Simplified Explanation of Risk Assessments
Supporting Draft Steam Generator Phase 2 SDP Table

Green Findings:

- ***Tube that does not satisfy plugging/repair limit was not plugged/repaired before return to service, but degradation at end of cycle does not lead to tube failing to meet 3 x ΔP_{No} margin***

  Risk evaluation is presumed to be less than 1 x 10^{-7}/RY, based on calculations, below for higher levels of degradation.

White Findings:

- ***Degradation that does not meet 3 x ΔP_{No}***

  High/Dry part of CDF typically = 1-to-2x10^{-5}/RY

  Probability of secondary depressurization during high/dry sequence ≈ 0.1

  Probability of tube being in high temperature position = 0.5

  Probability of tube failure at high temperatures during high/dry sequence ≈ 1

  So, ΔLERF = 1-to-2x10^{-5}/RY x 0.1 x 1 x 0.5 = 5x10^{-7}-to-1x10^{-6}/RY

Yellow Findings:

- ***Multiple degradations (in one inspection or over multiple inspections) that do not meet 3 x ΔP_{No}***

  There are multiple rationales for this shift in significance level when more than one tube does not meet margin requirements. The numerical rationale for multiple tubes in one inspection can be seen by the increase in the probability that at least one of the tubes will see the highest temperatures during a high/dry core damage sequence. An additional rationale is based on increasing probability that a tube could degrade to the degree of not sustaining ΔP_{MSLB} if the deficiency persistence and degradation rates combine to produce multiple instances of failure to meet 3 x ΔP_{No} margin.

- ***One or more SGs violate "accident leakage" performance criterion***

  This criterion is intended to be somewhat conservative, pending completion of research efforts. Numerically, it is assumed that leakage at this level would be capable of making the tube failure probability = 1 for a flaw at any location during high/dry accident sequences with the secondary depressurized, raising the ΔLERF above 1x10^{-6}/RY. It is important to note that a flaw which is too short to rupture at normal operating temperatures may still be long enough to rupture at severe accident temperatures. Leakage of single flaws at design basis "accident leakage" limits can be indicative of a flaw that is sufficiently large to rupture at severe accident temperatures.

- ***Degradation that makes tube susceptible to secondary depressurization events***

  CCDP for SG ruptures induced by secondary depressurizations = 10^{-2} (based on NUREG-1570 work on human error probabilities)

  Depressurization event frequencies for U-tube type RCSs = 10^{-3}/RY

  Credit for degradation not existing for full year ≈ 0.5

  So, ΔCDF = 10^{-3}/RY x 10^{-2} x 0.5 = 5 x10^{-6}/RY

  and ΔLERF = ΔCDF + ΔLERF from "white" degradation level calculation

  Exception for B&W plants with tube that cannot sustain ΔP_{MSLB},

  secondary depressurization frequency = 10^{-2}/RY

  So, ΔCDF = 10^{-2}/RY x 10^{-2} x 0.5 = 5 x10^{-5}/RY and significance level becomes "red"

Red Findings:

- ***In B&W plants, degradation that makes tube susceptible to secondary depressurization events***

  [See exception under "yellow" category directly above]

- ***Degradations leading to tube ruptures***

  CCDP for spontaneous tube ruptures = 1x10^{-4} (based on NUREG-1150 PRAs)

  For degradations leading to ruptures, frequency of occurrence of rupture in last year = 1.

  So, ΔCDF = 1 x 1x10^{-4}/RY

  and ΔLERF = ΔCDF + ΔLERF from "yellow" and "white" degradation level calculations

- ***Degradations that make a tube susceptible to tube rupture during normal operation***

  For degradations that would fail at differential pressures that have a probability of 0.1 for occurrence during normal operation,

  ΔCDF = 0.1 x 1x10^{-4}/RY = 1x10^{-5}/RY

  and ΔLERF = ΔCDF + ΔLERF from "yellow" and "white" degradation level calculations