

ANL NCSP Activities in the ND and IE Program Elements - FY2013

R. M. Lell

Nuclear Engineering Division
Argonne National Laboratory

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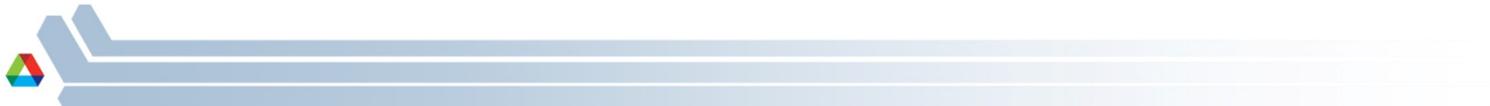
Overview of ANL Nuclear Data Activities

- Perform on-going data testing in support of the data validation effort for new evaluated nuclear data that are of interest to the criticality safety community
- Participate and provide leadership roles in nuclear data international expert groups and working groups – McKnight
 - US representative to NEA Working Party on Nuclear Criticality Safety (WPNCS)
 - ENDF representative to NEA Working Party on International Evaluation Cooperation (WPEC)
 - Member of WPEC High Priority Request List (HPRL)
 - Member of WPEC Subgroup 33 on Methods and Issues for the Combined Use of Integral Experiments and Covariance Data
 - Member of WPNCS Expert Group on Uncertainty Analysis for Criticality Safety Assessment (UACSA)



Overview of ANL Nuclear Data Activities (continued)

- Member of WPNCS Expert Group on Assay Data for Spent Nuclear Fuel (ADSNF)
- Chair of Nuclear Data Advisory Group (McKnight)
- Support on-going development of advanced nuclear data covariance methodologies
 - Chair of CSEWG Covariances Committee (McKnight)
- Generate integral experiment covariance data in on-going support of S/U methods, uncertainty quantification and nuclear data adjustment methods (McKnight)



Overview of ANL Integral Experiment Activities

- Provide status reports on all ANL CEdT related activities in NCSP Quarterly Progress Reports
- Provide ND analysis support for new IERs as designated by the NCSP Manager
 - Provide review to CEdT members on CED-3b document for IER-159 (Q1)
 - Provide review to CEdT members on CED-3b document for IER-160 (Q1)
 - Provide review to CEdT members on CED-3b document for IER-161 (Q1)
 - Provide review to CEdT members on CED-4a report for IER-159 (Q2)
 - Provide review to CEdT members on CED-2 document for IER-147 (Q2)
 - Provide review to CEdT members on CED-3b document for IER-160 (Q2)
 - Provide review to CEdT members on CED-1 document for IER-208 (Q2)



NCSP Data Testing and Validation

- Priority to provide timely testing and reporting of performance of new NCSP-supported nuclear data evaluations
 - All NCSP-supported data evaluations are delivered to BNL when completed
 - These preliminary ENDF/B files are processed by BNL with checking codes and posted to the NNDC web site as ENDF/A files
 - ANL processes these new files into libraries, determines the appropriate integral benchmarks to test the files, performs data testing calculations, and reports results (performance) to CSEWG and evaluators
- Generally try to provide validation results of high relevance and interest which would be difficult for other participants to provide



Test New Pu-239 in Intermediate Spectrum

- WPEC Subgroup 34: “Coordinated evaluation of Pu-239 in the resonance region”
- Goal: to obtain an improved Pu-239 resonance evaluation
 - including covariances
 - consistent with our fundamental cross section data
 - leading to improvements in calculations of integral data
- Selected assemblies, in order of softest to hardest spectrum were
 - ZPR-6/10 – small, clean assembly of Pu, C, stainless steel with no U
 - ZPR-3/53 – small, clean assembly of Pu-U-Mo, Pu-Al, C plates with DU reflector
 - ZPR-3/54 – identical to ZPR-3/53 except DU reflector was replaced by iron reflector
 - ZPR-6/7 – large single zone plutonium/uranium oxide benchmark that was part of LMFBR Demonstration Reactor Benchmark Program



Test New Pu-239 in Intermediate Spectrum (continued)

- Calculations indicate that new RR evaluation for Pu-239 had little effect for these assemblies

Benchmark	Assembly	EALF, keV	Experiment		239Pu Data	Calculated		C/E - 1, %		$\Delta(C/E-1)_{\text{New-VII.1, \%}}$	
			k-eff	σ	Version	k-eff	σ	C/E - 1	σ	$\Delta(C/E-1)$	σ
PU-MET-INTER-002	ZPR-6/10	11.33	1.0016	0.0013	New	1.02893	0.00005	2.729	0.133	0.082	0.189
PU-MET-INTER-002	ZPR-6/10	11.48	1.0016	0.0013	VII.1	1.02811	0.00005	2.647	0.133		
MIX-MET-INTER-003	ZPR-3/54	26.15	0.9981	0.0017	New	1.00838	0.00005	1.030	0.172	-0.009	0.243
MIX-MET-INTER-003	ZPR-3/54	26.27	0.9981	0.0017	VII.1	1.00847	0.00004	1.039	0.172		
MIX-MET-INTER-004	ZPR-3/53	58.15	1.0017	0.0009	New	1.00872	0.00004	0.701	0.091	-0.063	0.128
MIX-MET-INTER-004	ZPR-3/53	58.12	1.0017	0.0009	VII.1	1.00935	0.00004	0.764	0.091		
MIX-COMP-FAST-001	ZPR-6/7	120.56	1.0005	0.0009	New	1.00050	0.00003	0.000	0.090	-0.034	0.127
MIX-COMP-FAST-001	ZPR-6/7	120.30	1.0005	0.0009	VII.1	1.00084	0.00003	0.034	0.090		



Test New Pu-239 in Intermediate Spectrum (continued)

- Calculations indicate that new RR evaluation for Pu-239 had little effect for these assemblies

Benchmark	Assembly	EALF, MeV	Experiment		239Pu Data	Calculated		C/E - 1, %		Δ(C/E-1)New-VII.1, %	
			k-eff	σ	Version	k-eff	σ	C/E - 1	σ	Δ(C/E-1)	σ
PU-MET-INTER-002	ZPR-6/10	11.33	1.0016	0.0013	New	1.02893	0.00005	2.729	0.133	0.082	0.189
PU-MET-INTER-002	ZPR-6/10	11.48	1.0016	0.0013	VII.1	1.02811	0.00005	2.647	0.133		
MIX-MET-INTER-003	ZPR-3/54	26.15	0.9981	0.0017	New	1.00838	0.00005	1.030	0.172	-0.009	0.243
MIX-MET-INTER-003	ZPR-3/54	26.27	0.9981	0.0017	VII.1	1.00847	0.00004	1.039	0.172		
MIX-MET-INTER-004	ZPR-3/53	58.15	1.0017	0.0009	New	1.00872	0.00004	0.701	0.091	-0.063	0.128
MIX-MET-INTER-004	ZPR-3/53	58.12	1.0017	0.0009	VII.1	1.00935	0.00004	0.764	0.091		
MIX-COMP-FAST-001	ZPR-6/7	120.56	1.0005	0.0009	New	1.00050	0.00003	0.000	0.090	-0.034	0.127
MIX-COMP-FAST-001	ZPR-6/7	120.30	1.0005	0.0009	VII.1	1.00084	0.00003	0.034	0.090		



Test New Nickel Evaluation Against ENDF/B-VII.1 Nickel

- New nickel evaluation tested against ENDF/B-VII.1 nickel in five ZPR/ZPPR assemblies.

Benchmark	Assembly	EALF, MeV	Experiment		Ni Data Version	Calculated		C/E - 1, %	
			k-eff	σ		k-eff	σ	C/E - 1	σ
PU-MET-INTER-002	ZPR-6/10	1.16E-02	1.0016	0.0013	New	1.02611	0.00005	2.447	0.133
PU-MET-INTER-002	ZPR-6/10	1.15E-02	1.0016	0.0013	VII.1	1.02811	0.00005	2.647	0.133
MIX-COMP-FAST-001	ZPR-6/7	1.21E-01	1.0005	0.0009	New	1.00075	0.00003	0.025	0.090
MIX-COMP-FAST-001	ZPR-6/7	1.20E-01	1.0005	0.0009	VII.1	1.00084	0.00003	0.034	0.090
MIX-COMP-FAST-004	ZPR-3/56B	1.08E-01	0.9995	0.0011	New	0.99824	0.00004	-0.126	0.110
MIX-COMP-FAST-004	ZPR-3/56B	1.06E-01	0.9995	0.0011	VII.1	1.00154	0.00004	0.204	0.110
HEU-MET-INTER-001	ZPR-9/34 U/Fe	3.52E-02	1.0006	0.0011	New	1.00076	0.00004	0.016	0.110
HEU-MET-INTER-001	ZPR-9/34 U/Fe	3.49E-02	1.0006	0.0011	VII.1	1.00277	0.00004	0.217	0.110
MIX-COMP-FAST-006	ZPPR-2	1.25E-01	1.0005	0.0007	New	1.00284	0.00003	0.234	0.070
MIX-COMP-FAST-006	ZPPR-2	1.24E-01	1.0005	0.0007	VII.1	1.00315	0.00003	0.265	0.070

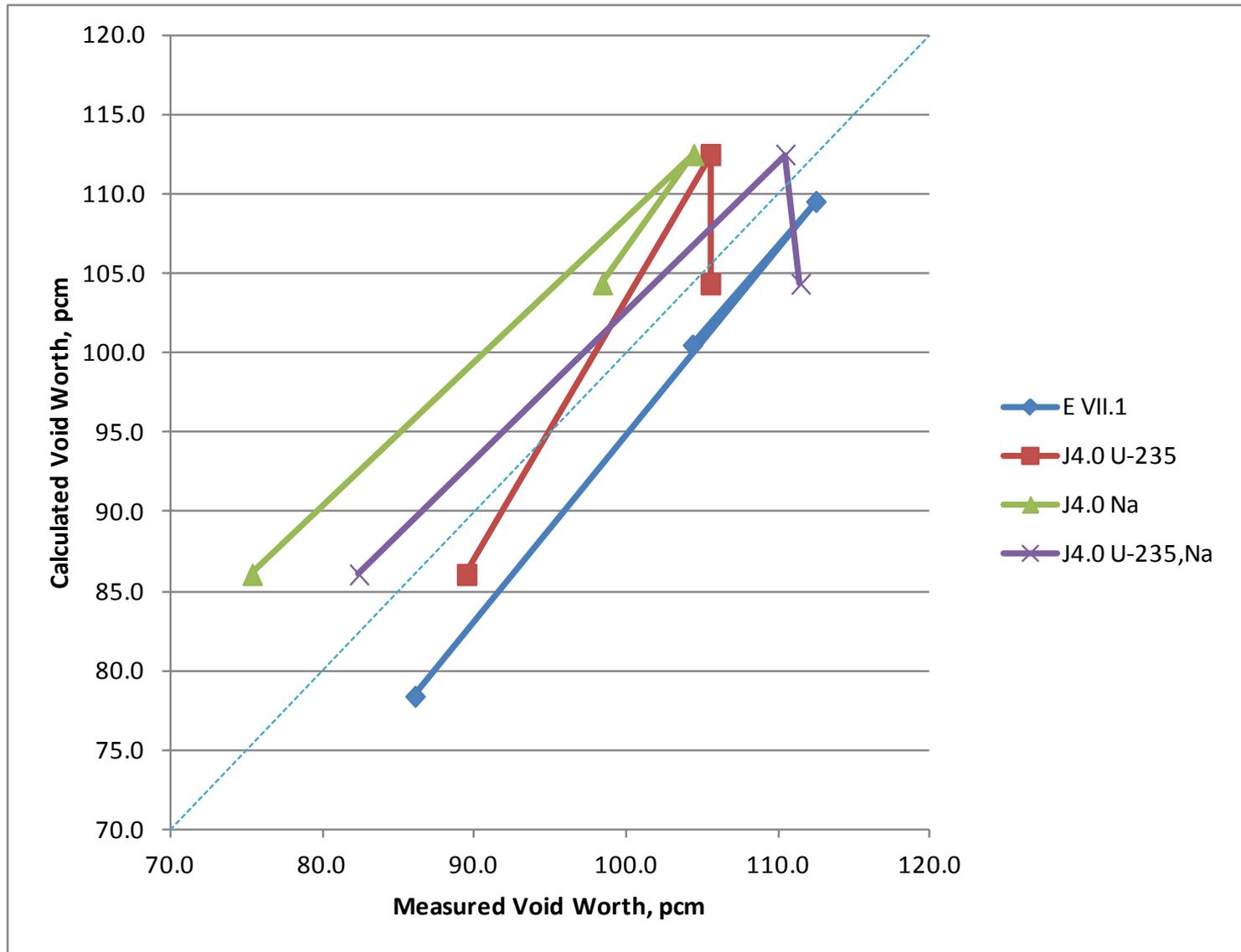


Sodium Void Worth - ENDF/B-VII.1 vs. JENDL-4.0 U-235, Na

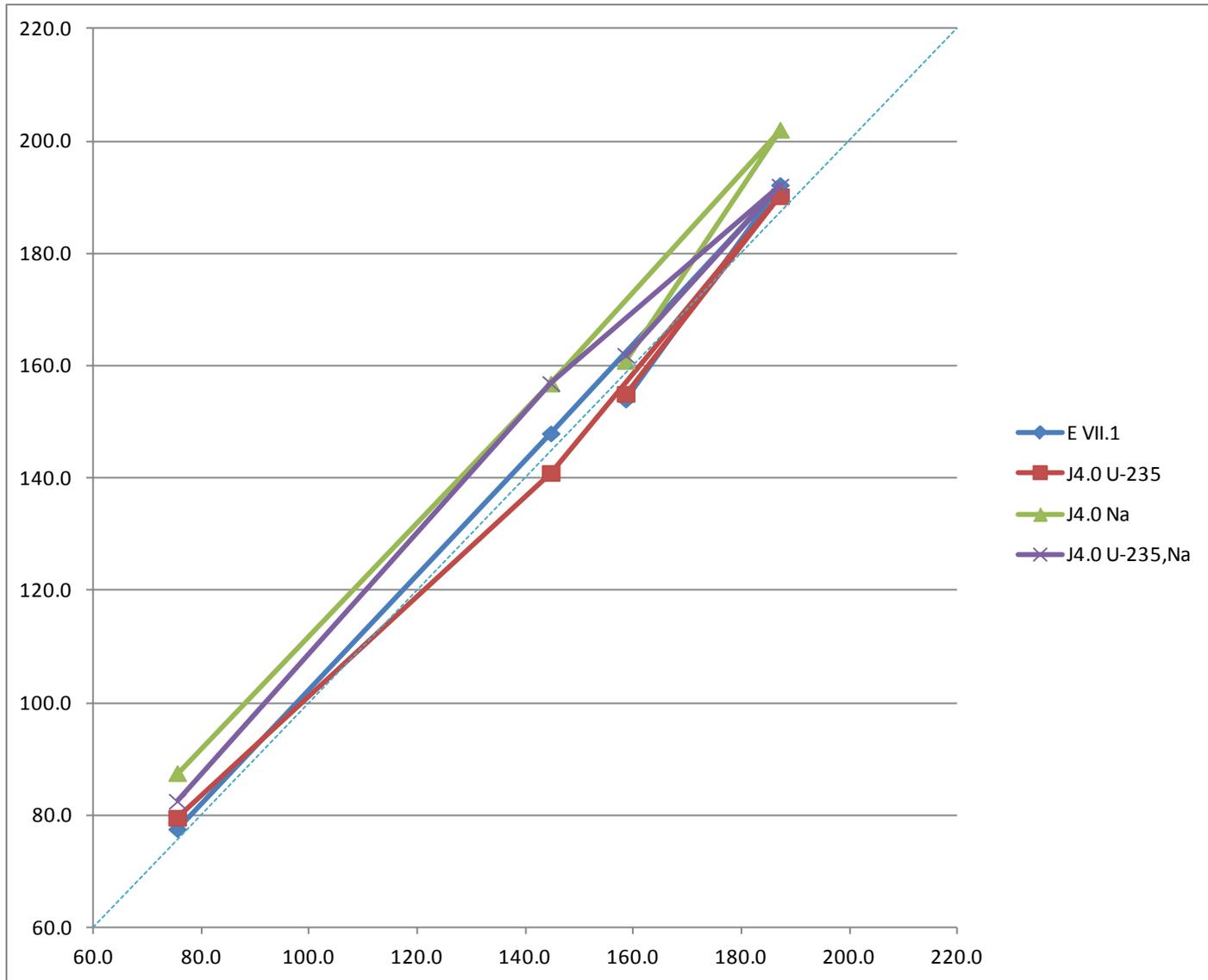
Assembly	Data	EALF, MeV	Exper. Worth, pcm		Calcul. Worth, pcm		C/E -1, %				
			$\Delta k/k_1 k_2$	σ	$\Delta k/k_1 k_2$	σ	C/E-1	σ			
ZPPR-9 L039	E VII.1	1.2518E-01	104.33	1.81	100.48	4.26	-3.69	4.41	8 in./20.32 cm Na void i		
ZPPR-9 L037	E VII.1	1.2652E-01	112.46	1.88	109.51	4.26	-2.62	4.12	20 in./50.80 cm Na void		
ZPPR-9 L038	E VII.1	1.2672E-01	86.05	1.46	78.39	4.26	-8.90	5.19	27 in./68.58 cm Na void		
ZPPR-9 L039	J4.0 Na	1.2245E-01	104.33	1.81	98.39	4.26	-5.69	4.40	8 in./20.32 cm Na void i		
ZPPR-9 L037	J4.0 Na	1.2381E-01	112.46	1.88	104.41	4.26	-7.16	4.09	20 in./50.80 cm Na void		
ZPPR-9 L038	J4.0 Na	1.2402E-01	86.05	1.46	75.32	4.26	-12.47	5.17	27 in./68.58 cm Na void		
ZPPR-9 L039	J4.0 U-235	1.2512E-01	104.33	1.81	105.51	4.26	1.13	4.44	8 in./20.32 cm Na void i		
ZPPR-9 L037	J4.0 U-235	1.2647E-01	112.46	1.88	105.51	4.26	-6.18	4.10	20 in./50.80 cm Na void		
ZPPR-9 L038	J4.0 U-235	1.2666E-01	86.05	1.46	89.45	4.26	3.95	5.26	27 in./68.58 cm Na void		
ZPPR-9 L039	J4.0 U-235,Na	1.2237E-01	104.33	1.81	111.46	4.26	6.83	4.48	8 in./20.32 cm Na void i		
ZPPR-9 L037	J4.0 U-235,Na	1.2380E-01	112.46	1.88	110.45	4.26	-1.79	4.13	20 in./50.80 cm Na void		
ZPPR-9 L038	J4.0 U-235,Na	1.2399E-01	86.05	1.46	82.36	4.26	-4.29	5.21	27 in./68.58 cm Na void		
ZPPR-10A L033	E VII.1	1.1485E-01	75.53	0.88	77.57	4.27	2.70	5.78	8 in./20.32 cm Na void i		
ZPPR-10A L034	E VII.1	1.1576E-01	144.68	1.56	147.99	4.27	2.29	3.15	8 in./20.32 cm Na void i		
ZPPR-10A L037	E VII.1	1.1735E-01	187.12	2.07	192.20	4.27	2.71	2.55	16 in./40.64 cm Na void		



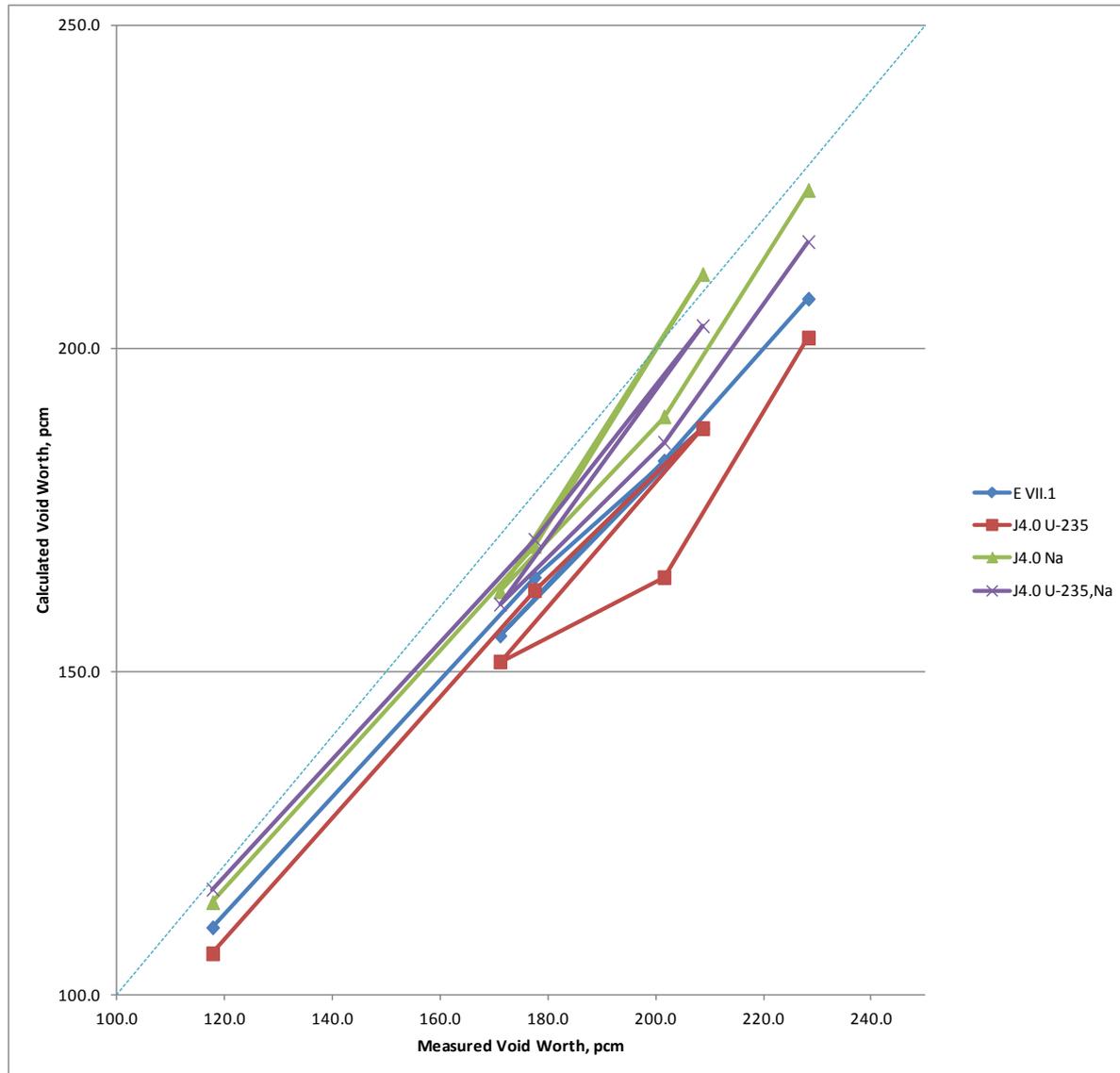
ZPPR-9 Sodium Void Worth



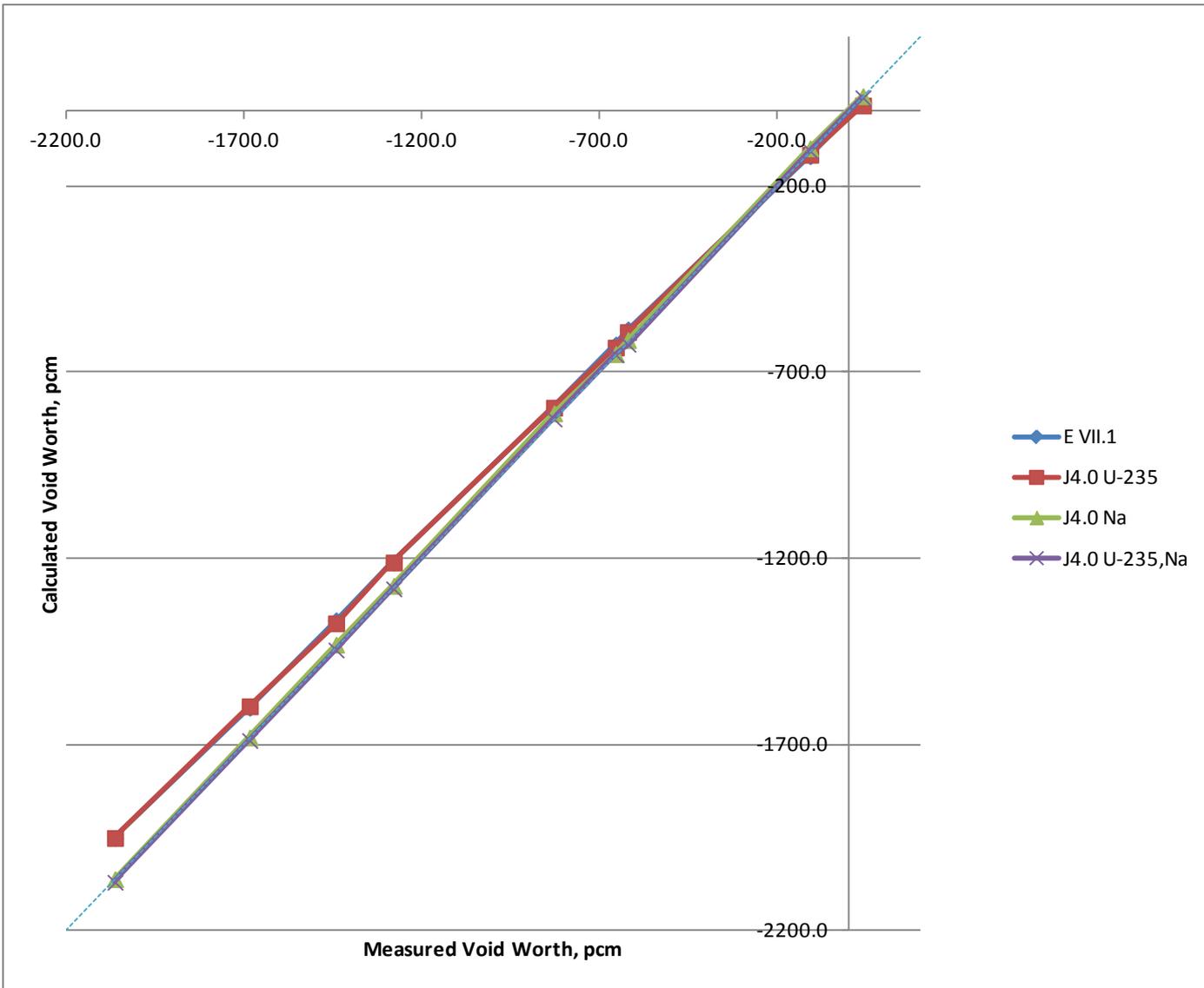
ZPPR-10A Sodium Void Worth



ZPPR-13A Sodium Void Worth



ZPPR-12 Sodium Void Worth



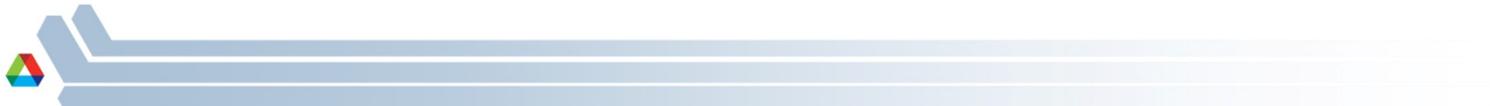
Expansion of ANL Data Validation and Testing Suite

- Goal – extend ANL data validation/testing suite of MCNP models
 - additional configurations and lower energy range
- BFS fast reactor assemblies
 - close matches to ANL ZPR/ZPPR assemblies
 - still operating so newer designs and materials are simulated
- BFS/COBRA (KBR) k-infinity measurements
 - test specific isotopes in relevant energy ranges
 - emphasize particular energy range or material



BFS Fast Reactor Critical Assemblies

- BFS-61-0 - MIX-MET-FAST-006 - Core of Pu, depleted uranium, graphite and lead surrounded by layers of lead, steel and depleted UO₂
- BFS-73-1 - BFS1-LMFR-EXP-001 - Sodium-cooled fast reactor with uranium metal fuel (IFR) and depleted UO₂ blanket – extends ZPPR-15 results
- BFS-76-0 - Sodium-cooled fast reactor with Pu and enriched U metal fuel (IFR) and depleted UO₂ blanket – extends ZPPR-15 results
- BFS-85-1, BFS-85-2, BFS-87-1, BFS-87-2 – Experiments to determine scattering and transport cross sections of lead and bismuth



BFS Fast Reactor Calculations - ENDF/B-VII.1

Assembly	EALF, MeV	Fuel	C/E - 1, %	σ , %
BFS-61-0	0.1786	Pu, depleted U	-0.428	0.289
BFS-73-1	0.1860	Uranium	-0.443	0.289
BFS-76-0	0.1435	Pu and Enriched U	-1.234*	
BFS-85-1	0.2283		0.045	0.270
BFS-85-2	0.2279		0.078	0.270
BFS-87-1	0.2392		-0.370	0.299
BFS-87-2	0.2331		-0.647	0.298



Miscellaneous BFS Assemblies - Fast, Intermediate and Lower Energy Ranges

- MIX-MISC-FAST-001 – BFS-31, -33, -35, -38, -42
 - k-infinity measurements with Pu or enriched U mixed with DU
- MIX-MISC-FAST-002 – BFS-49-1
 - Core of plutonium, DU and polyethylene
- PU-MET-MIXED-001 – BFS-81/1 through BFS-81/5
 - BFS-81 examined spent fuel storage
 - Assemblies consisted of pellets of Pu metal, silicon dioxide and polyethylene
- HEU-MET-MIXED-005 – BFS-79/1 through BFS-79/5
 - BFS-79 was the uranium-fueled companion to BFS-81
 - Assemblies consisted of pellets of HEU metal, silicon dioxide and polyethylene

