# Introduction to the NAC-LWT Petten FRR Shipment



#### May 14, 2007

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ENCLOSURE 3

### Petten / DOE Task 17 Application

NAC-LWT Legal Weight Truck Spent Fuel Transport Cask Docket #71-9225

Utilization in DOE National Nuclear Securty Administrations (NNSA's) Foreign Research Reactor (FRR) Program



## Application Certificate of Compliance # 9225

NAC prepared an Amendment Request to the NAC-LWT Certificate of Compliance by revising the Cask Safety Analysis Report for:

- Revised MTR element contents
  - In particular the addition of LEU elements with up to 640g <sup>235</sup>U
    - Elements, or loose plates in MTR plate canister, containing up to 32g <sup>235</sup>U per plate with up to 23 plates, provided a maximum 640g <sup>235</sup>U per element limit is met
    - o MTR elements allowed to contain a small (< 100 g) quantity of activated Cadmium
  - MTR content currently authorized at 470g <sup>235</sup>U per element (up to 23 plates at 22 g <sup>235</sup>U / plate)



## Application Certificate of Compliance # 9225 (continued)

- No changes in the physical description of the MTR elements
  - Plate width, thickness, and length
  - Element cross-section and length
  - Overall weight
  - Fuel element fissile and structural materials beyond the fissile material mass increase and the presence of Cd (wires)
- No changes in MTR basket drawing and configurations except
  - When loading high <sup>235</sup>U load (640g <sup>235</sup>U elements) basket is restricted to four elements as specified in Chapters 1 and 7 of the SAR
  - Specific basket location for loading of high load elements are Nos. 4 -7 of Figure 7.1-1



#### High Load (Petten) LEU MTR Element Structural and Thermal Evaluation Considerations



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#### **Thermal Considerations for Revising MTR Fuel Element Payload**





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#### **Structural Considerations for Revising MTR Fuel Element Payload**

- Currently authorized payload allows up to forty-two (42) MTR elements at a weight of up to 30 lb per element
- High load LEU elements proposed in the amendment are < 30 lb per element
- The proposed heat load LEU elements meet geometry constraints of pervious MTR evaluations
- No change to structural evaluations



# Summary of Nuclear Evaluations for the High Load LEU (Petten) MTR Elements



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#### High Load LEU MTR Fuel Nuclear Evaluations

- Shielding
  - SAS2H source term generation for 640g <sup>235</sup>U MTR elements
    - Included light element for Cd activation
  - SAS4 shielding evaluation with revised source terms
    - Bounded by existing MTR shielding analysis
  - Added high load LEU MTR cool time curve
  - All analysis codes and models identical to currently licensed MTR payloads
- Containment
  - Bounded by existing source due to reduction in allowed payload to four elements per basket (criticality constraint)
- Criticality
  - SCALE (CSAS) specific evaluations for LEU elements
    - Up to 32g <sup>235</sup>U per element and 23 plates per element
    - Limit basket module to 4 outer elements when high load LEU fuel is included



# **Shielding Evaluation**

- Fuel plates and in-core use falls within MTR assembly evaluation as previously specified in NAC-LWT SAR
- Source term evaluated using the SAS2H sequence
  - Maximum <sup>235</sup>U mass
    - 20 plates at 32g per plate for 640g <sup>235</sup>U per element
  - Generic LEU fuel geometry is applied in SAS2H
  - Variable burnup evaluated
    - Cool time set to obtain 30 watts per element
  - 100 gram Cadmium produces a light element source < 0.1% of the fuel source at any energy line and is therefore not significant to the shielding evaluation conclusions



#### **Shielding Evaluation (continued)**

Element source terms \_ 2.4 at fixed 30 watt 2.2 Identical code version \_ to previous MTR evaluation š No changes in input \_ 1.0 besides fuel material 0.8 (640g <sup>235</sup>U) and 0.6 burn-days 0.4 470) gram U-235 LEU 0.2 - 640 gram U-235 LEI Generated revised 0.0 load curve 20,000 120.000 0 40,000 60.000 80,000 100.000 140,000 160,000 Burnup [MWD/MTU]



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## **Shielding Evaluation (continued)**

- Generated dose profiles in SAS4
  - Evaluated dose rates for a full basket (7 element per basket)
  - Bounded by lower mass LEU payload (increased cool time required to meet 30 watt limit)
  - Significantly higher dose rates from HEU fuel at 30 watts
  - Maximum dose rates obtained from preferentially loaded (higher heat load per element) HEU elements currently authorized in the CoC

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- Updated SAR to contain dose comparison
  - Not previously included





# **Shielding Evaluation Summary**

- High load LEU 640g <sup>235</sup>U elements limited to 30 watts per element (previously authorized thermal limit)
- Dose rates from 640g <sup>235</sup>U LEU elements at 30 watts bounded by HEU elements
- New cool time curve added in Chapter 7 (Operating Procedures) for LEU elements containing > 470g <sup>235</sup>U but ≤ 640g <sup>235</sup>U



# **Criticality Evaluations**

- Fuel plates and element configuration falls within MTR assembly evaluation as previously specified in the NAC-LWT SAR
- Reactivity calculations using CSAS (KENO-Va) models employed in previous MTR evaluations
- Model changes limited to
  - Revising fuel plate core composition for higher fissile material loading
  - Revising finite cask model to allow a mix of full and partially (4 element) loaded basket modules
- Model based on previously determined maximum reactivity system configuration



# **Criticality Evaluation (continued)**

- Model Summary
  - Finite cask model
  - Infinite array of casks
  - Accident condition loss of neutron shield
  - Maximum reactivity fuel condition (max plate pitch)







# **Criticality Evaluation (continued)**

- Evaluation performed with full basket load of 32g <sup>235</sup>U per plate elements yielded k<sub>s</sub> > 0.95 (k<sub>s</sub> is less than 1)
- k<sub>eff</sub> = 0.7 for six basket stack containing four high load elements in each basket
- k<sub>eff</sub> across all MTR bounding fuel types is 0.01 ∆k lower for underloaded top and bottom baskets regardless of content of the underloaded basket
  - same fuel type as full intermediate basket or
  - high load LEU fuel
- System reactivity controlled by adjoining "full" baskets
- Evaluations bound loading of MTR elements or plate canisters as maximum plate pitch feasible in the basket cavity is used in the evaluations



# **Criticality Evaluation Summary**

- System reactivity is below previously evaluated levels provided
  - Basket is limited to four elements when elements (or plates) are loaded in excess of 22g <sup>235</sup>U per plate
  - High load LEU elements meet geometry restrictions specified in the criticality analysis (ex., plate thickness and active fuel height)
- Chapter 7 (Operating Procedures) is revised to restrict loading of LEU elements containing > 22g <sup>235</sup>U per plate, but ≤ 32g <sup>235</sup>U per plate, to the four basket module locations specified in the criticality analysis
  - Mixed assembly loading is permitted provided that the number of element restriction (4 elements maximum) is invoked if a single high load LEU element is placed in a basket module



# **Questions?**

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#### MTR Amendment Request Document Structure

- MTR Amendment Request Revision LWT 07B (Changes marked with revision bars on LWT- 07B pages)
- Basis: NAC-LWT SAR, Revision 37
- Approved but not yet incorporated amendments
  - ANSTO/TPBAR changes (Revision bars removed in MTR Amendment Request for clarity)
- Text Flow
  - due to ANSTO/TPBAR changes ANSTO/TPBAR Rev.
  - due to Revision LWT- 07B changes Revision LWT-07B
- Refer to List of Effective Pages for complete overview



#### Future Part 71 Licensing Efforts Docket No. 71-9225

- Prepare NAC-LWT SAR, Revision 38 to incorporate all approved amendments – After approval of MTR Amendment
- Incorporate MOX fuel as approved content 3<sup>rd</sup> Qtr. 2007
- Miscellaneous improvements/clean up items 4<sup>th</sup> Qtr 2007
- Incorporate ANSTO damaged fuel as approved content 1<sup>st</sup> Qtr 2008



# **Other Future Part 71 Licensing Efforts**

- NAC-UMS Transport (#9270) Expires October 31, 2007
  - Timely renewal September 2007
  - Incorporate change in BORAL supplier information and High Burnup PWR fuel as approved content in future Amendment Requests
- NLI 1/2 (#9010) and NLI 10/24 (#9034) casks
  - CoCs expire 10/01/2008 non-renewable
  - Potential for final disposal of casks pending DOE decision
- MAGNATRAN Application

- after re-submittal of MAGNASTOR

 Californium Package application on indefinite hold by DOE - Oak Ridge

