Pre-Submittal Meeting for

St. Lucie Unit 2
Spent Fuel Pool Criticality Analyses

April 30, 2018

Purpose

- **Describe the planned scope and methodology for the proposed St. Lucie Unit 2 Spent Fuel Pool Criticality Analysis License Amendment Request**
  - Partial criticality analysis for cask pit rack only

- **Seek feedback from NRC staff**

Agenda

Current Condition

- New Criticality Analysis
- Technical Specification Changes
- Closing Summary

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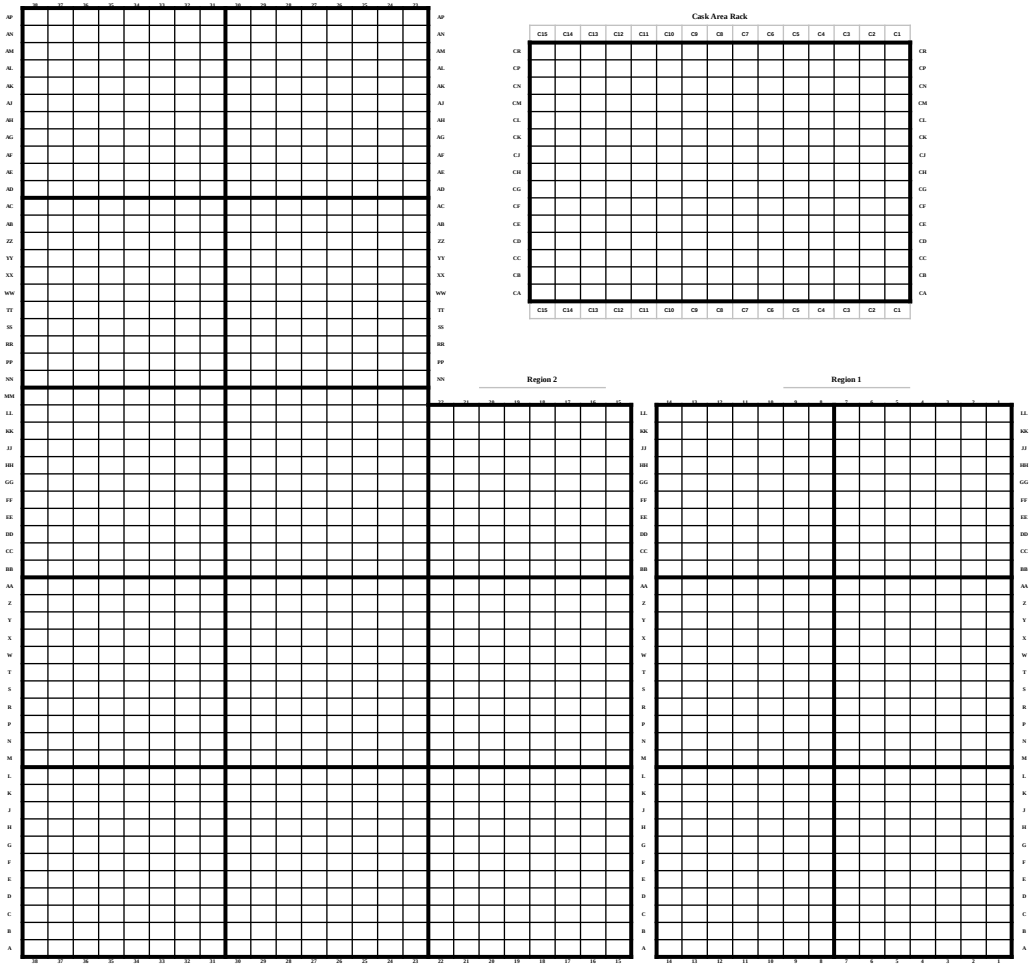
Current Condition – SFP Criticality Analysis

- **Safety Evaluation for St. Lucie Unit 2 Spent Fuel Pool Criticality Analysis LAR was issued in September 2012 (ML12263A224)**
  - Analysis was performed in support of Extended Power Uprate project
- **Analysis performed with CASMO-4 and MCNP5**
- **Analysis complies with DSS-ISG-2010-01**

Current Condition – Spent Fuel Pool

- **Analysis covers three regions in the St. Lucie Unit 2 Spent Fuel Pool**
  - Region 1
  - Region 2
  - Cask Pit Rack



Current Condition – Technical Specifications

- **Technical Specifications contains allowable storage patterns for each region**

Allowable Storage Patterns
(See Notes 1 and 2)

Pattern "A" See Definition 1		Pattern "B" See Definition 2		Pattern "C" See Definition 3	
F	WH	1	1	2	2
WH	F	CEA 1	1	WH	2

DEFINITIONS:

1. Allowable pattern is fresh or burned fuel checkerboarded with completely water-filled cells. Diagram is for illustration only, where F represents Fuel and WH represents a completely water-filled cell.
2. Allowable pattern is placement of fuel assemblies that meet the requirements of type 1 in each 2x2 array location with at least one full-length full-strength CEA placed in any cell. Minimum burnup for fuel assembly type 1 is defined in Table 5.6-1 as a function of maximum initial planar average enrichment. Diagram is for illustration only.
3. Allowable pattern is placement of fuel assemblies that meet the requirements of type 2 in three of the 2x2 array locations in combination with one completely water-filled cell. Minimum burnup for fuel assembly type 2 is defined in Table 5.6-1 as a function of maximum initial planar average enrichment. Diagram is for illustration only.

NOTES:

1. The storage arrangements of fuel within a rack module may contain more than one pattern. Each cell is a part of up to four 2x2 arrays, and each cell must simultaneously meet the requirements of all those arrays of which it is a part.
2. Completely water-filled cells within any pattern are acceptable.

FIGURE 5.6-1
Allowable Region 1 Storage Patterns and Fuel Arrangements

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Current Condition – Fuel Storage Limitations

- **Storage patterns included in criticality analysis were developed based on estimates for future storage needs under EPU conditions**

- **Current storage patterns are not optimal**
  - Reliance on empty cells limits capacity
  - Not aligned with fuel storage needs under EPU conditions

Current Condition – Options

- **NextEra Energy considered various options to improve storage capacity**
  - o new cask pit rack
  - o additional dry storage casks
  - o full criticality re-analysis
  - ➢ partial criticality analysis

Agenda

- Current Condition
- **New Criticality Analysis**
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New Criticality Analysis

- **Our plan is to perform a partial criticality analysis that will fully replace the parts of the current analysis addressing the cask pit rack only**
  - Follows precedent from Duane Arnold criticality analysis
- **All other parts of current analysis remain the same**
  - No changes to current Technical Specifications for Regions 1 and 2
- **Partial criticality analysis will be performed in-house**

New Criticality Analysis

- **Partial criticality analysis will follow**
  - NRC Guidance DSS-ISG-2010-01, “Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools”
  - NEI 12-16, “Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants”

- **Codes will be PARAGON 1.2.0b and MCNP6.1 with ENDF/B-VII.1 cross section library**

- **As for current analysis, the partial analysis will ensure that keff ≤ 0.95 with the pool flooded with borated water, and keff ≤ 1.0 with unborated water, with 95% confidence / 95% probability**

New Criticality Analysis

- **No significant changes or factors to address**
  - No change in fuel design
  - No change in operating conditions
  - No change in rack design
  - No Boraflex
- **Will revalidate all analysis parameters**
  - Reactor depletion parameters
  - Boral areal density
  - Axial burnup shape

New Criticality Analysis

- **Will re-perform all analyses for cask pit rack**
  - Design basis assembly
  - Tolerances
  - Uncertainties
  - Accidents
  - Code validation

- **No interfaces with Region 1 nor Region 2 will need to be addressed**

New Criticality Analysis

- **New storage patterns have been preliminarily developed**
  - 3 out of 4 fresh assemblies, crediting integral burnable absorber
  - 4 out of 4 irradiated assemblies with one CEA, burnup credit
  - 3 out of 4 irradiated assemblies, burnup credit
  - 1 fresh and 2 irradiated assemblies
    - To address interface between first two patterns

F_{BA}	
F_{BA}	F_{BA}

1	1
1	1

	1
F_{BA}	1

New Criticality Analysis

- **For the fresh fuel category crediting integral burnable absorber, it would require n number of rods at a minimum concentration**
  - If condition is not met, fresh assembly would then be stored in current 2 out of 4 configuration in Region 1

New Criticality Analysis - Implementation

- **As done today for all NextEra Energy PWRs, PISCES code will be used as supplementary verification tool**
  - After move plans are prepared and reviewed

- **PISCES code**
  - Determines fuel category for all fuel assemblies & non-fuel items
  - Tracks all inserts and panels (credited and non-credited)
  - Evaluates configuration/proposed moves against Technical Specification requirements
  - Provides summary & graphical output files

Agenda

- Current Condition
- New Criticality Analysis
- **Technical Specification Changes**
- Closing Summary

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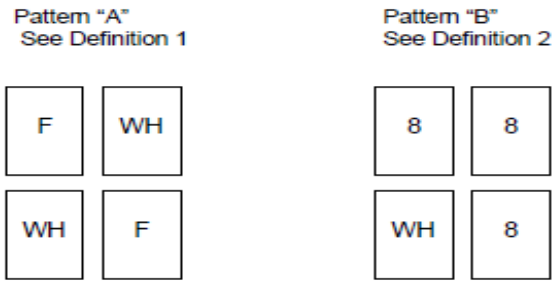
Technical Specification Changes

- **Technical Specification Figures 5.6-4, "Allowable Cask Pit Storage Rack Patterns," will be replaced**
  - New storage patterns, definitions and notes will be added
- **Technical Specification Table 5.6-1, "Minimum Burnup Coefficients," will be modified**
  - Values for fuel type 8 will be modified
  - New fuel types will be added
  - Values for fuel types 1-7 will NOT be modified

Technical Specification Changes

Allowable Storage Patterns
(See Notes 1 and 2)



DEFINITIONS:

1. Allowable pattern is fresh or burned fuel checkerboarded with completely water-filled cells. Diagram is for illustration only, where F represents Fuel and WH represents a completely water-filled cell.

2. Allowable pattern is placement of fuel assemblies that meet the requirements of type 8 in three of the 2x2 array locations in combination with one completely water-filled cell in any location. Minimum burnup for fuel assembly type 8 is defined in Table 5.6-1 as a function of maximum initial planar average enrichment. Diagram is for illustration only.

NOTES:

1. The storage arrangements of fuel within a rack module may contain more than one pattern. Each cell is a part of up to four 2x2 arrays, and each cell must simultaneously meet the requirements of all those arrays of which it is a part.

2. Completely water-filled cells within any pattern are acceptable.

FIGURE 5.6-4
Allowable Cask Pit Storage Rack Patterns

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Technical Specification Changes

TABLE 5.6-1
Minimum Burnup Coefficients

Fuel Type	Cooling Time (Years)	Coefficients		
		A	B	C
1	0	-33.4237	25.6742	-1.6478
2	0	-25.3198	14.3200	-0.4042
3	0	-23.4150	16.2050	-0.5500
4	0	-33.2205	24.8136	-1.5199
	2.5	-31.4959	23.4776	-1.4358
	5	-30.4454	22.7456	-1.4147
	10	-28.4361	21.2259	-1.2946
	15	-27.2971	20.3746	-1.2333
	20	-26.1673	19.4753	-1.1403
5	0	-24.8402	23.5991	-1.2082
	2.5	-22.9981	21.6295	-1.0249
	5	-21.8161	20.5067	-0.9440
	10	-20.0864	19.0127	-0.8545
	15	-19.4795	18.3741	-0.8318
	20	-18.8225	17.7194	-0.7985
6	0	-32.4963	25.3143	-1.5534
	2.5	-30.6688	23.6229	-1.4025
	5	-29.2169	22.5424	-1.3274
	10	-27.2539	21.0241	-1.2054
	15	-25.7327	19.8655	-1.1091
	20	-25.2717	19.5222	-1.1163
7	0	-24.6989	24.1660	-1.2578
	2.5	-23.0399	22.3047	-1.0965
	5	-21.2473	20.6553	-0.9403
	10	-20.1775	19.5506	-0.9015
	15	-19.4037	18.6626	-0.8490
	20	-18.3326	17.7040	-0.7526
8	0	-43.4750	11.6250	0.0000

NOTES:

1. To qualify in a "fuel type", the burnup of a fuel assembly must exceed the minimum burnup "BU" calculated by inserting the "coefficients" for the associated "fuel type" and "cooling time" into the following polynomial function:

   $BU = A + B*E + C*E^2$, where:

   BU = Minimum Burnup (GWD/MTU)

   E = Maximum Initial Planar Average Enrichment (weight percent U-235)

   A, B, C = Coefficients for each fuel type

2. Interpolation between values of cooling time is not permitted.

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- **Closing Summary**

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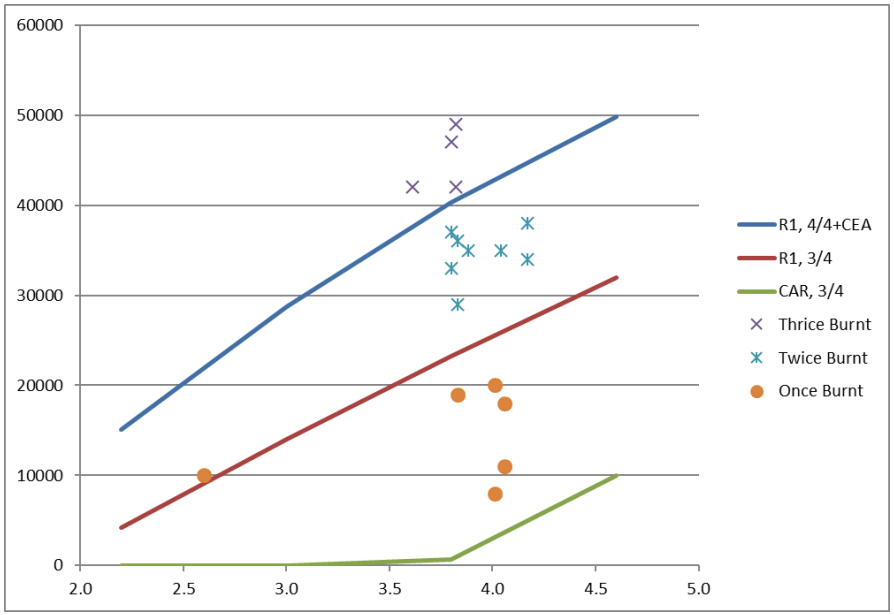
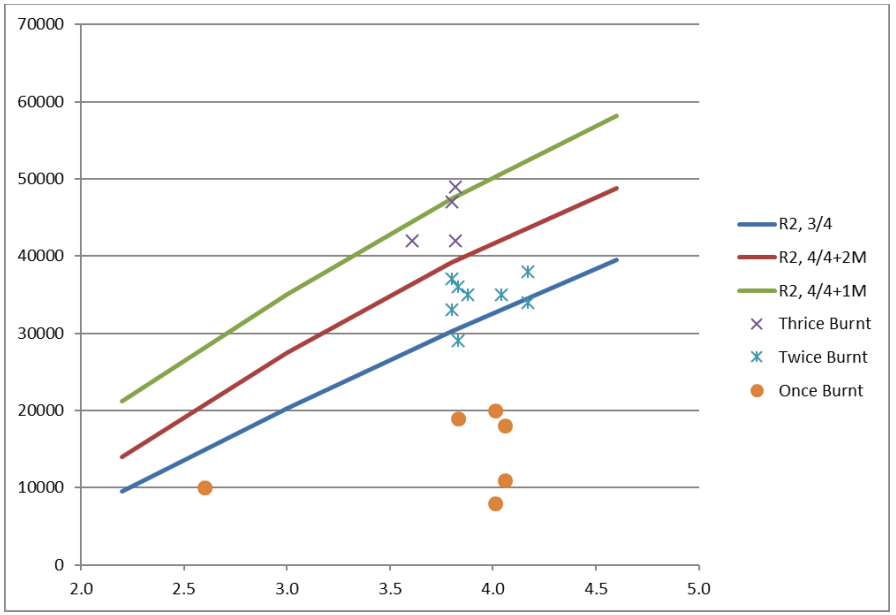
Closing Summary

- **Schedule of LAR submittal**
  - Plan to submit in December 2018
- **Summary of path forward**
- **Review action items**

Backup Slides

Current Condition – Fuel Storage Needs





- **Fresh fuel stored in 2 out of 4 configuration in R1 or CPR**
- **Once burnt fuel stored in 3 out of 4 configuration in CPR**
- **Twice burnt fuel stored in 3 out of 4 configuration in any of the three regions**

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Current Condition – Cask Pit Rack