



# Actinide Integral Cross Sections and CritView - Progress Report

## **NUCLEAR CRITICALITY SAFETY PROGRAM (NCSP) *TECHNICAL SEMINAR***

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**Los Alamos National Laboratory  
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*One Team. One Culture.*

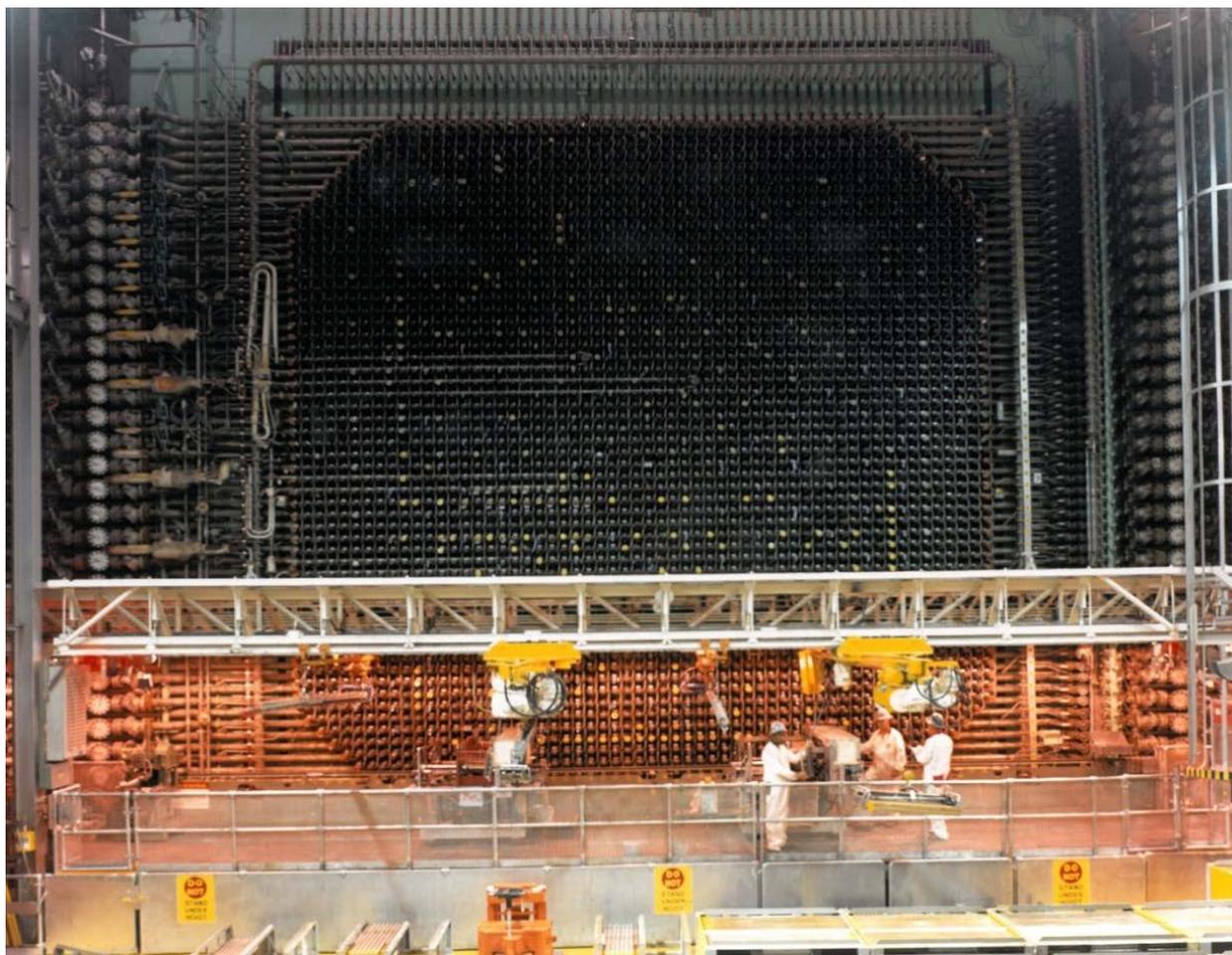
# H-IPD2 - Actinide Integral Cross Section Background

- Task Focus
  - Extraction of relevant integral cross section data for actinides from early Hanford and potentially Savannah River Site (SRS) reactor operations
  - Investigation of potential use of these data to support burn-up code validation
  - Identification of irradiated targets available for further investigation

# H-IPD2 - Actinide Integral Cross Section Background

- Extensive development testing performed in Hanford Single Pass Reactors to support Major Missions
  - Plutonium Production
  - U-233 Production
  - Pu-238 Production Development
- Tests included isotopic measurements on various target materials to support missions
- Experimental data have been data extracted from publicly release data

# H-IPD2 - Actinide Integral Cross Section Typical Single Pass Reactor (K Reactor)



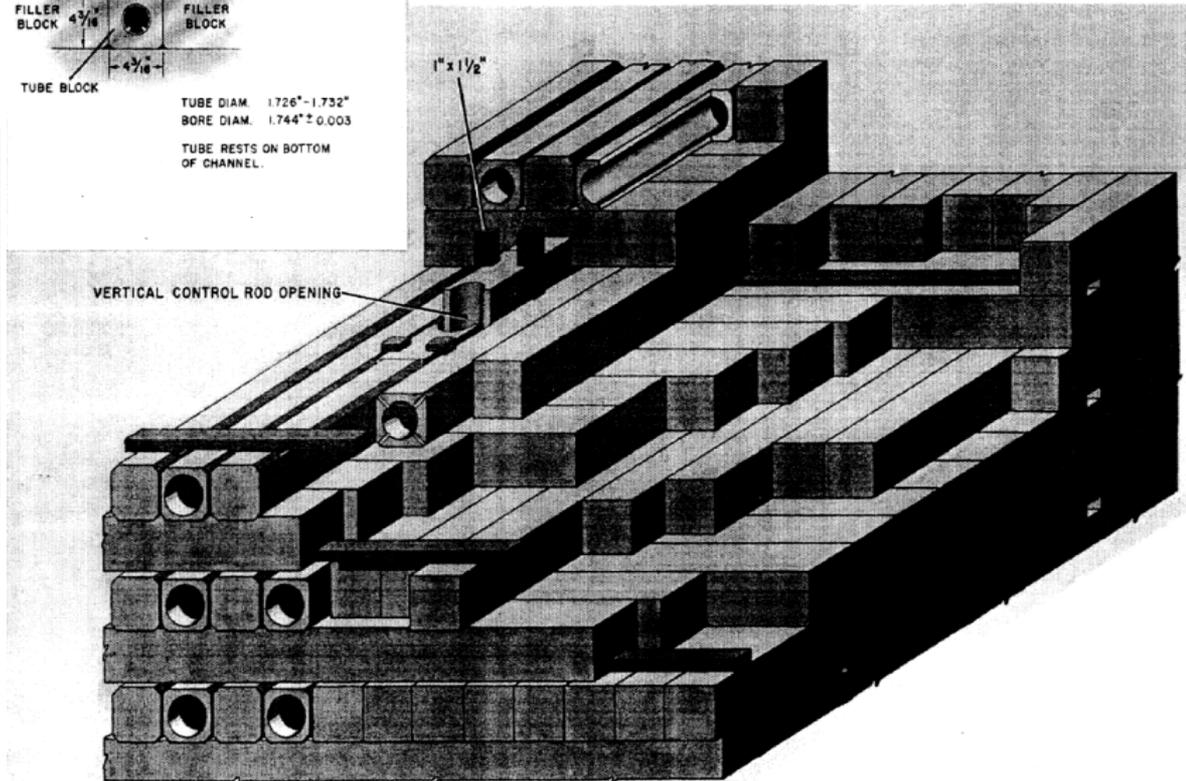
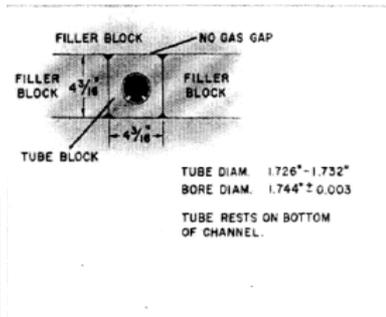
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# H-IPD2 - Actinide Integral Cross Section Reactor Configuration - B Reactor

Parameter	Dimension
Lattice geometry	Square
Lattice spacing (inches)	8.375
Equivalent cell radius (inches)	4.725
Process Tube O.D. (inches)	1.728
Process Tube I.D. <sup>a</sup> (inches)	1.598
Fuel dimensions	(see Table I.1)
a Average dimensions: tubes are not quite circular and contain ribs	



# H-IPD2 - Actinide Integral Cross Section Major FY2013 Activities

- Update existing compilation of data (reactor and special test), issue data compilation report, and provide report on NCSP website
- Issue letter report for Th-U Tree data and possible benchmark data for posting on NCSP website

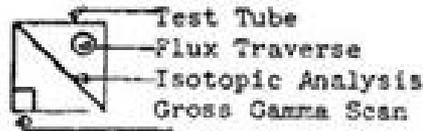
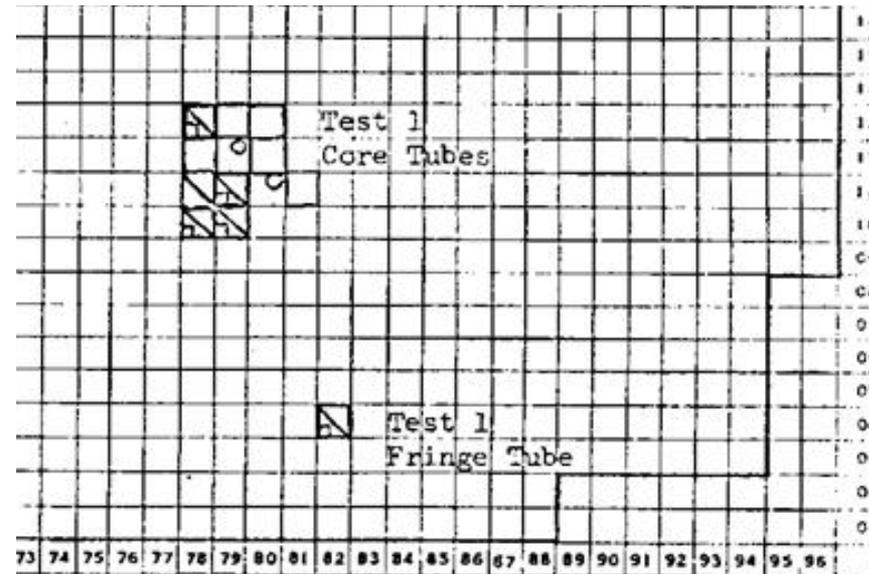
# H-IPD2 - Actinide Integral Cross Section U-Pu Tree Cross Section Data

Test Number	Doc. Title	Reactor	Year	Where	Radiochemical Data Available
PITA-48*	Central Zone Irradiation of Depleted Uranium - K Reactors	KE and KW	1967-1968	In Fuel	Yes
PTA-054*	210 E-N Demonstration Loading (2.1 wt% <sup>235</sup> U Fuel Examination)	KW	1967	In Fuel	Yes
PTA-069*	<sup>237</sup> Np Production from Natural Uranium with a High <sup>236</sup> U Content	B	1967-1968	In Fuel	Yes
PTA-084*	Evaluation of Fuel Performance at High Exposure	B	1967	In Fuel Eng. Test	Yes
PTA-103*	Operation and Evaluation of 44-Tube Reactor Modernization Facility at 105-C 1	C	1968-1969	In Fuel Eng. Test	Yes
PTA-107*	Controlled U-236 and Np-237 Production Test in K5E Fuel	KE	1968	In Fuel	Yes
PTA-137*	E-Q Monitor Columns (Thorium (Irradiation - Enriched Metal K5E)	KW	1968	In Fuel	Yes
PT-68*	N-Reactor Neptunium Irradiation	N	1966-1967	In Fuel	Yes
PTA-063*	Quick Turnaround Np Demonstration	KE	1967	Target	Yes
PT-NR-95	Irradiation and Analysis of High U-236 Mark I-C Fuel	N	1968-1969	In Fuel	No
IP-766	Irradiation of Aluminum-Plutonium Fuel Element	B	1965	In Fuel	No**
Unknown	Evaluation of Cm-244 Production	K Reactor	1967	In Fuel	No**
PTA-150	10kg Pu Al	KE	1970	Target	No**

\* Indicates the Test was determined to provide relevant, benchmark-like data.

# H-IPD2 - Actinide Integral Cross Section Typical Test Configuration

## PT-069 Test Configuration



Tube No.	Charge Length	Charged	Discharged
1079, 1178	32, 32	8/2/67	9/9/67
1179, 1181	32, 32	"	10/18/67
0582, 1078, 1280, 1380	32, 24, 32, 32	"	11/17/67
1378, 1278, 1279, 1379	24, 24, 24, 24	"	1/12/68
3485	32	5/5/67	11/17/67

# H-IPD2 - Actinide Integral Cross Section Typical Irradiation History

## Operating Data for the PTA-069 Experiment

PT #	Fuel Element #	Date Charged	Date Discharged	Oper. Full Power Days	Avg. Tube Pwr-kw	Est. Exp. MWD/T	Water Temp. °C		Avg. Fuel Pw. Pc.	Spec. Pwr. Kw/ft Fuel Pc.
							Inlet	Outlet		
1079	11	8/2/67	9/9/67	30	1059	285	19.9	98	69.6	50.5
	12								66.8	50.5
	17								53.7	76.0
	18								49.7	76.0
1179	10	8/2/67	10/18/67	55	1167	575	19.2	104	85.5	53.2
	11								82.4	56.8
	16								64.6	60.3
	17								61.3	60.3
1378	12	8/2/67	1/12/68	116	1239	1721	14.4	100	60.6	99.4
	13								55.9	91.7
0582	10	8/2/67	11/17/67	74	911	607	17.3	90	71.3	40.8
	11								68.9	40.8
	16								54.6	56.4
	17								51.4	54.0
1078	12	8/2/67	11/17/67	74	1153	1011	17.3	93	58.4	84.2
	13								54.3	84.2

Data taken from DUN-7243 RD

# H-IPD2 - Actinide Integral Cross Section U-Pu Tree Cross Section Data Summary

- Identified 9 Process Tests containing Relevant Data
- Tests conducted in B, C, KE, KW and N Reactors
- Fuel Enrichments ranged from natural to 2.1 wt % U-235
- Exposures ranged from 285 to 2406 MWD/T
- Code calculations being pursued under alternate funding (Mike Westfall)

# H-IPD2 - Actinide Integral Cross Section U-Th Tree Cross Section Data

Test Number	Doc. Title	Reactor	Year	Where	Radiochemical Data Available
IP-588-D	Development Test IP-588-D, Irradiation of thorium in a PCCF	D and DR	1963	Quartz-encapsulated Gram quantity Th in Al capsules	Y (HW-78959)
IP-614-A	Production Test IP-614-A, Irradiation of Thorium Target Elements	F	1963	Metallic Thorium target element	Y (HW-80960)
IP-618-D	Production Test IP-618-D, Irradiation Service Request HAPO-283, Irradiation of Thorium	DR and KE	1963	Quartz-encapsulated Gram quantity Th oxide in Al capsules	No
IP-627-A	Production Test-IP-627-A, Irradiation of Thorium Oxide Elements	D	1963	Thorium oxide target element	Y (HW-80960)
IP-648-AC	Production Test IP-648-AC, Evaluation of Thorium Oxide as a Fringe Loading	F	1964	Thorium oxide target element	No
IP-659-AC	Production Test IP-659-AC, Evaluation of Thorium Oxide Loading	F	1964	Thorium oxide target element	No
IP-695-AC	Production Test IP-695-AC, Thorium Oxide Irradiation – K Reactors	KE	1964	Thorium oxide target element	No
PITA-31	Fringe Blanket Irradiation of Thorium Oxide	SPRs	1964-1965	Thorium oxide target element	No
PITA-IP-34 <sup>(a)</sup>	PITA-IP-34 Central Zone Irradiation of Thorium Oxide, Smaller Reactors	D, KE	1965	Thorium oxide target element	No
PT 105-567-A	Production Test 105-567-A, Preliminary Irradiation of J-Q Columns	H	1954	Thorium oxide target element	Y (HW-40483)
PT 105-579-A	Production Test 105-579-A, Revised Quantity Irradiation of J-Q Columns		1956	Thorium oxide target element	Y (HW-40483)
PTA-076	Irradiation of On-site Recycled Thoria	C	1967	Thorium oxide target element	No
PTA-137	Production Test Authorization 137 - E-Q Monitor Columns	KW	1968	Thorium oxide target element	Y (DUN-5625)
PTA-149	Production Test Authorization 149 Large Scale Thoria Wafer Irradiation	KE and KW			No

<sup>a</sup> Production activity in multiple SPRs to produce needed quantity of <sup>233</sup>U

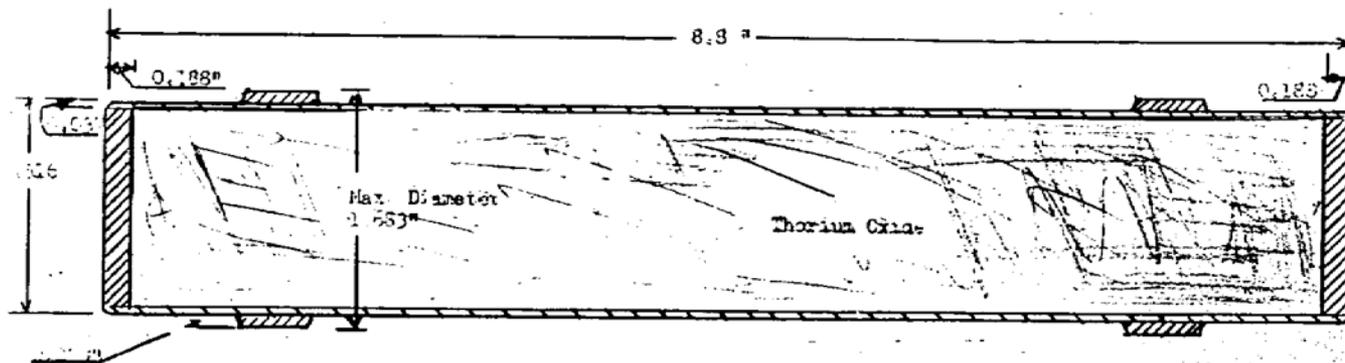
# H-IPD2 - Actinide Integral Cross Section U-Th Tree Cross Section Data

- Background
  - U-233 Production mission identified for Hanford Single Pass Reactors (SPRs)
  - Different target -fuel configurations evaluated
- Approach
  - Data Review and Compilation of Relevant Data
  - Used *Evaluation Guide for the International Reactor Physics Experiments Evaluation Project* (NEA/NSA/DOC[2006]2) to organize available data and identify any holes
  - Compiled relevant test configuration, reactor and post-irradiation examination (PIE) data

# H-IPD2 - Actinide Integral Cross Section U-Th Tree: Typical Target Design

## Typical Thoria Target for Irradiation in K Reactor

Length: 8.8 inches  
Diameter: 1.516 inches  
ThO<sub>2</sub> density: 7.35 g/cm<sup>3</sup>



# H-IPD2 - Actinide Integral Cross Section U-Th Tree Cross Section Data

- Identified 14 experiments conducted in the SPRs relevant to the U-Th tree
- Identified 6 Process Tests containing isotopic data
- Tests conducted in D, DR, F, KE and KW Reactors
- Target configurations included Th metal and oxide targets
- Exposures ranged from one to 15 months
- Only three tests included relevant target material and irradiation history data

# H-IPD2 - Actinide Integral Cross Section Typical Data Gaps

- Applicable to both data sets (U-Pu and U-Th data)
  - Specific core loading for test duration
  - Fuel burn-up estimates in neighboring fuel
  - Degree of non-uniformity in the graphite stack near the experiment
- Specific to the U-Th data
  - Target data (density, detailed composition)
  - Irradiation history details (coolant inlet/outlet temperatures, irradiation exposure details)

# H-IPD2 - Actinide Integral Cross Section FY2013 Reports

Actinide Cross-Section Data Summary for the U-Pu  
Reaction Chain (PRC-NS-00049, Rev. 0)

Hanford IP&D Subtask 3: Actinide Cross Section  
Extraction Status Report (PRC-NS-00028, Rev. 3)

Includes both new U-Pu reaction chain data and U-Th reaction  
chain data)

# H-IPD1 - ARH-600 Reissue FY2013 Activities

- Identified issue with the MCNP data sets for  $\text{UO}_2$  previously compiled into the CritView data libraries
  - MCNP results tabulated as a function of U-235 oxide concentration instead of U-235 concentration
  - Represents a scalar change in the documented concentrations
- NCSP Manager authorized use of FY2013 funds to address issue in timely manner

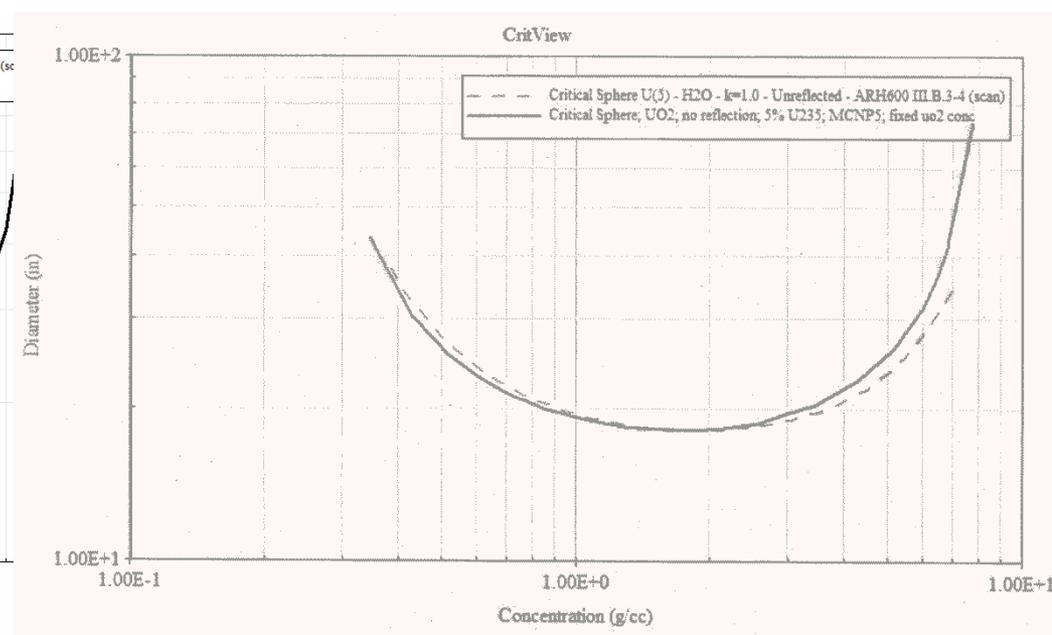
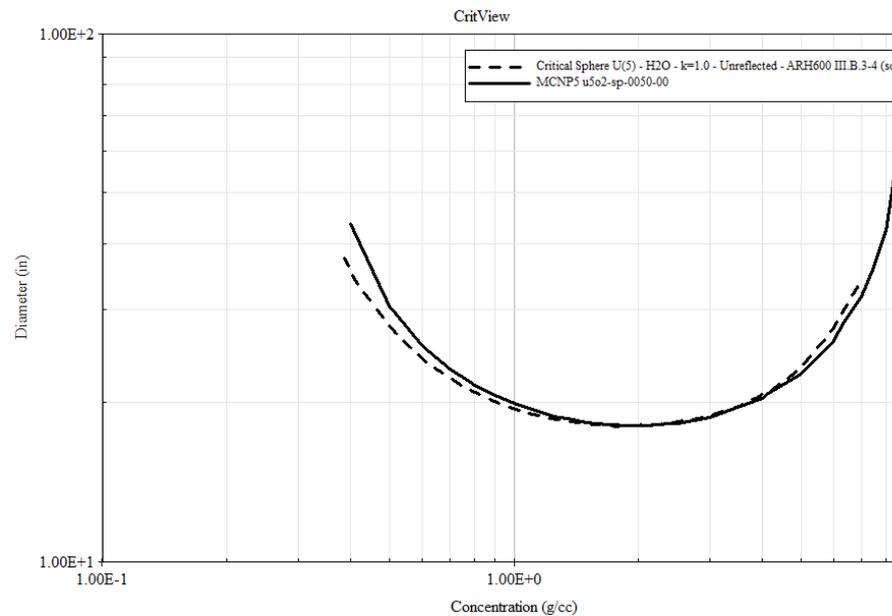
# H-IPD1 - ARH-600 Reissue FY2013

## Typical Impact on MCNP Results

Comparison of ARH-600 and MCNP Calculations for Unreflected  $UO_2$  Sphere

Original Calculation

Corrected Concentrations



# H-IPD1 - ARH-600 Reissue FY2013

## Updated CritView Data Libraries

- Updated CritView data libraries generated for added MCNP calculations for  $\text{UO}_2$ 
  - CritView data libraries peer reviewed
- Updated data libraries provided with CritView software and User Document to Lawrence Livermore National Laboratory (LLNL) and have been posted on the NCSP website

# Hanford NCSP FY2014 Activities

## ARH-600 Reissue Task (H-IPD1)

- Provide updated CritView database file and associated documentation to address user identified issues to LLNL for posting on the NCSP website – Completed last year
- Provide beta test version of updated CritView code and associated database file to LLNL for limited distribution
- Progress dependent on reassignment of task by NCSP manager

# Hanford NCSP FY2014 Activities (H-IPD2)

## Actinide Integral Cross Section Task

- Update existing compilation of data (reactor and special test), issue data compilation report, and provide report on NCSP website (T2: Q2)
- Issue letter report for data from Fast Flux Test Facility (FFTF) operations and special tests and possible benchmark listing for posting on NCSP website (T2: Q4)
- Progress dependent on reassignment of task by NCSP manager