UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 5, 2012

LICENSEE: Exelon Generation Company, LLC

FACILITY: QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

SUBJECT: SUMMARY OF FEBRUARY 9, 2012, MEETING WITH EXELON NUCLEAR REGARDING FUTURE SUBMITTAL OF AMENDMENT TO USE NETCO SPENT FUEL POOL INSERTS

On February 9, 2012, a public meeting was held between the U.S. Nuclear Regulatory Commission (NRC) and representatives of Exelon Nuclear at NRC Headquarters, Two White Flint North, 11545 Rockville Pike, Rockville, Maryland. The purpose of the meeting was to discuss the future submittal of an amendment to use NETCO spent fuel pool inserts at Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2. A list of attendees is provided in Enclosure 1.

The licensee presented the information contained in Enclosure 2. The NRC staff provided feedback regarding the scope of information that will likely be required during the acceptance review and detailed review of the future submittal. This information included but was not limited to:

- Addressing the requests for additional information involved with the staff review of the LaSalle County Station submittal regarding NETCO inserts.
- Addressing the requests for additional information involved with the staff review of the Peach Bottom Atomic Power Station submittal regarding NETCO inserts. These requests haven't been issued yet, but are expected prior to the QCNPS submittal.
- BADGER testing results and discussion of RACKLIFE calculations.
- Provide details of how the LaSalle Fast Start Program eliminates the need for a Fast Start Program at QCNPS. Include fuel pool chemistry similarities and differences.
- Misplaced fuel assembly into a restricted position unless physical barriers prevent it.
- Information required for the staff to perform the review discussed in DSS-ISG-2010-01, "Staff Guidance Regarding the Nuclear Criticality Safety Analysis For Spent Fuel Pools" (Agencywide Document and Management System Accession No. ML110620086).

Members of the public were not in attendance. Public Meeting Feedback forms were not received.

Please direct any inquiries to me at 301-415-6606, or Joel.Wiebe@nrc.gov.

Joel S. Wiebe, Senior Project Manager
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-254 and 50-265

Enclosures:
1. List of Attendees
2. Licensee Handout

cc w/encls

LIST OF ATTENDEES

FEBRUARY 9, 2012, PUBLIC MEETING REGARDING THE FUTURE SUBMITTAL FOR THE USE OF NETCO SPENT FUEL POOL INSERTS AND QUAD CITIES NUCLEAR POWER STATION

NRC

A. Pulvirenti
K. Wood
E. Wong
A. Obodoako
J. Zimmerman
J.Wiebe
J. McGhee, by phone
B. Cushman, by phone

Exelon

C. Schneider
R. Carmean
B. Khorsandi (Holtec)
J. Bauer
S. Anton (Holtec)
J. Dunlap
S. Leuenroth (NETCO)
G. Klone, by phone
B. Larkin, by phone
B. McGaffigan, by phone
D. Schumacher, by phone
D. Collins, by phone
B. Brickner, by phone (Holtec)
B. Gutherman, by phone (Gutherman Associates)

Exelon Nuclear

Pre-Submittal Meeting
Neutron Absorbing Inserts

Exelon Generation Company, LLC

Quad Cities Nuclear Power Station
Units 1 and 2

February 9, 2012

Exelon Nuclear

Agenda

Objectives	Joe Bauer
LAR Overview	Joe Bauer
NETCO-SNAP-IN® Rack Inserts	Rosanne Carmean Scot Leuenroth
Criticality Analysis	Dr. Stefan Anton
Interim Actions	Rosanne Carmean
Technical Specification Changes	Rosanne Carmean
Summary, Questions, NRC Feedback	Joe Bauer

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Objectives

- ✓ Provide the NRC with a clear summary of the LAR scope, content and analysis methodology
- ✓ Obtain NRC feedback
  - LAR content
  - Proposed dates for LAR submittal and approval
  - Identify LAR gaps and follow-up actions

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LAR Overview

- ✓ Purpose: Submit a LAR to use NETCO-SNAP-IN® inserts to permanently resolve the spent fuel pool (SFP) Boraflex degradation issue without crediting Boraflex
- ✓ Submittal target date: June 2012
- ✓ Approval target date: June 2013 (requested)
- ✓ BADGER Testing and RACKLIFE model calculations being used to confirm TS compliance and trend Boraflex degradation
- ✓ Clean pool insert installation tests scheduled for February 2012
- ✓ Insert installation testing scheduled for summer 2012 at Quad Cities
- ✓ Rack installation performed in accordance with 10 CFR 50.59
- ✓ Installation schedule prioritized based on projected Boraflex degradation from RACKLIFE model. Preliminary installation periods have been established:
  - Unit 1: 2012 – 2015
  - Unit 2: 2013 – 2016
- ✓ No credit taken for NETCO inserts until LAR approved by NRC

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LAR Overview – Lessons Learned

- ✓ Peach Bottom submitted License Amendment Request (LAR) in June 2008 to address the spent fuel pool issues
  - The long-term Criticality Analysis credited Boraflex; Unacceptable; LAR withdrawn
- ✓ LaSalle submitted LAR to use NETCO-SNAP-IN® neutron absorbing inserts on October 5, 2009
  - Did not submit an interim criticality analysis for Boraflex
  - Resulted in a required accelerated insert installation
  - LAR subsequently approved January 28, 2011 with License Conditions restricting use of SFP cells without NETCO inserts
- ✓ Peach Bottom submitted new LAR on November 3, 2011 following LaSalle's LAR (using NETCO-SNAP-IN® inserts)
  - Submittal included interim criticality analysis for Boraflex
  - Acceptance Review Supplemental Information requested to address seismic and structural issues

LAR Overview – Lessons Learned (continued)

- ✓ Criticality Analysis
  - Holtec International will perform the Quad Cities interim Boraflex and NETCO insert criticality analyses
- ✓ Quad Cities LAR will:
  - Analysis will bound fuel conditions for the planned power uprate
  - Utilize the recent Peach Bottom LAR as a template
  - Utilize NETCO-SNAP-IN® inserts
  - Include an interim criticality analysis crediting Boraflex
    - Appropriately model Boraflex parameters
  - Include a revised criticality analysis crediting NETCO inserts
  - Address seismic and structural issues
  - Include License Conditions similar to the Peach Bottom LAR

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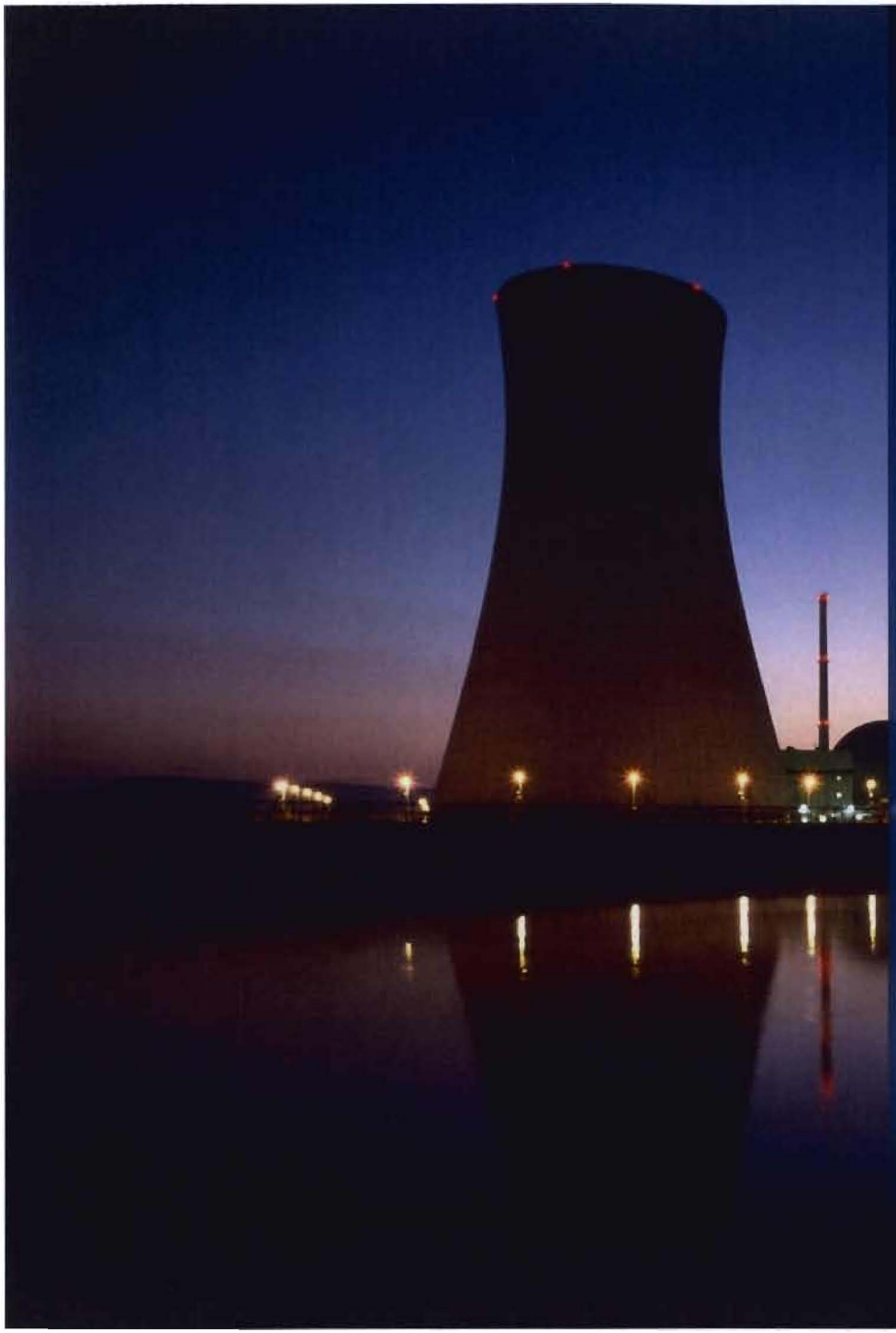
LAR Overview – Submittal Outline

- ✓ Technical Evaluation of Proposed Changes
- ✓ Mark-up of Proposed TS Pages
- ✓ Figure of NETCO-SNAP-IN® Insert
- ✓ NETCO Report, Material Qualification of Alcan
- ✓ Criticality Analysis with Rack Inserts (proprietary and non-proprietary versions)
- ✓ Criticality Analysis with Boraflex (proprietary and non-proprietary versions)
- ✓ Example of Completed Rack Module with Inserts
- ✓ Summary of Commitments



CURTISS WRIGHT
Flow Control Company
NETCO

NETCO-SNAP-IN® Rack Inserts: Neutron Poison Replacement for Fuel Storage Applications

Quad Cities Pre-Submittal Meeting,
2/9/2012

K. Scot Leuenroth
Principal Engineer

What are NETCO-SNAP-IN® Inserts?

Replace Lost Reactivity Hold-Down

Made of Al/B_4C Composite Material

NETCO-SNAP-IN®

Extends Useful Storage Rack Life

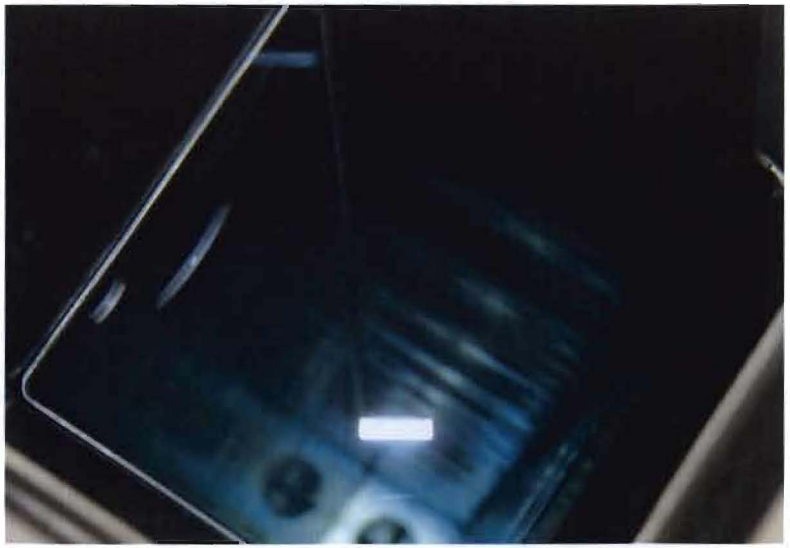
Minimal Impact on Fuel Move Operations

Project Overview

- K. Lindquist Issued U.S. Patent 6,741,669 B2 in 2004 for Absorber Insert Design
- Original Demonstration Program was a Joint Venture Between NETCO and Exelon Generation Company
- Prototype Testing and On-Site Demonstration Performed for LaSalle and Peach Bottom
- Testing Rigor to Continue for Quad Cities Inserts.
- First Installation at Exelon's LaSalle Station in 2007 (Three inserts installed in Demonstration Program)
- Full Scale Insert Installation at LaSalle Unit 2 Completed in 2011 with 4022 Spent Fuel Assembly Storage Locations

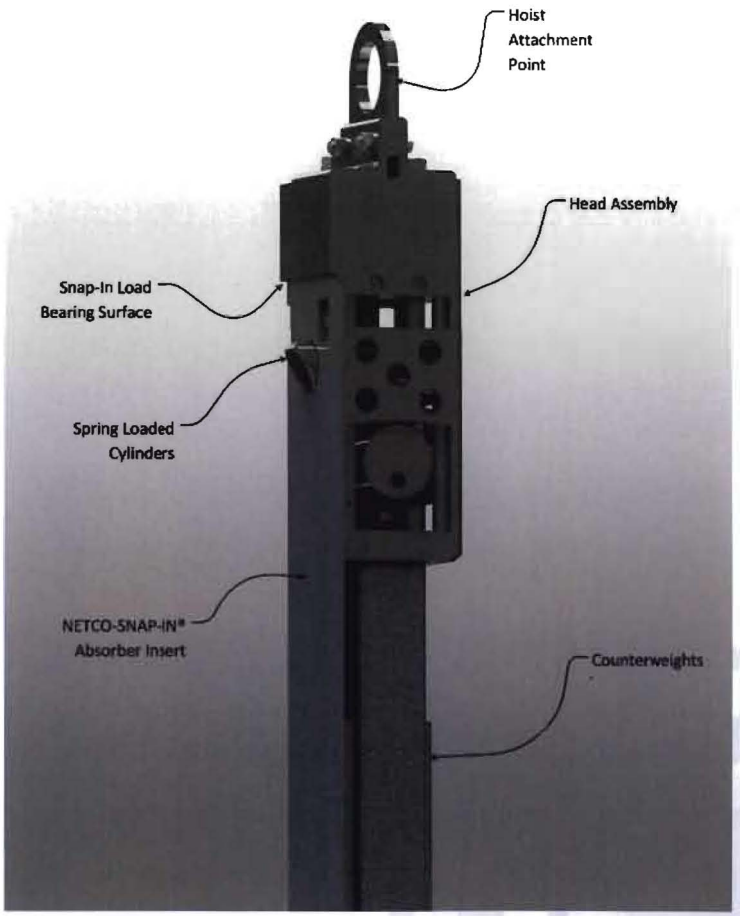
Description

- Al-1100/B_4C Composite, Provided by Rio Tinto Alcan, Formed Into a Chevron Shaped Rack Sleeve
- Installed via Custom Tool from the Refueling Bridge
- Chevron is Compressed During Installation; Friction and Compression Forces Hold it in Place



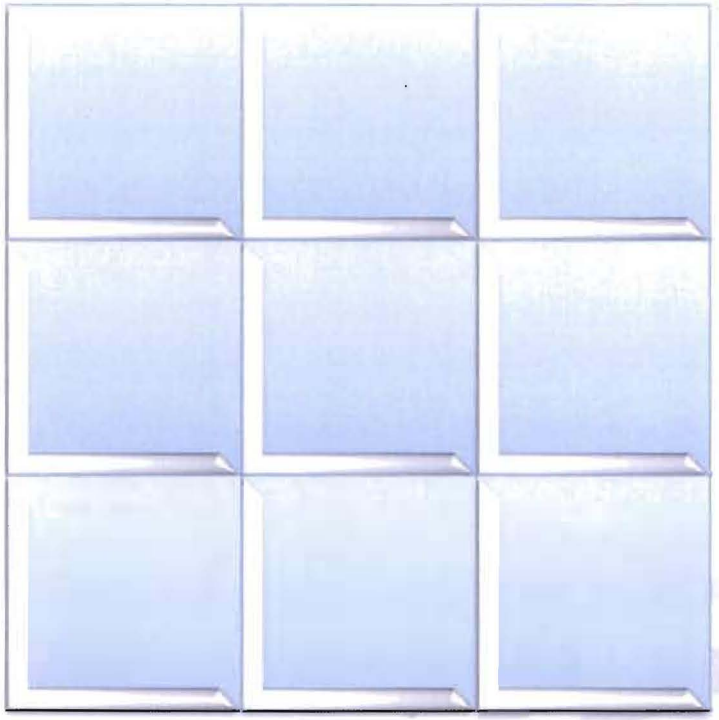
Key Features

- Simplicity of NETCO-SNAP-IN®
  - Standard fabrication methods used to form Al/B_4C composite material
- Simplicity of Installation Tool
  - Installation force provided by tool weight alone; no electrical or hydraulic systems
- Once Installed, NETCO-SNAP-IN® Inserts are an Integral Part of the Rack Modules



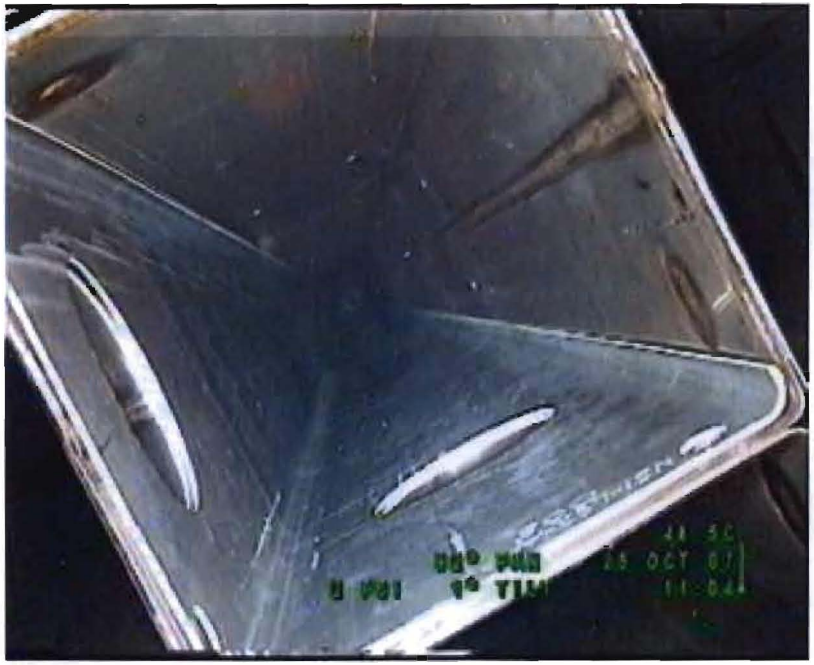
Application

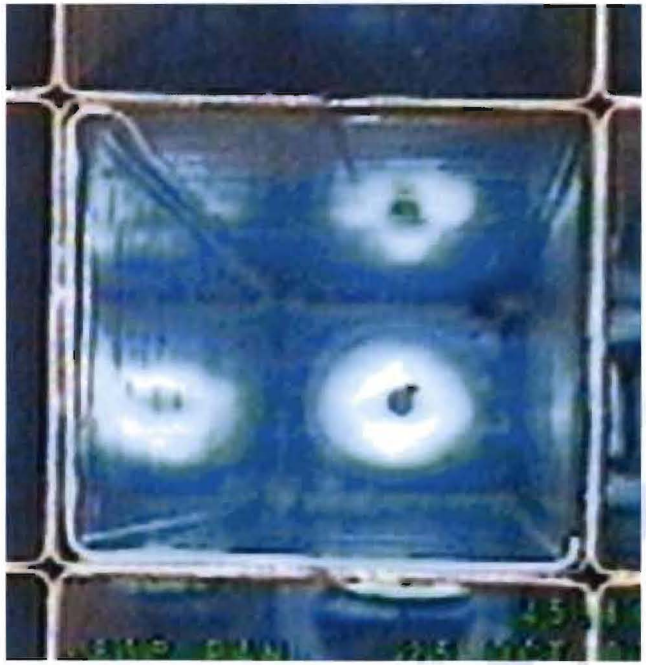
- When Placed in Each Storage Location, the NETCO-SNAP-IN® Inserts Supplement the Neutron Poison in the Existing Racks
- Once Installed, Fuel Can Be Moved In and Out of the Storage Locations as Usual
- Insert Installation Complete at LaSalle Unit 2
- Prior Installation Experience and Lessons Learned are Being Applied at Quad Cities



LaSalle Installation

- No clearance issues were encountered during installation; further use has validated acceptable clearance with irradiated fuel
- Same manufacturing technique used to fabricate the Quad Cities inserts





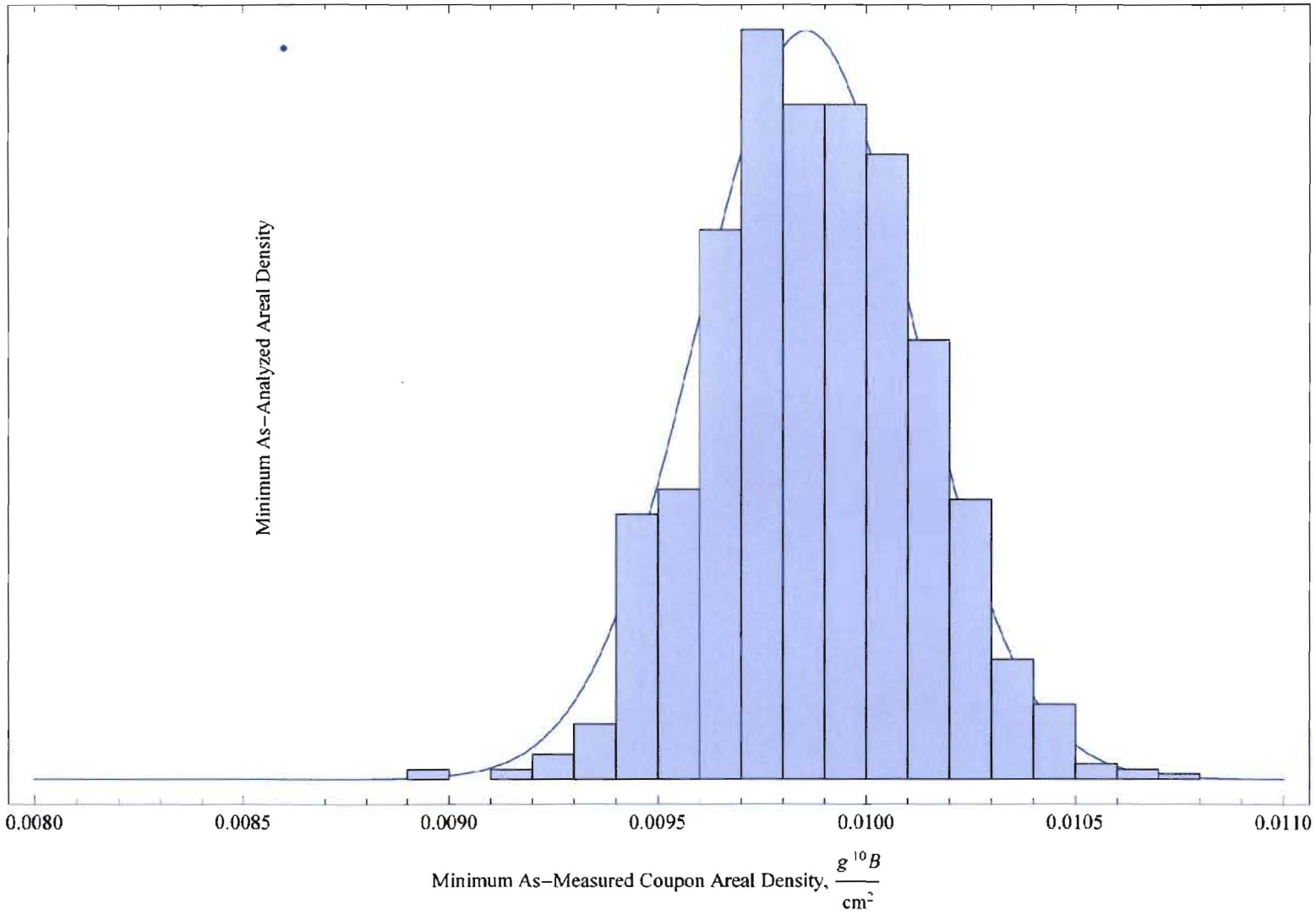
Insert Being Installed in Location B17 of the LaSalle Unit 2 Spent Fuel Pool

Borated Aluminum Material

- Material Qualification of Alcan Through Accelerated Corrosion Testing
  - Pre-test characterization
  - Post-test characterization
  - Accelerated corrosion environment
  - 2000, 4000, 6000 and 8000-hour test results
- Results Show Corrosion Rates Within Measurement Uncertainty of Zero for 8000-hr Tests
- Stability of B-10 Areal Density Values Throughout Test
- Fast-Start Results Show Consistency with Accelerated Test Predictions, Showing No Negative Change in Areal Density

Material Performance (LaSalle)

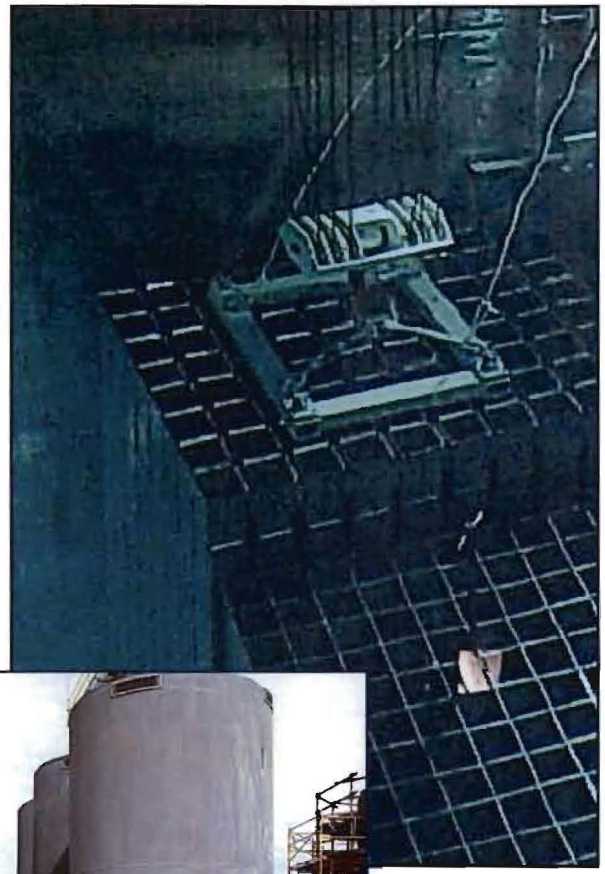
Alcan Material Shows Consistent Performance in Neutron Attenuation Tests



Material Surveillance

- Coupon Surveillance program will be similar to LaSalle
- Fast Start Program
  - Results of the LaSalle Program eliminate need for fast start program at Quad Cities
- Long Term Surveillance Program
  - General, Bend and Galvanic coupons will be included in surveillance program
  - Pre-Characterizations will include visual, dimensional, weight and areal density testing
- Removal Inspection
  - Insert with the highest fuel move frequency will be removed every 10 years to inspect for wear and overall performance

Quad Cities Spent Fuel Pool Criticality Analysis



NRC Pre-Submittal Meeting

Dr. Stefan Anton

February 9, 2012

HOLTEC INTERNATIONAL

Guidance and Regulations

GDC 62: Prevention of Criticality in Fuel Storage & Handling

"Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations."

10 CFR 50.68 (b) (4)

The k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with unborated water.

$$K_{max(95/95)} \leq 0.95$$

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Basic Analysis and Requirements

$$K_{max(95/95)} = K_{\text{Nominal}} + \Delta K_{\text{Bias}} + \Delta K_{\text{Tolerance+Uncertainty}}$$

$$\Delta K_{Bias} = \sum_{i=1} \Delta K_{Bi}$$

Contribution from Biases

$$\Delta K_{Tolerance+Uncertaint\,y} = \sqrt{\sum_{i=1} \Delta K_{Ti}^2 + \sum_{i=1} \Delta K_{Ui}^2}$$

Contribution from Independent Tolerances and Uncertainties

- All storage rack locations assumed to contain identical fuel assemblies at their most reactive state as a function of exposure
- Consideration given to all credible abnormal conditions, manufacturing tolerance implications, and computational uncertainties

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Computational Tools and Validation

CASMO-4

Studsvik 2-D lattice physics code

Determines exposure dependent, pin-by-pin isotopic fuel compositions

Utilizes ENDF/B-V cross-section data

Not used for k-inf calculations

MCNP5

LANL code

Calculates *in-rack* k-calc values

Uses CASMO-4 pin-specific isotopic specifications to establish peak reactivity

Utilizes ENDF/B-VII cross section data

95/95 Bias and bias uncertainty quantified and applied standard benchmark experiments (including HTC)

Uncertainties applied consistent with previous Holtec analyses, including:

- Depletion Isotopics Uncertainty
- Fission Product/Lumped Fission Product Uncertainty

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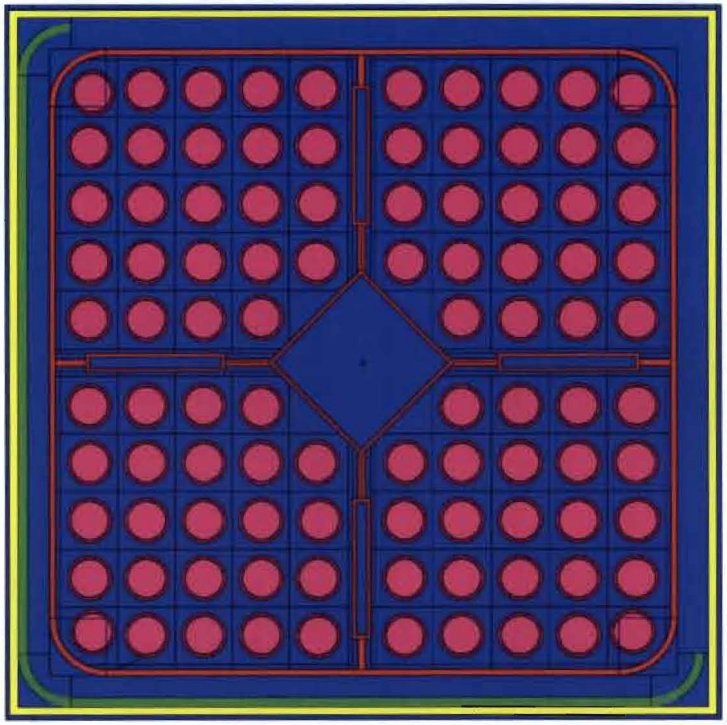
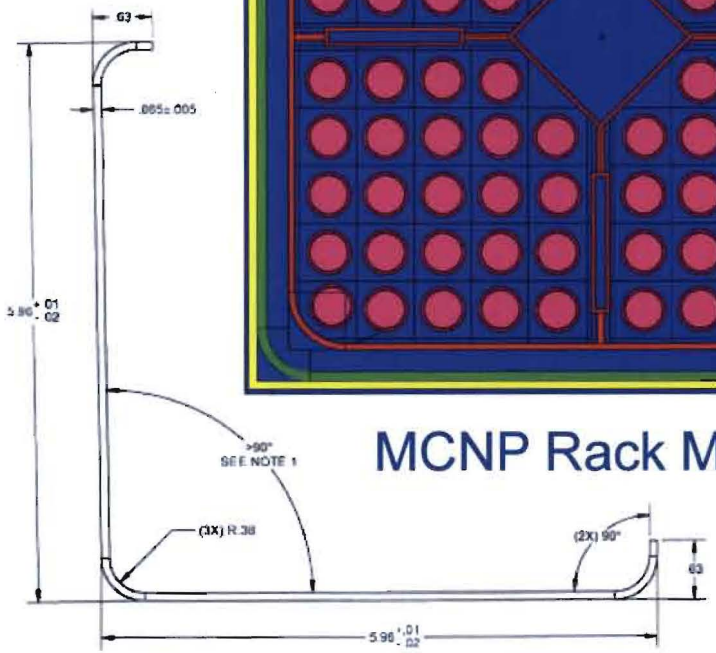
Spent Fuel Rack Cell Model – Rack Inserts



MCNP Rack Model



Rack Insert Schematic

- No credit taken for B_4C in Boraflex – Panels are modeled as water
- No credit taken for lateral neutron leakage
- Design basis analyses assume a single lattice design at peak reactivity for full bundle height in every storage location
- Stainless steel rack cell modeled explicitly
- Assumes a single rack insert with a minimum (95/95) areal density of 0.0116 g B-10/cm^2 in every accessible storage cell

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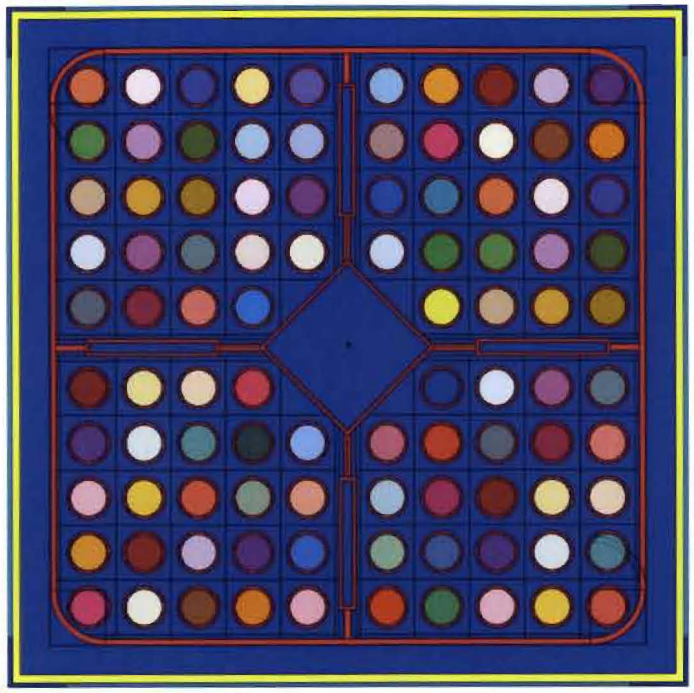
Spent Fuel Rack Cell Model - Boraflex



MCNP Rack Model

- Credit taken for degraded Boraflex – model includes various degradation mechanisms
- Only used for racks without inserts
- No credit taken for lateral neutron leakage
- Design basis analyses assume a single lattice design at peak reactivity for full bundle height in every storage location
- Stainless steel rack cell and degraded Boraflex modeled explicitly

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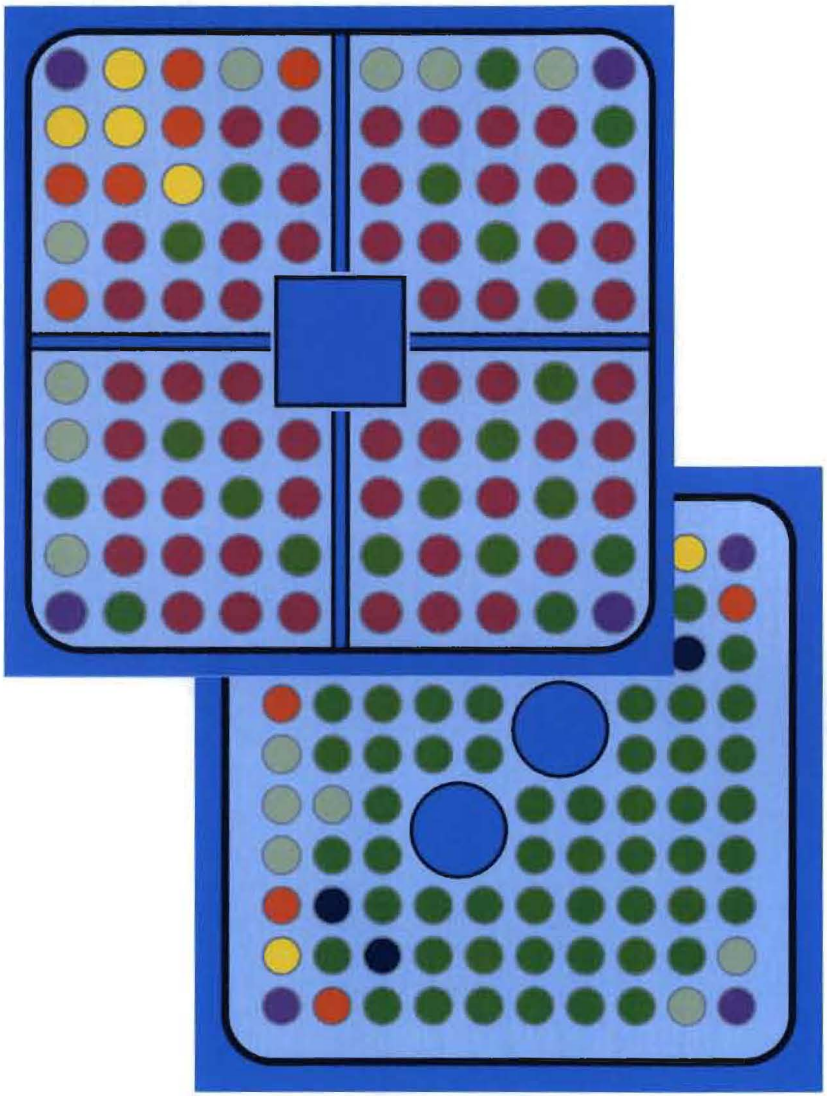
Design Basis Bundle Selection

- Optima 2 fuel is shown to bound all past and current fuel types in the Quad Cities SFP
- Each Optima 2 lattice is analyzed independently
- The lattice resulting in the highest in-rack k-eff is used to:
  - Define nominal in-rack k-eff value
  - Perform bias, tolerance, uncertainty sensitivity, interface, accident evaluations



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Storage Scenarios Addressed

Credible Normal Conditions

- Final Pool Configuration (Inserts only)
- Interim Pool Configuration (Inserts and Degraded Boraflex)
- Fuel Assembly Channeling (except for Optima 2 assembly)
- Eccentric Positioning
- Moderator Temperature
- Bundle Orientation

Credible Abnormal Conditions

- Dropped Fuel Assembly
- Mislocated Fuel Assembly
- Missing Rack Insert

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Storage Scenarios Addressed

Manufacturing Tolerances, Including

- Fuel Enrichment
- Fuel Pellet Density
- Gadolinium Content
- Rod Cladding Thickness
- Rack Wall Thickness
- Rack Pitch
- Rack Insert Thickness
- Rack Insert B-10 areal density

Interface Effects

- Racks with Inserts Adjacent to Storage Modules without Inserts
- Storage Cells without a Poison Panel on Every Side (on module edge or next to an inaccessible location)

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Compliance with ISG and IN

DSS-ISG-2010-01

- Fuel Assembly Selection
- Depletion Analysis
- Criticality Analysis
- Criticality Code Validation

Information Notice 2011-03

- Monte Carlo Bias Uncertainty
- Depletion Uncertainty

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Summary

- Analysis performed will fulfill requirements of 10 CFR 50.68 and GDC 62 with consideration given to DSS-ISG-2010-01 and IN-2011-03
- Consideration given to all credible abnormal conditions, manufacturing tolerance implications, and computational uncertainties in determining maximum in-rack eigenvalue
- Spent fuel racks will be demonstrated to remain >5% subcritical for storage of current and previous fuel types with defined enrichment and Gadolinium distribution
- Analyses will include final and interim SFP configuration

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Interim Actions

- ✓ RACKLIFE model revised every year to incorporate updated assembly power history, fuel movement, and pool chemistry
  - RACKLIFE model is also benchmarked against BADGER results following each BADGER campaign
  - Current RACKLIFE model conservatively bounds peak degradation values from most recent 2009 BADGER testing
- ✓ RACKLIFE results compared against minimum allowable areal density
- ✓ BADGER testing is performed every three years to validate the RACKLIFE model
  - BADGER results are compared against minimum allowable areal density
  - Most recent BADGER tests performed in November 2009 (both units)
  - BADGER campaign performed in January; results pending

Interim Actions

- ✓ Interim Boraflex analysis
  - Similar to interim analysis performed for Peach Bottom
  - Will address Boraflex degradation mechanisms and issues
    - Shrinkage and Edge Dissolution
    - Undetected Cracking
    - Gaps
    - Experimental and Measurement Uncertainties (from BADGER and RACKLIFE methodology)
    - Boraflex particle self-shielding
    - Non-uniform panel thinning
    - Effects of a seismic event on degraded Boraflex
- ✓ Analysis will establish the degradation acceptance criteria and confirm TS compliance
  - RACKLIFE and BADGER results will be compared to the minimum acceptable areal density analyzed

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Technical Specification Changes

- ✓ Unit 1 and Unit 2 TS will be the same
- ✓ Proposed TS similar to LaSalle with inserts
- ✓ TS 4.3.1.1 – include rack inserts as part of design
- ✓ TS 4.3.1.1.a. – in-rack keff ≤ 0.95, including allowance for uncertainties described in the UFSAR (no change)
- ✓ TS 4.3.1.1.b. – nominal center-to-center distance between assemblies of 6.22 inches (no change)
- ✓ TS 4.3.1.1.c. (new) – rack inserts will have a minimum certified B-10 areal density of 0.0116 g/cm2
- ✓ License Conditions – will establish restrictions on using SFP storage cells without NETCO Inserts

Exelon Nuclear

Summary
Questions
NRC Feedback

Please direct any inquiries to me at 301-415-6606, or Joel.Wiebe@nrc.gov.

Joel S. Wiebe, Senior Project Manager **/RA/**
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-254 and 50-265

Enclosures:
1. List of Attendees
2. Licensee Handout

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OFFICE	LPL3-2/PM	LPL3-2/LA	LPL3-2/BC	LPL3-2/PM
NAME	JWiebe	KGoldstein	JZimmerman	JWiebe
DATE	3/01/12	3/01/12	3/05/12	3/05/12

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