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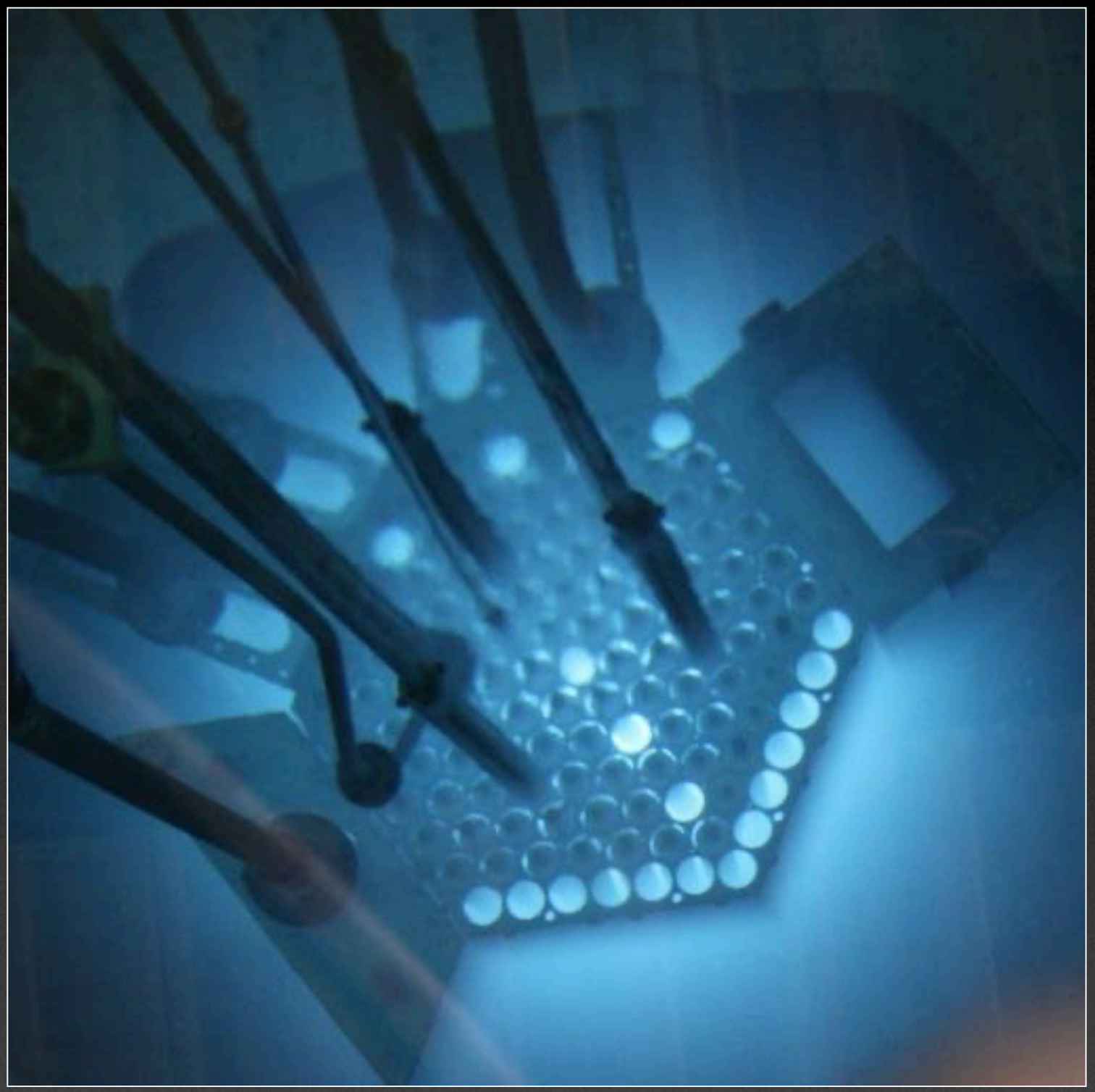

UUTR Tank Repair Efforts

Presented by
Andrew Allison
UUTR Reactor Supervisor

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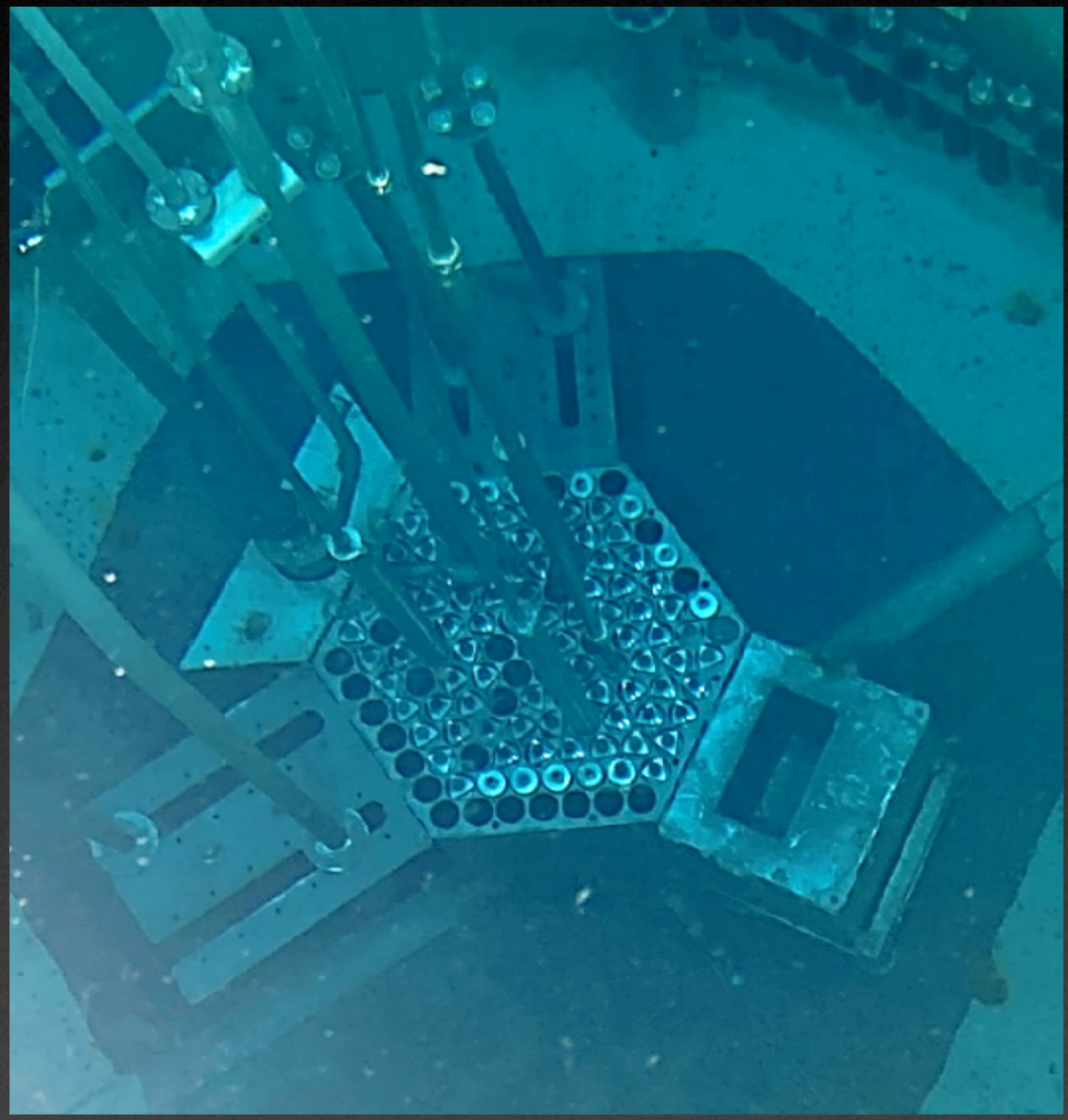
Overview

- Tank Design/Background
- First leak
- Second leak
- Key steps to empty tank
- Actions Taken
- Plan Ahead/Restoration



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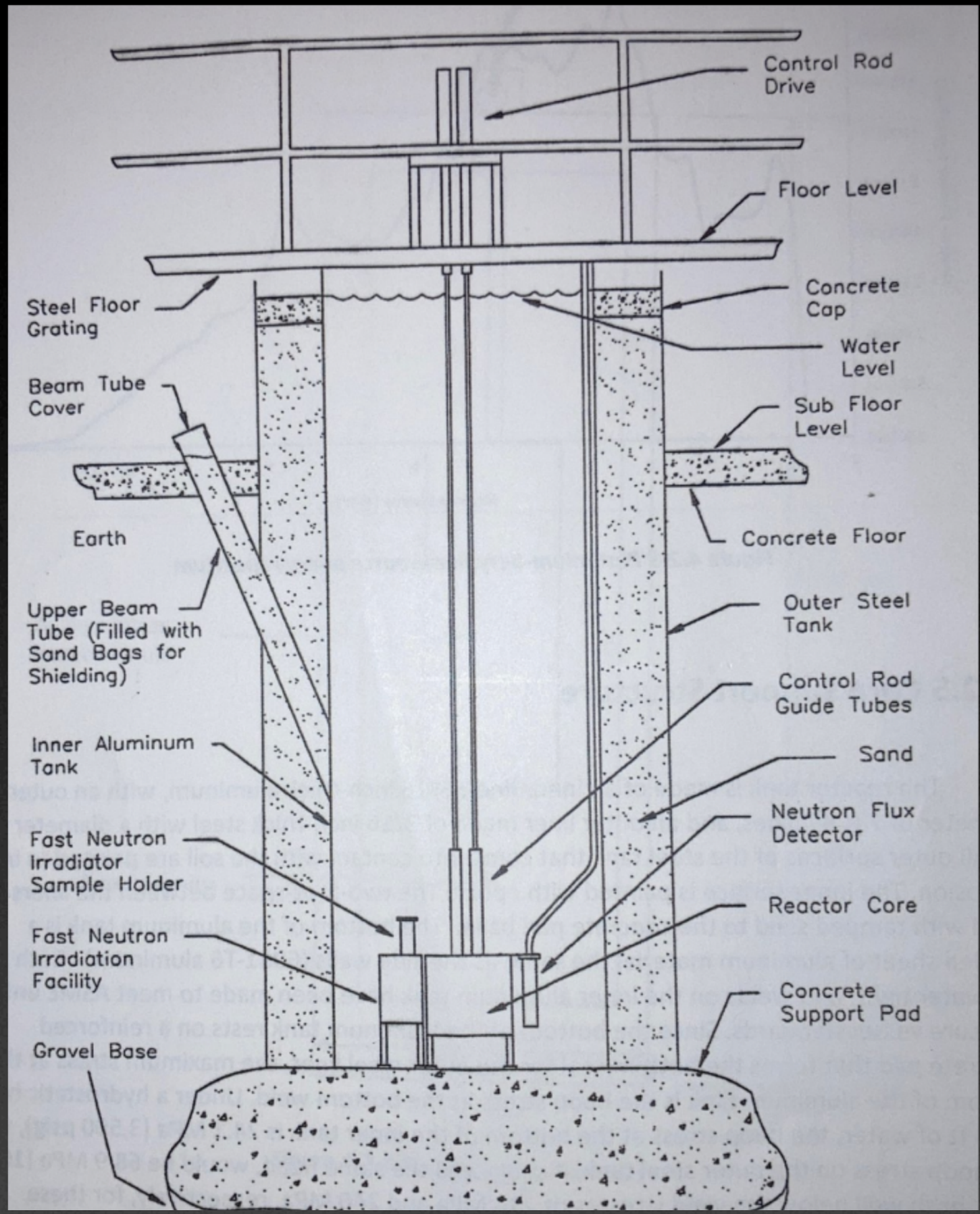
Tank Design

- Dimensions: 24ft deep
- 7ft 8inches across
- Tank holds ~ 8000gals of water
- 29.1gals/in of tank height

Double wall construction

-Steel outer tank
-6061 aluminum inner tank
-Sand in the middle
-2ft concrete support pad
-above ground water

Constructed in 1972



First Tank Leak

- Reactor Supervisor (RS) observed tank water level was abnormally lower than expected on March 28th and performed tank fill.
- March 29th: RS observed water level lowered substantially overnight:
  - Inspected cooling system/purification system piping for leaks
  - Reviewed console logs to determine leak began March 25th
    - Calculated initial leak rate of 20 gallons per day (gpd)
    - Notified Director and Radiation Safety Office of leak
    - Began sampling water for radioactivity analysis
- March 31st: Leak rate was observed increasing to ~50 gpd. Leak rate remained constant at 50 gpd until repaired.

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Tank Repair Planning

- Normal practice in research reactor community is to remove fuel/activated components and drain tank for dry repair.
- UUTR staff sought out options for performing an underwater repair since facility did not have storage capacity for all irradiated fuel contained in reactor tank.
- Underwater Construction Corporation (UCC) proposed using nuclear trained divers to apply Bio-Dur epoxy to all suspected/reachable welds in the tank.
- The reactor core would be covered with a tarp to prevent paint from dropping on the reactor. Fuel in storage racks would be moved around as divers worked.
- Divers had enough time to apply coating to bottom 16 feet of all accessible welds in tank.

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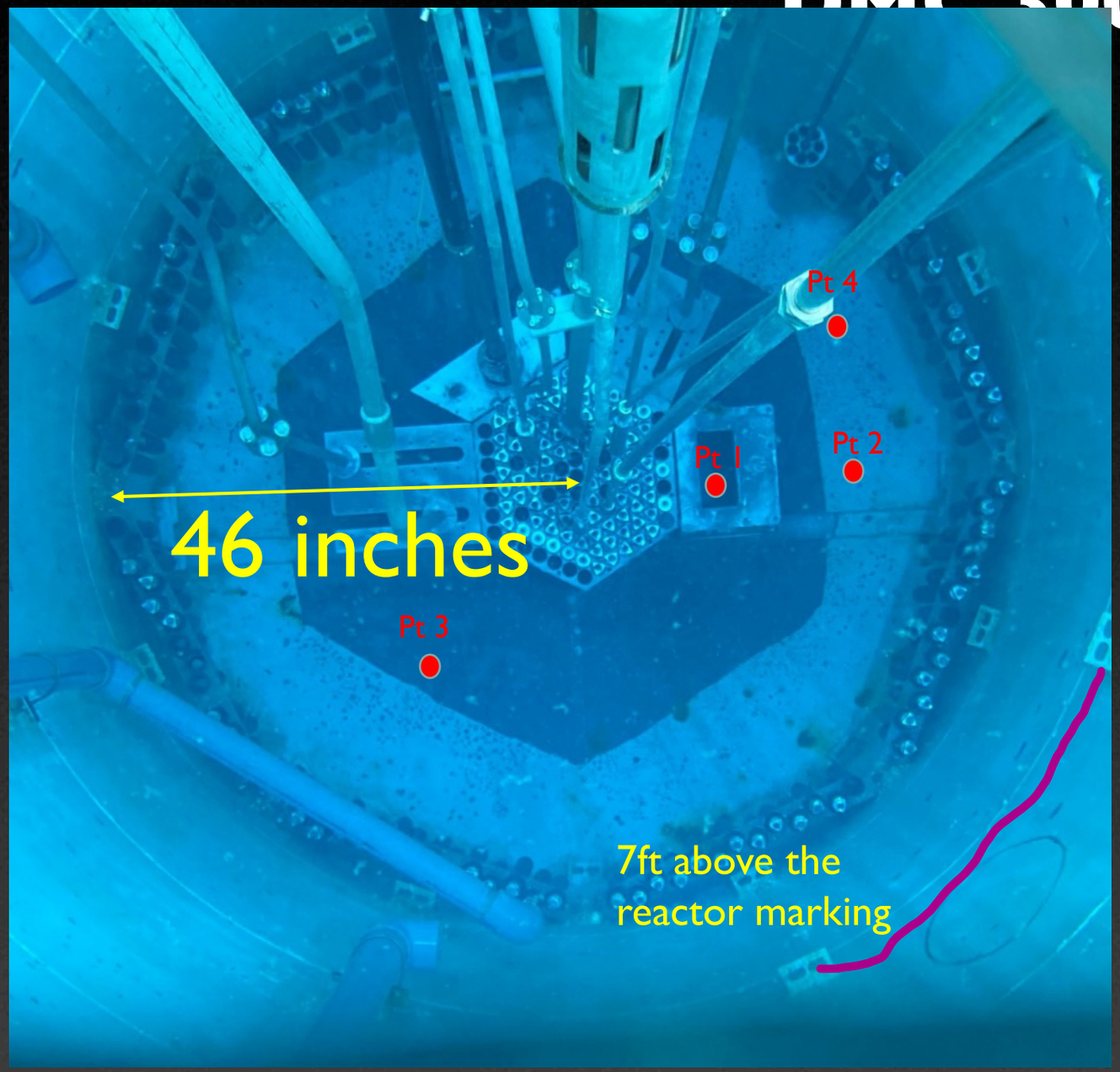
In Tank Dose Readings with a Mirion DMC 3000



Location	Average Rate (10×6min dose)	Max Rate
12 feet above point 1	0	0
7 feet above point 1	3.34mrem/hr	6.17mrem/hr
Floor: point 2	1.26Rem/hr	4.15Rem/hr
Floor: point 3	3.62Rem/hr	5.40Rem/hr
Resting on point 1	9.61Rem/hr	13.2Rem/hr
Pt 4 with Lead shielding towards Reactor	155mrem/hr	2.34Rem/hr

Point 1 chosen for reading to avoid having apparatus above the reactor.

Average Dose Rate was calculated by multiplying the dose from a 6 minute count in given location by 10.

Maximum Rate was reported by DMC 3000 after measurement.

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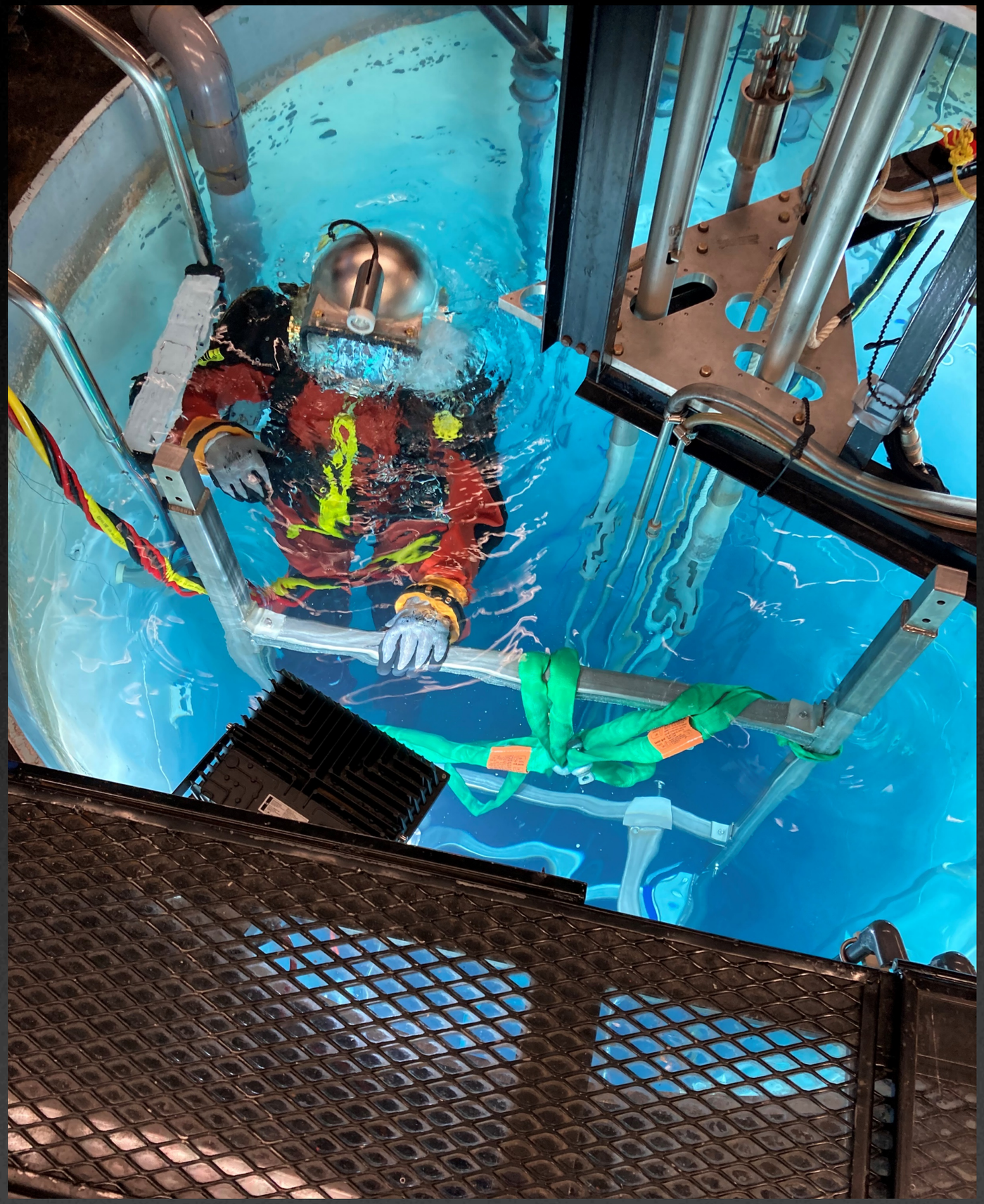
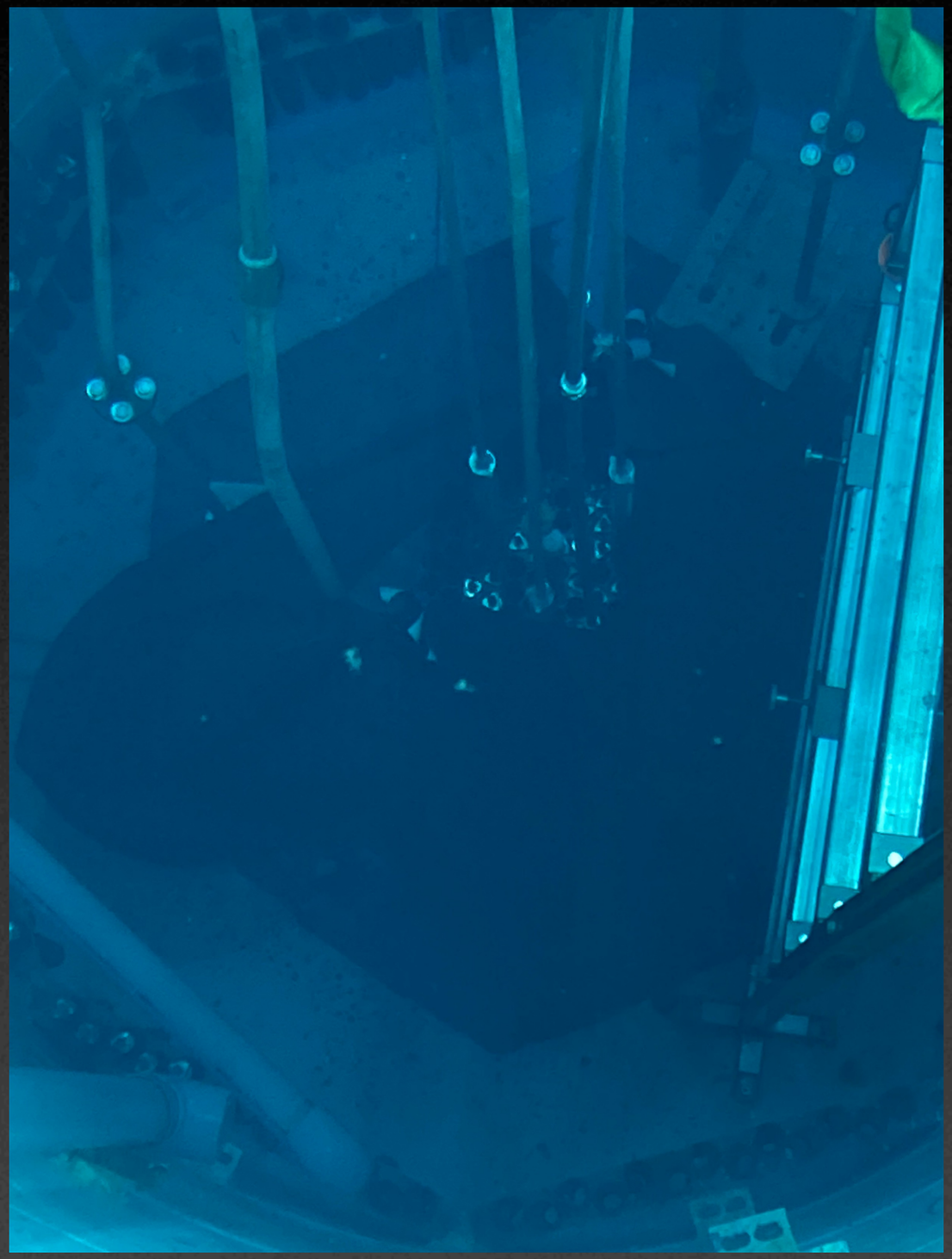
Diver Pictures





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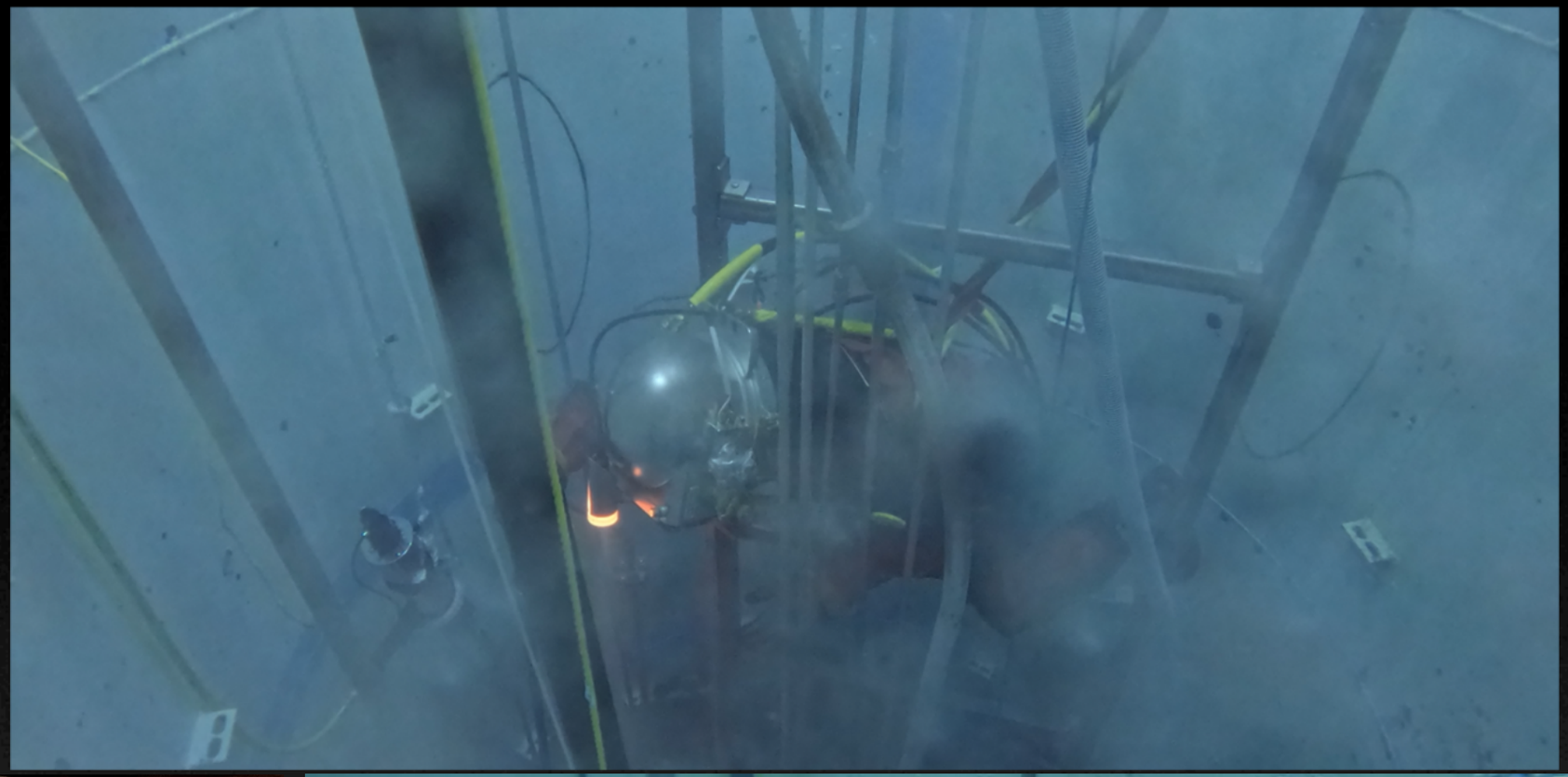

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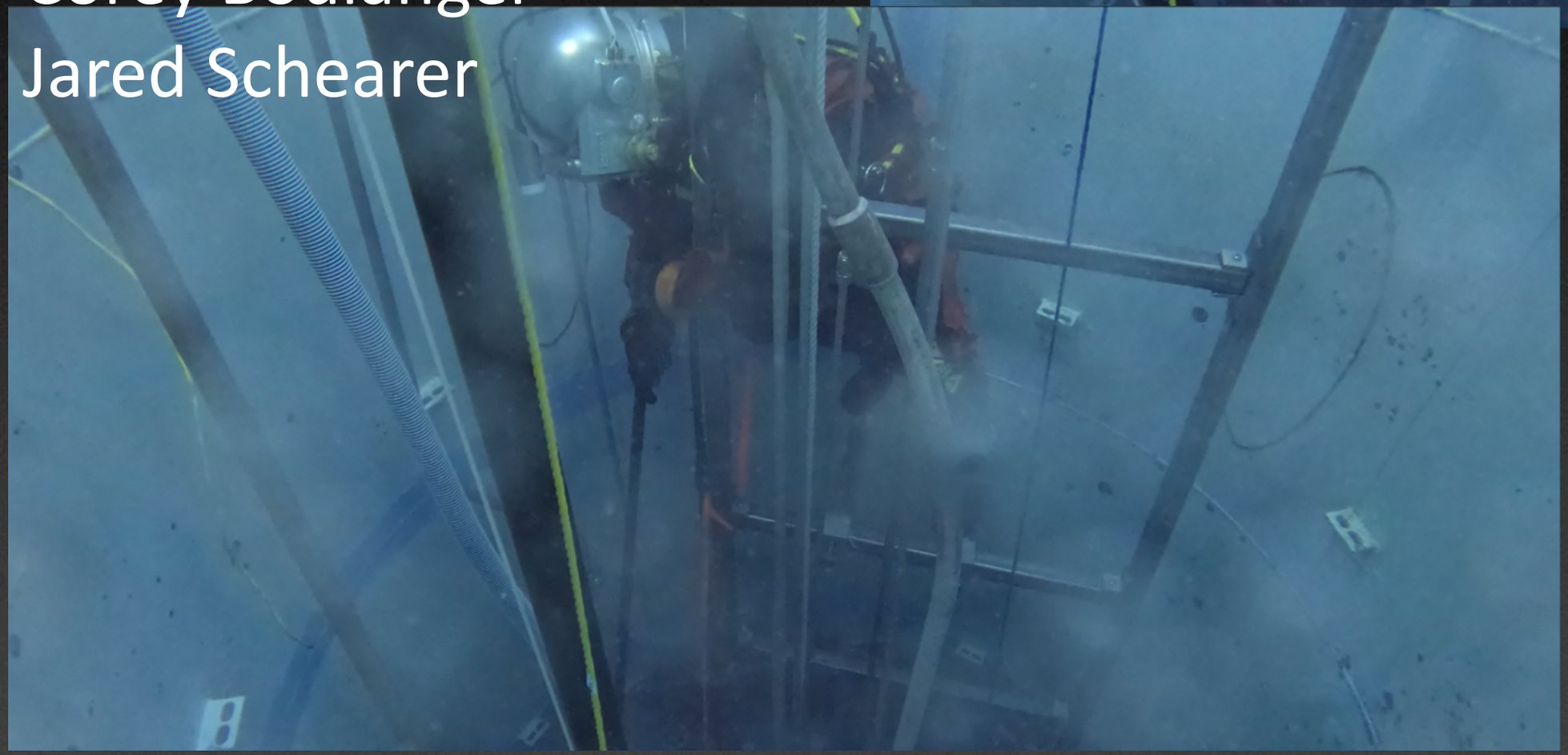
Special Thanks to UCC Divers:
Tim Schuster (Team Leader)
Derek Anderson
Corey Boulanger
Jared Schearer



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Restoration

Facility performed an inspection of all fuel elements and the core plate itself to ensure no paint affected the reactor.

Facility reported 5000 gallons of reactor tank water leaked into the environment with an estimated activity of 1.9mCi of tritium leaked into the environment. Cs-137 and other nuclides were below minimal detectable activity.

Facility accessed evaporation rate over the month of August to compare against historical data of water loss rate.

Performed a 50.59 evaluation for returning to normal operations following this tank leak.

2nd Leak Discovery

- Observed water level lowered by 3 inches overnight on September 19th. Review of logs determined leak rate was approximately 200 gals/day.
- Informed NRC project manager and Reactor Safety Committee (RSC) of intentions to perform a 50.59 evaluation for partial draining of tank because UUTR wanted to:

1. Reduce leak rate
2. Allow for dye testing of water

- On September 22nd, reactor was secured by removing 6 elements from center of core. 50.59 evaluation was approved by RSC to permit lowering water level past the low water level alarm
- Tank Area Radiation Monitor was set to alarm at 0.5mR/hr and placed in tank just above the detection threshold of radiation from the reactor. Therefore, if water level lowered beyond that point, a continuously monitored alarm signal would be sent to police/UUTR staff.

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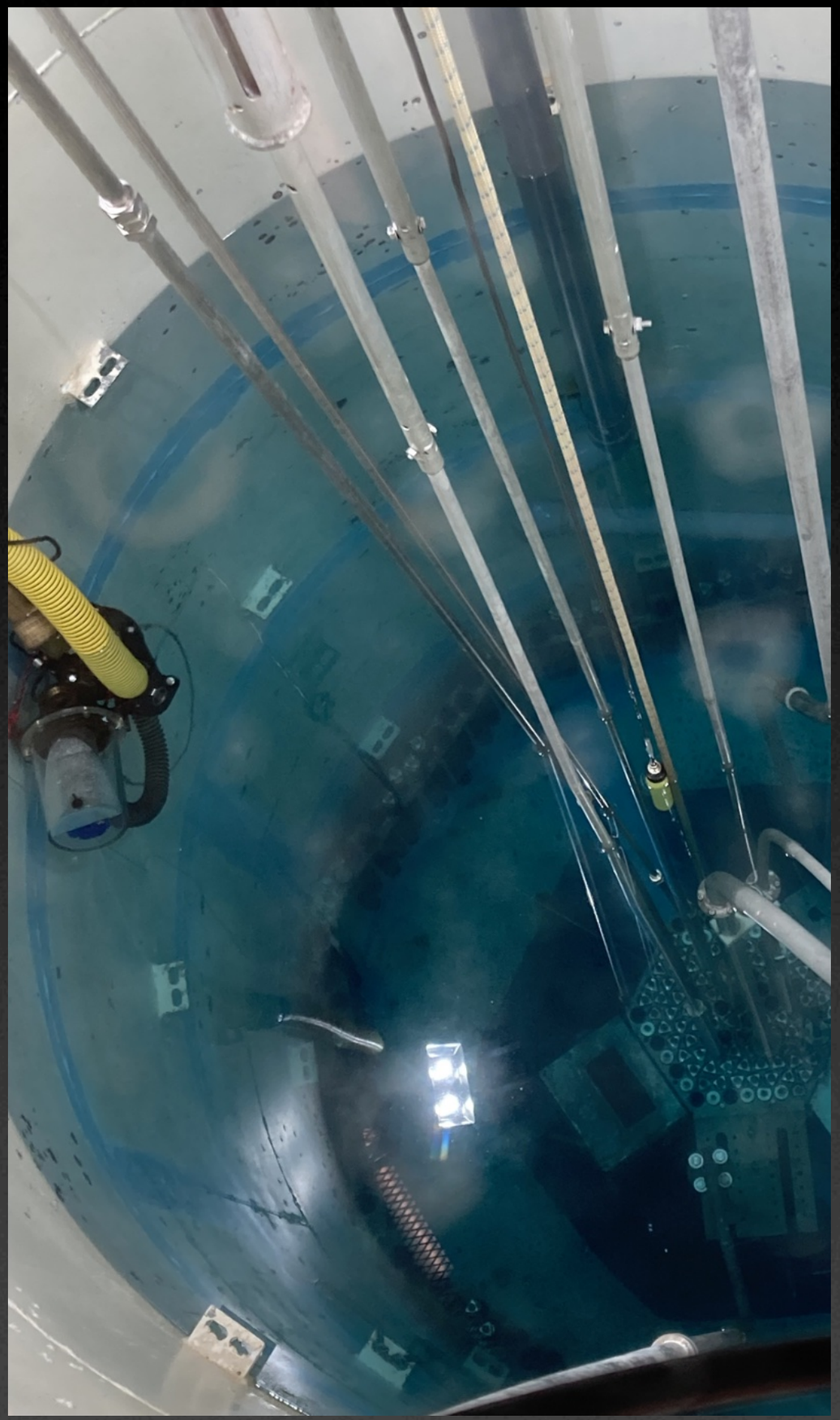
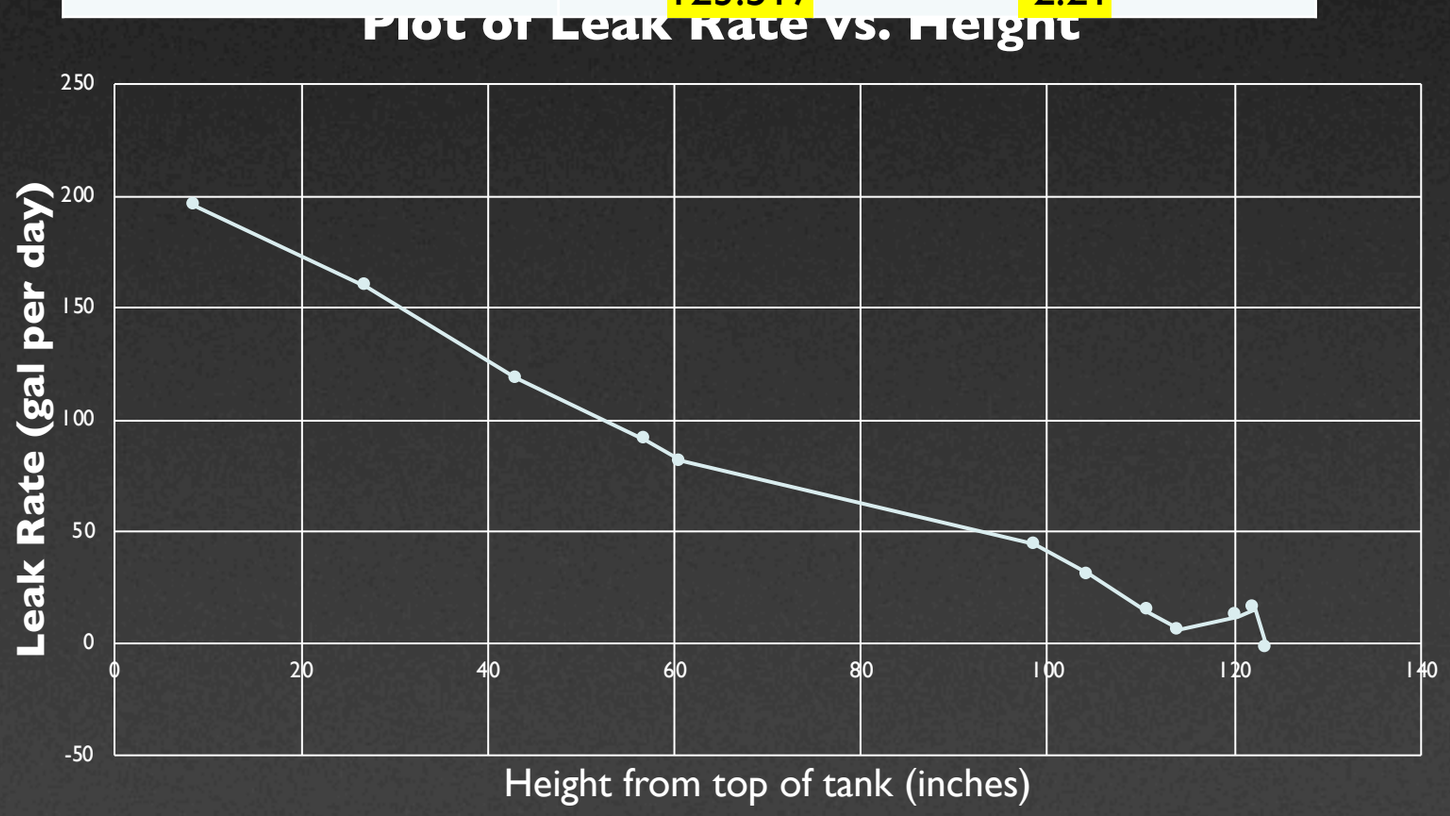
Tank Leak Assessment Data



	distance from top of tank	leak rate assuming 3 gal/day evaporation
	8.548	195.6
	27.039	159.46
	43.019	118.51
	56.95	90.72
	60.715	81.47
	98.54	44.06
data points have larger margin of error due to moving sensor by 47.67 inches deeper in tank	104.45	30.46
	110.67	14.4
	114.07	6.12
	120.285	12.09
	122.186	15.73
	123.517	-2.21



Key Steps to Empty Tank

- Storage of reactor fuel and startup neutron sources
- Changed security plan under 50.54p
- Qualification of licensed operators during shutdown period
- Creating New Fuel Transfer Cask
- Implementing fuel transfers with small staff and public dose rate concerns
- Draining reactor tank/removal of remaining reactor tank components

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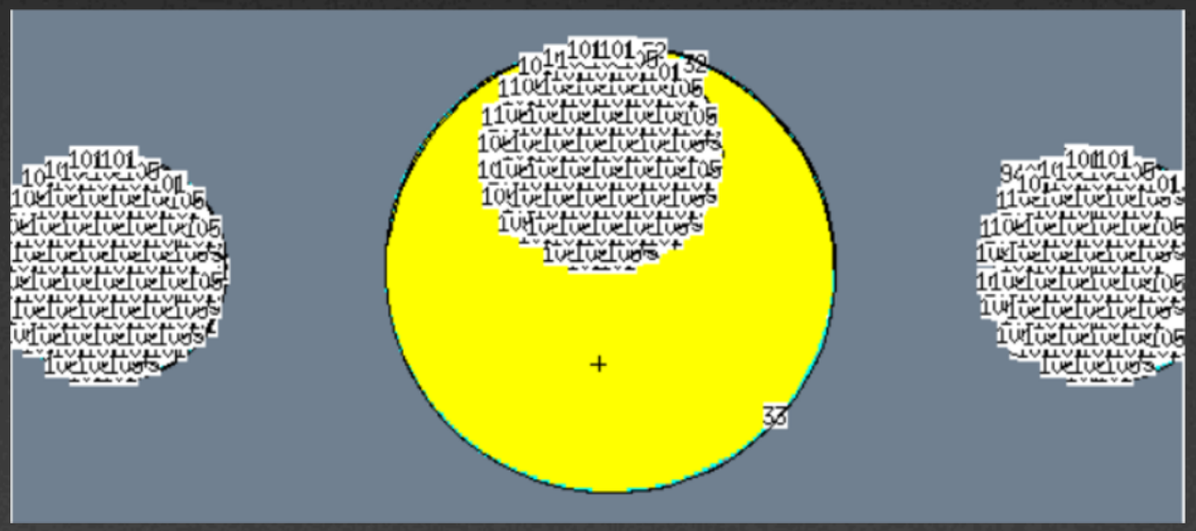
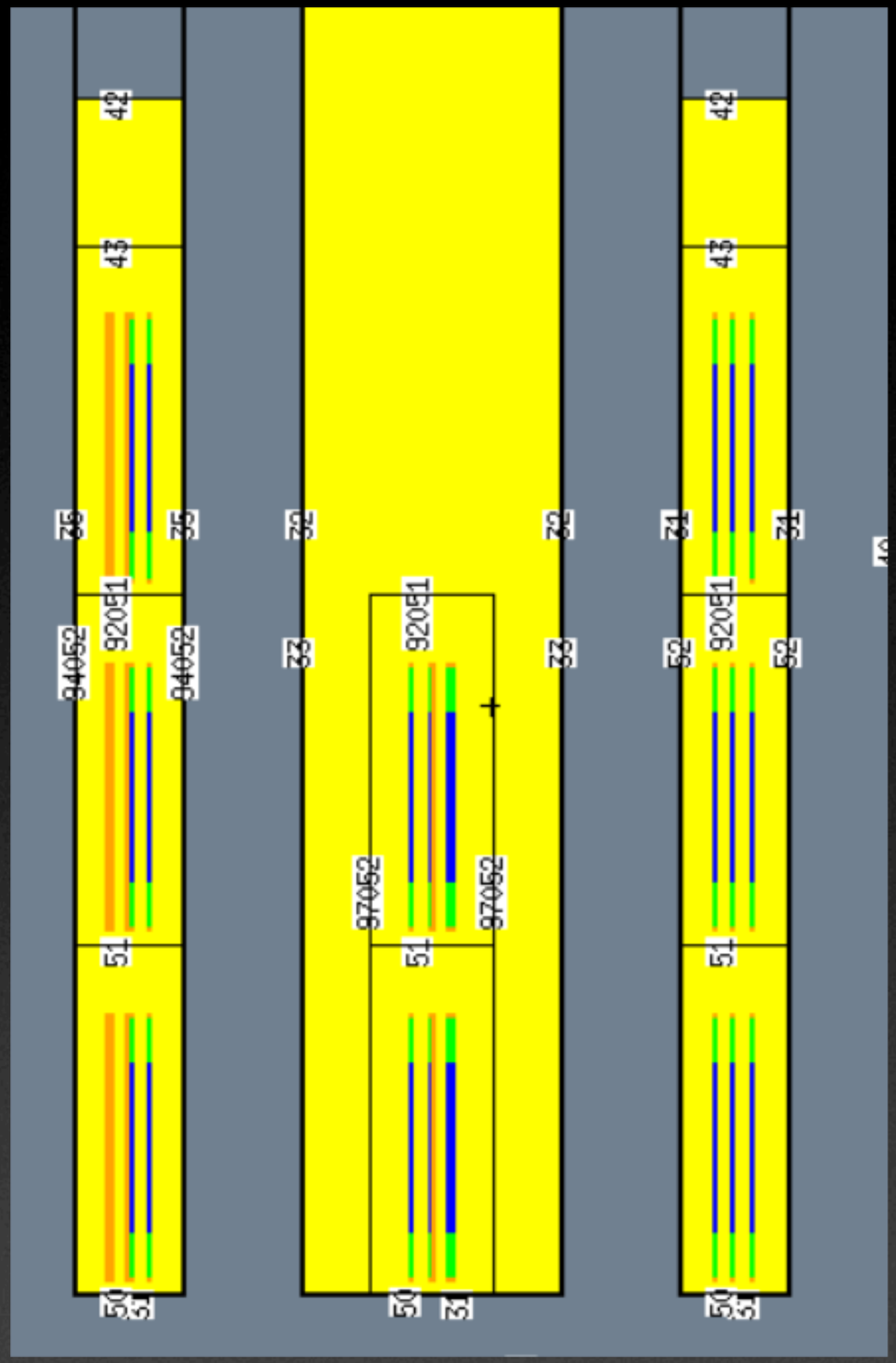
MCNP modeling

-SAR analyzed wet storage of 18 elements in each fuel storage pit will yield largest K_{eff} of 0.75.

-USGS suggested storage of 19 elements in a stacked configuration.

-MCNP 6.2 calculated K_{eff} of 0.759 (sd 0.00015) for new pits model





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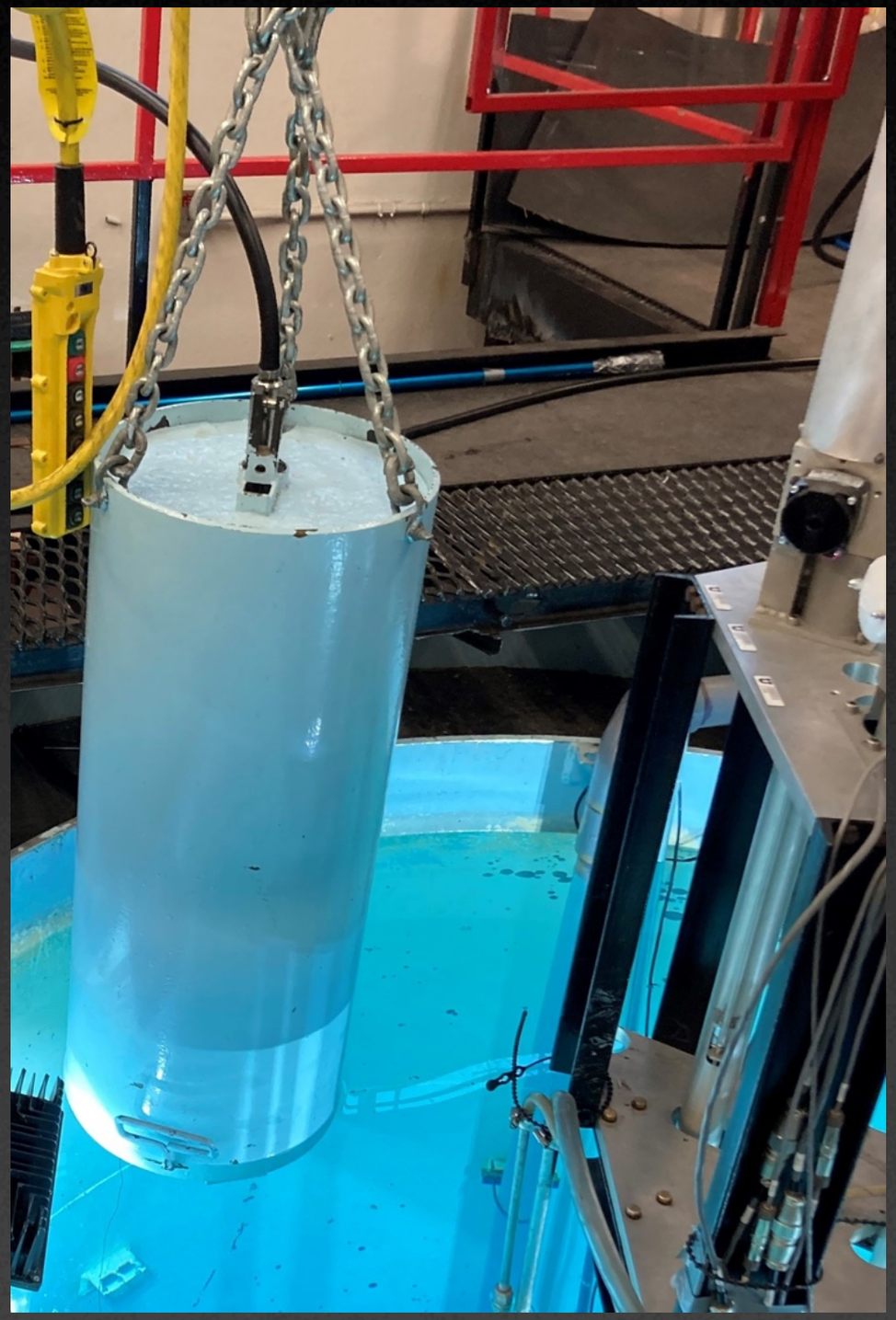
Constructed New Fuel Transfer Cask

Original Fuel Transfer Cask



Auxiliary Nuclear Device for Reactor Element Withdraw (ANDREW)

ANDREW Features

1. Trap door spring shut by pulling pin up allowed for elements to be secured in cask in partially drained tank

2. **<u>>3in of Lead Shielding</u>**: fuel transfers no longer provided a detectable dose to public spaces.

3. **<u>Element holder offset:</u>** from center to prevent instrumented element conduit from interfering with crane

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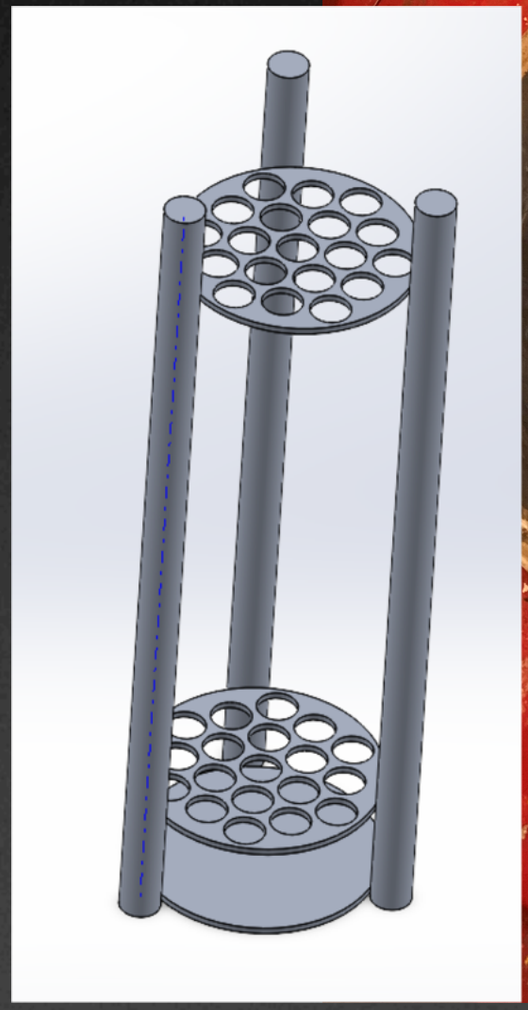
Storage of Fuel Elements in Pits

Most radioactive elements stored in bottom assemblies
Least radioactive elements stored in top assembly

Fuel Pit assembly design prevents fuel elements falling in between the pit wall and assembly rack.



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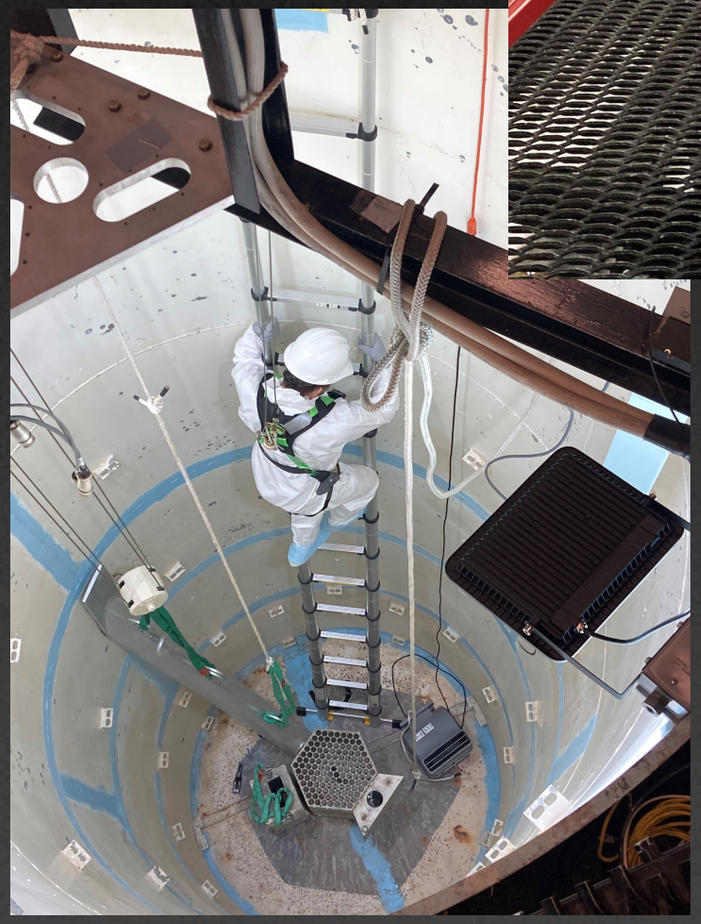
Emptying the Reactor



UUTR implemented confined space protocols and fall protection for workers entering the reactor tank

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Exposure Rates & Doses

Center of core plate: 50mR/hr contact
Control rod bolts: 20mR/hr contact
Tank center bottom: 0.8mR/hr contact
Fuel element racks: 0.02mR/hr contact

1st worker dose: 1.5mrem in 50mins
2nd worker dose: 0.8mrem in 60mins

Total dose for 8 workers during project estimated at <20mrem.

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Transfer of PuBe out of tank using concrete cask

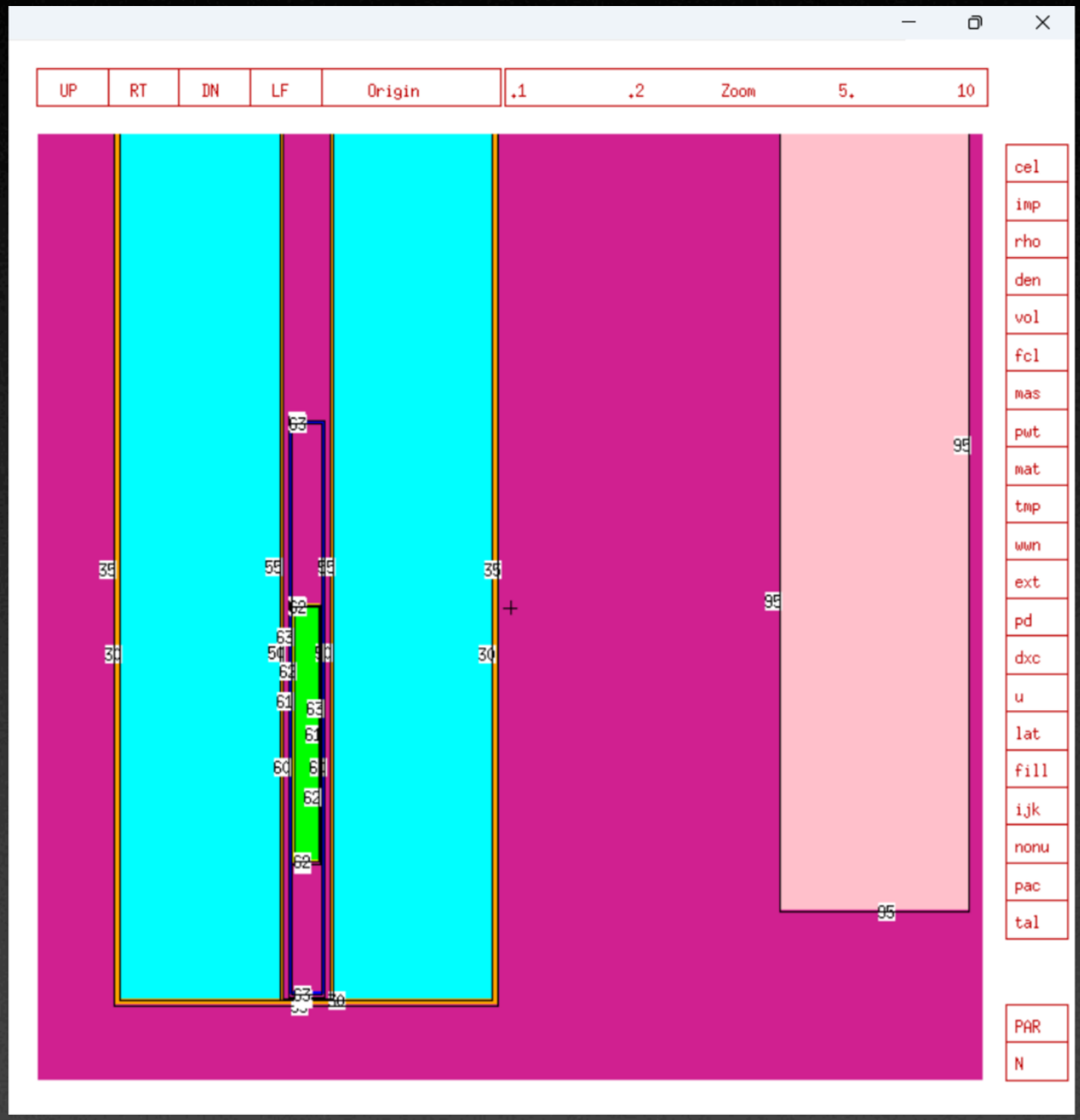
Cask height: 48 inches
Cask diameter: 16 inches
Shielding: 7 inches of concrete ¼ inch of steel

Dose rate estimates at 1 foot from cask:
Neutron: 3.8 mrem/hr
Total error: 0.0007

Secondary gamma: 0.442 mrem/hr
Total error: 0.0006

Primary gamma: 0.0015 mrem/hr
Total error: 0.0097

Anticipated time in cask: 30 minutes



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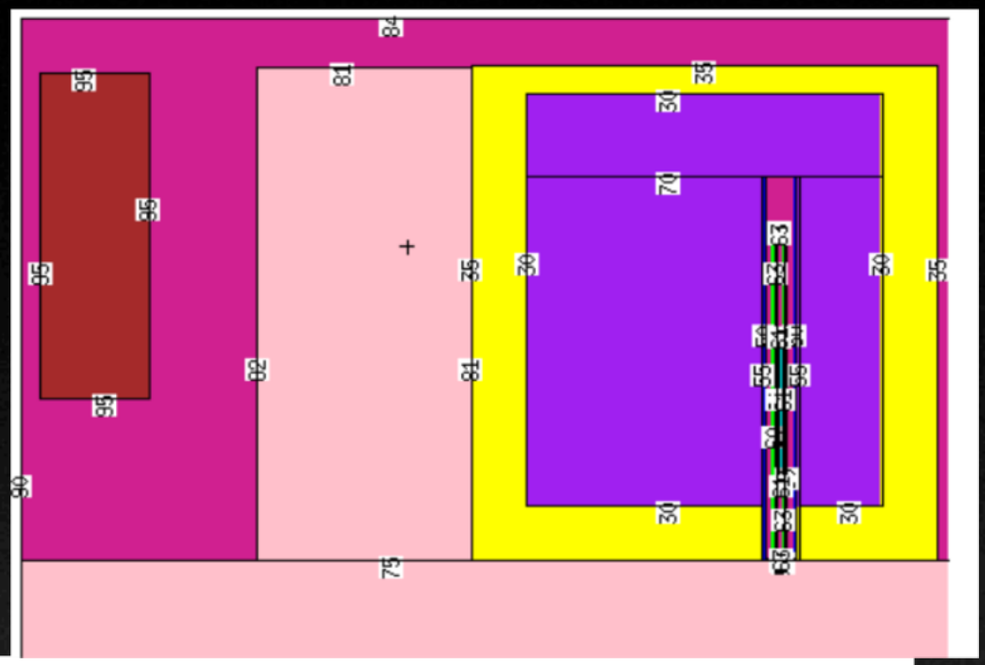
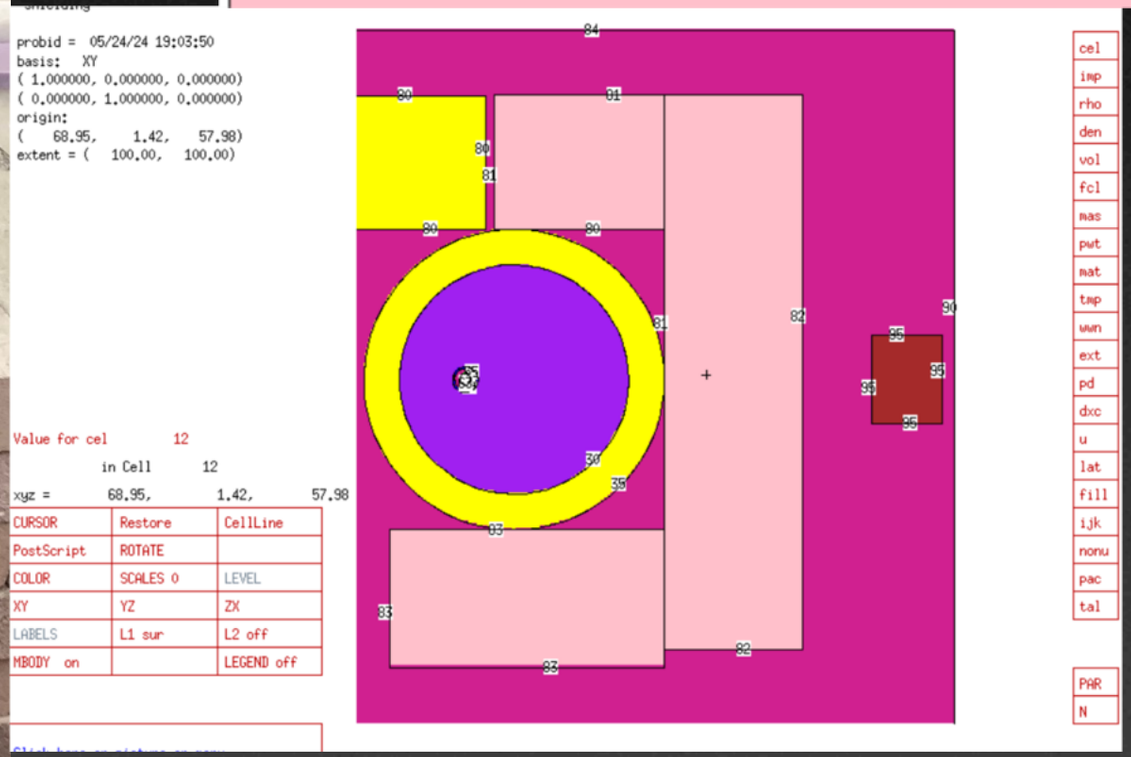
PuBe Bunker for long-term storage





Restoration Plans

- University Project Management Office is now in charge of repair

- Pending Exemption Request for Reactor Operators Annual Operating Examination and quarterly operator hours

- University of Utah intends to hire another staff member dedicated to the reactor facility.

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Questions