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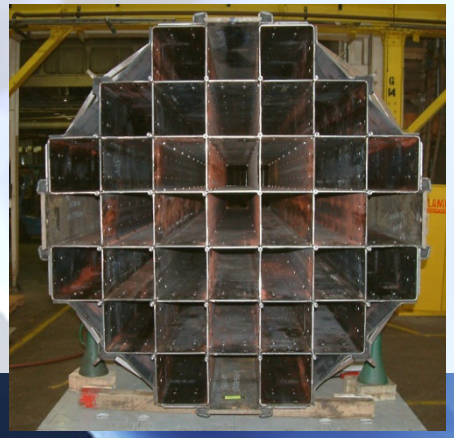
MAGNASTOR Amendment 3 Post-submission and MAGNATRAN Pre-submission Public Meeting

September 30th, 2010



Agenda

- Introduction / Opening Remarks
- General Overview of MAGNASTOR and MAGNATRAN Licensing Activities
- Presentation of Amendment 3 Document Structure
- Structural and Thermal Overview
- Shielding and Criticality Overview
- Schedule Requirements
- Public Questions / Comments

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General Overview of MAGNASTOR and MAGNATRAN Licensing Activities

- MAGNASTOR
  - Amendment 2 – Neutron Poison B4C Loading and TSC Shell Contamination Limits
  - Amendment 3 – PWR Damaged Fuel and Fuel Contents Expanded to Capture Zion Pool Inventory
- MAGNATRAN
  - Standard PWR and BWR Basket Configurations
  - PWR Damaged Fuel Basket Configuration
  - Zion Pool Inventory

Presentation of Amendment 3 Document Structure

- Amendment formatted to capture traceability of changes from FSAR Revision 0
  - 72.48 changes are bold italic text
  - Amendment 1 changes are noted with single underline
  - Amendment 2 changes are noted with double underline
  - Amendment 3 are noted with revision bars in margin

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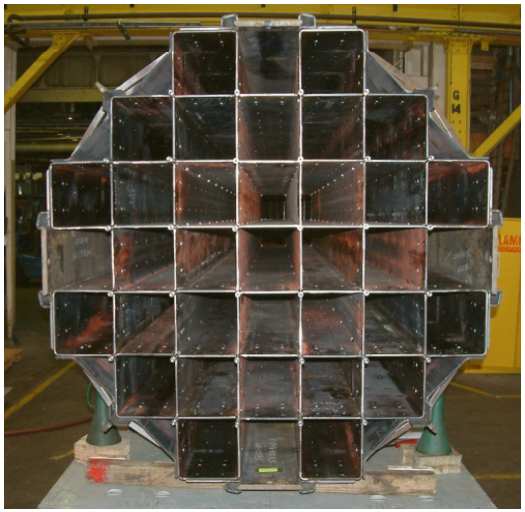
MAGNASTOR Amendment 3 and MAGNATRAN Overview Structural / Thermal



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Amendment 3: Canister for Damaged Fuel Can (DFC) and the DFC Evaluations

- Canister weight for DFC increased the loaded canister weight from 102,000 lb to 104,500 lb
  - Canister lift evaluation in original evaluation used 120,000 lb
  - Normal and Off-normal conditions used a the bounding canister loading of 120,000 lb
  - Tip over condition used a bounding weight of 120,000 lb
- No impact on the canister evaluations in the FSAR
- Hand calculations evaluate DFC for normal, off normal, and lift
- Hand calculations evaluate DFC for accident conditions
  - 24 inch drop
  - Tip over

DF Basket Storage Evaluation

- PWR basket permits four DFCs with the alternate corner weldment
- ANSYS basket model was modified to include the DF corner weldment
- Evaluations are performed for storage normal and accident conditions
- The increased stiffness of the DFC corner weldment enhances basket geometric stability

PWR DF Basket Factors of Safety

Component	Thermal stress	Off Normal	Tip over
Fuel tube	1.3	2.47	1.14
weldment	3.58	10.7	1.15

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Transport Basket Structural Evaluation

- Pin-slot model uses increased mesh density
- Boundary condition: Canister shell displacements:
  - Use a full-length canister model to incorporate the end effect of the canister
  - Canister shell displacements are based on transport conditions

PWR Basket Factors of Safety

Component	P+Q stress	30-foot drop
Fuel tube	1.20	1.14
Weldment	3.24	1.40 corner weldment 1.05 side weldment

BWR Basket Factors of Safety

Component	Thermal stress	30-foot drop
Fuel tube	1.26	1.10
Weldment	2.65	1.13

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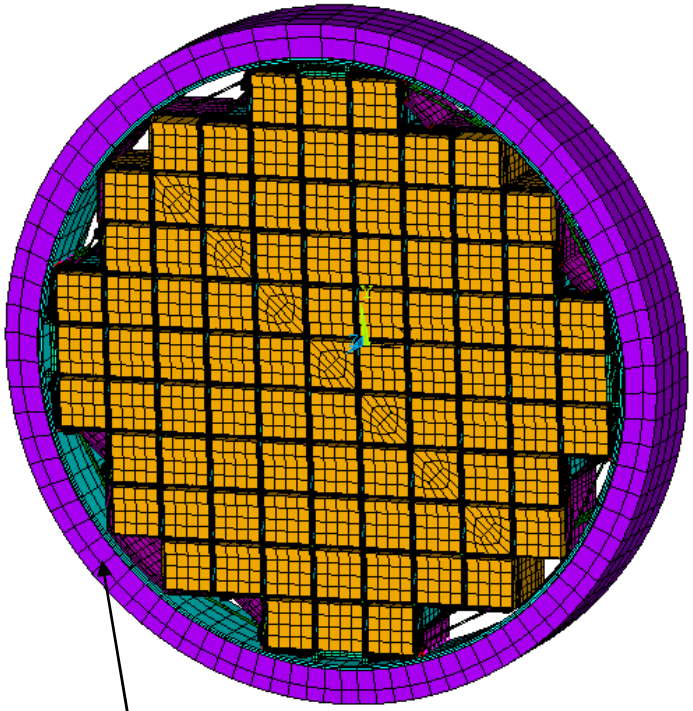
Transport Basket Structural Evaluation

- LS-DYNA Basket stability evaluation uses the same methodology as for storage
- The max gap between tubes is the same as for storage
- Multiple orientations are evaluated
- Stability model uses the same weldment model as used for the storage stability analysis
- Stability is confirmed by evaluating system at accelerations greater than maximum drop accelerations

BWR basket stability model (0° orientation)



Cask inner shell

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Amendment 3 Damaged Fuel Can Thermal Evaluation

- Fuel thermal conductivities are reduced based on guidance from IN 2009-23
  - Axial conductance of the fuel was recomputed
  - Effect on convection system is minimal
- The isotropic through tube wall-absorber conductance was replaced with an orthotropic conductance
  - Axial conductance is increased due to carbon steel and absorber conductivities
- The helium convection up through the DFC is neglected
- Damaged fuel is compacted 50% at the bottom of the DFC
  - Helium conductivity was used for the DFC region

Amendment 3 Damaged Fuel Can Thermal Evaluation (cont'd)

- Flow between the DFC and the slot walls is considered
- A separate resistance coefficient is computed using a 3D model of the region between the DFC and weldment wall
- Multiple cases were solved for different porous media configurations for the basket
  - A single porous media constant was computed for the basket region
  - The basket was separated into two regions
    - A composite porous constant was determined for the outer zone containing 16 slots with the 4 DFC's
    - Inner zone of the basket is associated with 21 fuel assemblies
- Transfer cask vacuum condition was rerun with revised properties
- Results confirm that the maximum clad temperatures in the existing license are bounding

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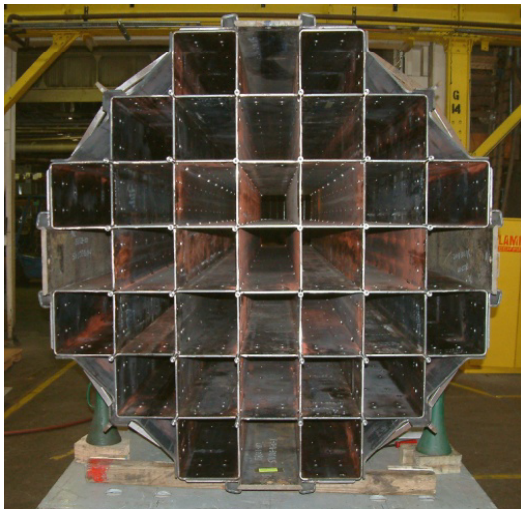
MAGNASTOR Amendment 3 and MAGNATRAN Overview Shielding / Criticality



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Storage Amendment 3 Shielding Scope

- Based on 72.48 system configuration including optional stainless steel transfer cask and augmented shield storage cask

- Amendment scope (PWR only)
  - Increased maximum assembly average burnup to 70 GWd/MTU
  - Damaged fuel can (DFC) contents
  - Additional non-fuel hardware
    - FSAR Rev. 0 allowed RCCA, BPRA, Thimble Plug

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Storage Amendment 3 Shielding Results

- Effects of increasing PWR maximum assembly average burnup from 60 to 70 GWd/MTU
  - No heat load changes as cool time is adjusted
  - No increase in maximum / average carbon steel transfer cask and standard shield concrete cask dose rates
  - Minor decrease in reported stainless steel transfer cask maximum and average radial dose rates as a result of better converged MCNP runs; no increase in axial dose rates
  - No increase in augmented shield concrete cask dose rates

Storage Amendment 3 Shielding Results (cont'd)

- Additional hardware (per Canister)
  - Minimum effect of 1 reconstituted assembly with stainless steel replacement rods (limited number of rods and exposure/burnup)
  - Hafnium flux reduction assemblies bounded by BPRA
  - One primary or secondary neutron source assembly has no significant effect on overall canister source or system dose rates

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Storage Amendment 3 Shielding Results(cont'd)

- Damaged fuel can (DFC) contents
  - Damaged fuel dose rates based on bounding carbon steel transfer cask and standard shield concrete cask
  - Increased self shielding offsets increased source density
    - Transfer cask bottom dose rate increased by 0.6%; radial dose rate less than bounding BWR fuel
    - Maximum concrete cask inlet dose rate increased by 9%; radial dose rate increased by 4%

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Storage Amendment 3 Criticality Scope

- Based on Amendment 2 request for absorber density options
  - PWR effective absorbers (0.036 g $^{10}B/cm^2$) in FSAR Rev. 0 modified to options at 0.030 and 0.027 g $^{10}B/cm^2$ in Amendment 2
- Amendment scope (PWR only)
  - Damaged fuel can contents
    - Damaged fuel basket with four oversized openings for DFC
    - DFC location neutron absorber width increased
  - Hardware in instrument tube

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Storage Amendment 3 Criticality Results

- Instrument tube hardware has no effect on system performance (expected as FSAR Rev. 0 demonstrated minimal effect of larger number of guide tubes filled)
- Damaged fuel allowable enrichments modified by 0 to 0.2 wt% ^{235}U (depending on fuel type, enrichment, and soluble boron content) to account for statistical variation in results (near limit) and the conservative fuel / water DFC mixture model applied in the DFC analysis

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Storage Amendment 3 Criticality Results (cont'd)

- Damaged fuel basket / DFC Contents
  - No statistically significant change in reactivity between undamaged fuel basket and damaged fuel baskets (no DFC in model)
  - No statistically significant change in reactivity for model containing DFC contents
    - Undamaged fuel
    - Fuel rod array without clad
    - Modified pitch rod array
    - Missing rods
  - Slight increase in reactivity for fuel / water mixtures associated with the conservative model of fresh, unborated water in DFC (no significant change without fresh water)

Transport Application Shielding Scope

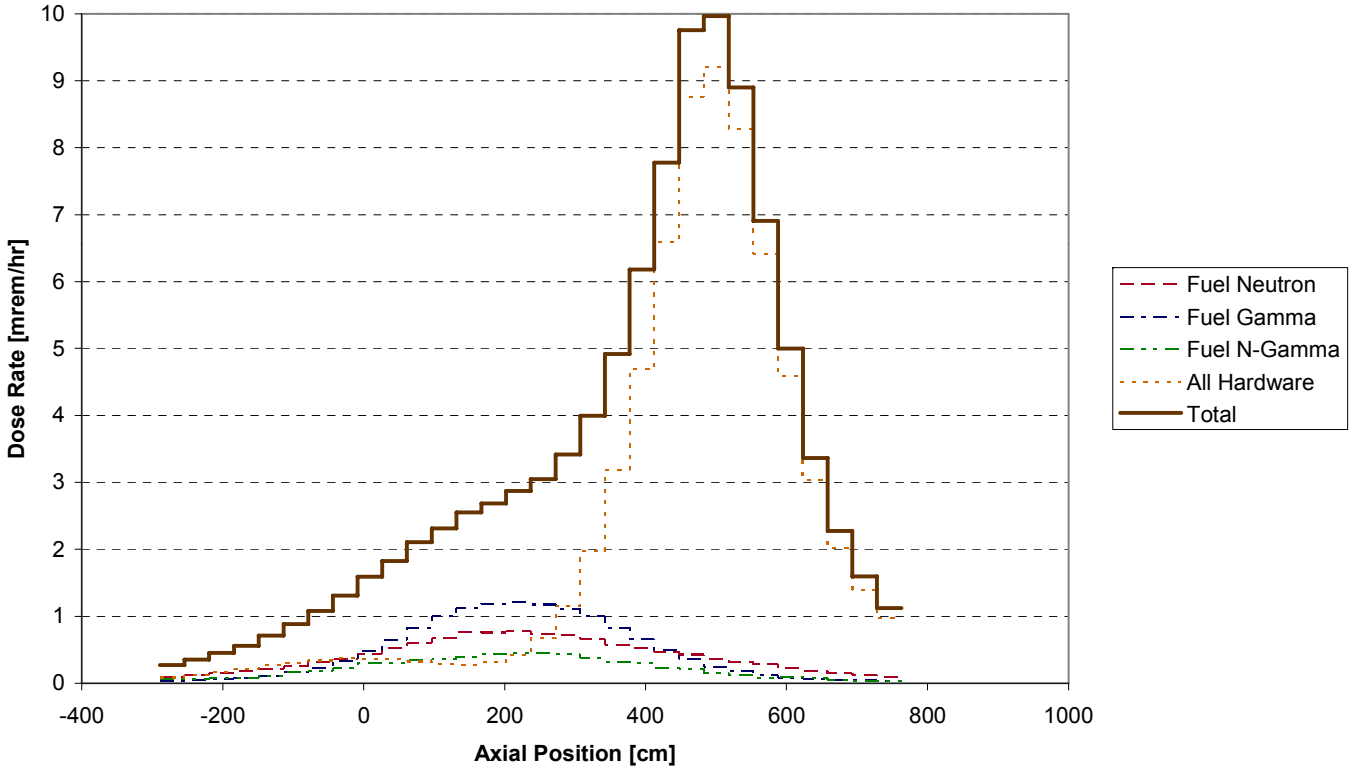
- MAGNASTOR canister and basket with transport cask overpack
- Maximum assembly average burnup
  - PWR fuel at 70 GWd/MTU
  - BWR fuel at 60 GWd/MTU
- Contents analyzed to meet decay heat and 10 CFR 71 dose rate limits
- No credit taken for increased shielding associated with the DFC cell plates (1.25 inch inner plate and 0.75 inch outer plate).
- Undamaged fuel (PWR/BWR) and damaged fuel (PWR only)
  - PWR fuel with non-fuel hardware

Primary Non-Fuel Hardware Contents

- MAGNASTOR FSAR Rev. 0
  - Burnable poison rod assemblies
  - Thimble plugs
  - Reactor control elements (CEAs, RCCAs)
- MAGNASTOR Amendment 3
  - Hafnium flux reduction / shield assemblies (HFRA)
  - Primary and secondary neutron source assemblies (NSA)
  - Activated stainless steel rods (reconstituted assembly)
- MAGNATRAN Rev. 0 Application
  - Combined list of MAGNASTOR FSAR Rev. 0 and Amendment 3

Transport Application Shielding Results

- Example undamaged PWR fuel normal condition radial (side) 2m dose rates



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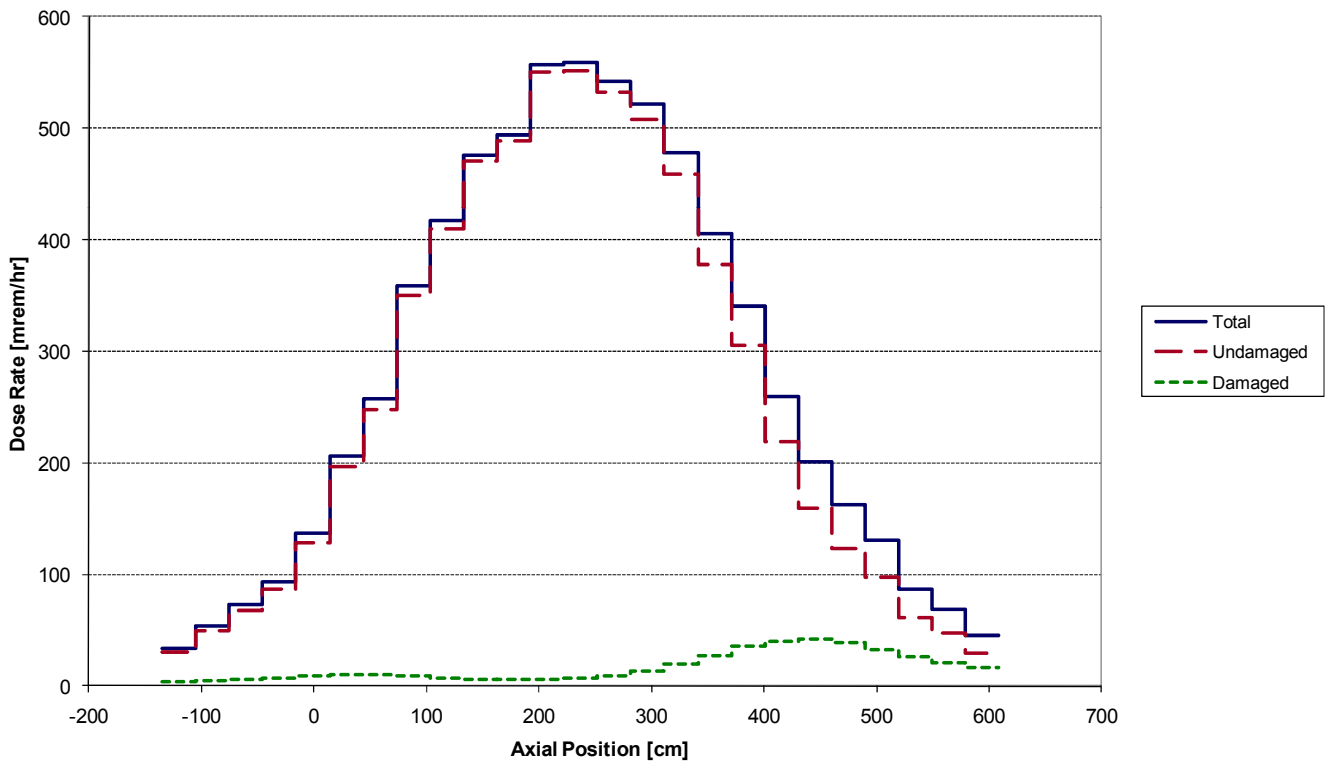
Transport Application Shielding Results (cont'd)

- Example damaged PWR fuel accident condition radial (side) 1m dose rates



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Schedule Requirements

	Submitted	Final Rule Effective Date or CoC Issue Date
MAGNASTOR Amendment 2	March 22, 2010	May 31, 2011
MAGNASTOR Amendment 3	August 26, 2010	December 31, 2011
MAGNATRAN -	4th Qtr 2010	December 31, 2012

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