Exceptional service in the national interest

SAND2015-8126C

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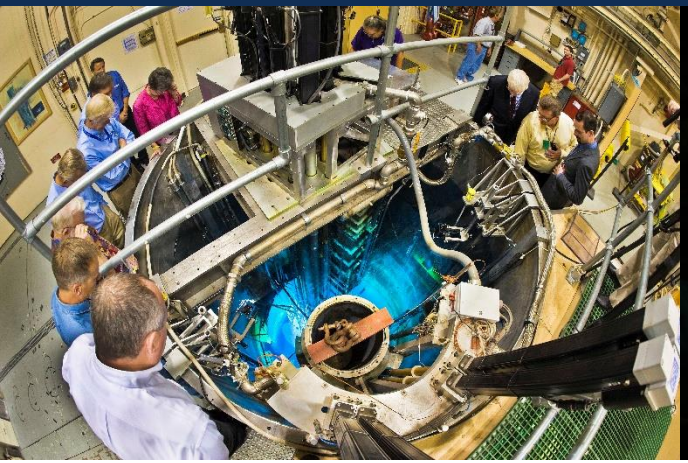

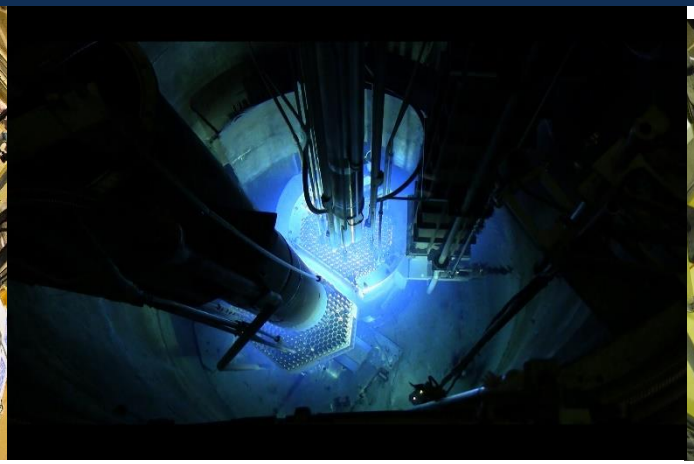

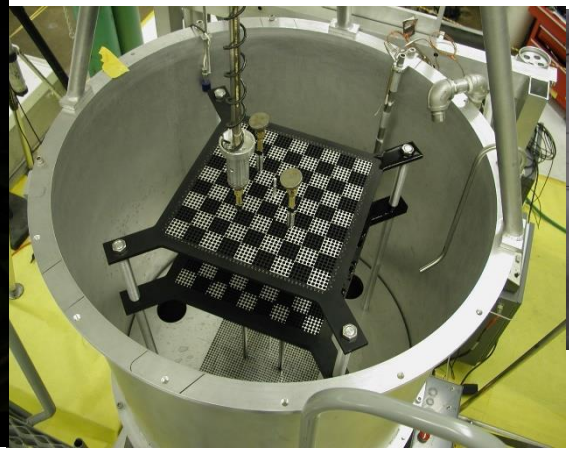

Sandia National Laboratories, Nuclear Facility Operations Year In Perspective

Test, Research & Training Reactor 2015 Conference

Lonnie Martin, ACRR Reactor Supervisor

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Nuclear Facility Operations

Full Range of Nuclear and Radiation Facilities for Research, Development and Testing

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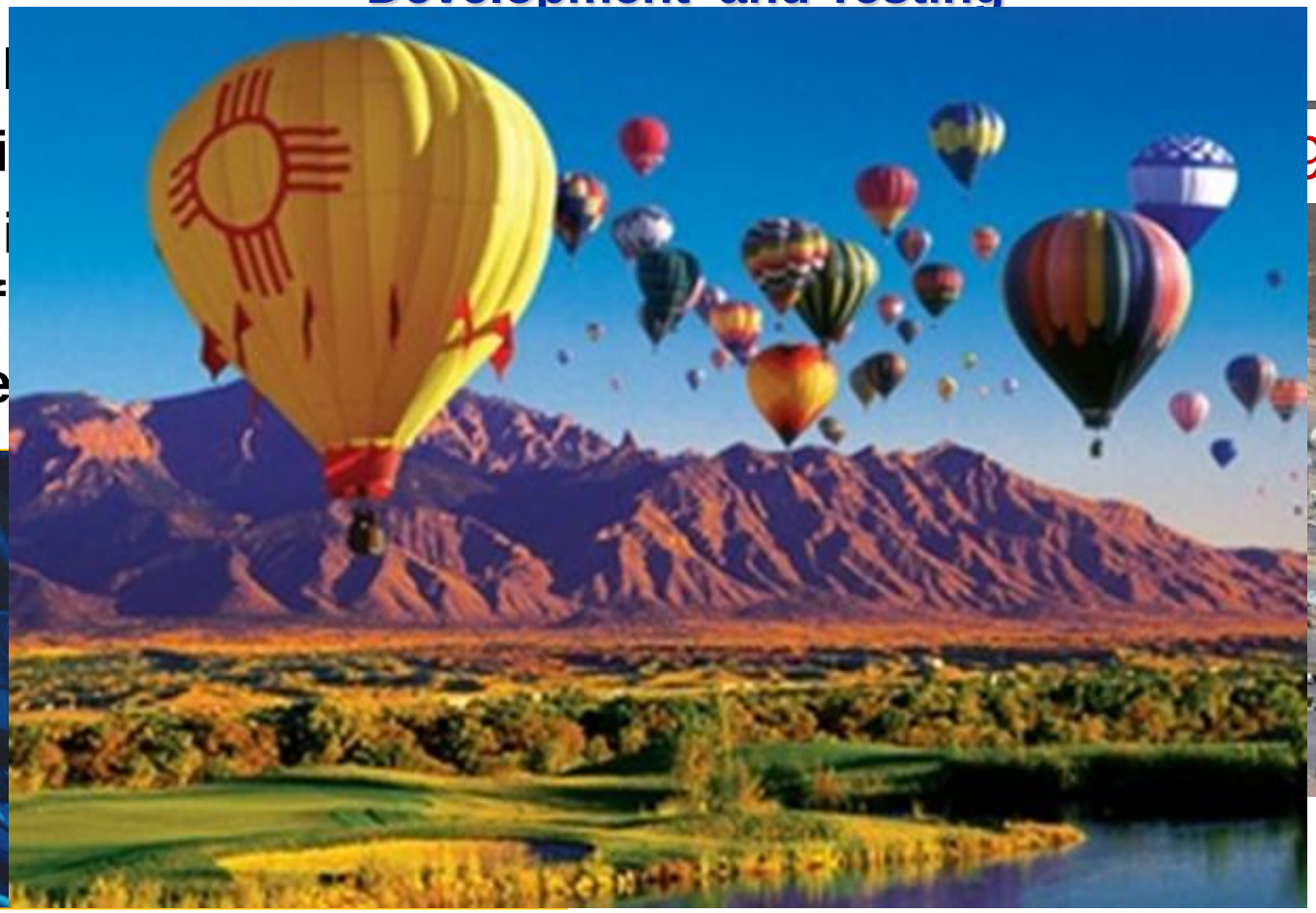

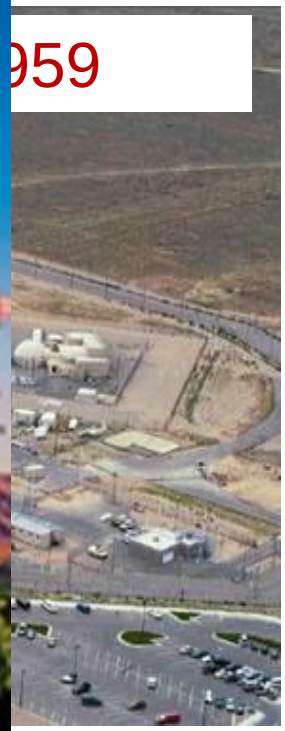

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Nuclear Facility Operations

Gamma Irradiation Facility

Since 2000

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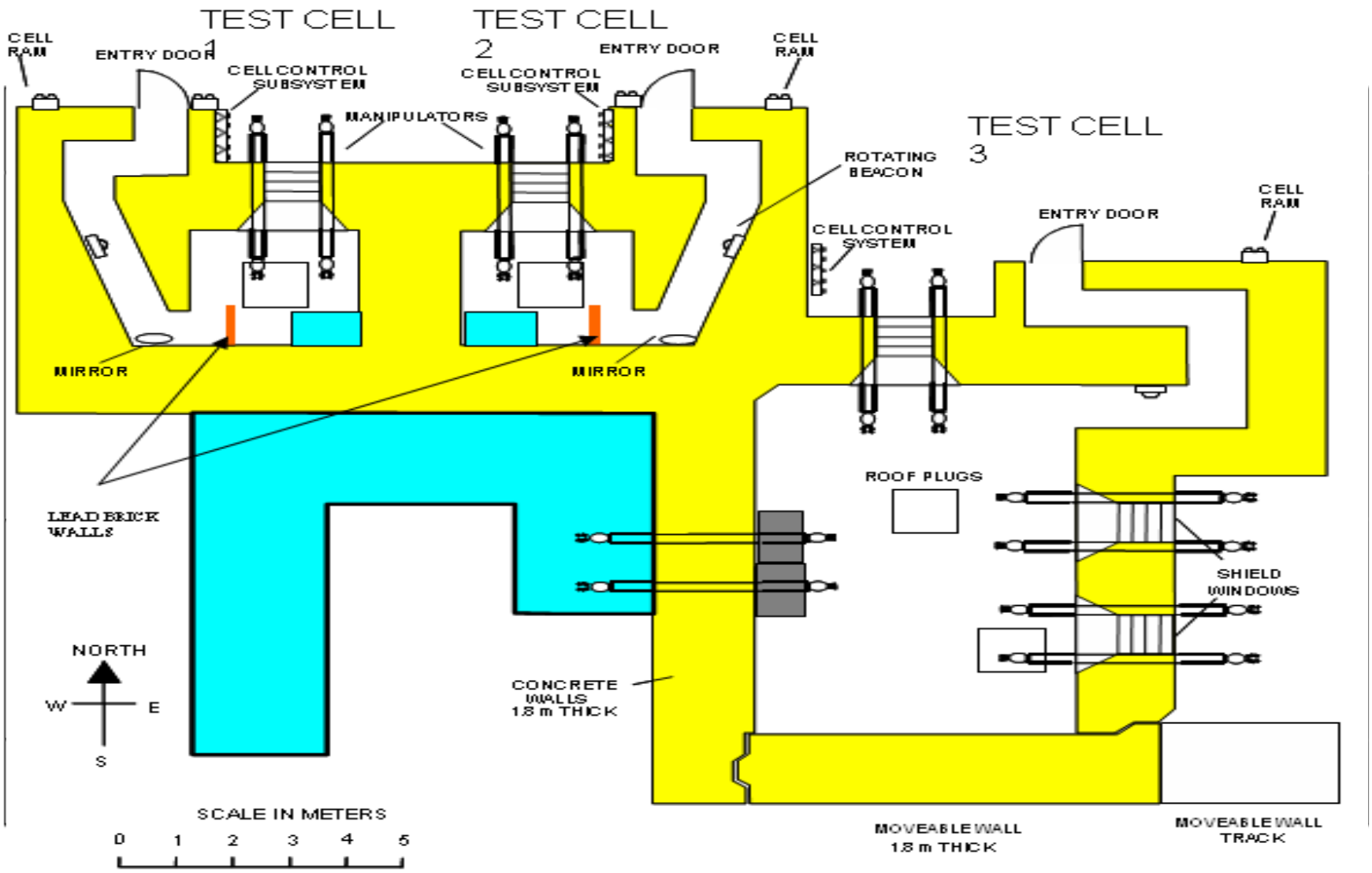
Nuclear Facility Operations - GIF



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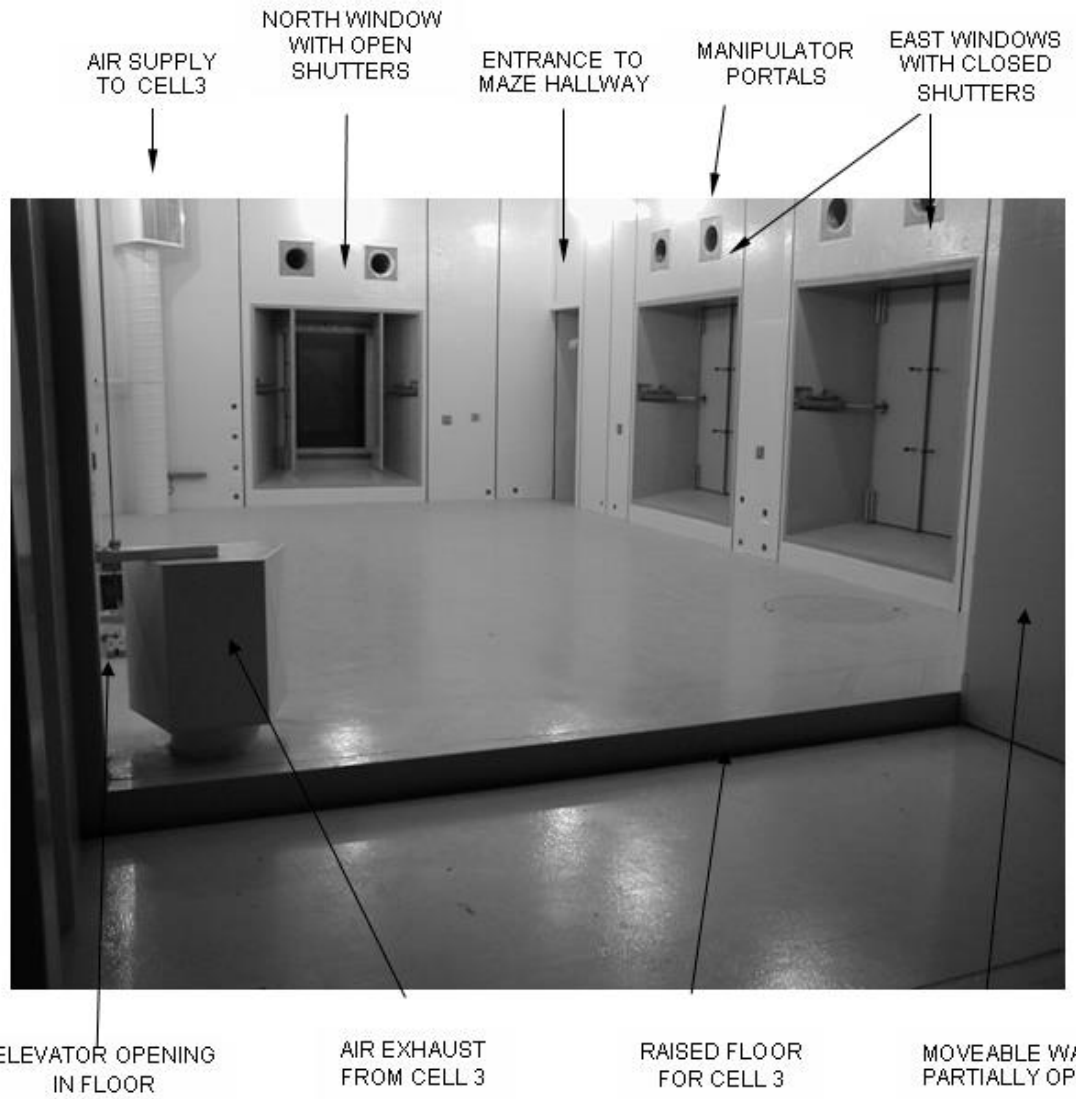
Nuclear Facility Operations - GIF

Movable Wall Operation



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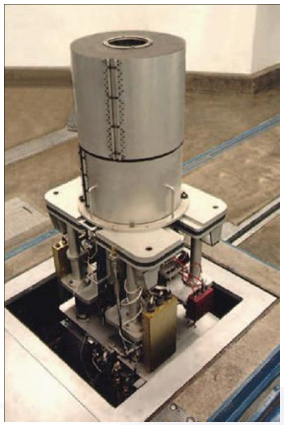
Nuclear Facility Operations – SPR/CX

Sandia Pulse Reactor / Critical Assembly - 2008



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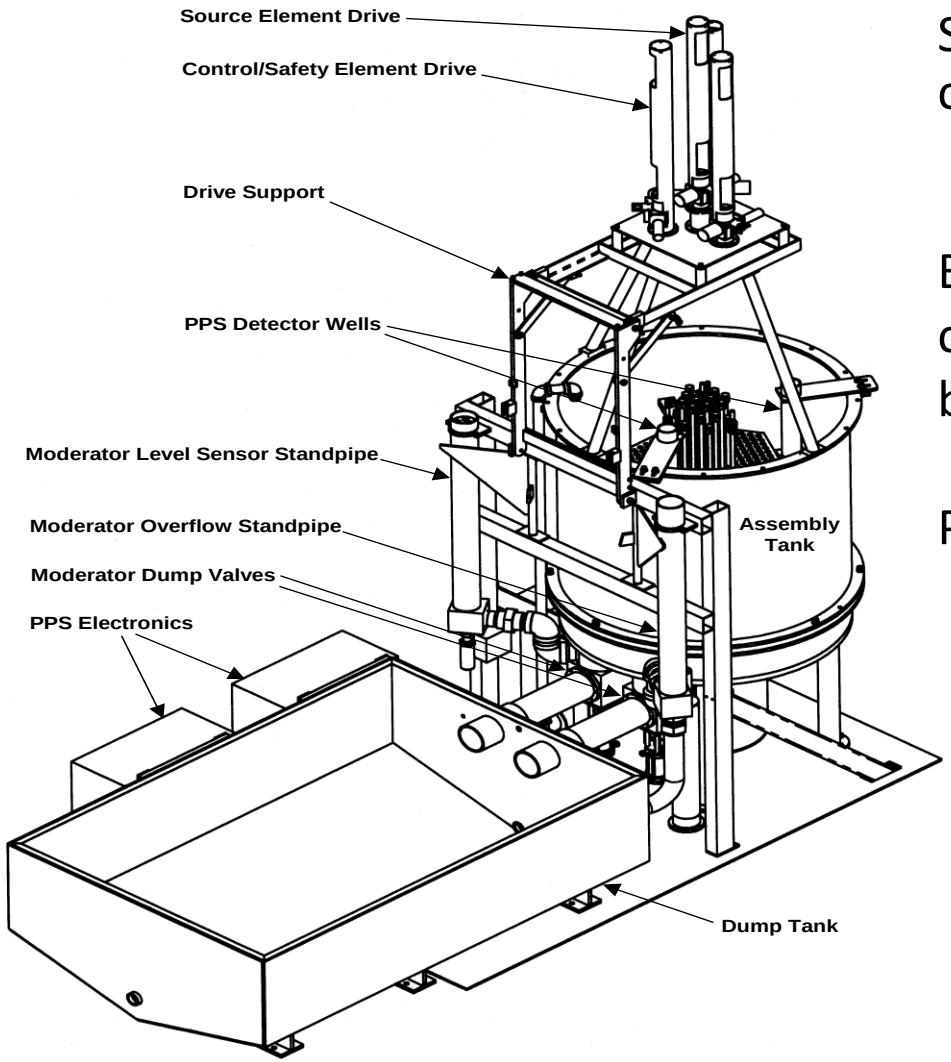
Nuclear Facility Operations – SPR/CX



SPR/CX Reactor – Small scale commercial power plant fuel bundle operates at 1-100 watts

Burn-up Credit designed to allow credit to be taken for reactor fuel burn-up

Provide training for critical assembly operators and criticality safety specialists

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Nuclear Facility Operations – SPR/CX

Current activities supported by NNSA Nuclear Criticality Safety Program:

7% Fuel Enrichment - Project is to provide benchmark data for validating commercial reactor physics methods for fuel enrichments greater than 5w/o U^{235} in geometries that can be modeled

Criticality Benchmarking - Nuclear Energy Research Initiative (NERI) project, Reactor Physics and Criticality Benchmark Evaluations for Advanced Nuclear Fuel

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Nuclear Facility Operations - CX

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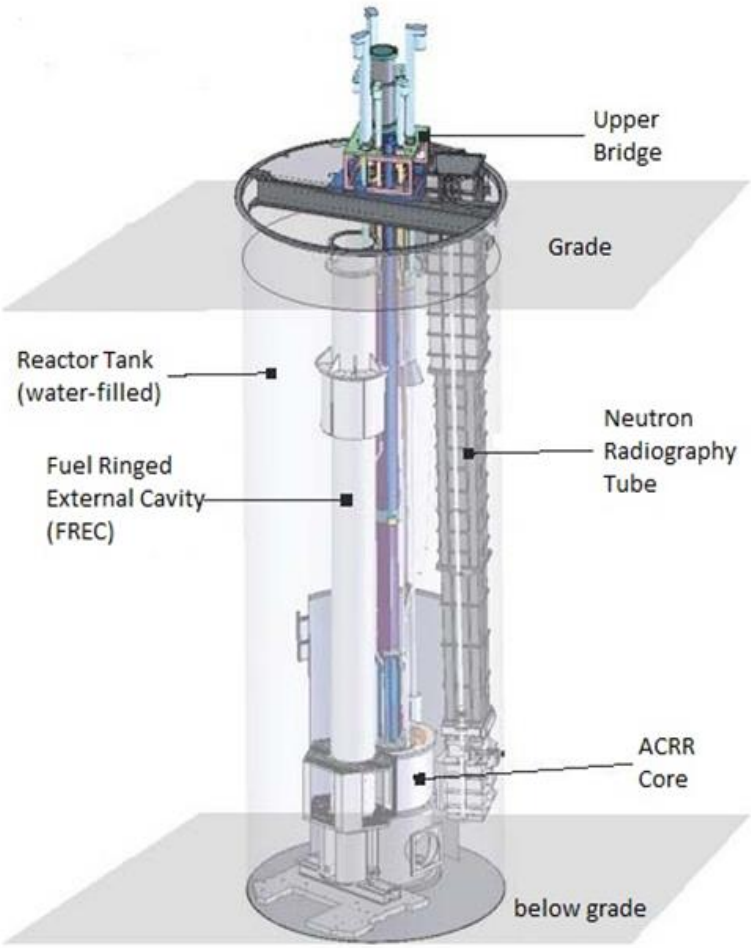
Nuclear Facility Operations - ACRR

Operating Power levels
- Steady State Mode - 4 MW_{th} ,
- Pulse Mode (6 ms FWHM) 300 MJ,
- Transient Mode (Programmed) 450 MJ

Dry cavity 9 in (23 cm) diameter,
- Extends full length of pool thru core
- Neutron Flux 4E13 n/cm^2-s @ 2 MW,
- 56% > 10 keV, 45% > 100 keV

Epithermal Spectrum - Flux in cavity can be tailored for desired energy spectrum using shield modifiers

Open-pool type reactor, fuel elements cooled by natural convection, Pool cooled by 10 MW HX and cooling tower



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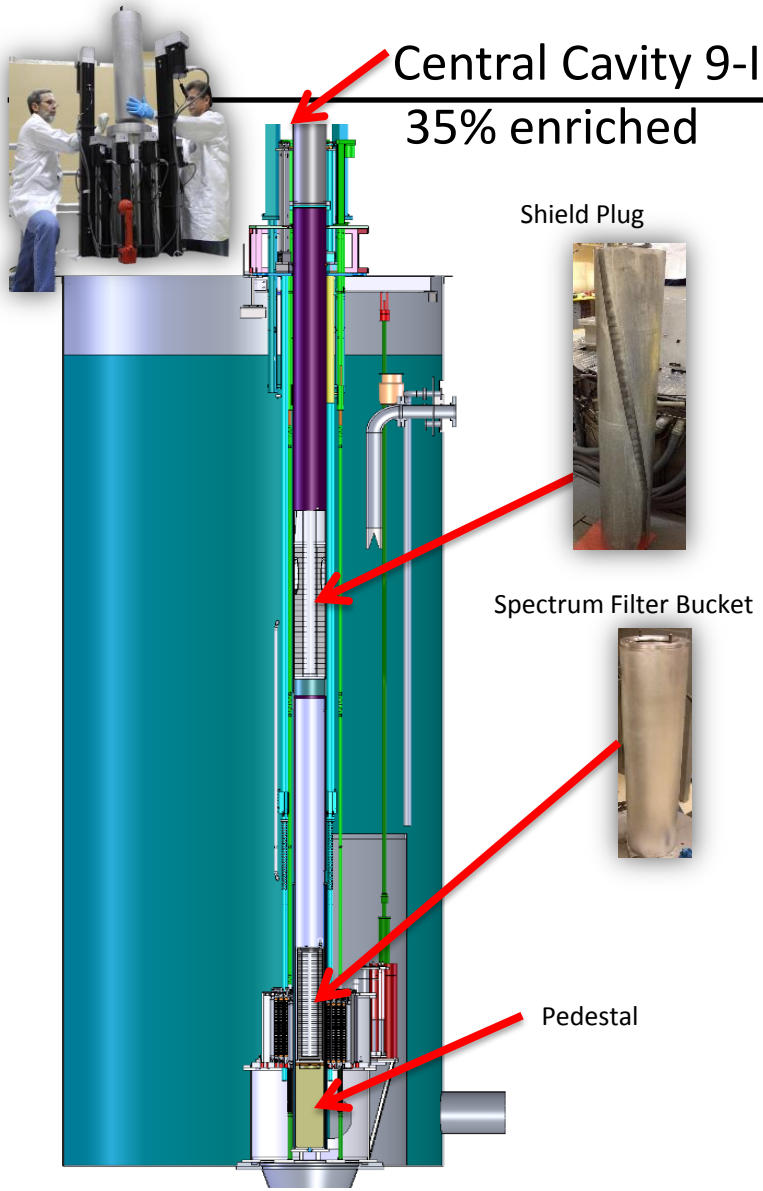
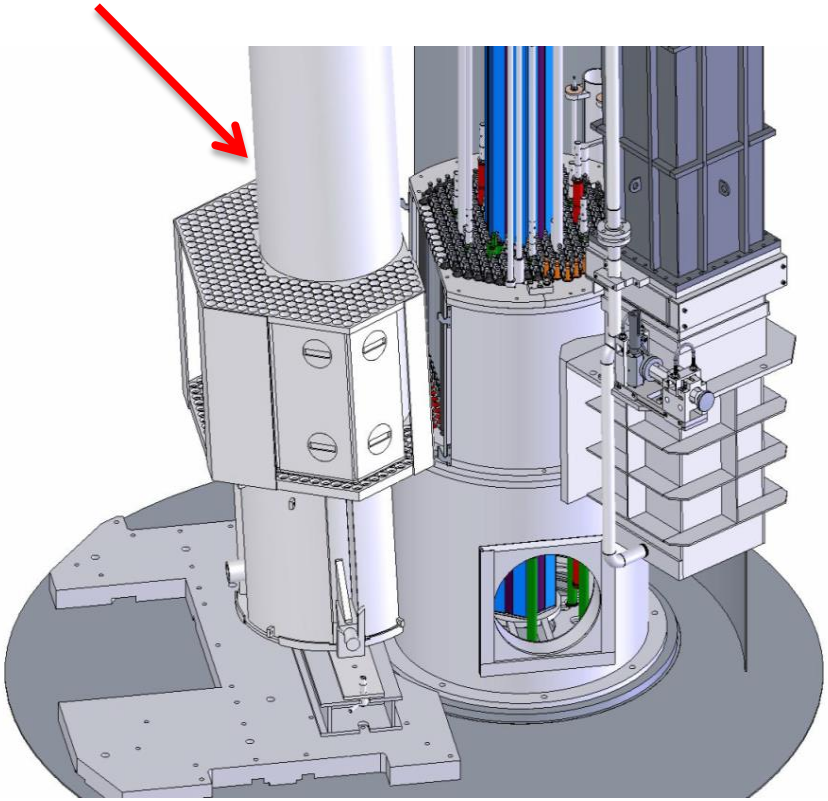
Nuclear Facility Operations - ACRR

Central Cavity 9-Inch, 236 UO_2-BeO fuel elements
35% enriched



Fueled Ring External Cavity 20-inch
186 U-ZrH fuel elements, 20% enriched



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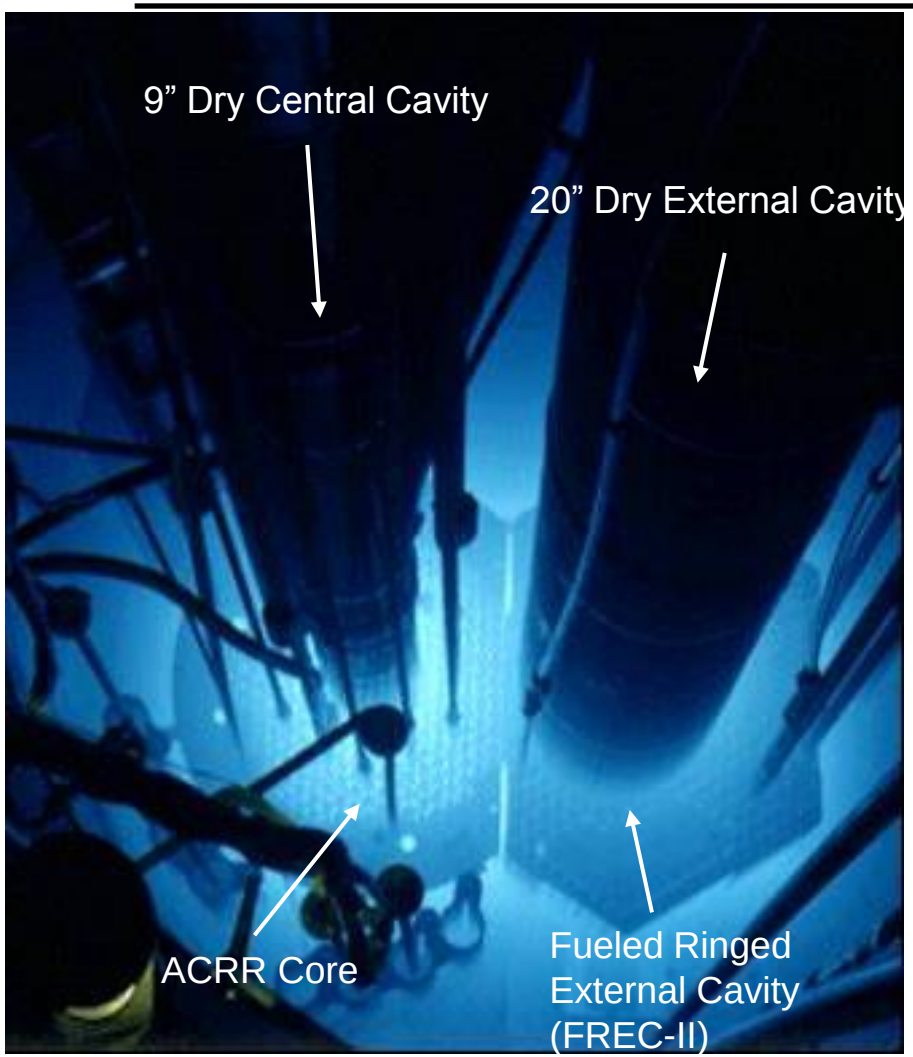
Nuclear Facility Operations - ACRR



- **Weapon Component Testing – Our original and continuing mission**
- **Radiation Effects Sciences – Fundamental science discovery**
- **QASPR – Qualification Alternative to SPR**
- **Neutron Radiography – Direct & Indirect**
- **Fast Reactor Safety – CRBR, Advanced fuel/cladding testing, equation of state**
- **Criticality Safety Training**
- **Criticality Benchmarking**
- **Experience and Ability to Perform Exotic Experiments In-Situ involving Classified Materials, Explosives (including detonation), Cryogens & Fissile**
- **World Class Radiation Metrology**

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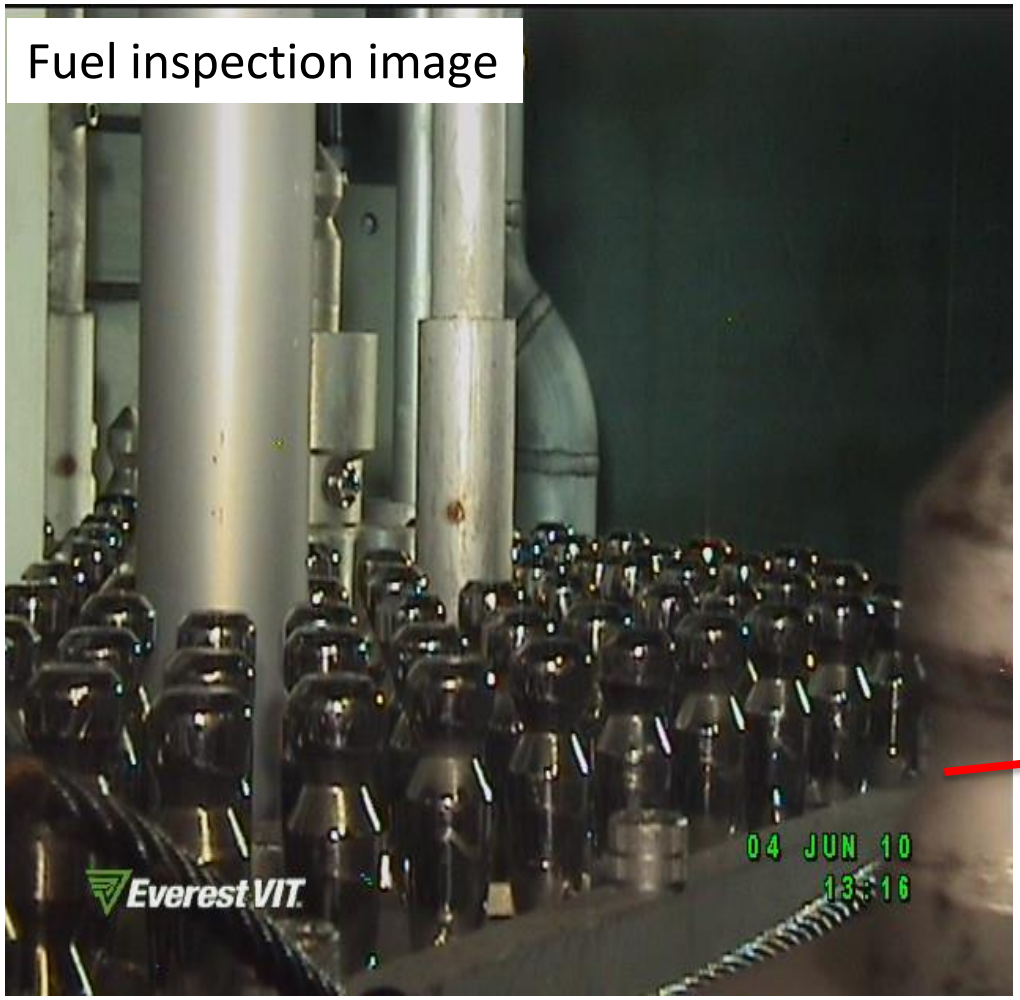
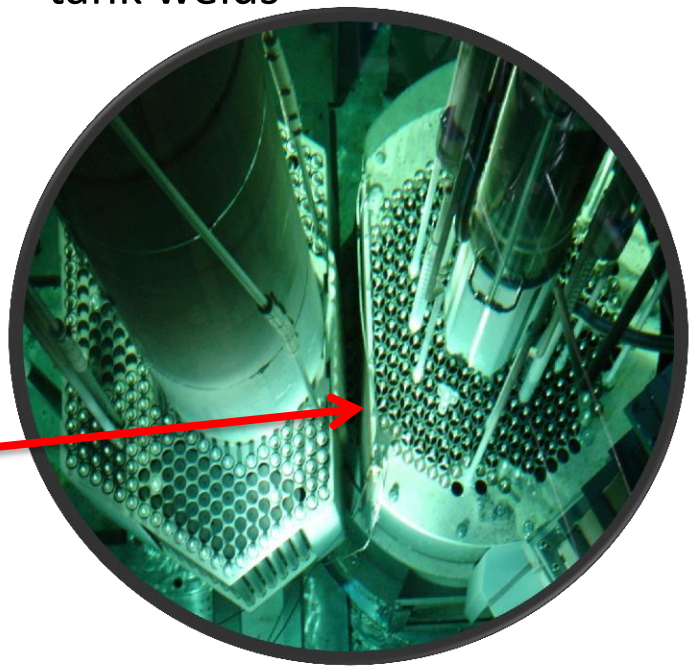
Nuclear & Reactor Facilities - ACRR



Idaho Cleanup Project conducted fuel inspections on 10% of ACRR's fuel elements and numerous tank welds



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Nuclear & Reactor Facilities - ACRR

Spectrum modifiers are designed for specific neutron spectrum and adjusted gamma requirements

Lead Poly Modifier (LP)

6-inch ID, Worth = - $2.50

Total Neutron Fluence n/cm2/MJ	**2.50E13**
Gamma [Rad/MJ]	**5.5E3**

Poly Lead Graphite Modifier (PLG)

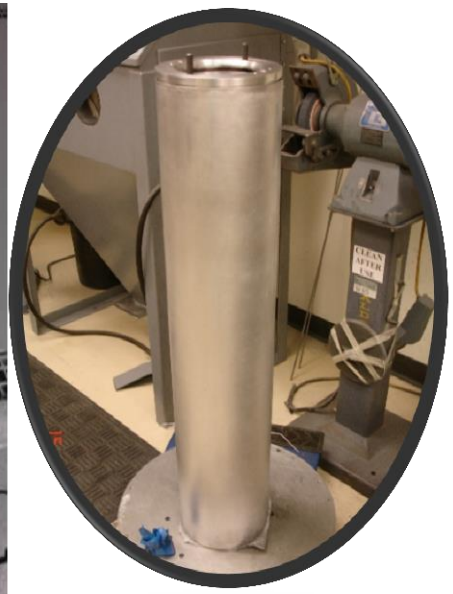
7-inch ID, Worth = + $0.42

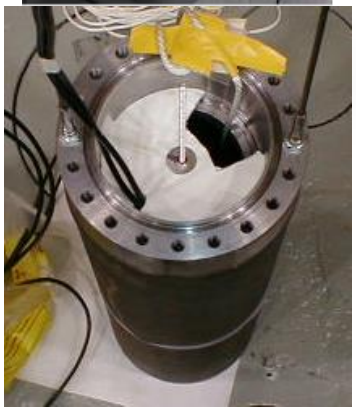
Total Neutron Fluence [n/cm2/MJ]	**2.36E13**
Gamma [Rad/MJ]	**6.6E3**

Lead Boron Carbide Modifier (LB-36 & LB-44)

4.9-inch ID, Worth = - ~$6.00

Total Neutron Fluence n/cm2/MJ	**1.16E13**
Gamma [Rad/MJ]	**1.02E3**





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Nuclear & Reactor Facilities - ACRR

- Improved Wide Range Nuclear Instruments
- Neutron Radiography Capability Restoration
- Control Console Upgrades
- Inter-institutional Visitors Agreement
- FREC II Restoration to full operation
- Wide Range Processor Upgrade
- Recovery of instrumented fuel element
- Characterization of spectrum modifiers
- Replacement of compressed air system with cleaner, dryer system
- Reactivity Control Upgrades (In Progress)

Console Updates

New Radiography Room

New WR Processors

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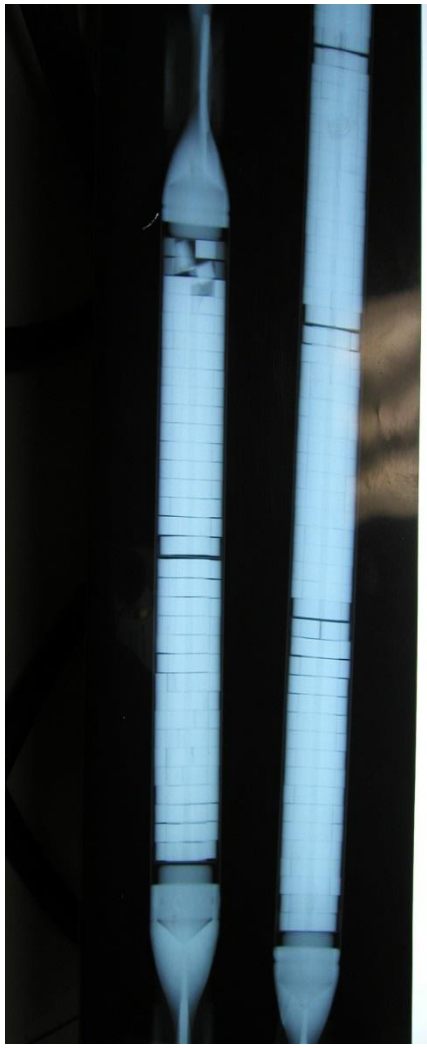
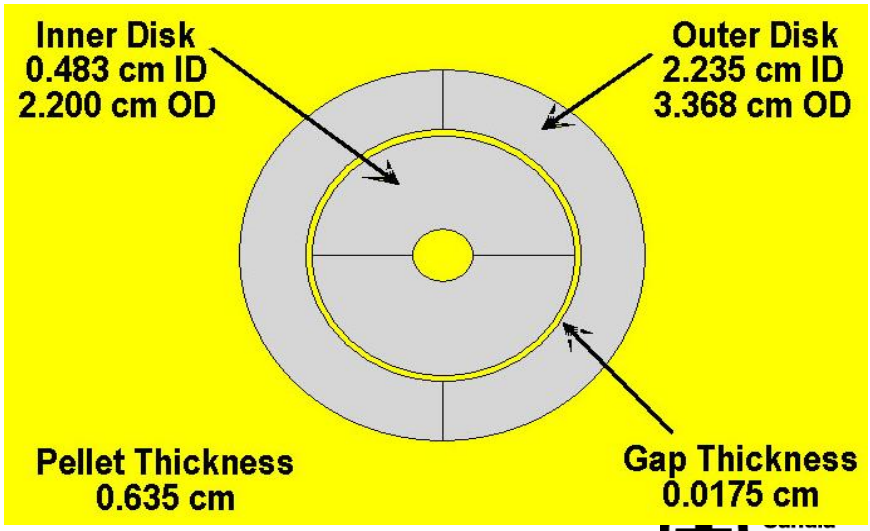
Nuclear & Reactor Facilities
Neutron Radiography Upgrade





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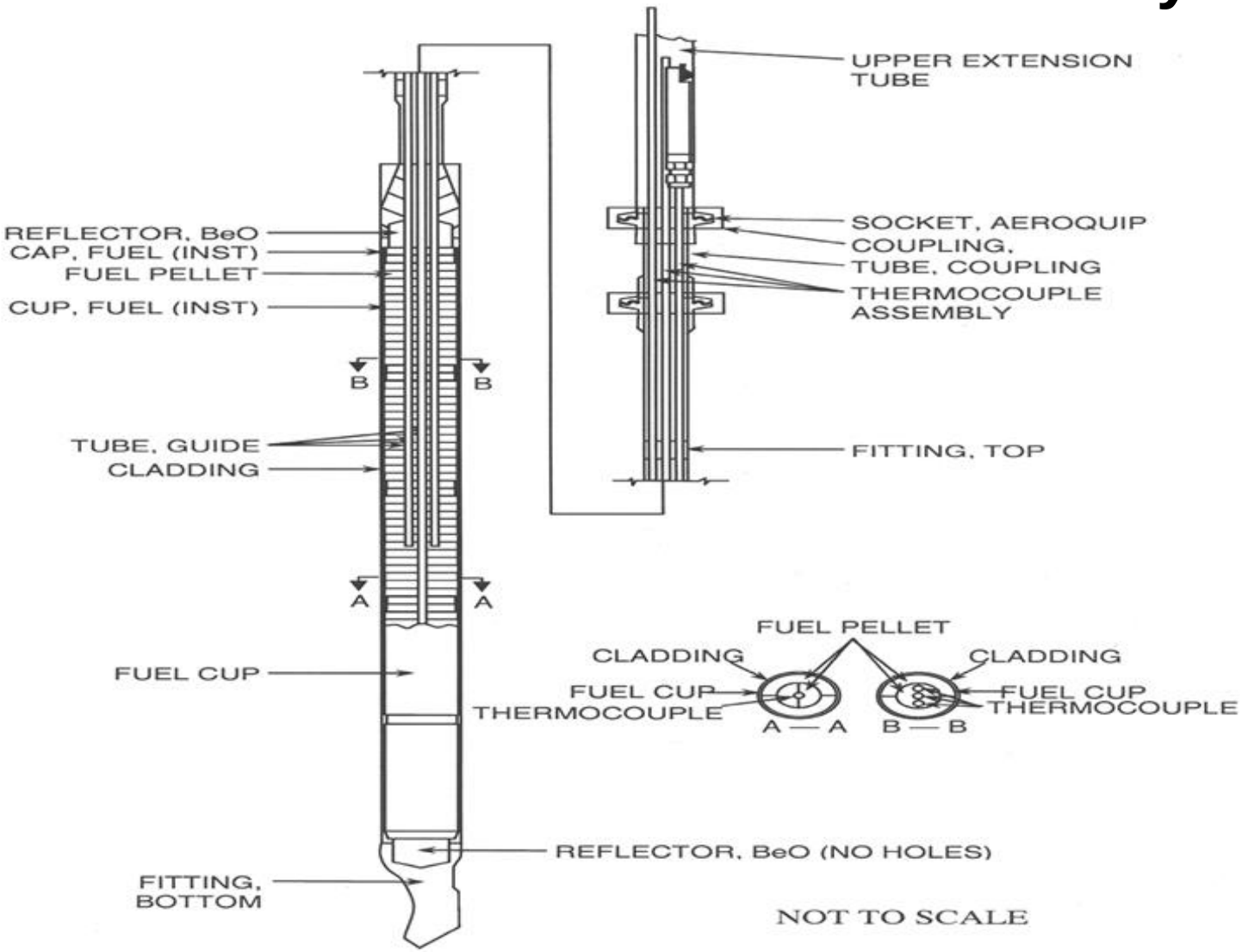
Nuclear & Reactor Facilities
Instrumented Element Recovery



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Nuclear & Reactor Facilities
Instrumented Fuel Element (IFE) Recovery

IFE returned to SNL for leak testing, rebuild & thermocouple replacement. IFE's are capable of measuring in excess of 2200°C. Thermocouples are individually enclosed in molybdenum guide tubes which extend from the mid-plane to elements top. Guide tubes are terminated in the elements midplane by welding to a moly plate. The inner annuli fuel ring in the upper half of the element is fabricated with a 40° segment removed for guide guide tube passage. The elements lower half is identical to a standard fuel element.

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Nuclear & Reactor Facilities
ACRR Wide Range

- The previous Gamma-Metrics wide-range system was recently replaced with a Mirion DWK250 System
- The new system provides power indication from ~ 1E-6% (0.02 watts) up to a power to 200 % (4.8 MW)
- The new system also provides automatic trips and interlocks to aid the operator in controlling reactivity and reactor power.
- Enables operations to support mission requirements without spurious, inadvertent reactor trips or shutdowns.

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Nuclear & Reactor Facilities
ACRR Control Room Layout

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Nuclear & Reactor Facilities
ACRR Control Room Layout

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PEOPLE

- Nine reactor operators, three are also qualified as reactor supervisors. One person is in initial operator qualification.
- Eight have bachelor degrees or higher in mechanical, electrical, nuclear, and chemical engineering.
- Two are registered professional engineers (nuclear).
- One MBA, one PhD candidate, two pursuing Masters Degrees (EE & NE).
- One is currently certified on both reactors (ACRR & SPR/CX) and three more are cross certifying to operate either reactor.
- One woman & eight men, two are single, seven are married.
- From California, Florida, Georgia, Pennsylvania, New Mexico, Maryland, Montana, and Massachusetts.
- Ranging in age from ~30 to 56.

PEOPLE

- A dosimetry supervisory for a large company.
- Two commercial nuclear power plant instrumentation specialists.
- A former police office.
- A semiconductor development engineer.
- A training supervisor at KAPL.
- Two were radiation protection specialist.
- Two are certified scuba divers.
- Several are avid mountains bikers, hikers, runners & climbers.
- Four are former Navy (submarines and air craft carrier sailors).

Conceptualization of New Facility Layout

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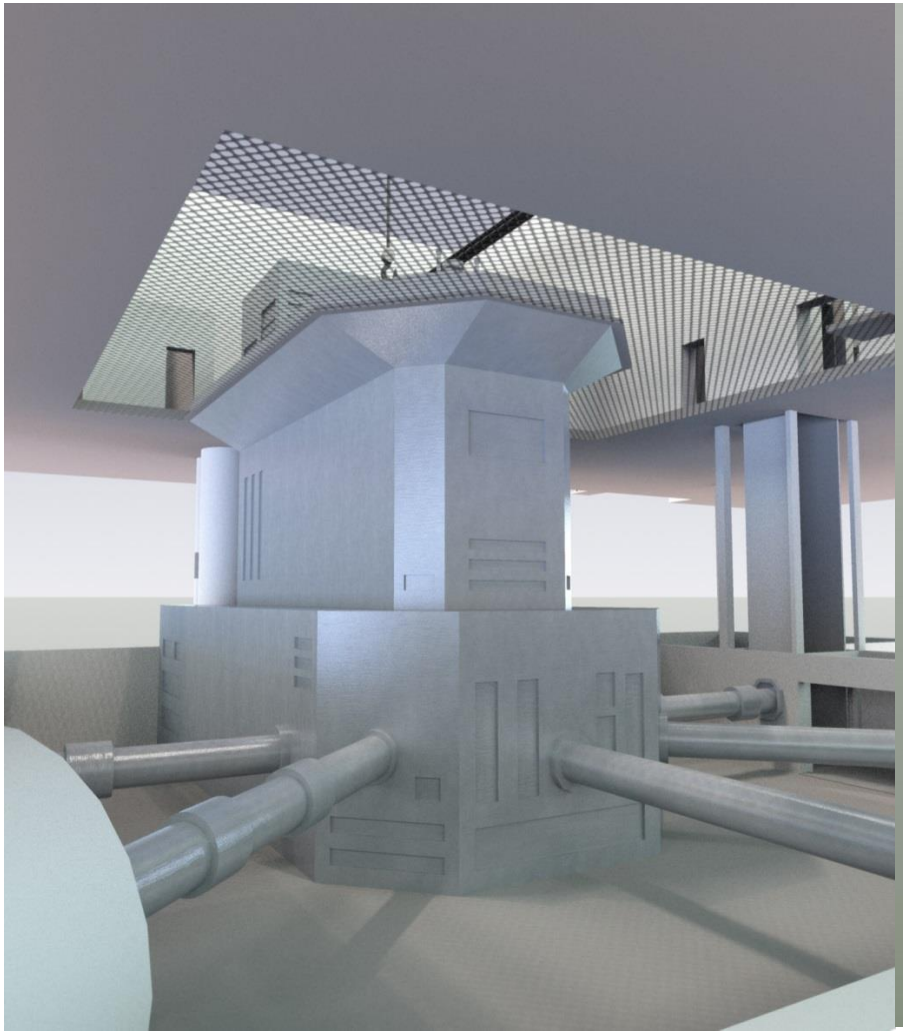
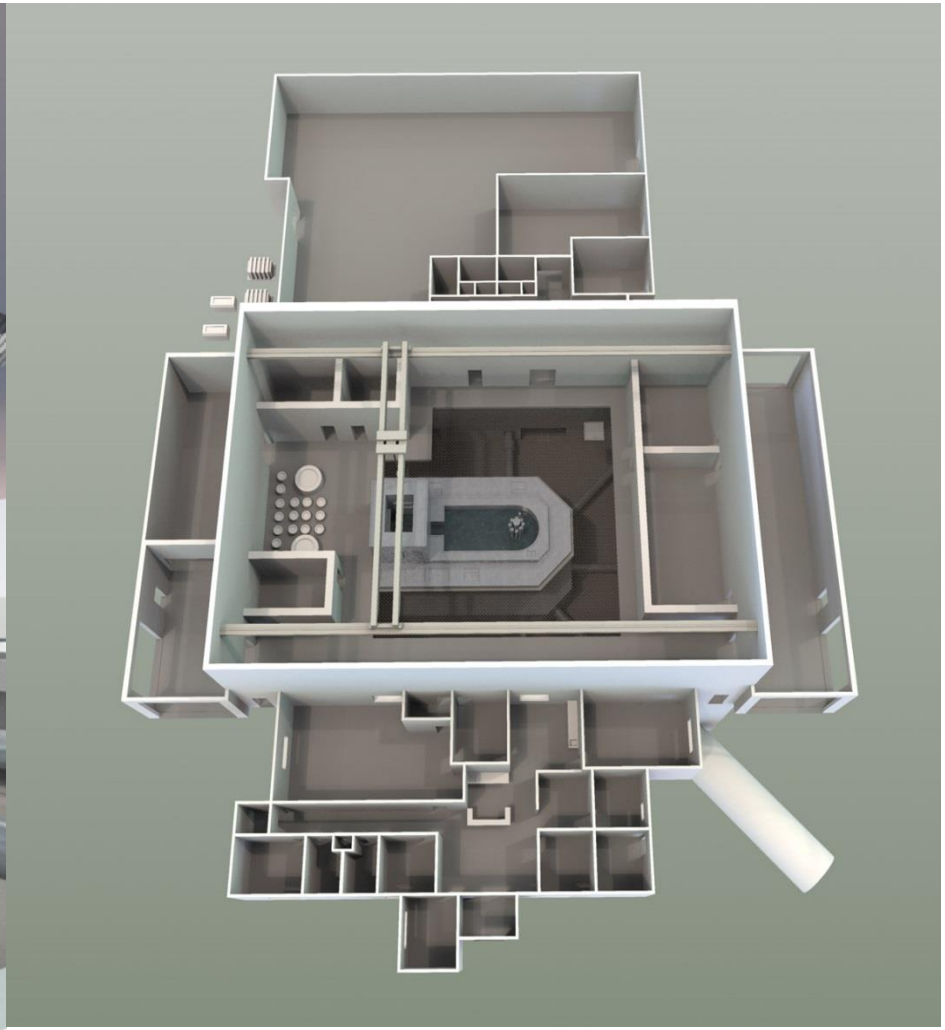
Conceptualization of New Reactor Facility





Nuclear Engineer

What my friends think I do

What my mom thinks I do

What society thinks I do

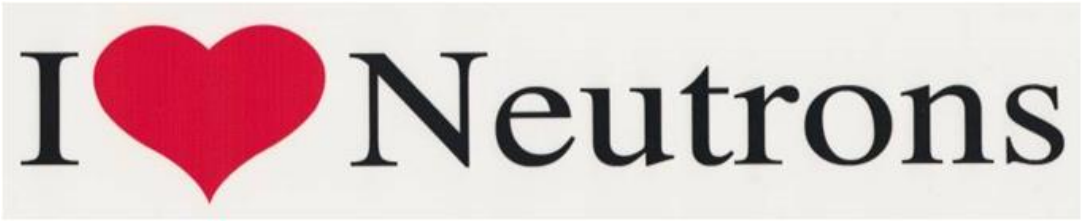
What my boss thinks I do

What I think I do

What I actually do

Nuclear Facility Operations

Questions?



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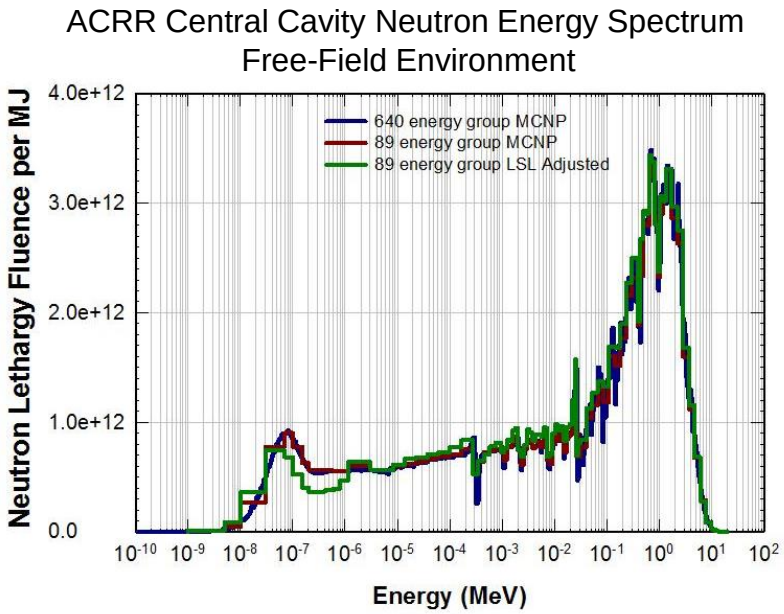
How can the ACRR Neutron/Gamma Flux and Energy Spectrum be Modified?

- **~~Neutronic characteristics can be changed by –~~**
  - **Removing the thermal neutrons (B4C)**
  - **Thermalizing the spectrum (Poly, Water, Graphite)**
- **Gamma-Ray characteristics can be changed by –**
  - **Removing gammas – (Lead)**
  - **Generating more gammas – (Cd, Gd, Cd-Poly, Gd-Poly)**

The ACRR is unique in that it maintains a significant epithermal neutron energy spectrum in the cavity in a free-field environment.

This allows for a significant amount of flexibility in using spectrum modifying buckets.



Most research reactors (TRIGAs

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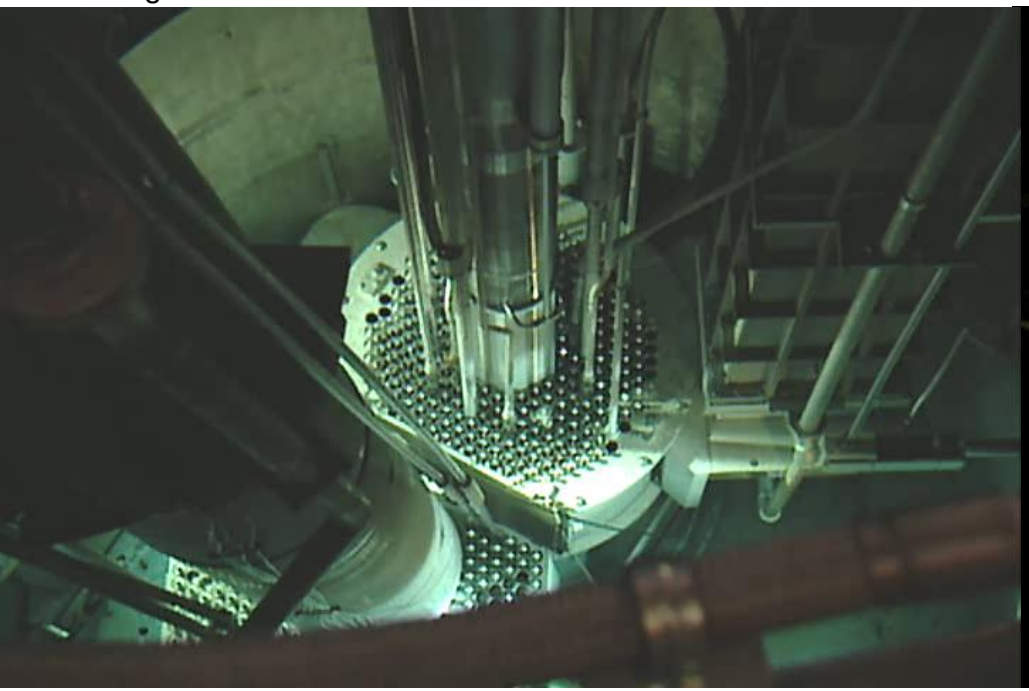
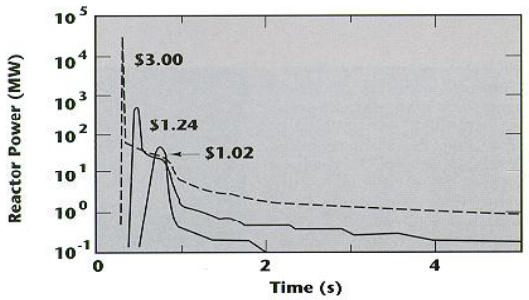
ACRR Pulse and Transient Operating Modes

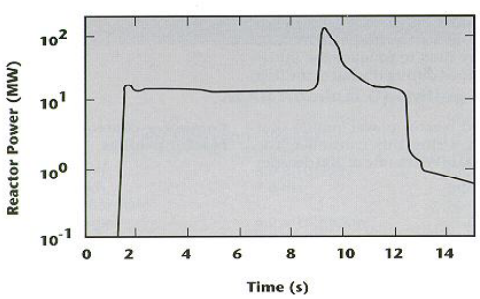
Single Pulse Mode



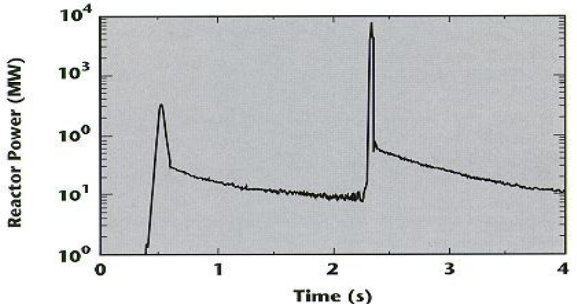
Programmed Transient Mode



Single Pulse Mode



Programmed Transient Mode



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Double Pulse Mode

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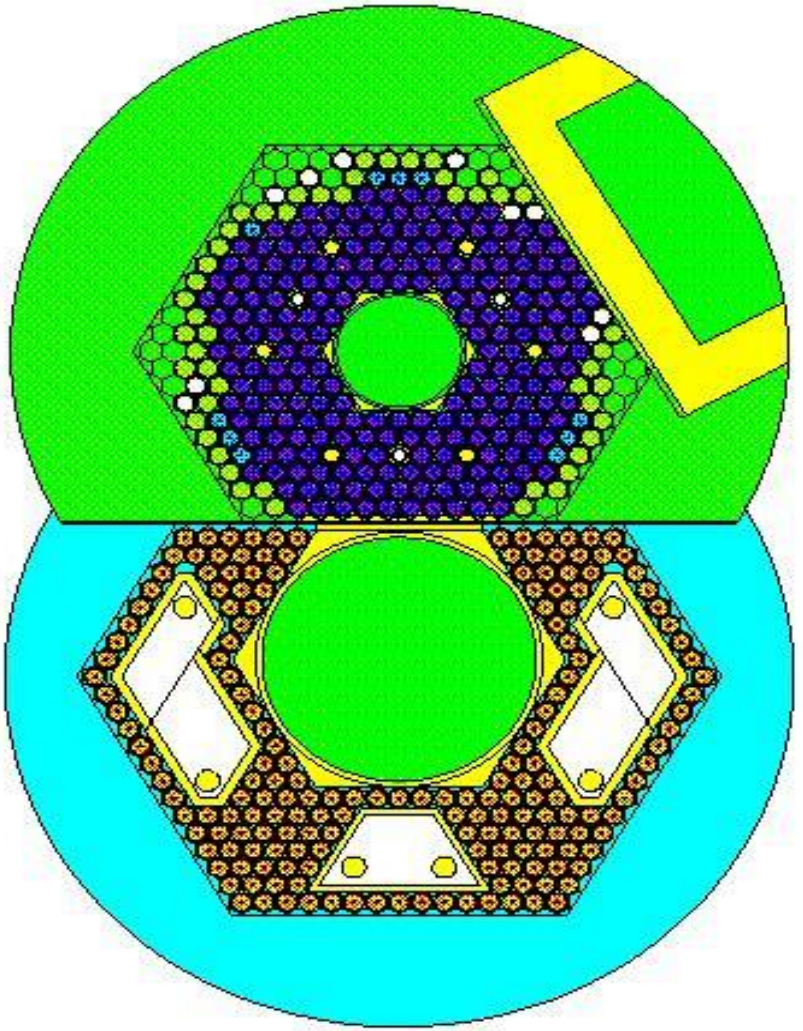
PROCESSES



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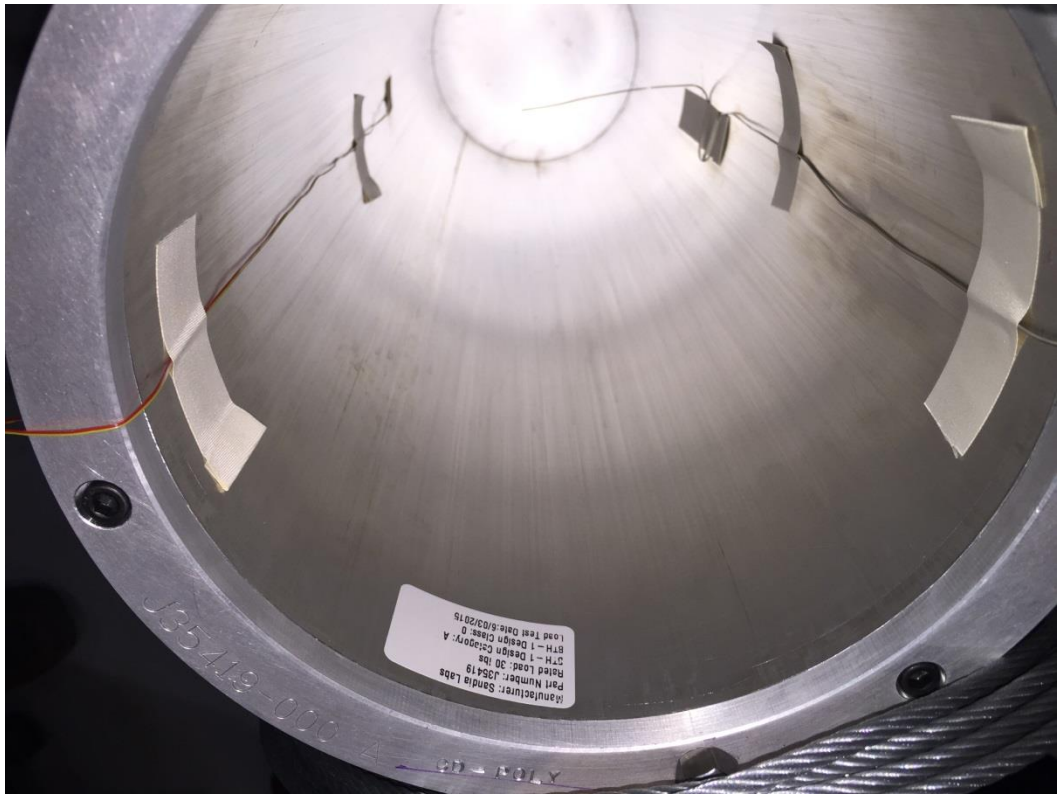

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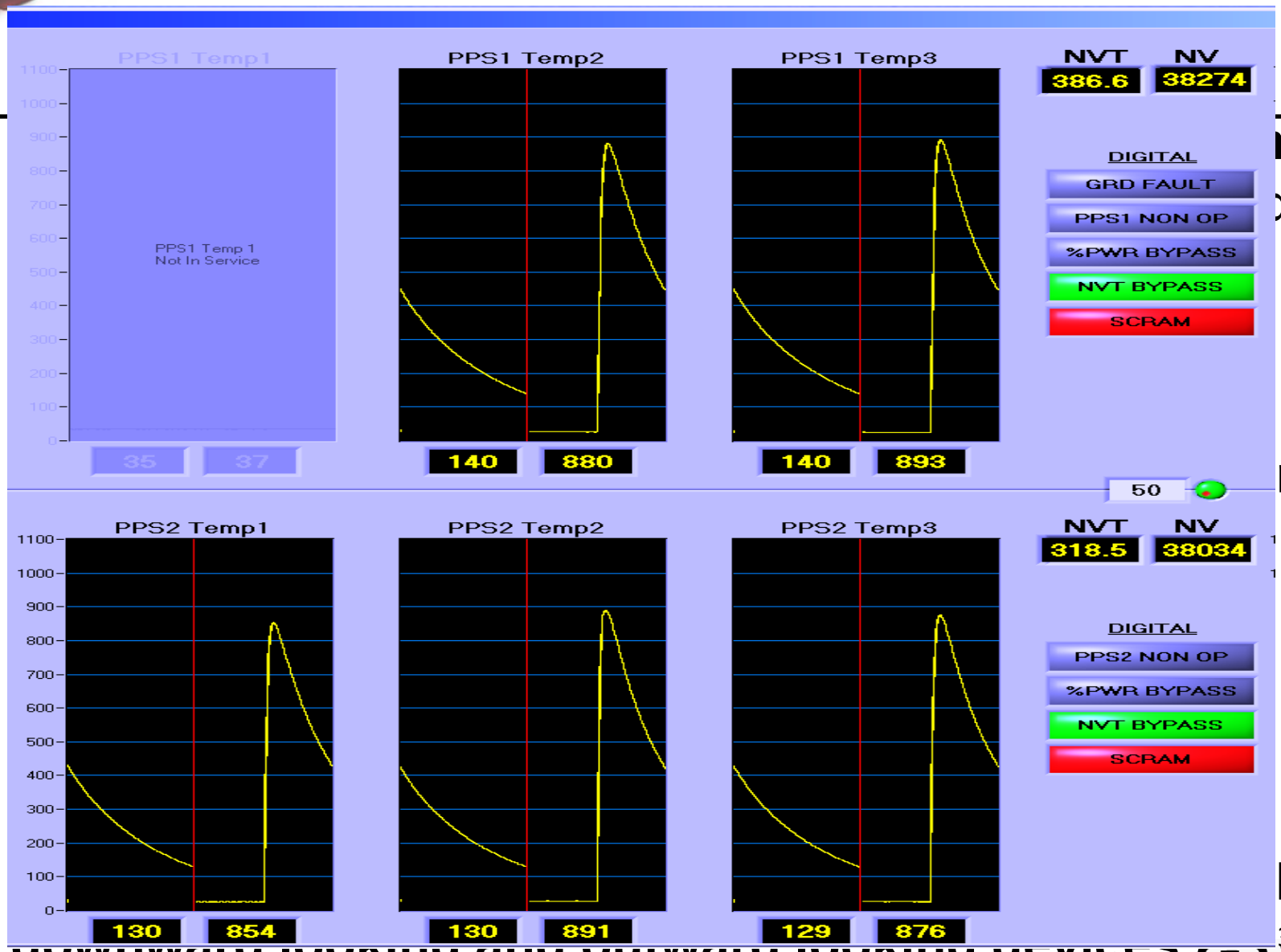

downward looking and outward looking devices.

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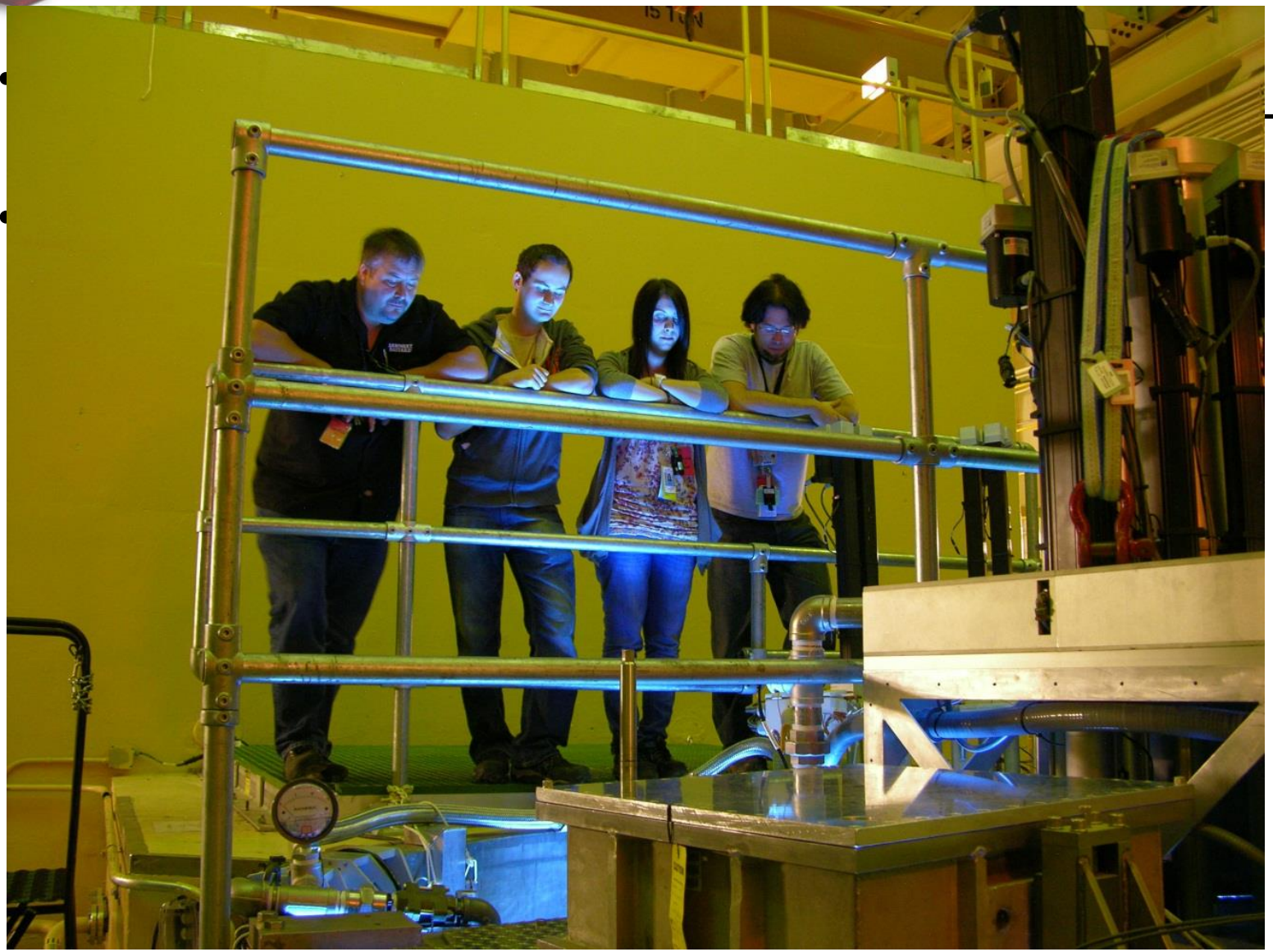
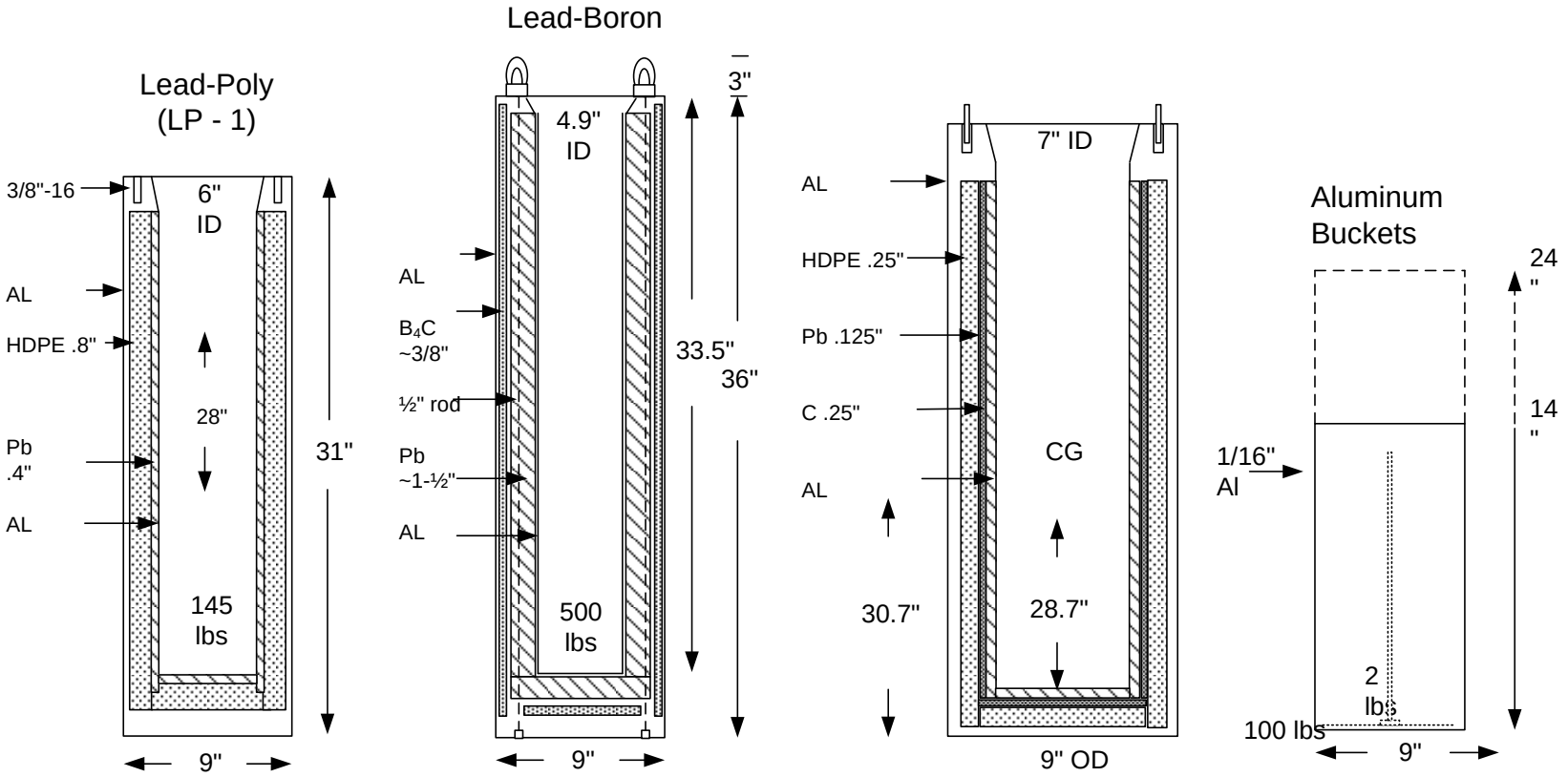


Experiment Buckets (ACRR)

(Dimensions are approximate)



6/29/05 RG

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