Luminant

Spent Fuel Pool Criticality License Amendment Request Pre-Submittal Meeting

November 20, 2012

SFP Meeting Agenda

- Introductions
- Purpose
- CPNPP Spent Fuel Pool Criticality Background and Status
- Proposed Technical Specification Changes
- Meeting Summary and Conclusion

Introductions

Luminant Power Company

Ben Mays	Vice President, Engineering
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Jimmy Seawright	Consulting Engineer – Regulatory Affairs
Matt Weeks	Manager, Core Performance Engineering
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Westinghouse Electric Company

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Purpose

To provide the NRC an overview of the upcoming Spent Fuel Pool License Amendment Request, which will supplement Technical Specifications to address fuel discharged from post-uprate conditions.

This License Amendment Request will satisfy the commitment to prepare and submit a LAR, as specified in Confirmatory Action Letter 4-12-004.

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CPNPP Proposed Approach

Note that this License Amendment Request will be the first of 2 LAR's CPNPP has committed to submitting related to Spent Fuel Pool Criticality.

1) The First LAR (discussed in this presentation):
   - will supplement TS 3.7.17 with limitations which will bound storage of fuel depleted at post-uprate conditions,
   - will implement additional controls which ensure significant additional margin is maintained, and
2) The Second LAR will "modernize" the CPNPP Criticality Analysis, and will include a full-scope reanalysis of the SFP storage limitations.

Goals

Goals regarding this submittal:

1) Continue the safe storage of the discharged fuel inventory at CPNPP
2) Demonstrate continued compliance with regulatory requirements including 10CFR50.68
3) Restore limited ability for CPNPP to utilize the Region II storage racks for discharge fuel
4) Enable limited ability to store fuel from 2RF13 (and future cycles) in a thermally dispersed configuration.

CPNPP Proposed Approach

The discussion will be divided into two focus areas:

- **Addressing the impacts of increased power level on the current Analysis of Record, and associated changes to the fuel burnup limits of TS 3.7.17**
- **Incorporating additional reactivity margin**
  - **Increased Soluble Boron Limit of TS 3.7.16**
  - **Administrative Controls for Low Margin Assemblies added to TS 4.3**

Addressing Impact of Power Uprate

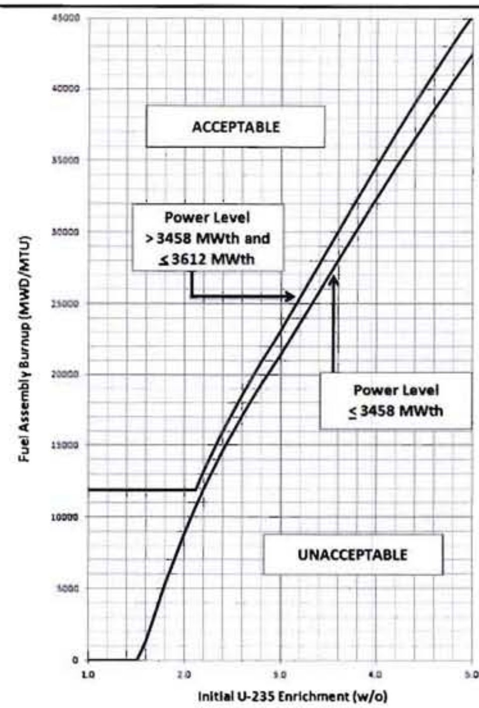
The License Amendment Request will revise Figure 3.7.17-2, Burnup vs Initial Enrichment limits for "3 out of 4" storage.

- **The existing limit will be identified as "Power History $\leq$ 3458 MWth"**
- **A second limit will be added, identified as "Power History > 3458 MWth and $\leq$ 3612 MWth"**
- **Requirements for determining the applicable curve will be clarified in the TS Bases, to specify that inclusion in any cycle with a Rated Thermal Power of up to 3612 MWth requires use of the higher limit**
- **Because CPNPP does not utilize fuel with initial enrichment values below 2% in Uprate Conditions, the post-uprate curve is conservatively "flat" below this value.**

Addressing Impact of Power Uprate

Draft revision to

Figure 3.7.17-2



Addressing Impact of Power Uprate

Figures 3.7.17-1 ("4 out of 4" limits) and 3.7.17-3 ("2 out of 4" limits") will also be revised.

- The existing burnup limits will be identified as "Power History ≤ 3458 MWth"
- No new curves applicable to Uprate fuel will be added to these Figures
- The TS Bases will be revised to clarify that:
  - fuel irradiated at Uprate conditions cannot be stored in Region II in a "2 of 4" or "4 of 4" configuration, and
  - <u>IF</u> the limitations are not satisfied for "3 of 4" storage, <u>THEN</u> the assembly will be limited to either:
    - "1 of 4" storage, or
    - storage in Region I

Addressing Impact of Power Uprate

To support the revision to Figure 3.7.17-2, CPNPP will utilize the results of an analysis performed in 2010.

The resulting administrative controls derived from this analysis were provided to the NRC during the May 2012 baseline inspection.

To determine the TS 3.7.17-2 limit for "3 out of 4" storage for a power level up to 3612 MWth,

- CPNPP utilized the methodology of the Analysis of Record which was approved by the NRC in 2001 (Reference ML012560143),
- The 2010 analysis utilized the specific codes and versions utilized in the Analysis of Record.

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Addressing Impact of Power Uprate

Changes to the inputs utilized in the original analysis are:

- Power level input changed from 3565 MWth to 3612 MWth
- Thermal Flow input changed to represent uprated conditions

No other inputs were changed.

Note that use of T-inlet value from original analysis is conservative for post uprate (actual moderator temperature lowered for the uprate, so using pre-uprate temperature is conservative)

Parameter	Reactivity Impact
Reactivity Impact of Power Change	0.00032 Δk
Changes to Reactivity Credits/Penalties	0.00478 Δk
Addition of Administrative Margin	0.00500 Δk
Total Reactivity Change Compensated by Revised TS 3.7.17-2 for the Uprate	0.01010 Δk

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Addressing Impact of Power Uprate

The CPNPP Analysis of Record is a site specific analysis based on a modified version of the Westinghouse Methodology described in WCAP-14416-NP.

Prior to 2001, a non-conservatism in the WCAP-14416-NP methodology was identified. This issue was addressed in the CPNPP Analysis of Record prior to receiving NRC approval.

- The NRC stated in a letter to Westinghouse that the methodology contained in WCAP-14416, other than the axial burnup bias, was still acceptable for use in new analyses (Reference ML012080337)
- The axial burnup bias is specifically addressed in the approved CPNPP Analysis of Record.
- The 2010 Analysis was performed consistent with the Analysis of Record regarding the axial burnup bias

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Increasing Reactivity Margin

During the May 2012 Baseline Inspection of the SFP storage configuration, the NRC indicated concerns with certain aspects of the current Analysis of Record:

- The Analysis of Record does not include Depletion Uncertainty in the unborated case (as was appropriate for the timeframe)
- The Analysis of Record does not consider the impact of burnable poisons on spent fuel reactivity.

To assure compliance with 10 CFR 50.68 and Design Basis Technical Specification 4.3.1, CPNPP has quantified uncredited reactivity margin in the SFP.

- The quantification of reactivity margin in the SFP offsets the concerns indicated by the NRC
- Low margin assemblies have been identified and collocation of low margin assemblies is managed through administrative controls which provide additional margin

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Increasing Reactivity Margin

The 2001 Analysis of Record includes many aspects and assumptions which are conservative including:

- utilizing conservative assumptions for axial burnup shape used to correct the axial burnup bias;
- ignoring the effect of annular axial blankets;
- ignoring decay time credit;
- Ignoring the presence of discharged Control Rods (RCCA) and spent burnable absorbers (i.e., WABA) in the spent fuel

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Increasing Reactivity Margin

Two Technical Specification changes are proposed which will increase the subcritical margin in the Spent Fuel Pool:

1) Increase Boron Requirement:

   Increase the SFP Boron Concentration Limit of TS 3.7.16 from 2000 ppm to 2400 ppm

2) Administrative Controls for Low Margin Assemblies:

   Controls which manage collocation of low-margin assemblies in close proximity will be described in the FSAR

   A change to the Technical Specification Fuel Storage Design Features (TS 4.3.1.1) will reference the appropriate FSAR section

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Increase Boron Requirement

The increase in Soluble Boron limit from 2000 ppm to 2400 ppm provides significant margin in the portions of the analysis which credit soluble boron.

The SFP boron is typically maintained above this value during normal operation.

Note that the Analysis of Record credits a maximum of 1900 ppm for accident scenarios.

- This change increases the margin above this value from 100 ppm to 500 ppm.
- more than 4000 pcm additional margin

Administrative Controls for Low Margin Assemblies

Administrative controls provide additional margin to the limits of 10CFR50.68, which also requires K_{eff} to be less than 1.0 with no soluble boron.

- The proposed method uses conservative estimates for various negative reactivity affects to determine the estimated reactivity margin for each fuel assembly.
- Administrative controls on fuel storage utilize the estimated reactivity margin to ensure multiple low margin fuel assemblies are not stored in close proximity.

Administrative Controls for Low Margin Assemblies

Examples of low margin fuel assemblies would include fuel with the following attributes:

- A burnup value close to the minimum value required by TS 3.7.17 for storage in its current configuration
- Contains less than 5 years of decay time
- Does not contain a discharged RCCA (which has a large negative reactivity affect due to neutron absorption)
- Does not contain a discharged discreet burnable poison (which have a smaller negative reactivity affect due to the water displacement)

Administrative Controls for Low Margin Assemblies

An overview of the process used to determine acceptability of a storage configuration is described below.

Step 1: Determine an estimate of "Reactivity Margin" for each fuel assembly which will be stored in Region II.

Various credits are taken, which are shown in the following 2 slides.

Each applicable credit is 'summed' for each fuel assembly to determine the total Estimated Uncredited Reactivity Margin.

An assembly with no decay time, no excess burnup, and no insert, would have very near 0 pcm of excess reactivity margin. This assembly would most closely represent the nominal fuel assembly assumed in the Analysis of Record, and in the current TS 3.7.17 limits.

Administrative Controls for Low Margin Assemblies

150 pcm for each assembly with a Nominal Fuel Density of < 95.5% (Analysis of Record assumes 96.5%).

1000 pcm for any assembly containing a discharged RCCA.

- Note that this value is a conservatively low estimate of the actual reactivity impact.

200 pcm for any assembly containing a discharged BPRA/WABA.

- This is a conservatively low estimate for the water displacement affects of these inserts. Note that they contain absorber pins in varying amounts up to 24 pins (the estimate for 200 pcm is representative of the presence of 8 pins in one assembly in a 3 of 4 configuration).

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Administrative Controls for Low Margin Assemblies

1000 pcm is credited for every 5000 MWD/MTU of excess burnup beyond the required value for storage in the current configuration.

Decay Time credit is applied, up to a maximum of **1351 pcm**, based on the table below. No interpolation is performed, and the lower value in a range is utilized for conservatism.

Decay Time	Reactivity (pcm)
< 5 years	0
5 - 10 years	534
10-15 years	900
15-20 years	1,161
>20	1,351

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Administrative Controls for Low Margin Assemblies

Step 2: For each storage location, review the reactivity margin of the eight adjacent locations (in a 3x3 array).

- The value of k_{eff} in the SFP is dependent on more than the single fuel assembly being reviewed; it is also dependent upon the surrounding fuel storage cells.
- By calculating an average value of the surrounding reactivity margins, an improved understanding of the reactivity margin of that area is achieved
  - This "average" value is only intended to identify areas of the SFP where multiple low margin assemblies could be stored in close proximity
- Average values are not calculated for assemblies which meet the burnup requirements for a denser configuration based on the TS 3.7.17 limit

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Administrative Controls for Low Margin Assemblies

Step 3: Compare minimum value of Averaged Reactivity Margin with a baseline standard

A baseline value of Averaged Reactivity Margin of 1363 pcm was established in the May 2012 inspection.

CPNPP committed to the NRC (ref TXX-12-000148) to maintain this level of margin, and therefore this baseline value will continue to be utilized.

IF the proposed fuel movement would result in a configuration which has a minimum averaged reactivity margin value below the established baseline, THEN:

- the fuel movement sequence will NOT be performed, and
- changes to the sequence will made to satisfy the baseline value before moving fuel.

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Administrative Controls for Low Margin Assemblies

Example configurations which would be <u>RESTRICTED</u> due to the Administrative Controls:

<u>Example #1:</u>

5 assemblies with no excess decay time or burnup (beyond the TS 3.7.17 requirements), but each of which has an <u>RCCA</u> stored within the fuel assembly.

	RCCA 0 decay 0 excess BU	
RCCA 0 decay 0 excess BU	RCCA 0 decay 0 excess BU	RCCA 0 decay 0 excess BU
	RCCA 0 decay 0 excess BU	

Each assembly has a nominal density ≤ 95.5%, which provides an additional 150 pcm credit.

The "averaged reactivity margin" value for the center location would only be **<u>1150 pcm</u>**, less than the baseline value of 1363 pcm.

Administrative Controls for Low Margin Assemblies

Example configurations which would be <u>RESTRICTED</u> due to the Administrative Controls:

<u>Example #2:</u>

5 assemblies with no excess decay time, but each with burnup values <u>5000 MWD/MTU</u> beyond the beyond the TS 3.7.17 requirements. The center assembly contains an <u>RCCA</u>.

	No insert 0 decay 5k excess BU	
No insert 0 decay 5k excess BU	RCCA 0 decay 5k excess BU	No insert 0 decay 5k excess BU
	No insert 0 decay 5k excess BU	

The "estimated reactivity margin" value for the center location is 2150 pcm (1000 for BU + 1000 for RCCA + 150 for density), but the surrounding assemblies would only have 1150 pcm.

The "averaged reactivity margin" in the center location would therefore be **<u>1350 pcm</u>**, slightly less than the established baseline.

Administrative Controls for Low Margin Assemblies

This example provides a <u>SATISFACTORY</u> result.

<u>Example #3:</u>

5 assemblies with no excess burnup, but each has <u>15 years of decay time</u>. Two of the assemblies contains a discharged <u>WABA</u>.

	No insert 15 yr decay 0 excess BU	
WABA 15 yr decay 0 excess BU	WABA 15 yr decay 0 excess BU	No insert 15 yr decay 0 excess BU
	No insert 15 yr decay 0 excess BU	

The "estimated reactivity margin" value for the center and left locations is 1511 pcm (1161 for decay + 200 for insert + 150 for density), but the surrounding assemblies would only have 1311 pcm.

The "averaged reactivity margin" in the center location would therefore be **<u>1391 pcm</u>**, slightly above than the established baseline.

- However, if one WABA was removed, the value would fall to 1351 pcm, below the baseline.

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Administrative Controls for Low Margin Assemblies

The above examples demonstrate the high level of conservatism provided by this approach.

- **The NRC reviewed the configuration in Region II in May 2012, which established the baseline margin value for our controls,**
- **CPNPP has utilized this method of margin management since June 2012.**
- **No safety concerns regarding the current SFP configuration were identified in the Confirmatory Action Letter.**
- **CPNPP has evaluated the margin impacts of storing the discharged fuel from 2RF13 into Region II, and determined that the established baseline would be maintained. However, this fuel is currently stored in Region I per commitments.**

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Summary and Conclusions

The License amendment Request will:

- Supplement TS 3.7.17 by adding a burnup vs. enrichment curve for "3 of 4" storage at uprated conditions, using methods utilized in the CPNPP Analysis of Record.
- Revise TS 3.7.16 to increase the required SFP soluble boron to 2400 ppm
- Provide Administrative Controls in the FSAR (referenced from TS 4.3.1) which manage storage of low margin fuel assemblies.

These controls provide confidence that the 10CFR 50.68 limits remain satisfied.

Questions / Open Discussion