PART 71--PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL

Package approval or modification--
Discussion of Near Term Need for Regulatory Reviews
May 14, 2009

Westinghouse

Purpose and Agenda

Purpose

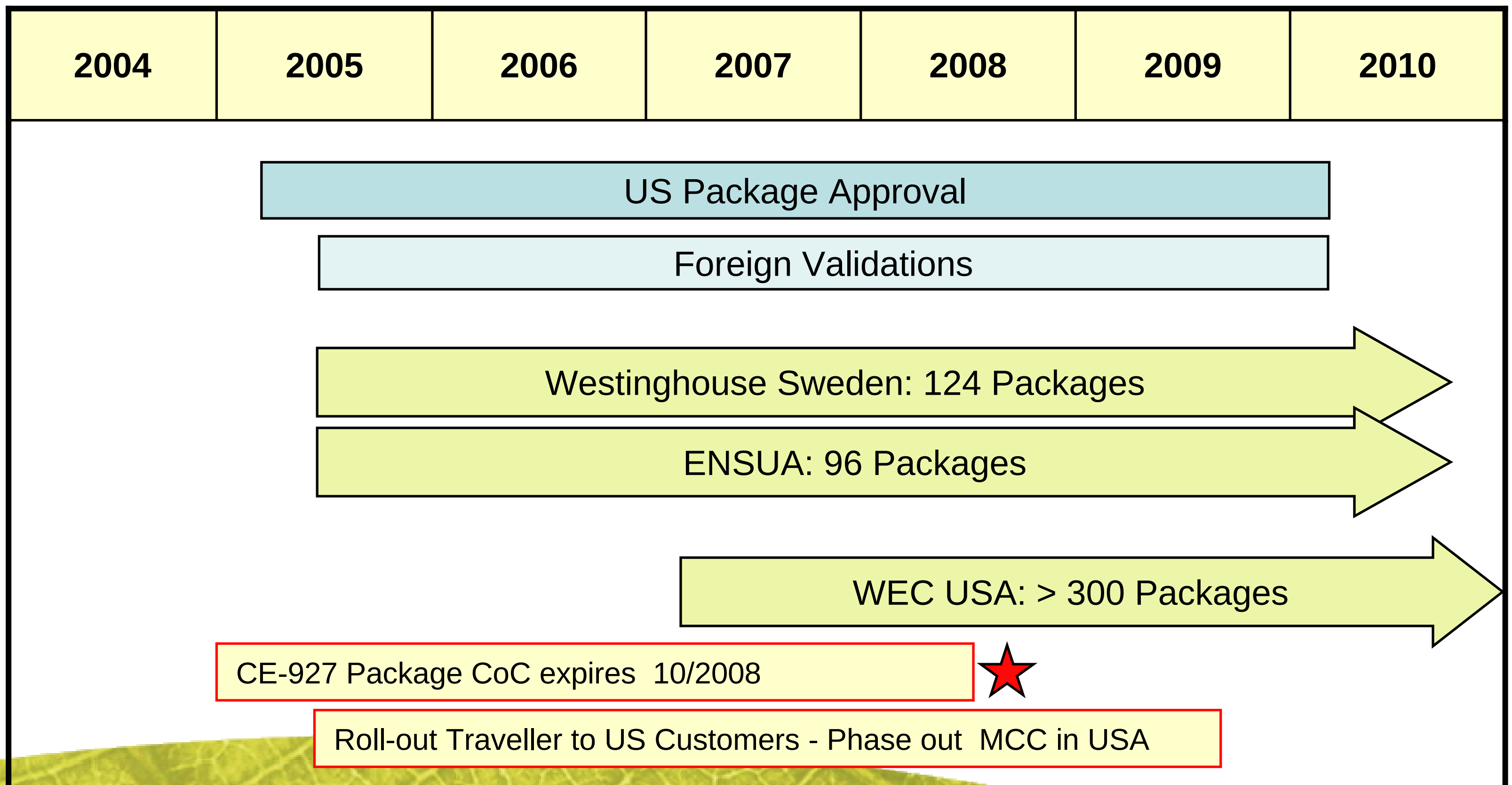
- Discuss near term (2009-2010) needs for regulatory review of amendments to current Certificates of Compliance
- Discuss issues governing package manufacture.

Agenda

- License Renewal for Traveller (USA/9297/AF-96)
- Traveller –VVER
- Traveller – Manufacture Outside USA
- Rod Transport Package Licensing

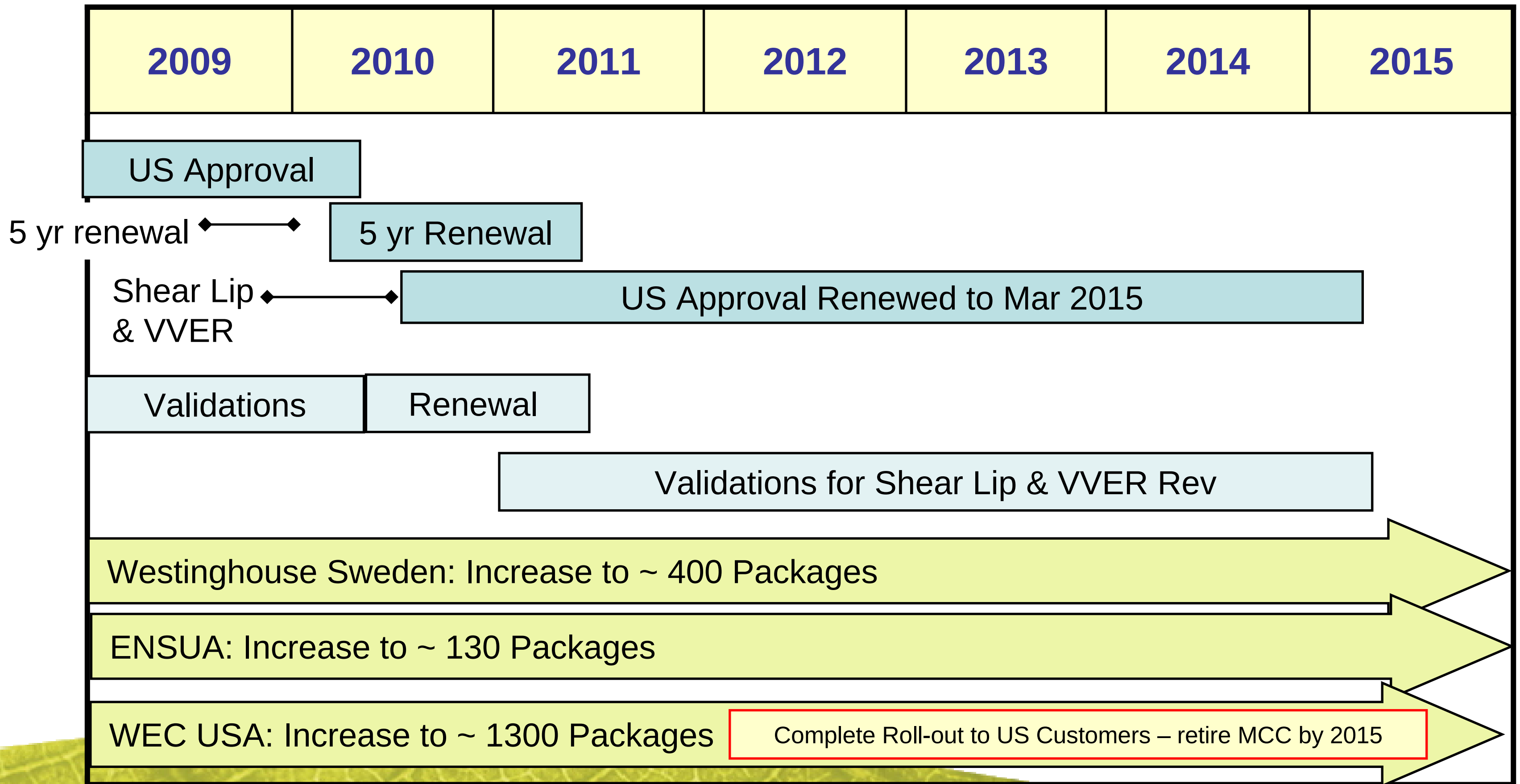
Traveller Introduction Timeline

Licensing and Roll-out Strategy in 2004

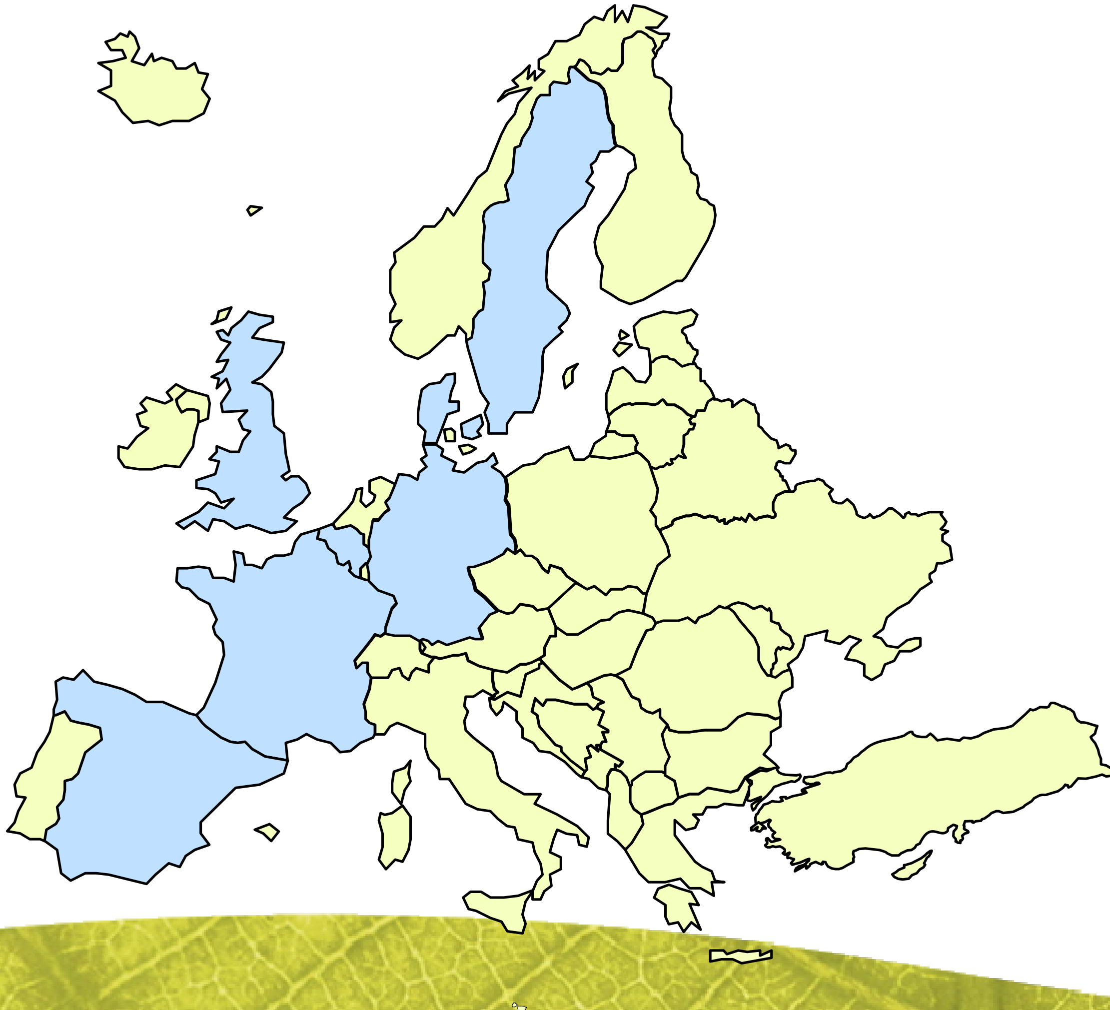


Traveller Introduction Timeline

Licensing and Roll-out Strategy in 2004



Traveller Licensing in Europe



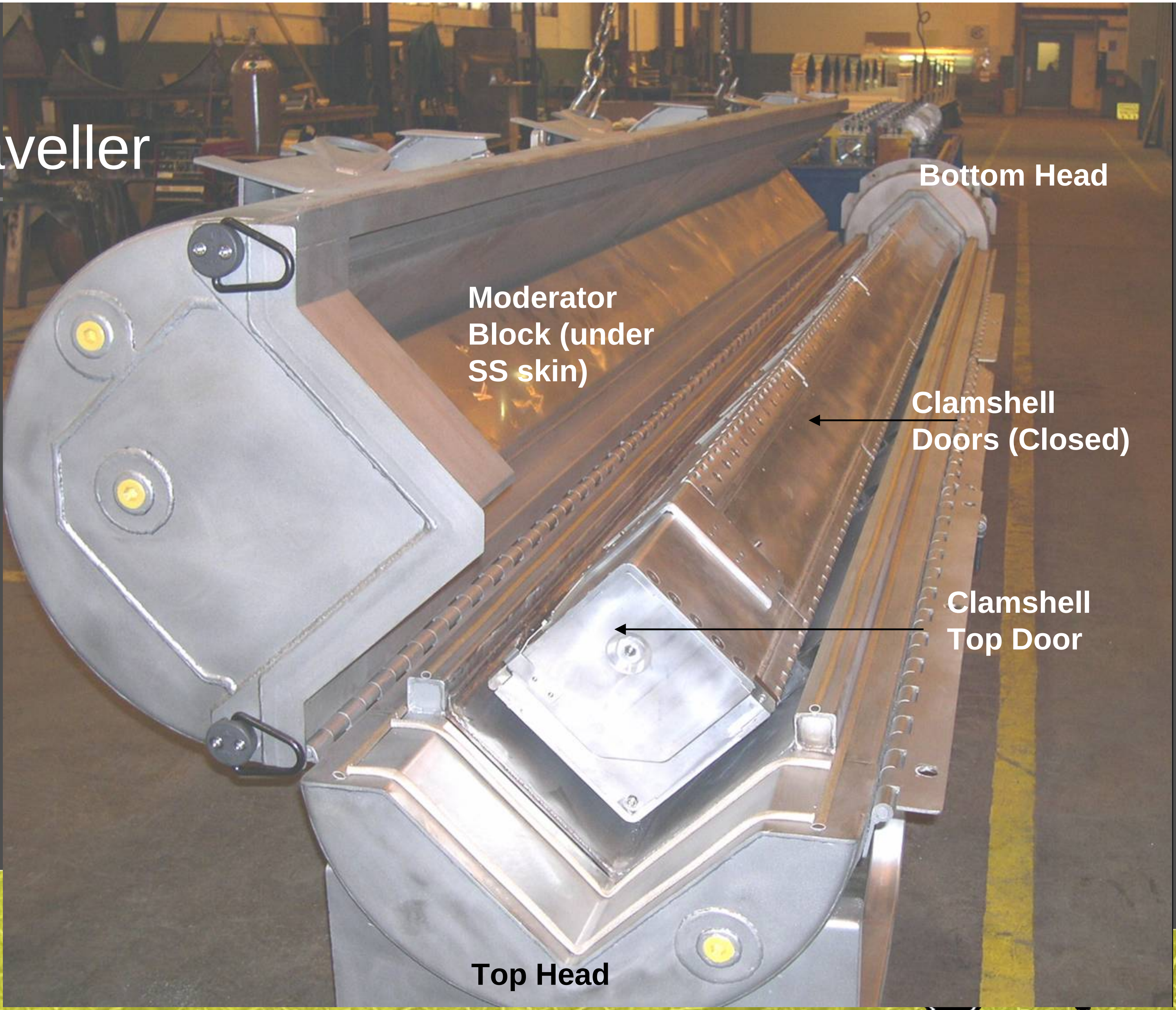
Traveller

- Belgium
- Denmark
- France
- Germany
- Spain
- Sweden
- United Kingdom

Traveller
Lift Eye/ Stacking Bracket
LIFT HERE
HOIST HERE
TS 251
Fork Lift Pockets
Full Length Hinge
Thermal Plugs
Two Lengths
Traveller Standard for 900 MW fuel
Traveller XL for 1300 MW fuel
26 8:19PM

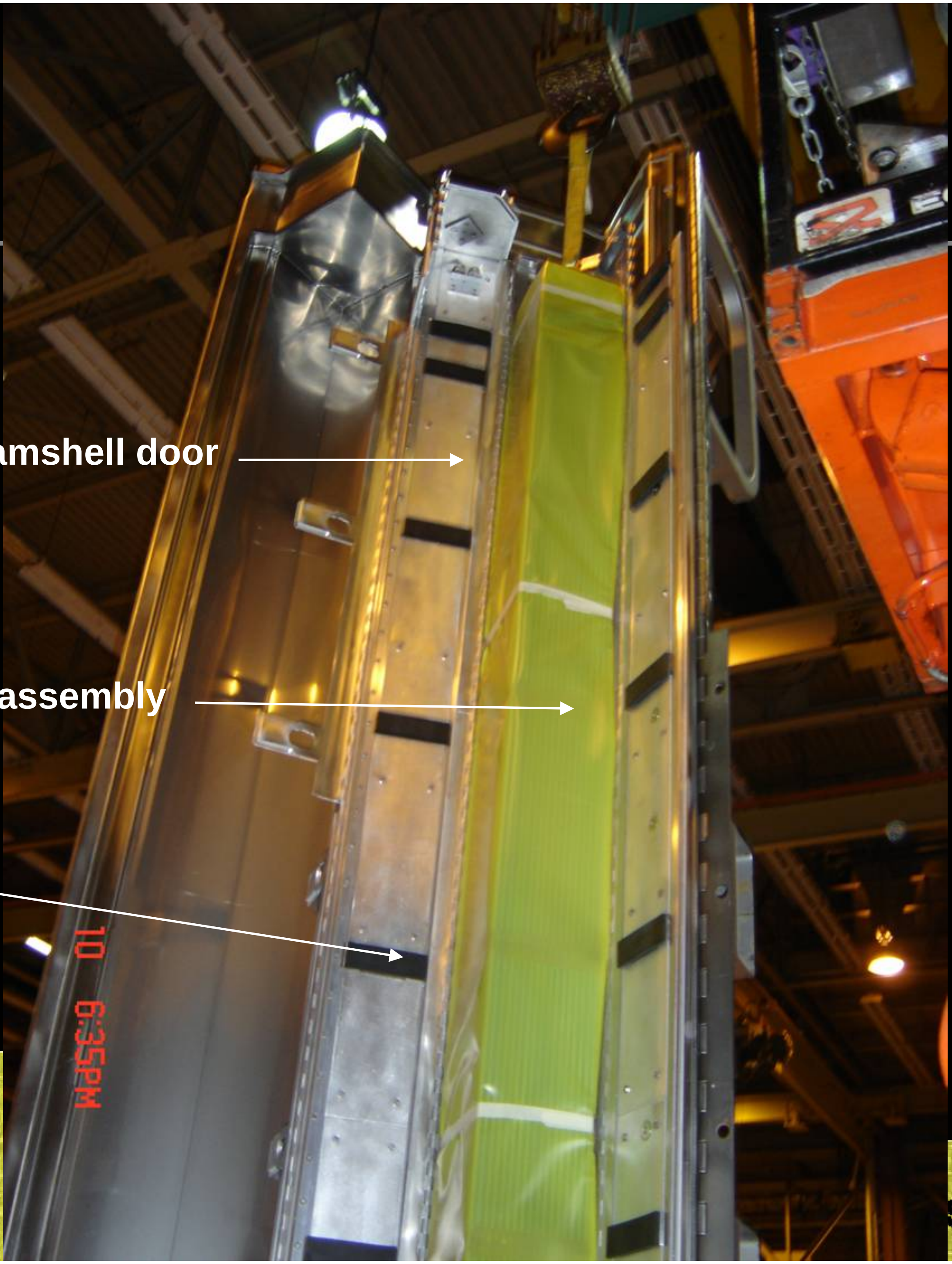
Traveller

Traveller


Bottom Head
Moderator Block (under SS skin)
Clamshell Doors (Closed)
Clamshell Top Door
Top Head

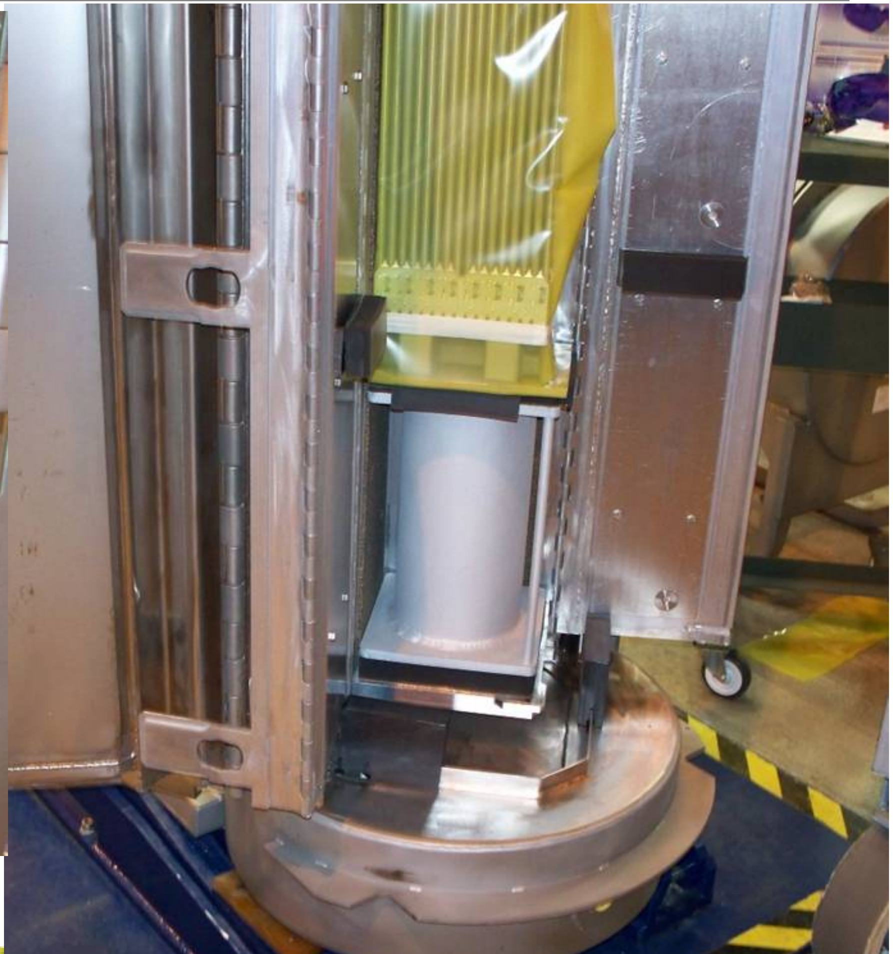
Traveller

Vertical with clamshell doors open



Traveller

Axial Restraint

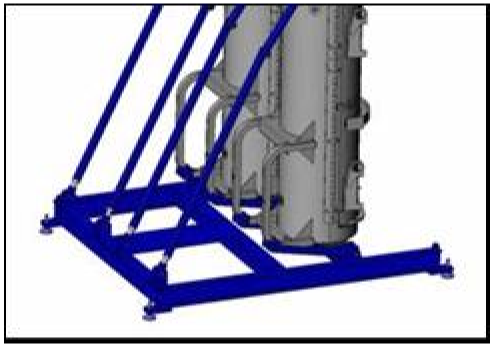


Bottom Spacer

Westinghouse

Traveller Upenders

Fixed Plate



Pivot Arm Outrigger

Powered

Modular

Modular on Outrigger

Mechanical and powered upenders have been designed for utilities to procure for operation of the Traveller.

Traveller Upender

Traveller Upender

Mechanical Upenders require a lift rig spreader plate to upend the Traveller to vertical

Lift Rig Spreader Plate

Traveller Upender

Traveller Powered Upender

Powered upender motor control and drive system

Powered upender eliminates use of the crane to upend a Traveller to vertical and it upends the fuel assembly within the existing container footprint

Westinghouse

Traveller Shear Lip Modification

Westinghouse

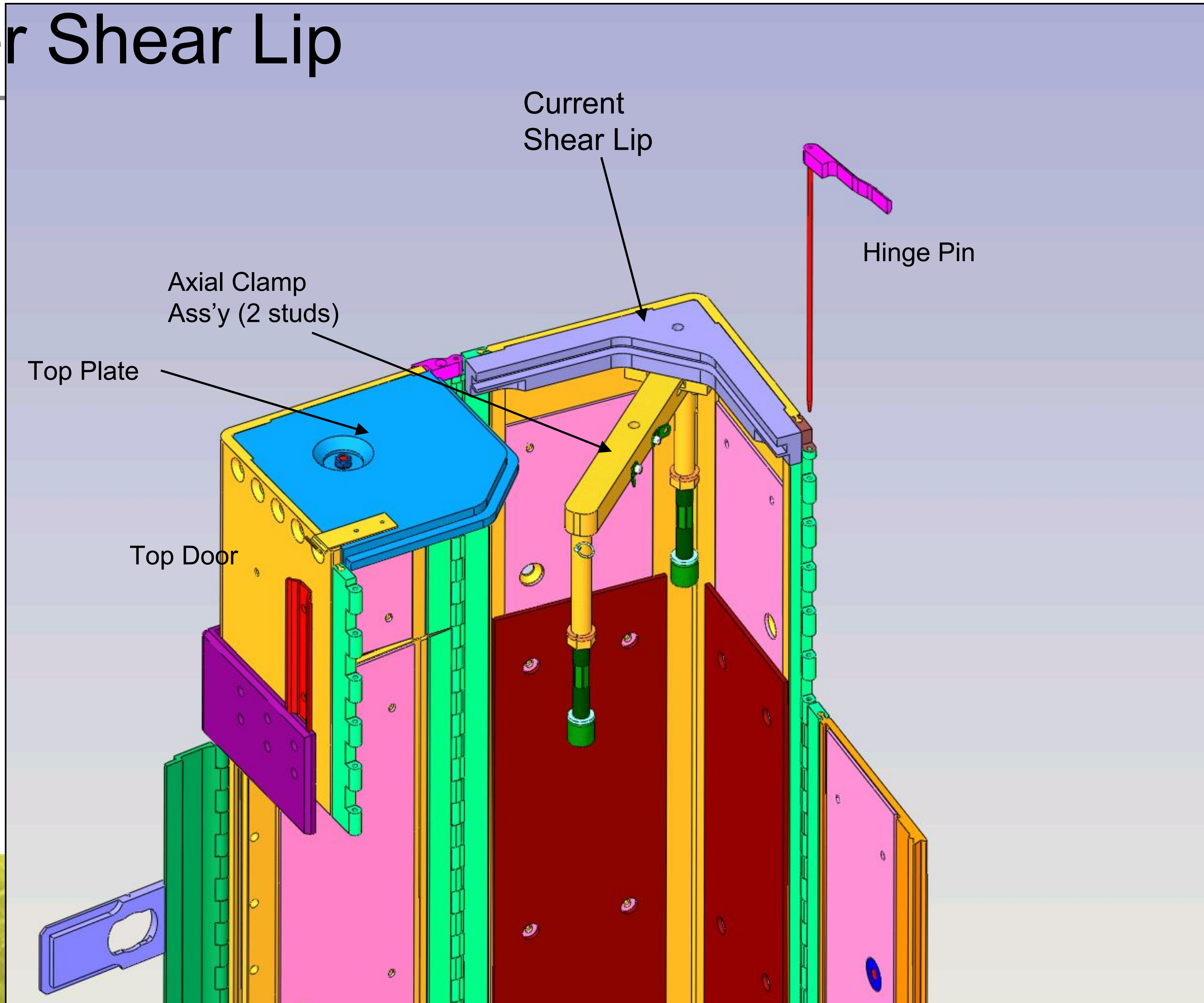
Traveller Shear Lip

The Need for new design clamshell top door

- Existing clamshell door works well for most fuel handling tool designs
- Some customers prefer more clearance between the handling tool and the clamshell (i.e., they cannot use their handling tool without tilting).
- New shear lip design also needed for US customers who want internal components (RCCA's) transported with fuel.

Traveller Shear Lip

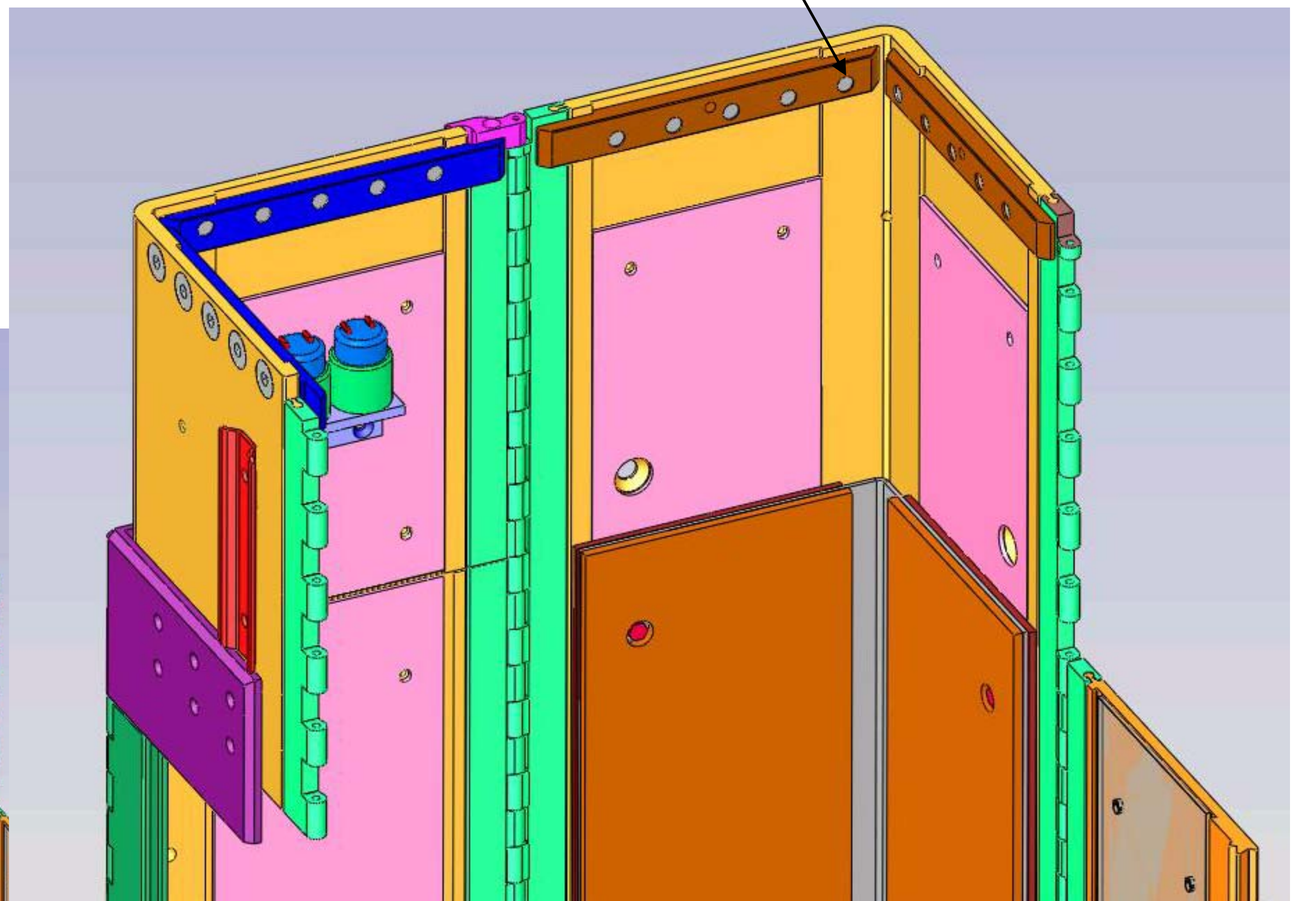
Current Design



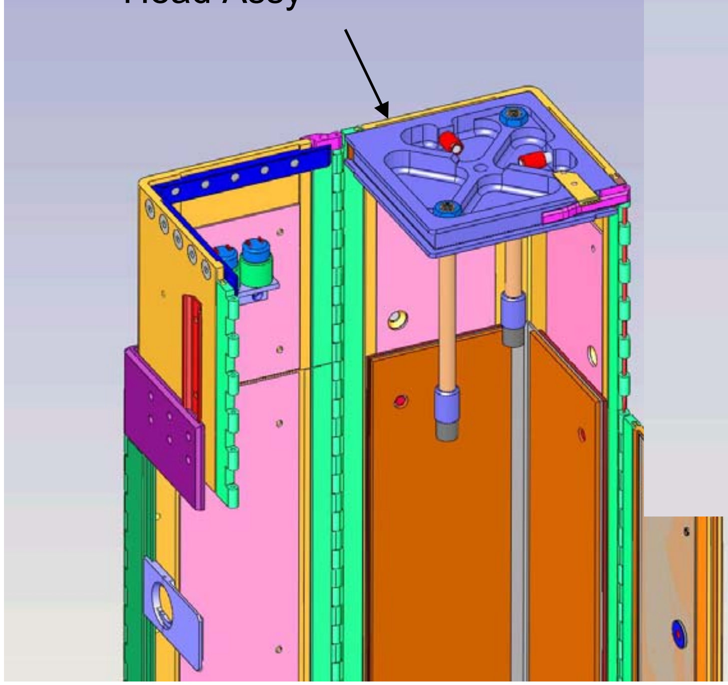
Traveller Shear Lip

Proposed New
Shear Lip
Design

Modified
Shear Lip



Removable Top
Head Assy

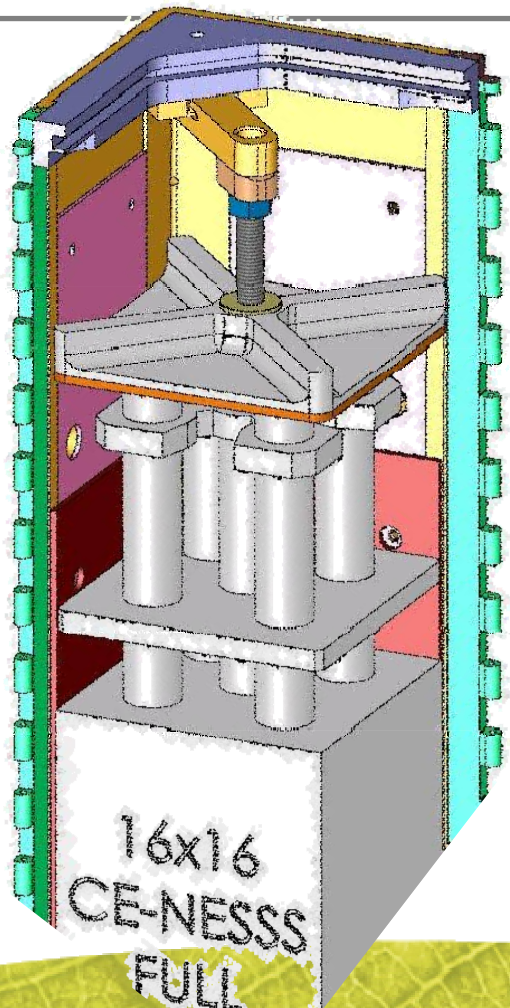


Westinghouse

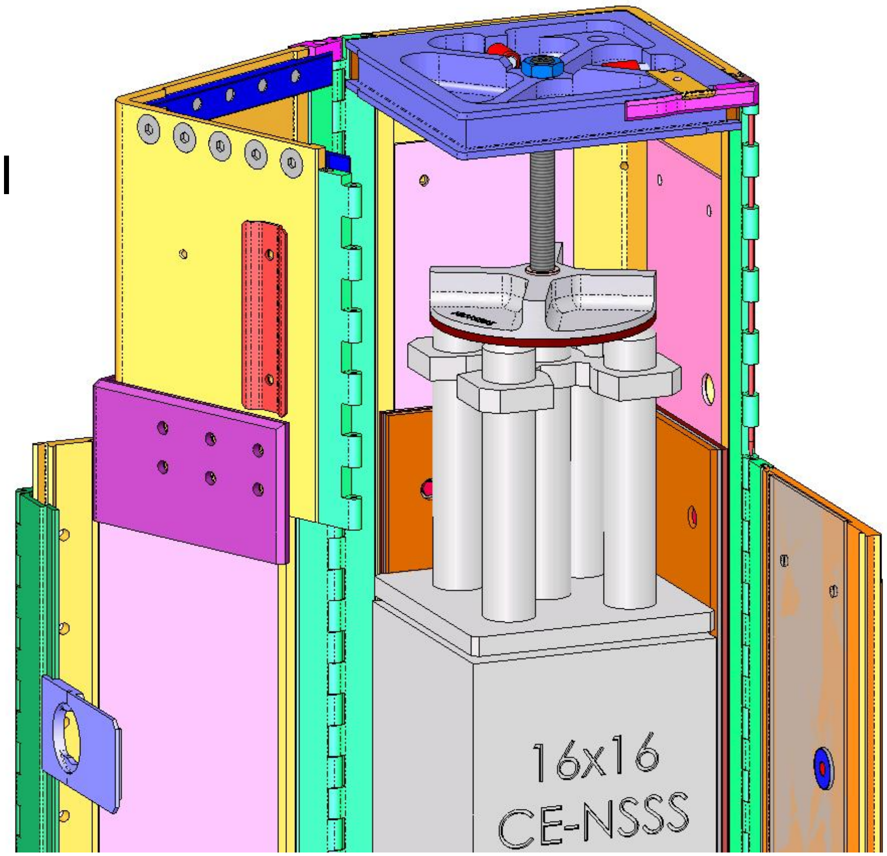
Traveller Shear Lip

Actual Shear Lip Prototype

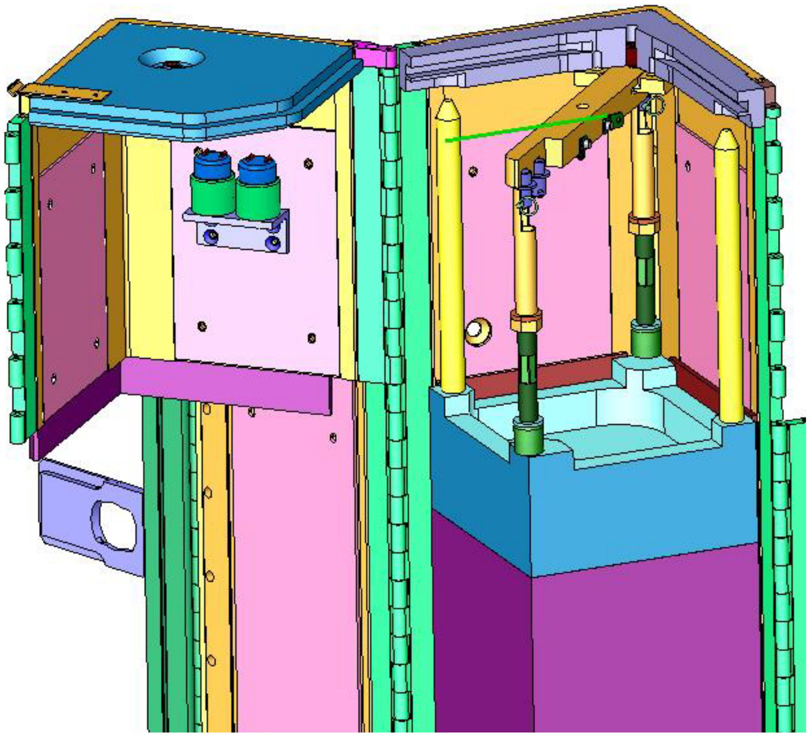
Traveller Shear Lip



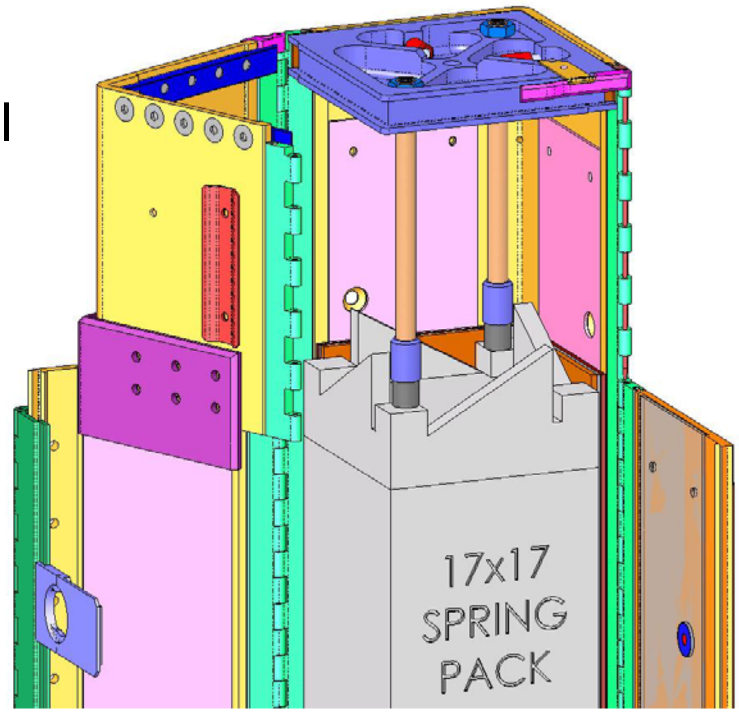
CE Fuel



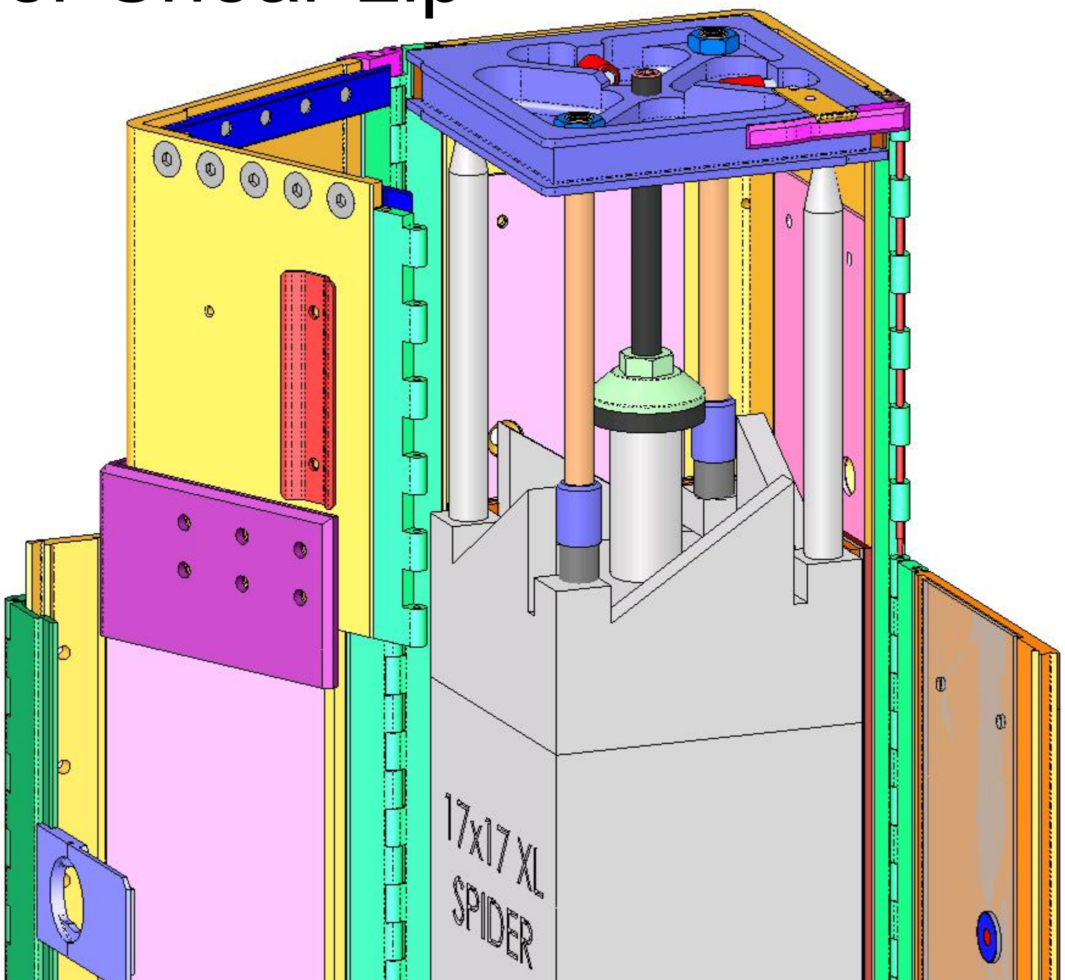
Traveller Shear Lip



WEC Fuel



Traveller Shear Lip



Shown With Core Components

Traveller Shear Lip

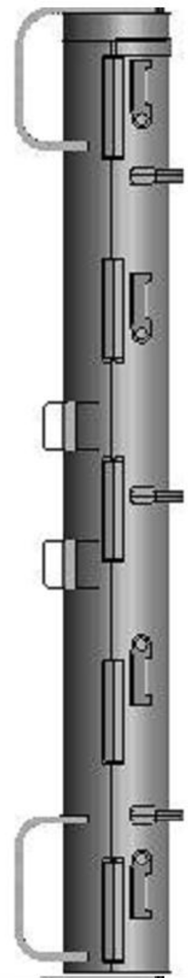
Use FEA to Demonstrate Equivalent to Existing Design

- FEA used for original SAR licensing not considered practical for this evaluation – too large: inherently slow running due to large number of elements

- A "simpler" FEA model was developed. Less fidelity (fewer nodes) but acceptable for analyzing high angle drop orientations (i.e., top nozzle 9 meter drop).

- New FEA model has been benchmarked against the SAR FEA model.

- New model is used to analyze top nozzle 9 meter drop with current clamshell and new shear lip design.

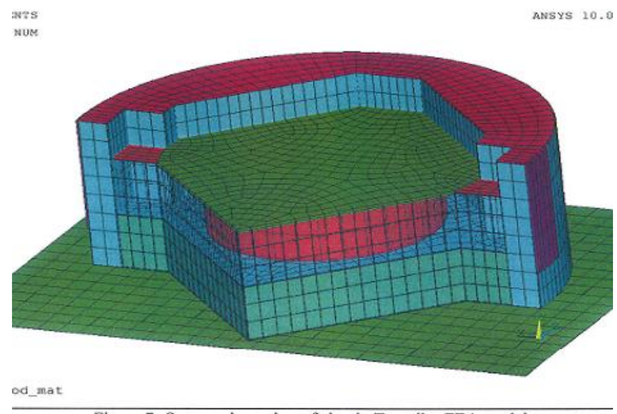


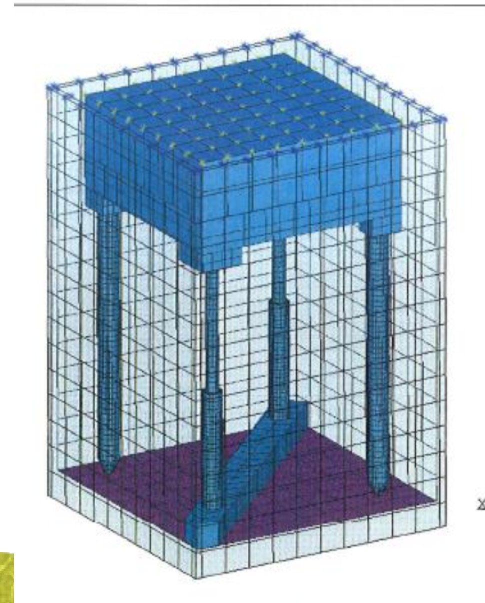
Traveller Shear Lip

Simplified Model

- Outerpack
  - Replaces most of outerpack with point masses
  - Includes outerpack foam pillow
  - Includes higher density foam limiter
  - No rubber shock mounts included – do not affect vertical drop performance

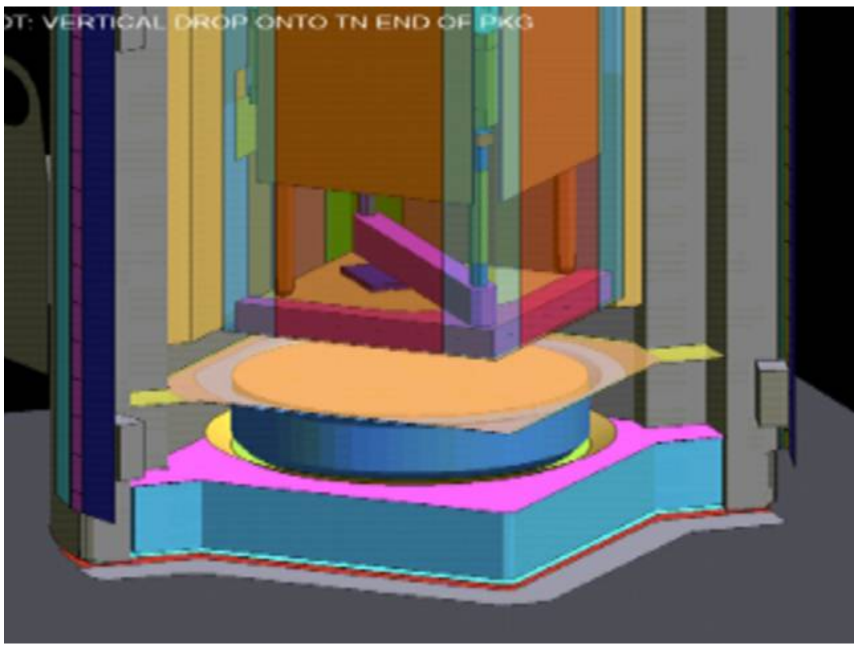
- Clamshell
  - Includes Clamshell top end components
  - Walls not included – demonstrated in actual testing not to buckle – relatively very stiff

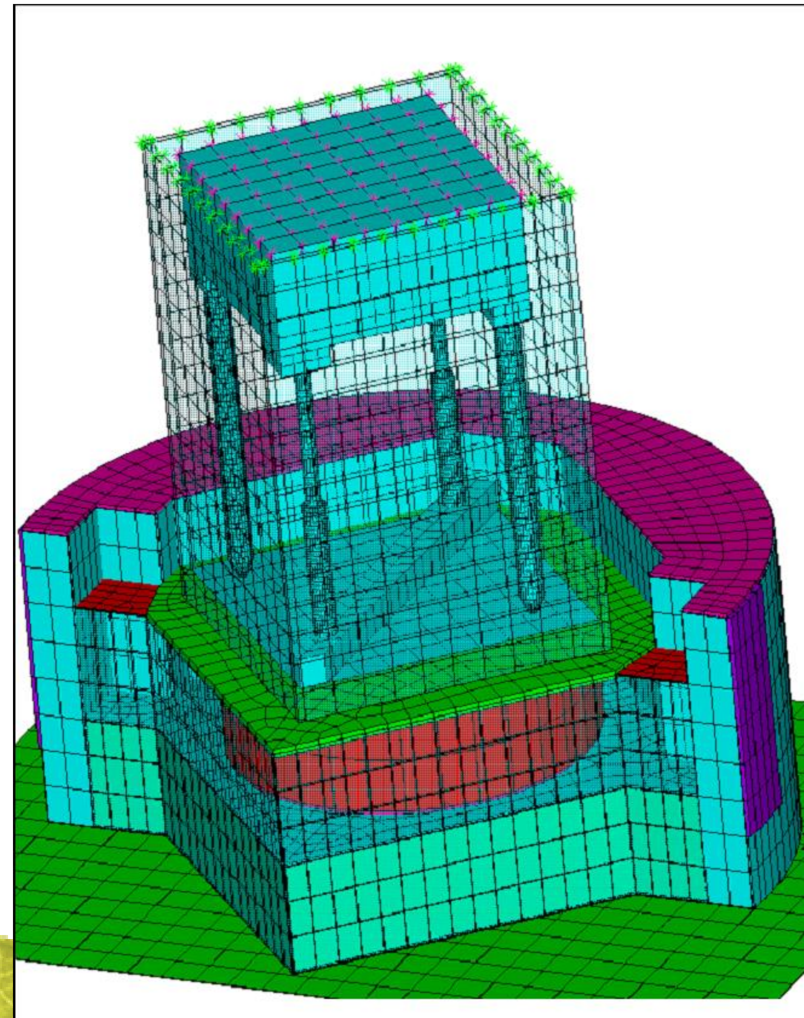




Traveller Shear Lip

Current and Simplified
FEA Models





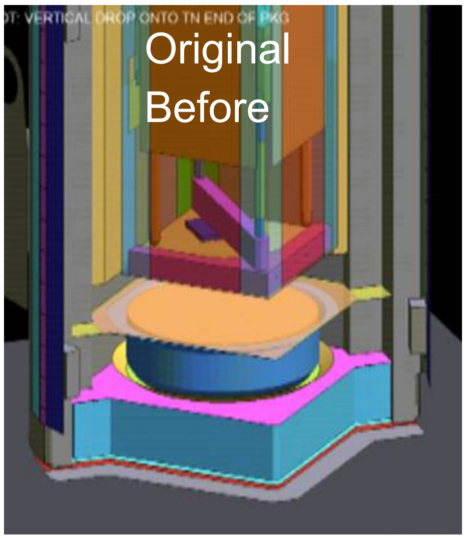
Westinghouse

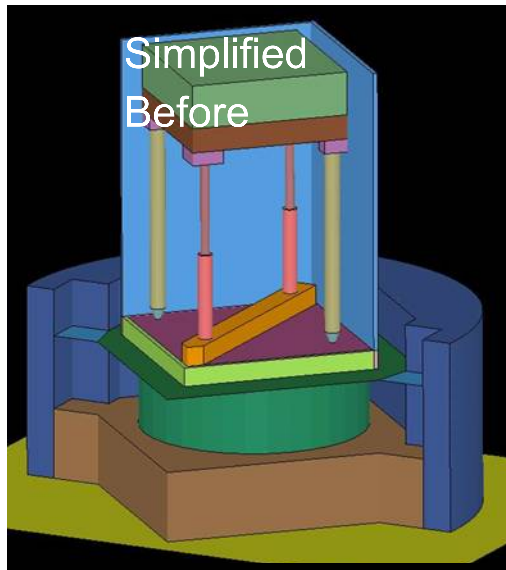
Traveller Shear Lip

[redacted]

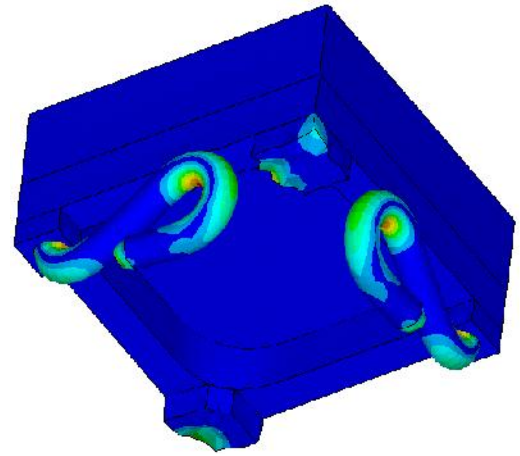
Westinghouse

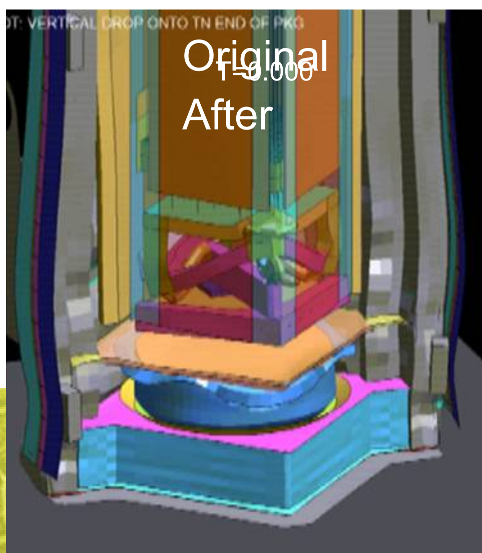
Traveller Shear Lip

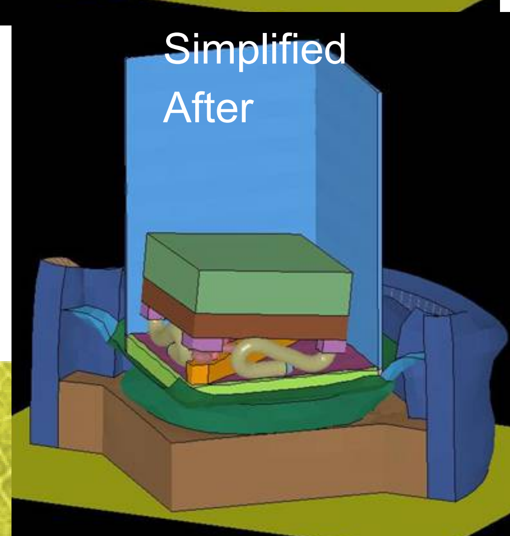




Simplified After







Westinghouse

Traveller Shear Lip

Results and Conclusions - Buckling
Original VS Simple

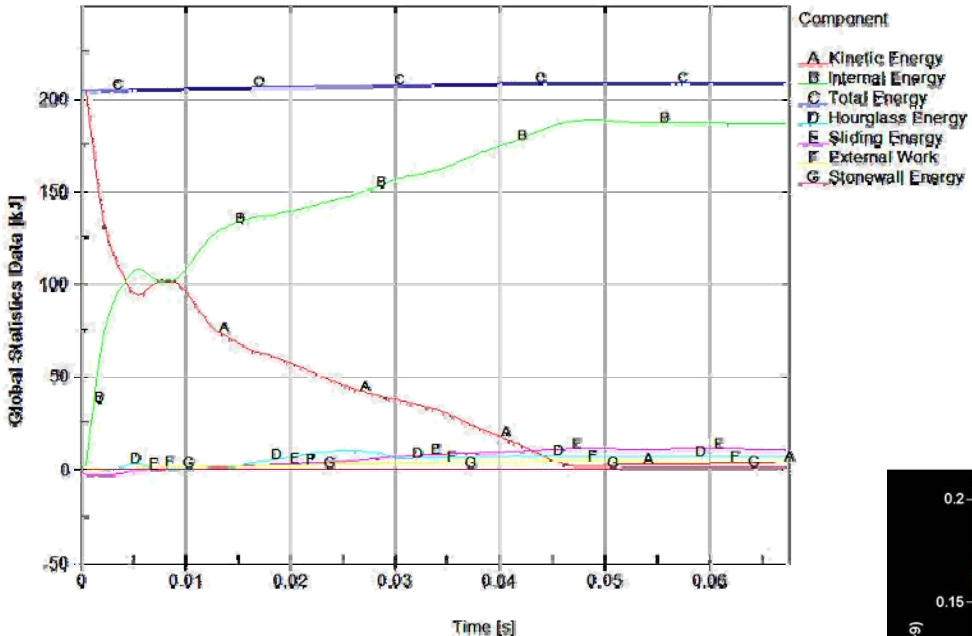
- From an overall general buckling perspective the original and simple models agree well with actual test results

- The original FEA model indicated that the top guide pins and axial clamp tubes/studs buckle extensively during the impact. This prediction was confirmed during actual drop testing. (Assumed a 17x17 XL FA with guide pins)

- The removable top plate design performed well in the FEA simulation and appears to have little effect on the overall performance of the container during impact.

Westinghouse

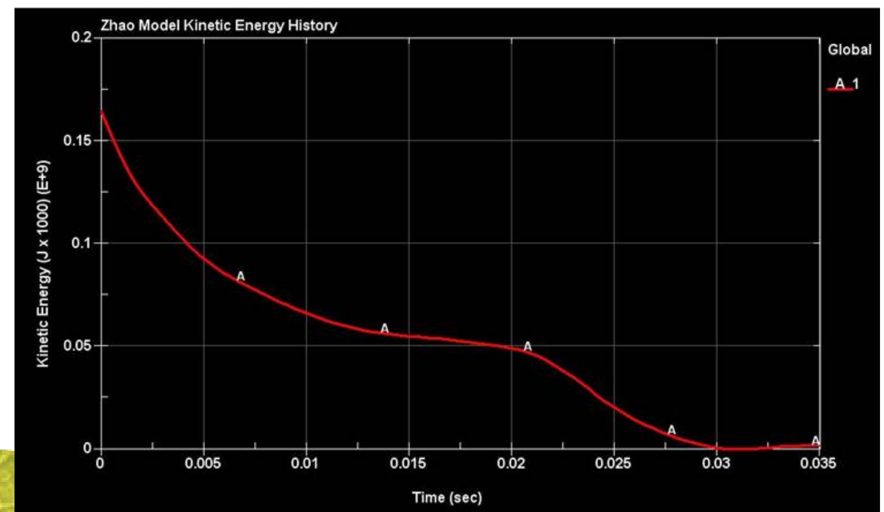
Traveller Shear Lip



Kinetic Energy

– Original FEA

Kinetic Energy – Simplified FEA



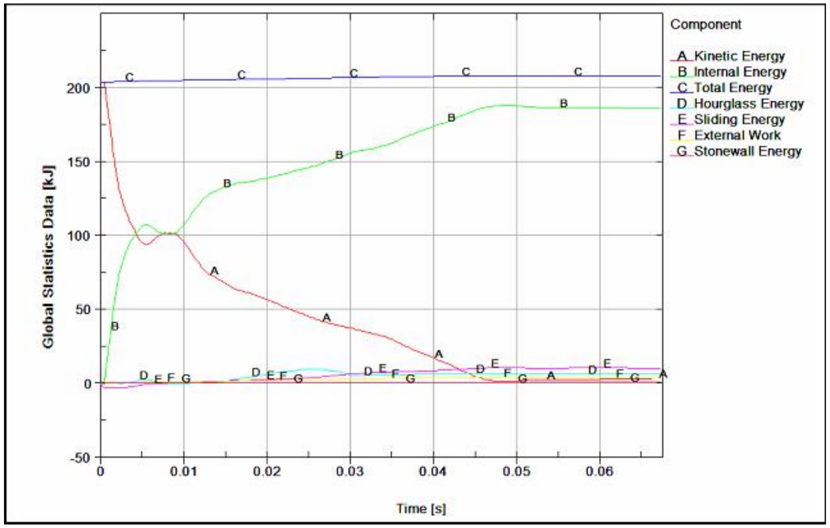
Westinghouse

Traveller Shear Lip

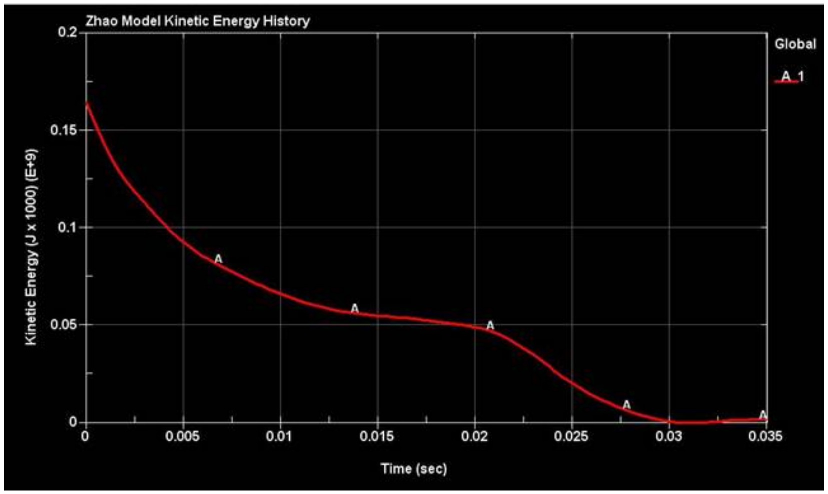
Results and Conclusions – Kinetic Energy
Original VS Simple

- The original model and simple model kinetic energy time history curves are similar.
- Duration of impact for simple model is shorter (0.031 sec) than original (0.047 sec). These differences are caused by differences in models
- Overall kinetic energy of original (~200 kJ) higher than simple (~164 kJ). Original was dropped above 9m
- The original model also has a relatively coarse mesh within the axial clamp components and the guide pin components, as well as discreet flexible rod elements to simulate the fuel rods. These will likely change the buckling and energy absorption characteristics of the system as compared to the simple model.

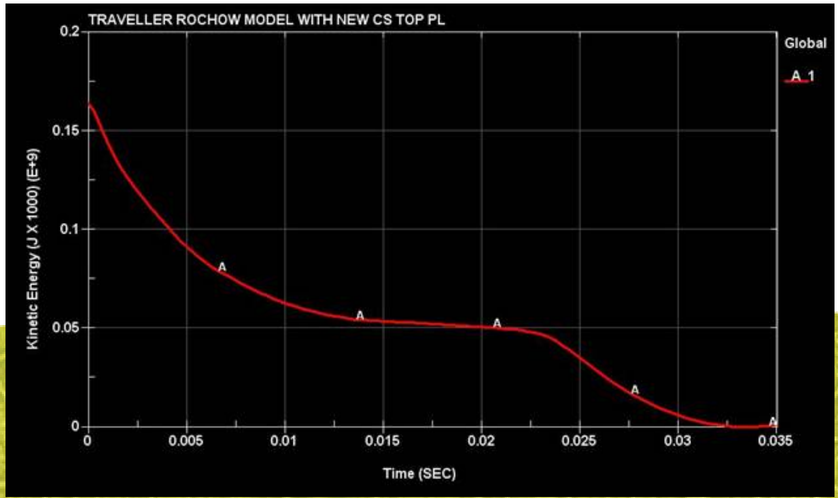
Traveller Shear Lip



Kinetic Energy – Original FEA



Kinetic Energy – Simplified FEA



Kinetic Energy Comparison

Original, Simplified, and New Shear Lip Design,

Westinghouse

Traveller Shear Lip

Shear Lip Removable Top Plate

- Removable top plate model eliminates the axial clamp arm assembly completely and replaces it with two (2) threaded fuel restraint studs (3/4" diameter, 16 threads per inch.
- The larger diameter, stronger axial clamp studs (3/4"-10 tpi) absorb a greater amount of energy over the simple model. It therefore takes longer for them to completely buckle. The remaining energy, starting at around 22 milliseconds is absorbed primarily by the pillow assembly.

Traveller Shear Lip

Shear Lip Removable Top Plate

- Excellent correlation can be seen in the plots where the maximum impact force is 2.5 million Newton (562,000 lbs) in the original model and 2.25 million Newton (506,000 lbs for the removable top plate model.

- The slightly larger mass of the original model accounts for the higher peak impact force,

- The detail in the Outerpack of the original model most likely accounts for the bulk of the difference in peak impact loads (it is stronger and stiffer in the original model).

Traveller Shear Lip

Results and Conclusions – Kinetic Energy

- The original model is more detailed and its Outerpack is stiffer axially. While this doesn't have a significant affect on the Clamshell buckling, it does appear to bounce in a more pronounced manner than the simple model and therefore takes longer to dissipate its kinetic energy.

- Despite these differences, the kinetic energy curve shape shows an acceptable agreement

- **"It is concluded that making a change to the removable top plate would not adversely affect the performance of the Traveller system during 9m, top end down impact. Other orientation impacts are not significantly affected by the Clamshell axial restraint system."**

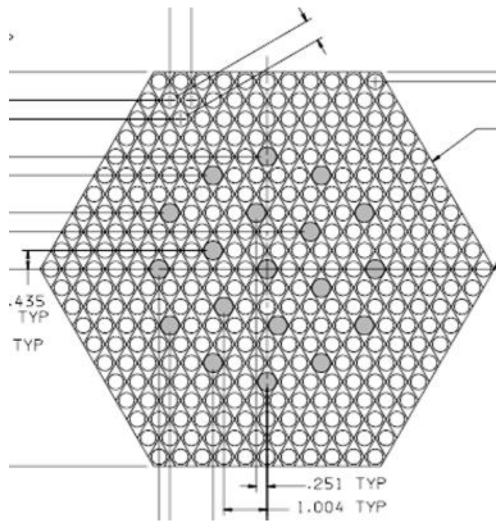
Traveller VVER

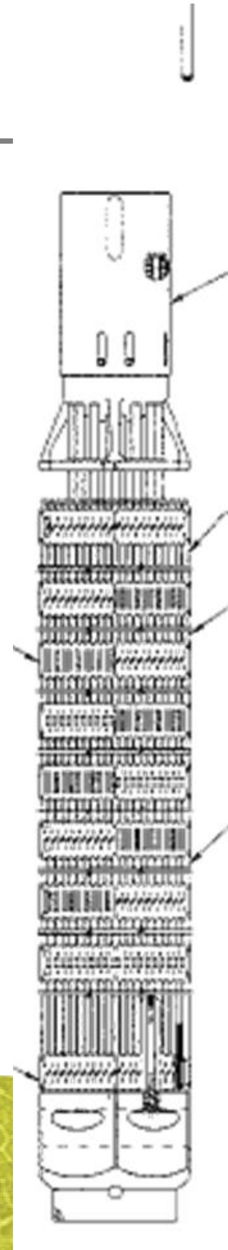
Traveller VVER

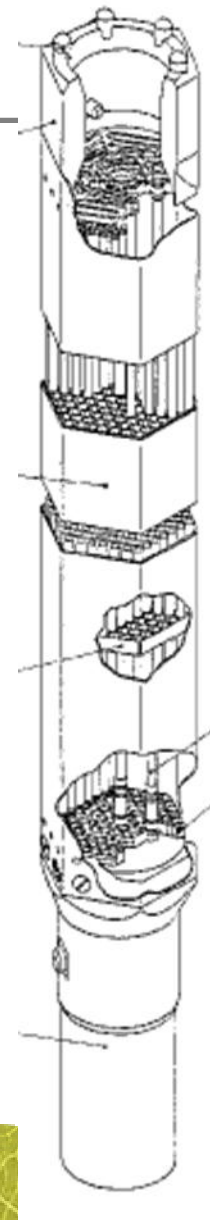
- Traveller has been developed and licensed to replace the MCC and 927 package families for shipment of PWR fuel
- A program was initiated in 2005 to identify design modifications that would allow the Traveller to transport VVER fuel, replacing the MCC5.
- A design approach was selected and a prototype was fabricated in 2008
- A design goal was to use the Traveller XL outerpack.

Traveller VVER

W typical
VVER-1000 FA



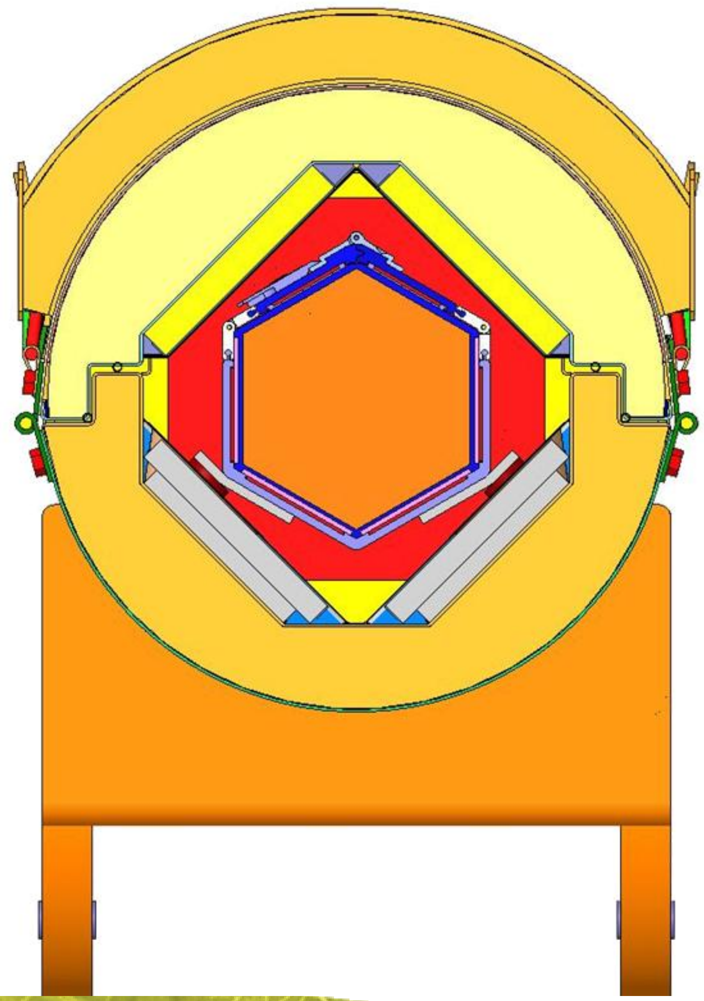




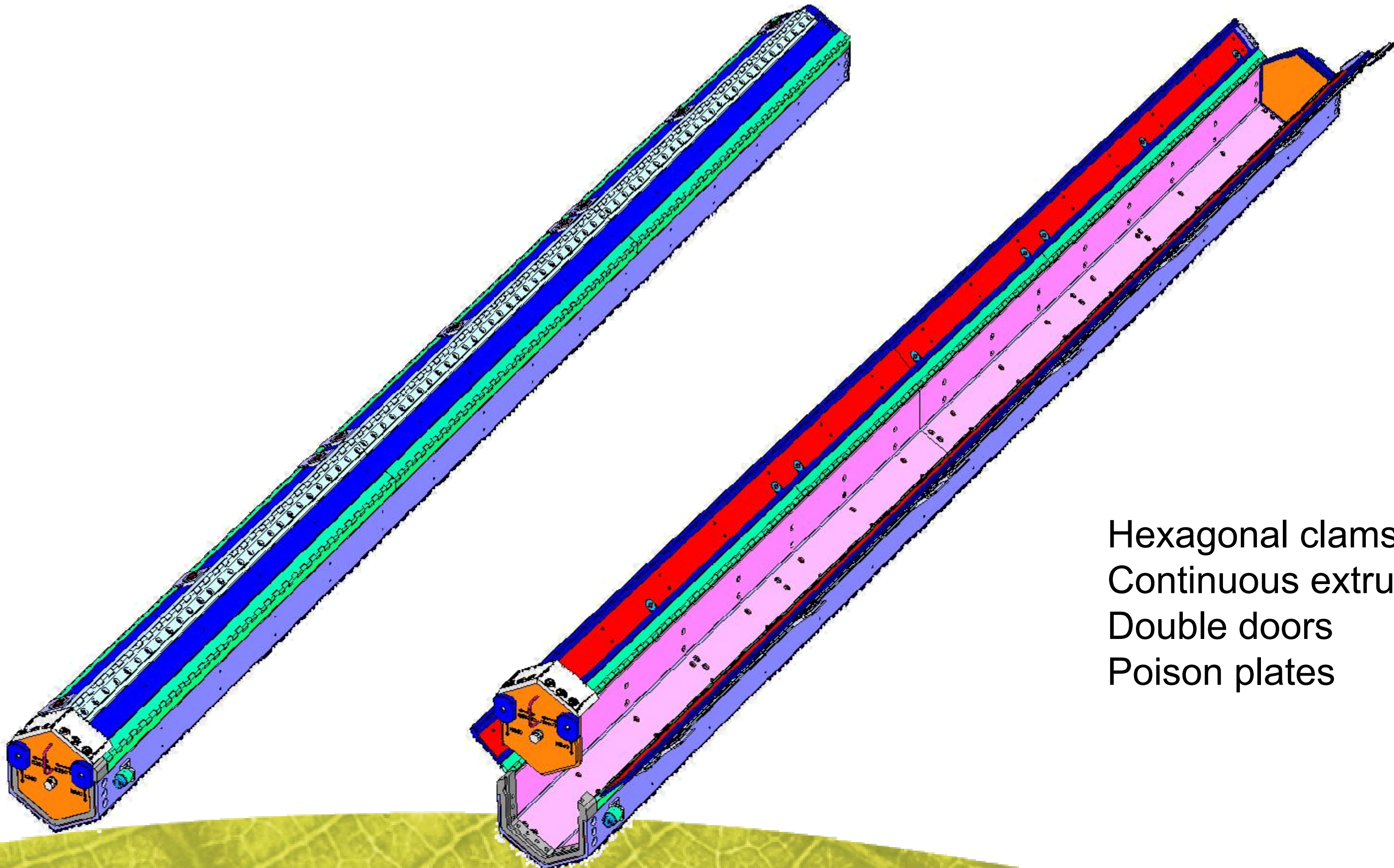
Westinghouse

Traveller VVER

- Hexagonal, close-fitting clamshell
- Stiffer shock mounts
- Reduced sway space (0.8” instead of 1.4”)
- Stiffness and sway space should be similar to 927 package



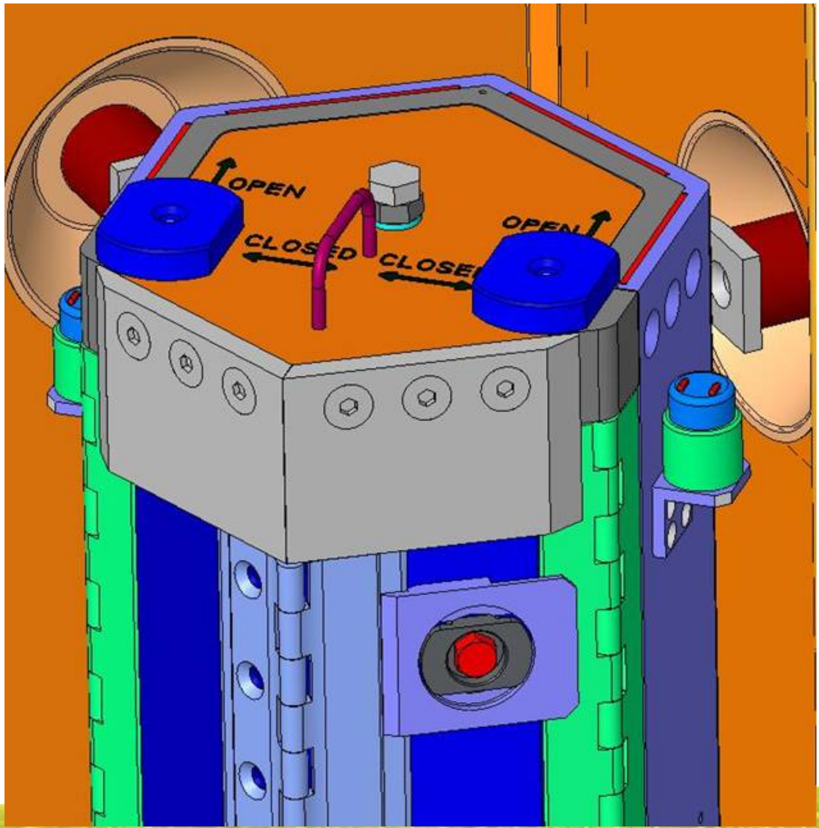
Traveller VVER

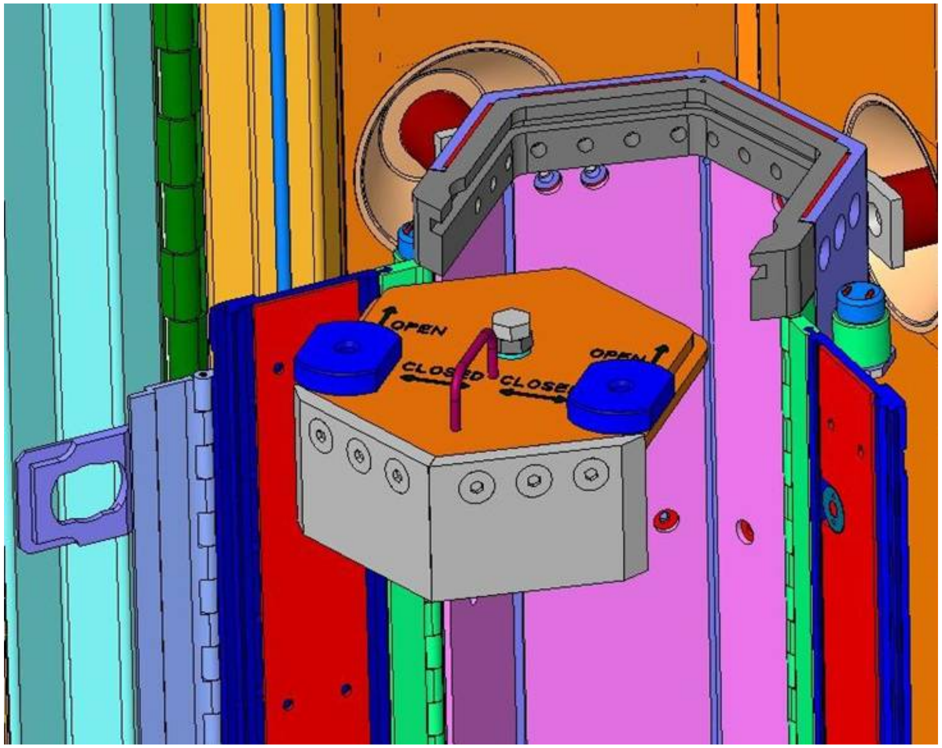


Hexagonal clamshell with:
Continuous extruded hinges
Double doors
Poison plates

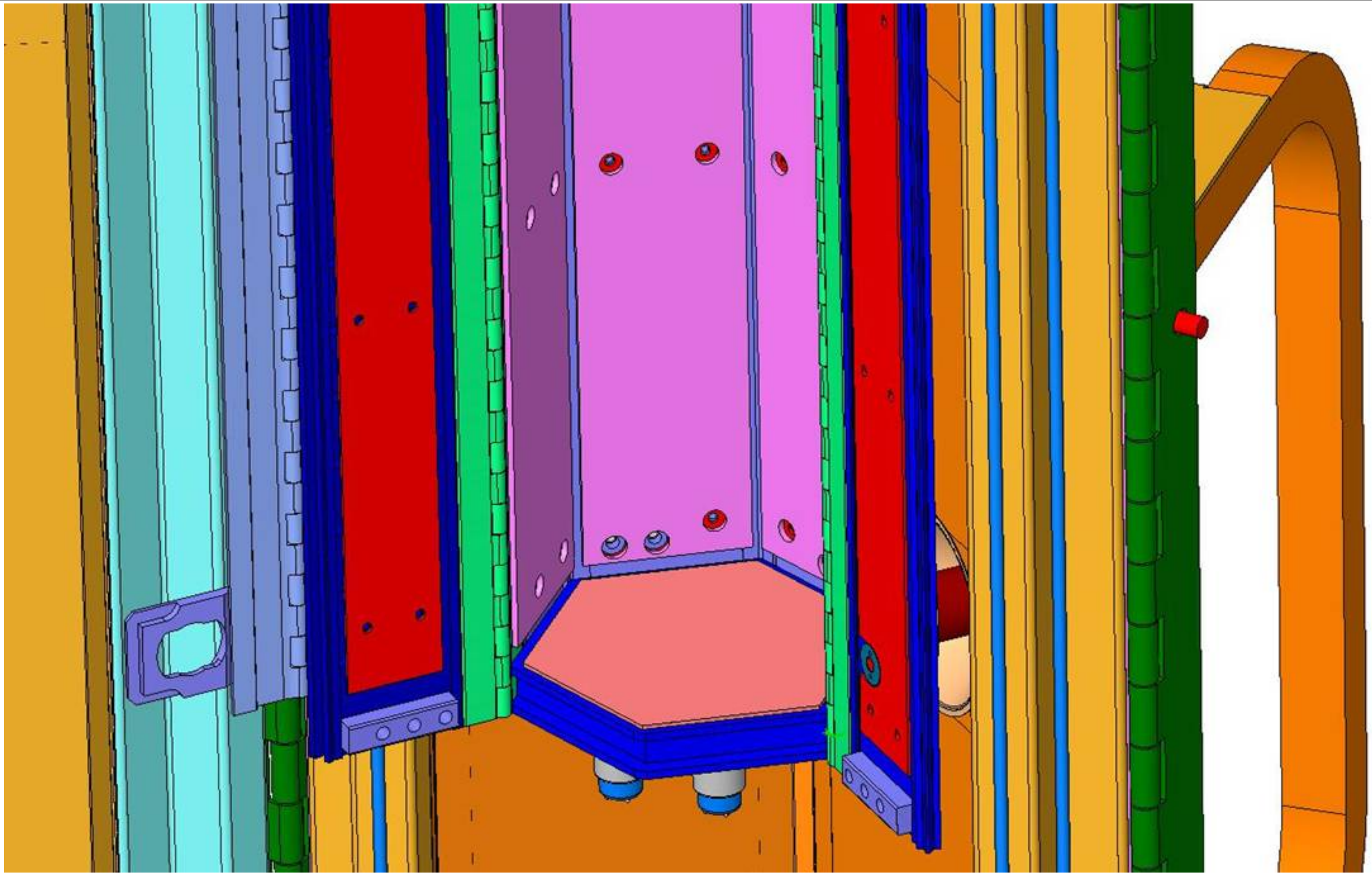
Traveller VVER

Top head retained by quick release pin and two rotating latches





Traveller VVER

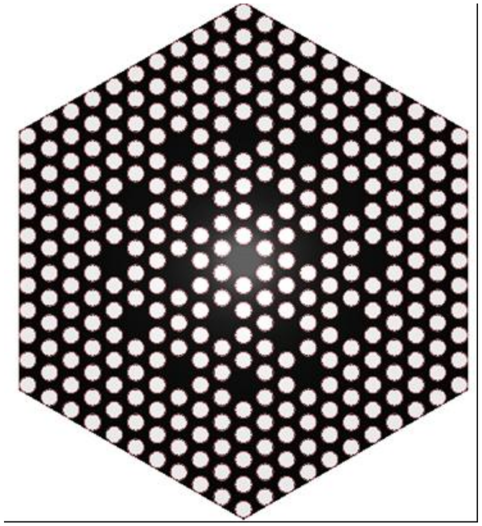


Traveller VVER

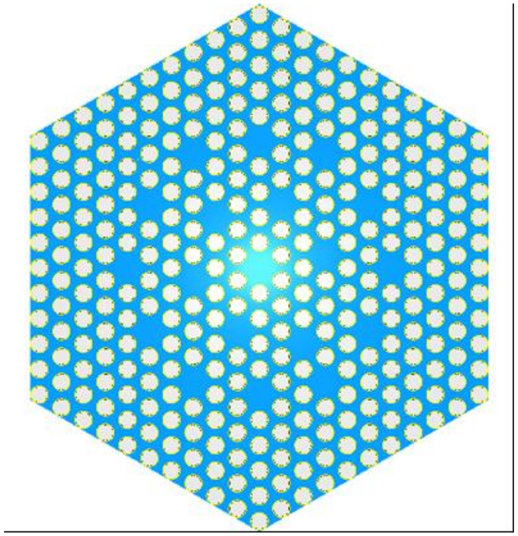
Demonstration Video – not included

Traveller VVER

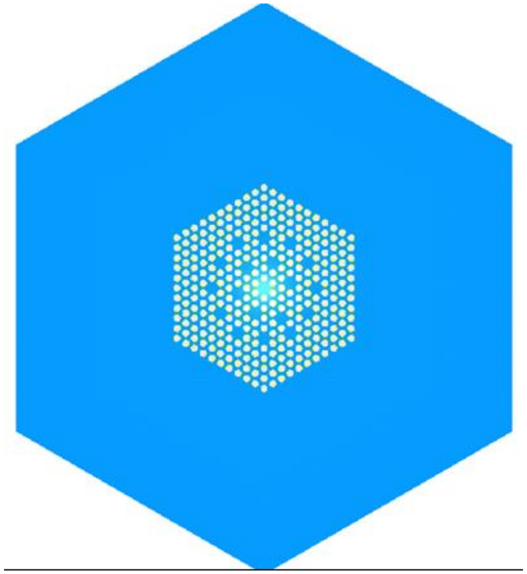
keff= 0.1055



keff=0.6763



keff= 0.9443

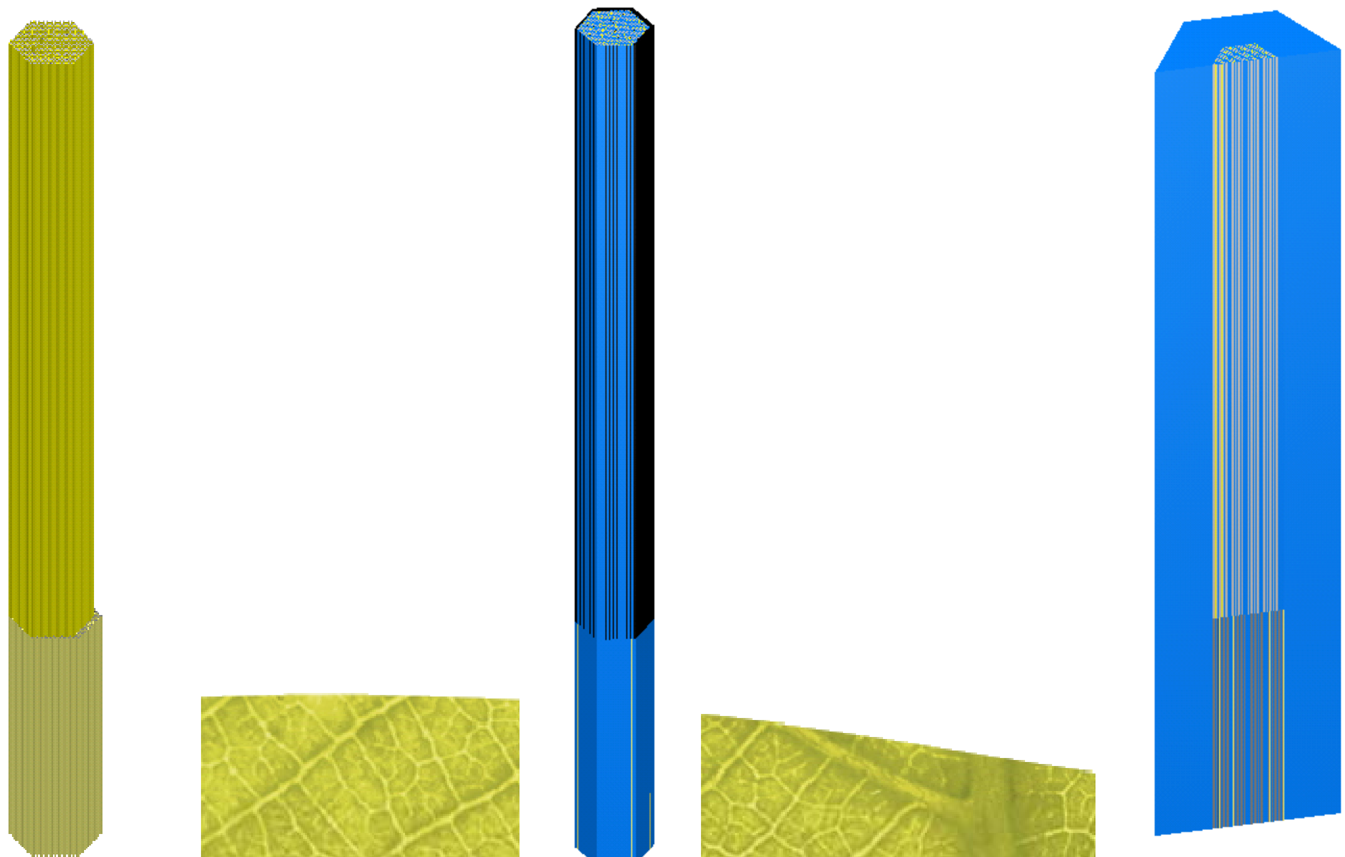


Single Undamaged Assembly Models

Traveller VVER

Single Damaged (100 cm lattice expansion region) Assembly

keff= 0.1052 keff= 0.7675 keff= 0.9929



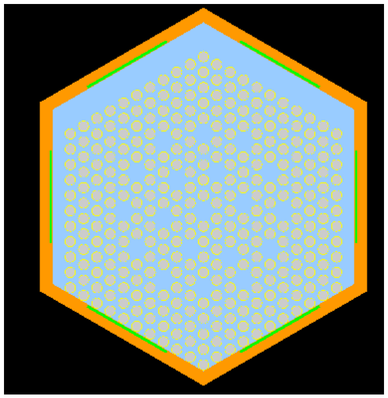
Westinghouse

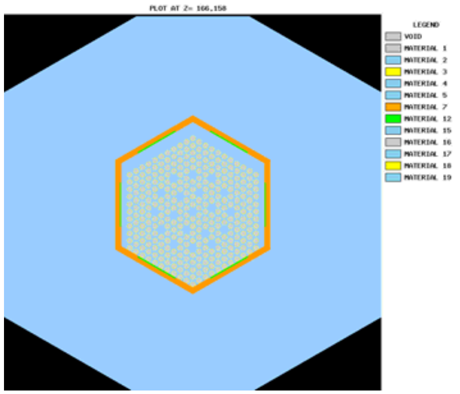
Traveller VVER

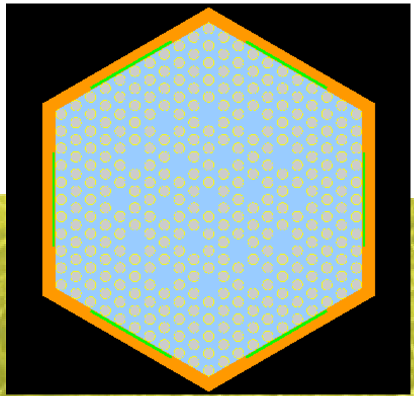
Single Damaged (100 cm lattice expansion region) Assembly in Clamshell Results

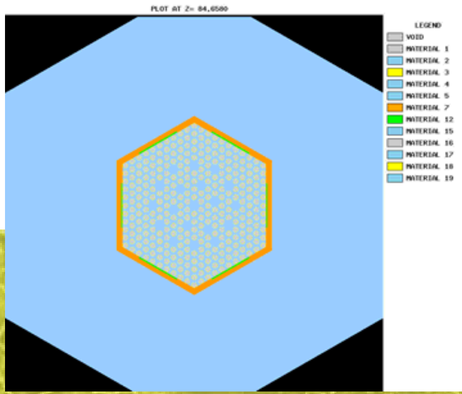
keff= 0.7979

keff= 0.8895









Traveller VVER

Routine_1 Case Description and Result

- VVER_Traveller_XL_routine_1 Conditions
  - Single Traveller-VVER Package with VVER clamshell
  - Single VVER-1000 Assembly
    - Top and Bottom Nozzle Modeled as H2O
      - No fuel-cladding gap flooding
      - No interstitial flooding in assembly
      - No lattice expansion
  - No Clamshell flooding
  - No flooding in interior of container to moderator blocks
  - Foam and shock mounts intact
  - No flooding in sway spaces
  - No reflection outside package

- keff=0.20309 + or - 0.00062

Traveller VVER

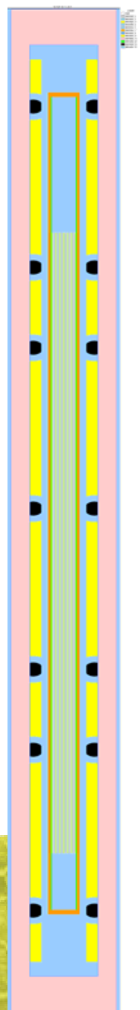
Normal_2 Case Description and Result

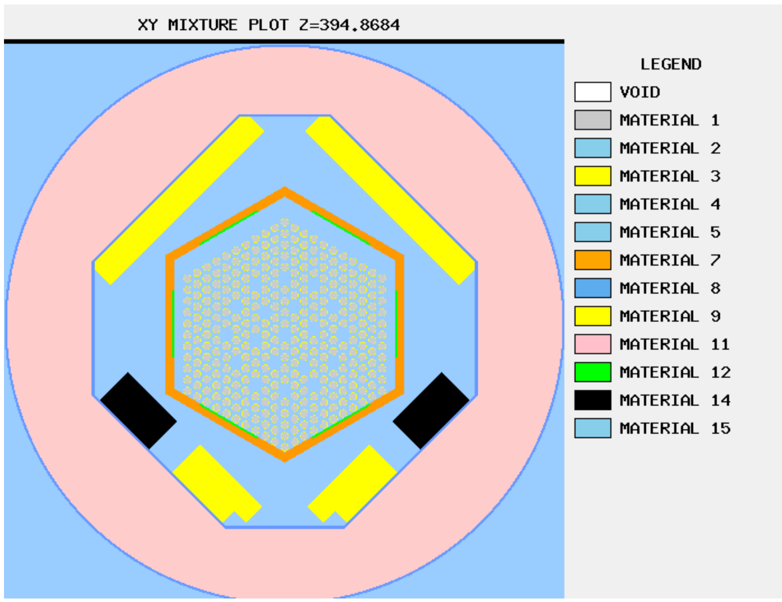
- VVER_1000_Traveller_VVER_Normal_2 Conditions
  - Single Traveller-VVER Package
  - Single VVER Assembly
    - Top and Bottom Nozzle Modeled as H2O
      - Fuel-cladding gap void
      - Full interstitial flooding in assembly
      - No lattice expansion
  - Clamshell flooded
- Foam and shock mounts intact
  - Sway spaces flooded
  - 20 cm H2O reflection outside package
- keff=0.8494 + or - 0.0013

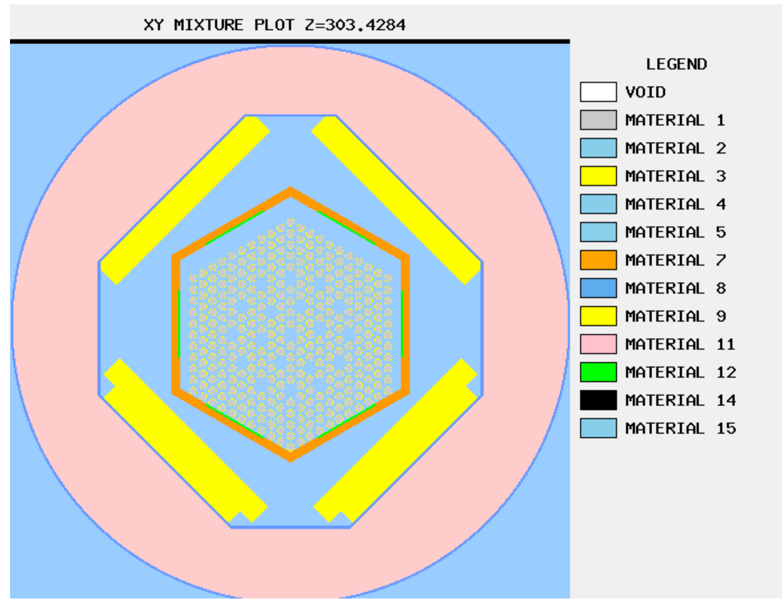
Westinghouse

Traveller VVER

keff=0.8494 + or - 0.0013







Normal_2 Case Plots

Traveller VVER

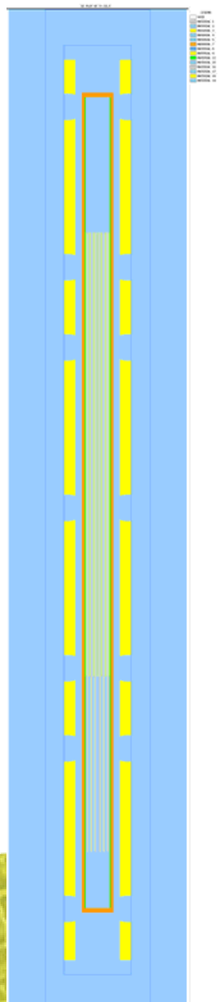
HAC_3 Case Description and Result

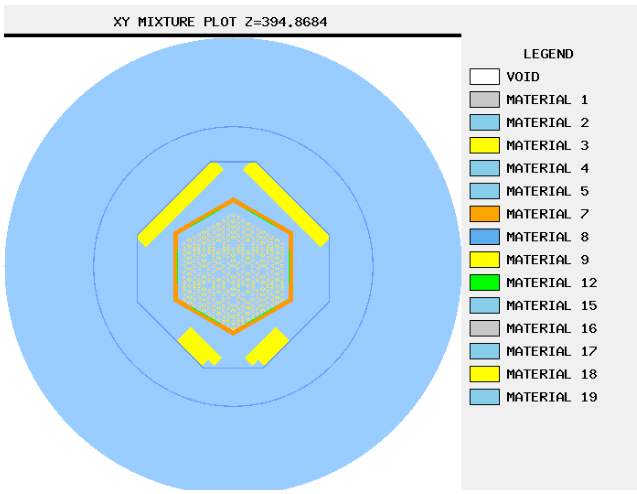
- VVER_Traveller_XL_HAC_3 Conditions
  - Single Traveller-STD Package
  - Single 17x17STD-HC Assembly in packaging
    - Top and Bottom Nozzle Modeled as H_2O
      - Fuel-cladding gap flooded
      - Full interstitial flooding in assembly
      - 100 cm expanded lattice section
  - Clamshell flooded
  - Foam and shock mounts removed and regions flooded
  - Sway spaces flooded
  - 20 cm H_2O reflection outside package

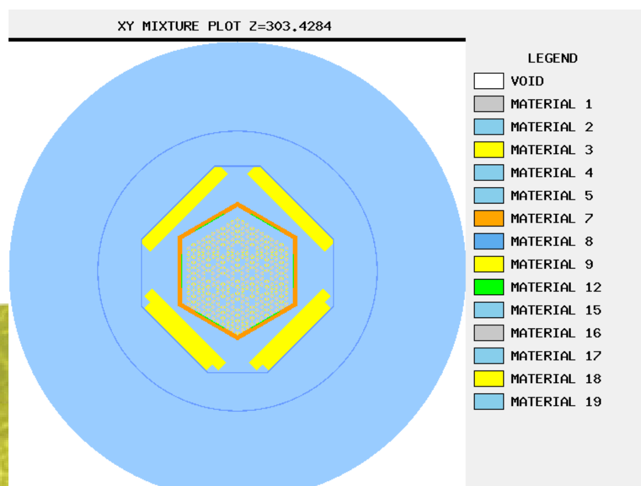
- keff=0.8896 + or - 0.0017

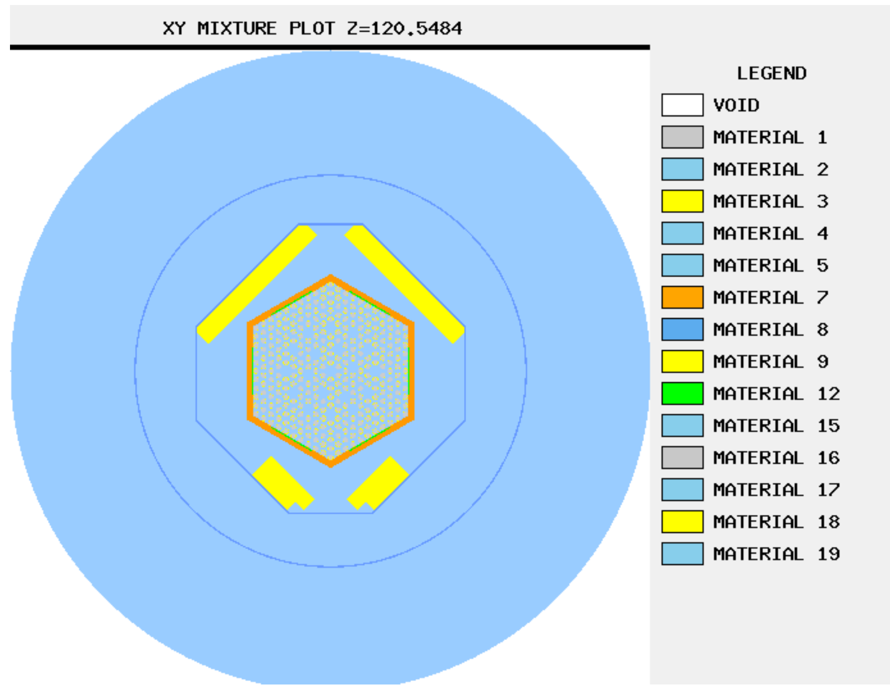
Traveller VVER

keff=0.8896 + or - 0.0017









HAC_3 Case Plots

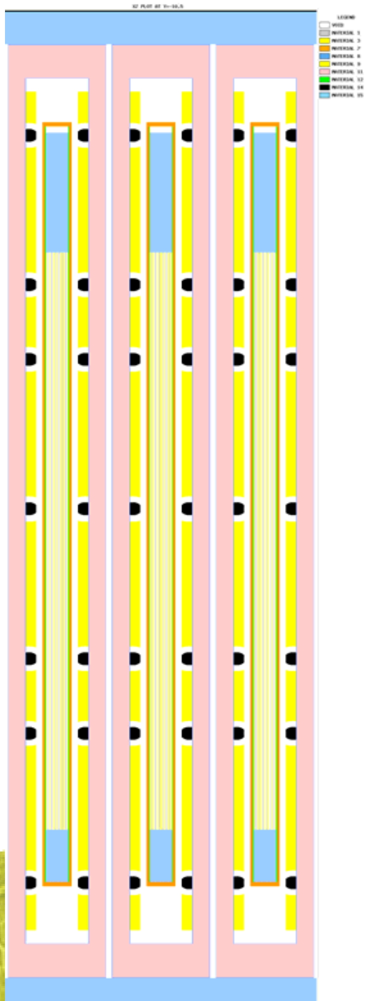
Traveller VVER

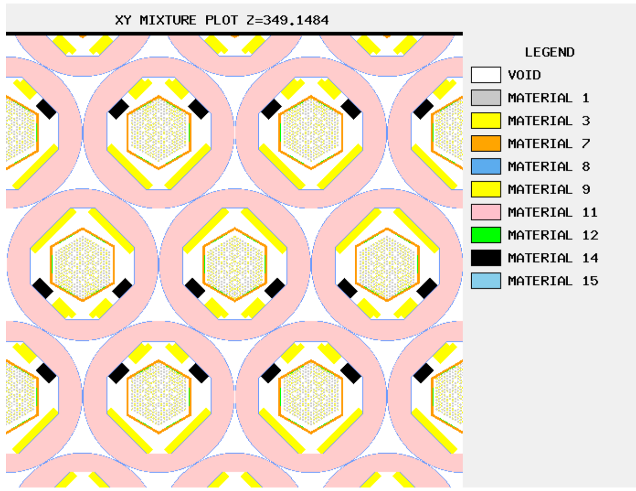
Routine_4 Case Description and Result

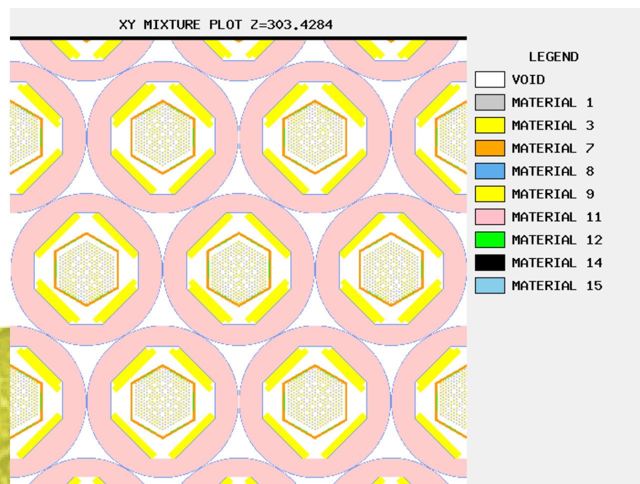
- VVER_Traveller_XL_routine_4 Conditions
  - 75 VVER_Traveller package array (1N)
  - Alternate rows of packages are rotated 180 degrees
  - Single VVER-1000 Assembly in each Packaging
    - Top and Bottom Nozzle Modeled as H_2O
      - No fuel-cladding gap flooding
      - No interstitial flooding in assembly
      - No lattice expansion
  - No Clamshell flooding
- No flooding in interior of container to moderator blocks
  - Foam and shock mounts intact
  - No flooding in sway spaces
  - 20 cm reflection outside package array
- keff=0.33879 + or - 0.00086

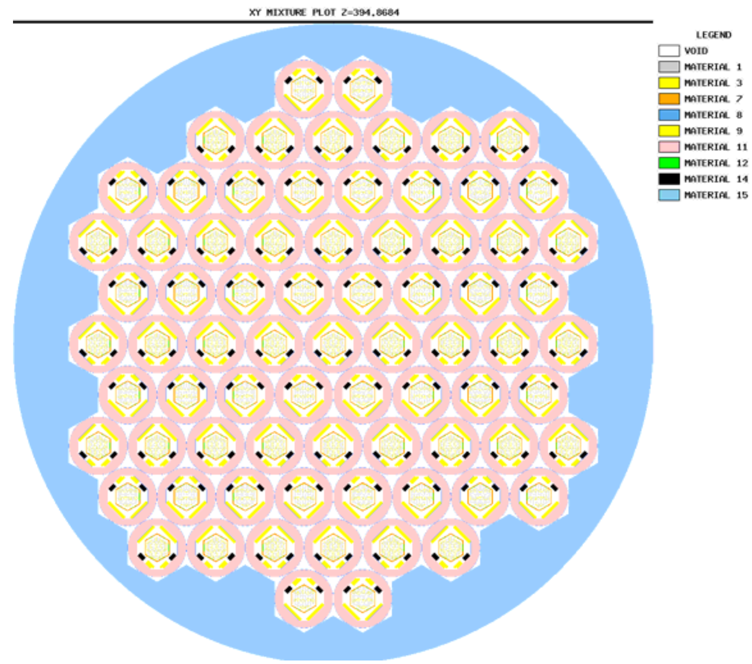
Traveller VVER

keff=0.33879 + or - 0.00086









Routine_4 Case Plots

Westinghouse

Traveller VVER

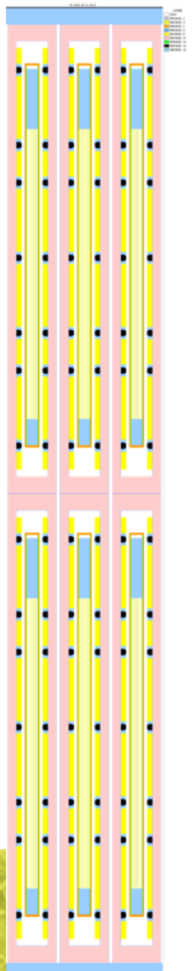
Normal_5 Case Description and Result

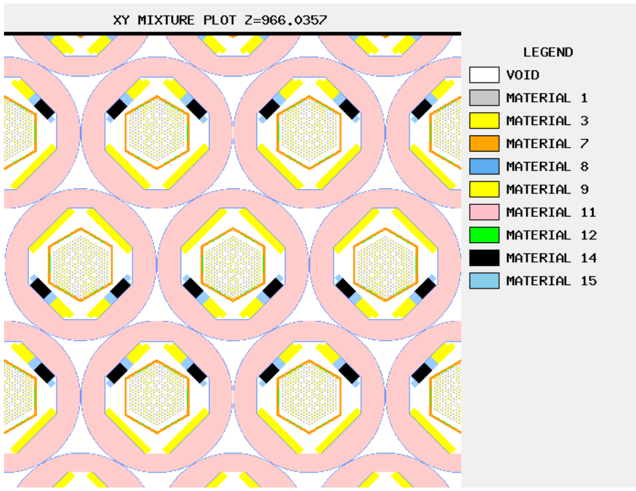
- VVER_Traveller_XL_normal_5 Conditions
  - 375 VVER Traveller-XL Package array (5N) [188 stacked on 188, actually 376 packages]
  - Alternate rows of packages are rotated 180 degrees
  - Single VVER Assembly in each Packaging
  - Top and Bottom Nozzle Modeled as H_2O
  - No fuel-cladding gap flooding
  - No interstitial flooding in assembly
  - No lattice expansion
  - No Clamshell flooding
  - No flooding in interior of container to moderator blocks
  - Foam and shock mounts intact
  - No flooding in sway spaces
  - 20 cm reflection outside package array
- keff=0.34242 + or - 0.00093

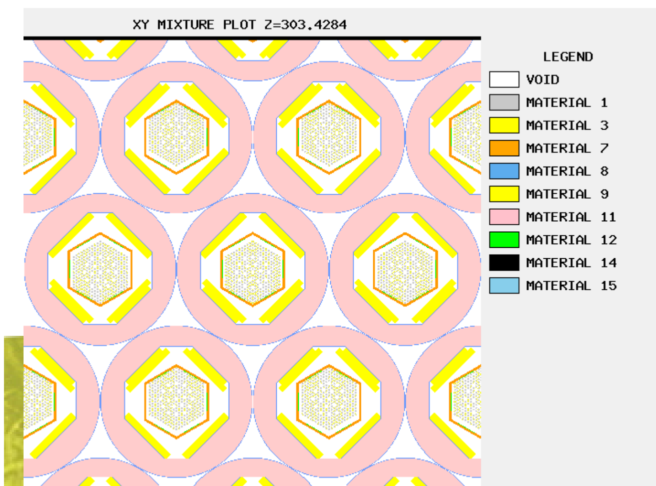
Westinghouse

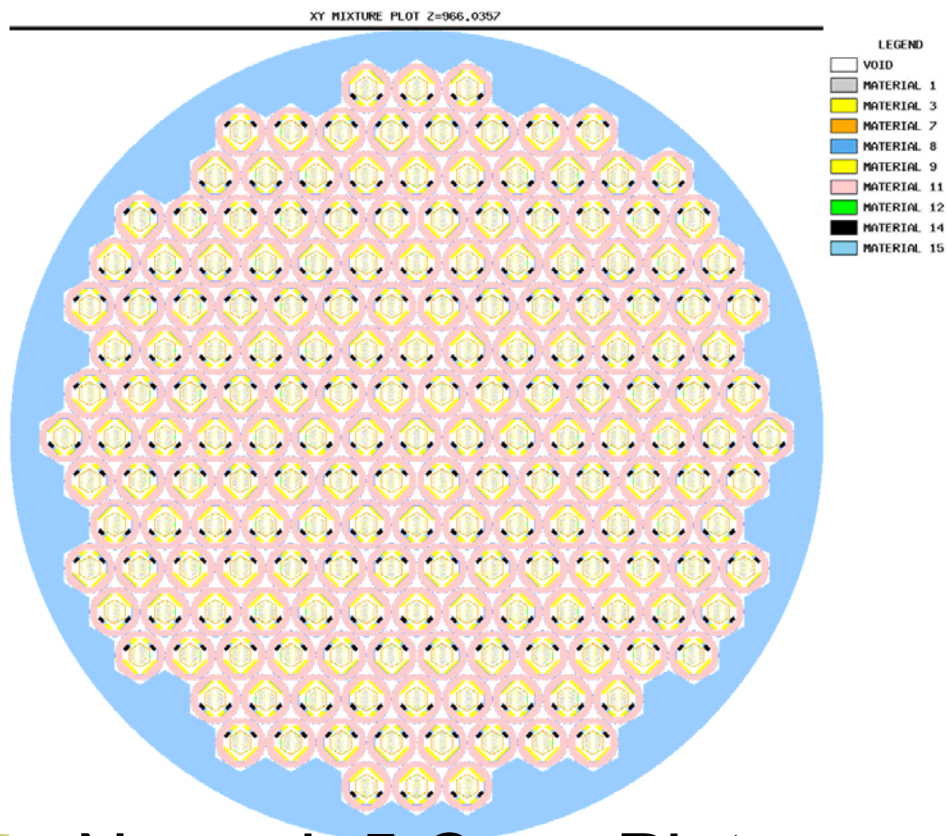
Traveller VVER

keff=0.34242 + or - 0.00093









Normal_5 Case Plots

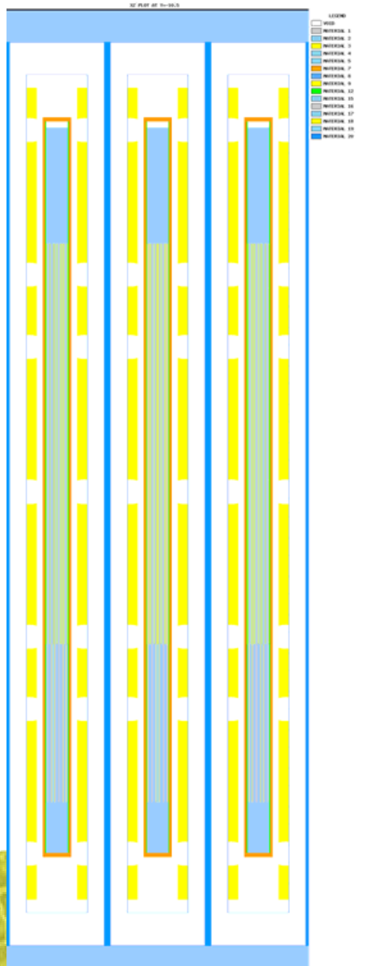
Traveller VVER

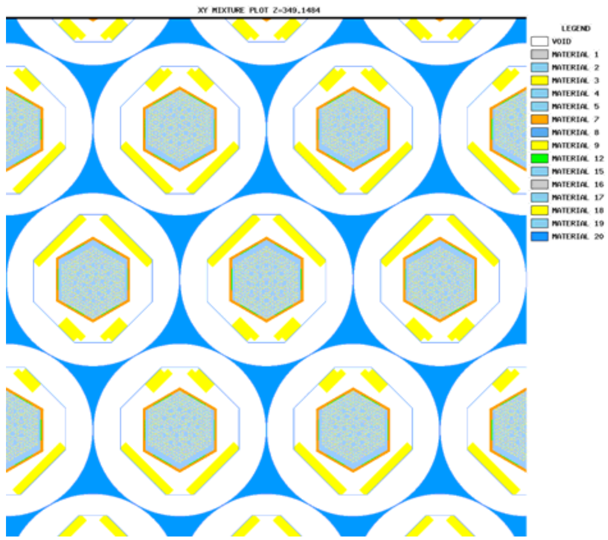
HAC_6 Case Description

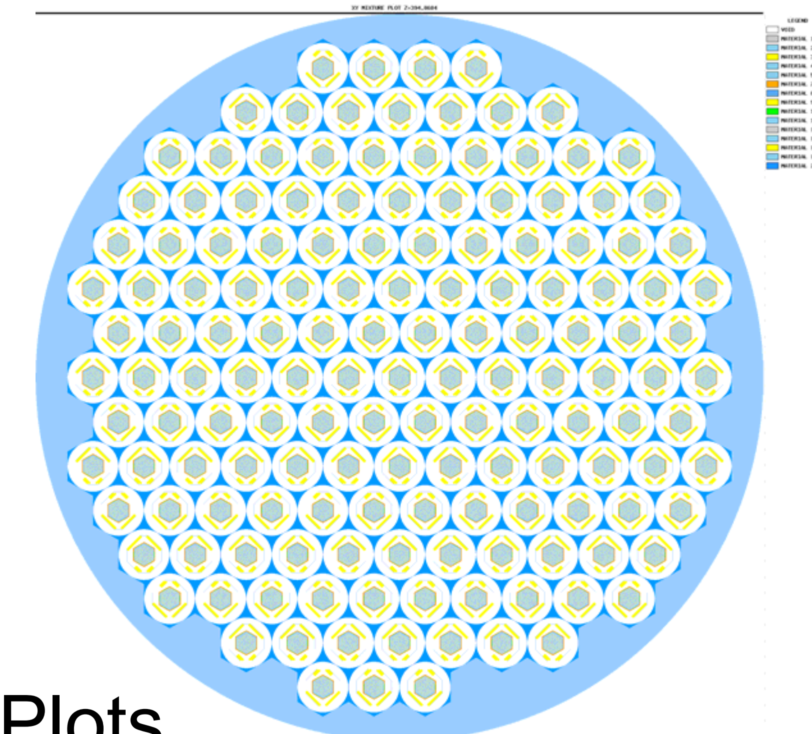
- VVER_Traveller_XL_HAC_6 Conditions
  - 150 Traveller-STD Package array, single tier (2N case)
  - Alternate rows of packages are rotated 180 degrees.
  - Packages are close packed in a triangular array.
  - Single VVER Assembly in each Packaging
    - Top and Bottom Nozzle Modeled as $H2O$
      - Fuel-cladding gap flooded
      - Full interstitial flooding in assembly
      - 100 cm lattice expansion region
  - Clamshell flooded
  - No flooding in interior of container to moderator blocks
  - Foam and shock mounts void for maximum interaction
  - Void in sway spaces
  - Variable moderation outside individual packages from 0 to 1gm/cc density water
- 20 cm reflection outside package array

Traveller VVER

keff=determination demonstrated in following slides







HAC_6 Case Plots

Traveller VVER

Summary

- Traveller VVER uses same Traveller XL outerpack
- NCS analysis demonstrates subcritical during HAC
- FEA demonstrates that clamshell retains structural integrity during HAC testing
- Licensing Plan – amend the SAR (similar to MCC5)

Traveller Manufacture
Outside United States

Westinghouse

Traveller Manufacture Outside USA

1. Vendor Requirements
   - Comply with 10CFR71?
   - Satisfy WEC QMS?

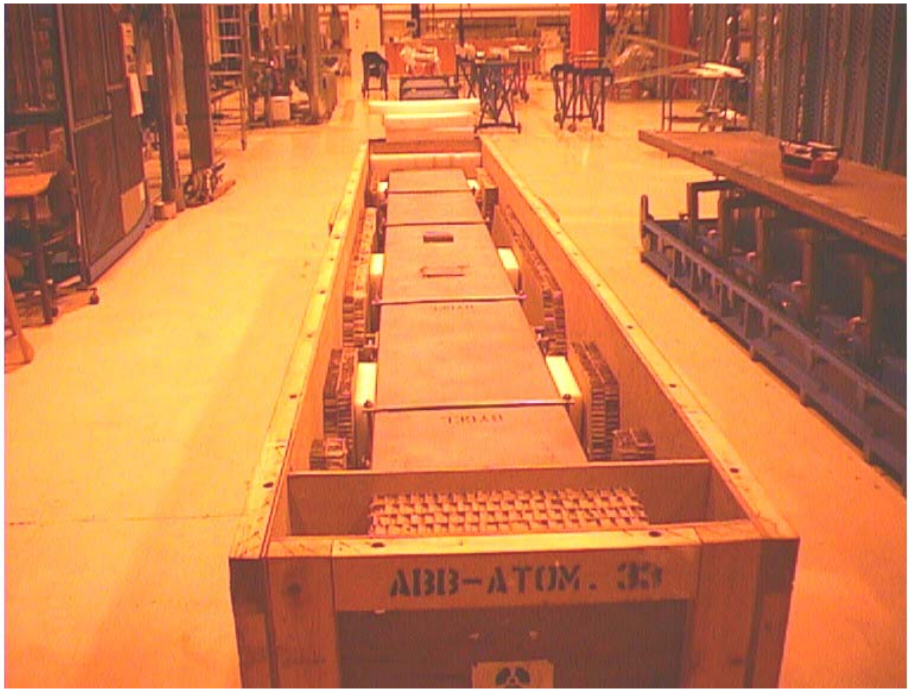
2. Foam Manufacturer

3. Dimensions – Imperial vs Metric

Rod Transport Package Licensing

Embrace   S/50/IF-96

- Validations – Germany, Switzerland
- Plan to validate by USDOT 2009
- May apply for US NRC Certificate of compliance (CoC) in 2009 to use for domestic rod transports .



Westinghouse