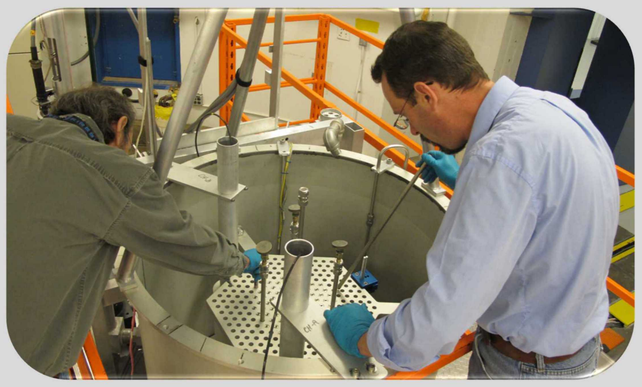
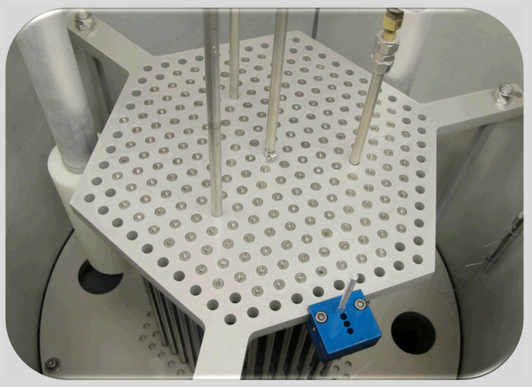
SAND2019-1920D

Sandia Critical Experiments Program and Nuclear Criticality Safety Program

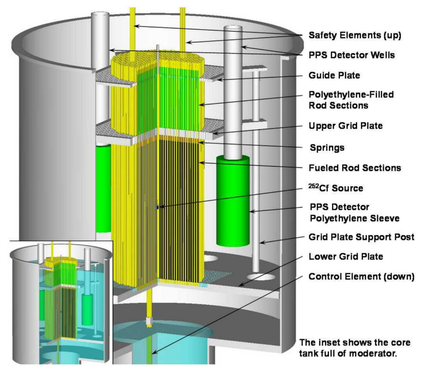




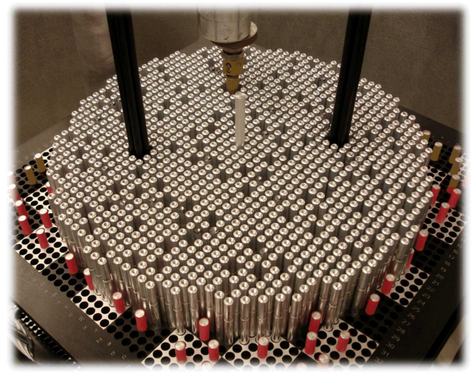
Seven Percent Critical Experiment (7uPCX)

Designed and built to perform and analyze critical benchmark experiments for validating reactor physics methods and models for fuel enrichments greater than 5% ^{235}U. The Core is a 45x45 array of rods to simulate 9 commercial fuel elements in a 3x3 array.

Multiple 7uPCX configurations for evaluating critical systems at different fuel-to-moderator ratios, fully and partially reflected cores, and with titanium/aluminum rod loadings have been performed and are documented in the International Critical Safety Benchmark Evaluation Project (ICSBEP) Handbook as LEU-COMP-THERM-078, LEU-COMP-THERM-080, LEU-COMP-THERM-096, and LEU-COMP-THERM-097.



Cut-away view of 7uPCX core tank

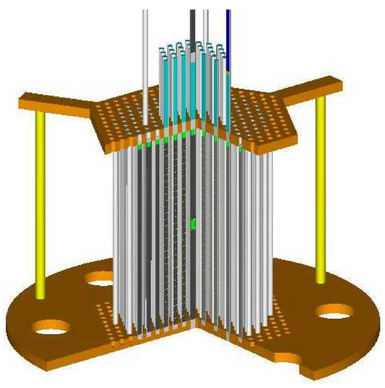


Critical fuel loading for 7uPCX

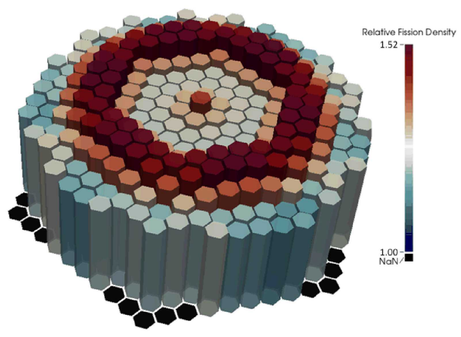
Burnup Credit Critical Experiment (BUCCX)

Designed and built for inserting fission product materials to measure reactivity effects. Experiments with rhodium completed and documented in the ICSBEP Handbook as LEU-COMP-THERM-079.

Experiments measuring the effect of titanium on critical systems were performed in 2018. They completed a series of experiments (with 7uPCX) that provided the first integral test of newly-evaluated titanium nuclear data. The results will also be used by Savanna River National Laboratory to decrease waste processing costs while maintaining the required level of safety. The experiments are documented in the ICSBEP Handbook as LEU-COMP-THERM-097 and LEU-COMP-THERM-099.



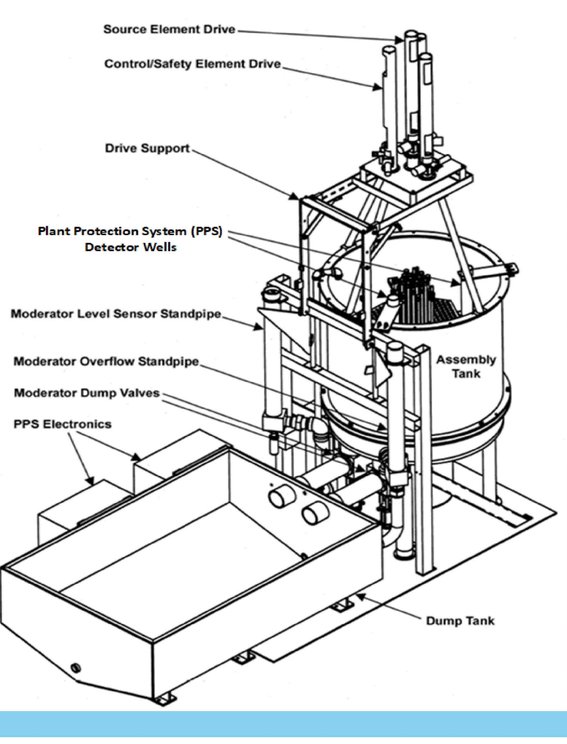
Cut-away view of BUCCX core



Calculated Fission Density in BUCCX with Ti-sleeves

Sandia Critical Experiments Program Capabilities

Design, perform, and document high quality critical benchmark experiments that meet and exceed ICSBEP standards. Expertise and design flexibility allow a wide range of customer needs to be accommodated. Some of the upcoming and proposed experiment ideas include the following topics:



- Fuel pitch variations near optimum moderation
- Water temperature effects on reactivity
- Reactivity effects of molybdenum and other materials of high interest
- Isothermal reactivity coefficient inversion point
- Spectrum shifting towards epithermal energies
- High Assay LEU fuel configurations

Characteristics of the Sandia Critical Experiments

Critical Experiment	BUCCX		7uPCX	
Fuel	UO_2		UO_2	
Enrichment (%)	4.306		6.903	
Moderator	Light Water		Light Water	
Fuel OD (cm)	1.265		0.526	
Fuel Length (cm)	48.7		48.8	
Fuel Density (g/cm^3)	10.4		10.3	
Fuel Rod OD (cm)	1.382		0.635	
Array Configuration	Triangular Pitch		Square Pitch	
Pitch (cm)	2.0	2.8	0.800	0.855
Fuel to Water Volume Ratio	0.640	0.238	0.672	0.524
H to ^{235}U Atom Ratio	131	332	62.0	79.5
H to U Atom Ratio	4.48	12.1	4.33	5.55

Sandia Nuclear Criticality Safety Program

Established to ensure that fissionable material activities outside of nuclear reactor operations remain safely subcritical under all normal and creditable abnormal conditions.

Qualified Nuclear Criticality Safety Engineer (NCSE): provide technical NCS guidance to managers, supervisors, and workers. Perform technical analyses for establishing NCS controls ensuring safe fissile material operations. Provide documented evaluations and assessments that comply with national standards.

U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration

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