Reasons for Reflector Replacement

- After 40 years of operation, reflector began experiencing water in-leakage, culminating in a breach on 7/31/2009
- Water-saturated graphite and water-filled voids caused flux depression in beam ports and thermal column facilities
- Previous reflector design had solid graphite in front of beam port #2 significantly reducing the thermal neutron flux

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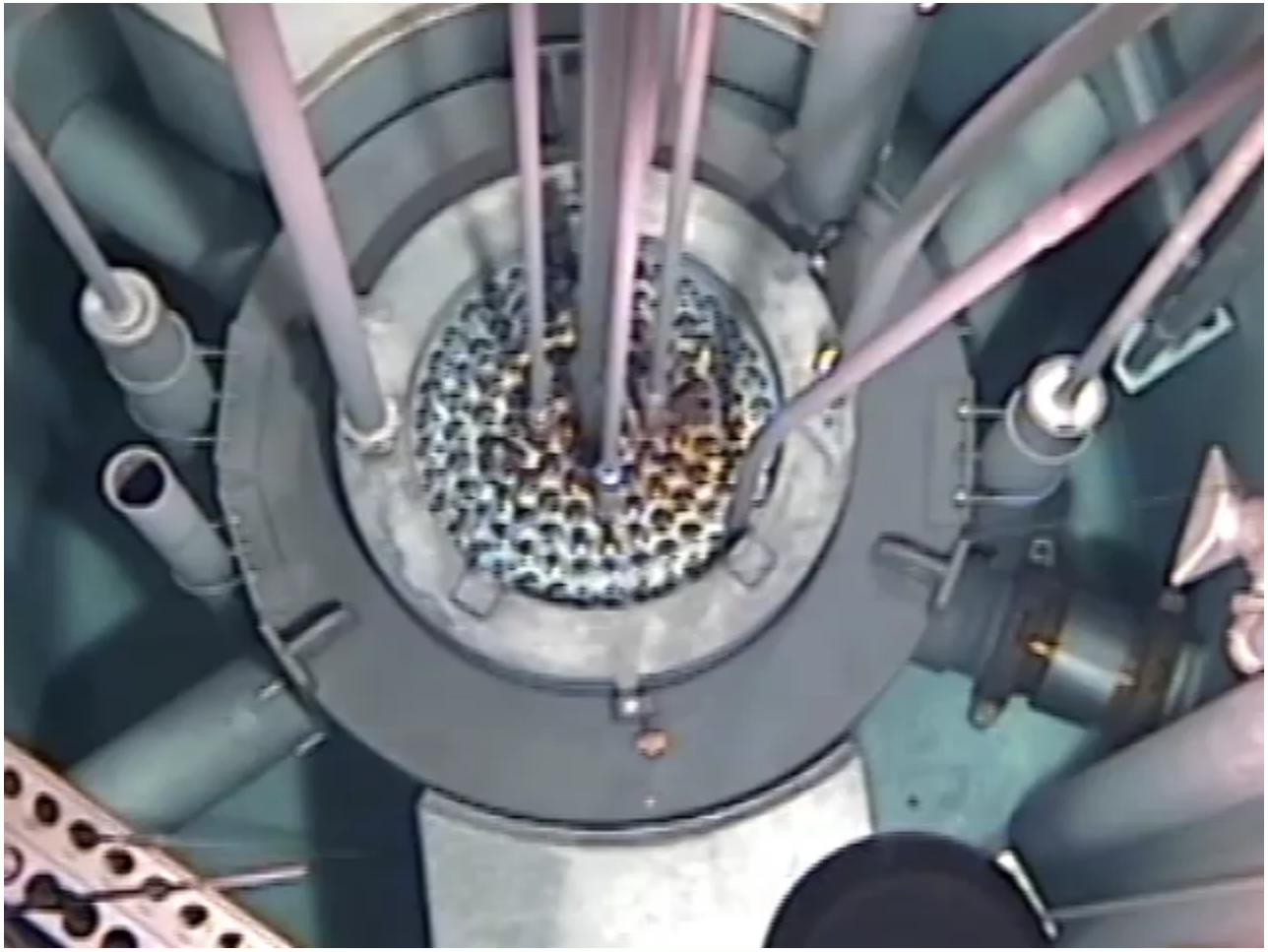
Evidence of Reflector Breach at 1 MW



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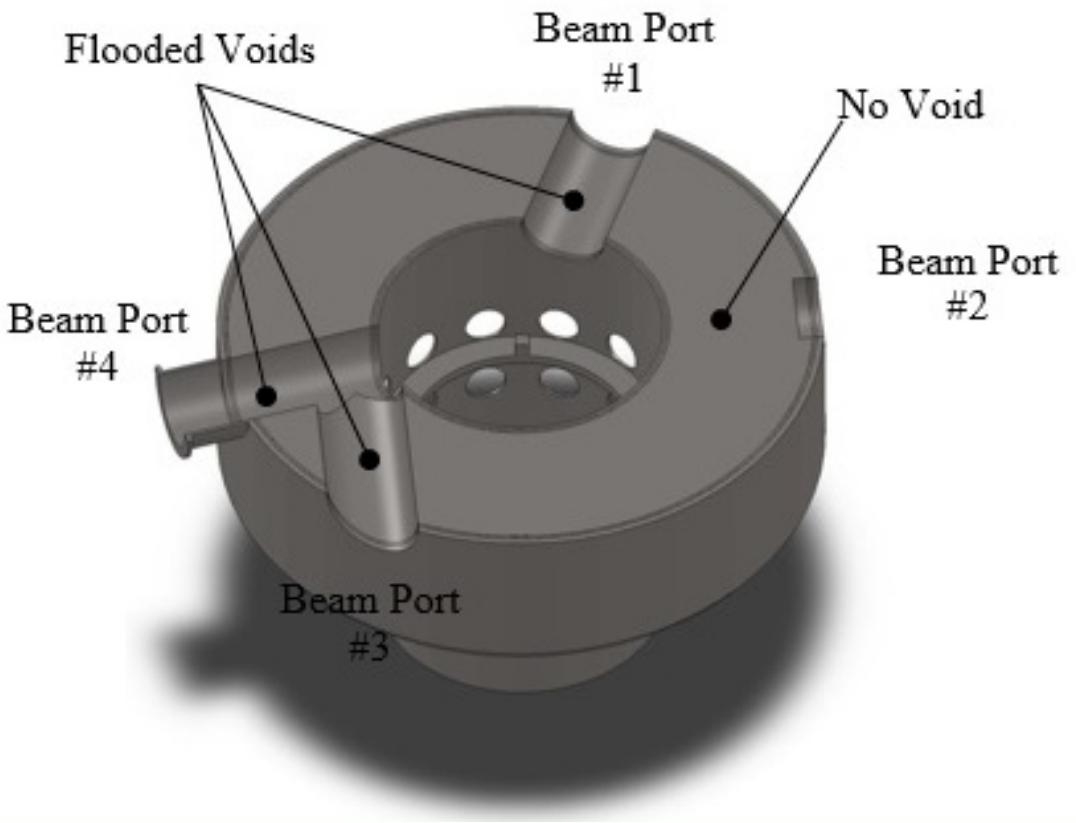
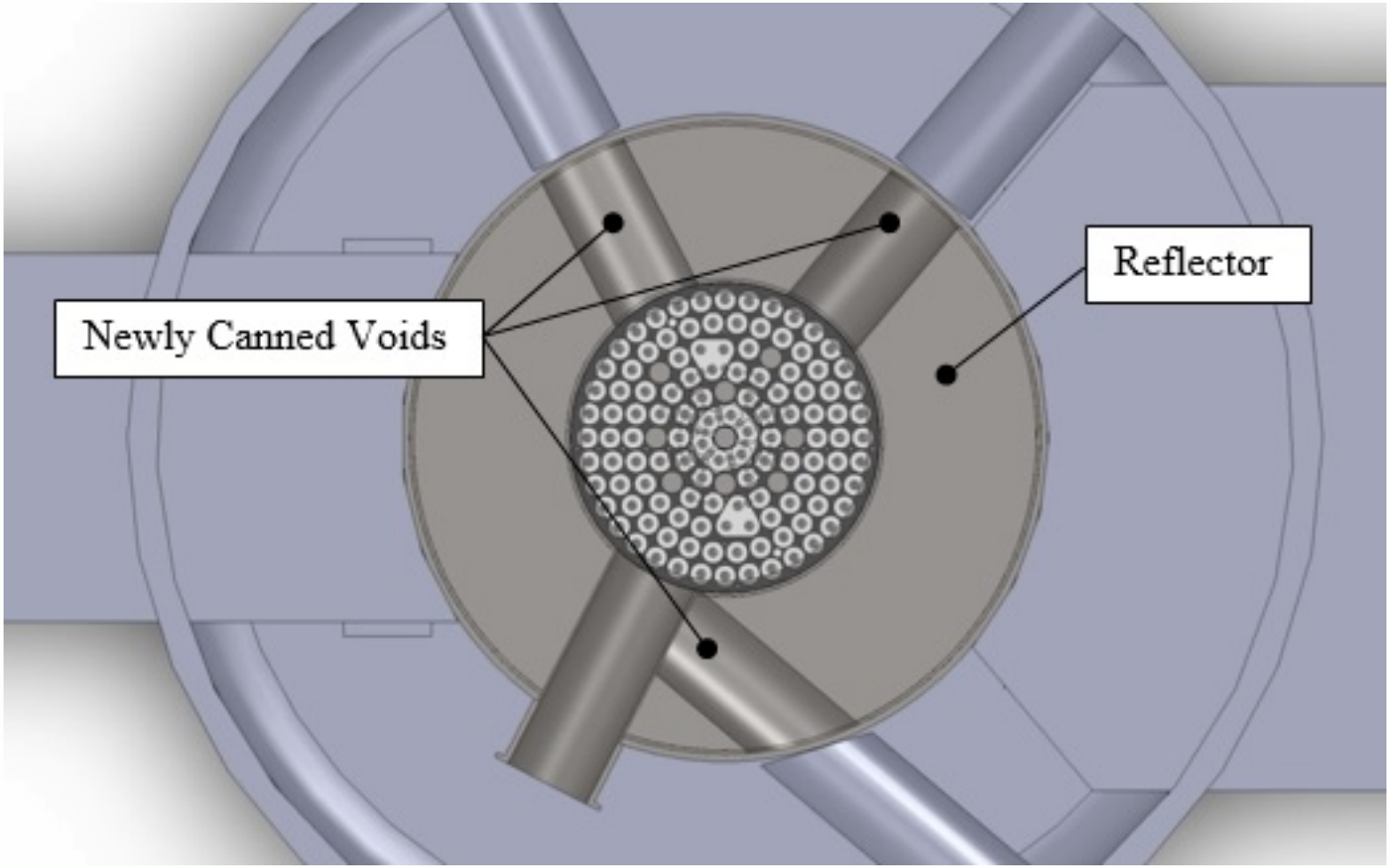
Old Reflector Design



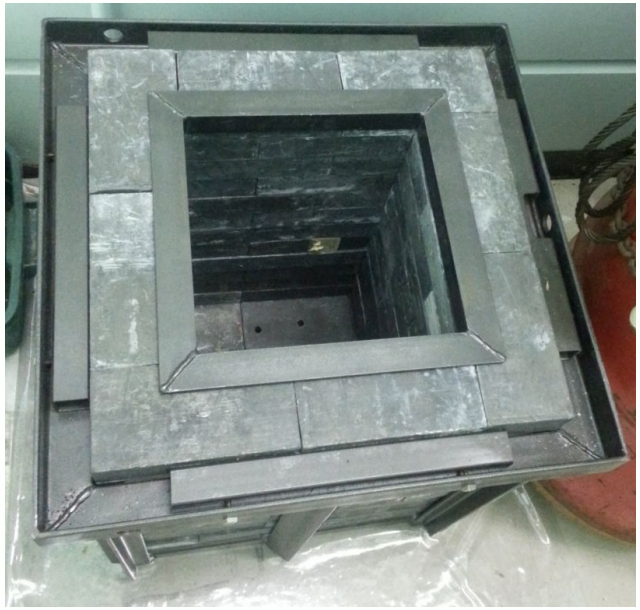
- Original reflector had voids in graphite, which eventually filled up with water, precluding flux
- Beam Port #2 facility had no void in graphite, severely reducing the potential thermal flux in that facility
- New reflector fixes these problems by placing sealed aluminum cans within the graphite gaps in beam ports #1, #2 and #3

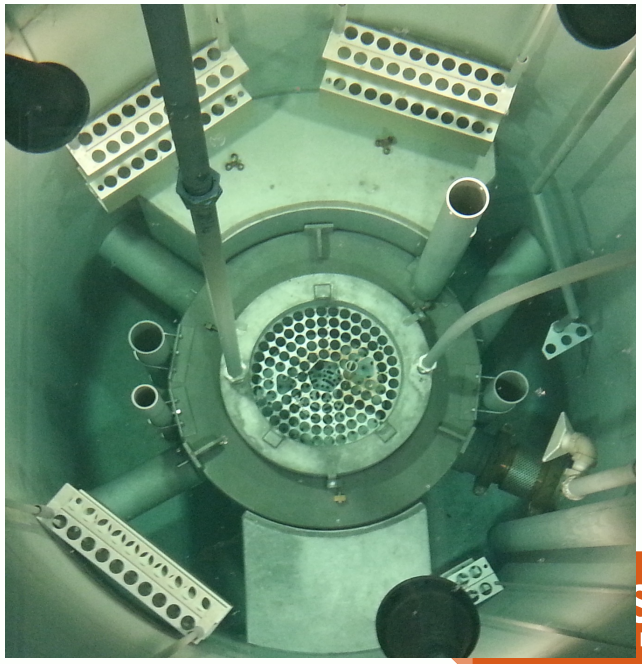
New Reflector Design



Timeline for Reflector Repair

- July 1st, 2013
  - Beginning of outage, waiting for fuel cooldown
  - Fabrication of transfer basket for bellows/steel tank parts removal
  - Mounted a temporary camera on reactor top to record significant events
- August 5th-8th, 2013
  - Began transfer of fuel from primary tank to adjacent bulk-shield tank (BST)
  - Removed all in-core fuel, graphite and irradiation facilities





Single Fuel Element Removal

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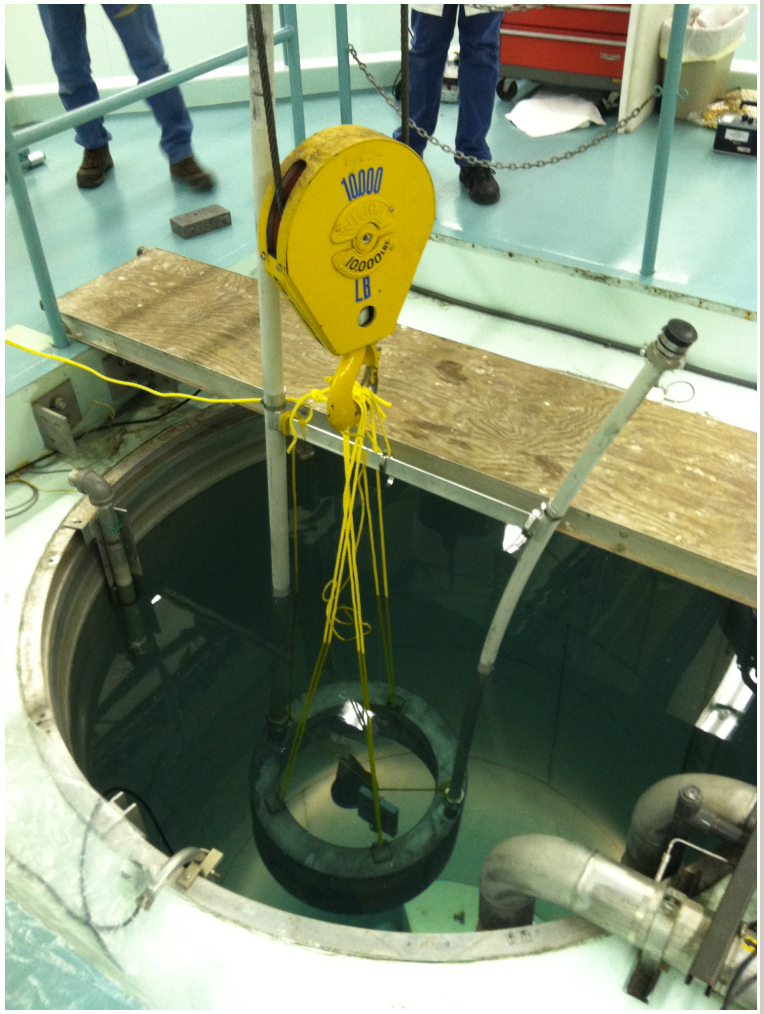
August 12th - Lazy Susan Removal



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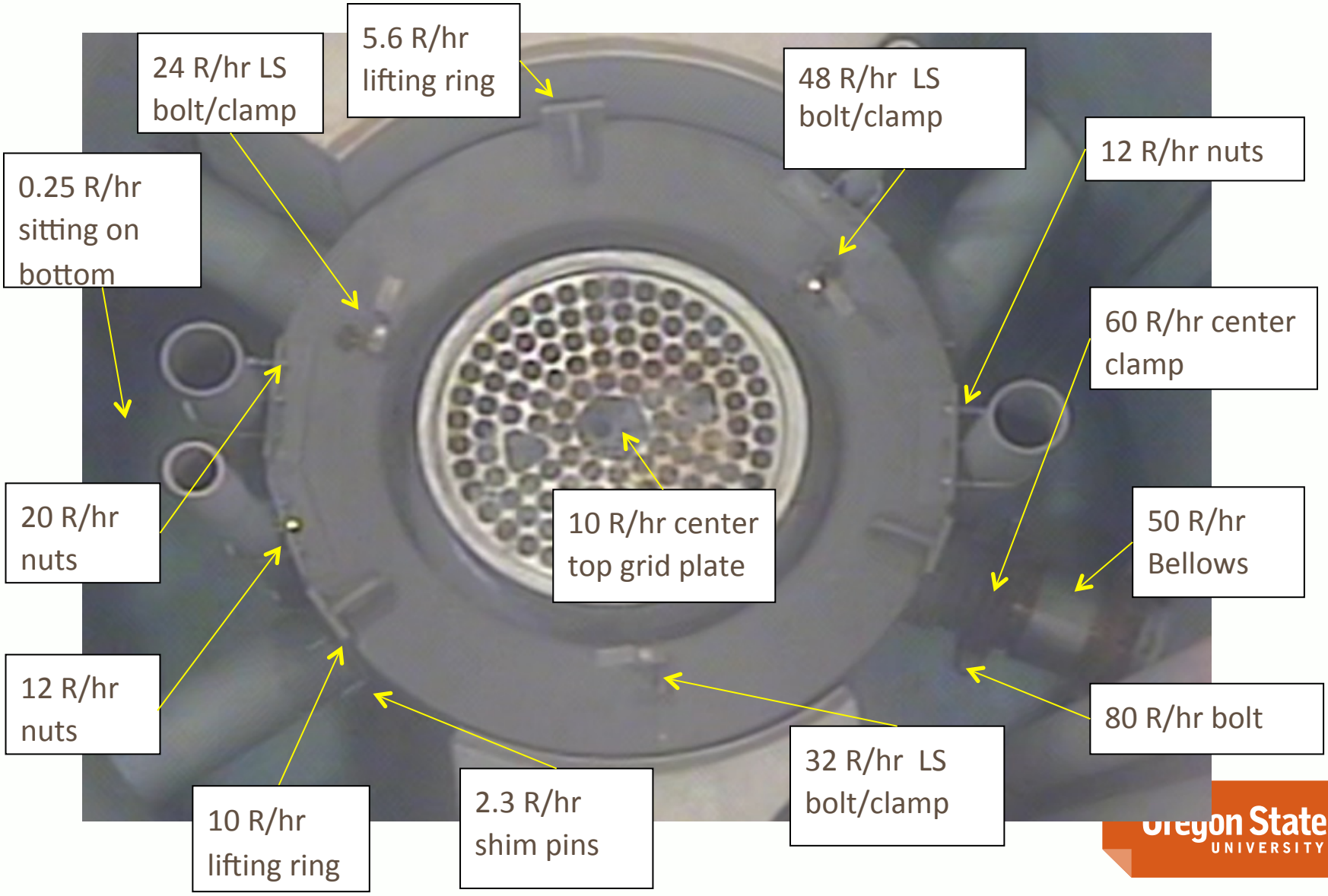
Defueled Underwater Survey Results



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September 10th - Reflector Removal

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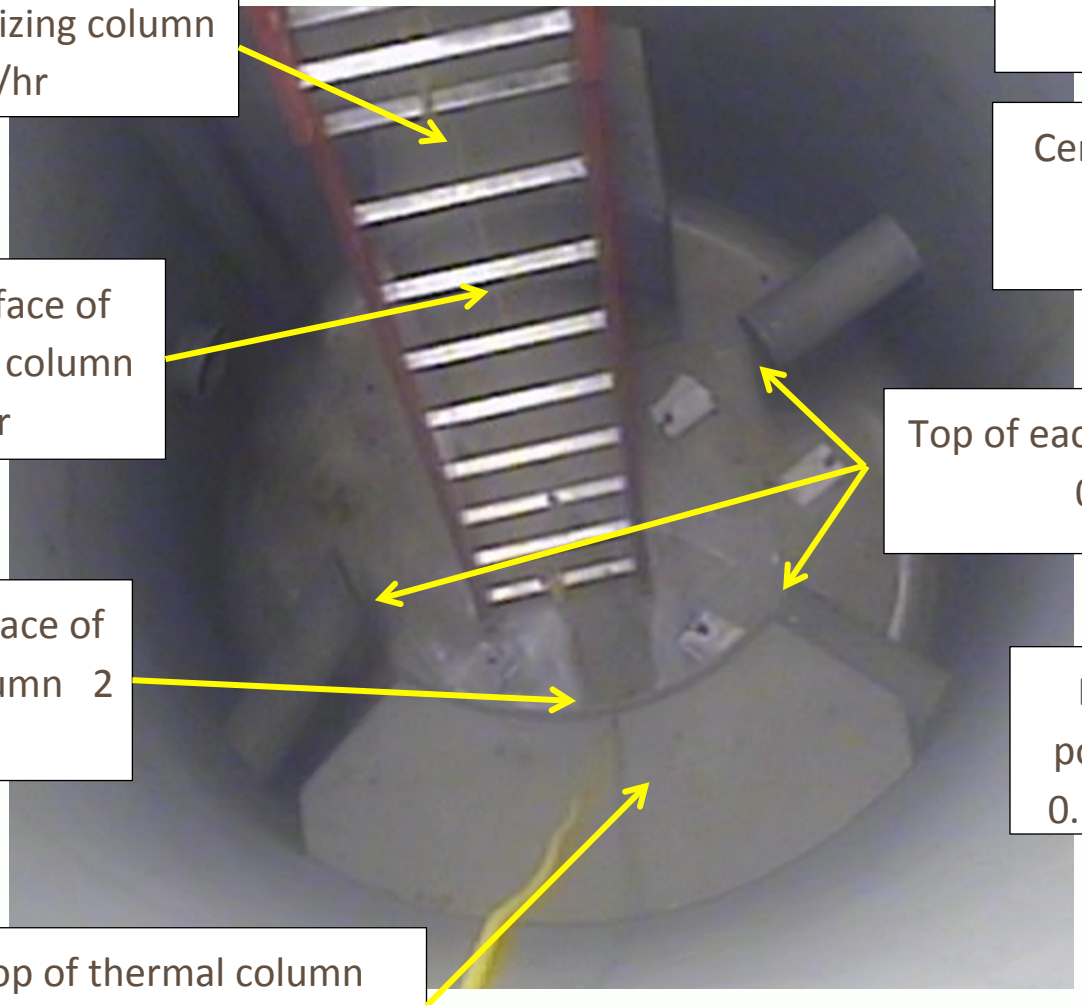
September 12th - Survey Results After Tank Draining



Top of thermalizing column
0.1 R/hr

11 ft down from top
0.020 R/hr

Center of tank 3 ft
off floor
0.600 R/hr

Centerline face of
thermalizing column
1 R/hr

Top of each beamport tube
0.5 R/hr

Centerline face of
thermal column 2
R/hr

Between beam
ports against tank
0.250 – 0.400 R/hr

Top of thermal column
0.200 R/hr

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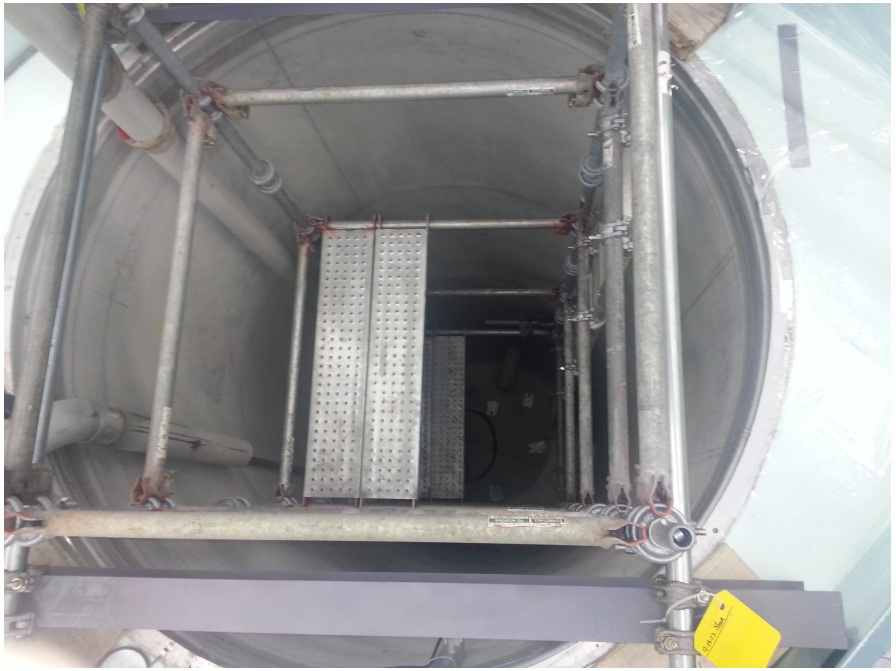
October 1st – Tank Inspection

- Scaffold was installed in order to perform a complete tank inspection
- Ultrasonic thickness tests were successfully performed up to the lowest scaffold level (~10 ft. from bottom of tank), no degradation found
- Remote tank inspection was performed with HD cameras near the tank bottom due to high radiation levels



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October 23rd - Epoxy Coating

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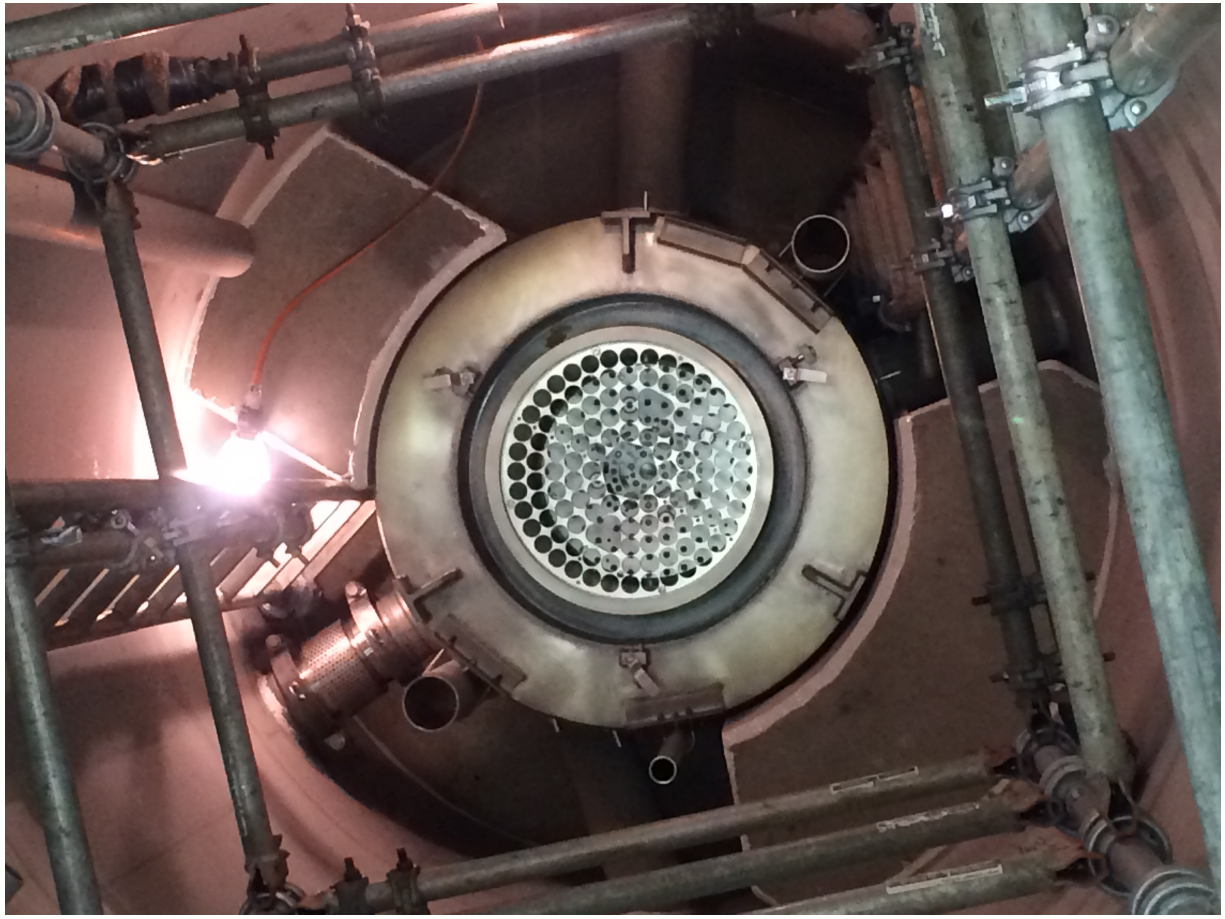
November 1st – New Reflector Installed



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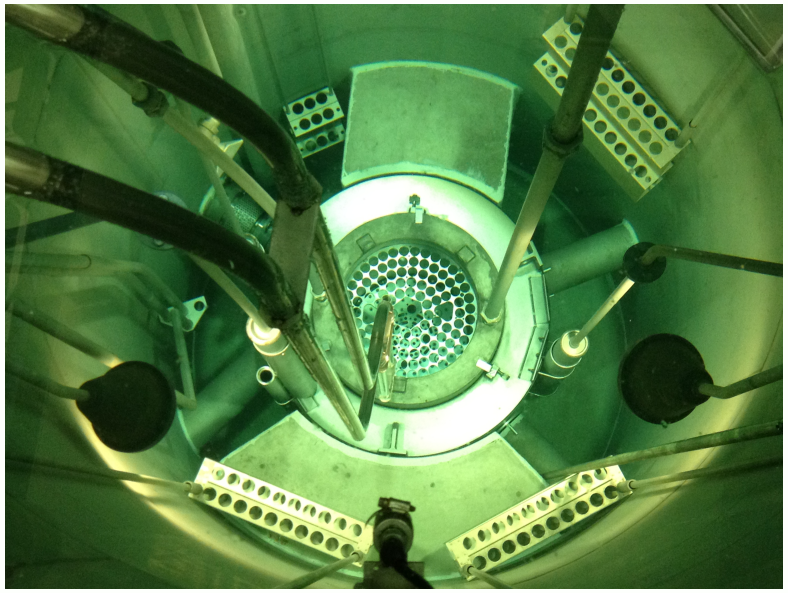
Remaining Milestones



November 26th

- All major components reinstalled

December 16th

- Achieved criticality on 67 FEs

December 17th, 2013 to January 3rd, 2014

- Performed calibrations and flux measurements

January 6th, 2014

Reactor Released For Normal Operation

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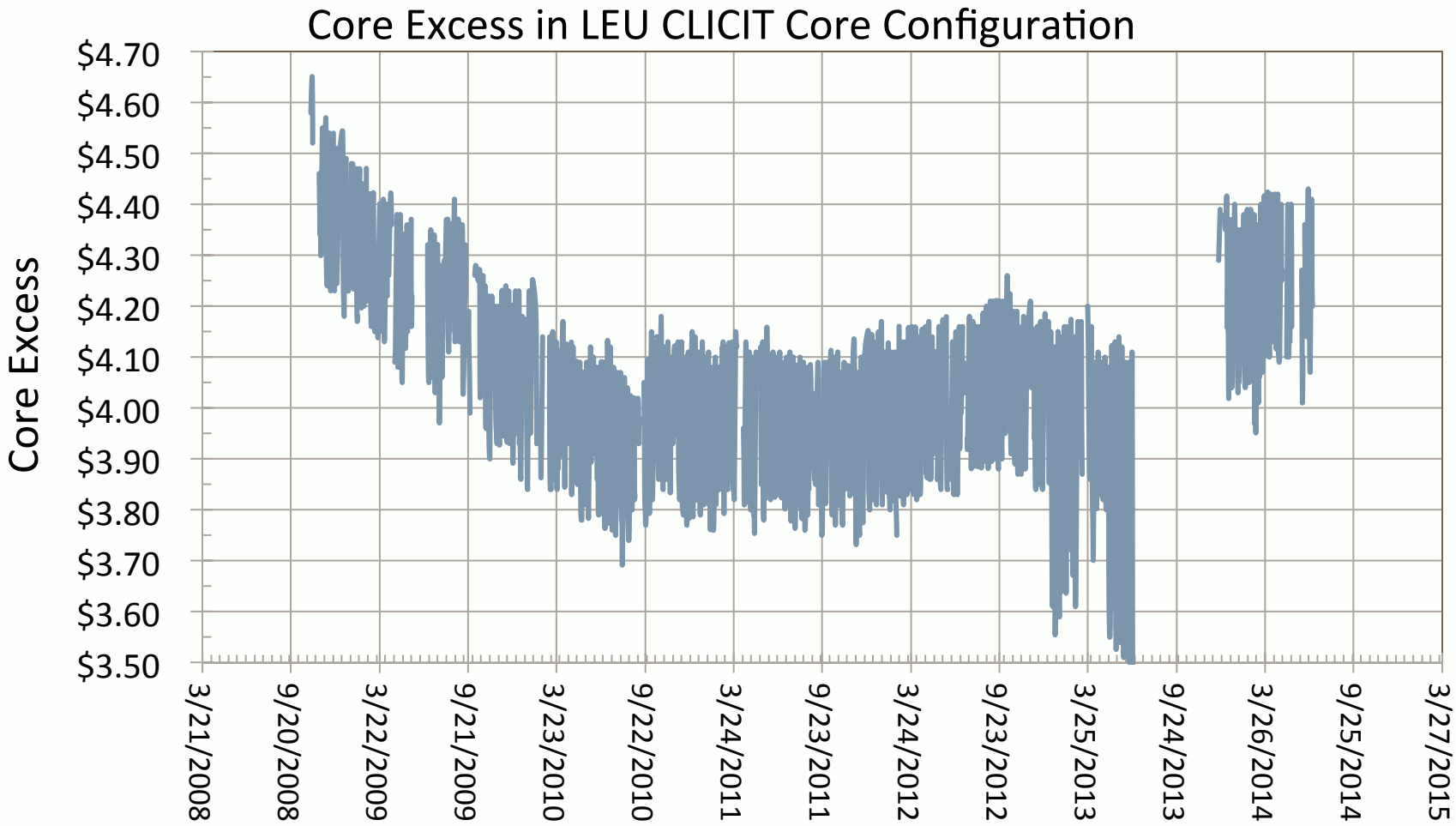
Final Doses for Entire Project

Group	DDE (mrem)	SDE (mrem)	Extremity (mrem)
Total - All	3,148	3,627	4,563
Total - Contractor	1,334	1,334	2,045
Total - OSU	1,814	2,293	2,518
Highest Individual - Contractor	683	683	773
Highest Individual – OSU	543	543	775

Change in Core Excess due to Reflector Replacement



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Facility Flux Improvements

Facility	Spectrum	Flux With Original Reflector (n/ cm^2s)	Flux With New Reflector (n/ cm^2s)	Ratio of Increase
Neutron Radiography Facility (Beam Port #3)	Thermal	1.2×10^5	4.5×10^6	37.5
	Epithermal	1.6×10^4	6.8×10^4	4.3
Thermal Column	Thermal	8.0×10^{10}	2.8×10^{11}	3.5
	Epithermal	6.4×10^8	1.1×10^9	1.7

Acknowledgments

- General Atomics - Jerome Gormley
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- Leo Bobek - Umass Lowell
- Melinda Krahenbuhl – Reed College