


| INTERAGENCY AGREEMENT | | 1. IAA NO. NRC-HQ-60-15-T-0001/M0012 | | | PAGE OF 1 12 | |
|--|--|---|-------------|--|-----------------|-------------------------|
| 2. ORDER NO. | | 3. REQUISITION NO. RES-19-0222 | | 4. SOLICITATION NO. | | |
| 5. EFFECTIVE DATE 05/10/2019 | | 6. AWARD DATE 05/10/2019 | | 7. PERIOD OF PERFORMANCE 12/15/2014 TO 12/31/2019 | | |
| 8. SERVICING AGENCY BROOKHAVEN NATIONAL LABORATORY ALC: DUNS: 027579460 +4: BROOKHAVEN SITE OFFICE PO BOX 5000 BLDG 464 UPTON NY 11973-5000 POC Jennifer Hartman TELEPHONE NO. 631-344-3438 | | | | 9. DELIVER TO TAREK ZAKI US NUCLEAR REGULATORY COMMISSION OFFICE OF NUCLEAR REGULATORY RESEARCH 11555 ROCKVILLE PIKE ROCKVILLE MD 20852 | | |
| 10. REQUESTING AGENCY ACQUISITION MANAGEMENT DIVISION ALC: 31000001 DUNS: 040535809 +4: US NUCLEAR REGULATORY COMMISSION ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE ROCKVILLE MD 20852-2738 POC Sandra Nesmith TELEPHONE NO. 301-415-6836 | | | | 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-07B20M WASHINGTON DC 20555-0001 | | | | 13. LEGISLATIVE AUTHORITY Energy Reorganization Act of 1974 | | |
| | | | | 14. PROJECT ID | | |
| | | | | 15. PROJECT TITLE SEE BLOCK 18 | | |
| 16. ACCOUNTING DATA 2019-X0200-FEEBASED-60-60D003-60B301-1147-17-6-161-253D-17-6-161-1147 | | | | | | |
| 17. ITEM NO. | 18. SUPPLIES/SERVICES | 19. QUANTITY | 20. UNIT | 21. UNIT PRICE | 22. AMOUNT | |
| | Project Title: Review of NuScale Scaling Methodology and the State-of-the-Art Review of Thermal-hydraulic Scaling for New Reactor Designs Master IAA: NRCHQ2514D0002 Agreement No. NRC-HQ-25-14-D-0002 Task Order No. NRC-HQ-60-15-T-0001 SUMMARY OF CHANGES: The purpose of this modification is to: (1) provide a within scope change to Task 3 and increase the level of effort; (2) increase the Continued ... | | | | | |
| 23. PAYMENT PROVISIONS | | | | 24. TOTAL AMOUNT \$97,499.00 | | |
| 25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING) | | | | 25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING)  | | |
| 25b. NAME AND TITLE | | 25c. DATE | | 26b. CONTRACTING OFFICER SANDRA R. NESMITH | | 26c. DATE 06/04/2019 |

authorized ceiling by \$97,499.00; (3) extend the period of performance through December 31, 2019; and (4) provide incremental funding in the amount of \$97,499.00;

Accordingly, this task order is modified as follows:

1. Reference to the "Statement of Work," is hereby deleted in its entirety and replaced with the following Statement of Work attached to this Modification No. 12.

2. The new authorized ceiling is \$607,460.00

3. The period of performance has changed from 12/15/14 - 9/20/19 to 12/15/14 - 12/31/19.

3. Incremental funding in the amount of \$97,499.00 is provided, thereby increasing the total obligations for this task order from \$509,961.00 to \$607,460.00

All other terms and conditions remain unchanged.

Attachment: Statement of Work

BNL PI: U. Roghatgi, 631-344-2475

NRC COR: Tarek Zaki, 301-415-0994

DUNS: 040535809 TAS: 31X0200.320
ALC: 31000001

STATEMENT OF WORK

| | | | |
|---|--|--|---|
| NRC Agreement Number | NRC Agreement Modification Number | NRC Task Order Number (If Applicable) | NRC Task Order Modification Number (If Applicable) |
| NRC-HQ-25-14-D-0002 | N/A | NRC-HQ-60-15-T-0001 | |
| Project Title | | | |
| Technical Assistance for the Review of NuScale Scaling Methodology and the State-of-the-Art Review of Thermal-hydraulic Scaling for New Reactor Designs | | | |
| Job Code Number | B&R Number | DOE Laboratory | |
| | 2015-60-17-6-100 | BNL | |
| NRC Requisitioning Office | | | |
| RES | | | |
| NRC Form 187, Contract Security and Classification Requirements | | | |
| <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> Not Applicable | | <input checked="" type="checkbox"/> Involves Proprietary Information <input type="checkbox"/> Involves Sensitive Unclassified | |
| <input checked="" type="checkbox"/> Non Fee-Recoverable | | <input checked="" type="checkbox"/> Fee-Recoverable (If checked, complete all applicable sections below) | |
| Docket Number (If Fee-Recoverable/Applicable) | | Inspection Report Number (If Fee Recoverable/Applicable) | |
| 99902043 | | N/A | |
| Technical Assignment Control Number (If Fee-Recoverable/Applicable) | | Technical Assignment Control Number Description (If Fee-Recoverable/Applicable) | |
| 000471 | | NuScale General Pre-Application Activities | |

1.0 BACKGROUND

Over the next several years, a number of small modular reactor (SMR) vendors, e.g. NuScale, mPower, and Westinghouse, are planning to submit design certification applications. Therefore, as a preliminary step toward these submittals, the vendors have begun engaging in pre-application activities and have submitted to the NRC several topical reports related to new reactor designs. These designs are unique and untested, so the topical reports, particularly those that include thermal-hydraulic scaling information, require increased scrutiny by NRC staff to understand and verify the acceptability of the novel scaling concepts. Some of the vendors are employing new thermal-hydraulic scaling techniques to design the experimental test facilities that will be used to verify the new reactor design concepts.

In 2012, NuScale submitted for review a new thermal hydraulic scaling technology called Dynamical System Scaling (DSS), a methodology based on the NRC-developed Hierarchical 2-Tier Scaling (H2TS) framework and some concepts of the Fractional Scaling Analysis (FSA) scaling method. As a result, the Office of Nuclear Regulatory Research (RES) was tasked, through the User Need NRO-2012-004, to support the Office of New Reactors (NRO) in

reviewing the DSS methodology. In November 2012, RES and NRO completed the initial review of the methodology and accepted the corresponding licensing topical report (LTR) for formal review.

However, due to the novel nature of the DSS methodology, the NRC staff recommended that NuScale perform a demonstration analysis showing the practical application of DSS on a scaled facility. In DSS, complex mathematics and physics are employed in order to develop a universal scaling methodology that generalizes most traditional scaling techniques. Therefore, a demonstration analysis would aid the NRC reviewers in the evaluation of the differential geometry theory employed and, ultimately, in determining the methodology's overall acceptability. In response, NuScale decided to submit a scaling analysis showing the application of the DSS methodology on the NuScale Integral System Test (NIST) facility. The submission of the NIST scaling analysis report is currently pending design modifications of the NIST facility.

Coincident with the SMR pre-application activities, RES has agreed to participate in the Working Group on Analysis and Management of Accidents (WGAMA) to conduct a state-of-the-art review (SOAR) on scaling-related subjects. The end product of this SOAR project will be a report that documents, by chapters, the findings on a number of scaling-related subjects. The SOAR report will cover scaling issues encountered over the past few decades, scaling techniques, and scaling as it applies to system codes and licensing. RES has been given the responsibility of leading the review of the scaling issues, designated as Chapter 2 in the report. In this chapter, the significance of scaling in the licensing process will be emphasized. In some sections of Chapter 3 and 4, the merits and limitations of commonly used scaling techniques will be critically reviewed and documented. Therefore, the work RES is responsible for is looked upon as an opportunity to provide the staff with the necessary skills to close knowledge gaps in the evaluation of the various SMR scaling designs including NuScale. The two underlying scaling techniques of the NuScale DSS methodology, H2TS and FSA, are relatively new techniques that will be critically reviewed in the SOAR.

The RES staff teamed up with BNL subject matter experts and started the SOAR effort in 2014 through an NRO agreement with BNL (Q4231, Task Order 4, Subtask 4E). This agreement enabled the staff and BNL to produce the first milestone of the SOAR project, the draft Chapter 2 report. This draft report is in the process of being reviewed by WGAMA. The work on the SOAR project will be continued with this SOW.

2.0 OBJECTIVE

The objective of this task order is for NRC staff to obtain:

- 1) Technical expertise from BNL to assist the NRC staff in closing the knowledge and skill gaps in thermal hydraulic scaling technology. BNL shall assist the staff in establishing an independent confirmatory scaling analysis procedure through the NuScale Scaling Analysis Technical Report review. In the SOAR review, BNL shall draw conclusions on the merits and limitations of currently available scaling methods which will be applied in future licensing reviews related to thermal hydraulic scaling.

- 2) Technical support from BNL in the review of the NuScale scaling analysis, and consultation during the SOAR project. The laboratory shall support the NRC by generating technical evaluation reports (TERs) based on the NuScale Scaling Analysis Technical Report review, refining Chapter 2 of the SOAR report and in drafting the scaling related sections in other chapters of the SOAR report.

3.0 SCOPE OF WORK

For the subject task order, BNL shall provide all resources necessary to accomplish the tasks and deliverables described in Sections 4 and 5 of this statement of work (SOW).

BNL shall assist the staff with the licensing review of the NuScale scaling analysis by reviewing the methodology, providing inputs to the staff evaluation reports at the various stages in the licensing process, and supporting all meetings with the licensee, if necessary. In parallel to the review, BNL shall develop an independent confirmatory scaling analysis procedure using an existing scaling method that is different from the methodology used by NuScale, and assist the staff in completing a confirmatory scaling analysis using the developed confirmatory scaling analysis procedure. The conclusion of the confirmatory analysis will serve as an input to the safety evaluation report (SER).

BNL shall also continue the work started with agreement Q4231, Task Order 4, Subtask 4E and refine Chapter 2 of the SOAR draft report by consolidating comments and topical contributions from NRC staff and other participating WGAMA members; draft write-ups for some topical sections in chapters other than Chapter 2; review all chapters in the draft full report, and provide consultation on scaling-related subjects, as needed.

4.0 SPECIFIC TASKS

Task 1: Review of the NuScale Scaling Analysis Technical Report (completed)

The contractor shall perform safety evaluation of the NuScale_Scaling Analysis Technical Report, support meetings with the licensee, and provide input for the development of Requests for Additional Information (RAIs). The contractor shall also prepare a draft TER that includes inputs to the SER.

Task 2: (deleted)

Task 3: Perform Confirmatory Scaling Analysis

The contractor shall:

- a. Support the NRC staff in reviewing and evaluating the RAI responses, including all updated and new information referenced by such responses, resolving any outstanding RAIs through audit teleconference, and investigating any scaling-related problems in the NuScale licensing topical reports.
- b. Perform confirmatory scaling analysis if needed, based on the RAI responses, for assessment of the NuScale scaling methodology.
- c. Prepare a final TER that includes inputs to the SER.

d. Support ACRS meetings by providing presentation material and briefings upon request.

Note: The completion of task 3 depends on the submittal of the NuScale scaling analysis report and associated technical reports, as well as the RAI responses.

Task 4: Refine Chapter 2 and Draft Sections in Other Chapters of the SOAR Report (completed)

The contractor shall continue the work started with agreement Q4231, Task Order 4, Subtask 4E and refine Chapter 2 of the draft SOAR report by consolidating comments and topical contributions from NRC staff and other WGAMA members into a final version. In addition, the contractor shall draft write-ups on topics related to scaling that belong to chapters other than Chapter 2. The topics will be determined by the start of contract.

Task 5: Review the draft SOAR Report and Provide Consultation (completed)

The contractor shall support NRC in reviewing all chapters of the draft SOAR report and provide consultation during the review. The contractor shall provide a two-hour seminar on thermal hydraulic scaling to NRC staff.

5.0 DELIVERABLES AND/OR MILESTONES SCHEDULE

| Task # | Deliverable | Due Date |
|--------|---|---|
| 1. | Draft TER that includes inputs to the SER <u>Standard:</u> Submit documents in Microsoft Word and submit to COR via email | completed |
| 2. | Deleted | Deleted |
| 3. | Final TER that includes inputs to the SER; audit teleconference talking points; ACRS meeting support materials upon request. <u>Standard:</u> Submit documents in Microsoft Word and submit to COR via email | 6 months after RAI responses are received |
| 4. | Provide a final Chapter 2 of the SOAR report and draft sections in other chapters of the SOAR report <u>Standard:</u> Submit documents in Microsoft Word and submit to COR via email | Completed |
| 5. | Review comments and revisions to the draft SOAR report and consultation to the NRC staff. Provide a two-hour seminar on thermal hydraulic scaling to the NRC staff. <u>Standard:</u> Submit documents in Microsoft Word and submit to COR via email | Completed |

6.0 TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED

This work shall be performed by someone with expert knowledge in thermal-hydraulic scaling, strong theoretical background in mathematics, and experience in developing an independent scaling analysis procedure. The expert should also have in-depth experience in implementing traditional scaling techniques in scaled test facilities and should be familiar with the licensing requirements of addressing scaling uncertainties in new advanced reactors. The publications listed under References in Section 16 of this SOW demonstrate some of the past BNL experience in scaling.

7.0 ESTIMATED LABOR CATEGORIES AND LEVELS OF EFFORT

Key personnel assigned to this task order is as follows:

Upendra Rohatgi, Principal Investigator

8.0 MEETINGS AND TRAVEL

The contractor shall plan to attend five one-day work meetings at the USNRC offices in Rockville, Maryland. The following table provides the meeting schedule.

| Schedule | Date |
|--|---|
| Kick-off meeting and seminar on thermal hydraulic scaling (Task 5) | Within 10 business days after task award |
| Three meetings to discuss deliverables (1 and 3) | Exact dates to be determined but before each milestone deliverable. |
| Meeting to discuss final version of Chapter 2 and draft report sections in other chapters. | Exact date to be determined |

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

9.0 REPORTING REQUIREMENTS

BNL shall provide draft and final reports as specified in Section 5, Deliverables and/or Milestones, of this SOW. The deliverable dates for both draft and final reports are listed under the Due Date column in Section 5.

The DOE Laboratory is responsible for structuring the deliverables to follow agency standards. The current agency standard is Microsoft Office Suite 2010. The current agency Portable Document Format (PDF) standard is Adobe Acrobat 9 Professional. Deliverables must be

submitted free of spelling and grammatical errors and conform to requirements stated in this section.

Monthly Letter Status Reports

As specified in Section 7.1 of the SOW for EWA NRC-HQ-25-14-D-0002 with BNL.

In addition, as specified in Section 7.0 of this SOW the level of effort will include fee-recoverable as well as none fee-recoverable components. Therefore, BNL shall list the monthly cost of each component in the MLSR. The COR will provide appropriate TACs to use for invoicing.

10.0 PERIOD OF PERFORMANCE

The estimated period of performance for this task order is 11/17/2014 – 12/31/2019.

11.0 CONTRACTING OFFICER'S REPRESENTATIVE

The COR monitors all technical aspects of the agreement/task order and assists in its administration. The COR is authorized to perform the following functions: assure that the DOE Laboratory performs the technical requirements of the agreement/task order; perform inspections necessary in connection with agreement/task order performance; maintain written and oral communications with the DOE Laboratory concerning technical aspects of the agreement/task order; issue written interpretations of technical requirements, including Government drawings, designs, specifications; monitor the DOE Laboratory's performance and notify the DOE Laboratory of any deficiencies; coordinate availability of NRC-furnished material and/or GFP; and provide site entry of DOE Laboratory personnel.

Contracting Officer's Representative

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Express mail should be sent to:
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11545 Rockville Pike, Rockville, MD 20852-2738

Alternate Contracting Officer's Representative

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Technical Point of Contact

Name: Peter Lien
Agency: U.S. Nuclear Regulatory Commission
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E-mail: Peter.Lien@nrc.gov
Phone: (301) 415-0757

12.0 MATERIALS REQUIRED

N/A

13.0 NRC-FURNISHED PROPERTY/MATERIALS

The contractor will have access to the NuScale DSS LTR, the supporting NIST scaling analysis report and related staff evaluation reports.

14.0 RESEARCH QUALITY

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)

Justification of major assumptions (12%)

Soundness of technical approach and results (52%)

Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)

Clarity of presentation (16%)

Identification of major assumptions (9%)

It is the responsibility of the DOE Laboratory to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC COR and Technical Contact will review all research products with these criteria in mind.

15.0 STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

The U.S. Nuclear Regulatory Commission (NRC) began to capture most of its official records electronically on January 1, 2000. The NRC will capture each final NUREG-series publication in its native application. Therefore, please submit your final manuscript that has been approved by your NRC Project Manager in both electronic and camera-ready copy.

The final manuscript shall be of archival quality and comply with the requirements of NRC Management Directive 3.7 "NUREG-Series Publications." The document shall be technically edited consistent with NUREG-1379, Rev. 2 (May 2009) "NRC Editorial Style Guide." The goals of the "NRC Editorial Style Guide" are readability and consistency for all agency documents.

All format guidance, as specified in NUREG-0650, "Preparing NUREG-Series Publications," Rev. 2 (January 1999), will remain the same with one exception. You will no longer be required to include the NUREG-series designator on the bottom of each page of the manuscript. The NRC will assign this designator when we send the camera-ready copy to the printer and will place the designator on the cover, title page, and spine. The designator for each report will no longer be assigned when the decision to prepare a publication is made. The NRC's Publishing Services Branch will inform the NRC Project Manager for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the Contractor shall prepare the text in Microsoft Word, and use any of the following file types for charts, spreadsheets, and the like.

| File Types to be Used for NUREG-Series Publications | |
|---|----------------|
| File Type | File Extension |
| Microsoft®Word® | .doc |
| Microsoft® PowerPoint® | .ppt |
| Microsoft®Excel | .xls |
| Microsoft®Access | .mdb |
| Portable Document Format | .pdf |

This list is subject to change if new software packages come into common use at NRC or by our licensees or other stakeholders that participate in the electronic submission process. If a portion of your manuscript is from another source and you cannot obtain an acceptable electronic file type for this portion (e.g., an appendix from an old publication), the NRC can, if necessary, create a tagged image file format (file extension.tif) for that portion of your report. Note that you should continue to submit original photographs, which will be scanned, since digitized photographs do not print well.

If you choose to publish a compact disk (CD) of your publication, place on the CD copies of the manuscript in both (1) a portable document format (PDF); (2) a Microsoft Word file format, and (3) an Adobe Acrobat Reader, or, alternatively, print instructions for obtaining a free copy of Adobe Acrobat Reader on the back cover insert of the jewel box.

16.0 OTHER CONSIDERATIONS

References

1. Zuber, N., Rohatgi, U. S., Wulff, W., and Catton, I., 2007, "Application of Fractional Scaling Analysis (FSA) to Loss of Coolant Accidents (LOCA): Methodology Development," Nucl. Eng. Des., 237, pp. 1593–1607.
2. Wulff, W., Zuber, N., Rohatgi U. S., and Catton, I., " Application of Fractional Scaling Analysis to Loss of Coolant Accidents, System Level Scaling for System Depressurization, " Journal of Fluids Engineering, AUGUST 2009, Vol. 131 / 081402-13
3. Catton, I., Wulff, W., Zuber, N., and Rohatgi, U. S., 2005, "Application of Fractional Scaling Analysis to Loss of Coolant Accidents (LOCA), Part 3:Component Level Scaling for Peak Clad Temperature," Proceedings of the 11th International Topical Meeting on Nuclear Thermal Hydraulics (NURETH-11), Popes' Palace Conference Center, Avignon, France.

Access to Non-NRC Facilities/Equipment

N/A

Applicable Publications

N/A

Controls over document handling and non-disclosure of materials

All work under this project is expected to be unclassified. Some documents or scaling methods for potential applicants may be categorized as Sensitive Unclassified Non-Safeguards Information (SUNSI) or proprietary information and shall be managed in accordance with applicable NRC policies and procedures.

17.0 ASSUMPTIONS AND UNDERSTANDINGS

- It is assumed that the laboratory has access to the NRC furnished material available on the Internet.
- It is understood that the scope of the review includes conference calls with the NRC staff to discuss:
 - a. any issues that may arise during the laboratory's efforts, or
 - b. to obtain additional information needed to complete the tasks described in this task order.

- It is understood that this task order involves reviews of NuScale LTR, full SOAR draft report, and refinement of SOAR Chapter 2 draft report. The deliverables and milestones in Section 5 are based on the assumption that the applicant will submit the LTR in early 2015 and the SOAR draft report will be ready by 2014. The tasks may be delayed or cancelled in case the aforementioned reports are postponed or cancelled for any unexpected reason.