

INTERAGENCY AGREEMENT		1. IAA NO. NRC-HQ-60-17-T-0019	PAGE OF 1 2			
2. ORDER NO.		3. REQUISITION NO. RES-17-0287	4. SOLICITATION NO.			
5. EFFECTIVE DATE 08/11/2017	6. AWARD DATE 08/11/2017	7. PERIOD OF PERFORMANCE 08/28/2017 TO 12/31/2018				
8. SERVICING AGENCY OAK RIDGE NATIONAL LAB ALC: DUNS: 012075755 +4: US DEPARTMENT OF ENERGY OAK RIDGE NATION LABORATORY SITE OFFICE BUILDING 4500N MS 6269 PO BOX 2008 OAK RIDGE TN 37831-6269 POC Deborah Garland, CO TELEPHONE NO. (865) 241-9566		9. DELIVER TO DON ALGAMA US NUCLEAR REGULATORY COMMISSION TWO WHITE FLINT NORTH BUILDING 11545 ROCKVILLE PIKE MAIL STOP T-10A36 ROCKVILLE MD 20852				
10. REQUESTING AGENCY ACQUISITION MANAGEMENT DIVISION ALC: 31000001 DUNS: 040535809 +4: US NUCLEAR REGULATORY COMMISSION TWO WHITE FLINT NORTH 11545 ROCKVILLE PIKE MAIL STOP T-8-06M ROCKVILLE MD 20852-2738 POC Carolyn A. Cooper TELEPHONE NO. 301-415-6734		11. INVOICE OFFICE US NUCLEAR REGULATORY COMMISSION ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE MAILSTOP O3-E17A ROCKVILLE MD 20852-2738				
12. ISSUING OFFICE US NRC - HQ ACQUISITION MANAGEMENT DIVISION MAIL STOP TWFN-8E06M WASHINGTON DC 20555-0001		13. LEGISLATIVE AUTHORITY Energy Reorganization Act of 1974				
		14. PROJECT ID ADM				
		15. PROJECT TITLE SHIFT DEVELOPMENT FOR SENSITIVITY/UNCERTAINTY ANAL				
16. ACCOUNTING DATA 2017-X0200-FEEBASED-60-60D003-60B302-1145-11-6-213-253D-11-6-213-1145						
17. ITEM NO.	18. SUPPLIES/SERVICES		19. QUANTITY	20. UNIT	21. UNIT PRICE	22. AMOUNT
	NRC-HQ-60-17-T-0019 The NRC and the DOE Laboratory (ORNL) hereby enter into this Task Order Agreement No. NRC-HQ-60-17-T-0019, for the project entitled "SCALE/Shift Development for Sensitivity/Uncertainty Analysis." NRC COR: Don Algama (301)415-1940 ALT COR: Dr. Mourad Aissa (301)415-0380 ORNL PI: Matthew Jessee (865)241-1503 Continued ...					
23. PAYMENT PROVISIONS			24. TOTAL AMOUNT \$100,000.00			
25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING) <i>Deborah Garland</i>			25b. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING) <i>Carolyn A. Cooper</i>			
25c. NAME AND TITLE Deborah L. Garland, Contracting Officer		25d. DATE 8/15/17	25e. CONTRACTING OFFICER CAROLYN A. COOPER		25f. DATE 8/11/2017	

The period of performance shall commence on August 28, 2017 and shall end on December 31, 2018. Notwithstanding the agreement effective dates and period of performance start dates stated elsewhere in the agreement, the effective date of the agreement and start date of the period of performance are the last date of signature by the parties.

CONSIDERATION AND OBLIGATION:

- (a) Authorized Ceiling Amount: \$460,000.00
- (b) The amount presently obligated with respect to this task order is \$100,000.00. When and if the amount(s) paid and payable to the DOE Laboratory hereunder equals the amount obligated, the DOE Laboratory shall not be obligated to continue performance of the work unless and until the NRC Contracting Officer increases the amount obligated with respect to this DOE Task Order Agreement. Any work undertaken by the DOE Laboratory in excess of the obligated amount specified above is done so at the DOE Laboratory's sole risk.

The following documents are hereby incorporated as part of this Agreement:

- Attachment No. 1: Statement of Work
- Attachment No. 2: DOE Standard Terms and Conditions

The work hereunder is non-fee recoverable.

This agreement is entered into pursuant to the authority of the Energy Reorganization Act of 1974, as amended (42 U.S.C 5801 et seq.). This work will be performed in accordance with the NRC/DOE Memorandum of Understanding dated November 24, 1998. To the best of our knowledge, the work requested will not place the DOE and its contractor in direct competition with the domestic private sector.

Master IAA: NRCHQ2514D0004

STATEMENT OF WORK

SCALE/SHIFT DEVELOPMENT FOR SENSITIVITY/UNCERTAINTY ANALYSIS

Background

Regulatory Context:

The Nuclear Regulatory Commission (NRC) relies on SCALE as a robust, state-of-the-art nuclear analysis computer code system that allows for independent review of licensee submittals and accurate investigations of reactor phenomena and nuclear criticality safety for fresh and spent fuel in transportation/storage containers and spent fuel pools.

The SCALE computer code system affects licensing evaluations that are being performed at the NRC that rely on nuclear criticality safety calculations. This work will impact analyses related to criticality safety assessments.

Technical Context:

Multigroup sensitivity/uncertainty (S/U) analysis capabilities were introduced in SCALE 5.0 more than a decade ago in the TSUNAMI/KENO Monte Carlo S/U code sequence. More recently, continuous energy (CE) S/U with TSUNAMI/KENO was released in SCALE 6.2. However, as part of the SCALE modernization effort, the modern high performance parallel Monte Carlo code Shift is currently being implemented into SCALE to replace KENO for criticality safety and reactor physics analyses. The CE S/U analysis capabilities need to be developed as a parallel-efficient computational package fully integrated into the Shift Monte Carlo code in SCALE.

Relationship to Other Projects

NRC-HQ-6015-T0026 "Shift - Integration of SCALE Nuclear Stochastic Methods" is focused on initial implementation of Shift into SCALE for criticality safety applications to replace CSAS/KENO. NRC-HQ-6017-T0021 "SCALE/Shift Hybrid Deterministic/Monte Carlo" will focus on initial implementation of hybrid shielding methods to replace MAVRIC/Monaco. This project will focus on initial implementation of continuous energy sensitivity/uncertainty capabilities to replace TSUNAMI/KENO.

Objective(s) of Proposed Work

This objective of this task order is to implement Sensitivity/Uncertainty capability into SCALE/Shift.

Work to Be Performed and Expected Results

Oak Ridge National Laboratory (ORNL) provide all resources necessary to accomplish the tasks and deliverables described in this Statement of Work (SOW).

Task 1. S/U Implementation into SCALE/Shift

ORNL will integrate Sensitivity/Uncertainty capabilities into the Shift Monte Carlo code to compute the sensitivity of k-eff and reaction rate ratios to energy-dependent cross section data for each reaction of each nuclide in a system model.

ORNL will compute sensitivity coefficients in a single forward Monte Carlo neutron transport calculation for either eigenvalue, or generalized reaction rate ratio responses.

ORNL will implement sensitivity analysis capabilities in Shift and the associated SCALE sequence and user interfaces to replicate the existing CLUTCH (Contributon-Linked eigenvalue sensitivity/Uncertainty estimation via Tracklength importance CHaracterization), IFP (Iterated Fission Probability), and GPT (Generalized Perturbation Theory) sensitivity capabilities available in CE TSUNAMI-3D. The GPT sensitivity capability shall incorporate recent updates to enable sensitivity coefficient calculations for an extended set of responses, which are consistent with the GPT sensitivity analysis capabilities offered in TSUNAMI-1D/2D. New capabilities of interest to the criticality safety and reactor physics communities will also be introduced such as the sensitivity of responses to the energy and angular distributions from scattering. Generation of new sensitivity coefficients for scattering anisotropy, especially important for fast spectrum systems, will also be investigated. Since Shift can perform fixed-source shielding calculations as well as eigenvalue calculations, an initial implementation of fixed-source reaction rate sensitivity coefficients will also be demonstrated leveraging the integration of MAVRIC methods integrated under NRCHQ6017T0021.

ORNL will leverage the SCALE/Shift parallel infrastructure to improve the parallel performance of the sensitivity coefficient calculations. The TSUNAMI/Shift implementation should achieve full high-performance parallelization for all sensitivity analysis methods. High performance should be achieved in part by implementing the algorithms such that the required amount of sensitivity tally communication is minimized, thereby achieving near-linear parallel efficiency.

ORNL will develop appropriate test cases using SCALE input for relevant application cases for criticality safety and reactor physics and test the new capability against both the current TSUNAMI/KENO sequence as well as against existing methods outside of SCALE, where possible. Performance testing against the current TSUNAMI/KENO capability and parallel scaling studies shall be included.

The TSUNAMI/Shift methods will produce traditional ASCII sensitivity data files (SDF's) for use in subsequent analyses (i.e. TSUNAMI-IP, TSURFER, etc.). Additionally, ORNL will use an HDF5-SDF format to enable efficient processing of sensitivity coefficients for simulations containing a large amount of sensitivity tally information and with the format fully supported throughout SCALE.

Task 2. Technical Support

Technical support and on-call assistance in the operation of the SCALE system shall be provided to NRC staff as requested by the NRC COR. This technical support shall include providing assistance with technical issues as they arise during performance of Task 1, and may include interaction with ACRS, and collaborations with other staff and/or contractors, as appropriate.

NOTE: Computer code development must conform to NURG/BR-0167 requirements for Software Quality Assurance as implemented under the SCALE Software Quality Assurance Program.

Key Personnel

Steve Bowman will be the Project Manager and Matt Jessee will be the Principal Investigator for this effort. Other key staff include Seth Johnson, Chris Perfetti, Mark Williams, Kursat Bekar, and William (BJ) Marshall. Résumés are attached.

Travel

The following travel is anticipated under the task order:

FY18

- One, one-person trip to NRC HQ for project related activities.
- Foreign travel for one traveler to the Organization for Economic Cooperation and Development, Nuclear Energy Agency, Working Party on Reactor Systems, Uncertainty Analysis in Modeling (UAM) and associated Best Estimate Plus Uncertainty (BEPU) meeting will be supported to present these new tools to the user community.

ORNL personnel will be authorized travel expenses consistent with the Federal Travel Regulation (FTR) and the limitation of funds specified for the travel within this agreement/order. All travel requires prior written approval from the COR.

Foreign travel for ORNL personnel requires a 60-day lead time for NRC approval. For prior approval of foreign travel, the servicing agency shall submit to the COR an NRC Form 445, "Request for Approval of Official Foreign Travel." NRC Form 445 is available in the MD 11.7 Documents library and on the NRC Web site at: <http://www.nrc.gov/reading-rm/doc-collections/forms/>. All foreign travel requires prior written approval from the NRC Executive Director for Operations (EDO).

Reporting Requirements and Schedule

Task Number	Deliverable	Deliverable Format	Due Date
1	Technical letter report. The report should detail the developments made, new input deck commands, and testing performed.	Technical letter report shall be in WORD and PDF formats.	9/30/2018
2	Computer Code delivery with SCALE release.	6.3 or next earliest release	9/30/2018

ORNL is responsible for structuring the deliverables to follow current agency standards. Deliverables will be technically edited and submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

ORNL will provide a Monthly Letter Status Report, which consists of a technical progress report and financial status report. This report will be used by the sponsoring agency to assess the adequacy of the resources utilized by ORNL to accomplish the work contained in this SOW and to provide status of ORNL progress in achieving tasks and producing deliverables. The report shall include agreement/order summary information, work completed during the specified period, milestone schedule information, problem identification and resolution, travel plans, and staff hour summary. Copies shall be sent to the COR and AMD at ContractsPOT.Resource@nrc.gov.

The MLSR must include the following: agreement number; task order number, if applicable; job code number; title of the project; project period of performance; task order period of performance, if applicable; COR's name, telephone number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period. At a minimum, the MLSR must include the information discussed in the NRC's [preferred] MSLR template.

The COR will acknowledge receipt of deliverables by email.

Period of Performance

The period of performance of this task order is from August 28, 2017 through December 31, 2018.

NRC-Furnished Property/Materials

N/A

Access to Non-NRC Facilities/Equipment

No special facilities are required for this project.