ANL NCSP Activities in the ND and IE Program Elements

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Overview of ANL Nuclear Data Activities

- Perform on-going data testing in support of the data validation effort for ENDF/B-VII and 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
  - 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)
  - Member of WPNCS Expert Group on Assay Data for Spent Nuclear Fuel (ADSNF)

Overview of ANL Nuclear Data Activities (Cont'd)

- Support on-going development of advanced nuclear data covariance methodologies
  - Chair of CSEWG Covariances Committee
- Generate integral experiment covariance data in on-going support of S/U methods, Uncertainty Quantification and nuclear data adjustment methods
- Chair the Nuclear Data Advisory Group (NDAG)

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.

WPEC Subgroup 34: "Coordinated evaluation of ^{239}Pu in the Resonance Region"

- Sub-group proposition by McKnight/Dunn/Chadwick on June 2009 Justification :
  - General discrepancies on Pu-SOL-THERMAL assemblies and Pu-INTER assemblies
  - JEFF 3.1.1 thermal part
  - New Derrien/Leal ENDF resonance files :
    - With covariances
    - Using new microscopic data sets
- Goal: to obtain an improved ^{239}Pu resonance evaluation :
  - including covariances
  - consistent with our fundamental cross section data
  - leading to improvements in calculations of integral data

Test New Evaluation in Intermediate Spectrum

Selected assemblies, in order of softest to hardest spectrum, included:

- ZPR-6/10 was a small, clean, cylindrical assembly consisting of plutonium, carbon, and stainless steel (no uranium) with intermediate spectrum.
- ZPR-3/53 was small clean core containing PuUMo, PuAl, and C plates with a DU reflector.
- ZPR-3/54 was identical to ZPR-3/53 except that the DU reflector was replaced by an iron reflector.
- ZPR6/7 was a large, cylindrical, single-zone plutonium / uranium oxide benchmark assembly that was part of the LMFBR Demonstration Reactor Benchmark Program.

Test New Evaluation in Intermediate Spectrum (Cont'd)

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

- Calculations for the Pu-INTER assemblies indicate the perhaps expected results that the new RR evaluation for 239Pu has little if any effect upon these assemblies.
  - Large discrepancies remain for these assemblies indicating the need for a new 239Pu evaluation in the URR region.

IE covariance data in on-going support of S/U methods, UQ and nuclear data adjustment methods

- Covariance data are evaluated and provide to ICSBEP for inclusion in DICE
- Some of these data were used in the WPEC subgroup 33 "data adjustment" exercise
  - Demonstrated the importance of accounting for correlations among the integral experiments
- Examples of Results

Total Correlation Factors for 33 ANL Critical Assemblies

	ZPR3 6F	ZPR3 11	ZPR3 12	ZPR3 23	ZPR3 41	ZPR3 48	ZPR3 48B	ZPR3 56B	ZPR6 6A	ZPR6 7	ZPR6 7Pu	ZPR6 9 U9	ZPR6 10	ZPR9 1	ZPR9 2	ZPR9 3	ZPR9 4	ZPR9 5	ZPR9 6	ZPR9 7	ZPR9 8	ZPR9 9	ZPR9 34 U/FE	ZPPR 20C	ZPPR 20D	ZPPR 20Dsub	ZPPR 20Esub	ZPPR 21A	ZPPR 21B	ZPPR 21C	ZPPR 21D	ZPPR 21E	ZPPR 21F
ZPR3 6F	1.00	0.86	0.91	0.54	0.52	0.41	0.42	0.15	0.63	0.00	0.00	0.75	0.00	0.52	0.67	0.66	0.54	0.53	0.52	0.47	0.46	0.48	0.38	0.38	0.48	0.17	0.09	0.00	0.08	0.23	0.29	0.39	0.48
ZPR3 11	0.86	1.00	0.91	0.37	0.51	0.39	0.40	0.08	0.64	0.00	0.00	0.91	0.00	0.47	0.68	0.65	0.48	0.46	0.46	0.41	0.40	0.42	0.33	0.34	0.42	0.15	0.08	0.00	0.08	0.21	0.26	0.35	0.43
ZPR3 12	0.91	0.91	1.00	0.48	0.52	0.40	0.41	0.14	0.65	0.00	0.00	0.82	0.00	0.51	0.69	0.67	0.53	0.51	0.51	0.46	0.45	0.47	0.37	0.37	0.47	0.16	0.09	0.00	0.09	0.22	0.28	0.39	0.47
ZPR3 23	0.54	0.37	0.48	1.00	0.33	0.34	0.34	0.28	0.29	0.00	0.00	0.22	0.00	0.28	0.30	0.31	0.30	0.29	0.29	0.26	0.25	0.27	0.21	0.21	0.27	0.09	0.05	0.00	0.04	0.12	0.15	0.21	0.25
ZPR3 41	0.52	0.51	0.52	0.33	1.00	0.27	0.27	0.14	0.38	0.00	0.00	0.44	0.00	0.31	0.40	0.39	0.33	0.32	0.31	0.28	0.28	0.29	0.23	0.23	0.29	0.10	0.05	0.00	0.05	0.14	0.17	0.24	0.28
ZPR3 48	0.41	0.39	0.40	0.34	0.27	1.00	0.85	0.21	0.16	0.00	0.07	0.28	0.07	0.01	0.10	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.01	0.01
ZPR3 48B	0.42	0.40	0.41	0.34	0.27	0.85	1.00	0.21	0.16	0.00	0.06	0.28	0.06	0.01	0.10	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.01	0.01	0.01
ZPR3 56B	0.15	0.08	0.14	0.28	0.14	0.21	0.21	1.00	0.05	0.18	0.12	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ZPR6 6A	0.63	0.64	0.65	0.29	0.38	0.16	0.16	0.05	1.00	0.36	0.36	0.69	0.15	0.54	0.65	0.66	0.58	0.56	0.56	0.50	0.49	0.51	0.41	0.42	0.52	0.18	0.10	0.02	0.10	0.25	0.32	0.43	0.51
ZPR6 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.36	1.00	0.66	0.10	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.03	0.01	0.01	0.22	0.22	0.21	0.20	0.18	0.16
ZPR6 7 Pu	0.00	0.00	0.00	0.00	0.00	0.07	0.06	0.12	0.36	0.66	1.00	0.10	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.03	0.01	0.01	0.22	0.21	0.20	0.19	0.17	0.15
ZPR6 9 U9	0.75	0.91	0.82	0.22	0.44	0.28	0.28	0.00	0.69	0.10	0.10	1.00	0.07	0.44	0.65	0.62	0.44	0.43	0.43	0.38	0.37	0.39	0.31	0.36	0.40	0.14	0.08	0.07	0.15	0.26	0.31	0.39	0.46
ZPR6 10	0.00	0.00	0.00	0.00	0.00	0.07	0.06	0.02	0.15	0.22	0.27	0.07	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.01	0.01	0.18	0.13	0.12	0.12	0.11	0.13
ZPR9 1	0.52	0.47	0.51	0.28	0.31	0.01	0.01	0.00	0.54	0.00	0.00	0.44	0.00	1.00	0.97	0.93	0.89	0.96	0.96	0.93	0.94	0.94	0.76	0.40	0.50	0.17	0.09	0.00	0.08	0.22	0.29	0.40	0.48
ZPR9 2	0.67	0.68	0.69	0.30	0.40	0.10	0.10	0.00	0.65	0.00	0.00	0.65	0.00	0.97	1.00	0.96	0.87	0.90	0.90	0.86	0.84	0.86	0.67	0.43	0.55	0.19	0.10	0.00	0.09	0.25	0.32	0.44	0.53
ZPR9 3	0.66	0.65	0.67	0.31	0.39	0.07	0.07	0.00	0.66	0.00	0.00	0.62	0.00	0.93	0.96	1.00	0.88	0.90	0.90	0.85	0.84	0.86	0.67	0.45	0.57	0.20	0.10	0.00	0.09	0.26	0.33	0.46	0.55
ZPR9 4	0.54	0.48	0.53	0.30	0.33	0.00	0.00	0.00	0.58	0.00	0.00	0.44	0.00	0.89	0.87	0.88	1.00	0.88	0.88	0.84	0.84	0.85	0.68	0.43	0.54	0.19	0.10	0.00	0.08	0.24	0.31	0.43	0.51
ZPR9 5	0.53	0.46	0.51	0.29	0.32	0.00	0.00	0.00	0.56	0.00	0.00	0.43	0.00	0.96	0.90	0.90	0.88	1.00	0.96	0.93	0.94	0.94	0.77	0.42	0.52	0.18	0.10	0.00	0.08	0.23	0.30	0.42	0.50
ZPR9 6	0.52	0.46	0.51	0.29	0.31	0.00	0.00	0.00	0.56	0.00	0.00	0.43	0.00	0.96	0.90	0.90	0.88	0.96	1.00	0.94	0.94	0.94	0.78	0.42	0.52	0.18	0.10	0.00	0.08	0.23	0.30	0.42	0.50
ZPR9 7	0.47	0.41	0.46	0.26	0.28	0.00	0.00	0.00	0.50	0.00	0.00	0.38	0.00	0.93	0.86	0.85	0.84	0.93	0.94	1.00	0.94	0.93	0.78	0.37	0.47	0.16	0.09	0.00	0.07	0.21	0.27	0.37	0.44
ZPR9 8	0.46	0.40	0.45	0.25	0.28	0.00	0.00	0.00	0.49	0.00	0.00	0.37	0.00	0.94	0.84	0.84	0.84	0.94	0.94	0.94	1.00	0.94	0.80	0.36	0.46	0.16	0.08	0.00	0.07	0.20	0.26	0.36	0.43
ZPR9 9	0.48	0.42	0.47	0.27	0.29	0.00	0.00	0.00	0.51	0.00	0.00	0.39	0.00	0.94	0.86	0.86	0.85	0.94	0.94	0.93	0.94	1.00	0.79	0.38	0.48	0.17	0.09	0.00	0.07	0.21	0.28	0.38	0.45
ZPR9 34 U/FE	0.38	0.33	0.37	0.21	0.23	0.00	0.00	0.00	0.41	0.00	0.00	0.31	0.00	0.76	0.67	0.67	0.68	0.77	0.78	0.78	0.80	0.79	1.00	0.31	0.38	0.13	0.07	0.02	0.08	0.19	0.24	0.32	0.37
ZPPR 20C	0.38	0.34	0.37	0.21	0.23	0.00	0.00	0.00	0.42	0.13	0.12	0.36	0.08	0.40	0.43	0.45	0.43	0.42	0.42	0.37	0.36	0.38	0.31	1.00	0.81	0.35	0.23	0.65	0.71	0.80	0.84	0.87	0.87
ZPPR 20D	0.48	0.42	0.47	0.27	0.29	0.00	0.00	0.00	0.52	0.03	0.03	0.40	0.02	0.50	0.55	0.57	0.54	0.52	0.52	0.47	0.46	0.48	0.38	0.81	1.00	0.31	0.18	0.39	0.46	0.60	0.65	0.72	0.76
ZPPR 20Dsub	0.17	0.15	0.16	0.09	0.10	0.00	0.00	0.00	0.18	0.01	0.01	0.14	0.01	0.17	0.19	0.20	0.19	0.18	0.18	0.16	0.16	0.17	0.13	0.35	0.31	1.00	0.94	0.14	0.16	0.22	0.26	0.27	0.27
ZPPR 20Esub	0.09	0.08	0.09	0.05	0.05	0.00	0.00	0.00	0.10	0.01	0.01	0.08	0.01	0.09	0.10	0.10	0.10	0.10	0.10	0.09	0.08	0.09	0.07	0.23	0.18	0.94	1.00	0.10	0.11	0.15	0.17	0.17	0.17
ZPPR 21A	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.22	0.22	0.07	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.65	0.39	0.14	0.10	1.00	0.87	0.82	0.79	0.70	0.62
ZPPR 21B	0.08	0.08	0.09	0.04	0.05	0.02	0.02	0.00	0.10	0.22	0.21	0.15	0.13	0.08	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.08	0.71	0.46	0.16	0.11	0.87	1.00	0.85	0.82	0.76	0.69
ZPPR 21C	0.23	0.21	0.22	0.12	0.14	0.02	0.02	0.00	0.25	0.21	0.20	0.26	0.12	0.22	0.25	0.26	0.24	0.23	0.23	0.21	0.20	0.21	0.19	0.80	0.60	0.22	0.15	0.82	0.85	1.00	0.87	0.85	0.80
ZPPR 21D	0.29	0.26	0.28	0.15	0.17	0.02	0.01	0.00	0.32	0.20	0.19	0.31	0.12	0.29	0.32	0.33	0.31	0.30	0.30	0.27	0.26	0.28	0.24	0.84	0.65	0.26	0.17	0.79	0.82	0.87	1.00	0.88	0.85
ZPPR 21E	0.39	0.35	0.39	0.21	0.24	0.01	0.01	0.00	0.43	0.18	0.17	0.39	0.11	0.40	0.44	0.46	0.43	0.42	0.42	0.37	0.36	0.38	0.32	0.87	0.72	0.27	0.17	0.70	0.76	0.85	0.88	1.00	0.90
ZPPR 21F	0.48	0.43	0.47	0.25	0.28	0.01	0.01	0.00	0.51	0.16	0.15	0.46	0.13	0.48	0.53	0.55	0.51	0.50	0.50	0.44	0.43	0.45	0.37	0.87	0.76	0.27	0.17	0.62	0.69	0.80	0.85	0.90	1.00

0.95 - 1.00	0.90 - 0.95	0.85 - 0.90	0.80 - 0.85	0.75 - 0.80	0.70 - 0.75	0.65 - 0.70	0.60 - 0.65	0.55 - 0.60	0.50 - 0.55	0.45 - 0.50	0.40 - 0.45	0.35 - 0.40	0.30 - 0.35	0.25 - 0.30	0.20 - 0.25	0.15 - 0.20	0.10 - 0.15	0.05 - 0.10	0.0 - 0.05

Covariance Plots for US (LANL), Russia (VNIITF) and French Bare & U-Reflected Reactors

Total	LANL Godiva	LANL Godiva4a	LANL Godiva4b	LANL Comet1	LANL Comet2	LANL Comet3	LANL Comet4	LANL Flattop	LANL Big Ten	VNIITF HMF08	VNIITF HMF14	VNIITF HMF15	VNIITF HMF18	VNIITF HMF29	VNIITF HMF65	Caliban HMF80
LANL Godiva	1.000	0.166	0.174	0.002	0.003	0.002	0.002	0.313	0.164	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Godiva4a	0.166	1.000	0.990	0.004	0.005	0.003	0.004	0.519	0.271	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Godiva4b	0.174	0.990	1.000	0.004	0.006	0.003	0.004	0.545	0.285	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Comet1	0.002	0.004	0.004	1.000	0.987	0.987	0.982	0.007	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Comet2	0.003	0.005	0.006	0.987	1.000	0.992	0.987	0.010	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Comet3	0.002	0.003	0.003	0.987	0.992	1.000	0.987	0.006	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Comet4	0.002	0.004	0.004	0.982	0.987	0.987	1.000	0.007	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Flattop	0.313	0.519	0.545	0.007	0.010	0.006	0.007	1.000	0.513	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LANL Big Ten	0.164	0.271	0.285	0.004	0.005	0.003	0.004	0.513	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
VNIITF HMF08	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.978	0.063	0.123	0.330	0.104	0.000
VNIITF HMF14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.978	1.000	0.034	0.066	0.184	0.056	0.000
VNIITF HMF15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.034	1.000	0.068	0.181	0.991	0.000
VNIITF HMF18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.123	0.066	0.068	1.000	0.464	0.112	0.000
VNIITF HMF29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.330	0.184	0.181	0.464	1.000	0.056	0.000
VNIITF HMF65	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.104	0.056	0.991	0.112	0.056	1.000	0.000
Caliban HMF80	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

0.95 - 1.00	0.45 - 0.50
0.90 - 0.95	0.40 - 0.45
0.85 - 0.90	0.35 - 0.40
0.80 - 0.85	0.30 - 0.35
0.75 - 0.80	0.25 - 0.30
0.70 - 0.75	0.20 - 0.25
0.65 - 0.70	0.15 - 0.20
0.60 - 0.65	0.10 - 0.15
0.55 - 0.60	0.05 - 0.10
0.50 - 0.55	0.0 - 0.05

Overview of ANL Integral Experiment Activities

- Provide status reports on all ANL $C_E dT$ related activities in NCSP Quarterly Progress Reports
- Provide ND analysis support for new IERs as designated by the NCSP Manager
  - Complete IER-147 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-153 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-159 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-160 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-161 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-206 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-208 ND analysis support and provide summary report to IER-159 $C_E dT$
  - Complete IER-226 ND analysis support and provide summary report to IER-159 $C_E dT$