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RESULTS OF TRIPOLI-4® VERSION 10 ON THE TRIPOLI CRITICALITY VALIDATION SUITE, PART I : THERMAL SPECTRA

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ABSTRACT

This paper presents the results of the latest version of TRIPOLI-4® [1] on its criticality validation suite, part I dedicated to thermal spectra. The criticality validation suite is made of 148 carefully chosen ICSBEP [2] benchmarks with various enrichments, fissile materials and spectra. The ICSBEP benchmarks computational models are prepared by the TRIPOLI-4® V&V team and are run in the same conditions for each benchmark : initial source, number of neutrons per cycle, number of inactive and active cycles, keff estimator, nuclear data. Comparisons are made with the measured keff as well as with previous versions of TRIPOLI-4®.

Key Words: **TRIPOLI-4®, criticality, validation, Monte Carlo, neutron**

1. INTRODUCTION

TRIPOLI-4® is a three-dimensional and continuous-energy Monte-Carlo transport code developed by the "Service d'Etudes des Réacteurs et de Mathématiques Appliquées" (SERMA), at the CEA Paris-Saclay center. It is devoted to shielding, reactor physics, criticality safety and nuclear instrumentation. TRIPOLI-4® has been developed from the mid 1990s in C++. A new version of the code is typically released every two years. In the validation process, the release candidate is run on several validation suites, one of them being devoted to criticality. This paper presents TRIPOLI-4® version 10 results on part of this validation suite.

TRIPOLI-4® is the reference Monte Carlo code for CEA, EDF and branches of AREVA. It is also the reference calculation route of the CRISTAL [3] Criticality Safety Package jointly developed by CEA, IRSN and AREVA.

2. THE TRIPOLI-4® CRITICALITY VALIDATION SUITE, THERMAL SPECTRA

All the benchmarks are coming from the ICSBEP HandBook, and have been modeled by the TRIPOLI-4® V&V Team. This validation suite has been established at the very beginning of the TRIPOLI-4® project, in the mid-1990s. The HandBook version is the 1995 one, for purposes of comparison between different versions of TRIPOLI-4®, different versions of the nuclear data, or different settings in the same version of the code, the TRIPOLI-4® team has tried to keep the input decks unchanged since the original work. Some exceptions were made when modeling errors have been found which needed a fix.

Table 1. TRIPOLI-4® Criticality Validation Suite, thermal spectra, ICSBEP benchmarks and cases

ICSBEP Benchmark	Selected cases in the TRIPOLI-4® Criticality suite, thermal spectra
LEU-SOL-THERM-001	1
LEU-SOL-THERM-002	1-3
LEU-SOL-THERM-003	1-9
MIX-SOL-THERM-002	58, 59, 61
MIX-SOL-THERM-003	1-10
MIX-SOL-THERM-004	65, 66, 69, 70, 77, 78
HEU-SOL-THERM-011	1-2
HEU-SOL-THERM-012	1
HEU-SOL-THERM-013	3-4
HEU-SOL-THERM-014	1-3
PU-SOL-THERM-001	1 (simple sphere-and truncated sphere), 2 (id.), 3 (id.), 4 (id.); 5 (id.), 6 (id.)
PU-SOL-THERM-004	3, 5 , 6, 8, 11
PU-SOL-THERM-009	3, 3A,
PU-SOL-THERM-011	16-1, 16-5, 18-1, 18-6
PU-SOL-THERM-013	1-22
LEU-COMP-THERM-006	1, 3, 4, 8, 9, 13, 14, 18
LEU-COMP-THERM-007	1-9
LEU-COMP-THERM-010	1, 10, 11, 13, 14, 16, 19, 20
LEU-COMP-THERM-027	1
MIX-COMP-THERM-004	1, 4, 7, 10
MIX-SOL-THERM-003	1-10
MIX-SOL-THERM-003	1-10

3. TRIPOLI-4® VERSION 10 RESULTS ON THE TRIPOLI-4® CRITICALITY VALIDATION SUITE, THERMAL SPECTRA

The cases are usually run with the same target standard deviation of 70 pcm, with a point source as initial guess The standard deviation estimate does not take intercycle correlation into account, the collision estimator is used for the keff. CEA512, The reference nuclear data library of TRIPOLI-4® version 10 is mainly based on the JEFF-3.1.1 European evaluation.

Table 2. TRIPOLI-4® version 10 results on the TRIPOLI-4® Criticality Validation Suite, thermal spectra : ICSBEP benchmark, case, measurement result (keff), measurement standard dev, TRIPOLI-4® version 10 result and standard dev, agreement between code and measure : * less than one combined standard dev, ** between one and two, *** between two and three, KO more than three.

ICSBEP benchmark	Case	Measurement (keff)	Measurement sdv (pcm)	T-4® v10 result	T-4® v10 sdv (pcm)	Agreement
LST-002	1	1.0038	0.0040	1.0002	0.0007	*
LST-003	1	0.9997	0.0039	0.9970	0.0007	*
MST-002	58	1.0000	0.0024	0.9956	0.0010	**
MST-003	1	0.9985	0.0020	1.0096	0.0007	KO
MST-004	65	1.0000	0.0033	0.9950	0.0007	**
To be continued in the full paper						

4. CONCLUSIONS

To be prepared for the final paper, the conclusion will summarize the results and discuss them.

ACKNOWLEDGMENTS

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[3] Reference ICSBEP 1995, to be prepared for the final paper
[4] Reference CRISTAL, to be prepared for the final paper