



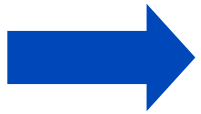
**Pre-Submittal Meeting for
Duane Arnold Energy Center
Spent Fuel Pool Criticality Analyses**

December 10, 2015

Purpose

- **Describe the NextEra Energy (NEE) criticality analyses methodology for the proposed Duane Arnold Energy Center (DAEC) License Amendment Request (LAR)**
- **Seek feedback on the approach from NRC staff**

Agenda



Background

- **Criticality Analysis Methodology**
- **Technical Specification Changes**
- **Closing Summary**

Background – Spent Fuel Pool

- The Duane Arnold Energy Center (DAEC) spent fuel pool is composed of ~50/50 split of original PaR racks and Holtec racks
- Both rack types use Boral as neutron absorber

Rack	Absorber Type	Areal Density (gm-B10/cm ²)	Spacing (in)
PaR	Boral	0.0250 +/- 0.0018	6.625
Holtec	Boral	0.0162 +/- 0.0012	6.060

Background – Current Technical Specification

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fuel storage racks are designed and shall be maintained with:

- a. Fuel assemblies having the following limits for maximum k-infinity in the normal reactor core configuration at cold conditions and maximum lattice-average U-235 enrichment weight percent:

	<u>k-∞</u>	<u>wt %</u>
i) 7x7 and 8x8 pin arrays (Holtec and PaR racks)	≤1.31	≤4.6
ii) 9x9 and 10x10 pin arrays (Holtec racks)	≤1.29	≤4.95
iii) 9x9 and 10x10 pin arrays (PaR racks)	≤1.39	≤4.95

- b. $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in 9.1 of the UFSAR; and
- c. A nominal 6.060 inches for HOLTEC designed and 6.625 inches for PaR designed center to center distance between fuel assemblies placed in the storage racks.

Background – Current State

- **In 2013, DAEC performed BADGER measurements on spent fuel pool PaR racks**
 - Results did not support PaR rack areal density used in spent fuel pool criticality analysis
- **DAEC currently operating with non-conservative TS for PaR racks**
 - Instead of k_{∞} limit of 1.39, using same limit of 1.29 as for Holtec racks
- **DAEC has a commitment to submit a license amendment request with a new spent fuel pool criticality analysis by 3/15/2016**

Agenda

- Background



Criticality Analysis Methodology

- Technical Specification Changes
- Closing Summary

Criticality Analysis Methodology

- **DAEC performing new spent fuel criticality analysis for entire pool**
 - Performing in-house
- **Will follow NRC Guidance DSS-ISG-2010-01, “Staff Guidance Regarding the Nuclear Criticality Safety Analysis for Spent Fuel Pools”**
- **Main codes will be CASMO4 and MCNP6.1 with ENDF/B-VII.1**

Criticality Analysis Methodology

- **Will model most reactive lattice over entire axial length**
 - No blankets
- **Will establish maximum in-core k-infinity so that $k_{95/95} < 0.95$ for normal and accident conditions**

Criticality Analysis Methodology

- **No significant changes or factors to address**
 - No change in fuel design
 - No change in operating conditions
 - No rack design changes
 - No burnup credit
 - No Boraflex
 - No loading patterns
 - No inserts
 - No new SFP loading restrictions
 - No New Fuel Vault analysis

Criticality Analysis Methodology

- **Fuel Assembly Selection (IV.1)**
 - Analysis will address all fuel designs used at DAEC
 - 7 X 7
 - Various 8 X 8 designs
 - Various 10 X 10 designs
- **Depletion Uncertainty (IV.2.a)**
 - Will use 5 percent to cover uncertainty in isotopic number densities, per ISG and Kopp memo

Criticality Analysis Methodology

- **Reactor Parameters (IV.2.b)**
 - Bounding values for moderator temperature, fuel temperature, and power density
 - Evaluated at multiple void conditions
- **Rodded Operation (IV.2.d)**
 - Included with Reactor Parameters

Criticality Analysis Methodology

- **Rack Model (IV.3.b)**
 - Reduced B-10 areal density for PaR racks (lower than minimum)
 - Minimum B-10 areal density for Holtec racks
 - Conservative modeling of small amount of blisters
 - Will demonstrate Holtec rack is limiting, and
- **Normal Conditions (IV.3.d)**
 - Will address normal fuel handling configurations
 - Will address eccentricity, orientation, de-channeled assemblies

Criticality Analysis Methodology

- **Area of Applicability (IV.4.a)**

- HTC experiments will be included
- Will include >200 experiments from International Handbook of Evaluated Criticality Safety Benchmark Experiments, September 2014

- **Trend Analysis (IV.4.b)**

- Will perform for all experiments combined, and also for subsets based on various parameters (e.g., HTC cases, non-HTC cases, square lattices)
 - Biases and uncertainties will be based on most limiting result

Agenda

- Background
- Criticality Analysis Methodology
- ➔ **Technical Specification Changes**
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Technical Specification Changes

- **It if can be supported by analysis results, will simplify TS 4.3.1.1.a to read as follows:**
Fuel assemblies having a maximum k-infinity of *TBD* in the normal reactor core configuration at cold conditions.
- **Otherwise, TS 4.3.1.1.a will remain split by rack design and fuel design, with update limits**
- **Additionally, will modify TS 4.3.1.2 to prohibit loading the New Fuel Vault**

Agenda

- Background
- Criticality Analysis Methodology
- Technical Specification Changes

 **Closing Summary**

Closing Summary

- **Review action items**
- **Summary of path forward**
- **Schedule for LAR submittal**
 - Commitment to submit LAR by 3/15/2016

Questions