Extremely Low Probability of Rupture (xLPR) Project

xLPR Code Acceptance Criteria

David Rudland
USNRC

xLPR External Review Board Meeting
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Acceptance Group Members

- Bob Hardies - NRC
- David Rudland - NRC
- Tim Lupold - NRC
- Robin Dyle - EPRI
- Al Csontos - NRC
- Stephen Dinsmore - NRC

Topics of on-going Discussion
Three Questions

- **What constitutes acceptable inputs?**
  - Code model input, data, configuration
  - Technical basis for the code
  - Code structure

TODAY'S FOCUS

- **What constitutes acceptable results?**
  - Guidance on risk limits as an NRC regulatory position for LBB
  - In other than regulatory applications other criteria may apply
- **What constitutes an acceptable delivery vehicle for this information?**
  - Regulatory guide
  - Lead plant application

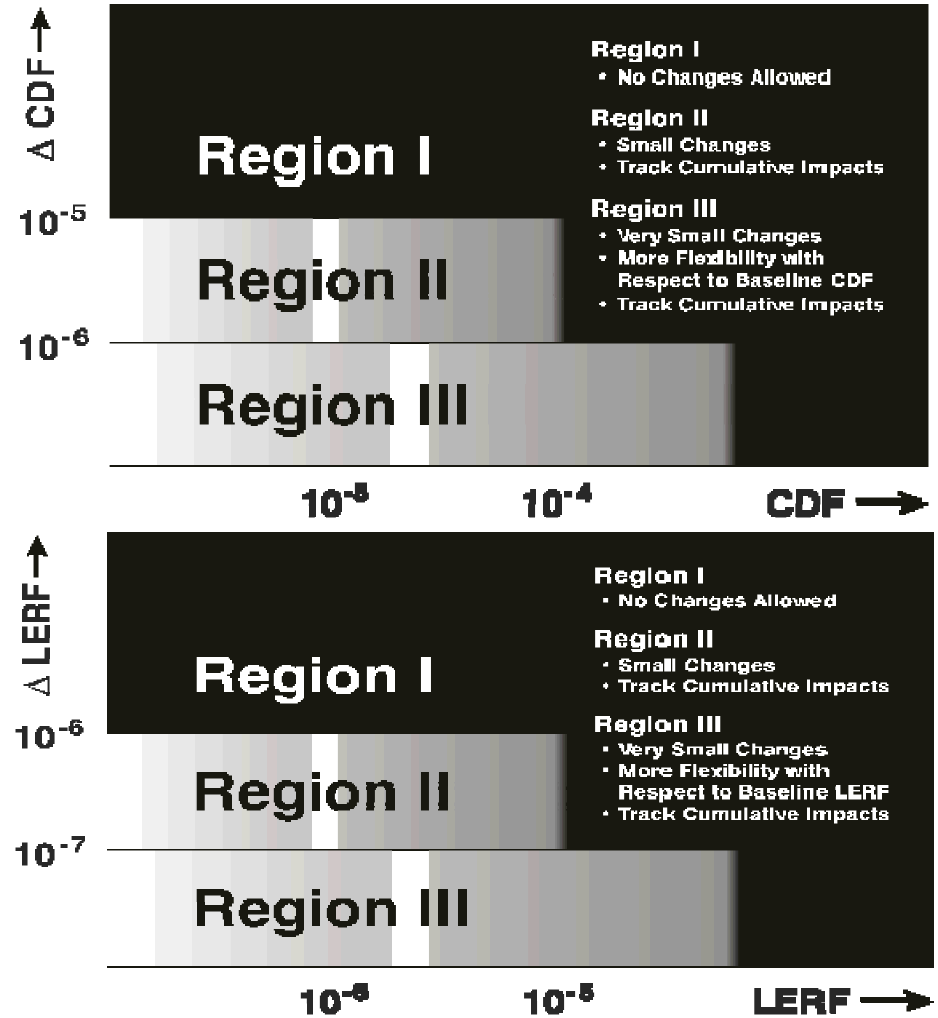
Initial Application is for LBB

- Acceptance Criteria Still Under Development
  - Nascent ideas are presented here, still a work in progress

- We expect that the xLPR project will evaluate changes in risk (Δ-Risk)
  - Is stress corrosion cracking active (or not)
  - Changes in inspection periodicity
  - Mitigation activities
  - Repairs

Acceptance Criteria being Considered

- Regulatory Guide 1.174 provides guidance on
  - Core Damage Frequency (CDF) and ΔCDF
  - Large Early Release Frequency (LERF) and ΔLERF
- Advantage
  - Criteria developed
  - NRC has experience with RG1.174 approach



Thoughts on xLPR Outputs & Comparison to RG 1.174 Limits

- xLPR output: failure probability/year
- Dependencies of interest
  - Effect of operational time
  - Effect of break size
- Quantiles
  - Mean values of failure probability used far from RG limits
  - Close to limits uncertainties need to be quantified (xLPR does this)
- Conversion of failure probability to CDF to compare with RG1.174 limits
  - Multiply failure probability by conditional core damage probability
  - Distinguish between different break sizes
  - e.g., $CDF_{total} = 10^{-2} * LBLOCA + 10^{-4} * MBLOCA + 10^{-3} * SBLOCA$
- LERF evaluation also needed
  - Conversion from CDF may be justified
  - e.g., $LERF = CDF \div X$
  - Magnitude of X depends on effect of pipe break on containment. As effect increases, so will X.

What Constitutes Failure?

- <u>Definition</u>: Any LOCA is a failure
- Potential mitigating factors
  - **Not all cracks progress rapidly to LOCA or rupture**
    - Some leak
    - Cracks that leak noticeably for a long time would be repaired before they rupture, so should not be counted as ruptures
  - **Crack has to leak noticeably**
    - Operators can reliably detect 10 GPM
  - **Cracks that leak >10 GPM get repaired if there is sufficient time between leak detection and rupture**

How Much Time Between Leak and Rupture?

Some definitions considered so far:

- If, at the next time step, a LOCA has occurred, then there was not enough time to notice the leak and shut down
- Define LOCA as a leak greater than charging pump capacity
  - Plant specific, but typically 55 GPM
  - Therefore recommend selecting 50 GPM
- If, at the next time step the leak rate >50GPM, then a LOCA has occurred

Failure Criteria

<u>Some definitions considered so far:</u>

- One candidate
  - Leak > 50 GPM AND
  - Leak at t-1 < 10 GPM
- Another candidate
  - Leak >50 GPM AND
  - Leak at t-2 < 10 GPM

Summary

- **Ideas thus far**
  - **Use established guidelines of RG1.174 for CDF & LERF**
  - **Define failure as any LOCA**
  - **Define a LOCA as being a leak rate exceeding the capacity of a single charging pump**

- **Work is continuing**