The redefined Tech Spec (SL_{TS}) value set by $MCPR_{95/95}$ is intended to be a lower bound for the $MCPR_{99.9}^{cap}$ values that are being calculated by the NRC currently-approved processes (cap superscript) used by the fuel suppliers. Critical power correlations typically have a standard deviation (σ) ranging from 3.0% to 4.0% which for the proposed SL_{TS} calculation will give $MCPR_{95/95}$ values ranging from 1.05 to 1.07 as shown by the table on slide 27 of the TSTF presentation and replicated in column A of Table 1 below. Note that these examples presume a representative experimental sample size (N) of 1000 samples and an experimental mean (μ) of 1.0.

Table 1: Example $MCRP_{P/C}$ Values for different σ%, P% and C%

	A	B	C
κ -->	1.71154	2.47467	3.09023
P%/C%->	**95 / 95**	**99 / 99**	**99.9 / 50**
σ %	**SL_{TS}**	**SL_{TS}**	**SL_{TS}**
2.0%	1.03	1.05	1.06
2.5%	1.04	1.06	1.08
3.0%	1.05	1.07	1.09
3.5%	1.06	1.09	1.11
4.0%	1.07	1.10	1.12
4.5%	1.08	1.11	1.14
5.0%	1.09	1.12	1.15

The 95/95 approach for protecting the lead rod is recommended since it is consistent with the PWR approach used to establish a Tech Spec value for a mininum departure from nucleate boiling ratio (DNBR). As indicated in columns B and C of Table 1, a different basis such as 99%/99% or 99.9%/50% for the lead rod would increase the value of $MCPR_{P/C}$ used to define SL_{TS} so that it would no longer be a floor value on $MCPR_{99.9}^{cap}$ values currently calculated but would instead increase them to be greater than the currently-approved licensing basis. Note that the currently-approved regulatory basis for calculating $MCPR_{99.9}^{cap}$ will remain unchanged hence the operating limit MCPR (OLMCPR) based on $MCPR_{99.9}^{cap}$ will also not change. In practice, the redefined SL_{TS} provides additional protection for the lead rod against boiling transition (BT) because adding the requirement that $MCPR_{99.9}^{cap} \geq SL_{TS}$ prevents unreasonably low values of the $MCPR_{99.9}^{cap}$ that could be calculated for some peaked core and/or bundle CPR distributions even with the approved processes.

There is no technical reason nor regulatory requirement that the redefined SL_{TS} be directly coupled to the currently-approved calculations for $MCPR_{99.9}^{cap}$. The two approaches for calculating SL_{TS} and $MCPR_{99.9}^{cap}$ are fundamentally distinct but share important common elements as illustrated in Figure 1 and explained here. Both approaches rely on the ECPR distribution defined as the ratio of experimental critical powers (CP) to the CP values calculated from a fuel-specific critical power correlation. The ECPR distribution is illustrated in the left part of the Figure 1. The ECPR distribution for each fuel type is characterized by a sample of N pointwise ratios of experimental CP divided by calculated CP from a fuel-type specific critical power correlation. The mean μ and an uncertainty σ for the ECPR distribution describe how well the CP correlation represents the experimental data. Typically, fuel suppliers consider the experimental CP data, the CP correlation, and values of N, μ, and σ to be proprietary.

The proposed SL_{TS}= $SLMCPR_{95/95}$ value corresponds to the nominal CPR where the lead rod will have 95% probability at 95% confidence of not being in boiling transition (BT). As indicated in the top row of Table 1, the number of standard deviations (κ) above the mean (μ) depends on N and the desired probability and confidence. This number of standard deviations to the right of the experimental mean (μ) of the ECPR distribution is what determines the position of the dashed green vertical line in Figure 1. Contrast this to a rod with a CPR at the center of the ECPR distribution where κ=0 and CPR=μ≈1 where there is only a 50% probability at 50% confidence that BT is avoided.

The current processes for calculating $MCPR_{99.9}^{cap}$ (used by GNF and Westinghouse) also depend on the ECPR distribution. To calculate $MCPR_{99.9}^{cap}$ for a core the rod CPRs and the bundle MCPRs are simulated along with proprietary uncertainties pertaining to the ability to calculate rod CPRs and bundle MCPR. The process is well described in the non-proprietary GETAB document NEDO-10958-PA (January 1977) as well as additional proprietary documents from the fuel suppliers.

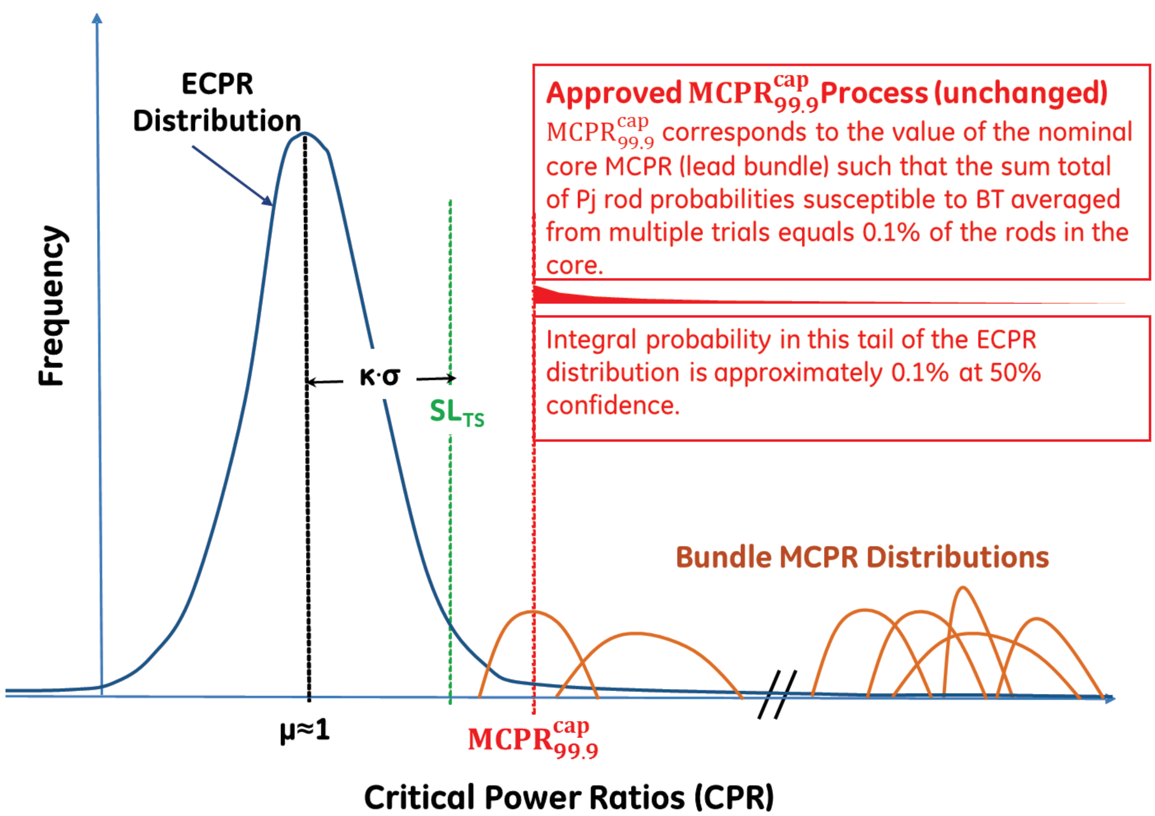

Figure 1: Illustration of Relationship between Proposed SL_{TS} and Currently Calculated $MCPR_{99.9}^{cap}$

The orange humps in Figure 1 illustrate the simulated bundle MCPR distributions that represent the uncertainty associated with the calculation of the rod CPR corresponding to the rod in the bundle with the minimum CPR. All other rods in the bundles also have a simulated CPR distribution (not shown) that would occur to the right of their specific bundle MCPR distribution. During statistical trial simulations of the core, perturbed values of CPRj for each rod j in the core are calculated and compared to the presumed normal ECPR distribution to calculate a probability Pj of that rod's susceptibility to BT. The summation of all such Pj values when averaged over a specified, statistically-significant number of trials must sum to ≤ 0.1% of the rods in the core. The tails of the ECPR distribution extend from -∞ to +∞ so even bundles with MCPR values significantly above the MCPR for the most limiting bundle in the core (to the right in Figure 1) will contribute non-zero Pj values to the summation. Each simulation set has an initial nominal MCPR distribution for the core that has been adjusted upward or downward for the set usually by changing the core power (or flow) to emulate the minimum CPR values expected for the worst case Anticipated Operational Occurrence (AOO) that initiated with the core at the OLMCPR. Subsequent sets of trials are adjusted until the trial-averaged Pj summations for the final set equals the 0.1% target. The nominal value of the lowest-valued bundle MCPR from the final set of trials where the 0.1% target is realized is the $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ for that core configuration. This $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ value is illustrated in Figure 1 by the dashed red vertical line. Note that the dashed red vertical line extends through the nominal MCPR value for the lead bundle somewhere close to the mean of the trial simulations for this bundle from the final set of trials. At a core nominal MCPR value equal to the $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$, at least 99.9% of the rods in the core will **not** be susceptible to boiling transition. The proposed redefinition of SL_{TS} will not changes this approved licensing basis nor will it change the approved processes for determining the OLMCPR that depends on the calculated $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$.

Adding the requirement that $\mathrm{MCPR}_{99.9}^{\mathrm{cap}} \geq SL_{TS}$ will provides additional quantifiable BT protection for the lead rod in the core that is not currently provided by the existing licensing basis established from the $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ alone. For example, a very peaked core MCPR distribution and/or peaked rod-by-rod CPR values within bundles could result in a very low value because $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ is defined based on a summation of rod probabilities for the core without regard to the probability of any specific rod being in BT. For the example in Figure 1 this would mean that the dashed red vertical line would be to the left of the dashed green vertical line and that nominally the lead rod in this bundle would have a probability and confidence of avoiding BT that was less than 95%/95%. Adding the requirement that $\mathrm{MCPR}_{99.9}^{\mathrm{cap}} \geq SL_{TS}$ prevents this scenario.

The important distinction for the proposed redefinition of SL_{TS} is its dependence only on the characterized ECPR distribution for a fuel type whereas $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ as calculated now depends on the ECPR distribution plus many additional parameters that depend on plant and modeling uncertainties as well as core and bundle designs that tend to vary from cycle-to-cycle with each reload. For the proposed change, $\mathrm{MCPR}_{99.9}^{\mathrm{cap}} \geq SL_{TS}$, thus the Tech Spec value represented by SL_{TS} provides a lower bound for core- and cycle-specific values of $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ that are currently calculated and will continue to be calculated per the NRC-approved methods. Because the redefined Tech Spec represented by SL_{TS} does not depend on cycle-specific information, the need for licensing amendment requests (LARs) to change a Tech Spec number because $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ increases will be substantially reduced without in any way reducing the amount of protection currently provided by the NRC-approved processes for calculating the cycle $\mathrm{MCPR}_{99.9}^{\mathrm{cap}}$ and determining the cycle OLMCPR value that regulates core operations.