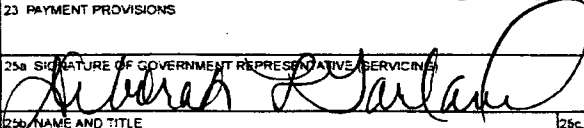
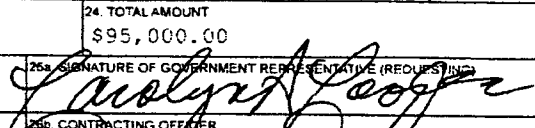


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| INTERAGENCY AGREEMENT | | 1. IAA NO NRC-HQ-60-15-T-0012 | | PAGE OF 1 2 | |
| 2. ORDER NO | | 3. REQUISITION NO. RES-15-0228 | | 4. SOLICITATION NO. | |
| 5. EFFECTIVE DATE 05/13/2015 | | 6. AWARD DATE 05/13/2015 | | 7. PERIOD OF PERFORMANCE 05/18/2015 TO 01/31/2016 | |
| 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 MOURAD AISSA US NUCLEAR REGULATORY COMMISSION OFFICE OF RESEARCH 11555 ROCKVILLE PIKE MAIL STOP CSB-3A7 ROCKVILLE MD 208421 | | |
| 10. REQUESTING AGENCY ACQUISITION MANAGEMENT DIVISION ALC: 3100001 DUNS: 040535809 +4: US NUCLEAR REGULATORY COMMISSION TWO WHITE FLINT NORTH 11545 ROCKVILLE PIKE MAIL STOP T-5E3 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-5E03 WASHINGTON DC 20555-0001 | | | 13. LEGISLATIVE AUTHORITY Energy Reorganization Act of 1974 | | |
| | | | 14. PROJECT ID | | |
| | | | 15. PROJECT TITLE TECHNICAL DATA FOR EXTENDED BURNUP FUEL ANALYSIS | | |
| 16. ACCOUNTING DATA 2015:CO200-FEEBASED-60-60D003-11-6-213-1045-253E | | | | | |
| 17. ITEM NO | 18. SUPPLIES/SERVICES | 19. QUANTITY | 20. UNIT | 21. UNIT PRICE | 22. AMOUNT |
| | NRC-HQ-60-15-T-0012 The NRC and the DOE Laboratory (ORNL) hereby enter into this Task Order Agreement No. NRC-HQ-60-15-T-0012, for the project entitled, "Technical Data for Extended Burnup Fuel Analysis- Inclusion of DOE GS-859 Data." NRC COR: Mourad Aissa (301)251-7511 ORNL PI: Ian Gault (865)574-5257 The period of performance of this agreement shall Continued ... | | | | |
| 23. PAYMENT PROVISIONS | | | 24. TOTAL AMOUNT \$95,000.00 | | |
| 25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING)  | | | 25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING)  | | |
| 25b. NAME AND TITLE Deborah L. Garland Contracting Officer | | 25c. DATE 5/18/15 | 25b. CONTRACTING OFFICER CAROLYN A. COOPER | | 25c. DATE 5/13/2013 |

| IAA NO NRC-HQ-60-15-T-0012 | ORDER NO | PAGE 2 | OF 2 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|---------|
| <p>commence on May 18, 2015 and will expire on January 31, 2016.</p> <p>CONSIDERATION AND OBLIGATION:</p> <p>(a) Authorized Task Order Ceiling Amount: \$100,700.00</p> <p>(b) The amount presently obligated with respect to this DOE task order agreement is \$95,000.00. 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.</p> <p>The following documents are hereby made part of this Agreement:</p> <p>Attachment No. 1: Statement of Work Attachment No. 2: DOE Standard Terms and Conditions</p> <p>NRC accepts ORNL's proposal dated April 23, 2015 which is hereby incorporated into this Agreement.</p> <p>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.</p> <p>The work hereunder is non-fee recoverable. Master IAA: NRCHQ6014D0005</p> | | | |

**OFFICE OF NUCLEAR REGULATORY RESEARCH
DIVISION OF SYSTEMS ANALYSIS
STATEMENT OF WORK FOR DOE AGREEMENTS**

NRC AGREEMENT NUMBER: NRC-HQ-60-14-D-0005

TASK ORDER NUMBER: NRC-HQ-60-15-T-0011

PROJECT TITLE: REGAL GADOLINIA-URANIUM LOW BURNUP SPENT NUCLEAR
FUEL ASSAY DATA

JOB CODE: V6449

LABORATORY: ORNL

SITE: Oak Ridge, TN

NRC CONTRACTING OFFICER'S REPRESENTATIVE: Mourad Aissa
(301) 251-7511

PRINCIPAL INVESTIGATOR : Ian Gauld
(865) 574-5257

PROJECT DURATION: 05/18/2015 to 02/01/2019

1. BACKGROUND

The NRC is expecting licensing applications based on BWR burnup credit at peak reactivity for storage and transportation casks. Peak reactivity is also the basis of criticality safety in BWR spent fuel pools. Initial research conducted by ORNL under JCN V6452 identified no spent fuel destructive assay data that can be used to validate code predictions in this burnup regime. The REGAL program will provide the necessary data for code validation in this burnup regime. This data will be applied in the scope of the current research project on BWR burnup credit JCN V6452 using SCALE to evaluate uncertainties associated with gadolinium depletion and peak reactivity.

The NRC is currently supporting research to develop a technical basis for BWR burnup credit under JCN V6452. The initial phase of this work focused on analyses based on peak reactivity. The magnitude and burnup of peak reactivity is sensitive to the depletion rate of gadolinium burnable absorbers widely used in BWR assembly designs. A main finding of this research is the credit for gadolinium at low burnup cannot be justified based on currently limited measurement data that are available on gadolinium absorber content and additional high quality data are required. Recent independent findings of an Organization of Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA) international computational benchmark on BWR burnup credit, involving commercial, academic, and research codes, identified that the treatment of the gadolinium rod burnup is still a key issue for BWR fuel burnup credit.

A new experimental program, REGAL (Rod Extremities and Gadolinia AnaLysis), has been initiated by the Belgian Research Center SCK•CEN to examine irradiated gadolinia fuel rods. The purpose is to increase the experimental database of nuclide inventories to cover the entire

fuel rod, including the top and bottom ends. These regions of the fuel rod are particularly important in burnup credit, because the extremities of the fuel rod have relatively low burnup and are important reactivity contributors in the criticality analyses. The measurements are to be performed over a wide burnup range to cover validation for peak reactivity. Current participants in the program include GdF-Suez/Electrabel and IRSN of France. Technical elements of the experimental program include three phases:

- Phase I – A base program that will involve 10 or 11 analyses performed at SCK•CEN on a high duty UO₂ fuel rod and on a low burnup Gadolinia fuel rod (Fig. 1). Analyses include high-precision TIMS (mass spectrometry) on fuel pellet actinide, fission product, and gadolinium isotopes (more than 30 nuclides). In addition, the analyses will include measurements of the radial distribution of elements in the fuel pellet, which are valuable data at low burnup.
- Phase II – A base program that will focus on independent cross-check analyses.
- Phase III – An extension program that will be defined jointly by the partners.

Measurements will be performed at the SCK•CEN laboratories in Mol, Belgium. Independent measurements will be conducted at either PSI (Switzerland) or ITU (Germany). The results of four analyses have already been completed and are available: two analyses for GdF-Suez/Electrabel (on the gadolinium fuel rod) and two analyses performed on the high duty UO₂ fuel rod.

2. OBJECTIVE

The objective of the proposed Task Order is to obtain isotopic radio-assay measurements of key nuclides for BWR burnup credit, especially at peak reactivity and low burnup reactor core exposures. These measurements will also be used for other code validations for reactor analysis and spent fuel applications and will enhance the tools and capabilities that support the NRC staff in license application reviews and reactor and spent nuclear fuel analyses

3. TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED

ORNL Laboratory shall commit the appropriate number of qualified personnel to the project. Team members such as Senior Scientists, Principal Engineers, Engineers, Computer Scientists and Engineers, etc. – or their equivalents – are to be available as needed for the completion of any tasks submitted. It is imperative that the staff involved with this project have knowledge or easy access to, of the last three decades' worth of experimental and measured data that have been used in the benchmarking, validation and development of SCALE models and capabilities.

The NRC reserves the right to approve the Project Manager and the individual personnel assigned to each task. The DOE Laboratory project manager shall be well experienced with SCALE, its application areas and the peculiarities that are inherent with the code system.

4. SCOPE OF WORK

Task 1: REGAL Program Data

Under this task experimental data on nuclide compositions of irradiated gadolinia-uranium fuel rods at low burnup will be acquired from the REGAL (Rod Extremities and Gadolinia AnaLysis) program, coordinated by the Belgian Research Center SCK•CEN. The REGAL program will provide gadolinium benchmark data for BWR burnup credit near peak reactivity and will be used to support the technical basis for burnup credit at peak reactivity. These data include:

- Analysis of more than 10 fuel samples at SCK•CEN involving a high duty UO₂ fuel rod and a low burnup gadolinia-uranium fuel rod.
- Destructive analysis measurements include the use of high-precision TIMS (mass spectrometry) on fuel pellet actinides, fission products, and gadolinium isotopes (more than 30 nuclides).
- Measurements of the radial distribution of main elements in the fuel pellet will be performed to validate the spatial variation in the pellet.
- Independent laboratory cross-check analyses.

ORNL will purchase this data from SCK•CEN by ORNL. Four samples have been analyzed to date and are available. Most measurements are expected to be completed mid-2017, with final cross check analyses available in 2019.

Deliverables:

- Status Reports
- Experimental program reports containing detailed and comprehensive descriptions of experimental methodology
- Data files

Task 2: REGAL Program Participation and Data Evaluation

ORNL shall participate in the REGAL program by attending project review meetings, technical planning for sample selection, and evaluating the measurement data and uncertainties to support BWR burnup credit near peak reactivity using the SCALE code system.

The results of the analyses shall be documented in a letter report, and any important findings shall be incorporated in recommendations for technical bases of BWR burnup credit.

ORNL shall develop a draft NUREG/CR that will capture all of the experimental measurements and results and provide an analysis of the various isotopic compositions. The objective of this report is to provide a reference set of isotopic and radiological data to support potential data needs in the future. See Section 11 for details on NUREG/CR preparation.

Expected Level of Effort: 650 staff-hours

Deliverables:

- Status Reports
- Letter report at end of each FY
- NUREG/CR at end of project

5. DELIVERABLES/SCHEDULES AND/OR MILESTONES

| TASK | DELIVERABLE | DUE DATE | COMMENTS |
|-------------|------------------------------|-----------------|---------------------------------|
| | | | |
| 1 | Experimental Program Reports | Varies | As data becomes available |
| 1 | Data Files | Varies | As data becomes available |
| 2 | Draft Letter Report | September | Each Fiscal Year of the Project |
| 2 | Final Letter Report | November | Each Fiscal Year of the Project |
| 2 | Draft NUREG/CR | December, 2018 | |
| 2 | Final NUREG/CR | January, 2019 | |

ORNL shall submit all draft documents to the NRC Contracting Officer's Representative for review and comment. The NRC will provide comments to ORNL within two weeks of receipt. ORNL shall revise the draft documents incorporating the NRC's comments and return the final documents to the NRC COR review and acceptance with two weeks of receipt.

6. REPORTING REQUIREMENTS

Required deliverables are outlined in the "DELIVERABLES/SCHEDULES AND/OR MILESTONES" sections above. All letter reports shall be reviewed by a first-level supervisor prior to submittal. All deliverables shall be submitted electronically, via email, to the NRC project manager.

7. MONTHLY LETTER STATUS REPORTS

In accordance with Section 4 of the attached Standard Terms and Conditions for DOE Work, a Monthly Letter Status Report (MLSR) is to be submitted to the NRC Project Manager, Mourad Aissa, by the 20th of the month following the month to be reported with copies provided to the following:

RESDSAMLSR.Resource@nrc.gov
ContractsPOT.Resource@nrc.gov
Mourad.Aissa@nrc.gov
Don.Algama@nrc.gov

The MLSR will identify the title of the project, the job code, the Principal Investigator, the period of performance, the reporting period, summarize each month's technical progress, list monthly spending, total spending to date, and the remaining funds and will contain information as directed in NRC Management Directive 11.7, Exhibit 7 (dated March 2, 2007). Any administrative or technical difficulties which may affect the schedule or costs of the project shall be immediately brought to the attention of the NRC project manager.

8. MEETINGS AND TRAVEL

To meet the objectives of this project, it is anticipated that travel will involve one domestic person-trip each year and one foreign person-trip each year of the project for 1) project review meetings at NRC headquarters and 2) international technical meetings with REGAL partners

approved by the NRC Project Manager. Any other travel will be contingent on the approval of the NRC Project Manager.

Foreign travel may be appropriate. Request for approval of official foreign travel of individuals conducting business on this project shall be submitted to NRC for approval via NRC Form 445.

9. NRC-FURNISHED MATERIAL

No NRC-furnished material is required.

10. 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(s) will review all research products with these criteria in mind.

11. NEW STANDARDS FOR DOE LABORATORIES 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 COR 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 COR for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the DOE Laboratory 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.

12. SUBCONTRACTING/CONSULTANT INFORMATION

Describe any technical support effort that is proposed to be performed by a subcontractor or consultant. Identify the level of effort, by task, of any proposed subcontractor or consultant and provide an explanation of the need for subcontracting that portion of the effort. Note that "pass through" contracting is not allowed under the requirements of the DOE/NRC Memorandum of Understanding. For the purposes of this effort, a "pass through" contract is generally defined as subcontracting 50 percent or more of the technical effort. For any subcontract or consultant effort, describe the following:

- the necessity of subcontracting,
- the tasks and subtasks the subcontractor or consultant will perform,
- the level of effort proposed for the subcontract effort,
- the status and expected time frame for selection, and
- the method of selection of the subcontractor or consultant.

13. INFORMATION TECHNOLOGY (IT) RESOURCES:

When IT resources are proposed by a DOE Laboratory that are not specifically identified in the Statement of Work, the need for and cost of those resources must be justified. Exhibit 8 of MD 11.7 can be used to help determine justification. Proposed IT resources should be those required to accomplish the work, but which are not available from within the laboratory's inventory of IT resources. Common office automation equipment and software, i.e., personal computers, word processing and spreadsheet software, and printers, should not routinely be proposed as they should normally be provided as part of the laboratory's information processing

infrastructure. Whenever IT resources are proposed, justification is necessary for the NRC to be able to evaluate the requirements and to approve their acquisition.

In addition to the total cost of IT resources to be reported on the NRC Form 189, the following justification is to be included in the proposal:

1. IT Resource Requirements. List as line items each IT resource (hardware, e.g., laptop computer, engineering workstation; software - by product name; and services, e.g., computer time, database services) proposed for acquisition and estimate the cost of each item by fiscal year. Funding should be indicated for the year in which the IT resources are needed. Provide totals for all items for each fiscal year which match the costs listed on the line labeled IT RESOURCES on the NRC Form 189. Any IT acquisition shall conform to the acquisition and reporting requirements identified in NRC Management Directive 11.7, Part 9.
2. Justification. For each required IT resource with an acquisition cost of \$500 or more, or group of resources, e.g., a system, provide specifications or the specific make/model, and other acquisition and reporting requirements identified in NRC Management Directive 11.7, Part 9. Briefly discuss how the IT resources will be used, including information about workload to be processed, required capacities, throughput, transfer rates, compatibility and expandability requirements, or any other information that supports the need to acquire the specific resources being proposed.

14. NRC Contracting Officers Representative's (COR)

Technical direction as defined in Section 1 of the Standard Terms and Conditions will be provided by the COR, Mourad Aissa, who can be reached at:

U. S. Nuclear Regulatory Commission
Mail Stop C3-A07M
Washington, D. C. 20555-0001

PRIMARY COR:

Mourad Aissa
Phone: (301) 251-7511
Fax: (301) 251-7425
Email: Mourad.Aissa@nrc.gov

ALTERNATE COR'S:

Don Algama
Phone: (301) 251-7940
Fax: (301) 251-7425
Email: Don.Algama@nrc.gov

Express mail should be sent to:

U. S. Nuclear Regulatory Commission
Mail Stop: CSB 03A07M
11545 Rockville Pike
Rockville, MD 20852-2738