RADIOLOGICAL DOSE RATE CALCULATION FOR SPENT FUEL PROCESSING IN THE AUXILIARY HOT CELL FACILITY (AHCF)

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TA-V LEADING NUCLEAR TECHNOLOGIES

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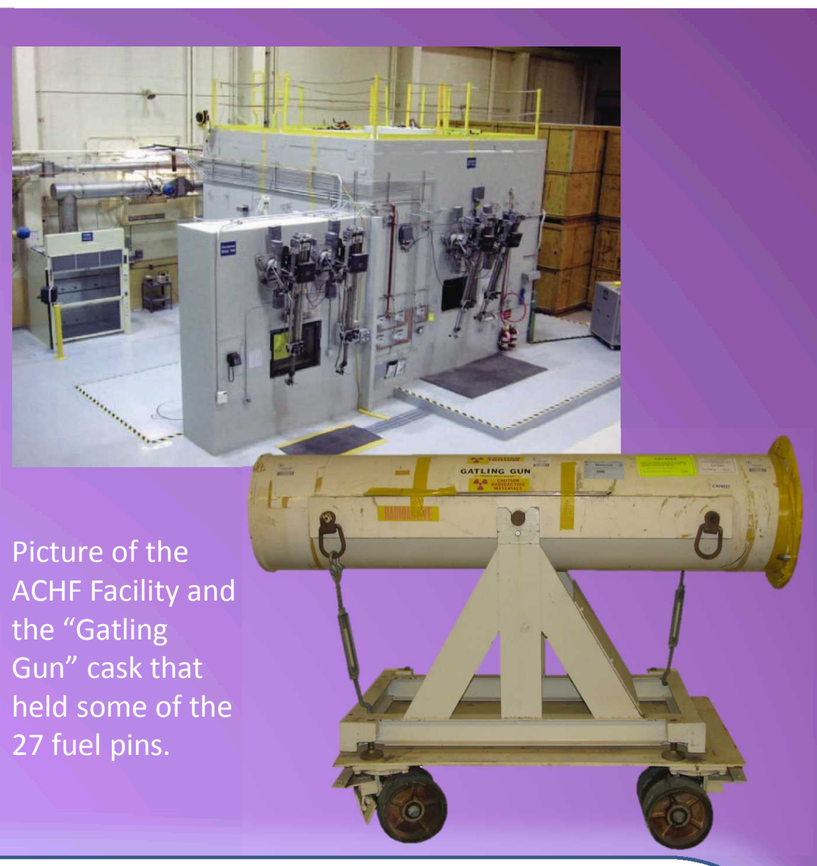
MOTIVATION

In order to process 27 legacy irradiated fuel pins at the AHCF, an evaluation of the potential radiological conditions associated with working in close proximity had to be performed. The pins consisted of 11 irradiated UO_2 and 16 MOX fuel pins. The calculations consist of various scenarios that would go into supporting radiological worker planning and control .

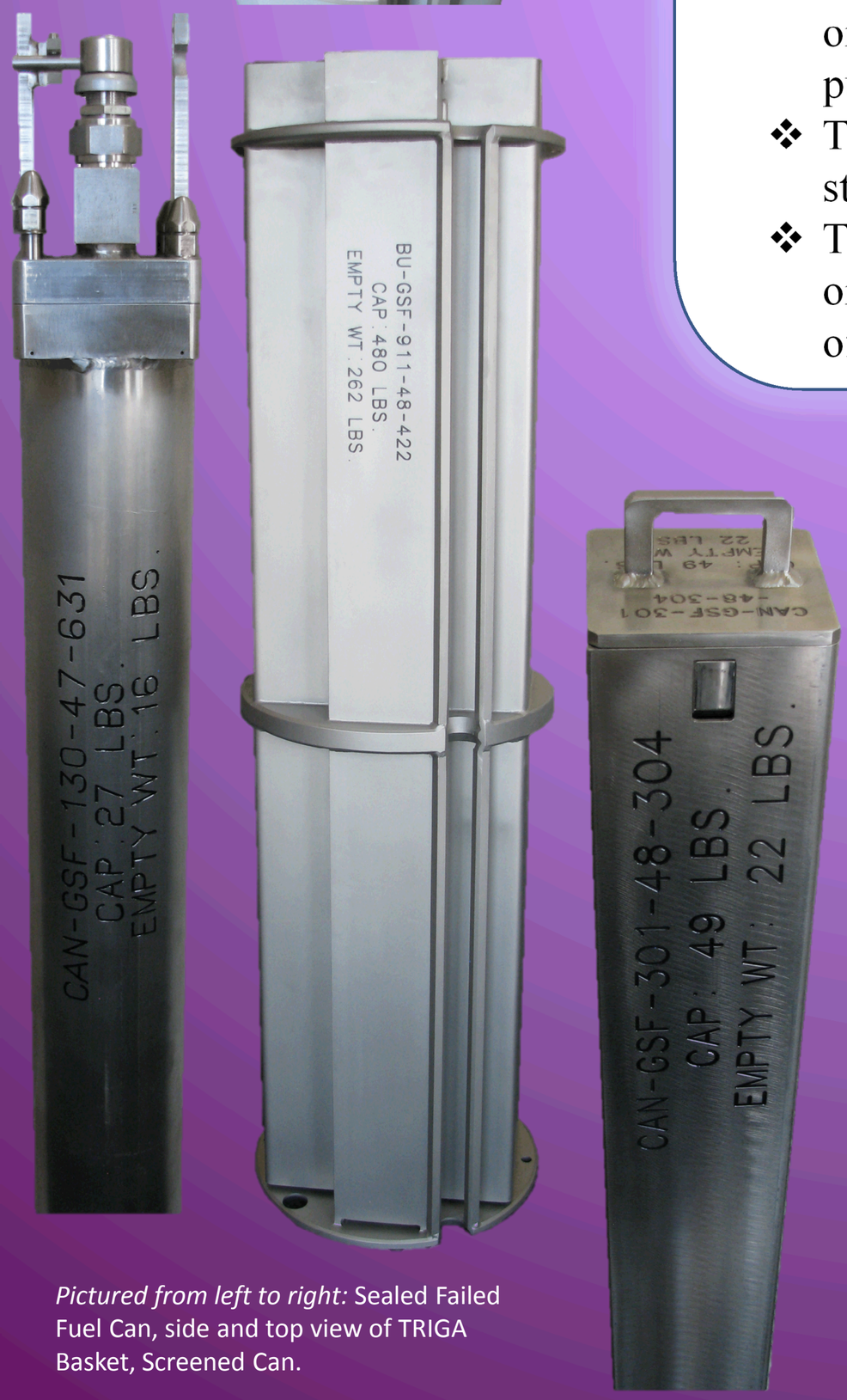
UTILIZED PROGRAMS

Primary program used:

- MicroShield 9 was used for calculating dose rates for shielded and unshielded sources.



Picture of the ACHF Facility and the "Gatling Gun" cask that held some of the 27 fuel pins.



Pictured from left to right: Sealed Failed Fuel Can, side and top view of TRIGA Basket, Screened Can.

MODEL APPROACH

- Several pins were represented in the models by a single pin whose activity combines the activities of its components and averages them over the volume. Total density accounts for the fuel material and void regions.
- Density of the UO_2 and MOX fuel was reduced by up to 66% in order to adjust for burnup and spacing between individual pins; putting the UO_2 density at 7.14 g/cm^3 and MOX at 7.11 g/cm^3
- The cladding thickness was assumed to be 0.05 mm, which is the standard.
- The activity of a single pin is based on the total activity of the original packaged container, which is then averaged for the number of pins in the container.

MODELS & SCENARIOS

- Inner Transfer System (ITS) Inner Shield
- Inner Cans (IC)
- Sealed Failed Fuel Cans (SFFC)
- Screened Fuel Cans (SFC)
- Transfer Cans (TC)
- King Cask

Legend:

Case *1* 4 PNL MOX pins
Case *2* 4 PNL MOX pins
Case *3* 6 BR3 pins
Case *4* 4 PNL MOX pins
Case *5* 4 PNL MOX pins
Case *6* 5 BR3 pins

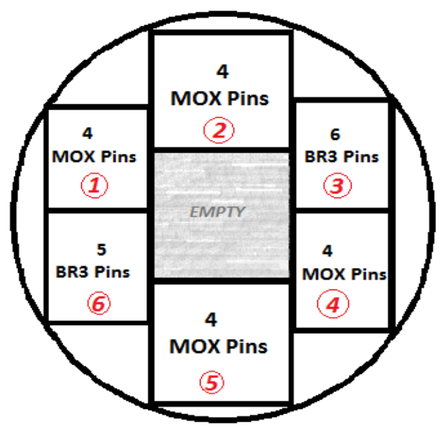
Detectors placed for dose rates at:

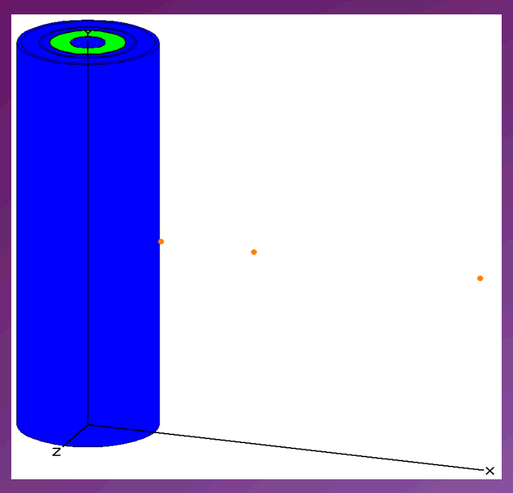
Middle Orientation

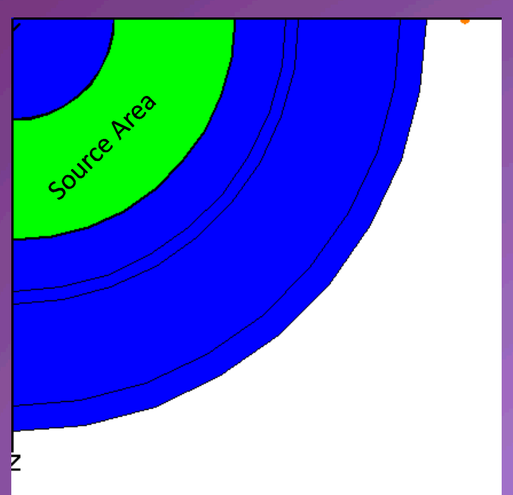
- On Contact (~2cm)
- 30 cm
- 1 m

Top Orientation

- On contact (hands)



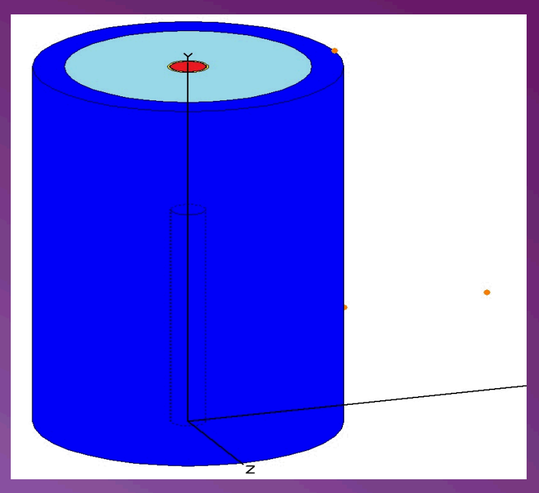


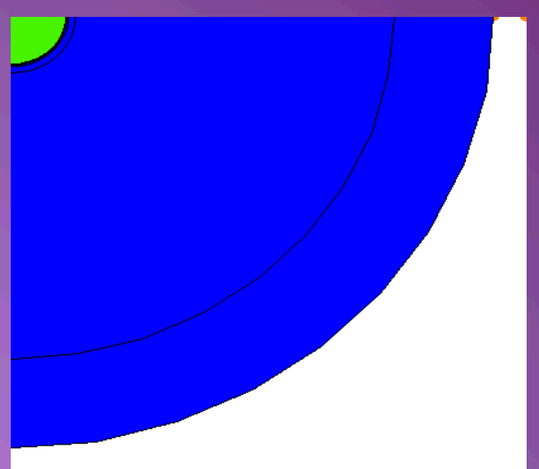


Side & Top view of MicroShield ITS system model

RESULTS

With all the needed dimensions, both simplified and complex models were made using MicroShield. Initially line sources were used, but volume sources where favored since self-shielding from the material could be accounted for in the simulation. Since MicroShield has very simplified geometries, all containers had to be transformed into cylindrical geometries, conserving mass and overall activity. While many aspects of the project were ever-changing all scenarios were assessed. In the end, 24 MicroShield scenarios were modeled using various materials and pin array set ups. Bremsstrahlung issues were known to exist and were addressed as needed during the processing.





Side & Top view of MicroShield King Cask model

Photo of ITS/TRIGA system in loading cradle

TRIGA Basket / ITS Inner Shield Dose Rates

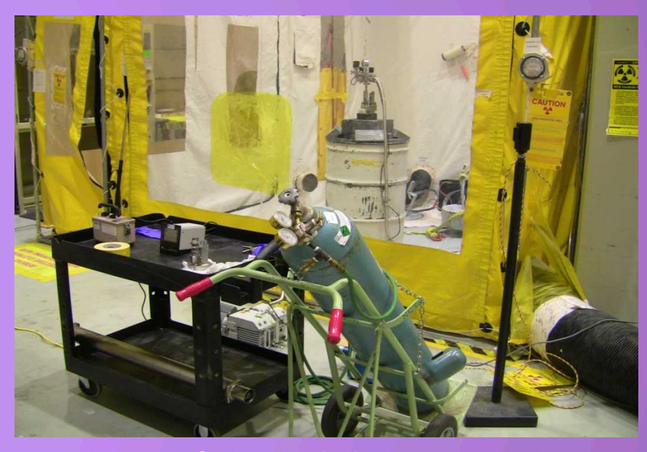
Type and Quantity of Fuel	Effective Dose Rate (mrem/hr)		
	On Contact	30 cm	1 m
11 BR3-16 PNL/PNL3 MOX (27 Pins)	520	226	83

King Cask Dose Rates

Type and Quantity of Fuel	Effective Dose Rate (mrem/hr)	
	On Contact	
	Middle Orientation	Top Orientation*
6 BR3	5.7E-8	9.4E-13
8 PNL MOX	3.6E-11	4.7E-19
6 PNL3	1.0E-08	3.1E-19

Inner Can Dose Rates

Type and Quantitiy of Fuel	Effective Dose Rate (mrem/hr)		
	On Contact	30 cm	1 m
4 BR3	304	35	4
6 PNL3	439	25	2
5 PNL MOX	427	24	2



Set-up of King Cask during processing

Sealed Failed Fuel Can Dose Rates

Type and Quantity of Fuel	Effective Dose Rate (mrem/hr)			
	Middle Orientation			Top Orientation*
	On Contact	30 cm	1 m	On Contact
6BR3	1527	121	15	2
10 PNL MOX	386	71	9	2
6 PNL3	214	39	5	1

Transfer Can Dose Rates

Type and Quantity of Fuel	Effective Dose Rate (mrem/hr)			
	Middle Orientation			Top Orientation*
	On Contact	30 cm	1 m	On Contact
6BR3	412	63	9	0
10 PNL MOX	123	21	3	0
6 PNL3	67	11	1	0

Pictured from left to right: John Garcia, John Miller, Richard Vega, Danielle Redhouse, and Mitchell Callahan

DISCUSSION

In conclusion, while it was expected that a majority of the does rates would be different, the dose rates calculated by MicroShield assisted the health physics and AHCF staff in determining the needed initial shielding and a rough estimate of the radiological buffer zone . The results came very close to actual measured dose rates; in most cases many of the results came within 1 standard deviation of the measured data. This was a great learning experience and allowed for training and practice in the field of health physics.

ACKNOWLEDGEMENTS

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