MIT Research Reactor

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Big Impact of a Small Leak at the MIT Reactor

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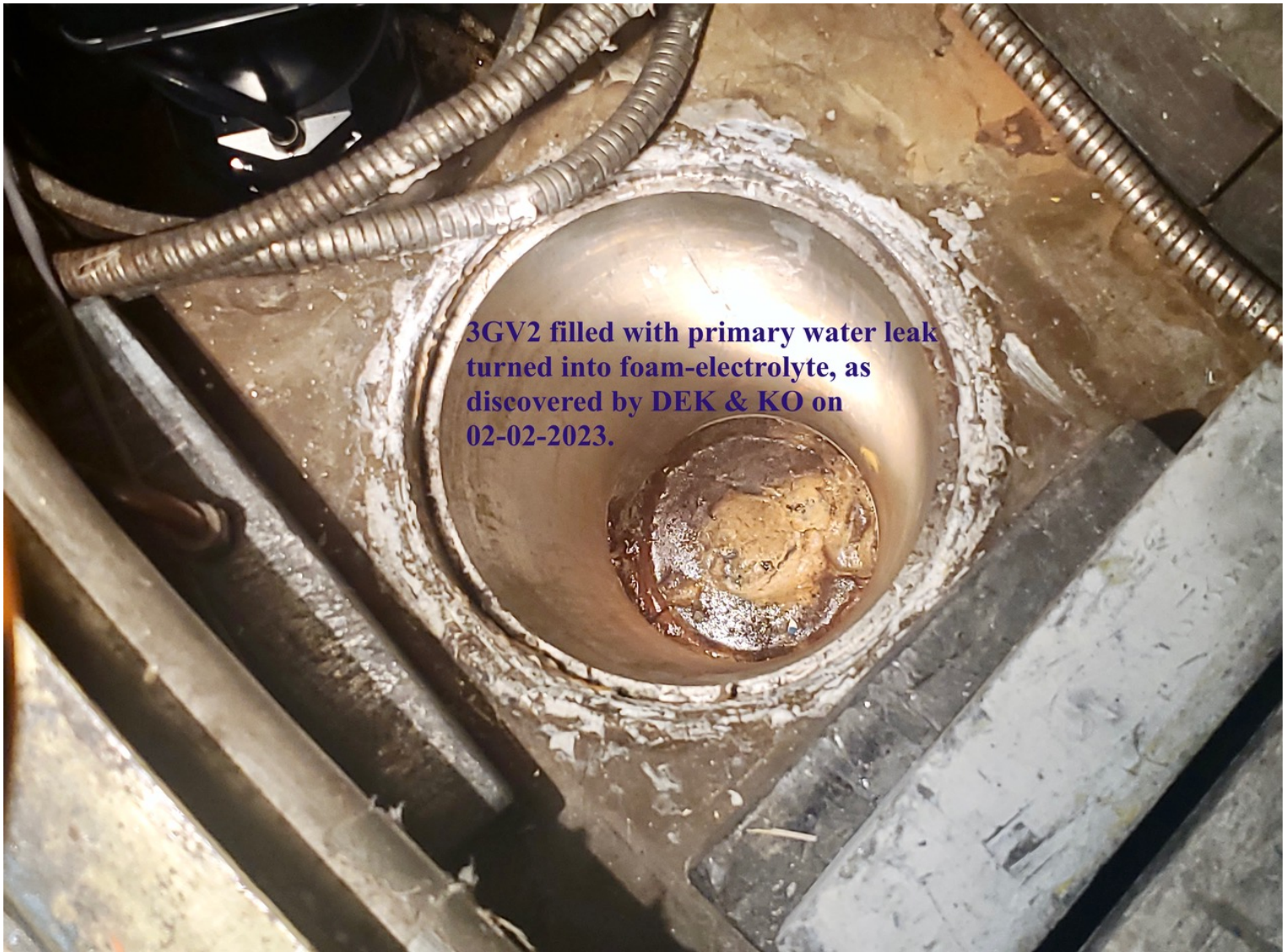
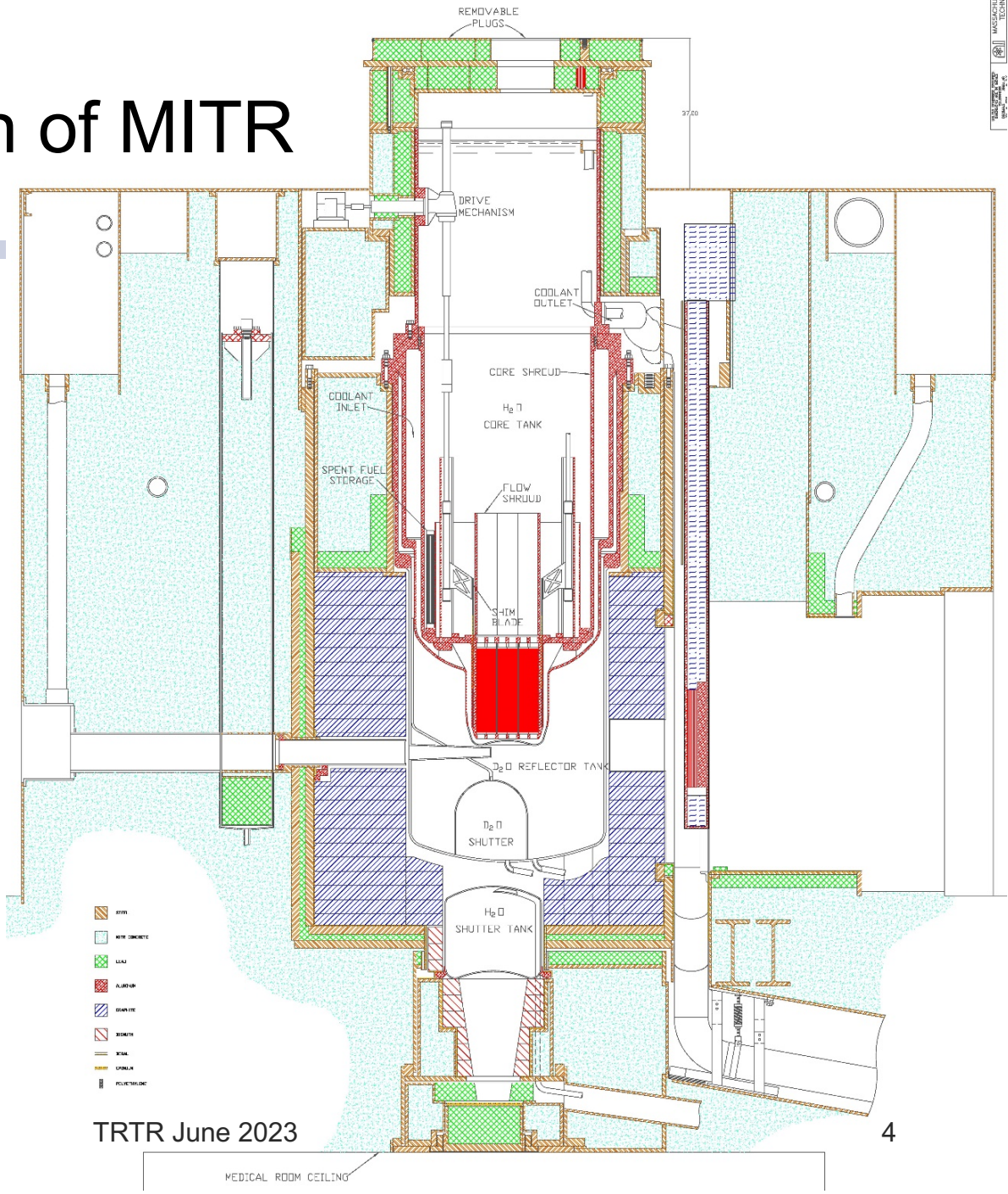
Leak Discovery

- December 12, 2022: 10% decrease in reading on one of the four nuclear safety channels
- All other neutron flux channels + thermal power channel indicate steady-state full power operation.
- Later that day: 4% decrease in a second nuclear safety channel
- The reactor was then shut down

Water in Vertical Port Attenuated Signal
(Fission Chamber removed in photo)



Cross-Section of MITR



Drawing courtesy of Dr. David Carpenter

Identifying Source of Leak

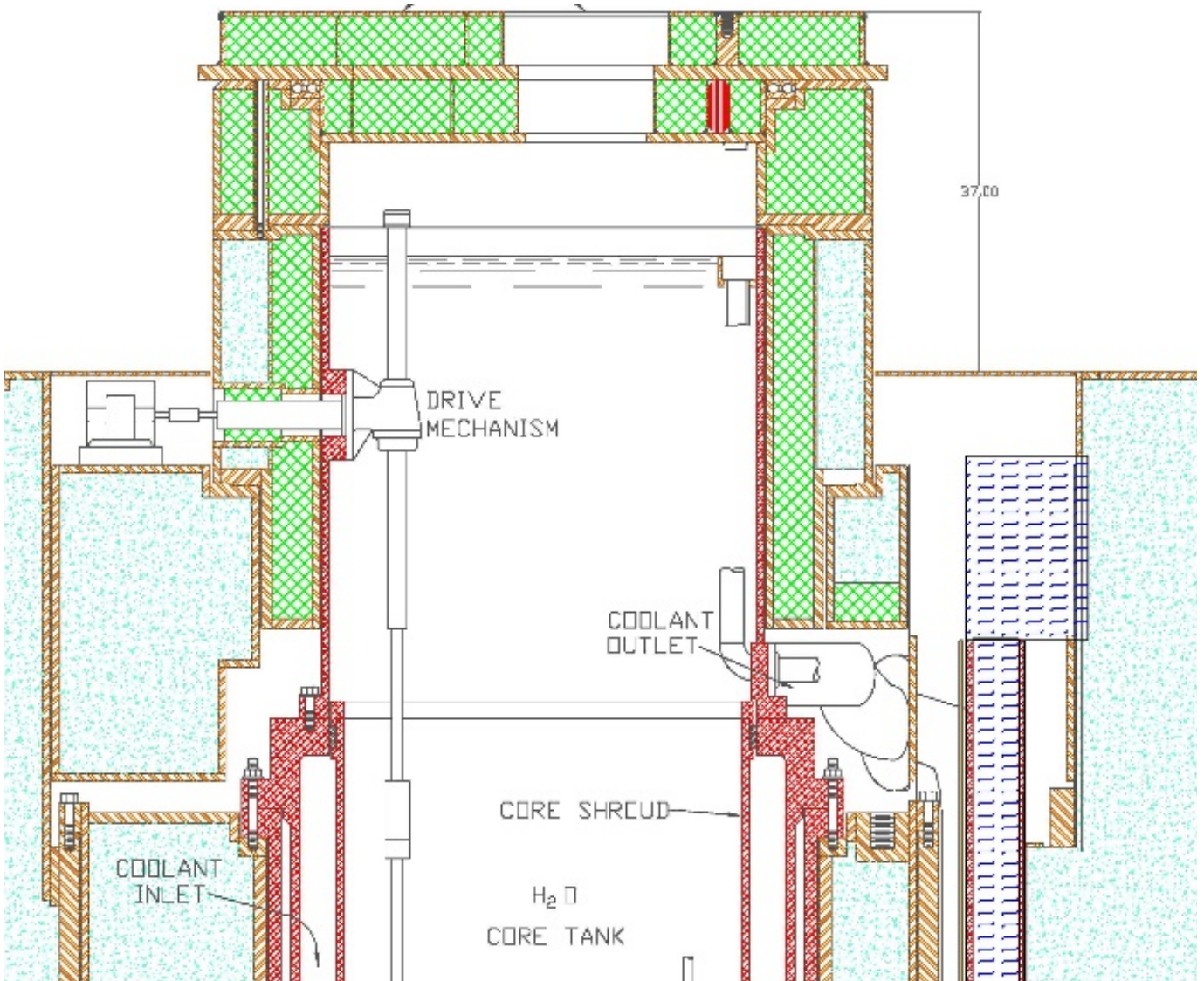
- Lowering the core tank water level below the primary coolant outlet pipe stopped the leak.
- Raising the core tank water level above the primary coolant outlet pipe restarted the leak.

Identifying Source of Leak

There were nine possible sources of primary water leakage at the level of the coolant outlet:

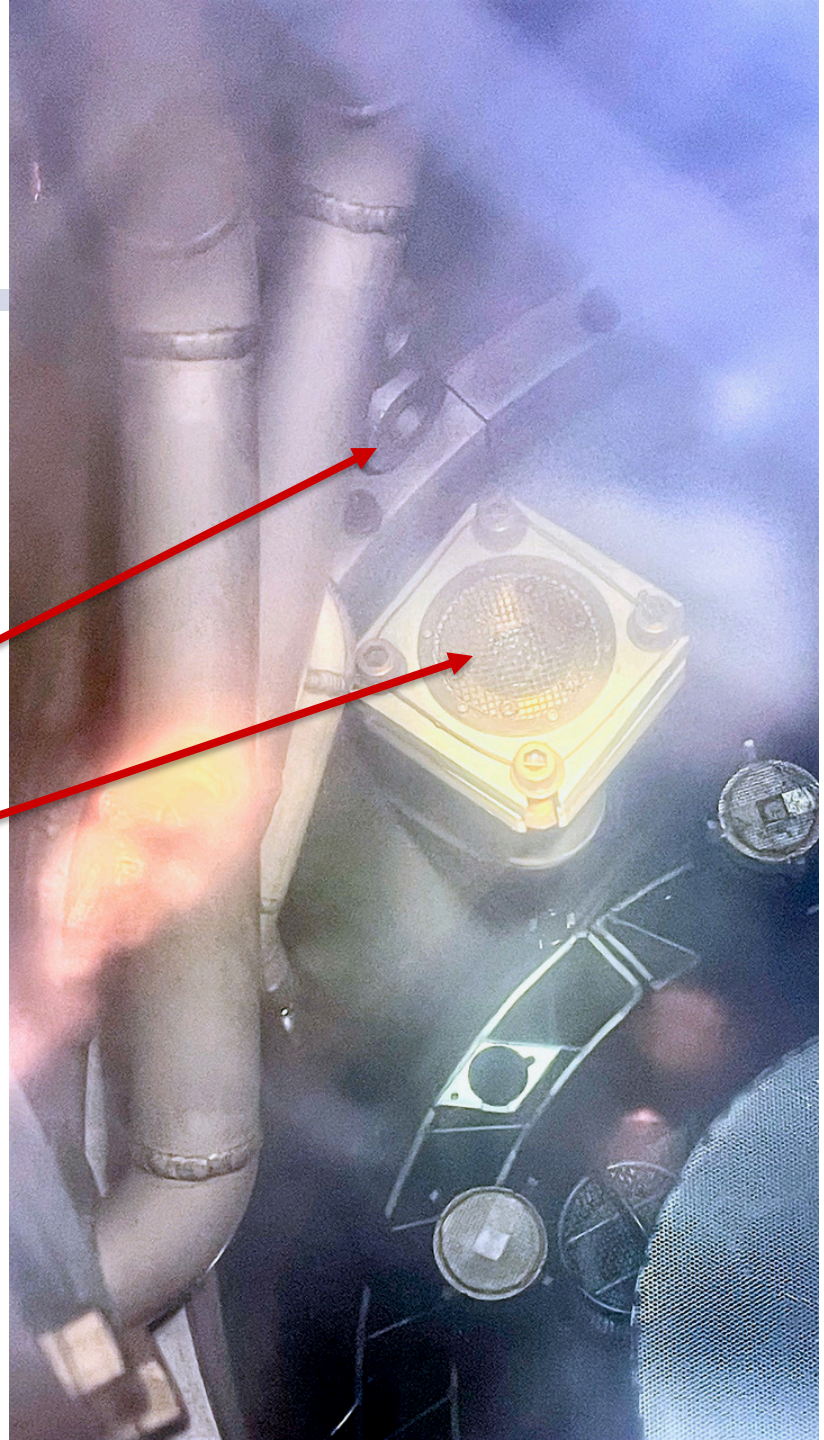
- Coolant outlet pipe/manifold
- Coolant inlet pipe/manifold
- Inlet differential pressure gages MP-6 and/or MP-6A
- Core tank overflow line/flange
- Core tank flange for core purge system piping
- Core tank level probes ML-3A and/or ML-3B
- Upper core tank gasket

Cross-Section of MITR (Upper Tank)



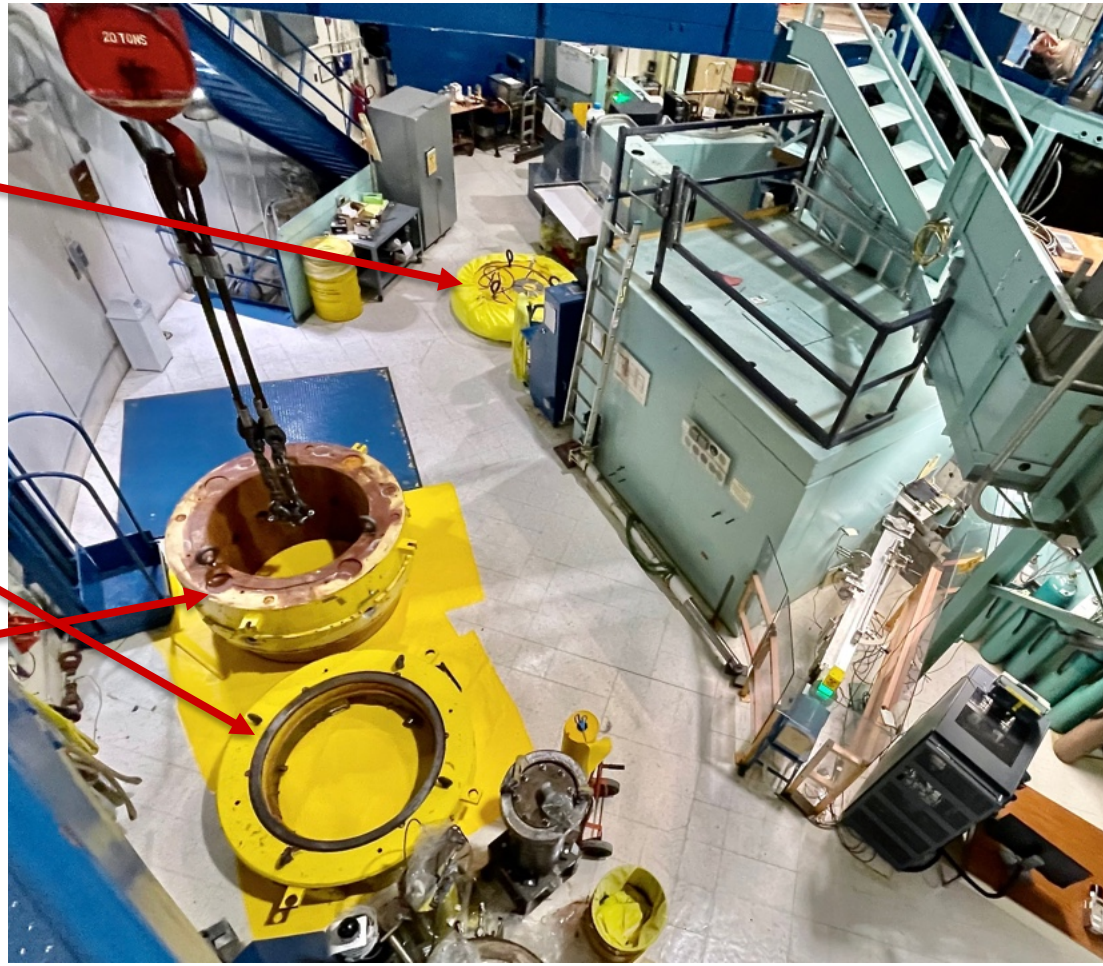
Core Tank (Interior)

- One pressure gage penetration visible
- One anti-siphon valve visible



Shielding Removal After Defueling

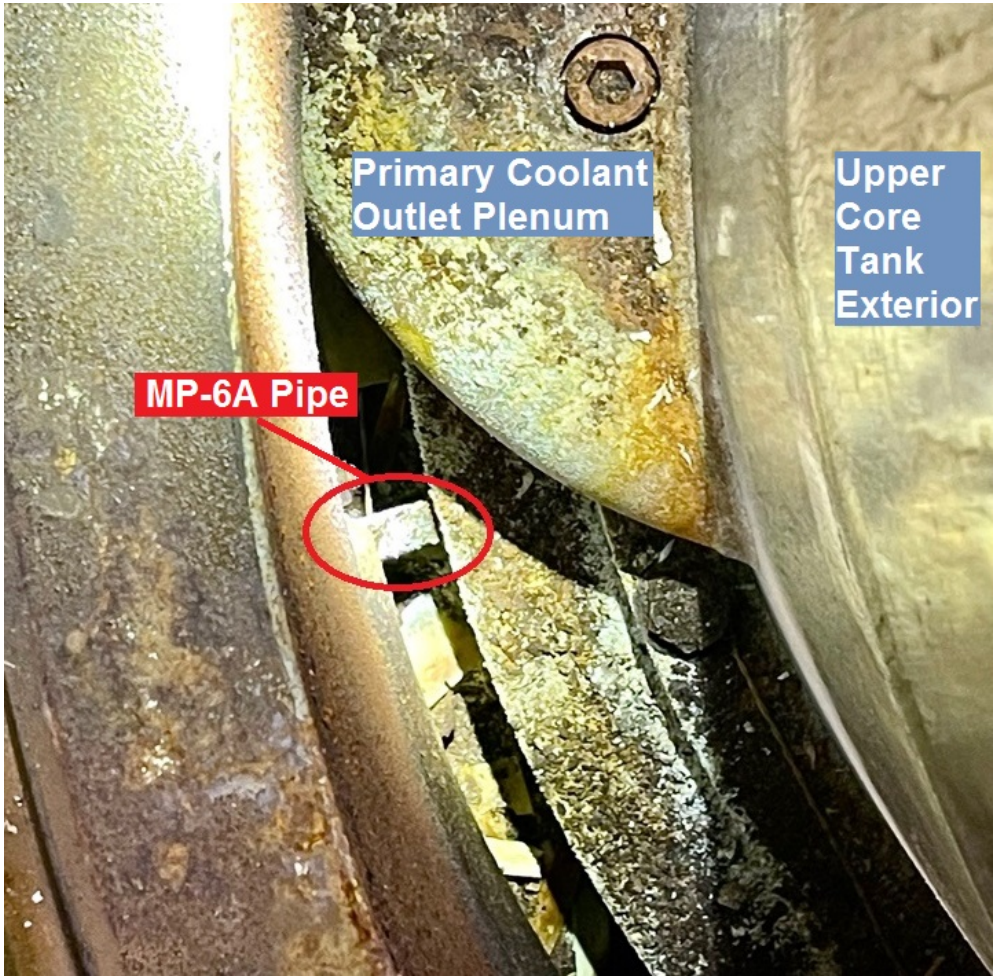
- 1) Top shield lid
  (+ protective bag)
- 2) Upper shield
  access ring
- 3) Upper shield ring
- 4) Upper annular ring
  is not yet removed
  in this photo



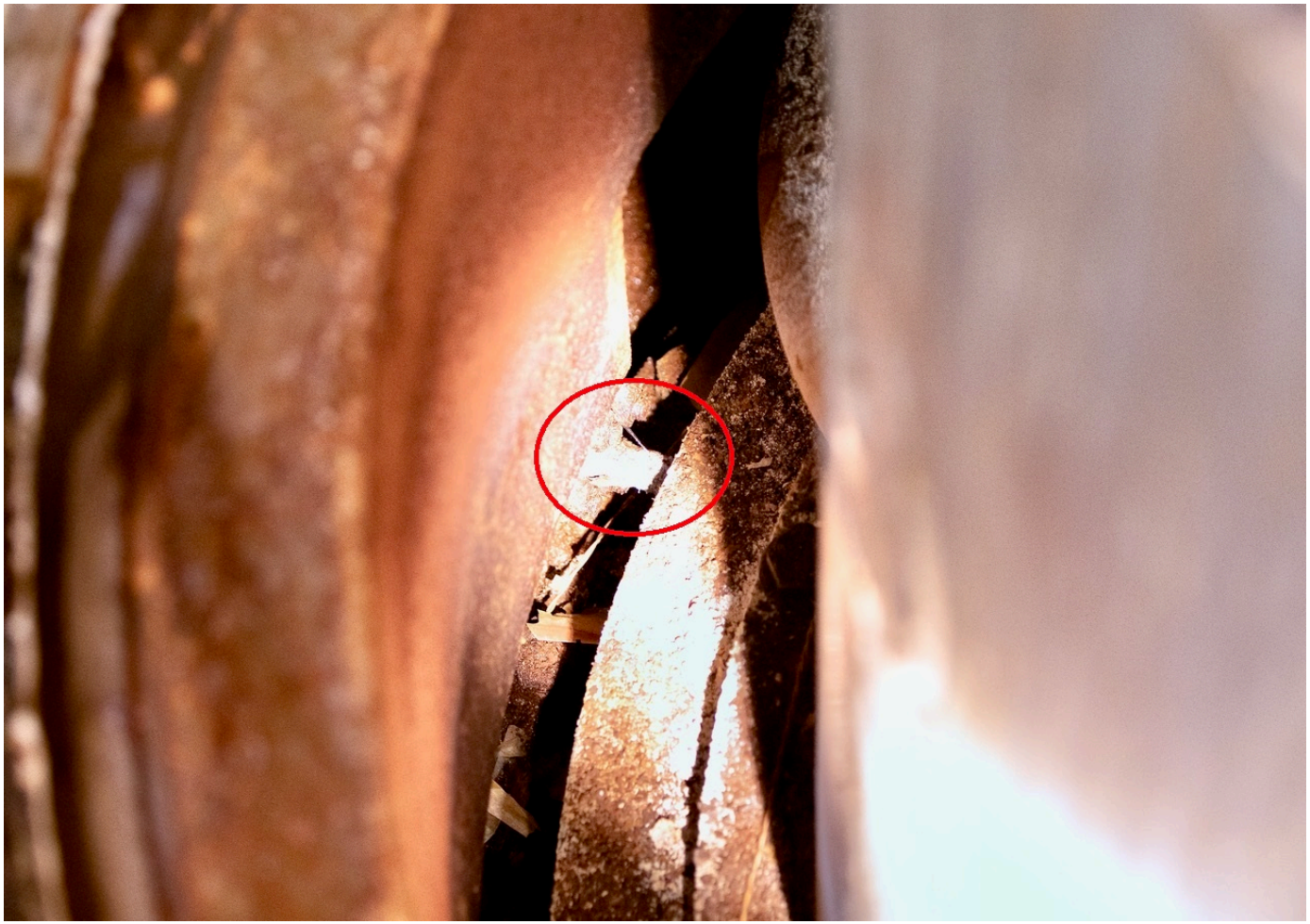
Upper Annular Ring (ok to stand on!)

Leak is at Base of Upper Annular Ring

View from Above (without Leak)

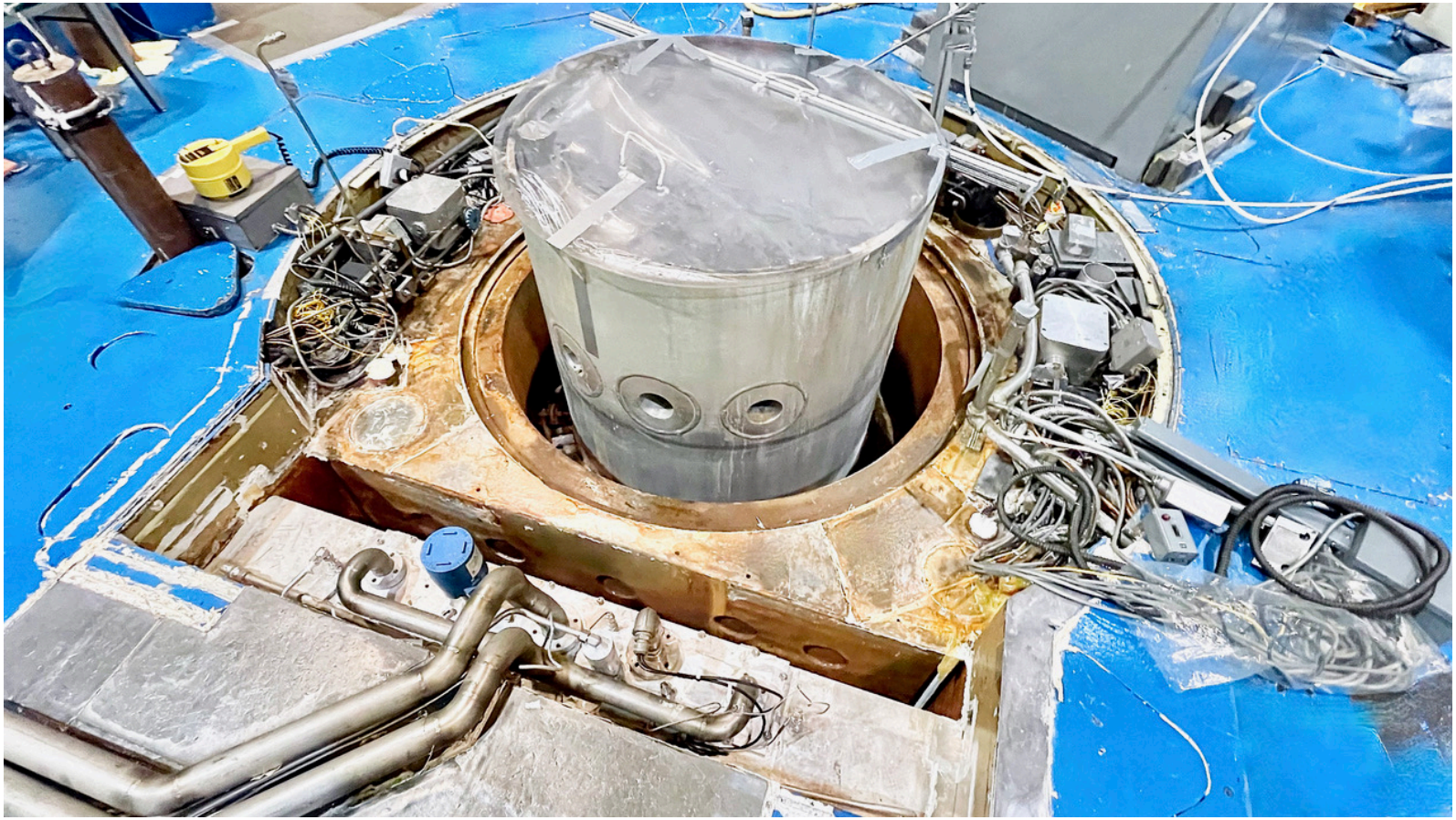


Angled View from Above (with Leak)

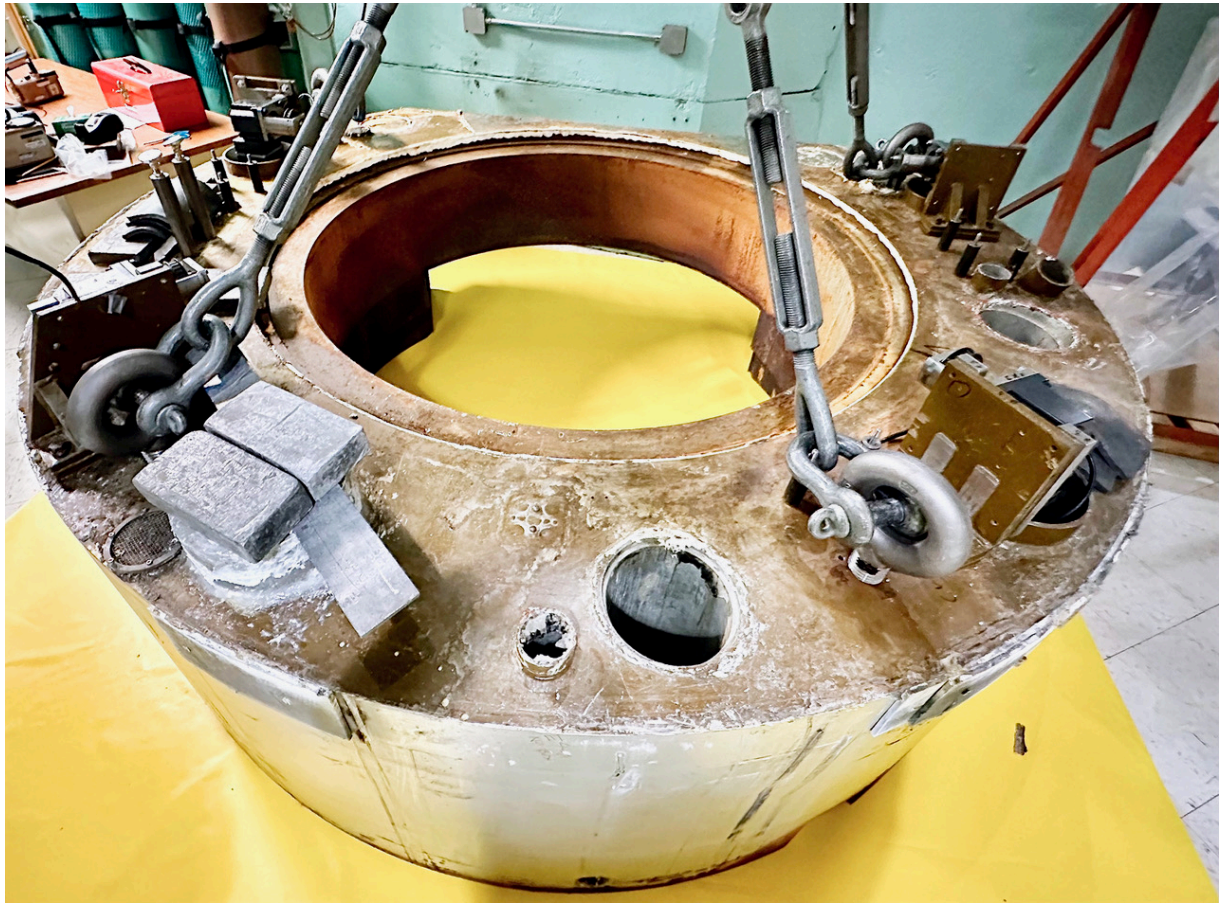


Close-Up View from Above (with Leak – 7.5 gallons per day)

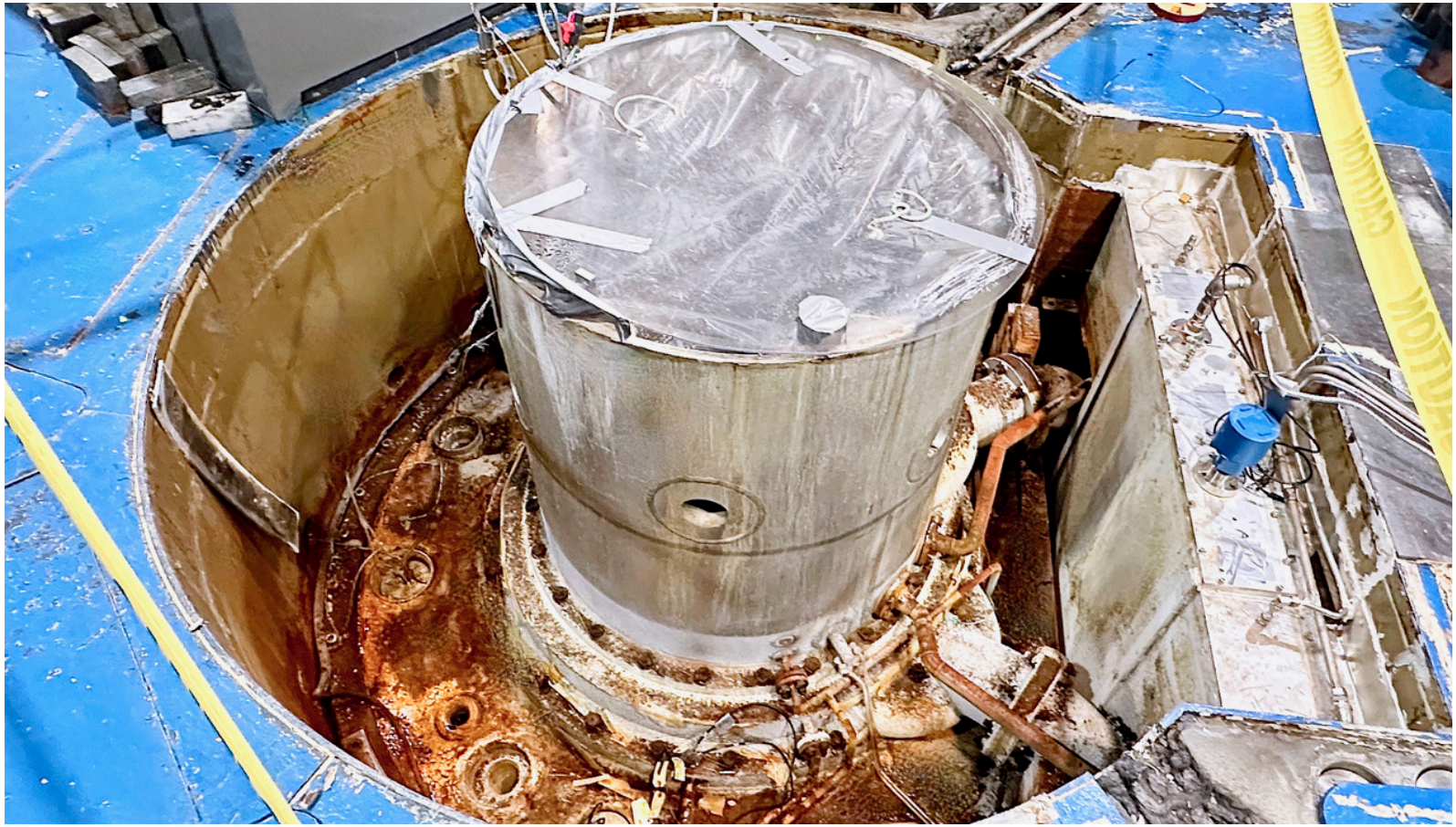
All the Control Blade Drives and Wiring had to be Removed…



…and then the Upper Annular Ring was Lifted Out using the Polar Crane



Without the Upper Annular Ring…



…there was Access to Replace the MP-6A (and MP-6) Pipes

What Caused the Leak?

- Corrosion to a ½” threaded aluminum pipe section for the MP-6A flow sensor
- Humid conditions prolonged in the area
- Iron rust covered the aluminum pipe!
- The rust acted as an oxygen reduction site, polarizing the aluminum above its corrosion potential, resulting in general localized corrosion.

Standard catalog part costing about $5 !

Corrective Actions

- The leaking aluminum threaded pipe was replaced with a 316 stainless-steel threaded pipe.
- Other threaded piping in the area was similarly replaced as a preventive measure
- The piping area was cleared of iron rust.
- The inner and outer surfaces of the shield rings that sit above the piping area were carefully cleaned by grinding and sanding, and then coated with rust inhibitor.
- All gaskets in the area were inspected; some were replaced.
- Leak detectors added in many locations for early detection. Use of humidity sensors is being considered as well.
- Inspection tubes added for future use.

Lessons Learned

- Excellent foresight in reactor design that allows disassembly and re-assembly.
- Notifying NRC via phone call to Project Manager early in the process and throughout the repair worked well.
- Notifying the MIT Reactor Safeguards Committee throughout the repair process worked well.
- Adhering to ALARA throughout the diagnostic and repair process worked well. – Defueling the core tank was a sound investment in terms of personnel dose exposure.
- Tap-holes should go deep enough for threaded pipe to have at least six threads of engagement. The MP-6/6A pipes went only about 2-1/2 threads deep, and attempted to compensate for this with a weld that was likely contaminated by pipe-dope.

Questions & Answers