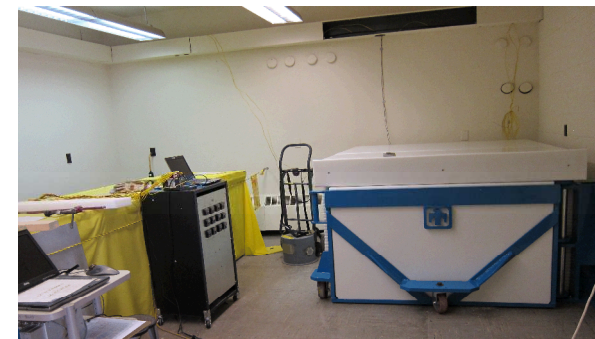


*Exceptional service in the national interest*



## Developing Low Dose Rate Neutron Irradiation Capabilities for Experimental Research

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Sandia National Laboratories

# Irradiation Facilities

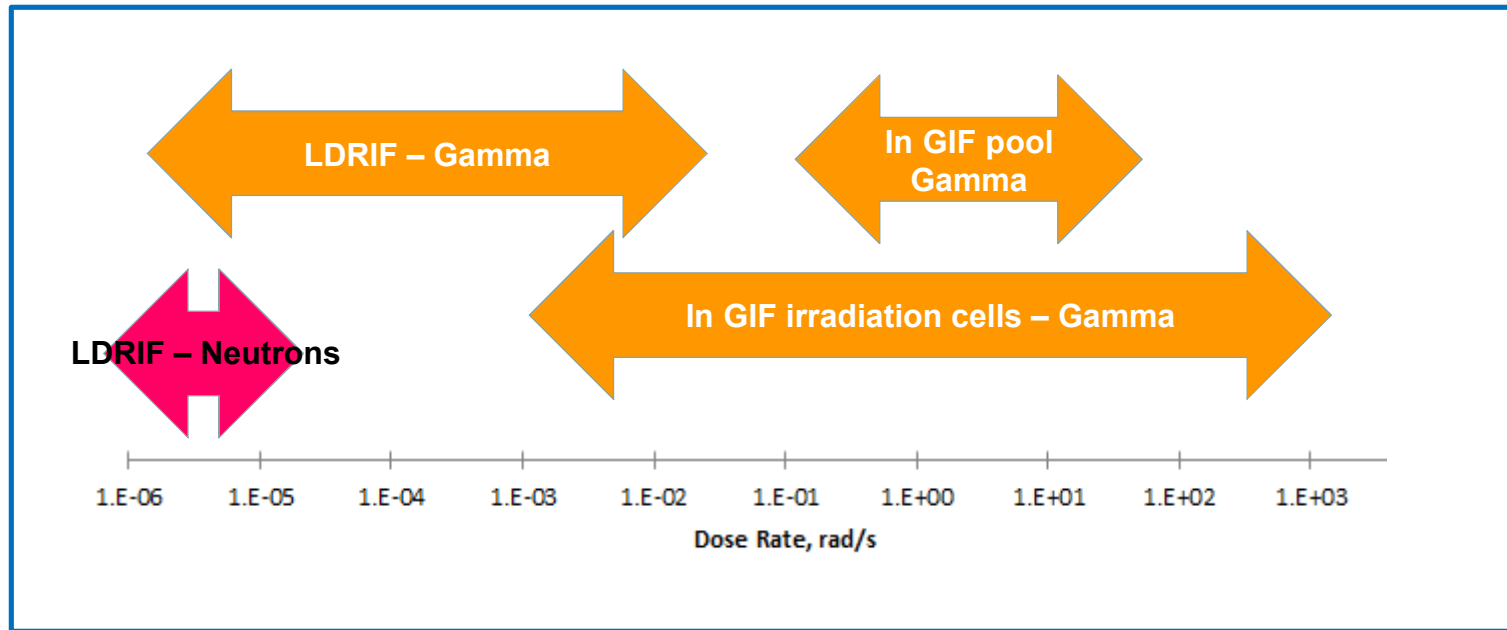


Gamma Irradiation  
Facility

Low Dose Rate  
Irradiation Facility



# Dose rate capabilities



## Gamma Irradiation Facility (GIF)

In-air (in irradiation cells):  $0.001$  rad/s to  $1500$  rad/s

In-water (in pool):  $0.1$  rad/s to  $10$  rad/s

## Low Dose Rate Irradiation Facility (LDRIF)

Gamma:  $1 \times 10^{-6}$  rad/s to  $0.1$  rad/s

Neutrons:  $1 \times 10^{-6}$  rad/s to  $1 \times 10^{-5}$  rad/s in  $H_2O$

# Component $^{241}\text{AmBe}$ Sources

- Three AmBe sources were scheduled to be disposed of.
- Two sources, dating to the early 1950s, were not documented well.
- One source manufactured in 1964 had sufficient documentation.
- The sources were taken out of their overpacks (55-gal drums) and put into an OSRP special form capsule.





# $^{241}\text{AmBe}$ Sources and OSRP Capsule

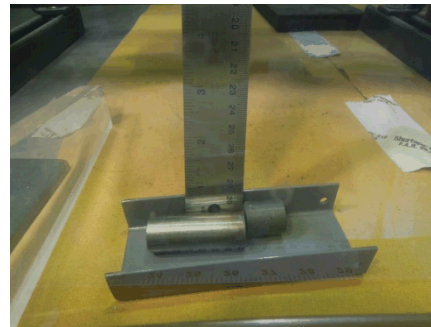
MRC-AmBe-44 (~6 Ci)



NB-540 (~1 Ci)



NB-570 (~2.5 Ci)



OSRP Special Form Capsule  
Model-II

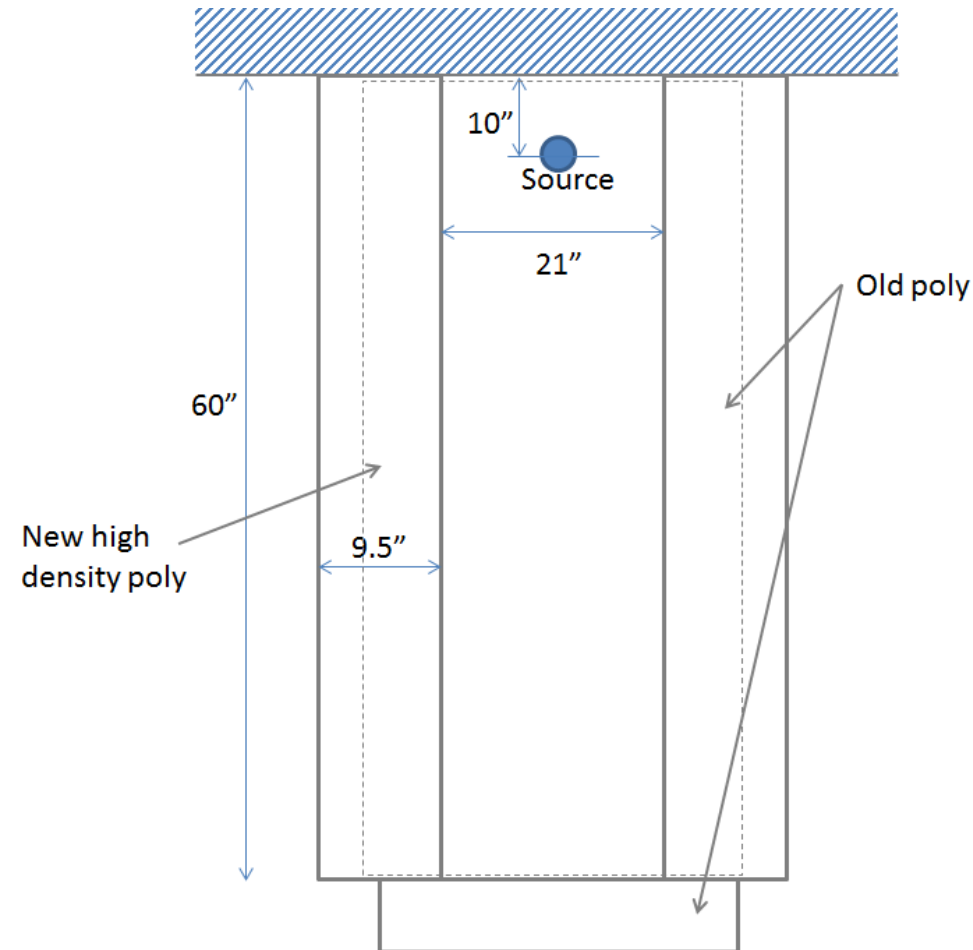


Final source activity ~9 Ci

# Special Considerations

- Activity of the composite source is 9 Ci (2.6 g)
- HC-3 threshold for  $^{241}\text{Am}$  is 2.9 Ci (0.84 g) (DOE-STD-1027, Hazard Categorization)
- Special form sources are excluded from hazard categorization.
- Quantity of  $^{241}\text{Am}$  exceeded reportable quantity of accountable nuclear material per DOE O 474.2, Nuclear Material Control and Accountability.
- Establish Material Balance Area.
- Perform fire hazard analysis.
- Perform background gamma measurements.

# Shielding test

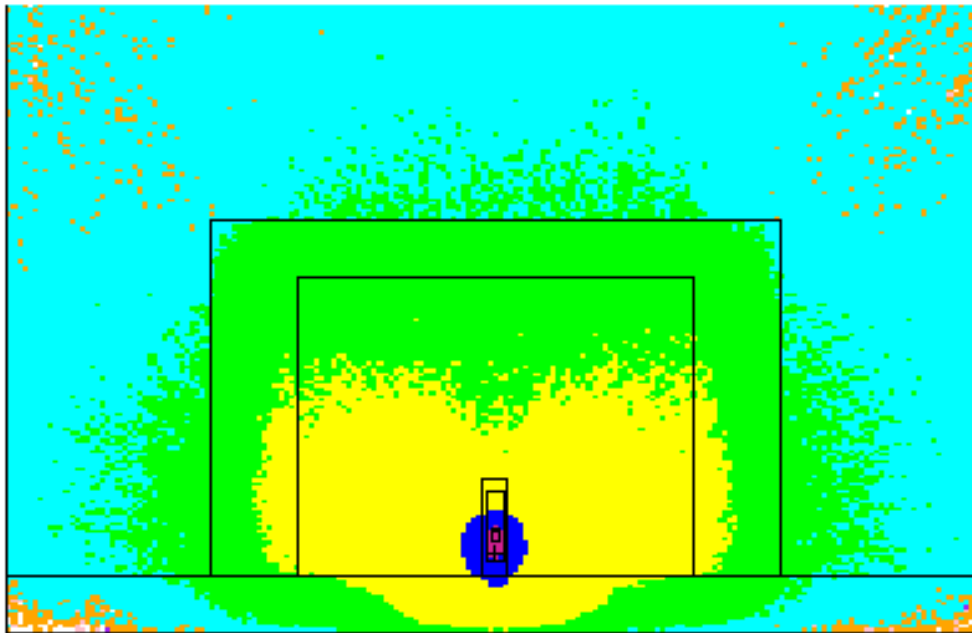


Performed two shielding tests:

- Using the available polyethylene (old poly), to determine the necessary thickness before purchasing large quantity of material
- Using old and new polyethylene for comparison.

# Preliminary MCNP Model

- MCNP Model was used for the initial shielding design
- The measurements were only performed laterally from the source.
- Based on the model, the roof thickness could be less than the walls.





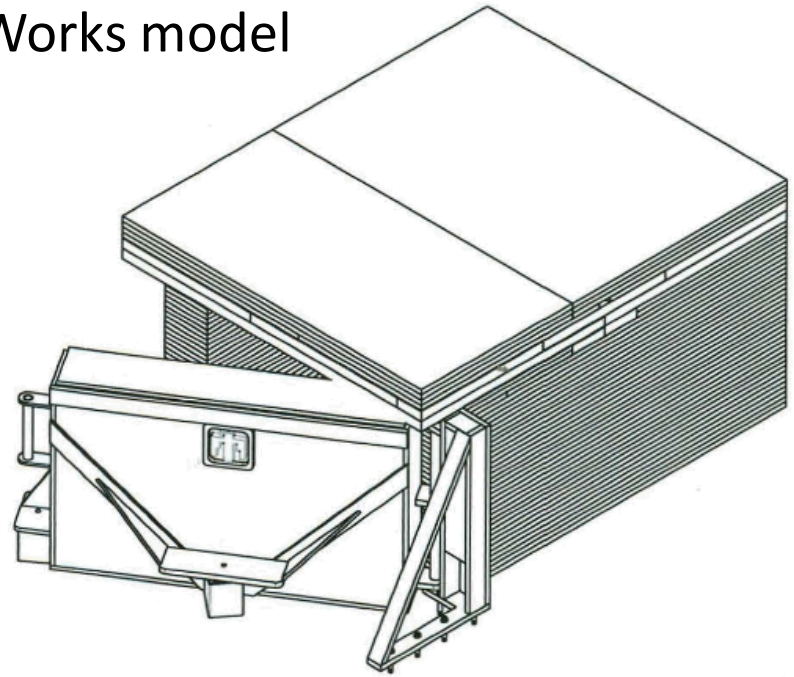
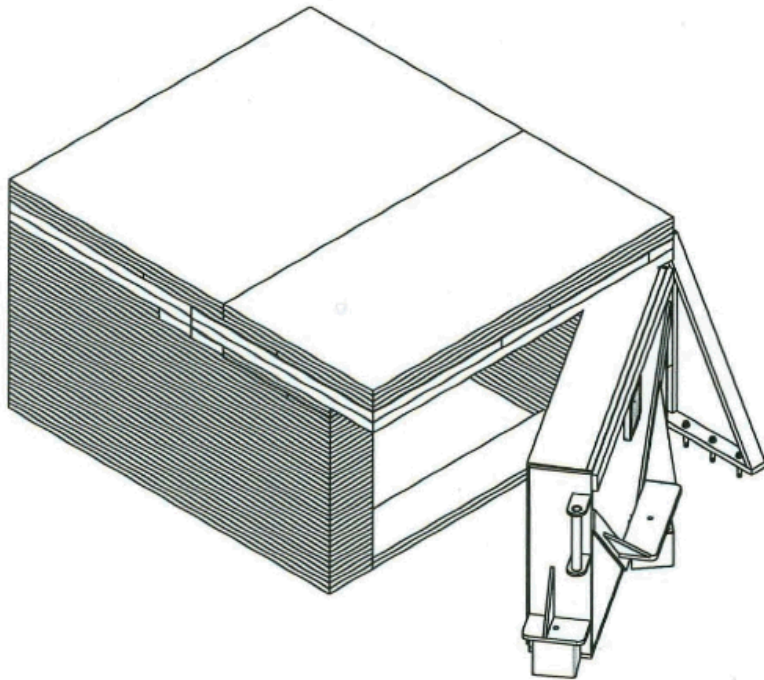
# ALARA Facility Design Evaluation

Formal process to evaluate worker exposure for a new facility or following facility modifications

- Facility already uses gamma sources
- Development of exposure scenarios for the facility involving combined exposure from neutron and gamma sources
- Consideration of the facility occupancy
- Consideration of exposure from existing radioactive sources in the facility
- Exposure evaluations for the facility staff and the experimenters (individual and collective doses)
- Facility design evaluated by the committee.

# Shielding Design

- Compile design requirements for the shielding
- Design shielding using the SolidWorks model



# Construction of the Shielding

The shielding was constructed of stacked 1" and 2" polyethylene sheets cut into planks.



Completed shielding ready for the source to be brought into the facility.

# Dose Rate Measurements

- Confirmatory measurements of the effective dose rate outside and inside the neutron irradiation system (consisting of the neutron source inside the polyethylene shielding) to determine the effectiveness of the shielding and determine dose rates to personnel.
- Effective dose rates outside the shielding were well below the radiation area level.
- The neutron irradiation system will be used to irradiate various experiments (materials, components, etc.)
- We needed to characterize the radiation field inside the shielding to evaluate absorbed dose rates for those experiments.

# Neutron Irradiation System Characterization

Characterization of the Neutron Irradiation System  
will be presented next.