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Title: Verification of MCNP5-1.60 and MCNP6-Beta-2 for Criticality Safety Applications

Author(s): Brown, Forrest B.
Kiedrowski, Brian C.
Bull, Jeffrey S.

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Report
Web

Verification of MCNP5-1.60 and MCNP6-Beta-2 for Criticality Safety Applications

Forrest Brown, Brian Kiedrowski, Jeffrey Bull
Monte Carlo Codes, XCP-3
Los Alamos National Laboratory

I. Introduction

To verify that both MCNP5-1.60 and MCNP6-Beta-2 are performing correctly for criticality safety applications, several suites of verification/validation benchmark problems were run in early 2012. Results from these benchmark suites were compared with results from previously verified versions of MCNP5. The goals of this verification testing were:

- Verify that MCNP5-1.60 works correctly for nuclear criticality safety applications, producing the same results as for the previous verification performed in 2010.
- Determine the sensitivity to computer roundoff using different Fortran-90 compilers for building MCNP5 and MCNP6, to support moving to current versions of the compilers.
- Verify that MCNP6-Beta-2 works correctly for nuclear criticality safety applications, producing the same results as for MCNP5-1.60. This provides support for eventual migration of users and applications to MCNP6.

The current production version of MCNP5 included in the RSICC release package is MCNP5-1.60 [1-5]. This version was first distributed by RSICC in October 2010. While there were subsequent RSICC distributions of the MCNP package in July 2011 and February 2012, no changes were made to MCNP5-1.60. The RSICC release package in February 2012 included both MCNP5-1.60 and the current beta version of MCNP6, MCNP6-Beta-2.

MCNP6 [6] is the merger of MCNP5 and MCNPX capabilities. The current release of MCNP6 available from RSICC as of February 2012 is MCNP6-Beta-2. This version includes all of the features for criticality safety calculations that are available in MCNP5-1.60, and many new features largely unrelated to nuclear criticality safety calculations. This release is a “beta” release to allow intermediate and advanced users to begin testing the merged code in their field of expertise. It should not be used for production calculations.

The benchmark suites used for the MCNP5 and MCNP6 verification are standard criticality suites in the MCNP code repository:

- **VALIDATION_CRITICALITY** - The “Criticality Validation Suite” [7,8,9] consisting of 31 problems from the *International Handbook of Evaluated Criticality Benchmark Experiments* [10], using the ENDF/B-VII.0 nuclear data libraries,
- **VALIDATION_CRIT_EXPANDED** - The “Expanded Criticality Validation Suite” [11] consisting of 119 problems from the *International Handbook of Evaluated Criticality Benchmark Experiments*, using the ENDF/B-VII.0 nuclear data libraries,

- **CRIT_LANL_SBCS** – A suite of 194 ICSBEP criticality benchmark problems from the LANL SB-CS Group used to verify and validate MCNP for their work, using ENDF/B-VI nuclear data libraries.

An important part of the recent testing was a comparison of results obtained from MCNP5-1.60 and MCNP6-Beta-2 after they were recompiled using different versions of the Intel Fortran-90 compiler. It should be noted that Fortran compilers are complex software programs, and all such programs have bugs. Testing MCNP using different versions of the Fortran-90 compiler helps to verify that both MCNP and the Fortran-90 compilers are performing correctly for criticality safety applications. It is also important to perform the MCNP and Fortran-90 compiler testing on different computer operating systems, e.g., Windows, Linux, and Mac OS X, since codes and compilers sometimes perform differently on different systems.

All of the testing performed recently was done in a parallel mode, using either OpenMP threading with 8-12 cpu-cores or MPI message-passing with 128 MPI processes.

For all systems, we have used the "*-O1*" optimization level. Past testing typically showed only small gains in performance with higher optimization levels, at the expense of tremendous complications in verification due to small roundoff differences. We discourage users from invoking higher optimization levels, unless they are willing to also perform the necessary additional verification of code correctness.

In general, we try to choose options for different Fortran-90 compilers and computer platforms that are as consistent as possible for building MCNP5. Nevertheless, computer roundoff differences will occur with different compilers/hardware. Roundoff differences are not considered errors. Careful examination of these differences is necessary in the verification process to ensure that these differences are due solely to roundoff, and not to errors in coding or compilers.

II. Verification Results for the VALIDATION_CRITICALITY Suite Using Different Fortran Compilers & Computer Platforms

A. MCNP5 - Different Fortran Compilers on Mac OS X

Code:	MCNP5-1.60
Test Suite:	VALIDATION_CRITICALITY
Data:	ENDF/B-VII.0
Computer Platform:	Mac Pro, 2 quad-core Xeon, OS X 10.6.8
Parallel Mode:	threading, with 8 threads
Fortran Compilers:	Intel-10.1.008, 32-bit addressing
	Intel-11.1.088, 32-bit addressing
	Intel-12.0.0, 64-bit addressing
Reference Results:	MCNP5-1.51, using Intel-10.1.008

Table 1 shows the K_{eff} results for 31 benchmark problems for the previous version of MCNP5 (MCNP5-1.51 compiled with Intel-10 Fortran) and MCNP5-1.60 compiled with 3 different versions of the Intel Fortran compiler. To simplify the comparisons, **Table 2** shows the MCNP5-1.51 results and differences that arise for MCNP5-1.60 using the different compilers. Cases that show differences are highlighted in green in both tables. For the 4 cases that show differences, the differences are within statistics and indicate computer roundoff (most likely from reordering

of arithmetic due to compiler optimization), not errors in either MCNP or the Intel compilers. Note that: (1) Using the same Intel-10 compiler, results for MCNP5-1.51 and MCNP5-1.60 match exactly for all 31 cases. (2) Results using the Intel-11 and Intel-12 compilers match exactly for all 31 cases. (3) MCNP5-1.60 compiled with the Intel-12 compiler in 64-bit addressing mode is roughly 20% faster than versions compiled with older compilers.

B. MCNP6 - Different Fortran Compilers on Mac OS X

Code:	MCNP6-Beta-2
Test Suite:	VALIDATION_CRITICALITY
Data:	ENDF/B-VII.0
Computer Platform:	Mac Pro, 2 quad-core Xeon, OS X 10.6.8
Parallel Mode:	threading, with 8 threads
Fortran Compilers:	Intel-10.1.008, 32-bit addressing
	Intel-11.1.088, 32-bit addressing
	Intel-12.0.0, 64-bit addressing
Reference Results:	MCNP5-1.60, using Intel-12.0.0

Table 3 shows the K_{eff} results for 31 benchmark problems for MCNP5-1.60 compiled with Intel-12 Fortran, and MCNP6-Beta-2 compiled with 3 different versions of the Intel Fortran compiler. To simplify the comparisons, **Table 4** shows the MCNP5-1.60 results and differences that arise for MCNP6-Beta-2 using the different compilers. Cases that show differences are highlighted in green in both tables. For the 4 cases that show differences, the differences are within statistics and indicate computer roundoff (most likely from reordering of arithmetic due to compiler optimization), not errors in either MCNP or the Intel compilers. Note that: (1) Using the Intel-11 or Intel-12 compilers, results for MCNP5-1.60 and MCNP6-Beta-2 match exactly for all 31 cases. (2) MCNP6-Beta-2 compiled with the Intel-10 compiler shows roundoff differences for the same 4 cases noted previously, and in fact matches MCNP5-1.60 compiled with Intel-10. (3) MCNP6-Beta-2 compiled with the Intel-12 compiler in 64-bit addressing mode is roughly 20% slower than MCNP5-1.60.

C. MCNP6 - Different Platforms – Windows vs Mac OS X

Code:	MCNP6-Beta-2		
Test Suite:	VALIDATION_CRITICALITY		
Data:	ENDF/B-VII.0		
Computer Platforms:	Mac Pro, 2 quad-core Xeon, OS X 10.6.8		
	Windows PC, 2 hex-core i7, Windows7 OS		
Parallel Mode:	threading, with 8 or 12 threads		
Fortran Compilers:	Mac:	Intel-12.0.0,	64-bit addressing
	Win:	Intel-12.03.175,	32-bit addressing
	Win:	Intel-12.03.175,	64-bit addressing
Reference Results:	MCNP5-1.60, using Intel-12.0.0, 64-bit addressing		

Table 5 shows the K_{eff} differences for 31 benchmark problems for MCNP5-1.60 and MCNP6-Beta-2 on Mac OS X, and MCNP6-Beta-2 on Windows using the Intel-12 Fortran compiler in 32- and 64-bit addressing modes. All results for all cases match exactly. MCNP6-Beta-2 compiled with the Intel-12 compiler in 64-bit addressing mode is roughly 20% slower than MCNP5-1.60.

Table 1. MCNP5 with Different Fortran Compilers – Results, Mac

```
mcnp5_151_70     = mcnp5-1.51   + Intel 10 Fortran90 + endf/b-vii.0
mcnp5_10_70      = mcnp5-1.60   + Intel 10 Fortran90 + endf/b-vii.0
mcnp5_11_70      = mcnp5-1.60   + Intel 11 Fortran90 + endf/b-vii.0
mcnp5_12_70      = mcnp5-1.60   + Intel 12 Fortran90 + endf/b-vii.0

Differences are relative to reference case:    mcnp5_151_70
```

	mcnp5_151_70		**mcnp5_10_70**		**mcnp5_11_70**		**mcnp5_12_70**	
	keff	std	keff	std	keff	std	keff	std
U233 Benchmarks								
JEZ233	0.9989	(5)	0.9989	(5)	0.9989	(5)	0.9989	(5)
FLAT23	0.9990	(7)	0.9990	(7)	0.9990	(7)	0.9990	(7)
UMF5C2	0.9931	(5)	0.9931	(5)	0.9931	(5)	0.9931	(5)
FLSTF1	0.9830	(11)	0.9830	(11)	0.9830	(11)	0.9830	(11)
SB25	1.0053	(10)	1.0053	(10)	1.0053	(10)	1.0053	(10)
ORNL11	1.0018	(4)	1.0018	(4)	1.0018	(4)	1.0018	(4)
HEU Benchmarks								
GODIVA	0.9995	(5)	0.9995	(5)	0.9995	(5)	0.9995	(5)
TT2C11	**1.0018**	**(8)**	**1.0018**	**(8)**	**1.0008**	**(7)**	**1.0008**	**(7)**
FLAT25	1.0034	(7)	1.0034	(7)	1.0034	(7)	1.0034	(7)
GODIVR	0.9990	(7)	0.9990	(7)	0.9990	(7)	0.9990	(7)
UH3C6	0.9950	(8)	0.9950	(8)	0.9950	(8)	0.9950	(8)
ZEUS2	**0.9974**	**(7)**	**0.9974**	**(7)**	**0.9972**	**(7)**	**0.9972**	**(7)**
SB5RN3	0.9985	(13)	0.9985	(13)	0.9985	(13)	0.9985	(13)
ORNL10	0.9993	(4)	0.9993	(4)	0.9993	(4)	0.9993	(4)
IEU Benchmarks								
IMF03	1.0029	(5)	1.0029	(5)	1.0029	(5)	1.0029	(5)
BIGTEN	0.9945	(5)	0.9945	(5)	0.9945	(5)	0.9945	(5)
IMF04	1.0067	(5)	1.0067	(5)	1.0067	(5)	1.0067	(5)
ZEBR8H	**1.0195**	**(5)**	**1.0195**	**(5)**	**1.0196**	**(5)**	**1.0196**	**(5)**
ICT2C3	1.0037	(7)	1.0037	(7)	1.0037	(7)	1.0037	(7)
STACY36	0.9994	(5)	0.9994	(5)	0.9994	(5)	0.9994	(5)
LEU Benchmarks								
BAWXI2	1.0013	(7)	1.0013	(7)	1.0013	(7)	1.0013	(7)
LST2C2	0.9940	(5)	0.9940	(5)	0.9940	(5)	0.9940	(5)
Pu Benchmarks								
JEZPU	1.0002	(5)	1.0002	(5)	1.0002	(5)	1.0002	(5)
JEZ240	1.0002	(5)	1.0002	(5)	1.0002	(5)	1.0002	(5)
PUBTNS	0.9996	(5)	0.9996	(5)	0.9996	(5)	0.9996	(5)
FLATPU	1.0005	(7)	1.0005	(7)	1.0005	(7)	1.0005	(7)
THOR	0.9980	(7)	0.9980	(7)	0.9980	(7)	0.9980	(7)
PUSH2O	1.0012	(7)	1.0012	(7)	1.0012	(7)	1.0012	(7)
HISHPG	**1.0122**	**(5)**	**1.0122**	**(5)**	**1.0118**	**(5)**	**1.0118**	**(5)**
PNL2	1.0046	(9)	1.0046	(9)	1.0046	(9)	1.0046	(9)
PNL33	1.0065	(7)	1.0065	(7)	1.0065	(7)	1.0065	(7)
Wall-clock:	36.4 min		34.7 min		34.0 min		30.5 min	
Threads:	8		8		8		8	
Rel. Speed:	1.00		1.05		1.07		1.19	

Table 2. MCNP5 with Different Fortran Compilers - Diffs, Mac

```
mcnp5_151_70     = mcnp5-1.51    + Intel 10 Fortran90 + endf/b-vii.0
mcnp5_10_70      = mcnp5-1.60    + Intel 10 Fortran90 + endf/b-vii.0
mcnp5_11_70      = mcnp5-1.60    + Intel 11 Fortran90 + endf/b-vii.0
mcnp5_12_70      = mcnp5-1.60    + Intel 12 Fortran90 + endf/b-vii.0
```

Differences are relative to reference case: mcnp5_151_70

	mcnp5_151_70		**mcnp5_10_70**		**mcnp5_11_70**		**mcnp5_12_70**	
	keff	std	deltak	std	deltak	std	deltak	std
U233 Benchmarks								
JEZ233	0.9989	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLAT23	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UMF5C2	0.9931	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLSTF1	0.9830	(11)	0.0000	(15)	0.0000	(15)	0.0000	(15)
SB25	1.0053	(10)	0.0000	(14)	0.0000	(14)	0.0000	(14)
ORNL11	1.0018	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
HEU Benchmarks								
GODIVA	0.9995	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
TT2C11	**1.0018**	**(8)**	**0.0000**	**(11)**	**-0.0010**	**(10)**	**-0.0010**	**(10)**
FLAT25	1.0034	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
GODIVR	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UH3C6	0.9950	(8)	0.0000	(11)	0.0000	(11)	0.0000	(11)
ZEUS2	**0.9974**	**(7)**	**0.0000**	**(9)**	**-0.0002**	**(9)**	**-0.0002**	**(9)**
SB5RN3	0.9985	(13)	0.0000	(18)	0.0000	(18)	0.0000	(18)
ORNL10	0.9993	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
IEU Benchmarks								
IMF03	1.0029	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
BIGTEN	0.9945	(5)	0.0000	(7)	0.0000	(7)	0.0000	(7)
IMF04	1.0067	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
ZEBR8H	**1.0195**	**(5)**	**0.0000**	**(8)**	**0.0001**	**(7)**	**0.0001**	**(7)**
ICT2C3	1.0037	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
STACY36	0.9994	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
LEU Benchmarks								
BAWXI2	1.0013	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
LST2C2	0.9940	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
Pu Benchmarks								
JEZPU	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
JEZ240	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
PUBTNS	0.9996	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLATPU	1.0005	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
THOR	0.9980	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
PUSH2O	1.0012	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
HISHPG	**1.0122**	**(5)**	**0.0000**	**(7)**	**-0.0004**	**(7)**	**-0.0004**	**(7)**
PNL2	1.0046	(9)	0.0000	(12)	0.0000	(12)	0.0000	(12)
PNL33	1.0065	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
Wall-clock:	36.4 min		34.7 min		34.0 min		30.5 min	
Threads:	8		8		8		8	
Rel. Speed:	1.00		1.05		1.07		1.19	

Table 3. MCNP6 with Different Fortran Compilers – Results, Mac

```
mcnp5_12_70     = mcnp5-1.60    + Intel 12 Fortran90 + endf/b-vii.0
mcnp6b2_10_70   = mcnp6-Beta-2 + Intel 10 Fortran90 + endf/b-vii.0
mcnp6b2_11_70   = mcnp6-Beta-2 + Intel 11 Fortran90 + endf/b-vii.0
mcnp6b2_12_70   = mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vii.0
```

Differences are relative to reference case: mcnp5_12_70

	mcnp5_12_70		**mcnp6b2_10_70**		**mcnp6b2_11_70**		**mcnp6b2_12_70**	
	keff	std	keff	std	keff	std	keff	std
U233 Benchmarks								
JEZ233	0.9989	(5)	0.9989	(5)	0.9989	(5)	0.9989	(5)
FLAT23	0.9990	(7)	0.9990	(7)	0.9990	(7)	0.9990	(7)
UMF5C2	0.9931	(5)	0.9931	(5)	0.9931	(5)	0.9931	(5)
FLSTF1	0.9830	(11)	0.9830	(11)	0.9830	(11)	0.9830	(11)
SB25	1.0053	(10)	1.0053	(10)	1.0053	(10)	1.0053	(10)
ORNL11	1.0018	(4)	1.0018	(4)	1.0018	(4)	1.0018	(4)
HEU Benchmarks								
GODIVA	0.9995	(5)	0.9995	(5)	0.9995	(5)	0.9995	(5)
TT2C11	**1.0008**	**(7)**	**1.0018**	**(8)**	**1.0008**	**(7)**	**1.0008**	**(7)**
FLAT25	1.0034	(7)	1.0034	(7)	1.0034	(7)	1.0034	(7)
GODIVR	0.9990	(7)	0.9990	(7)	0.9990	(7)	0.9990	(7)
UH3C6	0.9950	(8)	0.9950	(8)	0.9950	(8)	0.9950	(8)
ZEUS2	**0.9972**	**(7)**	**0.9974**	**(7)**	**0.9972**	**(7)**	**0.9972**	**(7)**
SB5RN3	0.9985	(13)	0.9985	(13)	0.9985	(13)	0.9985	(13)
ORNL10	0.9993	(4)	0.9993	(4)	0.9993	(4)	0.9993	(4)
IEU Benchmarks								
IMF03	1.0029	(5)	1.0029	(5)	1.0029	(5)	1.0029	(5)
BIGTEN	0.9945	(5)	0.9945	(5)	0.9945	(5)	0.9945	(5)
IMF04	1.0067	(5)	1.0067	(5)	1.0067	(5)	1.0067	(5)
ZEBR8H	**1.0196**	**(5)**	**1.0195**	**(5)**	**1.0196**	**(5)**	**1.0196**	**(5)**
ICT2C3	1.0037	(7)	1.0037	(7)	1.0037	(7)	1.0037	(7)
STACY36	0.9994	(5)	0.9994	(5)	0.9994	(5)	0.9994	(5)
LEU Benchmarks								
BAWXI2	1.0013	(7)	1.0013	(7)	1.0013	(7)	1.0013	(7)
LST2C2	0.9940	(5)	0.9940	(5)	0.9940	(5)	0.9940	(5)
Pu Benchmarks								
JEZPU	1.0002	(5)	1.0002	(5)	1.0002	(5)	1.0002	(5)
JEZ240	1.0002	(5)	1.0002	(5)	1.0002	(5)	1.0002	(5)
PUBTNS	0.9996	(5)	0.9996	(5)	0.9996	(5)	0.9996	(5)
FLATPU	1.0005	(7)	1.0005	(7)	1.0005	(7)	1.0005	(7)
THOR	0.9980	(7)	0.9980	(7)	0.9980	(7)	0.9980	(7)
PUSH2O	1.0012	(7)	1.0012	(7)	1.0012	(7)	1.0012	(7)
HISHPG	**1.0118**	**(5)**	**1.0122**	**(5)**	**1.0118**	**(5)**	**1.0118**	**(5)**
PNL2	1.0046	(9)	1.0046	(9)	1.0046	(9)	1.0046	(9)
PNL33	1.0065	(7)	1.0065	(7)	1.0065	(7)	1.0065	(7)
Wall-clock:	30.5 min		41.0 min		40.9 min		38.5 min	
Threads:	8		8		8		8	
Rel. Speed:	1.00		0.75		0.75		0.79	

Table 4. MCNP6 with Different Fortran Compilers – Results, Mac

```
mcnp5_12_70      = mcnp5-1.60    + Intel 12 Fortran90 + endf/b-vii.0
mcnp6b2_10_70    = mcnp6-Beta-2 + Intel 10 Fortran90 + endf/b-vii.0
mcnp6b2_11_70    = mcnp6-Beta-2 + Intel 11 Fortran90 + endf/b-vii.0
mcnp6b2_12_70    = mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vii.0
```

Differences are relative to reference case: mcnp5_12_70

	mcnp5_12_70		**mcnp6b2_10_70**		**mcnp6b2_11_70**		**mcnp6b2_12_70**	
	keff	std	deltak	std	deltak	std	deltak	std
U233 Benchmarks								
JEZ233	0.9989	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLAT23	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UMF5C2	0.9931	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLSTF1	0.9830	(11)	0.0000	(15)	0.0000	(15)	0.0000	(15)
SB25	1.0053	(10)	0.0000	(14)	0.0000	(14)	0.0000	(14)
ORNL11	1.0018	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
HEU Benchmarks								
GODIVA	0.9995	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
TT2C11	**1.0008**	**(7)**	**0.0010**	**(10)**	**0.0000**	**(9)**	**0.0000**	**(9)**
FLAT25	1.0034	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
GODIVR	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UH3C6	0.9950	(8)	0.0000	(11)	0.0000	(11)	0.0000	(11)
ZEUS2	**0.9972**	**(7)**	**0.0002**	**(9)**	**0.0000**	**(9)**	**0.0000**	**(9)**
SB5RN3	0.9985	(13)	0.0000	(18)	0.0000	(18)	0.0000	(18)
ORNL10	0.9993	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
IEU Benchmarks								
IMF03	1.0029	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
BIGTEN	0.9945	(5)	0.0000	(7)	0.0000	(7)	0.0000	(7)
IMF04	1.0067	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
ZEBR8H	**1.0196**	**(5)**	**-0.0001**	**(7)**	**0.0000**	**(7)**	**0.0000**	**(7)**
ICT2C3	1.0037	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
STACY36	0.9994	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
LEU Benchmarks								
BAWXI2	1.0013	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
LST2C2	0.9940	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
Pu Benchmarks								
JEZPU	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
JEZ240	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
PUBTNS	0.9996	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLATPU	1.0005	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
THOR	0.9980	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
PUSH2O	1.0012	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
HISHPG	**1.0118**	**(5)**	**0.0004**	**(7)**	**0.0000**	**(8)**	**0.0000**	**(8)**
PNL2	1.0046	(9)	0.0000	(12)	0.0000	(12)	0.0000	(12)
PNL33	1.0065	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)

	mcnp5_12_70	mcnp6b2_10_70	mcnp6b2_11_70	mcnp6b2_12_70
Wall-clock:	30.5 min	41.0 min	40.9 min	38.5 min
Threads:	8	8	8	8
Rel. Speed:	1.00	0.75	0.75	0.79

Table 5. MCNP6-Beta-2 on Windows - Diffs vs Mac

```
mcnp5_12_70   = Mac:  mcnp5-1.60   + Intel 12 Fortran90 + endf/b-vii.0
mcnp6b2_12_70 = Mac:  mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vii.0
win6b2_32_70  = Win:  mcnp6-Beta-2 + Intel 12 Fortran90 32-bit + endf/b-vii.0
win6b2_64_70  = Win:  mcnp6-Beta-2 + Intel 12 Fortran90 64-bit + endf/b-vii.0
```

Differences are relative to reference case: mcnp5_12_70

	mcnp5_12_70 keff	std	mcnp6b2_12_70 deltak	std	win6b2_32_70 deltak	std	win6b2_64_70 deltak	std
U233 Benchmarks								
JEZ233	0.9989	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLAT23	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UMF5C2	0.9931	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLSTF1	0.9830	(11)	0.0000	(15)	0.0000	(15)	0.0000	(15)
SB25	1.0053	(10)	0.0000	(14)	0.0000	(14)	0.0000	(14)
ORNL11	1.0018	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
HEU Benchmarks								
GODIVA	0.9995	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
TT2C11	1.0008	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
FLAT25	1.0034	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
GODIVR	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UH3C6	0.9950	(8)	0.0000	(11)	0.0000	(11)	0.0000	(11)
ZEUS2	0.9972	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
SB5RN3	0.9985	(13)	0.0000	(18)	0.0000	(18)	0.0000	(18)
ORNL10	0.9993	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
IEU Benchmarks								
IMF03	1.0029	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
BIGTEN	0.9945	(5)	0.0000	(7)	0.0000	(7)	0.0000	(7)
IMF04	1.0067	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
ZEBR8H	1.0196	(5)	0.0000	(7)	0.0000	(7)	0.0000	(7)
ICT2C3	1.0037	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
STACY36	0.9994	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
LEU Benchmarks								
BAWXI2	1.0013	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
LST2C2	0.9940	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
Pu Benchmarks								
JEZPU	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
JEZ240	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
PUBTNS	0.9996	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLATPU	1.0005	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
THOR	0.9980	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
PUSH2O	1.0012	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
HISHPG	1.0118	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
PNL2	1.0046	(9)	0.0000	(12)	0.0000	(12)	0.0000	(12)
PNL33	1.0065	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)

	mcnp5_12_70	mcnp6b2_12_70	win6b2_32_70	win6b2_64_70
Wall-clock:	30.5 min	38.5 min	30.1 min	26.0 min
Threads:	8	8	12	12
Rel. Speed:	1.00	0.79	0.68	0.78

D. MCNP6 - Different Platforms – Mac, Windows, Linux

Code:	MCNP6-Beta-2
Test Suite:	VALIDATION_CRITICALITY
Data:	ENDF/B-VII.0
Computer Platforms:	Mac Pro, 2 quad-core Xeon, OS X 10.6.8 Windows PC, 2 hex-core i7, Windows7 OS Linux, Turing cluster
Parallel Mode:	threading, with 8 or 12 threads
Fortran Compilers:	Mac: Intel-12.0.0, 64-bit addressing Win: Intel-12.03.175, 64-bit addressing Linux: Intel-11.1.072, 64-bit addressing
Reference Results:	Mac: MCNP5-1.60, using Intel-12.0.0, 64-bit addressing

Table 6 shows the K_{eff} differences for 31 benchmark problems for MCNP5-1.60 and MCNP6-Beta-2 on Mac OS X, Windows, and Linux using the Intel-11 or Intel-12 compilers. All results for all cases match exactly. MCNP6-Beta-2 compiled with the Intel-12 compiler in 64-bit addressing mode is roughly 20% slower than MCNP5-1.60.

II. Verification Results for the VALIDATION_CRIT_EXPANDED Suite - Linux

A. MCNP5 & MCNP6 - Linux

Code:	MCNP5-1.60, MCNP6-Beta-2
Test Suite:	VALIDATION_CRIT_EXPANDED
Data:	ENDF/B-VII.0
Computer Platform:	Linux cluster (Turing)
Parallel Mode:	MPI, with 128 MPI processes
Fortran Compilers:	Intel-11.1.072, 64-bit addressing

Tables 7a and 7b show the K_{eff} results from MCNP5-1.60 and the K_{eff} differences for MCNP6-Beta-2 for the 119 problems in the Expanded Criticality Validation Suite. Both sets of calculations were run on a Linux cluster using 128 MPI processes and the same Intel-11 compiler. Three of the 119 cases showed minor roundoff differences between MCNP5 and MCNP6 results. Two of the cases showed roundoff differences less than 1-σ, and the other case showed roundoff of just over 1-σ. These differences are judged to be insignificant, and simply the normal roundoff differences between the two codes that are expected when running very many calculations.

Table 6. MCNP6-Beta-2 on Mac, Windows, Linux – Diffs

```
mcnp5_12_70   = Mac:   mcnp5-1.60   + Intel 12 Fortran90 + endf/b-vii.0
mcnp6b2_12_70 = Mac:   mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vii.0
win6b2_64_70  = Win:   mcnp6-Beta-2 + Intel 12 Fortran90 64-bit + endf/b-vii.0
lin6b2_11_70  = Linux: mcnp6-Beta-2 + Intel 11 Fortran90 64-bit + endf/b-vii.0
```

Differences are relative to reference case: mcnp5_12_70

	mcnp5_12_70		mcnp6b2_12_70		win6b2_64_70		lin6b2_11_70	
	keff	std	deltak	std	deltak	std	deltak	std
U233 Benchmarks								
JEZ233	0.9989	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLAT23	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UMF5C2	0.9931	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLSTF1	0.9830	(11)	0.0000	(15)	0.0000	(15)	0.0000	(15)
SB25	1.0053	(10)	0.0000	(14)	0.0000	(14)	0.0000	(14)
ORNL11	1.0018	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
HEU Benchmarks								
GODIVA	0.9995	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
TT2C11	1.0008	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
FLAT25	1.0034	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
GODIVR	0.9990	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
UH3C6	0.9950	(8)	0.0000	(11)	0.0000	(11)	0.0000	(11)
ZEUS2	0.9972	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
SB5RN3	0.9985	(13)	0.0000	(18)	0.0000	(18)	0.0000	(18)
ORNL10	0.9993	(4)	0.0000	(5)	0.0000	(5)	0.0000	(5)
IEU Benchmarks								
IMF03	1.0029	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
BIGTEN	0.9945	(5)	0.0000	(7)	0.0000	(7)	0.0000	(7)
IMF04	1.0067	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
ZEBR8H	1.0196	(5)	0.0000	(7)	0.0000	(7)	0.0000	(7)
ICT2C3	1.0037	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
STACY36	0.9994	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
LEU Benchmarks								
BAWXI2	1.0013	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
LST2C2	0.9940	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
Pu Benchmarks								
JEZPU	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
JEZ240	1.0002	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
PUBTNS	0.9996	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
FLATPU	1.0005	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
THOR	0.9980	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
PUSH2O	1.0012	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
HISHPG	1.0118	(5)	0.0000	(8)	0.0000	(8)	0.0000	(8)
PNL2	1.0046	(9)	0.0000	(12)	0.0000	(12)	0.0000	(12)
PNL33	1.0065	(7)	0.0000	(9)	0.0000	(9)	0.0000	(9)
Wall-clock:	30.5 min		38.5 min		26.0 min		52.3 min	
Threads:	8		8		12		8	
Rel. Speed:	1.00		0.79		0.78		0.58	

Table 7a. Expanded Criticality Validation Suite - Linux

lin5_11_70 = **mcnp5-1.60** + Intel 11 Fortran90 64-bit + endf/b-vii.0
lin6b2_11_70 = **mcnp6-Beta-2** + Intel 11 Fortran90 64-bit + endf/b-vii.0

	lin5_11_70		lin6b2_11_70	
	keff	std	deltak	std
U233 Benchmarks				
u233-met-fast-001	0.9993	(2)	0.0000	(4)
u233-met-fast-002-case-1	0.9987	(2)	0.0000	(4)
u233-met-fast-002-case-2	1.0005	(2)	0.0000	(4)
u233-met-fast-003-case-1	0.9997	(2)	0.0000	(4)
u233-met-fast-003-case-2	1.0001	(2)	0.0000	(4)
u233-met-fast-006	0.9994	(2)	0.0000	(4)
u233-met-fast-004-case-1	1.0051	(2)	0.0000	(4)
u233-met-fast-004-case-2	1.0051	(2)	0.0000	(4)
u233-met-fast-005-case-1	0.9944	(2)	0.0000	(4)
u233-met-fast-005-case-2	0.9925	(2)	0.0000	(4)
u233-sol-inter-001-case-1	0.9848	(5)	0.0000	(7)
u233-comp-therm-001-case-3	1.0046	(5)	0.0000	(7)
u233-sol-therm-001-case-1	1.0015	(2)	0.0000	(4)
u233-sol-therm-001-case-2	1.0011	(2)	0.0000	(4)
u233-sol-therm-001-case-3	1.0009	(2)	0.0000	(4)
u233-sol-therm-001-case-4	1.0019	(2)	0.0000	(4)
u233-sol-therm-001-case-5	0.9996	(2)	0.0000	(4)
u233-sol-therm-008	1.0014	(2)	0.0000	(2)
HEU Benchmarks				
heu-met-fast-001	0.9993	(2)	0.0000	(4)
heu-met-fast-008	0.9957	(2)	0.0000	(4)
heu-met-fast-018-case-2	0.9999	(2)	0.0000	(4)
heu-met-fast-003-case-1	0.9954	(2)	0.0000	(4)
heu-met-fast-003-case-2	0.9942	(2)	0.0000	(4)
heu-met-fast-003-case-3	0.9994	(2)	0.0000	(4)
heu-met-fast-003-case-4	0.9971	(2)	0.0000	(4)
heu-met-fast-003-case-5	1.0008	(2)	0.0000	(4)
heu-met-fast-003-case-6	1.0017	(2)	0.0000	(4)
heu-met-fast-003-case-7	1.0027	(2)	0.0000	(4)
heu-met-fast-028	1.0032	(2)	0.0000	(4)
heu-met-fast-014	0.9978	(2)	0.0000	(4)
heu-met-fast-003-case-8	1.0081	(2)	0.0000	(4)
heu-met-fast-003-case-9	1.0095	(2)	0.0000	(4)
heu-met-fast-003-case-10	1.0129	(2)	0.0000	(4)
heu-met-fast-003-case-11	1.0166	(2)	0.0000	(4)
heu-met-fast-003-case-12	1.0083	(2)	0.0000	(4)
heu-met-fast-013	0.9975	(2)	0.0000	(4)
heu-met-fast-021-case-2	0.9969	(2)	0.0000	(4)
heu-met-fast-022-case-2	0.9977	(2)	0.0000	(4)
heu-met-fast-012	0.9982	(2)	0.0000	(4)
heu-met-fast-019-case-2	**1.0073**	**(2)**	**0.0001**	**(4)**
heu-met-fast-009-case-2	0.9955	(2)	0.0000	(4)
heu-met-fast-009-case-1	0.9957	(2)	0.0000	(4)
heu-met-fast-011	**0.9989**	**(2)**	**-0.0005**	**(4)***
heu-met-fast-020-case-2	1.0008	(2)	0.0000	(4)
heu-met-fast-004-case-1	1.0028	(2)	0.0000	(4)
heu-met-fast-015	0.9943	(2)	0.0000	(4)
heu-met-fast-026-case-c-11	1.0038	(2)	0.0000	(4)
heu-comp-inter-003-case-6	0.9950	(2)	0.0000	(4)
heu-met-inter-006-case-1	0.9925	(2)	0.0000	(4)
heu-met-inter-006-case-2	0.9971	(2)	0.0000	(4)
heu-met-inter-006-case-3	1.0011	(2)	0.0000	(4)
heu-met-inter-006-case-4	1.0075	(2)	0.0000	(4)
u233-comp-therm-001-case-6	0.9997	(4)	0.0000	(5)
heu-sol-therm-013-case-1	0.9985	(2)	0.0000	(4)
heu-sol-therm-013-case-2	0.9975	(2)	0.0000	(4)
heu-sol-therm-013-case-3	0.9942	(2)	0.0000	(4)
heu-sol-therm-013-case-4	0.9957	(2)	0.0000	(4)
heu-sol-therm-032	0.9991	(2)	0.0000	(2)

Table 7b. Expanded Criticality Validation Suite - Linux

```
lin5_11_70     = mcnp5-1.60   + Intel 11 Fortran90 64-bit + endf/b-vii.0
lin6b2_11_70   = mcnp6-Beta-2 + Intel 11 Fortran90 64-bit + endf/b-vii.0
```

	lin5_11_70		lin6b2_11_70	
	keff	std	deltak	std
IEU Benchmarks				
ieu-met-fast-003-case-2	1.0029	(2)	0.0000	(4)
ieu-met-fast-005-case-2	1.0018	(2)	0.0000	(4)
ieu-met-fast-006-case-2	0.9957	(2)	0.0000	(4)
ieu-met-fast-004-case-2	1.0075	(2)	0.0000	(4)
ieu-met-fast-001-case-1	1.0009	(2)	0.0000	(4)
ieu-met-fast-001-case-2	1.0013	(2)	0.0000	(4)
ieu-met-fast-001-case-3	1.0014	(2)	0.0000	(4)
ieu-met-fast-001-case-4	1.0015	(2)	0.0000	(4)
ieu-met-fast-002	0.9991	(2)	0.0000	(4)
ieu-met-fast-007-case-4	1.0049	(2)	0.0000	(2)
mix-met-fast-008-case-7	1.0193	(2)	0.0000	(2)
ieu-comp-therm-002-case-3	**1.0044**	**(2)**	**-0.0002**	**(4)**
leu-sol-therm-007-case-14	0.9950	(2)	0.0000	(4)
leu-sol-therm-007-case-30	0.9977	(2)	0.0000	(4)
leu-sol-therm-007-case-32	0.9958	(2)	0.0000	(4)
leu-sol-therm-007-case-36	0.9986	(2)	0.0000	(4)
leu-sol-therm-007-case-49	0.9975	(2)	0.0000	(4)
LEU Benchmarks				
leu-comp-therm-008-case-1	1.0012	(2)	0.0000	(4)
leu-comp-therm-008-case-2	1.0013	(2)	0.0000	(4)
leu-comp-therm-008-case-5	1.0006	(2)	0.0000	(4)
leu-comp-therm-008-case-7	1.0003	(2)	0.0000	(4)
leu-comp-therm-008-case-8	1.0007	(2)	0.0000	(4)
leu-comp-therm-008-case-11	1.0020	(2)	0.0000	(4)
leu-sol-therm-002-case-1	1.0000	(2)	0.0000	(4)
leu-sol-therm-002-case-2	0.9959	(2)	0.0000	(4)
Pu Benchmarks				
pu-met-fast-001	1.0000	(2)	0.0000	(4)
pu-met-fast-002	0.9999	(2)	0.0000	(4)
pu-met-fast-022-case-2	0.9983	(2)	0.0000	(4)
mix-met-fast-001	0.9993	(2)	0.0000	(4)
mix-met-fast-003	1.0008	(2)	0.0000	(4)
pu-met-fast-006	0.9995	(2)	0.0000	(4)
pu-met-fast-010	1.0001	(2)	0.0000	(4)
pu-met-fast-020	0.9981	(2)	0.0000	(4)
pu-met-fast-008-case-2	0.9977	(2)	0.0000	(4)
pu-met-fast-005	1.0092	(2)	0.0000	(4)
pu-met-fast-025-case-2	0.9988	(2)	0.0000	(4)
pu-met-fast-026-case-2	0.9985	(2)	0.0000	(4)
pu-met-fast-009	1.0053	(2)	0.0000	(4)
pu-met-fast-023-case-2	0.9993	(2)	0.0000	(4)
pu-met-fast-018	0.9964	(2)	0.0000	(4)
pu-met-fast-019	0.9975	(2)	0.0000	(4)
pu-met-fast-024-case-2	1.0019	(2)	0.0000	(4)
pu-met-fast-011	1.0006	(2)	0.0000	(4)
pu-met-fast-021-case-2	0.9931	(2)	0.0000	(4)
pu-met-fast-021-case-1	1.0021	(2)	0.0000	(4)
pu-met-fast-003-case-103	0.9981	(2)	0.0000	(4)
pu-comp-inter-001	1.0121	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl30	1.0011	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl31	1.0025	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl32	1.0031	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl33	1.0079	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl34	1.0042	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl35	1.0066	(2)	0.0000	(4)
pu-sol-therm-009-case-3a	1.0190	(2)	0.0000	(2)
pu-sol-therm-011-case-16-5	1.0060	(4)	0.0000	(5)
pu-sol-therm-011-case-18-1	0.9943	(4)	0.0000	(5)
pu-sol-therm-011-case-18-6	0.9996	(4)	0.0000	(5)
pu-sol-therm-021-case-1	1.0043	(4)	0.0000	(5)
pu-sol-therm-021-case-3	1.0044	(5)	0.0000	(7)
pu-sol-therm-018-case-9	1.0031	(2)	0.0000	(4)
pu-sol-therm-034-case-1	0.9999	(4)	0.0000	(5)

III. Verification Results for the LANL SBCS Criticality Validation Suite

A. MCNP5 & MCNP6 - Mac

Code:	MCNP5-1.60, MCNP6-Beta-2
Test Suite:	CRIT_LANL_SBCS
Data:	ENDF/B-VI
Computer Platform:	Mac Pro, 2 quad-core Xeon, OS X 10.6.8
Parallel Mode:	threading, with 8 threads
Fortran Compilers:	Intel-12.0.0, 64-bit addressing
Reference Results:	MCNP5-1.25, Intel-9, ~2003, SBCS Group

Tables 8a – 8d show the K_{eff} results from 194 ICSBEP problems in the LANL SBCS Group criticality validation suite, using ENDF/B-VI cross-sections and a very old version of MCNP5, MCNP5-1.25 from 2003 compiled with the Intel-9 Fortran-90 compiler. The tables also show the K_{eff} differences (relative to the SBCS results) for MCNP5-1.60 and MCNP6-Beta-2 compiled with the Intel-12 compiler.

The old MCNP5 results differ from the MCNP5-1.60 and MCNP6-Beta-2 results for 54 cases, with 43 of those cases within statistics and 11 with differences between 1-σ and 2-σ. Those 54 cases are highlighted in green in Tables 8a-8d. The other 140 cases all matched within the precision shown. This agreement is excellent, considering that nearly 10 years of MCNP5 development and bug-fixes, and 3 generations of Fortran-90 compilers, separate the old MCNP5 results from the new ones. All of the 194 cases show differences of less than 2-σ. (It should also be noted that 3 of the 11 problems showing differences from old results actually had problem input errors that were corrected for the MCNP5-1.60 and MCNP6-Beta-2 calculations.)

Comparing MCNP5-1.60 and MCNP6-Beta-2 results for the 194 cases (i.e., inspecting Tables 8a-8d for differences in the differences), 188 cases match, 3 show differences less than 1-σ, and 3 show differences between 1-σ and 2-σ. These differences are judged to be insignificant, and simply the normal roundoff differences between the two codes that are expected when running very many calculations.

Additional testing was performed using the Intel-10.1 Fortran-90 compiler for MCNP5-1.60 and MCNP6-Beta-2. The results are not shown in a table, but results from both codes matched exactly for 192 of the 194 cases, and differed within statistics for the other 2 cases.

Table 8a. LANL SBCS Validation Suite - Mac

```
sbcs_endf6      = SB-CS Group  + old mcnp5          + endf/b-vi
mcnp5_12_6      = mcnp5-1.60   + Intel 12 Fortran90 + endf/b-vi
mcnp6b2_12_6    = mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vi
```

Differences are relative to reference case: sbcs_endf6
*'s indicate differences > 1, 2, or 3 std

	sbcs_endf6 keff	std	mcnp5_12_6 deltak	std	mcnp6b2_12_6 deltak	std
HEU-comp-therm Benchmarks						
heu-comp-therm-002-001	**1.0082**	**(9)**	**0.0013**	**(13)***	**0.0006**	**(14)**
heu-comp-therm-002-002	1.0132	(8)	-0.0000	(11)	-0.0000	(11)
heu-comp-therm-002-003	1.0142	(9)	-0.0000	(12)	-0.0000	(12)
heu-comp-therm-002-004	1.0154	(7)	0.0000	(11)	0.0000	(11)
heu-comp-therm-002-005	1.0143	(8)	0.0000	(12)	0.0000	(12)
heu-comp-therm-002-006	1.0155	(7)	-0.0000	(11)	-0.0000	(11)
heu-comp-therm-002-007	1.0158	(7)	-0.0000	(11)	-0.0000	(11)
heu-comp-therm-002-008	1.0138	(7)	0.0000	(9)	0.0000	(9)
heu-comp-therm-002-009	1.0155	(7)	-0.0000	(10)	-0.0000	(10)
heu-comp-therm-002-010	1.0111	(7)	-0.0000	(10)	-0.0000	(10)
heu-comp-therm-002-011	**1.0123**	**(9)**	**0.0000**	**(13)**	**-0.0005**	**(13)**
heu-comp-therm-002-012	1.0111	(8)	-0.0000	(11)	-0.0000	(11)
heu-comp-therm-002-013	1.0148	(8)	0.0000	(12)	0.0000	(12)
heu-comp-therm-002-014	1.0156	(7)	0.0000	(11)	0.0000	(11)
heu-comp-therm-002-015	**1.0171**	**(7)**	**-0.0001**	**(11)**	**-0.0001**	**(11)**
heu-comp-therm-002-016	1.0148	(7)	-0.0000	(11)	-0.0000	(11)
heu-comp-therm-002-017	1.0201	(6)	0.0000	(9)	0.0000	(9)
heu-comp-therm-002-018	1.0136	(9)	-0.0000	(12)	-0.0000	(12)
heu-comp-therm-002-019	1.0115	(8)	0.0000	(12)	0.0000	(12)
heu-comp-therm-002-020	1.0130	(8)	0.0000	(11)	0.0000	(11)
heu-comp-therm-002-021	1.0141	(7)	-0.0000	(11)	-0.0000	(11)
heu-comp-therm-002-022	1.0134	(7)	0.0000	(10)	0.0000	(10)
heu-comp-therm-002-023	**1.0128**	**(8)**	**0.0005**	**(12)**	**0.0006**	**(12)**
heu-comp-therm-002-024	**1.0131**	**(8)**	**-0.0001**	**(11)**	**-0.0010**	**(11)**
heu-comp-therm-002-025	**1.0113**	**(8)**	**-0.0006**	**(12)**	**-0.0006**	**(12)**
HEU-met-fast Benchmarks						
heu-met-fast-001-001	**0.9952**	**(6)**	**0.0015**	**(9)***	**0.0015**	**(9)***
heu-met-fast-002-001	**1.0002**	**(7)**	**-0.0002**	**(9)**	**-0.0002**	**(9)**
heu-met-fast-002-002	**1.0014**	**(6)**	**-0.0005**	**(9)**	**-0.0005**	**(9)**
heu-met-fast-002-003	**0.9984**	**(6)**	**0.0012**	**(9)***	**0.0012**	**(9)***
heu-met-fast-002-004	**0.9980**	**(6)**	**0.0010**	**(8)***	**0.0010**	**(8)***
heu-met-fast-002-005	**1.0006**	**(7)**	**-0.0010**	**(9)***	**-0.0010**	**(9)***
heu-met-fast-002-006	**1.0010**	**(6)**	**-0.0001**	**(9)**	**-0.0001**	**(9)**
heu-met-fast-003-001	**0.9925**	**(6)**	**-0.0004**	**(8)**	**-0.0004**	**(8)**
heu-met-fast-003-002	**0.9895**	**(5)**	**0.0007**	**(7)**	**0.0007**	**(7)**
heu-met-fast-003-003	**0.9974**	**(6)**	**-0.0005**	**(8)**	**-0.0005**	**(8)**
heu-met-fast-003-004	**0.9952**	**(6)**	**0.0009**	**(9)**	**0.0009**	**(9)**
heu-met-fast-003-005	**0.9999**	**(6)**	**-0.0007**	**(8)**	**-0.0007**	**(8)**
heu-met-fast-003-006	**1.0002**	**(7)**	**-0.0002**	**(9)**	**-0.0002**	**(9)**
heu-met-fast-003-007	**1.0009**	**(6)**	**-0.0002**	**(9)**	**-0.0002**	**(9)**
heu-met-fast-003-008	1.0040	(6)	-0.0000	(9)	-0.0000	(9)
heu-met-fast-003-009	**1.0044**	**(5)**	**0.0008**	**(9)**	**0.0008**	**(9)**
heu-met-fast-003-010	**1.0089**	**(6)**	**-0.0009**	**(8)**	**-0.0009**	**(8)**
heu-met-fast-003-011	**1.0135**	**(6)**	**-0.0011**	**(8)***	**-0.0011**	**(8)***
heu-met-fast-003-012	**1.0053**	**(5)**	**-0.0004**	**(8)**	**-0.0004**	**(8)**
heu-met-fast-004-001	**0.9886**	**(7)**	**0.0002**	**(10)**	**0.0002**	**(10)**

Table 8b. LANL SBCS Validation Suite - Mac

```
sbcs_endf6      = SB-CS Group   + old mcnp5          + endf/b-vi
mcnp5_12_6      = mcnp5-1.60    + Intel 12 Fortran90 + endf/b-vi
mcnp6b2_12_6    = mcnp6-Beta-2  + Intel 12 Fortran90 + endf/b-vi

Differences are relative to reference case:    sbcs_endf6
*'s indicate differences > 1, 2, or 3 std
```

	sbcs_endf6		mcnp5_12_6		mcnp6b2_12_6		
	keff	std	deltak	std	deltak	std	
heu-met-fast-007-001	0.9895	(6)	0.0000	(8)	0.0000	(8)	
heu-met-fast-007-002	0.9955	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-007-003	0.9970	(7)	0.0000	(9)	0.0000	(9)	
heu-met-fast-007-004	0.9954	(6)	-0.0000	(8)	-0.0000	(8)	
heu-met-fast-007-005	0.9957	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-007-006	1.0019	(7)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-007	0.9967	(7)	0.0000	(9)	0.0000	(9)	
heu-met-fast-007-008	0.9962	(7)	0.0000	(9)	0.0000	(9)	
heu-met-fast-007-009	0.9978	(7)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-007-010	0.9961	(8)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-011	0.9954	(8)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-012	0.9899	(7)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-013	0.9968	(8)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-014	0.9934	(8)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-015	0.9931	(7)	0.0000	(10)	0.0000	(10)	
heu-met-fast-007-016	0.9935	(8)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-017	0.9937	(8)	-0.0000	(12)	-0.0000	(12)	
heu-met-fast-007-018	0.9966	(9)	0.0000	(12)	0.0000	(12)	
heu-met-fast-007-019	0.9923	(6)	-0.0000	(8)	-0.0000	(8)	
heu-met-fast-007-020	0.9938	(7)	0.0000	(10)	0.0000	(10)	
heu-met-fast-007-021	0.9937	(7)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-022	0.9950	(7)	0.0000	(10)	0.0000	(10)	
heu-met-fast-007-023	0.9955	(7)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-024	0.9965	(8)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-025	0.9941	(8)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-026	0.9952	(7)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-027	0.9939	(7)	0.0000	(9)	0.0000	(9)	
heu-met-fast-007-028	0.9947	(6)	0.0000	(8)	0.0000	(8)	
heu-met-fast-007-029	0.9941	(7)	0.0000	(10)	0.0000	(10)	
heu-met-fast-007-030	0.9932	(8)	0.0000	(12)	0.0000	(12)	
heu-met-fast-007-031	0.9963	(8)	0.0000	(11)	0.0000	(11)	
heu-met-fast-007-032	1.0016	(6)	0.0000	(9)	0.0000	(9)	
heu-met-fast-007-033	1.0124	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-007-034	1.0169	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-007-035	**0.9920**	**(8)**	**-0.0000**	**(12)**	**-0.0014**	**(11)**	*****
heu-met-fast-007-036	1.0001	(8)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-037	0.9993	(7)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-038	0.9979	(8)	-0.0000	(12)	-0.0000	(12)	
heu-met-fast-007-039	**1.0038**	**(7)**	**-0.0000**	**(10)**	**-0.0013**	**(10)**	*****
heu-met-fast-007-040	1.0023	(8)	0.0000	(12)	0.0000	(12)	
heu-met-fast-007-041	0.9977	(8)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-042	1.0002	(7)	-0.0000	(11)	-0.0000	(11)	
heu-met-fast-007-043	0.9985	(8)	-0.0000	(12)	-0.0000	(12)	
heu-met-fast-008-001	0.9930	(5)	0.0000	(7)	0.0000	(7)	
heu-met-fast-017-001	0.9989	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-019-001	1.0022	(6)	0.0000	(8)	0.0000	(8)	
heu-met-fast-028-001	**1.0016**	**(6)**	**-0.0003**	**(9)**	**-0.0003**	**(9)**	
heu-met-fast-030-001	**1.0046**	**(7)**	**-0.0001**	**(9)**	**-0.0001**	**(9)**	
heu-met-fast-041-001	1.0052	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-041-002	1.0036	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-041-003	0.9983	(6)	0.0000	(8)	0.0000	(8)	
heu-met-fast-041-004	1.0028	(6)	0.0000	(9)	0.0000	(9)	
heu-met-fast-041-005	0.9997	(6)	-0.0000	(9)	-0.0000	(9)	
heu-met-fast-041-006	1.0010	(6)	0.0000	(9)	0.0000	(9)	
heu-met-fast-067-001	1.0113	(6)	-0.0000	(8)	-0.0000	(8)	
heu-met-fast-067-002	**1.0075**	**(6)**	**0.0003**	**(8)**	**0.0003**	**(8)**	

Table 8c. LANL SBCS Validation Suite - Mac

```
sbcs_endf6      = SB-CS Group  + old mcnp5          + endf/b-vi
mcnp5_12_6      = mcnp5-1.60   + Intel 12 Fortran90 + endf/b-vi
mcnp6b2_12_6    = mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vi

Differences are relative to reference case:    sbcs_endf6
*'s indicate differences > 1, 2, or 3 std
```

	sbcs_endf6		mcnp5_12_6		mcnp6b2_12_6	
	keff	std	deltak	std	deltak	std
HEU-sol-therm Benchmarks						
heu-sol-therm-001-001	**0.9987**	**(10)**	**-0.0003**	**(15)**	**-0.0003**	**(15)**
heu-sol-therm-001-002	0.9952	(11)	-0.0000	(15)	-0.0000	(15)
heu-sol-therm-001-003	1.0015	(10)	0.0000	(14)	0.0000	(14)
heu-sol-therm-001-004	0.9986	(10)	-0.0000	(14)	-0.0000	(14)
heu-sol-therm-001-005	1.0020	(8)	0.0000	(11)	0.0000	(11)
heu-sol-therm-001-006	1.0028	(9)	0.0000	(12)	0.0000	(12)
heu-sol-therm-001-007	1.0003	(10)	-0.0000	(14)	-0.0000	(14)
heu-sol-therm-001-008	1.0010	(10)	0.0000	(14)	0.0000	(14)
heu-sol-therm-001-009	0.9950	(11)	-0.0000	(15)	-0.0000	(15)
heu-sol-therm-001-010	0.9935	(9)	0.0000	(12)	0.0000	(12)
mix-met-fast Benchmarks						
mix-met-fast-001-001	**0.9966**	**(6)**	**-0.0005**	**(8)**	**-0.0005**	**(8)**
mix-met-fast-002-001	1.0040	(6)	0.0000	(8)	0.0000	(8)
mix-met-fast-002-002	1.0060	(7)	0.0000	(10)	0.0000	(10)
mix-met-fast-002-003	1.0041	(6)	0.0000	(9)	0.0000	(9)
pu-met-fast Benchmarks						
pu-met-fast-001-001	0.9976	(5)	0.0000	(8)	0.0000	(8)
pu-met-fast-002-001	0.9992	(5)	-0.0000	(8)	-0.0000	(8)
pu-met-fast-005-001	**1.0065**	**(7)**	**0.0008**	**(9)**	**0.0008**	**(9)**
pu-met-fast-006-001	**1.0019**	**(7)**	**0.0005**	**(9)**	**0.0005**	**(9)**
pu-met-fast-008-001	**1.0060**	**(6)**	**0.0005**	**(8)**	**0.0005**	**(8)**
pu-met-fast-009-001	**1.0027**	**(6)**	**-0.0010**	**(8)***	**-0.0010**	**(8)***
pu-met-fast-010-001	**0.9997**	**(6)**	**-0.0002**	**(8)**	**-0.0002**	**(8)**
pu-met-fast-011-001	**0.9958**	**(7)**	**-0.0002**	**(10)**	**-0.0002**	**(10)**
pu-met-fast-012-001	**1.0044**	**(7)**	**0.0006**	**(10)**	**0.0006**	**(10)**
pu-met-fast-013-001	**1.0064**	**(6)**	**-0.0005**	**(9)**	**-0.0005**	**(9)**
pu-met-fast-014-001	**1.0044**	**(6)**	**0.0003**	**(8)**	**0.0003**	**(8)**
pu-met-fast-015-001	**0.9990**	**(6)**	**0.0009**	**(9)**	**0.0009**	**(9)**
pu-met-fast-018-001	**0.9986**	**(13)**	**0.0017**	**(14)***	**0.0017**	**(14)***
pu-met-fast-019-001	1.0015	(6)	0.0000	(8)	0.0000	(8)
pu-met-fast-020-001	0.9969	(6)	-0.0000	(9)	-0.0000	(9)
pu-met-fast-021-001	**1.0030**	**(7)**	**0.0005**	**(9)**	**0.0005**	**(9)**
pu-met-fast-021-002	**0.9914**	**(6)**	**-0.0007**	**(8)**	**-0.0007**	**(8)**
pu-met-fast-023-001	0.9976	(5)	0.0000	(8)	0.0000	(8)
pu-met-fast-024-001	1.0002	(6)	-0.0000	(8)	-0.0000	(8)
pu-met-fast-025-001	0.9961	(6)	0.0000	(9)	0.0000	(9)
pu-met-fast-026-001	0.9962	(6)	-0.0000	(8)	-0.0000	(8)
pu-met-fast-027-001	1.0012	(8)	-0.0000	(11)	-0.0000	(11)
pu-met-fast-028-001	0.9971	(6)	0.0000	(9)	0.0000	(9)
pu-met-fast-029-001	0.9939	(5)	0.0000	(8)	0.0000	(8)
pu-met-fast-030-001	1.0011	(6)	-0.0000	(8)	-0.0000	(8)
pu-met-fast-031-001	1.0013	(7)	-0.0000	(10)	-0.0000	(10)
pu-met-fast-032-001	0.9962	(6)	-0.0000	(8)	-0.0000	(8)
pu-met-fast-035-001	1.0074	(6)	0.0000	(8)	0.0000	(8)
pu-met-fast-045-001	**0.9983**	**(6)**	**-0.0004**	**(9)**	**-0.0004**	**(9)**
pu-met-fast-045-002	**1.0021**	**(6)**	**0.0009**	**(9)**	**0.0009**	**(9)**
pu-met-fast-045-003	**1.0017**	**(6)**	**0.0002**	**(8)**	**0.0002**	**(8)**
pu-met-fast-045-004	**1.0000**	**(6)**	**0.0007**	**(9)**	**0.0007**	**(9)**
pu-met-fast-045-005	**1.0065**	**(6)**	**-0.0007**	**(8)**	**-0.0007**	**(8)**
pu-met-fast-045-006	**1.0011**	**(7)**	**0.0009**	**(9)**	**0.0009**	**(9)**
pu-met-fast-045-007	**1.0023**	**(6)**	**-0.0004**	**(8)**	**-0.0004**	**(8)**

Table 8d. LANL SBCS Validation Suite - Mac

```
sbcs_endf6       = SB-CS Group  + old mcnp5          + endf/b-vi
mcnp5_12_6       = mcnp5-1.60   + Intel 12 Fortran90 + endf/b-vi
mcnp6b2_12_6     = mcnp6-Beta-2 + Intel 12 Fortran90 + endf/b-vi

Differences are relative to reference case:    sbcs_endf6
*'s indicate differences > 1, 2, or 3 std
```

	sbcs_endf6		mcnp5_12_6		mcnp6b2_12_6	
	keff	std	deltak	std	deltak	std
pu-sol-therm Benchmarks						
pu-sol-therm-001-001	1.0041	(9)	-0.0000	(14)	-0.0000	(14)
pu-sol-therm-001-002	1.0059	(9)	-0.0000	(12)	-0.0000	(12)
pu-sol-therm-001-003	1.0069	(9)	0.0000	(14)	0.0000	(14)
pu-sol-therm-001-004	1.0010	(9)	0.0000	(12)	0.0000	(12)
pu-sol-therm-001-005	1.0045	(9)	0.0000	(12)	0.0000	(12)
pu-sol-therm-001-006	1.0067	(9)	0.0000	(12)	0.0000	(12)
pu-sol-therm-002-001	1.0024	(8)	0.0000	(11)	0.0000	(11)
pu-sol-therm-002-002	1.0025	(8)	-0.0000	(12)	-0.0000	(12)
pu-sol-therm-002-003	1.0017	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-002-004	1.0030	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-002-005	1.0073	(9)	0.0000	(12)	0.0000	(12)
pu-sol-therm-002-006	1.0051	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-002-007	1.0056	(8)	0.0000	(12)	0.0000	(12)
pu-sol-therm-003-001	1.0021	(7)	0.0000	(11)	0.0000	(11)
pu-sol-therm-003-002	1.0017	(8)	0.0000	(12)	0.0000	(12)
pu-sol-therm-003-003	1.0055	(8)	-0.0000	(12)	-0.0000	(12)
pu-sol-therm-003-004	1.0022	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-003-005	1.0042	(8)	-0.0000	(12)	-0.0000	(12)
pu-sol-therm-003-006	1.0042	(7)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-004-001	1.0042	(7)	0.0000	(11)	0.0000	(11)
pu-sol-therm-004-002	0.9990	(7)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-004-003	**1.0009**	**(8)**	**0.0012**	**(11)***	**0.0012**	**(11)***
pu-sol-therm-004-004	0.9992	(7)	0.0000	(11)	0.0000	(11)
pu-sol-therm-004-005	0.9992	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-004-006	**1.0009**	**(8)**	**0.0002**	**(11)**	**0.0002**	**(11)**
pu-sol-therm-004-007	1.0063	(7)	-0.0000	(9)	-0.0000	(9)
pu-sol-therm-004-008	1.0002	(7)	0.0000	(10)	0.0000	(10)
pu-sol-therm-004-009	0.9992	(8)	0.0000	(11)	0.0000	(11)
pu-sol-therm-004-010	1.0012	(8)	0.0000	(12)	0.0000	(12)
pu-sol-therm-004-011	1.0000	(7)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-004-012	1.0007	(8)	0.0000	(11)	0.0000	(11)
pu-sol-therm-004-013	1.0001	(7)	0.0000	(10)	0.0000	(10)
pu-sol-therm-005-001	1.0011	(7)	0.0000	(11)	0.0000	(11)
pu-sol-therm-005-002	1.0020	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-005-003	1.0020	(8)	0.0000	(11)	0.0000	(11)
pu-sol-therm-005-004	1.0064	(7)	-0.0000	(10)	-0.0000	(10)
pu-sol-therm-005-005	1.0044	(7)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-005-006	1.0050	(8)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-005-007	1.0020	(8)	0.0000	(11)	0.0000	(11)
pu-sol-therm-005-008	0.9992	(8)	-0.0000	(12)	-0.0000	(12)
pu-sol-therm-005-009	1.0020	(7)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-006-001	0.9997	(7)	-0.0000	(10)	-0.0000	(10)
pu-sol-therm-006-002	1.0016	(7)	-0.0000	(11)	-0.0000	(11)
pu-sol-therm-006-003	1.0016	(7)	-0.0000	(10)	-0.0000	(10)
Wall-clock:			125.0 min		176.4 min	
Threads:	?		1		1	
Rel. Speed:			1.00		0.71	

Table 9. Summary of Verification Results

VALIDATION_CRITICALITY Suite – 31 ICSBEP Cases, ENDF/B-VII.0 Data

- MCNP5-1.51, MCNP5-1.60, MCNP6-Beta-2
  - Intel-10.1 Fortran-90 compiler for all 3: All results match exactly
- MCNP5-1.60, MCNP6-Beta-2
  - Intel 10.1 F90 for both: All results match exactly
  - Intel 11.1 F90 for both: All results match exactly
  - Intel 12.0 F90 for both: All results match exactly
  - Intel 11.1 vs 12.0 F90 for both: All results match exactly
  - Intel 10.1 vs 11.1/12.0 F90 for both:
    - For 27 problems, results match exactly
    - For 4 problems, results differ due to roundoff, match within statistics
  - Using Intel 11 or 12, there are no differences in results for Mac OS X, Windows, and Linux systems

VALIDATION_CRIT_EXPANDED Suite – 119 ICSBEP Cases, ENDF/B-VII.0 Data

- MCNP5-1.60 vs MCNP6-Beta-2, with Intel-12.0 F90
  - For 116 problems, results match exactly
  - For 3 problems, results differ due to roundoff, match within statistics

CRIT_LANL_SBCS Suite – 194 ICSBEP Cases, ENDF/B-VI data

- MCNP5-1.60 vs MCNP6-Beta-2, with Intel-10.1 F90
  - For 192 problems, results match exactly
  - For 2 problems, results differ due to roundoff, match within statistics
- MCNP5-1.60 (2010, Intel-12) vs MCNP5-1.25 (~2003, Intel-9)
  - For 140 problems, results match
  - For 54 problems, results differ due to roundoff, match within statistics

IV. Summary and Conclusions

Table 9 provides a summary of the verification results for the recent testing of MCNP5-1.60 and MCNP6-Beta-2 for criticality safety applications. The general conclusions from this testing are:

- Both MCNP5-1.60 and MCNP6-Beta-2 perform correctly for criticality safety applications.
- While small differences were noted for a few cases, these are strictly due to computer roundoff and are not a concern for verification/validation.
- MCNP5-1.60 and MCNP6-Beta-2 yield the same results on different computer platforms – Mac OS X, Linux, and Windows – for criticality safety applications.
- MCNP5-1.60 and MCNP6-Beta-2 yield the same results using OpenMP threading and/or MPI message-passing parallelism.
- Using the Intel-12 compiler and 64-bit addressing produces roughly a 20% speedup in the MCNP executables compared to using older compilers.

- MCNP6-Beta-2 runs roughly 20% slower than MCNP5-1.60.

As a result of this testing, it is recommended that all future development for MCNP be accomplished using the latest Fortran-90 compiler, Intel-12, rather than older versions of the compiler. Using the Intel-12 Fortran-90 compiler with 64-bit addressing permits the solution of very large problems that could not be run with older compilers and 32-bit addressing (where array sizes were limited to less than 2 GB), and also provides a speedup of roughly 20% in code execution.

Criticality safety analysts should consider testing MCNP6-Beta-2 on their particular problems and validation suites, to prepare for the eventual migration from MCNP5 to MCNP6. It is expected that this migration should be accomplished within the next 1-2 years. Currently, no further development of MCNP5 is planned, and all future MCNP improvements will be targeted to MCNP6.

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