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VSC-24 MSB Transportation Licensing Presubmittal Meeting

February 2, 2005

Presented by:
James Hopf
Steven Sisley

Agenda

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Criticality Update

- Results of Analyses Performed
  - Isotopic validation (adjustment factors)
  - Horizontal burnup slant effect (Δk_{eff})
  - Criticality validation (USL functions)
- Proceeding Forward – Open Issues
  - Use of more realistic conservative methods
  - Estimate of level of conservatism in BUC analyses
  - Other methodology issues

Schedule Update

Attachment 2

Isotopic Validation Analysis

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Code Benchmark & Isotopic Adjustment Factor Det.

- SAS2H (SCALE-4.4) Code
- 44-group ENDF/B-V cross-section library

Benchmark Performed Using NUREG-6811 Methodology and Data

- "Bounding" isotopic adjustment factor calculation method
- 56 actinide and 19 fission product benchmarks

Limited Isotope Set Evaluated

- 12 actinides
- 12 fission products
- ^{95}Mo, ^{101}Ru, ^{103}Rh, and ^{109}Ag not modeled (no data)

Isotopic Validation Analysis (Con't)

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Differences from ORNL Analyses

- By-cycle temperature & density data
- Sub-cycle library updates
  - nlibs/cycle > 1
  - Once every 5 GWd/MTU or less
- Partially Inserted Absorbers

Consistent w/ Main Analysis Method

Differences from ORNL Results

Method/Results Extremely Conservative

- More Realistic Methods May be Used (discussed later)

Isotope Adjustment Factors

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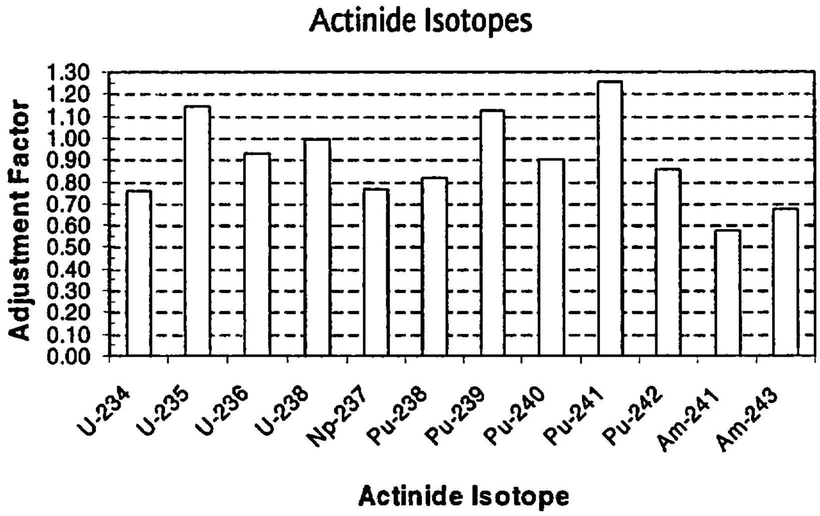

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Isotope Adjustment Factors

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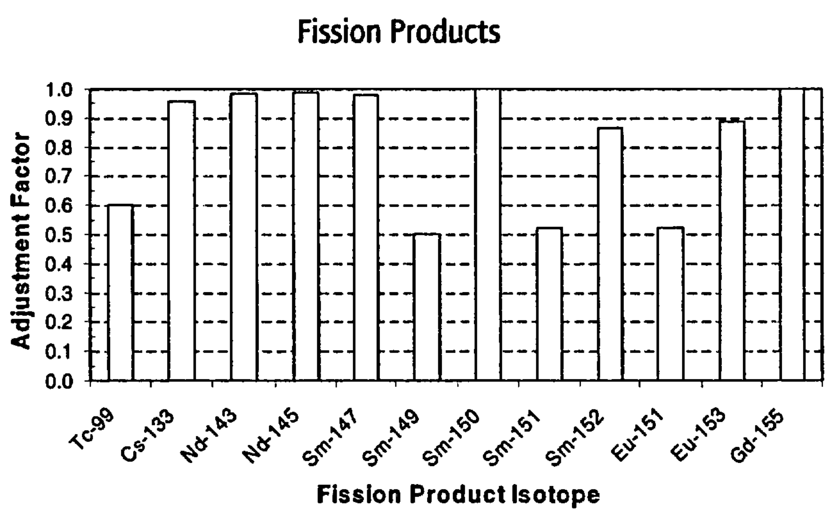

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Horizontal Burnup Δk Analysis

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Background

- Use of published data discussed at NRC meeting (8/12/04)
- NRC questioned applicability of data to MSB
  - Suggested additional analyses to either demonstrate applicability or perform analysis specifically for MSB

MSB-Specific Analyses Performed

- Most reactive assembly slant orientations determined
- All four assembly types explicitly evaluated
  - BW 15x15, CE 15x15, CE 16x16, W 14x14
- Increase in k_{eff} calculated vs. fuel parameters
  - Burnup, initial enrichment, cooling time

Horizontal Burnup Δk Analysis (Con't)

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Analysis Methodology

- Based on NUREG-6800
- Bounding Slant Data from DOE/RW-0496 used for all fuel
  - 25% for BU < 18 GWd/MTU
  - 20% for BU = 18-30 GWd/MTU
  - 15% for BU > 30 GWd/MTU
- Same Codes/Methods as Primary Analyses
- 3 Slant Configurations Evaluated
  - Half of Array (diagonal) at Low and High BU
  - Max. Quadrant Deviation Assumed over Half of Assembly
- Batch-Specific or Bounding Range of Parameters
- Axial Burnup Profile Not Modeled
  - Conservatively increases Δk_{eff}
- Analyses Performed w/ and w/o Isotopic Adjust Factors

Horizontal Burnup Δk Analysis (Con't)

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Summary of Results

- Different Most-Reactive Configuration (vs. NUREG-6800 32-element cask)
- Δk_{effs} Range from ~0.8-1.6%
  - Substantially higher than NUREG-6800 (3-4 times)
  - Lack of poison most likely cause
- Primarily Increases w/ BU and Slant %
- Little if Any Variation w/ Initial Enrichment
- Δk_{eff} Increases Very Slowly w/ Cooling Time
- Isotopic Adjustment Factors Yield Small Reduction in Δk_{eff}

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Criticality Benchmark

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38 Fresh UO_2 Benchmarks

- From Latest Revision of VSC-24 Storage Licensing Analysis

24 Fresh MOX Fuel Benchmarks

- From FuelSolutions Licensing Analyses

45 Burned (UO_2) Fuel Benchmarks

- From Published DOE CRC Benchmarks

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Criticality Benchmark (Con't)

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Benchmark Analysis Methodology

- K_{eff} Results Taken from the 107 Existing Benchmarks
- Results Combined/Processed to Determine USL
- NUREG-6361 Methodology Employed
  - Set of Key System Physical Parameters Selected
  - Parameter Values Taken from Reference Docs.
  - Regression vs. Each Parameter Performed
  - Uncertainty Factor and Margin Added to Yield USL
- "Best Estimate" (full FP) CRC K_{eff}s Used

Criticality Benchmark (Con't)

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Selected Physical Parameters

- Rod Pitch
- Water-to-Fuel Volume Ratio
- Hydrogen-to-Fissile Isotope Atom Ratio*
- Initial Fissile Isotope wt%
- Depleted Fissile Isotope wt%*
- Plutonium Percentage of Fissile Material*
- Average Burnup (CRC data only)
- Average Energy of Neutrons Causing Fission

(* Data Available for Only 12 of the 45 CRCs)

Criticality Benchmark (Con't)

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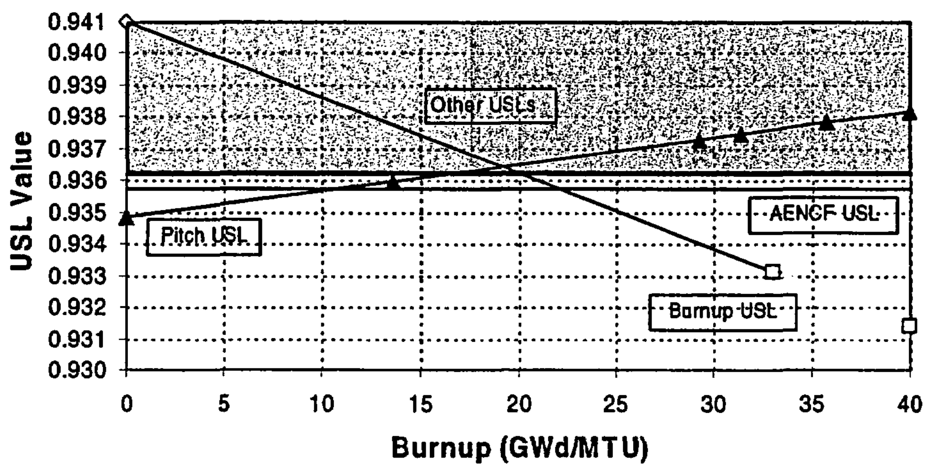
Summary of Results



Effect of Limited Isotope Set

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Separate CRC Benchmarks

- "Principle" Isotope Set (29 isotopes vs. 85)
- 2nd Set of MCNP Calculated k_{eff} Values

Regression Performed for Alternate K_{eff}s

Compared to "Best Estimate" Regression

Δk_{eff} vs. Burnup Coefficient Determined

Used as Part of Estimate of Conservatism

Use of Realistic-Conservative Methods

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Current Analyses Based on Standard Conservative Methods
- Most MSBs Will Not Pass at 0.95

- Two Different Alternative Methods Proposed
  - Advanced Statistical Methods (NUREG-6811)
    - "Bounding Method" Isotopic Adjustment Factors Increase K_{eff} by ~4-6%
    - Advanced Methods May Reduce ΔK_{eff} by Approximately One-Half
    - Criterion of 0.98 Probably Still Needed
      - Reduced Administrative Margins Supported by PRA Evaluations
  - Integral Benchmark (CRCs)
    - Casks Expected to Pass at 0.95

Estimate of Conservatism

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Isotopic Adjustment Factor Conservatism
- Recalculate Cask K_{eff} w/o Isotopic Adjustments

Limited Isotope Set Conservatism
- Apply ΔK_{eff} vs. BU Function (subtract ΔK_{eff})

Horizontal Slant (qualitative)
- Half vs. Quadrant of Assembly
- All in Worst Orientation Assumption

Compare Resulting Margin to Base Case

Other Issues

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$^{241}Pu/^{241}Am$ Treatment

Cross-Sections

- Most Up to Date or Consistent w/ CRCs?

Extrapolation of Burnup USL

Schedule Update

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- Submit LAR to NRC: September 2005
- Receive RAIs: February 2006*
- Submit RAI Responses: May 2006*
- Obtain NRC Approval: September 2006*

* Estimates

Isotopic Validation Analysis

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Actinides	Fission Products
^{234}U	^{99}Tc
^{235}U	^{133}Cs
^{236}U	^{143}Nd
^{238}U	^{145}Nd
^{237}Np	^{147}Sm
^{238}Pu	^{149}Sm
^{239}Pu	^{150}Sm
^{240}Pu	^{151}Sm
^{241}Pu	^{152}Sm
^{242}Pu	^{151}Eu
^{241}Am	^{153}Eu
^{242}Am	^{155}Gd

Assembly Orientation Pattern 1

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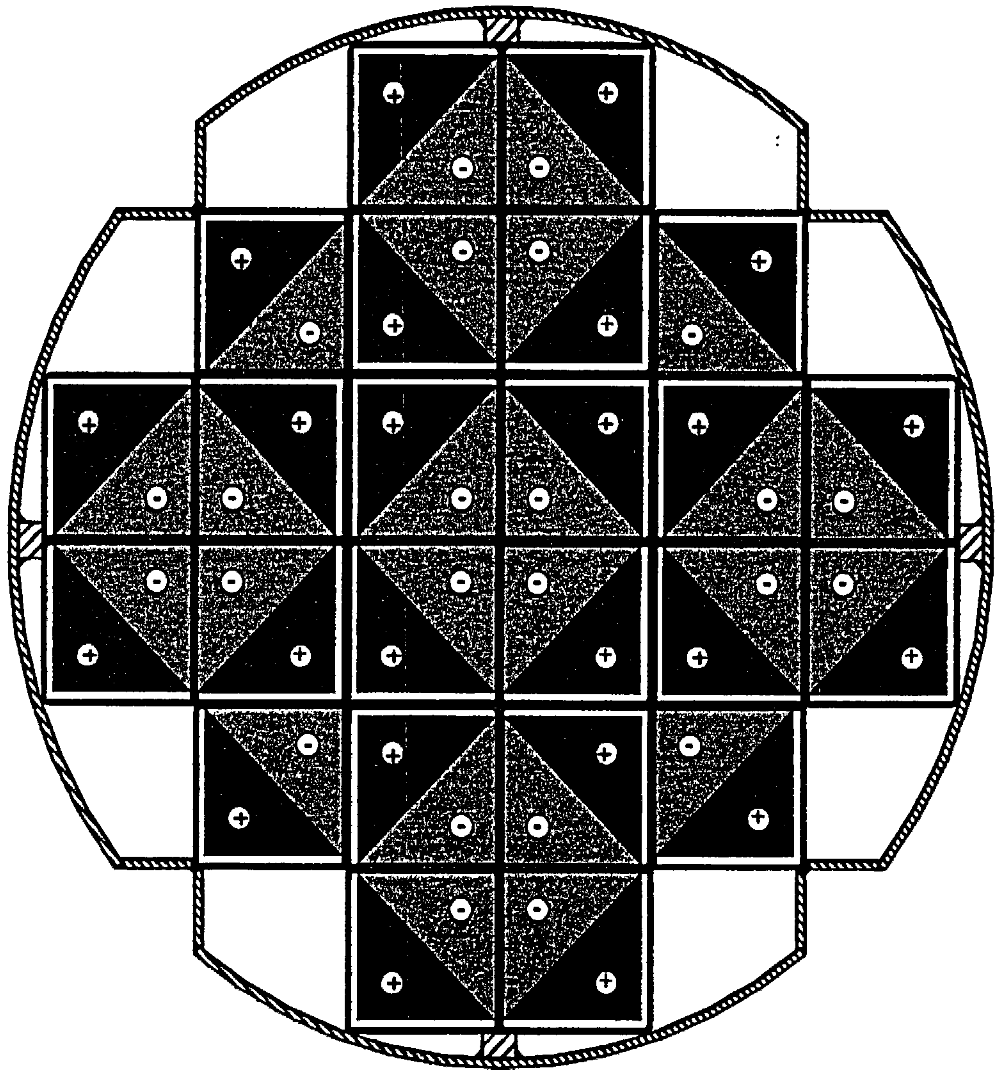

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Assembly Orientation Pattern 2

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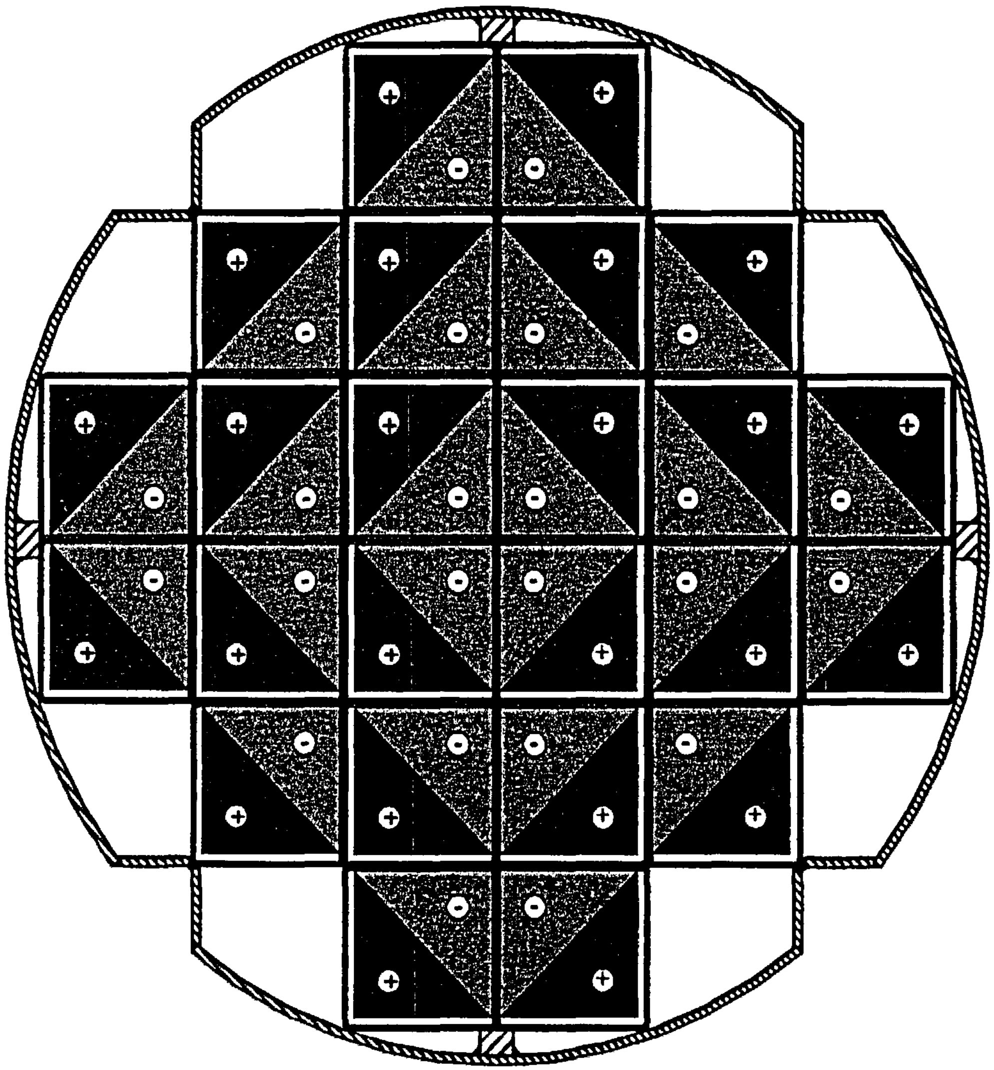

Assembly Orientation Pattern 3

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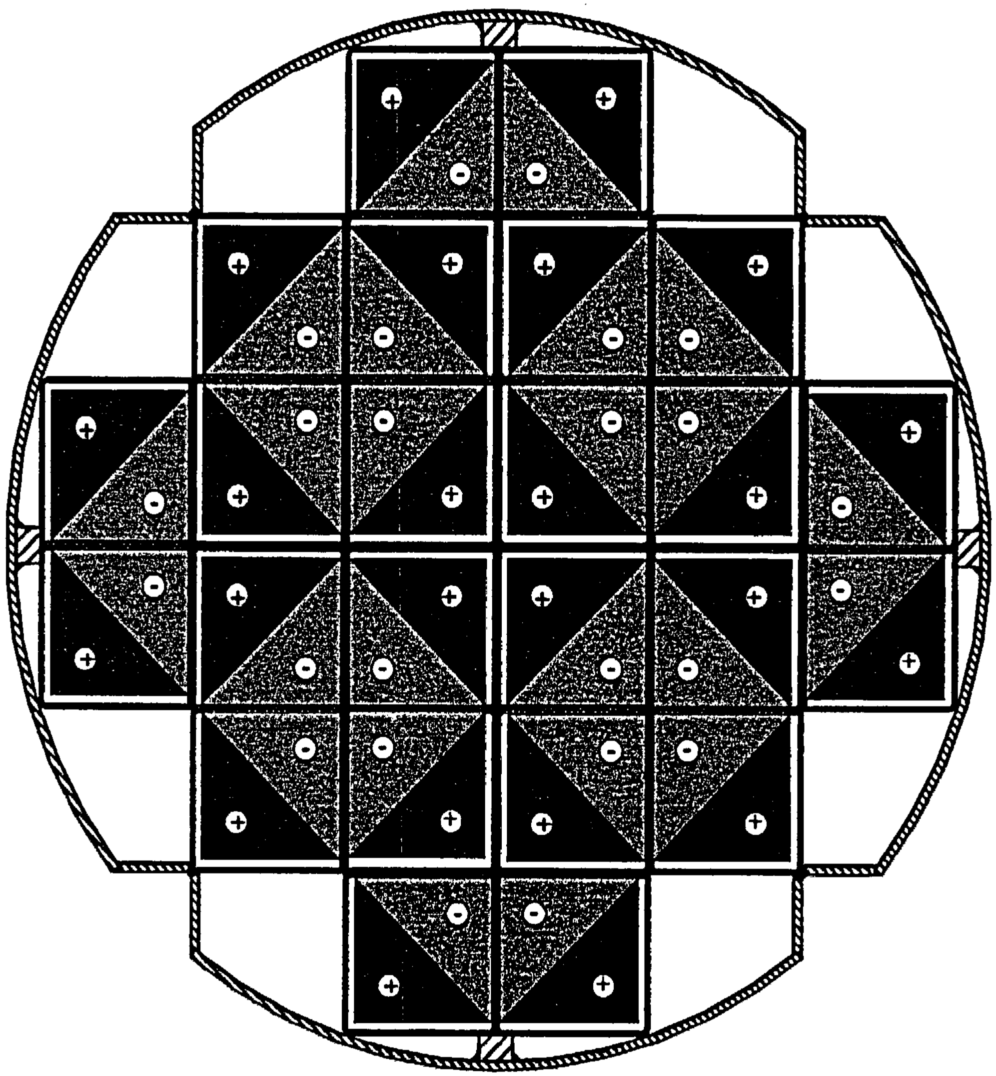

Horizontal Slant ΔK_{eff} Results (Typ.)

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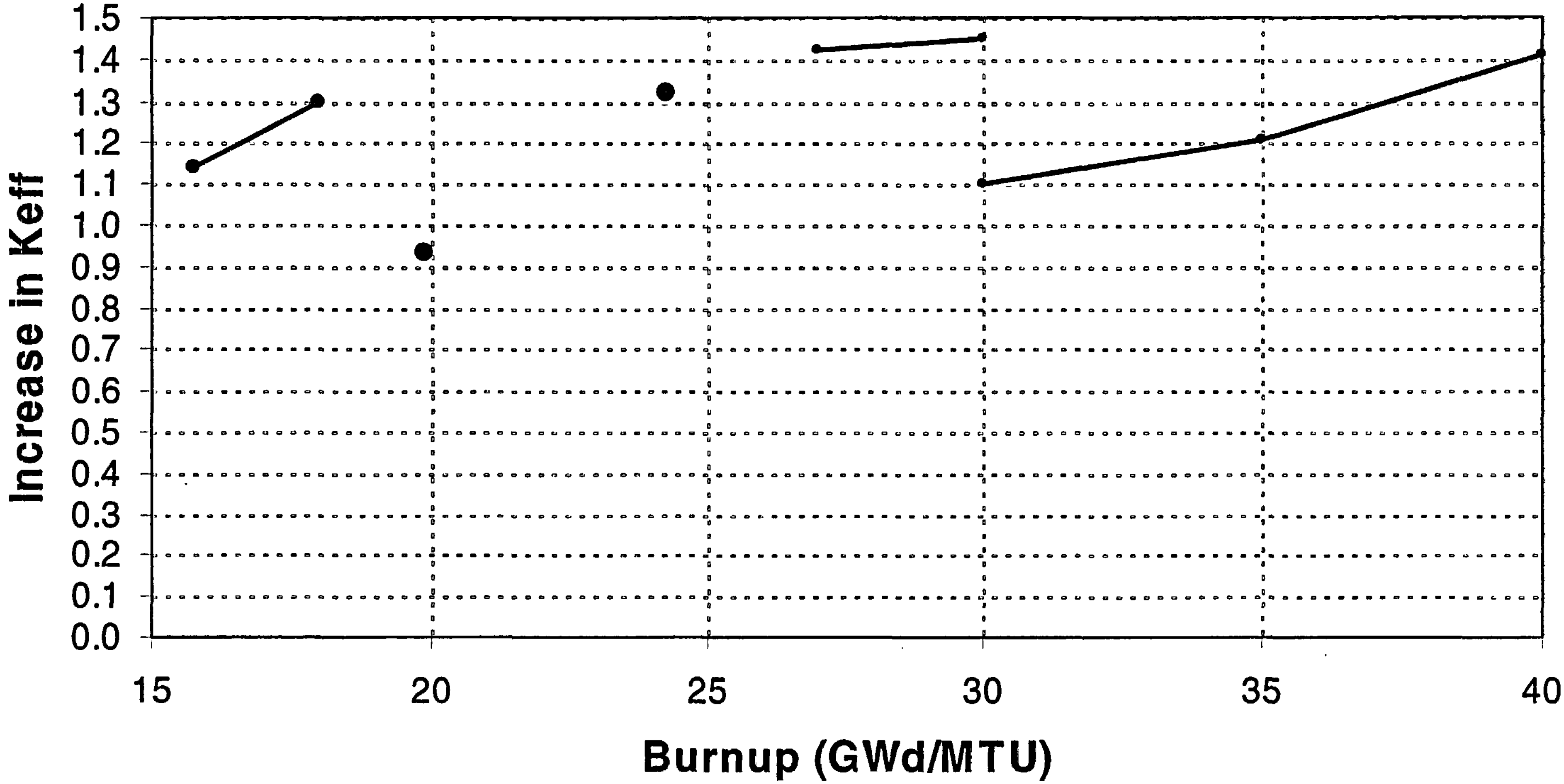

CRC Principle Isotope Set

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O-16	Nd-143	Sm-152	U-235	Pu-240
Mo-95	Nd-145	Eu-151	U-236	Pu-241
Tc-99	Sm-147	Eu-153	U-238	Pu-242
Ru-101	Sm-149	Gd-155	Np-237	Am-241
Rh-103	Sm-150	U-233	Pu-238	Am-242m
Ag-109	Sm-151	U-234	Pu-239	Am-243

Isotope Adjustment Factors

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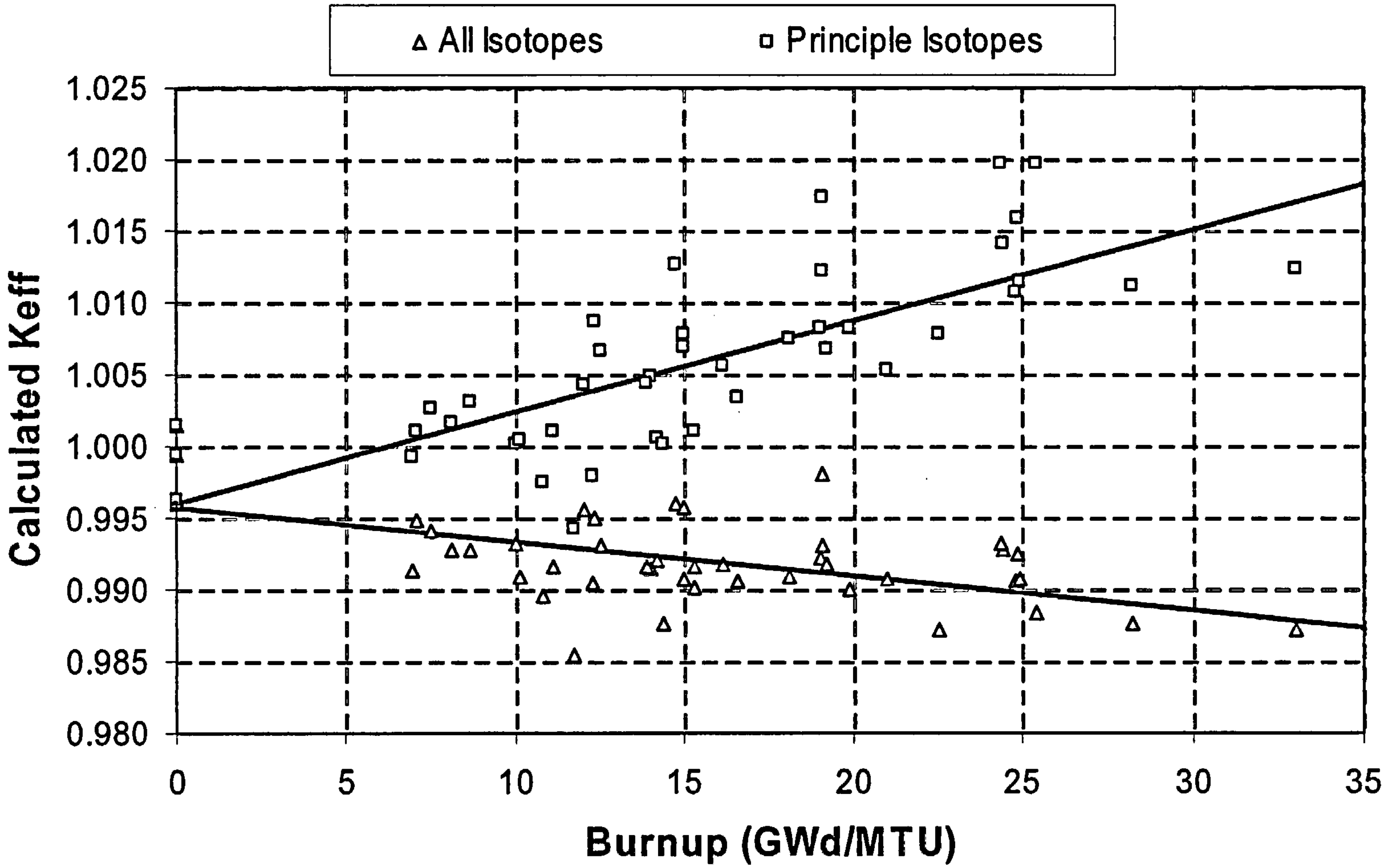

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Proposed Changes to VSC-24 Storage System Monitoring Requirements

February 2, 2005

Presented by:
Steven Sisley

Background

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10CFR72.122(h)(4) Requires Periodic Monitoring for Dry Spent Fuel Storage

- In a manner such that the licensee will be able to determine when corrective action must be taken to maintain safe storage conditions
- Monitoring period based on spent fuel storage cask design requirements

Requirement Currently Met for VSC-24 Storage System Technical Specifications

- TS 1.3.1 – Visual Inspection of Air Inlets and Outlets
- TS 1.3.4 – Cask Thermal Performance (temperature measurements)

Proposed Changes

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A License Amendment Request (LAR) is Planned to Seek Changes to the VSC-24 TS Requirement for Continuous Monitoring

Motivations for Change Request:

- ALARA – minimize occupational exposure from cask monitoring operations
  - Eliminate need for repairs of monitoring equipment
  - Establish longer inspection intervals for casks with lower heat loads

Outlet Vent Temperature Monitoring

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TS 1.3.4 – Cask Thermal Performance

- Requirement:
  - Daily temperature measurement to verify cask thermal performance (accomplished by measuring VCC outlet vent air temperature)
- Actions:
  - If measurement shows significant unexplained difference, determine cause and return cask to normal operation
  - If measurement indicates VCC short-term temperature limit has been exceeded for more than 24 hours, remove VCC from service
- Bases:
  - Positive means to identify conditions that could lead to exceeding temperature limits

Outlet Vent Temperature Monitoring

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TS 1.3.4 – Cask Thermal Performance

- Discussion:
  - Accident analysis (Section 11.2.7.2) does not identify temperature measurement as means of detecting blocked vents
  - Temperature measurement is indirect way of identifying blocked vent condition and is redundant with visual inspection of vents
  - Other storage systems require only visual inspection of vents to satisfy continuous monitoring requirement
- Proposed Change:
  - Delete TS 1.3.4 and rely only on visual inspections of vents for continuous monitoring

Visual Inspection of Cask Vents

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TS 1.3.1 – Visual Inspection of Air Inlets and Outlets

- Requirement:
  - Daily visual surveillance of wire mesh screens that cover the VCC inlet and outlet vents
- Actions:
  - If signs of blockage, conduct close-up inspection and remove blockage if present
- Bases:
  - Adiabatic heat-up thermal analysis for 24 kW heat load shows that VCC concrete short-term temperature limit of 350?F is reached at 30 hours after air flow stops
  - 24-hour inspection interval less than time required to reach short-term temperature limit

Visual Inspection of Cask Vents

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TS 1.3.1 – Visual Inspection of Air Inlets and Outlets

- Discussion:
  - Highest VCC heat load is 14.7 kW
  - Time to reach concrete temperature limit for 14.7 kW heat load is significantly longer than 30 hours
  - Longer inspection interval (e.g., 48-hours) could be justified for lower heat load casks
- Proposed Changes:
  - Provide new blocked vent adiabatic heat-up thermal analysis for 14.7 kW heat load to determine time to reach 350?F short-term temperature limit of concrete
  - Revise TS 1.3.1 to allow longer inspection interval for casks having low heat loads (e.g., below 14.7 kW)

Schedule

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BFS Plans to Submit LAR 1007-06 to NRC in May 2005

BFS Requests High Priority for NRC Review

- Needed to support operating ISFSIs
- Relatively simple changes
- Direct-final rulemaking?