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Verification of MCNP6.1 and MCNP6.1.1 for Criticality Safety Applications

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I. Introduction

MCNP6.1 is the new production version of MCNP [1] released in June 2013. An updated beta version, MCNP6.1.1, is targeted for release in summer 2014 to enable the use of several new features for homeland security and nonproliferation applications. The beta version does not include new capabilities for the criticality safety community, but does run significantly faster than the production version. From 2003 – 2013, the production version was MCNP5, with MCNP5-1.60 the final release in 2010.

To verify that both MCNP6.1 and MCNP6.1.1 are performing correctly for criticality safety applications, several suites of verification/validation benchmark problems were run in early 2014. Results from these benchmark suites were compared with results from the 2013 verification of MCNP6.1 [2]. The goals of this verification testing were:

- Verify that MCNP6.1 and MCNP6.1.1 work correctly for nuclear criticality safety applications, producing the same results as for the previous verification performed in 2013.
- Verify MCNP6.1 and MCNP6.1.1 are as reliable and accurate as MCNP5-1.60 for criticality safety applications. That is, users can safely switch from MCNP5 to MCNP6.
- Document a number of changes incorporated into MCNP6.1.1 that improve the code performance for criticality safety applications.
- Document the results from 1076 criticality benchmark problems taken from the ICSBEP Handbook [3]. This collection of problems was developed as part of an upgrade to the criticality safety analysis capabilities at LANL.

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

- **VERIFICATION_KEFF** – A suite of 75 criticality problems for which exact analytical results are available [4]. A representative set of 10 problems was chosen from this suite. While the problems use 1-group or few-group energy treatments and simple 1-D geometry, they verify that MCNP reproduces the exact analytical results. That is, they serve to verify the fundamental power iteration scheme used in MCNP that underlies all criticality calculations.
- **VALIDATION_CRITICALITY** - The "Criticality Validation Suite" [5] consisting of 31 problems from the ICSBEP Handbook, using the ENDF/B-VI.6, ENDF/B-VII.0, and ENDF/B-VII.1 nuclear data libraries,

- **VALIDATION_CRIT_EXPANDED** - The "Expanded Criticality Validation Suite" [6] consisting of 119 problems from the ICSBEP Handbook using the ENDF/B-VII.0 and ENDF/B-VII.1 nuclear data libraries,

All of the testing performed recently was done in a parallel mode, using OpenMP threading with 8-16 cpu-cores. The Intel 12 Fortran-90 compiler was used.

II. Verification Results - VERIFICATION_KEFF Problems

Codes:	MCNP6.1, MCNP6.1.1
Test Suite:	VERIFICATION_KEFF
Data:	1-group cross-sections
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:	Exact analytical results

Table 1 shows the K_{eff} results for 10 benchmark problems from the VERIFICATION_KEFF suite run using MCNP6.1 and MCNP6.1.1. The versions of MCNP6 gave identical results. The results shown in Table 1 are also identical to the results from 2013 given in [2]. The results agree with the exact analytic results for K_{eff}, with no significant differences. MCNP6.1.1 provides a 74% speedup over MCNP6.1.

Table 1. MCNP6.1 and MCNP6.1.1 Results for Analytic Keff Benchmarks

Case	Name	Analytic keff	mcnp_Results keff	std
prob11	Ua-1-0-IN	2.25000	2.25000	0.00000
prob14	Ua-1-0-SP	1.00000	1.00006	0.00010
prob18	Uc-H2O(2)-1-0-SP	1.00000	1.00005	0.00011
prob23	UD2O-1-0-CY	1.00000	1.00000	0.00006
prob32	PUa-1-1-SL	1.00000	0.99995	0.00011
prob41	UD2Ob-1-1-SP	1.00000	1.00003	0.00007
prob44	PU-2-0-IN	2.68377	2.68377	0.00003
prob54	URRa-2-0-SL	1.00000	1.00007	0.00013
prob63	URRd-H2Ob(1)-2-0-ISLC	1.00000	0.99993	0.00006
prob75	URR-6-0-IN	1.60000	1.59999	0.00001

Results are identical for mcnp6.1 and mcnp6.1.1.

Wall-clock time, using 8 threads on Mac Pro:

mcnp6.1	151 min
mcnp6.1.1	87 min

III. Verification Results for the VALIDATION_CRITICALITY Suite

Codes:	MCNP5-1.60, MCNP6.1, MCNP6.1.1
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-12.0.0, 64-bit addressing
Reference Results:	MCNP5-1.60, using Intel-12.0.0

Table 2 shows the K_{eff} results for 31 benchmark problems run with MCNP5-1.60, MCNP6.1, and MCNP6.1.1. To simplify the comparisons, Table 2 shows the MCNP6.1 results and differences that arise for MCNP5-1.60 and MCNP6.1.1. The results for all 3 codes match for all 31 problems in the suite.

MCNP6.1 compiled with the Intel-12 compiler in 64-bit addressing mode is roughly 30% slower than MCNP5-1.60. MCNP6.1.1 is about 10% faster than MCNP5-1.60 and about 50% faster than MCNP6.1.

(It should be noted that MCNP5-1.60 executables built with the Intel-10 and Intel-12 Fortran compilers give identical results for most problems, but sometimes exhibit roundoff differences due to the different Fortran compilers. That issue was fully examined in [2] and is not addressed in the current work. All comparisons in this work use only the Intel-12 Fortran compiler for both MCNP 5 and MCNP6.)

Table 2. MCNP5, MCNP6.1, & MCNP6.1.1 for VALIDATION_CRITICALITY Suite

mcnp5-1.60 - Intel 12 Fortran90 + endf/b-vii.0
mcnp6.1 - Intel 12 Fortran90 + endf/b-vii.0
mcnp6.1.1 - Intel 12 Fortran90 + endf/b-vii.0

Differences are relative to reference case: mcnp6.1
*'s indicate differences > 1, 2, or 3 std

	mcnp5-1.60 deltak std	mcnp6.1 keff std	mcnp6.1.1 deltak std
U233 Benchmarks			
JEZ233	0.0000 (8)	0.9989 (5)	0.0000 (8)
FLAT23	0.0000 (9)	0.9990 (7)	0.0000 (9)
UMF5C2	0.0000 (8)	0.9931 (5)	0.0000 (8)
FLSTF1	0.0000 (15)	0.9830 (11)	0.0000 (15)
SB25	0.0000 (14)	1.0053 (10)	0.0000 (14)
ORNL11	0.0000 (5)	1.0018 (4)	0.0000 (5)
HEU Benchmarks			
GODIVA	0.0000 (8)	0.9995 (5)	0.0000 (8)
TT2C11	0.0000 (9)	1.0008 (7)	0.0000 (9)
FLAT25	0.0000 (9)	1.0034 (7)	0.0000 (9)
GODIVR	0.0000 (9)	0.9990 (7)	0.0000 (9)
UH3C6	0.0000 (11)	0.9950 (8)	0.0000 (11)
ZEUS2	0.0000 (9)	0.9972 (7)	0.0000 (9)
SB5RN3	0.0000 (18)	0.9985 (13)	0.0000 (18)
ORNL10	0.0000 (5)	0.9993 (4)	0.0000 (5)
IEU Benchmarks			
IMF03	0.0000 (8)	1.0029 (5)	0.0000 (8)
BIGTEN	0.0000 (7)	0.9945 (5)	0.0000 (7)
IMF04	0.0000 (8)	1.0067 (5)	0.0000 (8)
ZEBR8H	0.0000 (7)	1.0196 (5)	0.0000 (7)
ICT2C3	0.0000 (9)	1.0037 (7)	0.0000 (9)
STACY36	0.0000 (8)	0.9994 (5)	0.0000 (8)
LEU Benchmarks			
BAWXI2	0.0000 (9)	1.0013 (7)	0.0000 (9)
LST2C2	0.0000 (8)	0.9940 (5)	0.0000 (8)
Pu Benchmarks			
JEZPU	0.0000 (8)	1.0002 (5)	0.0000 (8)
JEZ240	0.0000 (8)	1.0002 (5)	0.0000 (8)
PUBTNS	0.0000 (8)	0.9996 (5)	0.0000 (8)
FLATPU	0.0000 (9)	1.0005 (7)	0.0000 (9)
THOR	0.0000 (9)	0.9980 (7)	0.0000 (9)
PUSH2O	0.0000 (9)	1.0012 (7)	0.0000 (9)
HISHPG	0.0000 (8)	1.0118 (5)	0.0000 (8)
PNL2	0.0000 (12)	1.0046 (9)	0.0000 (12)
PNL33	0.0000 (9)	1.0065 (7)	0.0000 (9)
Wall-time (sec)	1807	2617	1698
Relative Speed:	1.0	0.7	1.1

IV. Verification Results for the VALIDATION_CRIT_EXPANDED Suite

A. MCNP5, MCNP6.1, MCNP6.1.1 – Shortened Problems

Code:	MCNP5-1.60, MCNP6.1, MCNP6.1.1
Test Suite:	VALIDATION_CRIT_EXPANDED, SHORT Version
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-12.0.0, 64-bit addressing
Reference Results:	MCNP6.1, using Intel-12.0.0

This testing involved shortened versions of the 119 problems in the Expanded Criticality Validation Suite (using "**`kcode 1000 1.0 10 50`**", rather than "**`kcode 10000 1.0 100 600`**"). The purpose was simply to look for any apparent differences in shortened problems, since the shorter problems are not as sensitive to computer roundoff as longer, standard runs. Any absolute results should be discounted, since the problems were just run mechanically without regard to proper convergence.

For this shortened set of problems, all 3 codes yielded the same results for all 119 cases.

B. MCNP5, MCNP6.1, MCNP6.1.1 – Standard Problems

Code:	MCNP5-1.60, MCNP6.1, MCNP6.1.1-Beta
Test Suite:	VALIDATION_CRIT_EXPANDED
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-12.0.0, 64-bit addressing
Reference Results:	MCNP6.1, using Intel-12.0.0

Tables 3a and 3b show the K_{eff} results from MCNP6.1 and the K_{eff} differences for MCNP5-1.60 and MCNP6.1.1 for the 119 problems in the Expanded Criticality Validation Suite (run in the standard way; not shortened). Three of the 119 cases showed minor roundoff differences between MCNP5 and MCNP6.1 results - 2 with differences less than 1σ, and 1 with a difference just over 1σ. One of the 119 cases showed minor roundoff differences between MCNP6.1 and MCNP6.1.1, with the difference less than 1σ. 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.

Running times were:

Code	Seconds	Relative Speed
MCNP5-1.60	24175	1.00
MCNP6.1	35599	0.68
MCNP6.1.1	21056	1.15

Thus, MCNP6.1 was about 30% slower than MCNP5. MCNP6.1.1 was about 70% faster than MCNP6.1 and 15% faster than MCNP5.

Table 3a. Expanded Criticality Validation Suite

mcnp5 = mcnp5-1.60 + Intel 12 + endf/b-vii.0
mcnp6.1 = mcnp6.1 + Intel 12 + endf/b-vii.0
mcnp6.1.1 = mcnp6.1.1 + Intel 12 + endf/b-vii.0
Differences are relative to reference case: mcnp6.1

	mcnp5		mcnp6.1		mcnp6.1.1	
	deltak	std	keff	std	deltak	std
U233 Benchmarks						
u233-met-fast-001	0.0000	(4)	0.9993	(2)	0.0000	(4)
u233-met-fast-002-case-1	0.0000	(4)	0.9987	(2)	0.0000	(4)
u233-met-fast-002-case-2	0.0000	(4)	1.0005	(2)	0.0000	(4)
u233-met-fast-003-case-1	0.0000	(4)	0.9997	(2)	0.0000	(4)
u233-met-fast-003-case-2	0.0000	(4)	1.0001	(2)	0.0000	(4)
u233-met-fast-006	0.0000	(4)	0.9994	(2)	0.0000	(4)
u233-met-fast-004-case-1	0.0000	(4)	1.0051	(2)	0.0000	(4)
u233-met-fast-004-case-2	0.0000	(4)	1.0051	(2)	0.0000	(4)
u233-met-fast-005-case-1	0.0000	(4)	0.9944	(2)	0.0000	(4)
u233-met-fast-005-case-2	0.0000	(4)	0.9925	(2)	0.0000	(4)
u233-sol-inter-001-case-1	0.0000	(7)	0.9848	(5)	0.0000	(7)
u233-comp-therm-001-case-3	0.0000	(7)	1.0046	(5)	0.0000	(7)
u233-sol-therm-001-case-1	0.0000	(4)	1.0015	(2)	0.0000	(4)
u233-sol-therm-001-case-2	0.0000	(4)	1.0011	(2)	0.0000	(4)
u233-sol-therm-001-case-3	0.0000	(4)	1.0009	(2)	0.0000	(4)
u233-sol-therm-001-case-4	0.0000	(4)	1.0019	(2)	0.0000	(4)
u233-sol-therm-001-case-5	0.0000	(4)	0.9996	(2)	0.0000	(4)
u233-sol-therm-008	0.0000	(2)	1.0014	(2)	0.0000	(2)
HEU Benchmarks						
heu-met-fast-001	0.0000	(4)	0.9993	(2)	0.0000	(4)
heu-met-fast-008	0.0000	(4)	0.9957	(2)	0.0000	(4)
heu-met-fast-018-case-2	0.0000	(4)	0.9999	(2)	0.0000	(4)
heu-met-fast-003-case-1	0.0000	(4)	0.9954	(2)	0.0000	(4)
heu-met-fast-003-case-2	0.0000	(4)	0.9942	(2)	0.0000	(4)
heu-met-fast-003-case-3	0.0000	(4)	0.9994	(2)	0.0000	(4)
heu-met-fast-003-case-4	0.0000	(4)	0.9971	(2)	0.0000	(4)
heu-met-fast-003-case-5	0.0000	(4)	1.0008	(2)	0.0000	(4)
heu-met-fast-003-case-6	0.0000	(4)	1.0017	(2)	0.0000	(4)
heu-met-fast-003-case-7	0.0000	(4)	1.0027	(2)	0.0000	(4)
heu-met-fast-028	0.0000	(4)	1.0032	(2)	0.0000	(4)
heu-met-fast-014	0.0000	(4)	0.9978	(2)	0.0000	(4)
heu-met-fast-003-case-8	0.0000	(4)	1.0081	(2)	0.0000	(4)
heu-met-fast-003-case-9	0.0000	(4)	1.0095	(2)	0.0000	(4)
heu-met-fast-003-case-10	0.0000	(4)	1.0129	(2)	0.0000	(4)
heu-met-fast-003-case-11	0.0000	(4)	1.0166	(2)	0.0000	(4)
heu-met-fast-003-case-12	0.0000	(4)	1.0083	(2)	0.0000	(4)
heu-met-fast-013	0.0000	(4)	0.9975	(2)	0.0000	(4)
heu-met-fast-021-case-2	0.0000	(4)	0.9969	(2)	0.0000	(4)
heu-met-fast-022-case-2	0.0000	(4)	0.9977	(2)	0.0000	(4)
heu-met-fast-012	0.0000	(4)	0.9982	(2)	0.0000	(4)
heu-met-fast-019-case-2	-0.0001	(4)	1.0074	(2)	0.0000	(4)
heu-met-fast-009-case-2	0.0000	(4)	0.9955	(2)	0.0000	(4)
heu-met-fast-009-case-1	0.0000	(4)	0.9957	(2)	0.0000	(4)
heu-met-fast-011	0.0005	(4)*	0.9984	(2)	0.0000	(4)
heu-met-fast-020-case-2	0.0000	(4)	1.0008	(2)	0.0000	(4)
heu-met-fast-004-case-1	0.0000	(4)	1.0028	(2)	0.0000	(4)
heu-met-fast-015	0.0000	(4)	0.9943	(2)	0.0000	(4)
heu-met-fast-026-case-c-11	0.0000	(4)	1.0038	(2)	0.0000	(4)
heu-comp-inter-003-case-6	0.0000	(4)	0.9950	(2)	0.0000	(4)
heu-met-inter-006-case-1	0.0000	(4)	0.9925	(2)	0.0000	(4)
heu-met-inter-006-case-2	0.0000	(4)	0.9971	(2)	0.0000	(4)
heu-met-inter-006-case-3	0.0000	(4)	1.0011	(2)	0.0000	(4)
heu-met-inter-006-case-4	0.0000	(4)	1.0075	(2)	0.0000	(4)
u233-comp-therm-001-case-6	0.0000	(5)	0.9997	(4)	0.0002	(5)
heu-sol-therm-013-case-1	0.0000	(4)	0.9985	(2)	0.0000	(4)
heu-sol-therm-013-case-2	0.0000	(4)	0.9975	(2)	0.0000	(4)
heu-sol-therm-013-case-3	0.0000	(4)	0.9942	(2)	0.0000	(4)
heu-sol-therm-013-case-4	0.0000	(4)	0.9957	(2)	0.0000	(4)
heu-sol-therm-032	0.0000	(2)	0.9991	(2)	0.0000	(2)

Table 3b. Expanded Criticality Validation Suite

mcnp5 = mcnp5-1.60 + Intel 12 + endf/b-vii.0
mcnp6.1 = mcnp6.1 + Intel 12 + endf/b-vii.0
mcnp6.1.1 = mcnp6.1.1 + Intel 12 + endf/b-vii.0
Differences are relative to reference case: mcnp6.1

	mcnp5		mcnp6.1		mcnp6.1.1	
	deltak	std	keff	std	deltak	std
IEU Benchmarks						
ieu-met-fast-003-case-2	0.0000	(4)	1.0029	(2)	0.0000	(4)
ieu-met-fast-005-case-2	0.0000	(4)	1.0018	(2)	0.0000	(4)
ieu-met-fast-006-case-2	0.0000	(4)	0.9957	(2)	0.0000	(4)
ieu-met-fast-004-case-2	0.0000	(4)	1.0075	(2)	0.0000	(4)
ieu-met-fast-001-case-1	0.0000	(4)	1.0009	(2)	0.0000	(4)
ieu-met-fast-001-case-2	0.0000	(4)	1.0013	(2)	0.0000	(4)
ieu-met-fast-001-case-3	0.0000	(4)	1.0014	(2)	0.0000	(4)
ieu-met-fast-001-case-4	0.0000	(4)	1.0015	(2)	0.0000	(4)
ieu-met-fast-002	0.0000	(4)	0.9991	(2)	0.0000	(4)
ieu-met-fast-007-case-4	0.0000	(2)	1.0049	(2)	0.0000	(2)
mix-met-fast-008-case-7	0.0000	(2)	1.0191	(2)	0.0000	(2)
ieu-comp-therm-002-case-3	0.0002	(4)	1.0042	(2)	0.0000	(4)
leu-sol-therm-007-case-14	0.0000	(4)	0.9950	(2)	0.0000	(4)
leu-sol-therm-007-case-30	0.0000	(4)	0.9977	(2)	0.0000	(4)
leu-sol-therm-007-case-32	0.0000	(4)	0.9958	(2)	0.0000	(4)
leu-sol-therm-007-case-36	0.0000	(4)	0.9986	(2)	0.0000	(4)
leu-sol-therm-007-case-49	0.0000	(4)	0.9975	(2)	0.0000	(4)
LEU Benchmarks						
leu-comp-therm-008-case-1	0.0000	(4)	1.0012	(2)	0.0000	(4)
leu-comp-therm-008-case-2	0.0000	(4)	1.0013	(2)	0.0000	(4)
leu-comp-therm-008-case-5	0.0000	(4)	1.0006	(2)	0.0000	(4)
leu-comp-therm-008-case-7	0.0000	(4)	1.0003	(2)	0.0000	(4)
leu-comp-therm-008-case-8	0.0000	(4)	1.0007	(2)	0.0000	(4)
leu-comp-therm-008-case-11	0.0000	(4)	1.0020	(2)	0.0000	(4)
leu-sol-therm-002-case-1	0.0000	(4)	1.0000	(2)	0.0000	(4)
leu-sol-therm-002-case-2	0.0000	(4)	0.9959	(2)	0.0000	(4)
Pu Benchmarks						
pu-met-fast-001	0.0000	(4)	1.0000	(2)	0.0000	(4)
pu-met-fast-002	0.0000	(4)	0.9999	(2)	0.0000	(4)
pu-met-fast-022-case-2	0.0000	(4)	0.9983	(2)	0.0000	(4)
mix-met-fast-001	0.0000	(4)	0.9993	(2)	0.0000	(4)
mix-met-fast-003	0.0000	(4)	1.0008	(2)	0.0000	(4)
pu-met-fast-006	0.0000	(4)	0.9995	(2)	0.0000	(4)
pu-met-fast-010	0.0000	(4)	1.0001	(2)	0.0000	(4)
pu-met-fast-020	0.0000	(4)	0.9981	(2)	0.0000	(4)
pu-met-fast-008-case-2	0.0000	(4)	0.9977	(2)	0.0000	(4)
pu-met-fast-005	0.0000	(4)	1.0092	(2)	0.0000	(4)
pu-met-fast-025-case-2	0.0000	(4)	0.9988	(2)	0.0000	(4)
pu-met-fast-026-case-2	0.0000	(4)	0.9985	(2)	0.0000	(4)
pu-met-fast-009	0.0000	(4)	1.0053	(2)	0.0000	(4)
pu-met-fast-023-case-2	0.0000	(4)	0.9993	(2)	0.0000	(4)
pu-met-fast-018	0.0000	(4)	0.9964	(2)	0.0000	(4)
pu-met-fast-019	0.0000	(4)	0.9975	(2)	0.0000	(4)
pu-met-fast-024-case-2	0.0000	(4)	1.0019	(2)	0.0000	(4)
pu-met-fast-011	0.0000	(4)	1.0006	(2)	0.0000	(4)
pu-met-fast-021-case-2	0.0000	(4)	0.9931	(2)	0.0000	(4)
pu-met-fast-021-case-1	0.0000	(4)	1.0021	(2)	0.0000	(4)
pu-met-fast-003-case-103	0.0000	(4)	0.9981	(2)	0.0000	(4)
pu-comp-inter-001	0.0000	(4)	1.0121	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl30	0.0000	(4)	1.0011	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl31	0.0000	(4)	1.0025	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl32	0.0000	(4)	1.0031	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl33	0.0000	(4)	1.0079	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl34	0.0000	(4)	1.0042	(2)	0.0000	(4)
mix-comp-therm-002-case-pnl35	0.0000	(4)	1.0066	(2)	0.0000	(4)
pu-sol-therm-009-case-3a	0.0000	(2)	1.0190	(2)	0.0000	(2)
pu-sol-therm-011-case-16-5	0.0000	(5)	1.0060	(4)	0.0000	(5)
pu-sol-therm-011-case-18-1	0.0000	(5)	0.9943	(4)	0.0000	(5)
pu-sol-therm-011-case-18-6	0.0000	(5)	0.9996	(4)	0.0000	(5)
pu-sol-therm-021-case-1	0.0000	(5)	1.0043	(4)	0.0000	(5)
pu-sol-therm-021-case-3	0.0000	(7)	1.0044	(5)	0.0000	(7)
pu-sol-therm-018-case-9	0.0000	(4)	1.0031	(2)	0.0000	(4)
pu-sol-therm-034-case-1	0.0000	(5)	0.9999	(4)	0.0000	(5)

V. Performance Improvements Included in MCNP6.1.1

During the multiyear effort to merge MCNP5 and MCNPX into the MCNP6 code, the principal focus was on code correctness for the combined sets of capabilities. The size of the source code grew from 100k lines of coding to over 500k lines; very many additional if-tests and conditionals were added to accommodate the expanded set of code options; a larger group of code developers with varying styles, experience, and coding expertise were focused on merging 2 complex Monte Carlo codes. While those efforts were successful in that MCNP6 was released and preserves the capabilities of the parent codes, little effort was applied to the efficiency and performance (i.e., speed) of MCNP6. The general engineering approach of "first make it right, then make it faster" was adopted.

During 2013, it was evident that MCNP6 was slower than MCNP5, typically by 20-30%, but sometimes by factors of 2-4x. Assessment of the code and comparison to previous and other Monte Carlo codes led to a proposal for improving the performance and structure of MCNP6. That proposal and work effort are called "MCNP 2020" [7], with the stated goals of: (1) improve performance, with a 2x speedup within 2 years, (2) upgrade the core MCNP6 software, including code cleanup and reorganizing the data structures, and (3) prepare for future computers, with improved parallel coding and algorithms.

The initial focus of MCNP 2020 is to improve MCNP6 performance. After a few months of work, a number of performance improvement changes were incorporated into MCNP6.1.1. These changes included:

- Eliminate strided Fortran-90 vector operations.
- Inline the binary searches used for neutron cross-section routines.
- Use IF-statement guards, to avoid calling accessor functions.
- Inline selected coding in some heavily used portions of the transport coding.
- Make use of thread-private common blocks, instead of declaring individual variables as thread-private.
- Eliminate unnecessary clearing of certain scratch arrays.
- Implement a new hash-based algorithm for the lookup of energy in the cross-section data arrays.
- Some focused improvement of coding logic and structure.
- Experimentation with different levels of Fortran compiler optimization confirmed past experience: Higher compiler optimization levels yielded only small gains in performance (e.g., 0-5%) and lead to code errors for some problems. This confirmed that there was no quick fix.

Most of the initial performance improvements were targeted toward neutron problems, particularly criticality problems. Testing on a variety of problems demonstrated that the performance improvements were effective, yielding speedups by factors of 1.2x – 4x compared to MCNP6.1, depending on the type of problem and portions of MCNP6 that were exercised. Additionally, MCNP6.1.1 is faster than MCNP5-1.60 for many problems by factors of up to 1.8x. For some other problems, MCNP6.1.1 is still about 20% slower than MCNP5-1.60.

For the problems in this report, MCNP6.1.1 runs 50-70% faster than MCNP6.1 and even about 10-15% faster than MCNP5-1.60. While there is much more work planned for improving MCNP6 performance, the initial efforts have been very successful.

VI. Validation Suite Development

To support an ongoing upgrade to the analytical and computational capabilities of the LANL Nuclear Criticality Safety Division (NCS), we have compiled a collection of over 1,000 criticality benchmark problems based on the ICSBEP Handbook specifications. Most of these problems had been previously used at LANL for related, but different, purposes: by the T-2 group for testing new and proposed revisions to the ENDF/B nuclear datasets; by the XCP-5 Nuclear Data Team for testing the ACE files prepared for MCNP; by the XCP-3 MCNP Team for MCNP verification; and by the previous NCS group for criticality safety validation and USL determination. The combined collection of problems is being consolidated, and will form a very extensive set of standard problems shared among the different LANL groups.

Appendix A provides the current list of benchmark problems, along with the experimental and MCNP6.1-calculated values of K_{eff}. The problems and results in Appendix A are preliminary, and may change as the benchmark suite is expanded, quality-checked, etc.

VII. Summary and Conclusions

Table 4 provides a summary of the verification results for the recent testing of MCNP6.1 and MCNP6.1.1 for criticality safety applications. The general conclusions from this testing are:

- Both MCNP6.1 and MCNP6.1.1 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.
- MCNP6.1 runs roughly 20-30% slower than MCNP5-1.60.
- MCNP6.1.1 runs at least 50-70% faster than MCNP6.1 and 10-15% faster than MCNP5-1.60.

Criticality safety analysts should consider testing MCNP6.1 or MCNP6.1.1 on their particular problems and validation suites, to prepare for the migration from MCNP5 to MCNP6. It is expected that this migration should be accomplished within the next 1-3 years. Currently, no further development of MCNP5 is planned; all future MCNP improvements, bug fixes, and new capabilities are targeted only to MCNP6.

Table 4. Summary of Verification Results

VERIFICATION_KEFF Suite – 10 analytical problems with exact K_{eff} results

mcnp6.1, mcnp6.1.1	**All results match**

VALIDATION_CRITICALITY Suite – 31 ICSBEP Cases

mcnp5-1.60, mcnp6.1, mcnp6.1.1	**All results match**

VALIDATION_CRIT_EXPANDED Suite – 119 ICSBEP Cases

Shortened Problems	
mcnp5-1.60, mcnp6.1, mcnp6.1.1	**All results match**
Standard Problems	
mcnp5-1.60 & mcnp6.1	**3 diffs (2: < 1σ, 1: < 2σ)**
mcnp6.1 & mcnp6.1.1	**1 diff (< 1σ)**

All cases: Intel 12.0 Fortran compiler, Mac OS X 10.6.8, Mac Pro, 8 threads, ENDF/B-VII.0 nuclear data,

References

1. MCNP documentation, including release notes & verification reports – available for all versions on the MCNP website, mcnp.lanl.gov.
2. F.B. Brown, B.C. Kiedrowski, J.S. Bull, "Verification of MCNP5-1.60 and MCNP6.1 for Criticality Safety Applications", LA-UR-13-22196 (2013).
3. International Handbook of Evaluated Criticality Safety Benchmark Experiments, NEA/NSC/DOC(95)03, OECD Nuclear Energy Agency (2007).
4. Sood, R.A. Forster, D.K. Parsons, "Analytic Benchmark Test Set for Criticality Code Verification", LA-13511 and LA-UR-01-3082 (2001).
5. Russell D. Mosteller, "Validation Suites for MCNP," Proceedings of the American Nuclear Society Radiation Protection and Shielding Division 12th Biennial Topical Meeting, Santa Fe, New Mexico (April 2002), LA-UR-02-0878 (2012).
6. R.D. Mosteller, "An Expanded Criticality Validation Suite for MCNP", LA-UR-10-06230 Rev3 (2010).
7. F.B. Brown, B.C. Kiedrowski, J.S. Bull, L.J. Cox, “MCNP 2020 – Preparing LANL Monte Carlo for Exascale Computer Systems”, white paper for internal LANL planning (July, 2013).

Appendix A: MCNP6.1 Results for LANL-NCS Validation Suite (Preliminary)

```
Code:       mcnp6.1
Data:       ENDF/B-VII.1
Computer:   Linux cluster

number of cases = 1076

number of diffs < 1 sigma =  542,  50.4 %
number of diffs < 2 sigma =  278,  25.8 %
number of diffs < 3 sigma =  133,  12.4 %
number of diffs > 3 sigma =  123,  11.4 %

Flags:
   *   = results agree within 2 sigma
   **  = results agree within 3 sigma
   *** = results differ by  > 3 sigma
 ----- = no Experimental uncertainty available
```

Problem Name	Experiment	Calculation	Flags
heu-comp-inter-003-006	1.0000 0.0047	0.9956 0.0001	
heu-comp-therm-002-001	1.0011 0.0069	1.0115 0.0001	*
heu-comp-therm-002-002	1.0011 0.0069	1.0138 0.0001	*
heu-comp-therm-002-003	1.0011 0.0069	1.0167 0.0001	**
heu-comp-therm-002-004	1.0011 0.0069	1.0160 0.0001	**
heu-comp-therm-002-005	1.0011 0.0069	1.0170 0.0001	**
heu-comp-therm-002-006	1.0011 0.0069	1.0172 0.0001	**
heu-comp-therm-002-007	1.0011 0.0069	1.0174 0.0001	**
heu-comp-therm-002-008	1.0011 0.0069	1.0175 0.0001	**
heu-comp-therm-002-009	1.0011 0.0069	1.0188 0.0001	**
heu-comp-therm-002-010	1.0011 0.0069	1.0156 0.0001	**
heu-comp-therm-002-011	1.0011 0.0053	1.0145 0.0001	**
heu-comp-therm-002-012	1.0011 0.0055	1.0137 0.0001	**
heu-comp-therm-002-013	1.0011 0.0055	1.0179 0.0001	**
heu-comp-therm-002-014	1.0011 0.0055	1.0177 0.0001	**
heu-comp-therm-002-015	1.0011 0.0055	1.0192 0.0001	***
heu-comp-therm-002-016	1.0011 0.0053	1.0188 0.0001	***
heu-comp-therm-002-017	1.0011 0.0053	1.0234 0.0001	***
heu-comp-therm-002-018	1.0020 0.0043	1.0157 0.0001	***
heu-comp-therm-002-019	1.0020 0.0043	1.0129 0.0001	**
heu-comp-therm-002-020	1.0020 0.0043	1.0155 0.0001	***
heu-comp-therm-002-021	1.0020 0.0043	1.0168 0.0001	***
heu-comp-therm-002-022	1.0020 0.0043	1.0172 0.0001	***
heu-comp-therm-002-023	1.0008 0.0085	1.0144 0.0001	*
heu-comp-therm-002-024	1.0008 0.0085	1.0150 0.0001	*
heu-comp-therm-002-025	1.0008 0.0085	1.0136 0.0001	*
heu-met-fast-001-001	1.0000 0.0010	1.0000 0.0001	
heu-met-fast-002-001	1.0000 0.0030	1.0015 0.0001	
heu-met-fast-002-002	1.0000 0.0030	1.0019 0.0001	
heu-met-fast-002-003	1.0000 0.0030	1.0004 0.0001	
heu-met-fast-002-004	1.0000 0.0030	0.9995 0.0001	
heu-met-fast-002-005	1.0000 0.0030	1.0000 0.0001	
heu-met-fast-002-006	1.0000 0.0030	1.0013 0.0001	
heu-met-fast-003-001	1.0000 0.0050	0.9949 0.0001	
heu-met-fast-003-002	1.0000 0.0050	0.9943 0.0001	*
heu-met-fast-003-003	1.0000 0.0050	0.9992 0.0001	
heu-met-fast-003-004	1.0000 0.0030	0.9972 0.0001	
heu-met-fast-003-005	1.0000 0.0030	1.0016 0.0001	

heu-met-fast-003-006	1.0000	0.0030	1.0015	0.0001	
heu-met-fast-003-007	1.0000	0.0030	1.0020	0.0001	
heu-met-fast-003-008	1.0000	0.0050	1.0022	0.0001	
heu-met-fast-003-009	1.0000	0.0050	1.0027	0.0001	
heu-met-fast-003-010	1.0000	0.0050	1.0049	0.0001	
heu-met-fast-003-011	1.0000	0.0050	1.0088	0.0001	*
heu-met-fast-003-012	1.0000	0.0030	1.0086	0.0001	**
heu-met-fast-004-001	0.9985	------	0.9941	0.0001	
heu-met-fast-005-001	1.0000	0.0036	0.9951	0.0001	*
heu-met-fast-005-002	1.0007	0.0036	0.9980	0.0001	
heu-met-fast-005-003	0.9996	0.0036	1.0005	0.0001	
heu-met-fast-005-004	0.9989	0.0036	0.9944	0.0001	*
heu-met-fast-005-005	0.9980	0.0036	0.9991	0.0001	
heu-met-fast-005-006	0.9987	0.0036	0.9979	0.0001	
heu-met-fast-007-001	0.9950	0.0024	0.9925	0.0001	*
heu-met-fast-007-002	0.9964	0.0014	0.9983	0.0001	*
heu-met-fast-007-003	0.9990	0.0013	0.9998	0.0001	
heu-met-fast-007-004	0.9948	0.0013	0.9977	0.0001	**
heu-met-fast-007-005	0.9978	0.0018	0.9997	0.0001	*
heu-met-fast-007-006	1.0006	0.0013	1.0056	0.0001	***
heu-met-fast-007-007	0.9974	0.0014	1.0012	0.0001	**
heu-met-fast-007-008	0.9973	0.0013	0.9992	0.0001	*
heu-met-fast-007-009	0.9995	0.0056	1.0021	0.0001	
heu-met-fast-007-010	0.9981	0.0012	0.9990	0.0001	
heu-met-fast-007-011	0.9958	0.0013	0.9972	0.0001	*
heu-met-fast-007-012	0.9932	0.0012	0.9928	0.0001	
heu-met-fast-007-013	0.9990	0.0012	1.0009	0.0001	*
heu-met-fast-007-014	0.9964	0.0012	0.9970	0.0001	
heu-met-fast-007-015	0.9959	0.0012	0.9967	0.0001	
heu-met-fast-007-016	0.9969	0.0012	0.9972	0.0001	
heu-met-fast-007-017	0.9953	0.0012	0.9958	0.0001	
heu-met-fast-007-018	0.9972	0.0012	0.9982	0.0001	
heu-met-fast-007-019	0.9956	0.0015	0.9961	0.0001	
heu-met-fast-007-020	0.9950	0.0017	0.9978	0.0001	*
heu-met-fast-007-021	0.9956	0.0018	0.9984	0.0001	*
heu-met-fast-007-022	0.9963	0.0019	0.9993	0.0001	*
heu-met-fast-007-023	0.9962	0.0017	0.9990	0.0001	*
heu-met-fast-007-024	0.9970	0.0018	0.9995	0.0001	*
heu-met-fast-007-025	0.9959	0.0018	0.9981	0.0001	*
heu-met-fast-007-026	0.9966	0.0017	0.9984	0.0001	
heu-met-fast-007-027	0.9948	0.0014	0.9967	0.0001	*
heu-met-fast-007-028	0.9970	0.0023	0.9980	0.0001	
heu-met-fast-007-029	0.9961	0.0014	0.9987	0.0001	*
heu-met-fast-007-030	0.9964	0.0021	0.9973	0.0001	
heu-met-fast-007-031	0.9996	0.0022	1.0011	0.0001	
heu-met-fast-007-032	0.9941	0.0012	1.0045	0.0001	***
heu-met-fast-007-033	0.9977	0.0019	1.0139	0.0001	***
heu-met-fast-007-034	0.9959	0.0017	1.0173	0.0001	***
heu-met-fast-007-035	1.0003	0.0018	0.9949	0.0001	**
heu-met-fast-007-036	0.9999	0.0007	1.0035	0.0001	***
heu-met-fast-007-037	0.9988	0.0008	1.0018	0.0001	***
heu-met-fast-007-038	1.0000	0.0008	1.0027	0.0001	**
heu-met-fast-007-039	1.0018	0.0014	1.0064	0.0001	***
heu-met-fast-007-040	1.0013	0.0008	1.0060	0.0001	***
heu-met-fast-007-041	0.9994	0.0009	1.0009	0.0001	*
heu-met-fast-007-042	1.0016	0.0009	1.0029	0.0001	*
heu-met-fast-007-043	0.9998	0.0008	1.0004	0.0001	
heu-met-fast-008-001	0.9989	0.0016	0.9958	0.0001	*
heu-met-fast-009-001	0.9992	0.0015	0.9976	0.0001	
heu-met-fast-009-002	0.9992	0.0015	0.9965	0.0001	*
heu-met-fast-010-001	0.9992	0.0015	0.9983	0.0001	
heu-met-fast-010-002	0.9992	0.0015	0.9979	0.0001	
heu-met-fast-011-001	0.9989	0.0015	0.9989	0.0001	
heu-met-fast-012-001	0.9992	0.0018	0.9982	0.0001	
heu-met-fast-013-001	0.9990	0.0015	0.9975	0.0001	

heu-met-fast-014-001	0.9989	0.0017	0.9978	0.0001	
heu-met-fast-015-001	0.9996	0.0017	0.9947	0.0001	**
heu-met-fast-016-001	0.9996	0.0018	1.0016	0.0001	*
heu-met-fast-016-002	0.9996	0.0018	1.0026	0.0001	*
heu-met-fast-017-001	0.9993	0.0014	1.0006	0.0001	
heu-met-fast-018-002	1.0000	0.0014	0.9997	0.0001	
heu-met-fast-019-001	1.0000	0.0030	1.0071	0.0001	**
heu-met-fast-020-002	1.0000	0.0028	1.0006	0.0001	
heu-met-fast-021-002	1.0000	0.0024	0.9976	0.0001	
heu-met-fast-022-002	1.0000	0.0019	0.9976	0.0001	*
heu-met-fast-025-001	0.9987	0.0014	0.9991	0.0001	
heu-met-fast-025-002	0.9990	0.0016	1.0012	0.0001	*
heu-met-fast-025-003	0.9991	0.0016	1.0037	0.0001	**
heu-met-fast-025-004	0.9995	0.0016	1.0054	0.0001	***
heu-met-fast-025-005	0.9991	0.0016	1.0056	0.0001	***
heu-met-fast-026-011	1.0000	0.0038	1.0033	0.0001	
heu-met-fast-027-001	1.0000	0.0025	1.0006	0.0001	
heu-met-fast-028-001	1.0000	0.0030	1.0030	0.0001	
heu-met-fast-029-001	1.0000	0.0020	1.0057	0.0001	**
heu-met-fast-030-001	1.0000	0.0009	1.0022	0.0001	**
heu-met-fast-031-001	1.0000	0.0059	1.0049	0.0001	
heu-met-fast-032-001	1.0000	0.0016	1.0041	0.0001	**
heu-met-fast-032-002	1.0000	0.0027	1.0049	0.0001	*
heu-met-fast-032-003	1.0000	0.0017	1.0002	0.0001	
heu-met-fast-032-004	1.0000	0.0017	1.0010	0.0001	
heu-met-fast-033-001	0.9991	0.0014	0.9990	0.0001	
heu-met-fast-033-002	0.9991	0.0014	0.9977	0.0001	
heu-met-fast-034-001	0.9990	0.0012	0.9970	0.0001	*
heu-met-fast-034-002	0.9990	0.0012	0.9987	0.0001	
heu-met-fast-034-003	0.9990	0.0012	0.9977	0.0001	*
heu-met-fast-036-001	0.9993	0.0015	0.9991	0.0001	
heu-met-fast-036-002	0.9993	0.0013	0.9984	0.0001	
heu-met-fast-037-001	0.9997	0.0011	1.0022	0.0001	**
heu-met-fast-037-002	0.9997	0.0011	0.9978	0.0001	*
heu-met-fast-038-001	0.9999	0.0007	1.0030	0.0001	***
heu-met-fast-038-002	0.9999	0.0009	1.0019	0.0001	*
heu-met-fast-040-001	0.9991	0.0011	1.0045	0.0001	***
heu-met-fast-041-001	1.0013	0.0030	1.0069	0.0001	*
heu-met-fast-041-002	1.0022	0.0043	1.0052	0.0001	
heu-met-fast-041-003	1.0006	0.0029	1.0024	0.0001	
heu-met-fast-041-004	1.0006	0.0025	1.0072	0.0001	**
heu-met-fast-041-005	1.0006	0.0031	1.0029	0.0001	
heu-met-fast-041-006	1.0006	0.0045	1.0043	0.0001	
heu-met-fast-043-001	0.9995	0.0018	0.9990	0.0001	
heu-met-fast-043-002	0.9995	0.0019	0.9982	0.0001	
heu-met-fast-043-003	0.9995	0.0021	0.9988	0.0001	
heu-met-fast-043-004	0.9995	0.0015	0.9972	0.0001	*
heu-met-fast-043-005	0.9995	0.0015	0.9983	0.0001	
heu-met-fast-044-001	0.9995	0.0019	1.0000	0.0001	
heu-met-fast-044-002	0.9995	0.0017	0.9996	0.0001	
heu-met-fast-044-003	0.9995	0.0019	0.9999	0.0001	
heu-met-fast-044-004	0.9995	0.0014	0.9993	0.0001	
heu-met-fast-044-005	0.9995	0.0015	0.9999	0.0001	
heu-met-fast-049-001	0.9990	0.0016	0.9981	0.0001	
heu-met-fast-049-002	0.9994	0.0015	0.9996	0.0001	
heu-met-fast-049-003	0.9994	0.0016	0.9989	0.0001	
heu-met-fast-050-001	0.9990	0.0012	0.9980	0.0001	
heu-met-fast-051-001	0.9971	0.0005	0.9950	0.0001	***
heu-met-fast-051-002	0.9968	0.0005	0.9955	0.0001	**
heu-met-fast-051-003	0.9974	0.0005	0.9950	0.0001	***
heu-met-fast-051-004	0.9969	0.0005	0.9952	0.0001	**
heu-met-fast-051-009	0.9982	0.0002	0.9949	0.0001	***
heu-met-fast-051-014	0.9996	0.0002	0.9986	0.0001	***
heu-met-fast-051-015	0.9998	0.0001	0.9980	0.0001	***
heu-met-fast-051-016	0.9981	0.0001	0.9964	0.0001	***

heu-met-fast-051-017	0.9969	0.0001	0.9955	0.0001	***
heu-met-fast-051-018	0.9984	0.0002	0.9939	0.0001	***
heu-met-fast-057-001	1.0000	0.0020	0.9896	0.0001	***
heu-met-fast-057-002	1.0000	0.0023	0.9982	0.0001	
heu-met-fast-057-003	1.0000	0.0032	1.0172	0.0001	***
heu-met-fast-057-004	1.0000	0.0040	0.9878	0.0001	**
heu-met-fast-057-005	1.0000	0.0019	1.0218	0.0001	***
heu-met-fast-057-006	1.0000	0.0029	0.9967	0.0001	*
heu-met-fast-058-001	1.0000	0.0026	1.0032	0.0001	*
heu-met-fast-058-002	1.0000	0.0035	1.0050	0.0001	*
heu-met-fast-058-003	1.0000	0.0027	1.0029	0.0001	*
heu-met-fast-058-004	1.0000	0.0021	1.0021	0.0001	
heu-met-fast-058-005	1.0000	0.0033	1.0010	0.0001	
heu-met-fast-063-001	0.9993	0.0049	1.0006	0.0001	
heu-met-fast-063-002	0.9988	0.0047	1.0009	0.0001	
heu-met-fast-064-001	0.9996	0.0008	0.9954	0.0001	***
heu-met-fast-064-002	0.9996	0.0010	0.9956	0.0001	***
heu-met-fast-064-003	0.9996	0.0009	0.9936	0.0001	***
heu-met-fast-065-002	0.9995	0.0013	0.9981	0.0001	
heu-met-fast-066-001	1.0030	0.0033	1.0037	0.0001	
heu-met-fast-066-002	1.0023	0.0029	1.0019	0.0001	
heu-met-fast-066-003	1.0023	0.0026	1.0047	0.0001	
heu-met-fast-066-004	1.0043	0.0043	1.0050	0.0001	
heu-met-fast-066-005	1.0030	0.0033	1.0043	0.0001	
heu-met-fast-066-006	1.0028	0.0030	1.0034	0.0001	
heu-met-fast-066-007	1.0048	0.0039	1.0058	0.0001	
heu-met-fast-066-008	1.0039	0.0040	1.0046	0.0001	
heu-met-fast-066-009	1.0027	0.0036	1.0029	0.0001	
heu-met-fast-067-001	1.0086	0.0004	1.0011	0.0001	***
heu-met-fast-067-002	0.9938	0.0024	0.9962	0.0001	
heu-met-fast-072-001	0.9991	0.0024	1.0087	0.0001	***
heu-met-fast-072-003	1.0016	0.0069	1.0122	0.0001	*
heu-met-fast-073-001	1.0004	0.0016	1.0081	0.0001	***
heu-met-fast-077-001	1.0001	0.0031	1.0007	0.0001	
heu-met-fast-077-002	0.9995	0.0027	1.0007	0.0001	
heu-met-fast-077-003	0.9995	0.0040	0.9979	0.0001	
heu-met-fast-077-004	0.9998	0.0032	0.9984	0.0001	
heu-met-fast-077-005	0.9994	0.0027	1.0001	0.0001	
heu-met-fast-077-006	0.9996	0.0033	0.9997	0.0001	
heu-met-fast-077-007	0.9994	0.0056	1.0006	0.0001	
heu-met-fast-077-008	0.9994	0.0035	0.9983	0.0001	
heu-met-fast-078-001	0.9995	0.0018	0.9946	0.0001	**
heu-met-fast-078-003	0.9994	0.0022	0.9959	0.0001	*
heu-met-fast-078-005	0.9991	0.0019	0.9964	0.0001	*
heu-met-fast-078-007	1.0000	0.0019	0.9984	0.0001	
heu-met-fast-078-009	0.9997	0.0022	0.9957	0.0001	*
heu-met-fast-078-011	0.9995	0.0015	0.9958	0.0001	**
heu-met-fast-078-013	1.0000	0.0017	0.9973	0.0001	*
heu-met-fast-078-015	0.9991	0.0018	0.9966	0.0001	*
heu-met-fast-078-017	0.9995	0.0018	0.9966	0.0001	*
heu-met-fast-078-023	0.9992	0.0022	0.9982	0.0001	
heu-met-fast-078-025	0.9992	0.0025	0.9974	0.0001	
heu-met-fast-078-027	0.9992	0.0021	0.9960	0.0001	*
heu-met-fast-078-029	1.0000	0.0025	1.0021	0.0001	
heu-met-fast-078-031	0.9994	0.0020	0.9952	0.0001	**
heu-met-fast-078-033	0.9996	0.0026	0.9959	0.0001	*
heu-met-fast-078-035	0.9991	0.0022	0.9944	0.0001	**
heu-met-fast-078-037	0.9986	0.0021	0.9962	0.0001	*
heu-met-fast-078-039	0.9989	0.0021	0.9969	0.0001	
heu-met-fast-078-041	0.9992	0.0025	0.9966	0.0001	
heu-met-fast-078-043	1.0000	0.0019	0.9977	0.0001	*
heu-met-fast-079-001	0.9996	0.0015	0.9998	0.0001	
heu-met-fast-079-002	0.9996	0.0014	0.9992	0.0001	
heu-met-fast-079-003	0.9996	0.0015	1.0001	0.0001	
heu-met-fast-079-004	0.9996	0.0014	1.0011	0.0001	*

heu-met-fast-079-005	0.9996	0.0015	0.9998	0.0001	
heu-met-fast-084-001	0.9994	0.0019	0.9988	0.0001	
heu-met-fast-084-002	0.9994	0.0021	0.9995	0.0001	
heu-met-fast-084-003	0.9993	0.0021	0.9999	0.0001	
heu-met-fast-084-004	0.9994	0.0020	0.9987	0.0001	
heu-met-fast-084-005	0.9993	0.0021	1.0050	0.0001	**
heu-met-fast-084-006	0.9994	0.0024	0.9986	0.0001	
heu-met-fast-084-007	0.9995	0.0020	0.9974	0.0001	*
heu-met-fast-084-008	0.9994	0.0034	1.0084	0.0001	**
heu-met-fast-084-009	0.9993	0.0054	1.0025	0.0001	
heu-met-fast-084-010	0.9993	0.0022	1.0011	0.0001	
heu-met-fast-084-011	0.9995	0.0019	1.0015	0.0001	
heu-met-fast-084-012	0.9994	0.0020	0.9974	0.0001	
heu-met-fast-084-013	0.9994	0.0022	0.9990	0.0001	
heu-met-fast-084-014	0.9994	0.0019	0.9999	0.0001	
heu-met-fast-084-015	0.9995	0.0021	0.9979	0.0001	
heu-met-fast-084-016	0.9994	0.0020	0.9991	0.0001	
heu-met-fast-084-017	0.9995	0.0019	1.0004	0.0001	
heu-met-fast-084-018	0.9995	0.0022	0.9974	0.0001	
heu-met-fast-084-019	0.9996	0.0019	0.9977	0.0001	
heu-met-fast-084-020	0.9995	0.0025	1.0030	0.0001	*
heu-met-fast-084-021	0.9995	0.0045	1.0002	0.0001	
heu-met-fast-084-022	0.9994	0.0020	0.9982	0.0001	
heu-met-fast-084-023	0.9993	0.0024	0.9996	0.0001	
heu-met-fast-084-024	0.9996	0.0018	0.9986	0.0001	
heu-met-fast-084-025	0.9995	0.0020	0.9981	0.0001	
heu-met-fast-084-026	0.9993	0.0022	1.0004	0.0001	
heu-met-fast-084-027	0.9994	0.0020	0.9977	0.0001	
heu-met-fast-087-001	0.9987	0.0013	0.9984	0.0001	
heu-met-fast-088-001	0.9993	0.0008	0.9968	0.0001	**
heu-met-fast-088-002	0.9993	0.0007	0.9967	0.0001	***
heu-met-fast-089-001	0.9991	0.0014	1.0001	0.0001	
heu-met-fast-090-001	0.9994	0.0007	1.0057	0.0001	***
heu-met-fast-090-002	0.9993	0.0007	1.0023	0.0001	***
heu-met-fast-091-001	0.9996	0.0009	0.9996	0.0001	
heu-met-fast-092-001	0.9986	0.0011	1.0010	0.0001	**
heu-met-fast-092-002	0.9989	0.0013	1.0028	0.0001	**
heu-met-fast-092-003	0.9993	0.0012	1.0040	0.0001	***
heu-met-fast-092-004	0.9993	0.0013	1.0036	0.0001	***
heu-met-fast-093-001	0.9978	0.0012	1.0033	0.0001	***
heu-met-fast-094-001	0.9994	0.0012	1.0035	0.0001	***
heu-met-fast-094-002	0.9993	0.0010	1.0037	0.0001	***
heu-met-fast-100-001	1.0031	0.0007	1.0049	0.0001	**
heu-met-fast-100-002	0.9966	0.0007	0.9988	0.0001	**
heu-met-inter-006-001	0.9977	0.0008	0.9929	0.0001	***
heu-met-inter-006-002	1.0001	0.0008	0.9968	0.0001	***
heu-met-inter-006-003	1.0015	0.0009	1.0007	0.0001	
heu-met-inter-006-004	1.0016	0.0008	1.0073	0.0001	***
heu-met-mixed-001-001	0.9995	0.0013	1.0023	0.0001	*
heu-met-mixed-002-001	1.0000	0.0037	1.0065	0.0001	*
heu-met-mixed-003-001	1.0000	0.0038	1.0076	0.0001	*
heu-met-mixed-004-001	0.9999	0.0009	1.0025	0.0001	**
heu-met-mixed-015-001	0.9996	0.0008	0.9970	0.0001	**
heu-met-mixed-016-001	0.9995	0.0008	1.0016	0.0001	**
heu-met-mixed-016-002	0.9995	0.0007	1.0025	0.0001	***
heu-met-mixed-017-001	0.9995	0.0008	0.9955	0.0001	***
heu-met-therm-010-001	1.0065	0.0072	1.0088	0.0001	
heu-met-therm-012-001	0.9971	0.0025	1.0092	0.0001	***
heu-met-therm-014-001	0.9939	0.0015	1.0079	0.0001	***
heu-met-therm-031-001	1.0037	0.0024	1.0085	0.0001	*
heu-sol-therm-001-001	1.0000	0.0025	0.9983	0.0002	
heu-sol-therm-001-002	1.0000	0.0025	0.9960	0.0001	*
heu-sol-therm-001-003	1.0000	0.0025	1.0018	0.0002	
heu-sol-therm-001-004	1.0000	0.0025	0.9985	0.0001	
heu-sol-therm-001-005	1.0000	0.0025	0.9987	0.0001	

heu-sol-therm-001-006	1.0000	0.0025	1.0020	0.0001	
heu-sol-therm-001-007	1.0000	0.0025	0.9978	0.0001	
heu-sol-therm-001-008	1.0000	0.0025	0.9982	0.0001	
heu-sol-therm-001-009	1.0000	0.0025	0.9943	0.0001	**
heu-sol-therm-001-010	1.0000	0.0025	0.9926	0.0001	**
heu-sol-therm-009-001	0.9990	0.0043	1.0022	0.0001	
heu-sol-therm-009-002	1.0000	0.0039	1.0025	0.0001	
heu-sol-therm-009-003	1.0000	0.0036	1.0021	0.0001	
heu-sol-therm-010-001	1.0000	0.0029	1.0011	0.0001	
heu-sol-therm-011-001	1.0000	0.0023	1.0048	0.0001	*
heu-sol-therm-011-002	1.0000	0.0023	1.0007	0.0001	
heu-sol-therm-012-001	0.9999	0.0058	1.0009	0.0001	
heu-sol-therm-013-001	1.0012	0.0026	0.9986	0.0001	
heu-sol-therm-013-002	1.0007	0.0036	0.9978	0.0001	
heu-sol-therm-013-003	1.0009	0.0036	0.9941	0.0001	*
heu-sol-therm-013-004	1.0003	0.0036	0.9960	0.0001	*
heu-sol-therm-019-001	0.9991	0.0041	0.9974	0.0001	
heu-sol-therm-019-002	0.9991	0.0041	0.9990	0.0001	
heu-sol-therm-019-003	0.9991	0.0067	0.9946	0.0001	
heu-sol-therm-025-001	1.0002	0.0025	1.0009	0.0001	
heu-sol-therm-025-002	1.0007	0.0025	1.0005	0.0001	
heu-sol-therm-025-003	1.0002	0.0064	0.9953	0.0001	
heu-sol-therm-025-004	1.0003	0.0027	1.0008	0.0001	
heu-sol-therm-025-005	1.0013	0.0030	1.0031	0.0001	
heu-sol-therm-025-006	1.0002	0.0067	1.0086	0.0001	*
heu-sol-therm-025-007	1.0009	0.0073	1.0126	0.0001	*
heu-sol-therm-025-008	1.0000	0.0067	1.0100	0.0001	*
heu-sol-therm-025-009	1.0002	0.0065	1.0040	0.0001	
heu-sol-therm-025-010	1.0003	0.0043	1.0082	0.0001	*
heu-sol-therm-025-011	1.0002	0.0045	1.0074	0.0001	*
heu-sol-therm-025-012	1.0002	0.0045	1.0058	0.0001	*
heu-sol-therm-025-013	1.0009	0.0047	1.0136	0.0001	**
heu-sol-therm-025-014	1.0008	0.0053	1.0049	0.0001	
heu-sol-therm-025-015	1.0002	0.0058	0.9991	0.0001	
heu-sol-therm-025-016	1.0002	0.0049	1.0092	0.0001	*
heu-sol-therm-025-017	1.0009	0.0055	1.0011	0.0001	
heu-sol-therm-025-018	1.0000	0.0061	0.9986	0.0001	
heu-sol-therm-032-001	1.0015	0.0026	0.9994	0.0001	
heu-sol-therm-038-001	1.0000	0.0025	0.9950	0.0001	*
heu-sol-therm-038-002	1.0000	0.0025	0.9972	0.0001	*
heu-sol-therm-038-003	1.0000	0.0025	0.9978	0.0001	
heu-sol-therm-038-004	1.0000	0.0025	0.9951	0.0001	*
heu-sol-therm-038-005	1.0000	0.0025	0.9954	0.0001	*
heu-sol-therm-038-006	1.0000	0.0025	0.9963	0.0001	*
heu-sol-therm-038-007	1.0000	0.0032	0.9980	0.0001	
heu-sol-therm-038-008	1.0000	0.0026	0.9982	0.0001	
heu-sol-therm-038-009	1.0000	0.0033	0.9985	0.0001	
heu-sol-therm-038-010	1.0000	0.0026	0.9974	0.0001	
heu-sol-therm-038-011	1.0000	0.0025	0.9964	0.0001	*
heu-sol-therm-038-012	1.0000	0.0025	0.9957	0.0001	*
heu-sol-therm-038-013	1.0000	0.0050	1.0008	0.0001	
heu-sol-therm-038-014	1.0000	0.0050	1.0013	0.0001	
heu-sol-therm-038-015	1.0000	0.0050	1.0008	0.0001	
heu-sol-therm-038-016	1.0000	0.0050	1.0002	0.0001	
heu-sol-therm-038-017	1.0000	0.0026	0.9968	0.0001	*
heu-sol-therm-038-018	1.0000	0.0032	0.9954	0.0001	*
heu-sol-therm-038-019	1.0000	0.0032	0.9972	0.0001	
heu-sol-therm-038-020	1.0000	0.0032	0.9972	0.0001	
heu-sol-therm-038-021	1.0000	0.0025	0.9969	0.0001	*
heu-sol-therm-038-022	1.0000	0.0027	0.9975	0.0001	
heu-sol-therm-038-023	1.0000	0.0027	0.9969	0.0001	*
heu-sol-therm-038-024	1.0000	0.0026	0.9971	0.0001	*
heu-sol-therm-038-025	1.0000	0.0032	0.9974	0.0001	
heu-sol-therm-038-026	1.0000	0.0032	0.9975	0.0001	
heu-sol-therm-038-027	1.0000	0.0032	0.9972	0.0001	

heu-sol-therm-038-028	1.0000	0.0025	0.9975	0.0001	
heu-sol-therm-042-001	0.9957	0.0039	0.9966	0.0001	
heu-sol-therm-042-002	0.9965	0.0036	0.9966	0.0001	
heu-sol-therm-042-003	0.9994	0.0028	1.0007	0.0001	
heu-sol-therm-042-004	1.0000	0.0034	1.0023	0.0000	
heu-sol-therm-042-005	1.0000	0.0034	0.9999	0.0000	
heu-sol-therm-042-006	1.0000	0.0037	1.0005	0.0000	
heu-sol-therm-042-007	1.0000	0.0036	1.0014	0.0000	
heu-sol-therm-042-008	1.0000	0.0035	1.0020	0.0000	
heu-sol-therm-043-001	0.9986	0.0031	0.9948	0.0001	*
heu-sol-therm-043-002	0.9995	0.0026	1.0051	0.0001	**
heu-sol-therm-043-003	0.9990	0.0025	1.0010	0.0001	
heu-sol-therm-050-001	0.9953	0.0086	1.0071	0.0001	*
heu-sol-therm-050-002	0.9987	0.0083	1.0028	0.0001	
heu-sol-therm-050-003	0.9984	0.0079	1.0047	0.0001	
heu-sol-therm-050-004	0.9987	0.0084	1.0045	0.0001	
heu-sol-therm-050-005	0.9985	0.0085	1.0007	0.0001	
heu-sol-therm-050-006	0.9985	0.0081	1.0090	0.0001	*
heu-sol-therm-050-007	0.9978	0.0078	0.9980	0.0001	
heu-sol-therm-050-008	0.9975	0.0084	0.9979	0.0001	
heu-sol-therm-050-009	0.9966	0.0082	0.9972	0.0001	
heu-sol-therm-050-010	0.9960	0.0090	0.9799	0.0001	*
heu-sol-therm-050-011	0.9964	0.0089	0.9911	0.0001	
ieu-comp-therm-002-003	1.0017	0.0044	1.0042	0.0001	
ieu-met-fast-001-001	0.9988	------	1.0001	0.0001	
ieu-met-fast-001-002	0.9988	------	1.0002	0.0001	
ieu-met-fast-001-003	0.9990	------	1.0005	0.0001	
ieu-met-fast-001-004	0.9990	------	1.0014	0.0001	
ieu-met-fast-002-001	1.0000	0.0030	0.9989	0.0001	
ieu-met-fast-003-001	1.0000	0.0017	1.0022	0.0001	*
ieu-met-fast-004-001	1.0000	0.0030	1.0075	0.0001	**
ieu-met-fast-005-001	1.0000	0.0021	1.0018	0.0001	
ieu-met-fast-006-001	1.0000	0.0023	0.9961	0.0001	*
ieu-met-fast-007-001	1.0045	0.0007	1.0044	0.0001	
ieu-met-fast-008-001	1.0000	0.0018	1.0054	0.0001	**
ieu-met-fast-009-001	1.0000	0.0053	1.0106	0.0001	*
leu-comp-therm-001-001	0.9998	0.0031	0.9996	0.0001	
leu-comp-therm-001-002	0.9998	0.0031	0.9988	0.0001	
leu-comp-therm-001-003	0.9998	0.0030	0.9985	0.0001	
leu-comp-therm-001-004	0.9998	0.0030	0.9991	0.0001	
leu-comp-therm-001-005	0.9998	0.0030	0.9969	0.0001	
leu-comp-therm-001-006	0.9998	0.0030	0.9990	0.0001	
leu-comp-therm-001-007	0.9998	0.0030	0.9981	0.0001	
leu-comp-therm-001-008	0.9998	0.0030	0.9972	0.0001	
leu-comp-therm-002-001	0.9997	0.0020	0.9987	0.0001	
leu-comp-therm-002-002	0.9997	0.0020	0.9998	0.0001	
leu-comp-therm-002-003	0.9997	0.0020	0.9992	0.0001	
leu-comp-therm-002-004	0.9997	0.0020	0.9988	0.0001	
leu-comp-therm-002-005	0.9997	0.0020	0.9980	0.0001	
leu-comp-therm-005-001	1.0000	0.0023	1.0028	0.0001	*
leu-comp-therm-005-002	1.0000	0.0021	0.9996	0.0001	
leu-comp-therm-005-003	1.0000	0.0029	0.9991	0.0001	
leu-comp-therm-005-004	1.0000	0.0025	0.9978	0.0001	
leu-comp-therm-005-005	1.0000	0.0047	1.0050	0.0001	*
leu-comp-therm-005-006	1.0000	0.0042	1.0054	0.0001	*
leu-comp-therm-005-007	1.0000	0.0043	1.0014	0.0001	
leu-comp-therm-005-008	1.0000	0.0021	1.0016	0.0001	
leu-comp-therm-005-009	1.0000	0.0040	1.0022	0.0001	
leu-comp-therm-005-010	1.0000	0.0028	1.0011	0.0001	
leu-comp-therm-005-011	1.0000	0.0043	1.0017	0.0001	
leu-comp-therm-005-012	1.0000	0.0066	1.0066	0.0001	
leu-comp-therm-005-013	1.0000	0.0064	1.0121	0.0001	*
leu-comp-therm-006-001	1.0000	0.0030	0.9999	0.0001	
leu-comp-therm-006-002	1.0000	0.0030	1.0005	0.0001	
leu-comp-therm-006-003	1.0000	0.0030	1.0003	0.0001	

leu-comp-therm-006-004	1.0000	0.0030	1.0002	0.0001	
leu-comp-therm-006-005	1.0000	0.0030	0.9997	0.0001	
leu-comp-therm-006-006	1.0000	0.0030	1.0003	0.0001	
leu-comp-therm-006-007	1.0000	0.0030	1.0000	0.0001	
leu-comp-therm-006-008	1.0000	0.0030	1.0001	0.0001	
leu-comp-therm-006-009	1.0000	0.0030	0.9998	0.0001	
leu-comp-therm-006-010	1.0000	0.0030	0.9998	0.0001	
leu-comp-therm-006-011	1.0000	0.0030	0.9999	0.0001	
leu-comp-therm-006-012	1.0000	0.0030	0.9998	0.0001	
leu-comp-therm-006-013	1.0000	0.0030	0.9995	0.0001	
leu-comp-therm-006-014	1.0000	0.0030	0.9998	0.0001	
leu-comp-therm-006-015	1.0000	0.0030	0.9997	0.0001	
leu-comp-therm-006-016	1.0000	0.0030	0.9997	0.0001	
leu-comp-therm-006-017	1.0000	0.0030	0.9994	0.0001	
leu-comp-therm-006-018	1.0000	0.0030	0.9995	0.0001	
leu-comp-therm-007-001	1.0000	0.0014	0.9977	0.0001	*
leu-comp-therm-007-002	1.0000	0.0008	0.9989	0.0001	*
leu-comp-therm-007-003	1.0000	0.0007	0.9976	0.0001	**
leu-comp-therm-007-004	1.0000	0.0008	0.9981	0.0001	**
leu-comp-therm-007-005	1.0000	0.0014	0.9969	0.0001	**
leu-comp-therm-007-006	1.0000	0.0008	0.9988	0.0001	*
leu-comp-therm-007-007	1.0000	0.0007	0.9985	0.0001	*
leu-comp-therm-007-008	1.0000	0.0014	0.9982	0.0001	*
leu-comp-therm-007-009	1.0000	0.0008	0.9981	0.0001	**
leu-comp-therm-007-010	1.0000	0.0007	0.9986	0.0001	*
leu-comp-therm-008-001	1.0007	0.0012	1.0006	0.0001	
leu-comp-therm-008-002	1.0007	0.0012	1.0011	0.0001	
leu-comp-therm-008-005	1.0007	0.0012	1.0003	0.0001	
leu-comp-therm-008-007	1.0007	0.0012	1.0001	0.0001	
leu-comp-therm-008-008	1.0007	0.0012	0.9998	0.0001	
leu-comp-therm-008-011	1.0007	0.0012	1.0014	0.0001	
leu-comp-therm-009-001	1.0000	0.0021	0.9991	0.0001	
leu-comp-therm-009-002	1.0000	0.0021	0.9989	0.0001	
leu-comp-therm-009-003	1.0000	0.0021	0.9983	0.0001	
leu-comp-therm-009-004	1.0000	0.0021	0.9993	0.0001	
leu-comp-therm-009-005	1.0000	0.0021	0.9996	0.0001	
leu-comp-therm-009-006	1.0000	0.0021	0.9991	0.0001	
leu-comp-therm-009-007	1.0000	0.0021	1.0000	0.0001	
leu-comp-therm-009-008	1.0000	0.0021	0.9989	0.0001	
leu-comp-therm-009-010	1.0000	0.0021	0.9988	0.0001	
leu-comp-therm-009-011	1.0000	0.0021	0.9990	0.0001	
leu-comp-therm-009-013	1.0000	0.0021	0.9994	0.0001	
leu-comp-therm-009-015	1.0000	0.0021	0.9997	0.0001	
leu-comp-therm-009-016	1.0000	0.0021	0.9989	0.0001	
leu-comp-therm-009-017	1.0000	0.0021	0.9995	0.0001	
leu-comp-therm-009-018	1.0000	0.0021	0.9986	0.0001	
leu-comp-therm-009-019	1.0000	0.0021	0.9996	0.0001	
leu-comp-therm-009-020	1.0000	0.0021	0.9989	0.0001	
leu-comp-therm-009-021	1.0000	0.0021	0.9996	0.0001	
leu-comp-therm-009-022	1.0000	0.0021	0.9993	0.0001	
leu-comp-therm-009-023	1.0000	0.0021	1.0000	0.0001	
leu-comp-therm-009-024	1.0000	0.0021	0.9989	0.0001	
leu-comp-therm-009-025	1.0000	0.0021	0.9991	0.0001	
leu-comp-therm-009-026	1.0000	0.0021	0.9993	0.0001	
leu-comp-therm-009-027	1.0000	0.0021	0.9993	0.0001	
leu-comp-therm-010-001	1.0000	0.0021	1.0047	0.0001	**
leu-comp-therm-010-002	1.0000	0.0021	1.0051	0.0001	**
leu-comp-therm-010-003	1.0000	0.0021	1.0043	0.0001	*
leu-comp-therm-010-004	1.0000	0.0021	0.9968	0.0001	*
leu-comp-therm-010-005	1.0000	0.0021	0.9997	0.0001	
leu-comp-therm-010-006	1.0000	0.0021	1.0004	0.0001	
leu-comp-therm-010-007	1.0000	0.0021	1.0014	0.0001	
leu-comp-therm-010-008	1.0000	0.0021	0.9980	0.0001	
leu-comp-therm-010-009	1.0000	0.0021	0.9996	0.0001	
leu-comp-therm-010-010	1.0000	0.0021	1.0003	0.0001	

leu-comp-therm-010-011	1.0000	0.0021	1.0005	0.0001	
leu-comp-therm-010-012	1.0000	0.0021	0.9997	0.0001	
leu-comp-therm-010-013	1.0000	0.0021	0.9976	0.0001	*
leu-comp-therm-011-002	1.0009	0.0032	0.9980	0.0001	
leu-comp-therm-011-003	1.0009	0.0032	0.9980	0.0001	
leu-comp-therm-011-007	1.0009	0.0032	0.9984	0.0001	
leu-comp-therm-011-009	1.0009	0.0032	0.9982	0.0001	
leu-comp-therm-011-015	1.0010	0.0018	0.9962	0.0001	**
leu-comp-therm-017-001	1.0000	0.0031	1.0014	0.0001	
leu-comp-therm-017-002	1.0000	0.0031	1.0013	0.0001	
leu-comp-therm-017-003	1.0000	0.0031	0.9997	0.0001	
leu-comp-therm-017-004	1.0000	0.0031	0.9982	0.0001	
leu-comp-therm-017-005	1.0000	0.0031	0.9997	0.0001	
leu-comp-therm-017-006	1.0000	0.0031	1.0000	0.0001	
leu-comp-therm-017-007	1.0000	0.0031	0.9998	0.0001	
leu-comp-therm-017-008	1.0000	0.0031	0.9981	0.0001	
leu-comp-therm-017-009	1.0000	0.0031	0.9977	0.0001	
leu-comp-therm-017-010	1.0000	0.0031	0.9982	0.0001	
leu-comp-therm-017-011	1.0000	0.0031	0.9986	0.0001	
leu-comp-therm-017-012	1.0000	0.0031	0.9986	0.0001	
leu-comp-therm-017-013	1.0000	0.0031	0.9990	0.0001	
leu-comp-therm-017-014	1.0000	0.0031	0.9993	0.0001	
leu-comp-therm-022-001	1.0000	0.0046	1.0030	0.0001	
leu-comp-therm-022-002	1.0000	0.0046	1.0069	0.0001	*
leu-comp-therm-022-003	1.0000	0.0036	1.0077	0.0001	**
leu-comp-therm-022-004	1.0000	0.0037	1.0080	0.0001	**
leu-comp-therm-022-005	1.0000	0.0038	1.0033	0.0001	
leu-comp-therm-022-006	1.0000	0.0046	1.0014	0.0001	
leu-comp-therm-022-007	1.0000	0.0046	1.0039	0.0001	
leu-comp-therm-024-001	1.0000	0.0054	1.0012	0.0001	
leu-comp-therm-024-002	1.0000	0.0054	1.0084	0.0001	*
leu-comp-therm-025-001	1.0000	0.0041	0.9884	0.0001	**
leu-comp-therm-025-002	1.0000	0.0044	0.9958	0.0001	
leu-comp-therm-025-003	1.0000	0.0047	1.0006	0.0001	
leu-comp-therm-025-004	1.0000	0.0052	1.0026	0.0001	
leu-comp-therm-027-001	1.0000	0.0011	1.0043	0.0001	***
leu-comp-therm-027-002	1.0000	0.0011	1.0066	0.0001	***
leu-comp-therm-027-003	1.0000	0.0011	1.0070	0.0001	***
leu-comp-therm-027-004	1.0000	0.0011	1.0092	0.0001	***
leu-comp-therm-028-001	0.9998	0.0047	0.9982	0.0001	
leu-comp-therm-028-002	1.0001	0.0054	0.9993	0.0001	
leu-comp-therm-028-003	0.9999	0.0051	0.9987	0.0001	
leu-comp-therm-028-004	1.0000	0.0043	1.0012	0.0001	
leu-comp-therm-028-005	1.0002	0.0048	1.0000	0.0001	
leu-comp-therm-028-006	1.0001	0.0045	1.0011	0.0001	
leu-comp-therm-028-007	0.9998	0.0047	0.9962	0.0001	
leu-comp-therm-028-008	0.9998	0.0052	0.9940	0.0001	*
leu-comp-therm-028-009	0.9998	0.0047	0.9926	0.0001	*
leu-comp-therm-028-010	1.0004	0.0045	0.9975	0.0001	
leu-comp-therm-028-011	1.0002	0.0045	0.9979	0.0001	
leu-comp-therm-028-012	1.0000	0.0049	0.9962	0.0001	
leu-comp-therm-028-013	0.9998	0.0050	0.9951	0.0001	
leu-comp-therm-028-014	1.0001	0.0047	0.9929	0.0001	*
leu-comp-therm-028-015	0.9997	0.0044	0.9978	0.0001	
leu-comp-therm-028-016	1.0000	0.0049	0.9984	0.0001	
leu-comp-therm-028-017	1.0000	0.0047	0.9983	0.0001	
leu-comp-therm-028-018	0.9999	0.0047	0.9987	0.0001	
leu-comp-therm-028-019	1.0002	0.0046	0.9980	0.0001	
leu-comp-therm-028-020	1.0001	0.0046	0.9958	0.0001	
leu-comp-therm-035-001	1.0000	0.0018	0.9999	0.0001	
leu-comp-therm-035-002	1.0000	0.0019	0.9992	0.0001	
leu-comp-therm-035-003	1.0000	0.0022	0.9953	0.0001	**
leu-comp-therm-039-001	1.0000	0.0014	0.9974	0.0001	*
leu-comp-therm-039-002	1.0000	0.0014	0.9979	0.0001	*
leu-comp-therm-039-003	1.0000	0.0014	0.9974	0.0001	*

leu-comp-therm-039-004	1.0000	0.0014	0.9964	0.0001	**
leu-comp-therm-039-005	1.0000	0.0009	0.9975	0.0001	**
leu-comp-therm-039-006	1.0000	0.0009	0.9972	0.0001	**
leu-comp-therm-039-007	1.0000	0.0012	0.9968	0.0001	**
leu-comp-therm-039-008	1.0000	0.0012	0.9972	0.0001	**
leu-comp-therm-039-009	1.0000	0.0012	0.9968	0.0001	**
leu-comp-therm-039-010	1.0000	0.0012	0.9976	0.0001	*
leu-comp-therm-060-001	0.9990	0.0026	0.9987	0.0001	
leu-comp-therm-060-002	0.9977	0.0026	0.9973	0.0001	
leu-comp-therm-060-003	1.0001	0.0026	0.9998	0.0001	
leu-comp-therm-060-004	1.0017	0.0026	0.9995	0.0002	
leu-comp-therm-060-005	1.0009	0.0026	1.0015	0.0001	
leu-comp-therm-060-006	0.9894	0.0027	0.9887	0.0002	
leu-comp-therm-079-001	0.9999	0.0016	0.9982	0.0001	*
leu-comp-therm-079-002	1.0002	0.0016	0.9985	0.0001	
leu-comp-therm-079-003	1.0005	0.0016	0.9990	0.0001	
leu-comp-therm-079-004	1.0004	0.0016	0.9995	0.0001	
leu-comp-therm-079-005	1.0004	0.0016	0.9996	0.0001	
leu-comp-therm-079-006	0.9994	0.0008	0.9984	0.0001	*
leu-comp-therm-079-007	1.0003	0.0008	0.9978	0.0001	**
leu-comp-therm-079-008	1.0008	0.0008	0.9990	0.0001	*
leu-comp-therm-079-009	1.0003	0.0008	0.9986	0.0001	*
leu-comp-therm-079-010	1.0009	0.0008	0.9995	0.0001	*
leu-sol-therm-002-001	1.0038	0.0040	0.9999	0.0001	
leu-sol-therm-002-002	1.0024	0.0037	0.9959	0.0001	*
leu-sol-therm-004-001	0.9994	0.0008	1.0004	0.0001	*
leu-sol-therm-004-002	0.9999	0.0009	1.0018	0.0001	*
leu-sol-therm-004-003	0.9999	0.0009	0.9997	0.0001	
leu-sol-therm-004-004	0.9999	0.0010	1.0019	0.0001	*
leu-sol-therm-004-005	0.9999	0.0010	1.0019	0.0001	*
leu-sol-therm-004-006	0.9994	0.0011	1.0011	0.0001	*
leu-sol-therm-004-007	0.9996	0.0011	1.0012	0.0001	*
leu-sol-therm-007-001	0.9994	0.0008	0.9954	0.0001	***
leu-sol-therm-007-002	0.9994	0.0008	0.9974	0.0001	**
leu-sol-therm-007-003	0.9994	0.0008	0.9962	0.0001	***
leu-sol-therm-007-004	0.9994	0.0008	0.9987	0.0001	
leu-sol-therm-007-005	0.9994	0.0008	0.9974	0.0001	**
leu-sol-therm-007-014	0.9961	0.0009	0.9948	0.0001	*
leu-sol-therm-007-030	0.9973	0.0009	0.9974	0.0001	
leu-sol-therm-007-032	0.9985	0.0010	0.9963	0.0001	**
leu-sol-therm-007-036	0.9988	0.0011	0.9990	0.0001	
leu-sol-therm-007-049	0.9983	0.0011	0.9975	0.0001	
leu-sol-therm-020-001	0.9995	0.0010	1.0001	0.0001	
leu-sol-therm-020-002	0.9996	0.0010	0.9996	0.0001	
leu-sol-therm-020-003	0.9997	0.0012	0.9990	0.0001	
leu-sol-therm-020-004	0.9998	0.0012	1.0001	0.0001	
leu-sol-therm-021-001	0.9983	0.0009	0.9978	0.0001	
leu-sol-therm-021-002	0.9985	0.0010	0.9982	0.0001	
leu-sol-therm-021-003	0.9989	0.0011	0.9973	0.0001	*
leu-sol-therm-021-004	0.9993	0.0012	0.9995	0.0001	
mix-comp-fast-001-001	0.9866	0.0023	0.9872	0.0001	
mix-comp-fast-002-001	0.9874	0.0022	0.9854	0.0001	
mix-comp-inter-005-001	1.1602	0.0055	1.1671	0.0001	*
mix-comp-therm-001-001	1.0000	0.0025	1.0009	0.0001	
mix-comp-therm-001-002	1.0000	0.0026	0.9999	0.0001	
mix-comp-therm-001-003	1.0000	0.0032	0.9997	0.0001	
mix-comp-therm-001-004	1.0000	0.0039	1.0014	0.0001	
mix-comp-therm-002-001	1.0010	0.0059	1.0010	0.0001	
mix-comp-therm-002-002	1.0009	0.0045	1.0012	0.0001	
mix-comp-therm-002-003	1.0024	0.0029	1.0024	0.0001	
mix-comp-therm-002-004	1.0024	0.0021	1.0059	0.0001	*
mix-comp-therm-002-005	1.0038	0.0022	1.0243	0.0001	***
mix-comp-therm-003-001	1.0000	0.0071	1.0001	0.0001	
mix-comp-therm-003-002	1.0000	0.0057	1.0007	0.0001	
mix-comp-therm-003-003	1.0000	0.0052	1.0035	0.0001	

mix-comp-therm-003-004	1.0000	0.0024	1.0000	0.0001	
mix-comp-therm-003-005	1.0000	0.0028	1.0003	0.0001	
mix-comp-therm-003-006	1.0000	0.0020	1.0010	0.0001	
mix-met-fast-001-001	1.0000	0.0016	0.9995	0.0001	
mix-met-fast-002-001	1.0000	0.0042	1.0053	0.0001	*
mix-met-fast-002-002	1.0000	0.0044	1.0052	0.0001	*
mix-met-fast-002-003	1.0000	0.0048	1.0055	0.0001	*
mix-met-fast-003-001	0.9993	0.0017	1.0008	0.0001	
mix-met-fast-004-001	0.9993	0.0013	1.0005	0.0001	
mix-met-fast-004-002	0.9993	0.0013	0.9994	0.0001	
mix-met-fast-005-001	0.9990	0.0017	1.0039	0.0001	**
mix-met-fast-007-001	1.0000	0.0045	1.0031	0.0001	
mix-met-fast-007-002	1.0000	0.0023	1.0079	0.0001	***
mix-met-fast-007-003	1.0000	0.0028	1.0065	0.0001	**
mix-met-fast-007-004	1.0000	0.0028	1.0054	0.0001	*
mix-met-fast-007-005	1.0000	0.0032	1.0025	0.0001	
mix-met-fast-007-006	1.0000	0.0035	1.0010	0.0001	
mix-met-fast-007-007	1.0000	0.0032	1.0061	0.0001	*
mix-met-fast-007-008	1.0000	0.0030	1.0051	0.0001	*
mix-met-fast-007-009	1.0000	0.0028	1.0051	0.0001	*
mix-met-fast-007-010	1.0000	0.0027	1.0051	0.0001	*
mix-met-fast-007-011	1.0000	0.0026	1.0037	0.0001	*
mix-met-fast-007-012	1.0000	0.0030	1.0026	0.0001	
mix-met-fast-007-013	1.0000	0.0033	1.0007	0.0001	
mix-met-fast-007-014	1.0000	0.0032	1.0080	0.0001	**
mix-met-fast-007-015	1.0000	0.0032	1.0076	0.0001	**
mix-met-fast-007-016	1.0000	0.0028	1.0059	0.0001	**
mix-met-fast-007-017	1.0000	0.0028	1.0059	0.0001	**
mix-met-fast-007-018	1.0000	0.0030	1.0080	0.0001	**
mix-met-fast-007-019	1.0000	0.0034	1.0070	0.0001	*
mix-met-fast-007-020	1.0000	0.0030	1.0047	0.0001	*
mix-met-fast-007-021	1.0000	0.0031	1.0050	0.0001	*
mix-met-fast-007-022	1.0000	0.0030	1.0040	0.0001	*
mix-met-fast-007-023	1.0000	0.0028	1.0034	0.0001	*
mix-met-fast-009-001	1.0000	0.0010	1.0001	0.0001	
mix-met-fast-010-001	1.0000	0.0009	0.9998	0.0001	
mix-met-mixed-001-001	0.9991	0.0013	0.9997	0.0001	
mix-sol-therm-001-001	1.0000	0.0016	0.9951	0.0001	**
mix-sol-therm-001-002	1.0000	0.0016	0.9951	0.0001	**
mix-sol-therm-001-003	1.0000	0.0016	0.9888	0.0001	***
mix-sol-therm-001-004	1.0000	0.0016	0.9943	0.0001	***
mix-sol-therm-001-005	1.0000	0.0016	0.9979	0.0001	*
mix-sol-therm-001-006	1.0000	0.0016	0.9956	0.0001	**
mix-sol-therm-001-007	1.0000	0.0016	1.0003	0.0001	
mix-sol-therm-001-008	1.0000	0.0016	0.9996	0.0001	
mix-sol-therm-001-009	1.0000	0.0016	0.9991	0.0001	
mix-sol-therm-001-010	1.0000	0.0016	0.9997	0.0001	
mix-sol-therm-001-011	1.0000	0.0052	1.0358	0.0001	***
pu-comp-fast-004-001	1.0004	0.0044	0.9932	0.0001	*
pu-comp-inter-001-001	1.0000	0.0110	1.0117	0.0001	*
pu-comp-mixed-001-001	0.9986	0.0041	1.0248	0.0001	***
pu-comp-mixed-001-002	1.0000	0.0068	1.0278	0.0001	***
pu-comp-mixed-001-003	0.9990	0.0067	1.0239	0.0001	***
pu-comp-mixed-001-004	1.0000	0.0066	0.9934	0.0001	
pu-comp-mixed-001-005	0.9989	0.0072	0.9803	0.0001	**
pu-comp-mixed-002-001	0.9990	0.0046	1.0311	0.0001	***
pu-comp-mixed-002-002	0.9990	0.0046	1.0294	0.0001	***
pu-comp-mixed-002-003	0.9990	0.0046	1.0247	0.0001	***
pu-comp-mixed-002-004	0.9990	0.0046	1.0147	0.0001	***
pu-comp-mixed-002-005	0.9990	0.0046	1.0148	0.0001	***
pu-comp-mixed-002-006	1.0000	0.0075	1.0253	0.0001	***
pu-comp-mixed-002-007	1.0000	0.0075	1.0237	0.0001	***
pu-comp-mixed-002-008	1.0000	0.0075	1.0223	0.0001	**
pu-comp-mixed-002-009	1.0000	0.0075	1.0226	0.0001	**
pu-comp-mixed-002-010	1.0000	0.0073	1.0321	0.0001	***

pu-comp-mixed-002-011	1.0000	0.0073	1.0295	0.0001	***
pu-comp-mixed-002-012	1.0000	0.0073	1.0297	0.0001	***
pu-comp-mixed-002-013	1.0000	0.0073	1.0278	0.0001	***
pu-comp-mixed-002-014	1.0000	0.0073	1.0319	0.0001	***
pu-comp-mixed-002-015	1.0000	0.0073	1.0298	0.0001	***
pu-comp-mixed-002-016	1.0000	0.0073	1.0255	0.0001	***
pu-comp-mixed-002-017	0.9988	0.0055	1.0074	0.0001	*
pu-comp-mixed-002-018	0.9988	0.0055	1.0113	0.0001	**
pu-comp-mixed-002-019	0.9988	0.0055	1.0105	0.0001	**
pu-comp-mixed-002-020	0.9988	0.0055	1.0105	0.0001	**
pu-comp-mixed-002-021	0.9988	0.0055	1.0112	0.0001	**
pu-comp-mixed-002-022	0.9988	0.0055	1.0151	0.0001	**
pu-comp-mixed-002-023	1.0000	0.0068	1.0069	0.0001	
pu-comp-mixed-002-024	1.0000	0.0068	1.0076	0.0001	*
pu-comp-mixed-002-025	1.0000	0.0068	1.0076	0.0001	*
pu-comp-mixed-002-026	1.0000	0.0068	1.0087	0.0001	*
pu-comp-mixed-002-027	1.0000	0.0068	1.0092	0.0001	*
pu-comp-mixed-002-028	1.0000	0.0068	1.0092	0.0001	*
pu-comp-mixed-002-029	1.0000	0.0068	1.0101	0.0001	*
pu-met-fast-001-001	1.0000	0.0020	1.0000	0.0001	
pu-met-fast-002-001	1.0000	0.0020	1.0000	0.0001	
pu-met-fast-003-103	1.0000	0.0030	0.9987	0.0001	
pu-met-fast-005-001	1.0000	0.0013	1.0012	0.0001	
pu-met-fast-006-001	1.0000	0.0030	1.0011	0.0001	
pu-met-fast-008-001	1.0000	0.0006	0.9981	0.0001	**
pu-met-fast-009-001	1.0000	0.0027	1.0057	0.0001	**
pu-met-fast-010-001	1.0000	0.0018	0.9997	0.0001	
pu-met-fast-011-001	1.0000	0.0010	1.0001	0.0001	
pu-met-fast-012-001	1.0009	0.0021	1.0030	0.0001	
pu-met-fast-013-001	1.0034	0.0023	1.0082	0.0001	**
pu-met-fast-014-001	1.0037	0.0031	1.0065	0.0001	
pu-met-fast-015-001	1.0041	0.0026	1.0000	0.0001	*
pu-met-fast-016-001	0.9976	0.0042	1.0176	0.0001	***
pu-met-fast-016-002	1.0000	0.0038	1.0071	0.0001	*
pu-met-fast-016-003	1.0000	0.0033	1.0051	0.0001	*
pu-met-fast-016-004	1.0000	0.0030	1.0048	0.0001	*
pu-met-fast-016-005	1.0000	0.0034	1.0046	0.0001	*
pu-met-fast-016-006	1.0000	0.0032	1.0068	0.0001	**
pu-met-fast-018-001	1.0000	0.0030	0.9994	0.0001	
pu-met-fast-019-001	0.9992	0.0015	1.0010	0.0001	*
pu-met-fast-020-001	0.9993	0.0017	0.9979	0.0001	
pu-met-fast-021-001	1.0000	0.0026	1.0046	0.0001	*
pu-met-fast-021-002	1.0000	0.0026	0.9934	0.0001	**
pu-met-fast-022-001	1.0000	0.0021	0.9983	0.0001	
pu-met-fast-023-001	1.0000	0.0022	1.0000	0.0001	
pu-met-fast-024-001	1.0000	0.0022	1.0018	0.0001	
pu-met-fast-025-001	1.0000	0.0022	0.9989	0.0001	
pu-met-fast-026-001	1.0000	0.0022	0.9987	0.0001	
pu-met-fast-027-001	1.0000	0.0024	1.0032	0.0001	*
pu-met-fast-028-001	1.0000	0.0024	0.9991	0.0001	
pu-met-fast-029-001	1.0000	0.0024	0.9958	0.0001	*
pu-met-fast-030-001	1.0000	0.0023	1.0032	0.0001	*
pu-met-fast-031-001	1.0000	0.0023	1.0044	0.0001	*
pu-met-fast-032-001	1.0000	0.0022	0.9986	0.0001	
pu-met-fast-035-001	1.0000	0.0016	0.9977	0.0001	*
pu-met-fast-036-001	1.0000	0.0031	1.0064	0.0001	**
pu-met-fast-038-001	1.0007	0.0019	1.0025	0.0001	
pu-met-fast-039-001	1.0000	0.0022	0.9922	0.0001	***
pu-met-fast-040-001	1.0000	0.0038	0.9967	0.0001	
pu-met-fast-041-001	1.0000	0.0016	1.0058	0.0001	***
pu-met-fast-044-001	0.9977	0.0021	1.0005	0.0001	*
pu-met-fast-044-002	0.9980	0.0022	1.0000	0.0001	
pu-met-fast-044-003	0.9927	0.0021	0.9994	0.0001	***
pu-met-fast-044-004	0.9978	0.0026	1.0000	0.0001	
pu-met-fast-044-005	0.9977	0.0024	0.9993	0.0001	

pu-met-fast-045-001	1.0000	0.0047	1.0016	0.0001	
pu-met-fast-045-002	1.0000	0.0046	1.0078	0.0001	*
pu-met-fast-045-003	1.0000	0.0044	1.0054	0.0001	*
pu-met-fast-045-004	1.0000	0.0046	1.0046	0.0001	
pu-met-fast-045-005	1.0000	0.0045	1.0086	0.0001	*
pu-met-fast-045-006	1.0000	0.0049	1.0048	0.0001	
pu-met-fast-045-007	1.0000	0.0050	1.0054	0.0001	*
pu-sol-therm-001-001	1.0000	0.0050	1.0058	0.0001	*
pu-sol-therm-001-002	1.0000	0.0050	1.0073	0.0001	*
pu-sol-therm-001-003	1.0000	0.0050	1.0113	0.0001	**
pu-sol-therm-001-004	1.0000	0.0050	1.0044	0.0001	
pu-sol-therm-001-005	1.0000	0.0050	1.0087	0.0001	*
pu-sol-therm-001-006	1.0000	0.0050	1.0095	0.0001	*
pu-sol-therm-002-001	1.0000	0.0047	1.0038	0.0001	
pu-sol-therm-002-002	1.0000	0.0047	1.0048	0.0001	
pu-sol-therm-002-003	1.0000	0.0047	1.0038	0.0001	
pu-sol-therm-002-004	1.0000	0.0047	1.0067	0.0001	*
pu-sol-therm-002-005	1.0000	0.0047	1.0094	0.0001	*
pu-sol-therm-002-006	1.0000	0.0047	1.0052	0.0001	*
pu-sol-therm-002-007	1.0000	0.0047	1.0077	0.0001	*
pu-sol-therm-003-001	1.0000	0.0047	1.0027	0.0001	
pu-sol-therm-003-002	1.0000	0.0047	1.0024	0.0001	
pu-sol-therm-003-003	1.0000	0.0047	1.0051	0.0001	*
pu-sol-therm-003-004	1.0000	0.0047	1.0043	0.0001	
pu-sol-therm-003-005	1.0000	0.0047	1.0057	0.0001	*
pu-sol-therm-003-006	1.0000	0.0047	1.0061	0.0001	*
pu-sol-therm-003-007	1.0000	0.0047	1.0067	0.0001	*
pu-sol-therm-003-008	1.0000	0.0047	1.0054	0.0001	*
pu-sol-therm-004-001	1.0000	0.0047	1.0040	0.0001	
pu-sol-therm-004-002	1.0000	0.0047	0.9987	0.0001	
pu-sol-therm-004-003	1.0000	0.0047	1.0009	0.0001	
pu-sol-therm-004-004	1.0000	0.0047	0.9990	0.0001	
pu-sol-therm-004-005	1.0000	0.0047	0.9998	0.0001	
pu-sol-therm-004-006	1.0000	0.0047	1.0019	0.0001	
pu-sol-therm-004-007	1.0000	0.0047	1.0056	0.0001	*
pu-sol-therm-004-008	1.0000	0.0047	1.0012	0.0001	
pu-sol-therm-004-009	1.0000	0.0047	1.0007	0.0001	
pu-sol-therm-004-010	1.0000	0.0047	1.0023	0.0001	
pu-sol-therm-004-011	1.0000	0.0047	1.0009	0.0001	
pu-sol-therm-004-012	1.0000	0.0047	1.0031	0.0001	
pu-sol-therm-004-013	1.0000	0.0047	1.0004	0.0001	
pu-sol-therm-005-001	1.0000	0.0047	1.0023	0.0001	
pu-sol-therm-005-002	1.0000	0.0047	1.0030	0.0001	
pu-sol-therm-005-003	1.0000	0.0047	1.0035	0.0001	
pu-sol-therm-005-004	1.0000	0.0047	1.0050	0.0001	*
pu-sol-therm-005-005	1.0000	0.0047	1.0062	0.0001	*
pu-sol-therm-005-006	1.0000	0.0047	1.0058	0.0001	*
pu-sol-therm-005-007	1.0000	0.0047	1.0042	0.0001	
pu-sol-therm-005-008	1.0000	0.0047	0.9994	0.0001	
pu-sol-therm-005-009	1.0000	0.0047	1.0022	0.0001	
pu-sol-therm-006-001	1.0000	0.0035	1.0007	0.0001	
pu-sol-therm-006-002	1.0000	0.0035	1.0020	0.0001	
pu-sol-therm-006-003	1.0000	0.0035	1.0016	0.0001	
pu-sol-therm-007-002	1.0000	0.0047	1.0096	0.0001	*
pu-sol-therm-007-003	1.0000	0.0047	1.0036	0.0001	
pu-sol-therm-007-005	1.0000	0.0047	1.0093	0.0001	*
pu-sol-therm-007-006	1.0000	0.0047	1.0031	0.0001	
pu-sol-therm-007-007	1.0000	0.0047	1.0052	0.0001	*
pu-sol-therm-007-008	1.0000	0.0047	0.9987	0.0001	
pu-sol-therm-007-009	1.0000	0.0047	0.9973	0.0001	
pu-sol-therm-007-010	1.0000	0.0047	1.0009	0.0001	
pu-sol-therm-009-003	1.0000	0.0033	1.0193	0.0001	***
pu-sol-therm-010-001	1.0000	0.0048	1.0181	0.0001	***
pu-sol-therm-010-002	1.0000	0.0048	1.0143	0.0001	**
pu-sol-therm-010-003	1.0000	0.0048	1.0082	0.0001	*

pu-sol-therm-010-004	1.0000	0.0048	1.0126	0.0001	**
pu-sol-therm-010-005	1.0000	0.0048	1.0106	0.0001	**
pu-sol-therm-010-006	1.0000	0.0048	1.0095	0.0001	*
pu-sol-therm-010-007	1.0000	0.0048	1.0024	0.0001	
pu-sol-therm-010-008	1.0000	0.0048	1.0038	0.0001	
pu-sol-therm-010-009	1.0000	0.0048	1.0145	0.0001	**
pu-sol-therm-010-010	1.0000	0.0048	1.0026	0.0001	
pu-sol-therm-010-011	1.0000	0.0048	1.0098	0.0001	**
pu-sol-therm-010-012	1.0000	0.0048	1.0095	0.0001	*
pu-sol-therm-010-013	1.0000	0.0048	1.0158	0.0001	***
pu-sol-therm-010-014	1.0000	0.0048	1.0097	0.0001	*
pu-sol-therm-011-161	1.0000	0.0052	1.0096	0.0001	*
pu-sol-therm-011-162	1.0000	0.0052	1.0148	0.0001	**
pu-sol-therm-011-163	1.0000	0.0052	1.0166	0.0001	***
pu-sol-therm-011-164	1.0000	0.0052	1.0093	0.0001	*
pu-sol-therm-011-165	1.0000	0.0052	1.0064	0.0001	*
pu-sol-therm-011-181	1.0000	0.0052	0.9943	0.0001	*
pu-sol-therm-011-182	1.0000	0.0052	1.0005	0.0001	
pu-sol-therm-011-183	1.0000	0.0052	0.9968	0.0001	
pu-sol-therm-011-184	1.0000	0.0052	0.9937	0.0001	*
pu-sol-therm-011-185	1.0000	0.0052	1.0037	0.0001	
pu-sol-therm-011-186	1.0000	0.0052	1.0003	0.0001	
pu-sol-therm-011-187	1.0000	0.0052	0.9997	0.0001	
pu-sol-therm-012-001	1.0000	0.0043	1.0054	0.0001	*
pu-sol-therm-012-002	1.0000	0.0043	1.0062	0.0001	*
pu-sol-therm-012-003	1.0000	0.0058	1.0074	0.0001	*
pu-sol-therm-012-004	1.0000	0.0058	1.0075	0.0001	*
pu-sol-therm-012-005	1.0000	0.0058	1.0098	0.0001	*
pu-sol-therm-012-006	1.0000	0.0007	1.0066	0.0001	***
pu-sol-therm-012-007	1.0000	0.0013	1.0054	0.0001	***
pu-sol-therm-012-008	1.0000	0.0013	1.0042	0.0001	**
pu-sol-therm-012-009	1.0000	0.0043	1.0097	0.0001	**
pu-sol-therm-012-010	1.0000	0.0043	1.0041	0.0001	
pu-sol-therm-012-011	1.0000	0.0043	1.0067	0.0001	*
pu-sol-therm-012-012	1.0000	0.0043	1.0072	0.0001	*
pu-sol-therm-012-013	1.0000	0.0058	1.0096	0.0001	*
pu-sol-therm-018-001	1.0000	0.0034	1.0085	0.0001	**
pu-sol-therm-018-002	1.0000	0.0034	1.0119	0.0001	***
pu-sol-therm-018-003	1.0000	0.0032	1.0094	0.0001	**
pu-sol-therm-018-004	1.0000	0.0030	1.0076	0.0001	**
pu-sol-therm-018-005	1.0000	0.0030	1.0065	0.0001	**
pu-sol-therm-018-006	1.0000	0.0031	1.0046	0.0001	*
pu-sol-therm-018-007	1.0000	0.0032	1.0040	0.0001	*
pu-sol-therm-018-008	1.0000	0.0033	1.0036	0.0001	*
pu-sol-therm-018-009	1.0000	0.0034	1.0018	0.0001	
pu-sol-therm-022-001	1.0000	0.0020	0.9995	0.0001	
pu-sol-therm-022-002	1.0000	0.0016	1.0021	0.0001	*
pu-sol-therm-022-003	1.0000	0.0015	1.0007	0.0001	
pu-sol-therm-022-004	1.0000	0.0017	1.0013	0.0001	
pu-sol-therm-022-005	1.0000	0.0019	1.0023	0.0001	*
pu-sol-therm-022-006	1.0000	0.0021	1.0027	0.0001	*
pu-sol-therm-022-007	1.0000	0.0021	1.0042	0.0001	*
pu-sol-therm-022-008	1.0000	0.0023	1.0050	0.0001	**
pu-sol-therm-022-009	1.0000	0.0024	1.0037	0.0001	*
pu-sol-therm-028-001	1.0000	0.0012	1.0079	0.0001	***
pu-sol-therm-028-002	1.0000	0.0012	1.0071	0.0001	***
pu-sol-therm-028-003	1.0000	0.0012	1.0089	0.0001	***
pu-sol-therm-028-004	1.0000	0.0012	1.0087	0.0001	***
pu-sol-therm-028-005	1.0000	0.0012	1.0099	0.0001	***
pu-sol-therm-028-006	1.0000	0.0012	1.0107	0.0001	***
pu-sol-therm-028-007	1.0000	0.0012	1.0082	0.0001	***
pu-sol-therm-028-008	1.0000	0.0012	1.0083	0.0001	***
pu-sol-therm-028-009	1.0000	0.0012	1.0099	0.0001	***
pu-sol-therm-032-001	1.0000	0.0019	0.9962	0.0001	*
pu-sol-therm-032-002	1.0000	0.0019	1.0014	0.0001	

pu-sol-therm-032-003	1.0000	0.0019	1.0026	0.0001	*
pu-sol-therm-032-004	1.0000	0.0019	1.0026	0.0001	*
pu-sol-therm-032-005	1.0000	0.0019	1.0044	0.0001	**
pu-sol-therm-032-006	1.0000	0.0019	1.0048	0.0001	**
pu-sol-therm-032-007	1.0000	0.0019	1.0050	0.0001	**
pu-sol-therm-032-008	1.0000	0.0019	1.0044	0.0001	**
pu-sol-therm-032-009	1.0000	0.0019	1.0033	0.0001	*
pu-sol-therm-032-010	1.0000	0.0019	1.0051	0.0001	**
pu-sol-therm-032-011	1.0000	0.0019	1.0045	0.0001	**
pu-sol-therm-032-012	1.0000	0.0019	1.0035	0.0001	*
pu-sol-therm-032-013	1.0000	0.0019	1.0023	0.0001	*
pu-sol-therm-032-014	1.0000	0.0019	1.0021	0.0001	*
pu-sol-therm-032-015	1.0000	0.0019	1.0040	0.0001	*
pu-sol-therm-032-016	1.0000	0.0019	1.0038	0.0001	*
pu-sol-therm-032-017	1.0000	0.0019	1.0039	0.0001	*
pu-sol-therm-034-001	1.0000	0.0062	1.0000	0.0001	
pu-sol-therm-034-002	1.0000	0.0044	1.0015	0.0001	
pu-sol-therm-034-003	1.0000	0.0040	0.9995	0.0001	
pu-sol-therm-034-004	1.0000	0.0039	1.0025	0.0001	
pu-sol-therm-034-005	1.0000	0.0040	0.9999	0.0001	
pu-sol-therm-034-006	1.0000	0.0042	1.0011	0.0001	
pu-sol-therm-034-007	1.0000	0.0057	0.9987	0.0001	
pu-sol-therm-034-008	1.0000	0.0055	0.9989	0.0001	
pu-sol-therm-034-009	1.0000	0.0052	0.9978	0.0001	
pu-sol-therm-034-010	1.0000	0.0052	0.9973	0.0001	
pu-sol-therm-034-011	1.0000	0.0048	0.9990	0.0001	
pu-sol-therm-034-012	1.0000	0.0042	0.9985	0.0001	
pu-sol-therm-034-013	1.0000	0.0043	0.9970	0.0001	
pu-sol-therm-034-014	1.0000	0.0044	0.9968	0.0001	
pu-sol-therm-034-015	1.0000	0.0042	0.9972	0.0001	
pu-sol-therm-038-001	1.0005	0.0015	1.0032	0.0001	*
pu-sol-therm-038-002	1.0005	0.0015	1.0036	0.0001	*
pu-sol-therm-038-003	1.0005	0.0018	1.0036	0.0001	*
pu-sol-therm-038-004	1.0005	0.0013	1.0017	0.0001	
pu-sol-therm-038-005	1.0005	0.0013	1.0019	0.0001	*
u233-comp-therm-001-001	1.0006	0.0027	0.9995	0.0001	
u233-comp-therm-001-002	1.0015	0.0025	1.0021	0.0001	
u233-comp-therm-001-003	1.0000	0.0024	1.0022	0.0001	
u233-comp-therm-001-004	1.0007	0.0025	1.0006	0.0001	
u233-comp-therm-001-005	1.0015	0.0026	1.0002	0.0001	
u233-comp-therm-001-006	1.0015	0.0028	0.9987	0.0001	
u233-comp-therm-001-007	0.9995	0.0027	1.0017	0.0001	
u233-comp-therm-001-008	1.0004	0.0028	0.9995	0.0001	
u233-comp-therm-004-001	1.0017	0.0018	0.9980	0.0001	*
u233-met-fast-001-001	1.0000	0.0010	0.9999	0.0001	
u233-met-fast-002-001	1.0000	0.0010	0.9987	0.0001	*
u233-met-fast-002-002	1.0000	0.0011	1.0002	0.0001	
u233-met-fast-003-001	1.0000	0.0010	0.9992	0.0001	
u233-met-fast-003-002	1.0000	0.0010	0.9996	0.0001	
u233-met-fast-004-001	1.0000	0.0007	0.9985	0.0001	*
u233-met-fast-004-002	1.0000	0.0008	0.9957	0.0001	***
u233-met-fast-005-001	1.0000	0.0010	0.9961	0.0001	***
u233-met-fast-005-002	1.0000	0.0030	0.9951	0.0001	*
u233-met-fast-006-001	1.0000	0.0014	0.9990	0.0001	
u233-sol-inter-001-001	1.0000	0.0083	0.9851	0.0002	*
u233-sol-inter-001-002	1.0000	0.0085	0.9810	0.0001	**
u233-sol-inter-001-003	1.0000	0.0066	0.9819	0.0002	**
u233-sol-inter-001-004	1.0000	0.0061	0.9934	0.0001	*
u233-sol-inter-001-005	1.0000	0.0082	0.9849	0.0001	*
u233-sol-inter-001-006	1.0000	0.0061	0.9866	0.0001	**
u233-sol-inter-001-007	1.0000	0.0059	0.9825	0.0002	**
u233-sol-inter-001-008	1.0000	0.0056	0.9818	0.0002	***
u233-sol-inter-001-009	1.0000	0.0068	0.9797	0.0002	**
u233-sol-inter-001-010	1.0000	0.0053	0.9790	0.0002	***
u233-sol-inter-001-011	1.0000	0.0057	0.9807	0.0002	***

u233-sol-inter-001-012	1.0000	0.0091	0.9816	0.0001	*
u233-sol-inter-001-013	1.0000	0.0071	0.9826	0.0002	**
u233-sol-inter-001-014	1.0000	0.0052	0.9913	0.0001	*
u233-sol-inter-001-015	1.0000	0.0075	0.9805	0.0001	**
u233-sol-inter-001-016	1.0000	0.0028	0.9819	0.0001	***
u233-sol-inter-001-017	1.0000	0.0055	0.9896	0.0001	*
u233-sol-inter-001-018	1.0000	0.0057	0.9788	0.0001	***
u233-sol-inter-001-019	1.0000	0.0083	0.9759	0.0002	**
u233-sol-inter-001-020	1.0000	0.0056	0.9808	0.0002	***
u233-sol-inter-001-021	1.0000	0.0050	0.9733	0.0002	***
u233-sol-inter-001-022	1.0000	0.0049	0.9787	0.0002	***
u233-sol-inter-001-023	1.0000	0.0047	0.9903	0.0002	*
u233-sol-inter-001-024	1.0000	0.0081	0.9927	0.0001	
u233-sol-inter-001-025	1.0000	0.0081	0.9856	0.0001	*
u233-sol-inter-001-026	1.0000	0.0065	0.9895	0.0001	*
u233-sol-inter-001-027	1.0000	0.0051	0.9914	0.0002	*
u233-sol-inter-001-028	1.0000	0.0061	0.9841	0.0002	**
u233-sol-inter-001-029	1.0000	0.0098	0.9777	0.0001	**
u233-sol-inter-001-030	1.0000	0.0053	0.9788	0.0002	***
u233-sol-inter-001-031	1.0000	0.0071	0.9914	0.0002	*
u233-sol-inter-001-032	1.0000	0.0053	0.9761	0.0002	***
u233-sol-inter-001-033	1.0000	0.0046	0.9941	0.0002	*
u233-sol-therm-001-001	1.0000	0.0031	1.0013	0.0001	
u233-sol-therm-001-002	1.0005	0.0033	1.0014	0.0001	
u233-sol-therm-001-003	1.0006	0.0033	1.0008	0.0001	
u233-sol-therm-001-004	0.9998	0.0033	1.0009	0.0001	
u233-sol-therm-001-005	0.9999	0.0033	0.9999	0.0001	
u233-sol-therm-005-001	1.0000	0.0040	1.0018	0.0001	
u233-sol-therm-005-002	1.0000	0.0049	1.0047	0.0001	
u233-sol-therm-008-001	1.0006	0.0029	1.0014	0.0001	
u233-sol-therm-009-001	0.9966	0.0044	0.9961	0.0001	
u233-sol-therm-009-002	0.9981	0.0040	0.9993	0.0001	
u233-sol-therm-009-003	0.9989	0.0038	1.0004	0.0001	
u233-sol-therm-009-004	0.9998	0.0038	0.9993	0.0001	
u233-sol-therm-012-001	1.0000	0.0028	1.0008	0.0001	
u233-sol-therm-012-002	1.0000	0.0025	1.0001	0.0001	
u233-sol-therm-012-003	1.0000	0.0023	1.0095	0.0001	***
u233-sol-therm-012-004	1.0000	0.0015	1.0025	0.0001	*
u233-sol-therm-012-005	1.0000	0.0071	1.0051	0.0001	
u233-sol-therm-012-006	1.0000	0.0010	1.0058	0.0001	***
u233-sol-therm-012-007	1.0000	0.0038	1.0017	0.0001	
u233-sol-therm-012-008	1.0000	0.0048	0.9992	0.0001	
u233-sol-therm-013-001	0.9992	0.0073	1.0053	0.0002	
u233-sol-therm-013-002	0.9992	0.0070	1.0060	0.0002	
u233-sol-therm-013-003	0.9992	0.0069	1.0059	0.0002	
u233-sol-therm-013-004	0.9992	0.0073	1.0066	0.0002	
u233-sol-therm-013-005	0.9992	0.0067	1.0072	0.0001	*
u233-sol-therm-013-006	0.9992	0.0050	1.0062	0.0002	*
u233-sol-therm-013-007	0.9992	0.0054	1.0061	0.0001	*
u233-sol-therm-013-008	0.9992	0.0050	1.0073	0.0002	*
u233-sol-therm-013-009	0.9992	0.0045	1.0074	0.0002	*
u233-sol-therm-013-010	0.9992	0.0046	1.0083	0.0002	*
u233-sol-therm-013-011	0.9992	0.0054	1.0051	0.0002	*
u233-sol-therm-013-012	0.9992	0.0050	1.0059	0.0002	*
u233-sol-therm-013-013	0.9992	0.0062	1.0035	0.0002	
u233-sol-therm-013-014	0.9992	0.0051	1.0067	0.0001	*
u233-sol-therm-013-015	0.9996	0.0077	1.0213	0.0002	**
u233-sol-therm-013-016	0.9996	0.0069	0.9938	0.0001	
u233-sol-therm-013-017	0.9996	0.0052	0.9964	0.0001	
u233-sol-therm-013-018	0.9996	0.0020	1.0003	0.0002	
u233-sol-therm-013-019	0.9996	0.0089	0.9962	0.0002	
u233-sol-therm-013-020	0.9996	0.0056	0.9997	0.0001	
u233-sol-therm-013-021	0.9996	0.0034	1.0028	0.0001	
u233-sol-therm-015-001	1.0000	0.0075	0.9903	0.0001	*
u233-sol-therm-015-002	1.0000	0.0070	0.9860	0.0001	*

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u233-sol-therm-015-003    1.0000 0.0068    0.9871 0.0001 *
u233-sol-therm-015-004    1.0000 0.0041    0.9903 0.0001 **
u233-sol-therm-015-005    1.0000 0.0055    0.9867 0.0002 **
u233-sol-therm-015-006    1.0000 0.0099    0.9771 0.0002 **
u233-sol-therm-015-007    1.0000 0.0070    0.9880 0.0001 *
u233-sol-therm-015-008    1.0000 0.0067    0.9736 0.0001 ***
u233-sol-therm-015-009    1.0000 0.0050    0.9695 0.0002 ***
u233-sol-therm-015-010    1.0000 0.0051    0.9898 0.0002 *
u233-sol-therm-015-011    1.0000 0.0075    0.9936 0.0002
u233-sol-therm-015-012    1.0000 0.0069    0.9941 0.0002
u233-sol-therm-015-013    1.0000 0.0069    0.9921 0.0002 *
u233-sol-therm-015-014    1.0000 0.0036    0.9985 0.0001
u233-sol-therm-015-015    1.0000 0.0060    0.9897 0.0002 *
u233-sol-therm-015-016    1.0000 0.0043    0.9888 0.0002 **
u233-sol-therm-015-017    1.0000 0.0029    0.9981 0.0002
u233-sol-therm-015-018    1.0000 0.0056    0.9748 0.0002 ***
u233-sol-therm-015-019    1.0000 0.0052    0.9750 0.0002 ***
u233-sol-therm-015-020    1.0000 0.0079    0.9953 0.0001
u233-sol-therm-015-021    1.0000 0.0070    0.9980 0.0001
u233-sol-therm-015-022    1.0000 0.0062    0.9964 0.0002
u233-sol-therm-015-023    1.0000 0.0055    0.9948 0.0001
u233-sol-therm-015-024    1.0000 0.0051    0.9909 0.0002 *
u233-sol-therm-015-025    1.0000 0.0023    0.9985 0.0001
u233-sol-therm-015-026    1.0000 0.0066    0.9942 0.0001
u233-sol-therm-015-027    1.0000 0.0063    0.9991 0.0001
u233-sol-therm-015-028    1.0000 0.0058    0.9972 0.0001
u233-sol-therm-015-029    1.0000 0.0051    0.9955 0.0001
u233-sol-therm-015-030    1.0000 0.0048    0.9948 0.0001 *
u233-sol-therm-015-031    1.0000 0.0055    0.9942 0.0001 *
u233-sol-therm-016-001    0.9987 0.0037    1.0042 0.0002 *
u233-sol-therm-016-002    0.9983 0.0044    1.0049 0.0002 *
u233-sol-therm-016-003    0.9992 0.0036    1.0044 0.0002 *
u233-sol-therm-016-006    0.9993 0.0034    0.9964 0.0002
u233-sol-therm-016-007    1.0008 0.0034    0.9971 0.0002 *
u233-sol-therm-016-008    1.0011 0.0028    0.9968 0.0002 *
u233-sol-therm-016-010    1.0000 0.0030    1.0049 0.0002 *
u233-sol-therm-016-011    0.9992 0.0041    1.0049 0.0002 *
u233-sol-therm-016-012    0.9992 0.0047    1.0048 0.0002 *
u233-sol-therm-016-013    0.9993 0.0036    1.0050 0.0002 *
u233-sol-therm-016-014    1.0000 0.0026    1.0058 0.0002 **
u233-sol-therm-016-015    1.0000 0.0027    1.0062 0.0002 **
u233-sol-therm-016-016    0.9994 0.0031    1.0098 0.0002 ***
u233-sol-therm-016-017    1.0000 0.0028    0.9955 0.0001 *
u233-sol-therm-016-018    0.9988 0.0036    0.9957 0.0002
u233-sol-therm-016-021    1.0000 0.0028    1.0097 0.0002 ***
u233-sol-therm-016-022    1.0000 0.0034    1.0094 0.0002 **
u233-sol-therm-016-023    1.0000 0.0031    1.0100 0.0002 ***
u233-sol-therm-016-025    0.9981 0.0040    1.0004 0.0001
u233-sol-therm-016-026    0.9980 0.0034    1.0053 0.0001 **
u233-sol-therm-016-027    0.9988 0.0037    1.0037 0.0001 *
u233-sol-therm-016-028    0.9986 0.0037    0.9991 0.0001
u233-sol-therm-016-029    0.9985 0.0031    0.9998 0.0001
u233-sol-therm-016-030    0.9993 0.0032    0.9996 0.0002
u233-sol-therm-016-031    0.9990 0.0034    1.0104 0.0001 ***
u233-sol-therm-016-032    0.9985 0.0032    1.0126 0.0001 ***
u233-sol-therm-016-033    0.9986 0.0039    1.0125 0.0001 ***
u233-sol-therm-017-001    0.9997 0.0032    1.0043 0.0001 *
u233-sol-therm-017-002    1.0000 0.0025    1.0001 0.0001
u233-sol-therm-017-003    1.0001 0.0035    1.0055 0.0001 *
u233-sol-therm-017-004    0.9994 0.0040    1.0055 0.0001 *
u233-sol-therm-017-005    1.0000 0.0029    1.0016 0.0001
u233-sol-therm-017-006    1.0000 0.0029    1.0006 0.0001
u233-sol-therm-017-007    1.0000 0.0037    1.0006 0.0001

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