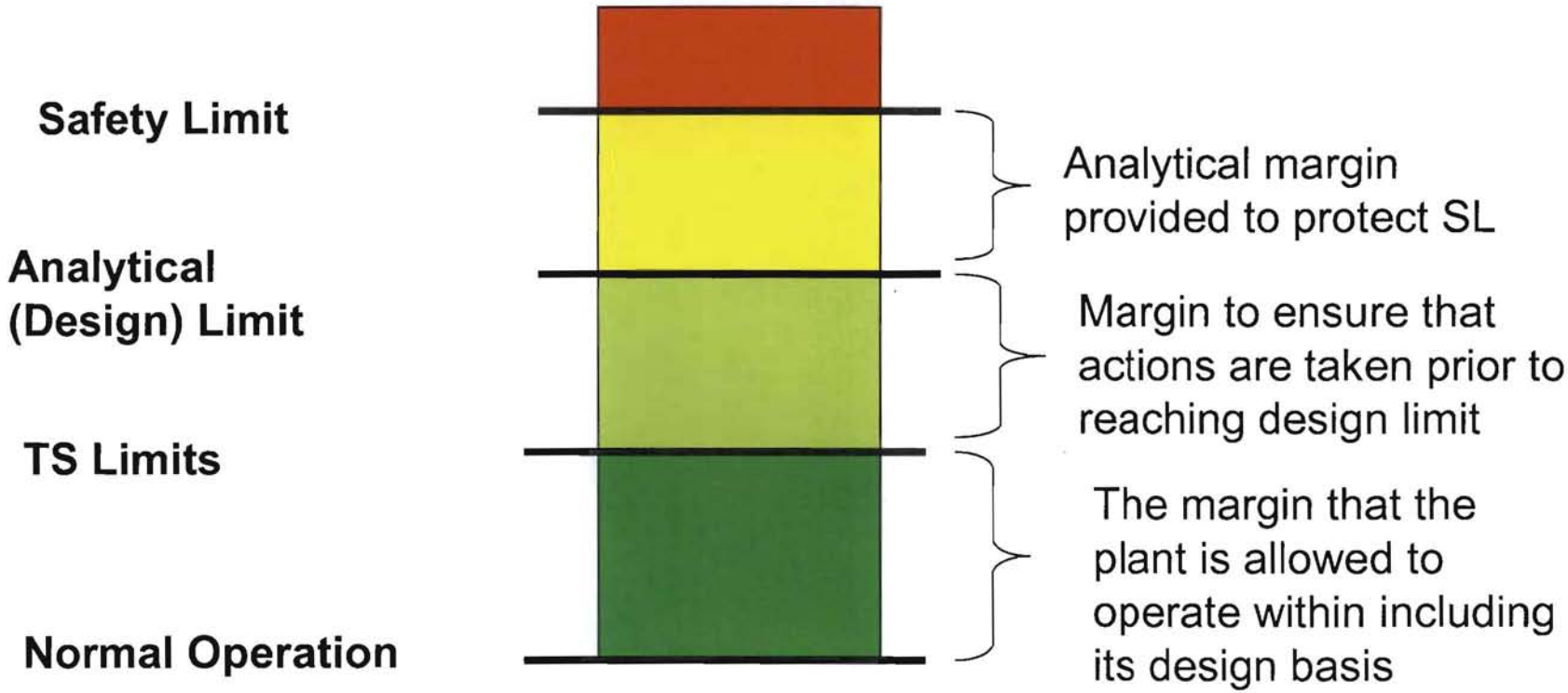
NRC Technical Specification Guidance

- **10 CFR 50.36(c)(2) Criteria 1 evaluates instrumentation used to detect a significant abnormal degradation of RCPB**
  - Purpose is to allow operators to detect significant abnormal degradation and correct or shutdown the plant safely to reduce the likelihood of an accident
    - Significant abnormal leakage should be determined based upon LBB fracture mechanics analyses
    - Shutting down the plant safely should be based on detection and adequate time to take safety measures
- **Per 1993 TS Policy, Criterion 1 is not intended to detect precursors to RCPB leakage**

  "This criterion is intended to ensure that Technical Specifications control those instruments specifically installed to detect excessive reactor coolant system leakage. This criterion should not, however, be interpreted to include instrumentation to detect precursors to RCPB leakage ..."

NRC Technical Specification Guidance

Typical Design of Protective Functions for TS Limits



Treatment of LBB Margins

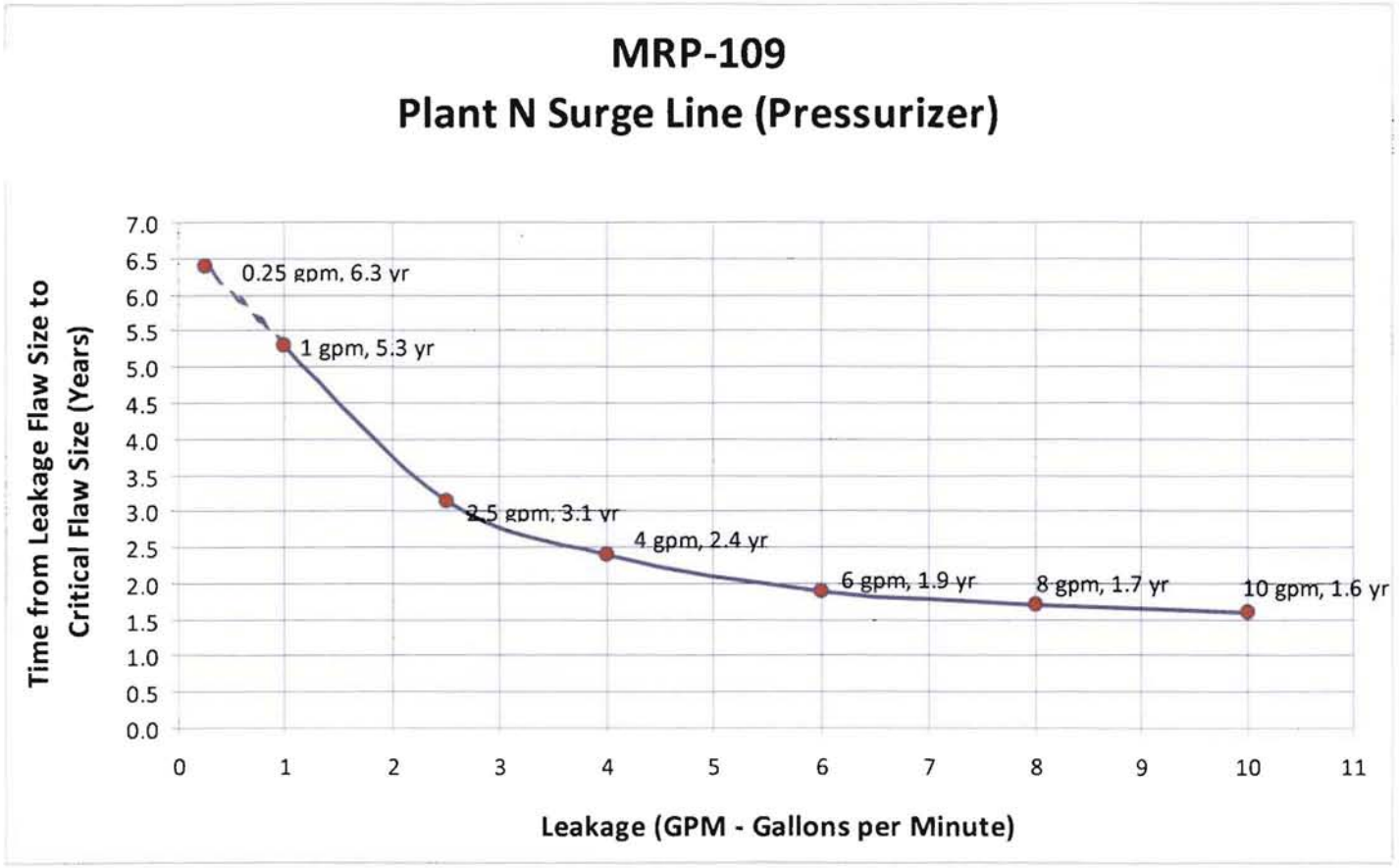
Per LBB analysis:

- The critical flaw is the analyzed point where the leakage flaw would become unstable (i.e. the Safety Limit)
- The factor of 2 provides margin for analytical uncertainty between the leakage flaw and the critical flaw (i.e. Analytical Limit)
- A TS Limit should be established with sufficient margin to protect against a potential piping failure that would result in an immediate threat to the public health and safety
  - This can be performed within existing TS LCO limits of 1 gpm

Treatment of LBB Margins

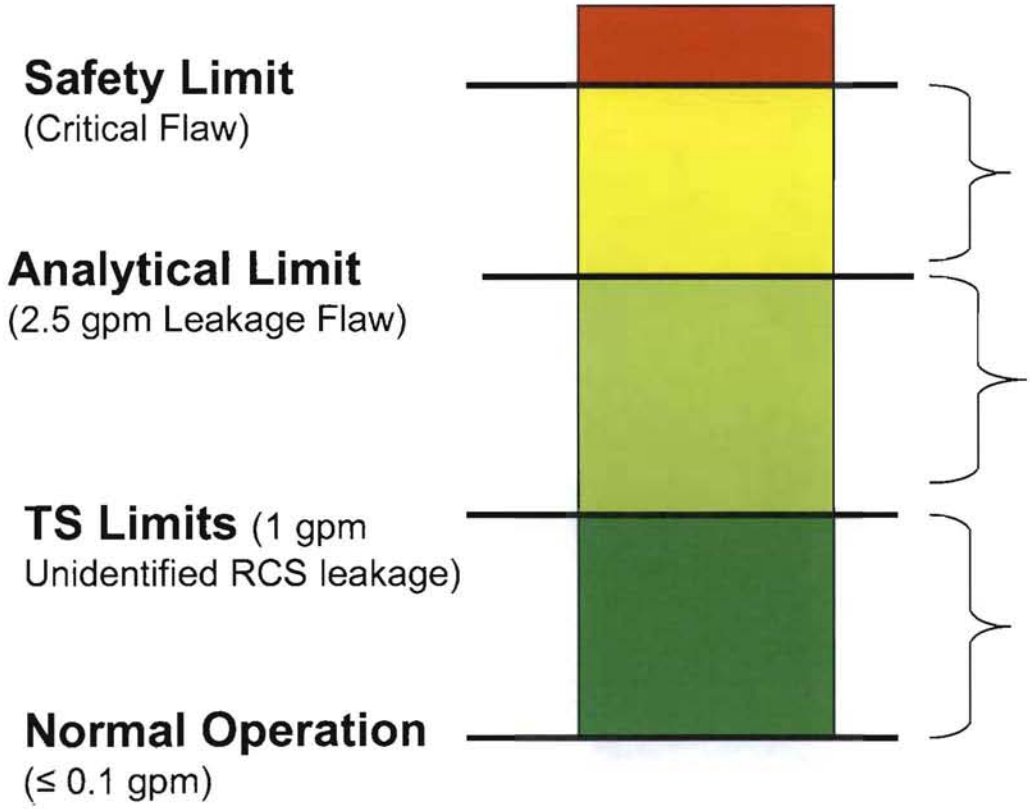
- Per TS Policy, a TS LCO should be based on the ability to effectively detect and respond to RCS unidentified leak prior to exceeding specified design [analytical] limits
  - The WCAP-17187-P analysis confirms that the surge line leakage flaw remains stable at a 2.5 gpm leak rate
  - The Waterford 3 surge line is not susceptible to quickly propagating flaws
  - Stability periods are shown in MRP-109 (Alloy 82/182 Butt Weld Safety Assessment)

Treatment of LBB Margins



1. Data based on MRP-109, Table 5-5 and Figure 5-68
2. MRP-109 provides relative periods and does not directly equate to WCAP-17187-P analysis

Treatment of LBB Margins



Leakage flaw remains stable greater than 3 years. Factor of 2 margin to critical flaw.

Existing TS: Shutdown at greater than 1.0 gpm unidentified RCS leakage.
Greater than 5 years to critical flaw

Includes:

- Plant RCS leakage monitoring performed ≤ 0.1 gpm
- 0.25 gpm GDC 4 sensitivity

Waterford Leakage Detection TS Limits and Controls

- Waterford 3 TS LCO 3.4.5.1 requires the containment sump monitor to be Operable
  - Containment sump level indication is a continuous indication.
  - TS SR 4.4.5.1 performs a channel check every 12 hours.
- Waterford 3 TS LCO 3.4.5.2 requires operational leakage to be limited to:
  - 1 gpm Unidentified Leakage
  - Zero RCPB leakage
- Waterford TS SR 4.4.5.2.1 also requires RCS inventory balance every 72 hours

Waterford Leakage Detection TS Limits and Controls

- Both containment sump level indication and the RCS inventory balance meet the 0.25 gpm sensitivity
- Leakage monitoring actions are procedurally performed well ahead of TS limits
- Substantial time is available to take appropriate shutdown actions before a leakage flaw could become a pressure boundary rupture concern
- Existing TS LCO limits address plant safety for both GDC 30 and GDC 4 requirements

Compliance to 10 CFR 50.36 Criteria

- Based on 10 CFR 50.36(c)(2), Criterion 1:
  - Significant abnormal degradation only requires a detection limit to protect against an immediate threat to public health and safety
  - The analyzed leakage flaw of 2.5 gpm provides analytical margin well ahead of a potential piping failure
  - A shutdown TS LCO limit of 1.0 gpm provides substantial margin including uncertainty well ahead of the analytical limit of 2.5 gpm
- The existing TS limits remain conservative to protect LBB analytical results

Regulatory Precedent

- **Neither SRP 3.6.3 or RG 1.45 addresses the assumed leakage detection margin as a new TS limit**
- **Previous LBB precedent would suggest that reduced TS limits are not required**
  - **Ginna LBB License Amendment Application**
    - Established a 0.25 gpm leakage detection capability
    - No TS change proposed or required by NRC
    - Accepted in September 22, 2005 Amendment [ML0524303043]
  - **License Amendments for Beaver Valley 2 has an LBB RCS leakage requirement of 0.5 gpm and Kewaunee has a 0.25 gpm RCS leakage requirement with no TS revisions**

RAI 2 Conclusions

- Additional TS requirements are not necessary for the 0.25 leakage detection capability:
  - Regulatory guidance indicates an RCS leakage detection design capability and not a TS limit
  - Substantial detection periods exist for taking action prior to reaching the analytical limit for protection of public health and safety
  - Existing TS leakage detection capability meet 10 CFR 50.36(c)(2) Criterion 1 for LBB
  - NRC precedent does not support changing TS LCO limits

Additional NRC RAI 1

The licensee proposed crediting leak detection capabilities beyond those specified in RG 1.45 (e.g., sensitivity of 0.25 gallons per minute) without adequate supporting analysis

Waterford 3 Leakage Detection and Monitoring

- SRP 3.6.3 and RG 1.45 provide leakage detection/ monitoring requirements for LBB applications
  - SRP 3.6.3 (March 2007) ensures leakage detection is sufficiently reliable, redundant, and sensitive
  - RG 1.45, Rev. 1 (May 2008) provides various detection and monitoring approaches that are considered acceptable including
    - RCS leakage detection instrumentation has capability and sensitivity to detect unidentified leakage (Reg. Pos C.2)
    - Having leakage monitoring processes including action levels for monitoring unidentified RCS leakage (Reg. Pos C.3)

Waterford 3 Leakage Detection and Monitoring

- Waterford 3 has leakage detection instrumentation that satisfies the LBB sensitivity requirements of 0.25 gpm
  - TS LCO 3.4.5.1, *RCS Leakage Detection Instrumentation*, includes Containment Sump level instrumentation as one of the leakage detection methods
  - Containment sump level is provided by a computer point having a sensitivity of ≤ 0.1 gpm (computer point is non-safety)
  - The associated sump level transmitter is safety related, seismic, environmentally qualified (Accepted in NRC Amendment 197)
- The containment sump level instrument satisfies the RG 1.45 instrumentation guidance for LBB leakage detection sensitivity

Waterford 3 Leakage Detection and Monitoring

- Leakage Monitoring for meeting RG 1.45
  - Waterford implemented procedural instructions based on Owners Group leakage monitoring and action levels (WCAP-16465)
    - Post outage RCS leakage baseline established ≤ 0.075 gpm
    - Uses multiple plant leakage detection inputs
    - Established various action levels consistent with Owners Group guidance
    - Actions are initiated (i.e. condition report) beginning at 0.1 gpm (7-day average RCS unidentified leakage)
- The Waterford Leakage Monitoring process satisfies the RG 1.45 Monitoring Requirements

RAI 1 Conclusion

- Waterford 3 installed instrumentation satisfies RG 1.45 leakage detection for LBB sensitivity
- Waterford 3 leakage monitoring program satisfies RG 1.45 leakage trending for LBB sensitivity
- Combined processes provide sufficient diversity to detect and address RCS unidentified RCS leakage of 0.25 gpm
- Waterford 3 leakage detection/monitoring satisfies response time requirements specified in RG 1.45 based on the LBB fracture mechanics analysis of 0.25 gpm unidentified leakage

Additional Comments and Questions?