

Written Comment for the 730th ACRS Full Committee
Meeting (November 5, 2025)

**Comment on Holtec's Use of 95/50 Probability Criteria in the
Palisades Steam Generator Operational Assessment**

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1. Introduction

Holtec's 2025 Steam Generator Operational Assessment (OA) for the Palisades Nuclear Plant concludes that tube structural and leakage integrity will be maintained for a 1.5 Effective Full Power Year (EFPY) operating interval—i.e., one nominal 18-month cycle. However, this conclusion is based on a 95 percent probability at 50 percent confidence (95/50) statistical criterion. This represents a material departure from the higher-confidence 95 percent probability at 95 percent confidence (95/95) standard more often used by the nuclear industry and the NRC when determining the acceptable interval between inspections—particularly when the projected period to the next inspection is 1.5 EFPY or less. Such shorter intervals inherently carry greater uncertainty because crack-growth variability, probe sizing errors, and environmental effects have

proportionally larger impacts when little or no operating margin remains before the next inspection.

Although the use of 95/50 is not prohibited by regulation, the ACRS and NRC staff should interpret the results in the context of the current, well-documented poor condition of the Palisades' aging steam generators.

Holtec's own Operational Assessment and Condition Monitoring Report identify more than 800 tubes with detectable degradation, including a high concentration of axial outside-diameter stress corrosion cracking (ODSCC) at tube-support-plate (TSP) intersections, several hundred sleeved or plugged tubes, and the presence of multiple coexisting degradation mechanisms—ODSCC, primary-water stress corrosion cracking (PWSCC), and mechanical wear—as well as over 2,200 pounds of remaining tube-surface deposits in each steam generator. These deposits, concentrated between the second and eighth TSP elevations, were described in the OA as “persistent accumulations that could not be removed during cleaning,” indicating long-term fouling at locations already prone to corrosion and stress concentration. These findings confirm that the Palisades steam generators—installed in 1990 and at the late stage of their service life—are among the most extensively degraded Alloy-600 thermally treated units still in service. In this context, reliance on a 95/50 confidence model—without compensating conservatism or interval margin—provides only

nominal statistical assurance and could materially understate the true probability of tube failure during the proposed 1.5 EFPY period.

2. Understanding 95/95 vs 95/50 in Steam-Generator Integrity

Analyses

- **95/95:** The licensee can assert, with 95% confidence, that 95% of tubes will meet the structural-integrity criterion (e.g., burst pressure $> 3\Delta P$ or accident leakage < 1 gpm).
- **95/50:** The licensee can assert, with 50% confidence, that 95% of tubes meet the criterion.

The latter accepts a **one-in-two chance** that actual performance could fall outside the predicted bound—a **best-estimate** rather than a **high-confidence** evaluation. Moving from 95/95 to 95/50 roughly **doubles the likelihood** that actual degradation will exceed the predicted bound. That may be tolerable for new or clean steam generators, but **not** for systems already operating near structural limits.

3. The Importance of Remaining Interval Margin

The conservatism of any statistical model depends on how much operating time remains before the next inspection. A 95/50 analysis can be acceptable when steam generators are in excellent or good condition and

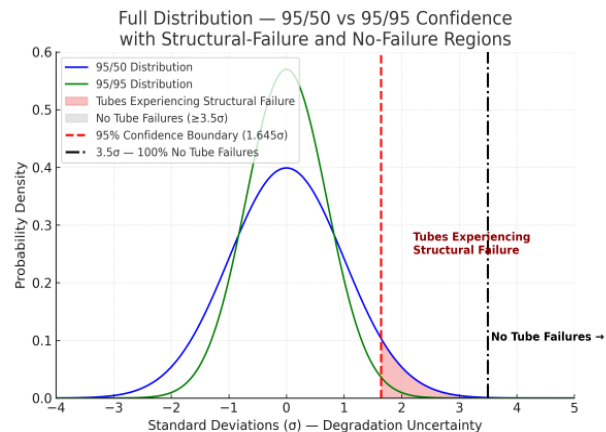
the next inspection is scheduled earlier than the calculated limit, leaving a measurable safety buffer for tubes that fall above the 95 percent probability of survival but below the 100 percent certainty threshold.

However, **a single tube failure constitutes a design-basis steam-generator tube rupture**, directly challenging containment and offsite dose assumptions. To maintain positive public-safety assurance, the **interval to the next inspection** must therefore include a **statistical buffer** that places any projected tube failure **well beyond**

the upper bound of the expected distribution of future degradation.

The sketch shows these concepts....the area of concern is shaded red....note the differing area under the curve for 95/50 vs 95/95 distributions:

Holtec OA — Full Distribution with Structural-Failure and No-Failure Regions (Final High-Resolution Version)



In practice, most NRC-reviewed OAs that used 95/50 met one or both conditions:

- **Shortened interval:** The next inspection was limited to **less than a full cycle**; or

- Bounding check: The OA included a 95/95 accident-leakage evaluation.

In contrast, Holtec's OA applies 95/50 while consuming the full 1.5 EFPY interval, leaving no residual margin. This assumes all tubes behave exactly as predicted, with no allowance for model or measurement uncertainty—an assumption inconsistent with both statistical practice and Palisades' degraded condition.

4. Degraded Steam Generators Require Greater Statistical Confidence

Palisades' 2024 inspections identified numerous axial ODSCC indications at TSPs, many near or exceeding the 40–50% through-wall threshold typically used for repair. Several degradation mechanisms (ODSCC, PWSCC, and wear) now lie close to Technical Specification limits for structural and leakage performance.

When inspection data cluster near acceptance limits, uncertainties in **growth rate**, **sizing accuracy**, and **chemistry** increase. Under these conditions, a **50% confidence** level is inherently **non-conservative**, because it assumes symmetric uncertainty and ignores the bias toward under-prediction associated with small-sample or evolving mechanisms. A **conservative evaluation increases the confidence level** as uncertainty

grows. For Palisades—returning from decommissioning with incomplete lay-up history and a high crack density—95/95 is the only defensible confidence level for maintaining equivalent assurance of public health and safety.

5. Industry and Regulatory Precedent

Although NEI 97-06 and EPRI integrity guidelines do not prescribe a numeric probability/confidence pair to be used in OA evaluations, multiple NRC Safety Evaluations reference licensee analyses that apply or bound results at 95/95 for full-cycle conclusions. Conversely, where 95/50 was used (e.g., Diablo Canyon, Surry, Seabrook), plants retained substantial margin—either by shortening the interval or by presenting a 95/95 leakage bound for accident conditions. No NRC-reviewed OA pairs 95/50 with a zero-margin, full-cycle interval as Holtec does for Palisades in 2025.

6. Comparative Implications for Palisades

Scenario	Condition	Confidence Model	Remaining Margin	Conservatism
Typical industry case	Stable degradation, low growth	95/50 acceptable	> 1 EFPY beyond current interval	Moderate / High
Degraded or uncertain SG	Multiple cracks near limits	95/95 preferred	< 0.3 EFPY	High
Palisades 2025 OA	Degraded SGs, uncertain chemistry history	95/50 only	0 EFPY (1.5 EFPY full-use)	Low / Non-conservative

Palisades occupies the **lowest-conservatism quadrant** of current practice: **reduced statistical confidence (95/50), full interval (1.5 EFPY), and no buffer**. That combination is out-of-family with the prudence typically demonstrated when steam generators are late-life and margin is thin.

7. Regulatory Significance

NRC's reasonable-assurance finding under 10 CFR Part 50 depends on demonstrable technical confidence. When a licensee lowers statistical confidence, other conservatisms—such as a shorter inspection interval, broader inspection scope, or a bounding leakage evaluation—must be introduced to compensate. Holtec's OA introduces none of these offsets. It replaces 95/95 with 95/50 and consumes all available margin, leaving no statistical cushion against either un-modeled degradation or degradation that falls above the 95 percent probability line of tube structural failure. Such a case does not meet the NRC's reasonable-assurance standard for a plant returning to service with aging, late-life steam generators.

8. Margin Concerns Supporting the Need for a 95/95 Standard at Palisades

1. **Circumferential PWSCC at the Hot-Leg Expansion Transition — Minimal Burst Margin**

Predicted end-of-cycle depths reach **~77.5% TW**, with failure expected at **~89% TW**, leaving **~11% structural margin**. With so little wall remaining, modest under-prediction (chemistry, measurement, stress) could exceed burst limits before 1.5 EFPY. **95/95** is warranted to reflect realistic uncertainty.

2. **Axial ODSCC at TSP Elevations — Most Prevalent, Rapidly Growing Mechanism**

1D28 documented **>1,000 axial ODSCC indications** (up from four), many **70–80% TW**. The OA relied on an **EPRI default 0.03 in/yr** (**~2.1% TW/EFPY**) and favorable crack-shape assumptions, despite internal data showing **~9% TW/EFPY** average growth (**≈4×** higher). Mixed use of unrelated wear-rate data understates degradation. The surge in cracking and contradictory modeling make **95/50** unjustified; **95/95** is needed.

3. **Circumferential ODSCC — Poor Leak-Before-Break**

Circumferential ODSCC near TSPs lacks reliable leak-before-break. A **73% TW** crack observed **0.18 in** below the burst threshold shows rupture proximity without prior leakage. Historical leakage

distributions may not reflect the current high-density flaw population; **95/50** underestimates undetected rupture probability.

4. Tube-to-Tube and Loose-Part Wear — Modeled Stable, Not Validated for Restart

Wear modeled at **0.3% TW/EFPY** assumes unchanged vibration, yet restart alters hydraulic forcing. **701 tubes (SG A)** and **248 (SG B)** were initially flagged for plugging; many were **later unplugged** and returned to service without re-analysis. No evaluation of the new vibration environment or reintroduced tubes is provided. Higher-confidence **95/95** is appropriate.

5. Chemistry and Baseline Data Gaps — Unquantified Uncertainty

Primary-side chemistry (**May 2022–May 2024**) was not monitored/recorded, and a prior baseline CM/OA is unavailable in ADAMS.

Growth was extrapolated without verified environmental inputs—directly affecting corrosion kinetics and initiation. **95/95** is necessary to bound chemistry-driven uncertainty.

6. Aggregate Margin Erosion — Compounding Mechanisms

Individually within limits, together they form a **system at the edge of analytical validity**. Interacting modes (PWSCC, ODSCC, wear,

chemistry effects) reduce tolerance to modeling error. Compounded uncertainty demands **95/95** to retain reasonable assurance.

7. Uncharacterized Metallic Deposits at TSPs — Potential Hidden Accelerator

Deposit mapping shows **~2,200 lbs per SG**, concentrated between the **2nd–8th TSPs**. Despite NRC requests, no chemical/metallurgical characterization is documented. Potential **lead/copper-assisted corrosion** remains unresolved at known stress sites, undermining any claim that **95/50** bounds future behavior.

8. Inconsistency in Growth Projections — Interval Not Adjusted

The OA acknowledges mechanisms are “**at the margin**” by the end of 1.5 EFPY yet simultaneously predicts **an even larger flaw population** next cycle—normalizing rapid degradation without shortening the interval. Under such internal contradiction, **95/50** cannot be interpreted as reasonable assurance; **95/95** or a shorter interval is needed.

9. Summary

Taken individually and collectively, these concerns show Palisades’ steam generators are **not candidates for reduced statistical conservatism**.

With thin burst margins, accelerating ODSCC, unvalidated wear assumptions, missing chemistry data, and thousands of pounds of uncharacterized deposits, uncertainty is high and available margin is small. Under these conditions, **only a 95/95 probability/confidence standard** provides the level of assurance traditionally accepted for safe operation between inspections.

10. Conclusion and Request

Holtec's use of a **95/50** criterion in the Palisades OA is **statistically and operationally non-conservative**. Other plants have used 95/50 only when significant interval margin or 95/95 bounding checks remained. Applying 95/50 to a full-cycle, zero-buffer interval at Palisades undermines the OA's purpose: to demonstrate, with high confidence, that tube integrity will be maintained for the entire operating period.

I respectfully request that the ACRS:

1. Ask NRC staff to require ** Holtec to re-perform the OA using a 95/95 probability/confidence criterion; or
2. If Holtec retains 95/50, **limit the inspection interval** to a shorter period that restores equivalent statistical confidence; and

3. Ensure the staff **explicitly document** any rationale for accepting a lower-confidence model under the NRC's reasonable-assurance standard.

****NRC Approval For Propose Period of Next Operations**

Although there is no direct Technical Specification (TS) “hook” governing NRC approval to restart Palisades following completion of steam-generator inspections, the NRC recognized the unique, first-of-its-kind return to service from a certified decommissioning status. Accordingly, the agency established a dedicated **Palisades Restart Panel**, and restart authorization has been formally tied to final approval by both the **NRC Region III Administrator** and the **NRC Executive Director for Operations (EDO)**—creating an NRC review and approval checkpoint outside the Technical Specifications to ensure comprehensive oversight before fuel load and power ascension.