INL/CON-18-45105-Revision-0

Reactivation of the Transient Reactor Test (TREAT) Facility Neutron Radiography Program

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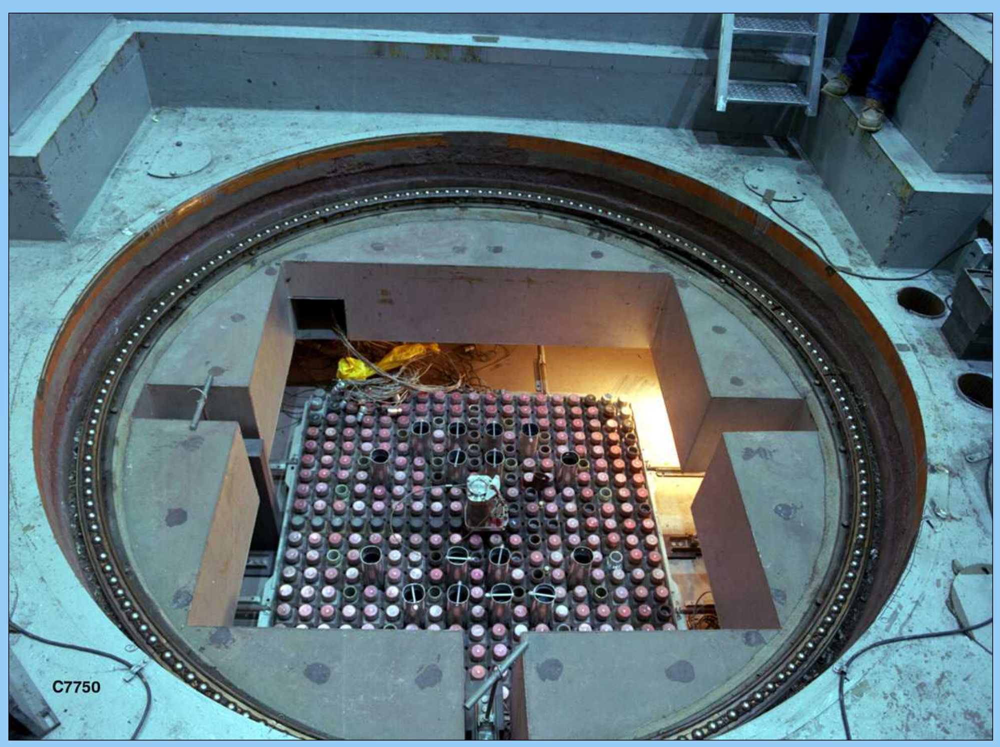
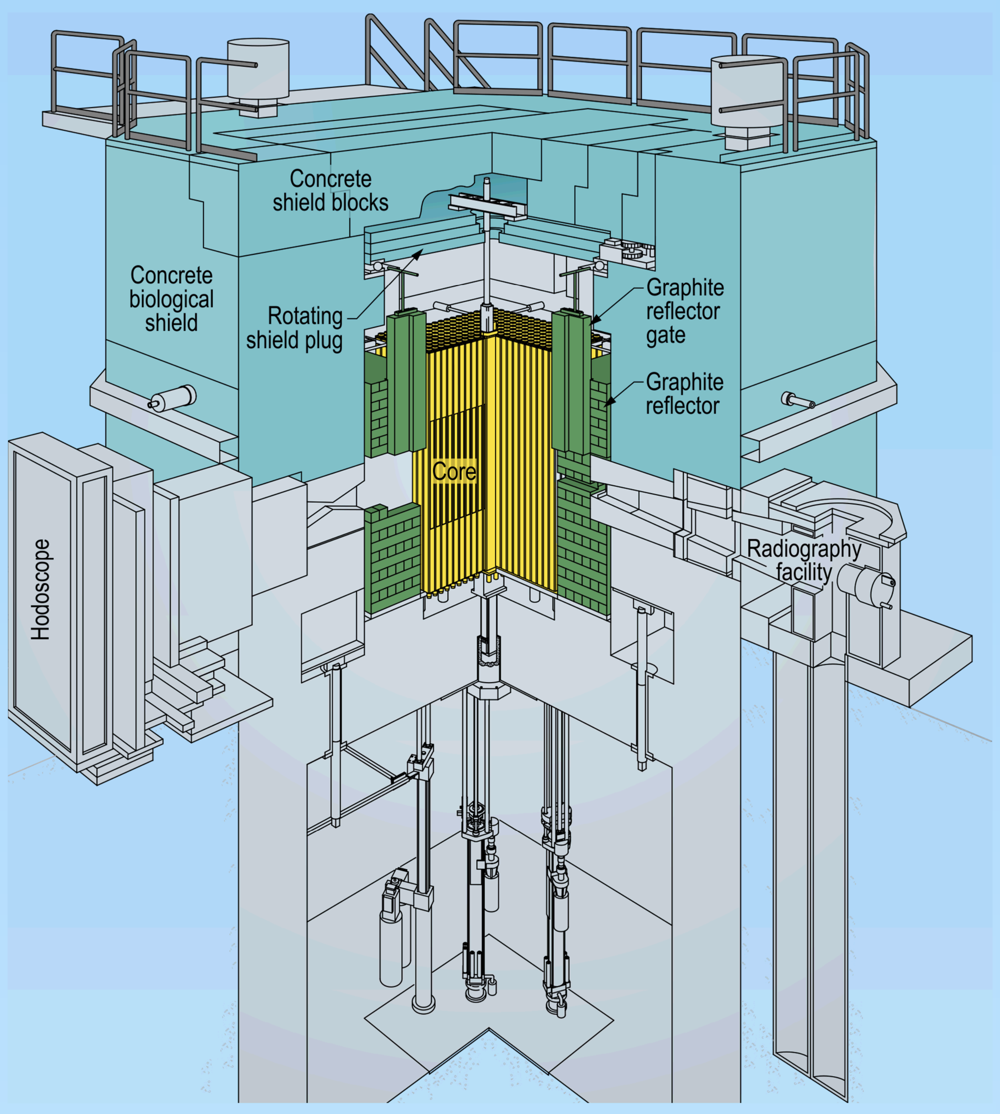
TREAT Reactor

- Construction for the Transient Reactor Test (TREAT) Facility began in February 1958 and reached initial criticality in February 1959
- Designed for steady-state irradiation and high power transient testing of materials, including new and used nuclear fuels

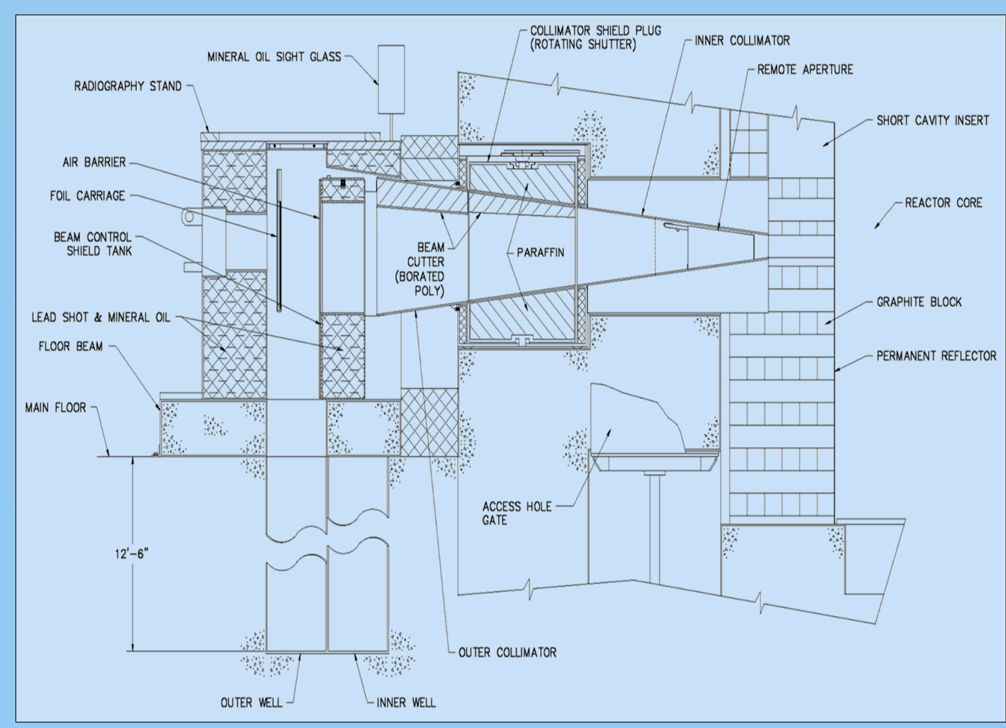


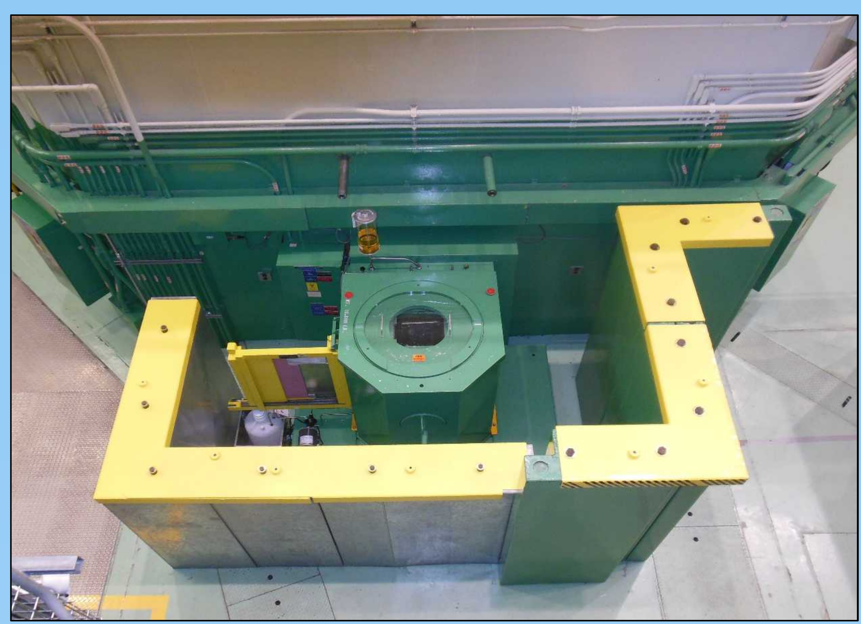
- The core is air cooled, graphite moderated, and highly configurable
- Capable of 120 kW steady-state and up to 19,000 MW peak transient power levels to simulate off-normal conditions
- Placed in shutdown status in 1994 and successfully restarted in November 2017



Radiography Facility and Upgrades

- Performs neutron radiography of fuels, experiments, and other specimens before and after irradiation
- First neutron radiograph obtained in 1967
- Acquired over 5,000 radiographs by 1977
- The neutron beam is radial to the core and contains thermal and epithermal neutrons
- Capable of imaging specimens 10cm x 20cm and up to 4 m long
- Utilizes transfer method neutron radiography with dysprosium or indium conversion foils and computed radiography image plates

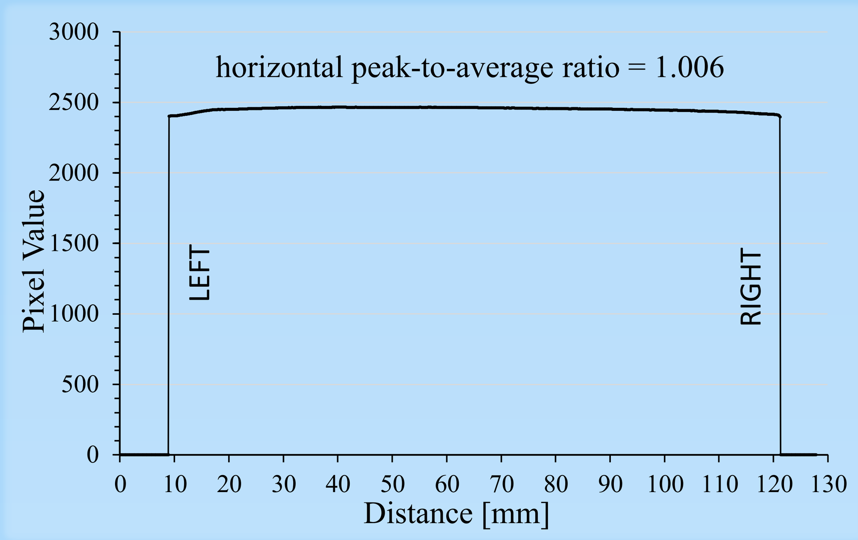


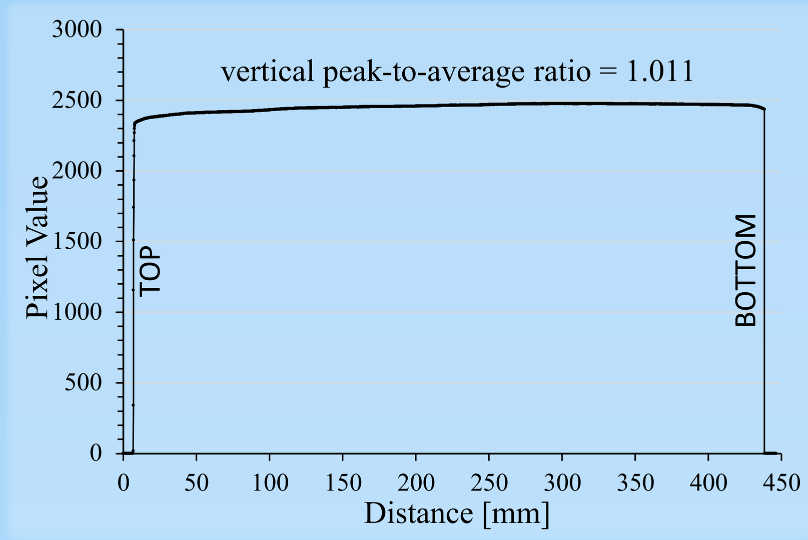


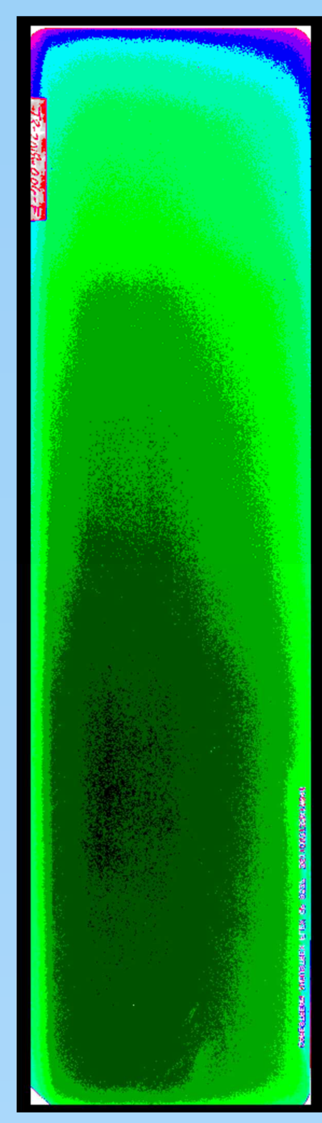
- Upgraded the stand and drive system in 1975-76 providing additional shielding and remote operating capabilities
- Structural upgrades in 1984 increased the load carrying capacity to 44 metric tons to accommodate larger casks
- Installed a remote aperture assembly in 1986 allowing for two different aperture sizes allowing for different collimation ratios
- Recently upgrades include: shielding oil recovery system, external shielding and seismic bracing, electro-mechanical to electronic exposure timer conversion, dedicated room for image preparation and processing, and installation of a computed radiography system

Neutron Beam Characterization

- Measured neutron flux by irradiated 21 gold foils for 3 hours at 80 kW then measured activity using a calibrated high-purity germanium detector
- From the measured activities, the average neutron flux was calculated to be $8.25 \times 10^6 \pm 1.89 \times 10^5$ n/cm^2s
- Neutron energy spectrum will be quantified using foil activation techniques with multiple foil materials
- Beam uniformity was measured using a radiograph of the open beam
- The peak-to-average ratio is 1.006 (horizontal) and 1.011 (vertical) indicating a uniform beam profile



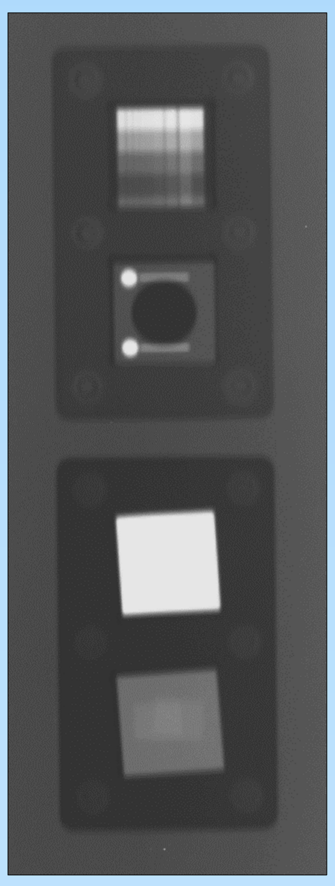




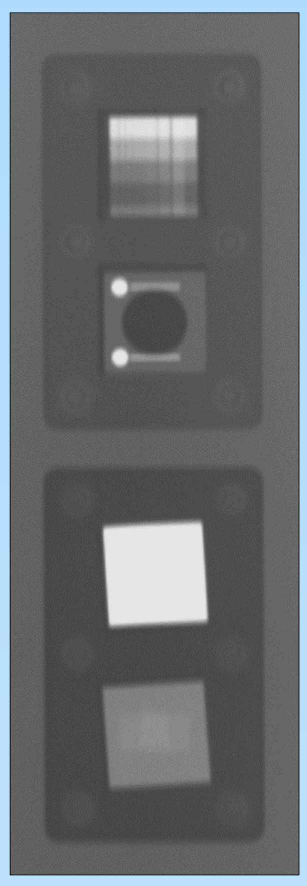
Colorized radiograph indicating beam uniformity

Determining Exposure and Decay Times and Effective Resolution

- Three sets of qualification radiographs were taken of a Resolution Test Piece (RTP) containing ASTM Sensitivity Indicator and Beam Purity Indicator along with gadolinium and hafnium edge specimens
- Used transfer method neutron computed radiography (nCR) with dysprosium conversion foil and Carestream general purpose (GP) and high resolution (HR) image plates
- Exposure times greater than 10 minutes showed diminished peak pixel and Signal-to-Noise Ratio (SNR) values using GP plates
- Programmatic quality radiographs using 10 minute exposure and 120 minute decay times provided 94% of peak SNR using GP plates
- Information-only quick-shot radiographs using 10 minute exposure and 20 minute decay times provided 60% of peak SNR using GP plates
- The effective spatial resolution seems unaffected by exposure time
- Additional analysis using HR plates will be conducted in the future



10 minute exposure with 120 minute decay



10 minute exposure with 20 minute decay

Authors and Acknowledgements

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