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Performing k_{eff} Validation of As-Loaded Criticality Safety Calculations Using UNF-ST&DARDS: Applicable Experiment Selection

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Outline

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Introduction and background

- UNF-ST&DARDS performs many analyses for as-loaded SNF canisters: criticality safety, shielding, thermal-hydraulic, containment
  - Overall plan for NCS validation presented by Clarity in Minneapolis
  - k_{eff} sensitivity calculations presented in previous paper
- Experiment selection based on c_k assessment of similarity
  - c_k value of 0.8 or greater considered applicable for validation
- 11 PWR SNF canisters (MPC-32) used in this work
  - 1 model represents a failed fuel assembly as fresh, per the design basis
  - Remaining 10 models represent all 32 assemblies with depleted fuel

Application systems considered

- 11 total MPC-32 systems were considered
  - TSC-069 was used to establish parameters for effective TSUNAMI-3D calculations, as discussed in previous presentation
  - Canisters included Westinghouse 17×17 and Combustion Engineering 16×16 fuel assemblies
- 1 MPC-32 (GC-011) contains damaged fuel assemblies which are modeled as a fresh fuel

Cask Identifiers		
TSC-069	MPC-32-34	CASK001
CASK007	GC-005	GC-011
MPC-085	MPC-137	MPC-143
MPC-224	TSC-0110	

Critical experiment suite

- Experiments with sensitivity data available pooled from VALID, ICSBEP Handbook, and ORNL-generated HTC models
- Over 2,300 experiments from LEU, MIX, and PU categories

Experiment Categories	Number of SDFs	Experiment Categories	Number of SDFs
LEU-COMP-THERM	1,163	MIX-MISC-FAST	2
LEU-MET-THERM	79	MIX-SOL-THERM	42
LEU-MISC-THERM	48	PU-COMP-FAST	5
LEU-SOL-THERM	113	PU-COMP-INTER	1
HTC	155	PU-COMP-MIXED	8
MIX-COMP-FAST	3	PU-COMP-THERM	16
MIX-COMP-THERM	249	PU-MET-FAST	82
MIX-MET-FAST	36	PU-MET-INTER	1
MIX-MET-INTER	2	PU-SOL-THERM	346

c_k results

- Each of the 11 applications compared with each of the 2,351 critical experiments
- For applications with only SNF isotopics:
  - 127 to 151 applicable benchmarks
  - All HTC experiments
- For application with SNF and fresh fuel:
  - 1,300 benchmarks
  - Marked increase due to applicability of many fresh fuel experiments

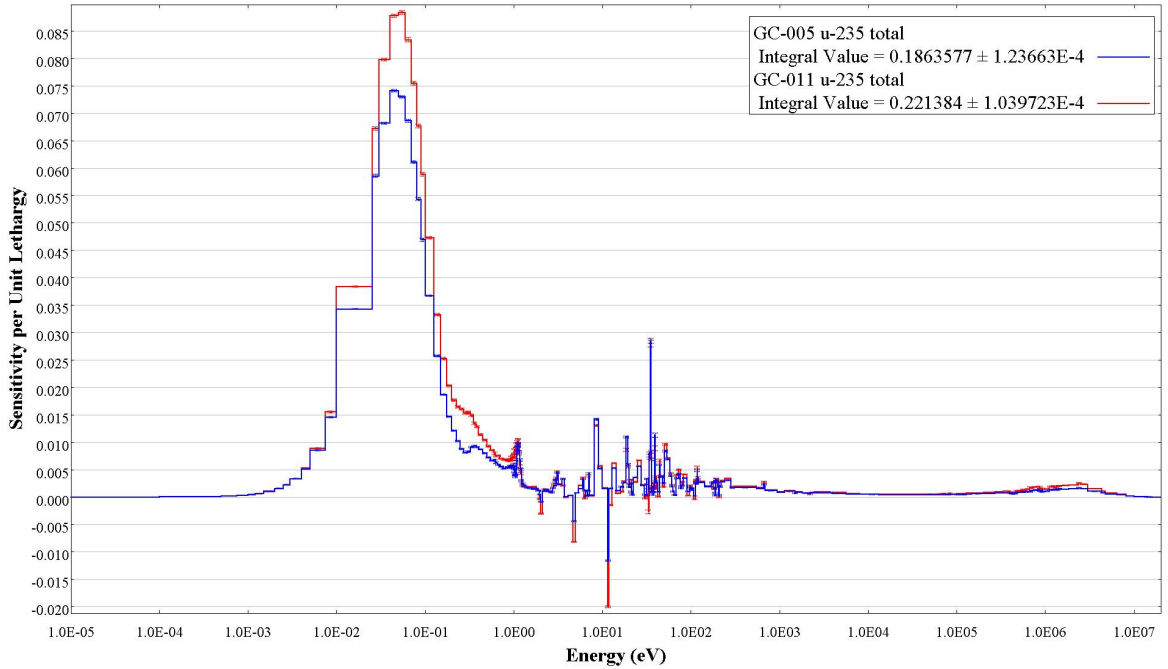
c_k results (continued)

DPC	Number of Applicable Benchmarks
TSC-069	128
MPC-32-34	147
CASK001	149
CASK007	148
GC-005	149
GC-011	1,300
MPC-085	149
MPC-137	147
MPC-143	148
MPC-224	151
TSC-0110	127

Experient Category	Number of Applicable Benchmarks
HTC	139
LEU-COMP-THERM	1,075
LEU-MET-THERM	36
LEU-MISC-THERM	48
LEU-SOL-THERM	2

c_k results (continued)

- Modest increases in ^{235}U and ^{238}U sensitivity caused by fresh fuel in the model significantly increase contribution to c_k



GC-005		GC-011	
Isotope	c_k contribution	Isotope	c_k contribution
^{235}U	0.3308	^{235}U	0.5443
^{238}U	0.2955	^{238}U	0.3389
^{1}H	0.0478	^{1}H	0.0491
^{16}O	0.0165	^{16}O	0.0201

Conclusions

- Critical experiment selection can be performed with S/U techniques for as-loaded canisters in UNF-ST&DARDS
- Sufficient benchmark experiments exist to support validation
  - Additional MOX experiments that are a good match for commercial SNF would be a benefit to provide independent data
- S/U techniques identify different pools of experiments for different systems
  - More LCT experiments for system including fresh fuel, as expected
- Process amenable to automation within UNF-ST&DARDS

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Questions?

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