

AOS Cask System SAR Submittal

NRC Meeting
February 9, 2016

Discussion Outline

1. MCNP Models

Changes to MCNP geometry, materials, source spectra, etc.

2. New Configurations

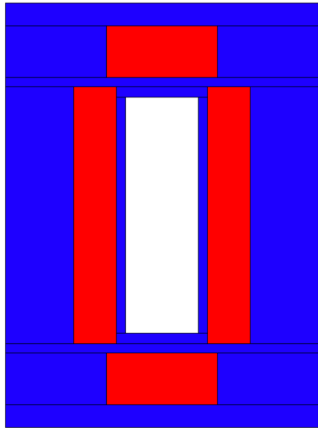
Additional configurations/analyses to meet customer needs

3. Results

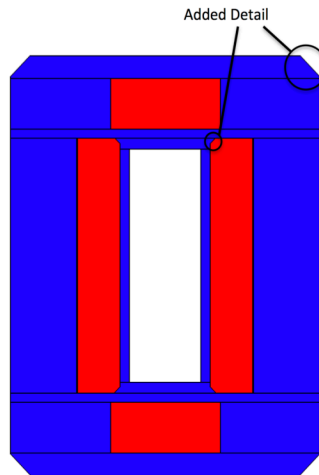
4. Schedule / Discussion

MCNP Models

Cask Models -

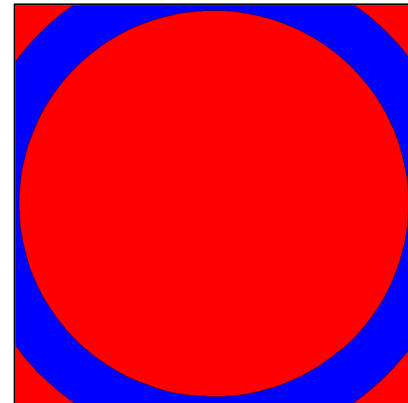


Old Model

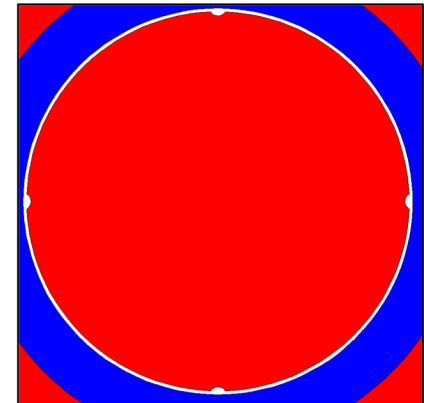


New Model

Tungsten Axial Shield Plates -



Old Model



New Model

SCALE 6.1 ORIGEN Libraries -

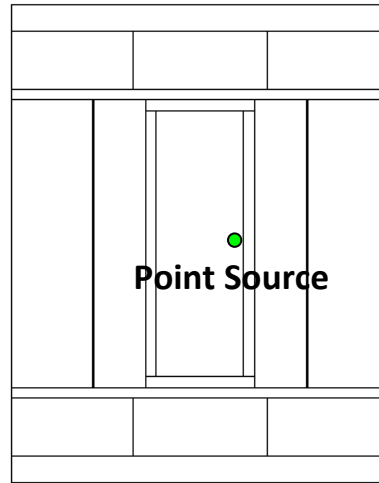
- Gamma Distribution Library: `origen.rev04.mpdkxgam.data`
- Isotope Decay Heat: `origen.rev03.decay.data`

Material Definitions -

- Tungsten: $17.8 \text{ g/cm}^3 \rightarrow 17.75 \text{ g/cm}^3$
 - W – 95%
 - Ni – 3.5%
 - Fe – 1.5%
- Stainless Steel: $7.8 \text{ g/cm}^3 \rightarrow 8.0 \text{ g/cm}^3$
- Air \rightarrow Void

MCNP Models (Side Source)

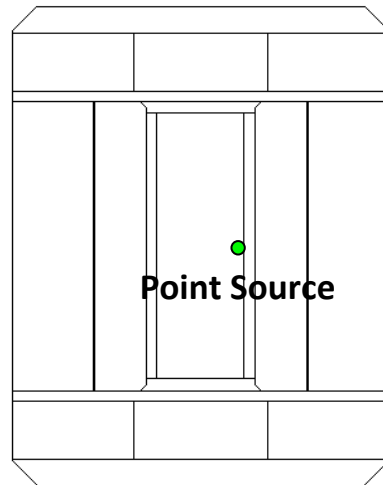
Old Model:



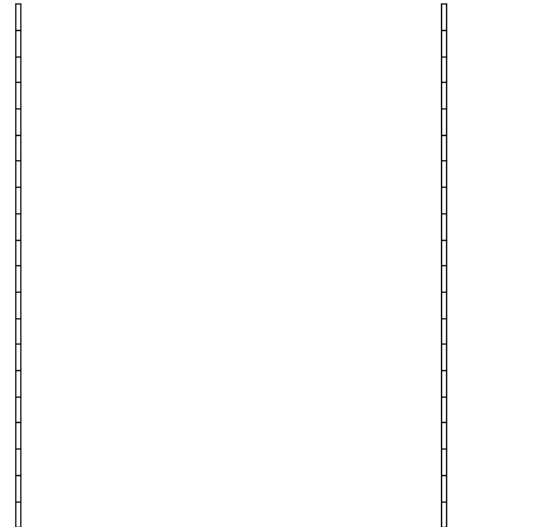
Point Detectors



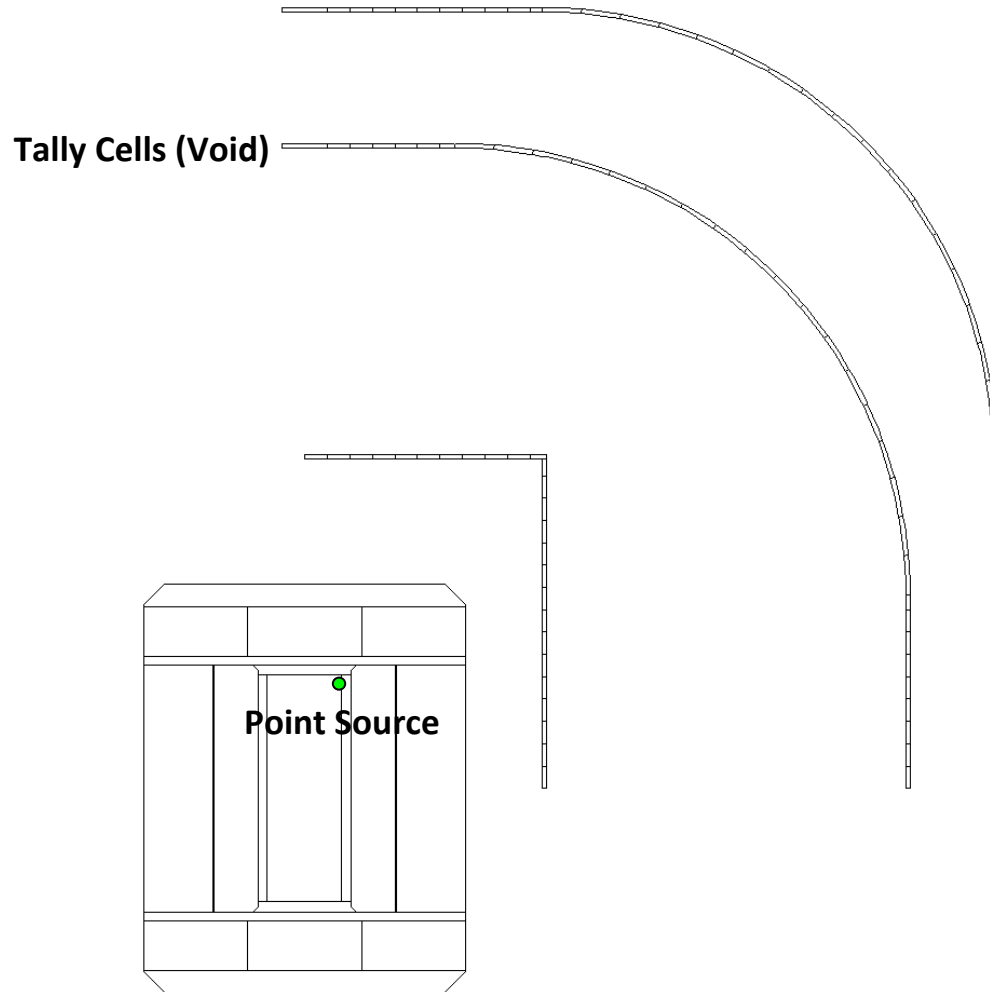
New Model:



Void Tally Cells

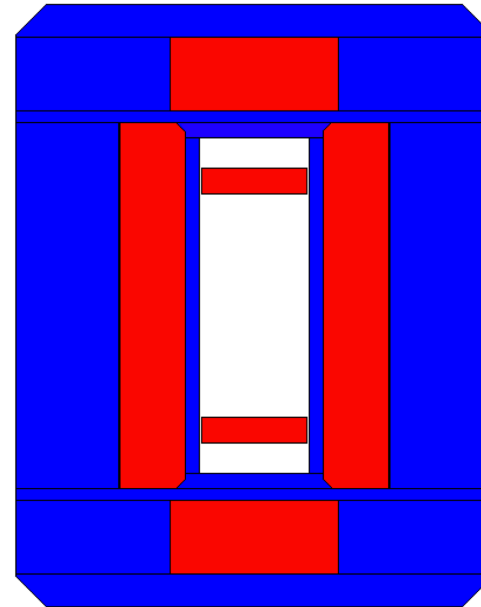
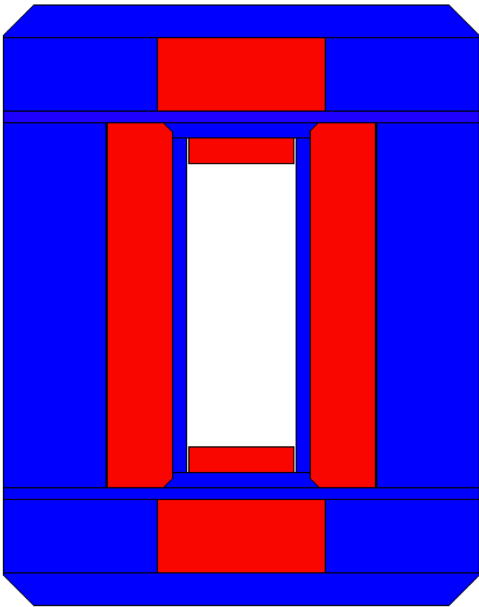


MCNP Models (Corner Source)



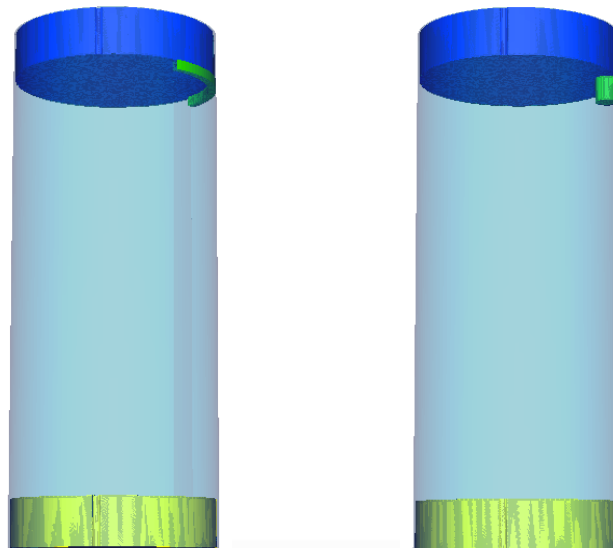
New Configuration (AOS-100A)

- Addition of new spacer plates that separate the Tungsten axial shield plates from the cask lid plugs, reducing the usable cavity to 34cm.
- New spacer components are fabricated out of Stainless Steel or Aluminum, and are only used for Co-60 shipments in the AOS-100A.
- No Credit taken for material of the spacers, only displacement of Axial shield plates.
- New activity limit Added to Table 1-2 in the AOS SAR under isotope 'Co-60-C'.



New Configuration (AOS-100A Cont'd)

- To optimize Co-60-C activity limit, a volume source is used.
- Source volume is based on the desired activity limit (19kCi), a set specific activity limit (350 Ci/g), and the density of Cobalt (8.9 g/cm³).
- Multiple geometries (examples shown below) are analyzed and the Co-60-C activity limit is determined by the most limiting source geometry.
- **Other than the Co-60-C isotope, all other dose rate calculations still use a point source.**



Iridium-192/194 Limits

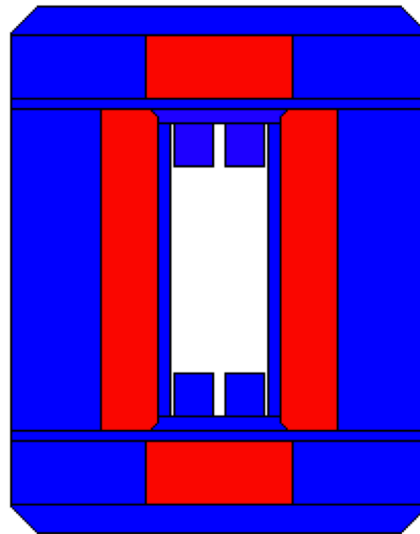
- Shipments of Iridium-192 sources sometimes include Iridium-194 impurities.
- A separate activity limit table is added to Section 1 of the SAR with Ir-192 activity limits based on the activity of the Ir-194 impurity.
- The total dose rate from the Ir-192 source and Ir-194 impurity are calculated as:

$$DR_{\text{Limit}} = A_{192} \cdot \left(\frac{DR}{Ci} \right)_{192} + A_{194} \cdot \left(\frac{DR}{Ci} \right)_{194}$$

- Ir-192 activity limits calculated by selecting an Ir-194 impurity activity and determining what activity of Ir-192 results in the external dose rate being equal to 90% of the regulatory limit.

New Configuration (AOS-050A)

- New component for the AOS-050A
- A solid stainless steel disc with a hole modeled through the center to allow for penetrations for handling.
- Component is **only** required for the Ir-192 and Ir-194 dose rate calculations in the AOS-050A.



Results (Revised SAR Table 1-2)

Isotope ^a	Decay Heat (Ci/Watt) ^b	Model							
		AOS-025		AOS-050		AOS-100			
		A (10W)		A (100W)		A, A-S (400W)		B (400W)	
		TBq	Ci	TBq	Ci	TBq	Ci	TBq	Ci
Co-60	6.45E+01	4.92E-03	1.33E-01	2.78E-02	7.50E-01	1.01E+01	2.73E+02	4.03E-01	1.09E+01
Co-60-B	6.45E+01	-	-	-	-	3.05E+01	8.23E+02	-	-
Co-60-C	6.45E+01	-	-	-	-	7.48E+02	2.02E+04	-	-
Cs-137	2.00E+02	3.70E-01	1.00E+01	7.13E-01	1.93E+01	1.32E+03	3.55E+04	2.15E+01	5.82E+02
Hf-181	2.31E+02	-	-	3.41E+00	9.23E+01	3.42E+03	9.24E+04	1.62E+02	4.39E+03
Zr/Nb-95 ^c	6.17E+01	-	-	1.07E-01	2.90E+00	1.34E+02	3.61E+03	2.70E+00	7.31E+01
Ho-166	2.33E+02	4.87E-01	1.32E+01	2.81E+00	7.59E+01	-	-	-	-
Yb-169	3.92E+02	1.45E+02	3.92E+03	3.49E+02	9.44E+03	-	-	-	-
Shipping Configuration		Use of Liner 183C8485 is required		No additional Shielding is required		Co-60-B quantities require use of Axial Shielding Plates 183C8491 Co-60-C quantities require use of Axial Shielding Plates 183C8491 and additional Spacer Plates		No additional Shielding is required	

a. Solid Material, including metals, that meets Normal or Special form criteria. Special form materials require a current certificate of compliance

Results (New Ir-192/194 Table)

Model	Ir-194 Impurity		Ir-192 Limit		Shipping Configuration
	TBq	Ci	TBq	Ci	
AOS-025A (10W)	0.0185	0.5	2.62	71	Use of Liner 183C8485 is required
	0.0740	2.0	2.33	63	
	0.1110	3.0	2.10	57	
AOS-050A (100W)	0.37	10	41.32	1,117	Use of 1.5" Stainless Steel Axial Plate is required
	0.74	20	39.84	1,077	
	1.48	40	36.88	997	
	2.22	60	33.92	917	
	2.96	80	30.96	837	
	3.70	100	28.04	758	
AOS-100A (400W)	148.0	4,000	2286.37	61,794	No additional Shielding is required
	370.0	10,000	2094.42	56,606	
AOS-100B (400W)	3.70	100	89.31	2,414	No additional Shielding is required
	8.51	230	76.22	2,060	

**rows may be added to or removed from this table prior to submittal of SAR.

Project Schedule

Submittal to NRC	03-01-2016
NRC Review (45 Days)	04-15-2016
NRC Response/RAI	04-30-2016
RAI Response by AOS	05-31-2016
Submitted Response to NRC	06-01-2016
NRC Review	06-15-2016
NRC CofC	07-15-2016

Correction to Certification Drawing reference

CofC rev 4: Drawing No. 105E9713 was at Revision J

CofC rev 5: Drawing No. 105E9713 changed to Revision I

The change from 105E9713 Revision I to Revision J was to correct a weld symbol on the AOS-100 Impact Limiter

Discussion