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| AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT | | 1. CONTRACT ID CODE | | PAGE OF PAGES | |
| 2. AMENDMENT/MODIFICATION NO. 0046 | | 3. EFFECTIVE DATE See Block 16C | | 5. PROJECT NO. (if applicable) 1 5 | |
| 6. ISSUED BY U.S. Department of Energy ORNL Site Office P.O. Box 2008 Oak Ridge TN 37831 | | 7. ADMINISTERED BY (if other than Item 6) CODE | | 4. REQUISITION/PURCHASE REQ. NO. | |
| 8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code) OAK RIDGE ASSOCIATED UNIVERSITIES, INCORPORATED Attn: Matt Albert P.O. BOX 117 OAK RIDGE TN 37831 | | (x) 9A. AMENDMENT OF SOLICITATION NO. | | 9B. DATED (SEE ITEM 11) | |
| CODE 041152224 FACILITY CODE | | x 10A. MODIFICATION OF CONTRACT/ORDER NO. DE-SC0014664 | | 10B. DATED (SEE ITEM 13) 03/10/2016 | |

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers is extended, is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 9 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (if required)
See Schedule

13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

| | |
|-----------|---|
| CHECK ONE | A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A. |
| | B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b). |
| X | C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: FAR 52.243-2 Changes (AUG 1987) |
| | D. OTHER (Specify type of modification and authority) |

E. IMPORTANT: Contractor is not, is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

The purpose of this MODIFICATION is to update and replace Section J List of Attachments, Attachment K - Contractor Commitments.

A. The original Section J List of Attachments, Attachment K - Contractor Commitments is hereby deleted in it's entirety and replaced with the Revised Attachment K - Contractor Commitments.

B. All other terms and conditions remain unchanged.
Payment:

Except as provided herein, all terms and conditions of the document referenced in Item 9 A or 10A, as heretofore changed, remains unchanged and in full force and effect.

| | | | |
|---|--|--|---|
| 18A. NAME AND TITLE OF SIGNER (Type or print) Ivan A. Boatner Vice President & General Counsel | | 18A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) Kenneth Lowell Kimbrough | |
| 15B. CONTRACTOR/OFFEROR  (Signature of person authorized to sign) | | 15C. DATE SIGNED 5.11.17 | 16B. UNITED STATES OF AMERICA (Signature of Contracting Officer) |
| | | | 18C. DATE SIGNED |

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A. The original Section J List of Attachments, Attachment K - Contractor Commitments is hereby deleted in it's entirety and replaced with the Revised Attachment K - Contractor Commitments.

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| | | | |
|---|------------------|--|--------------------------------|
| 15A. NAME AND TITLE OF SIGNER (Type or print) | | 16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) Kenneth Lowell Kimbrough | |
| 15B. CONTRACTOR/OFFEROR (Signature of person authorized to sign) | 15C. DATE SIGNED | 16B. UNITED STATES OF AMERICA Signature on File (Signature of Contracting Officer) | 16C. DATE SIGNED 05/15/2017 |

PART III – List of Documents, Exhibits and Other Attachments

Section J – List of Attachments

Attachment K – Contractor Commitments

1. Laboratory Upgrades

| NAME | LOCATION | ESTIMATED TOTAL VALUE | EXPECTED BENEFIT | DATE OF COMMITMENT |
|--|-----------------------------------|-----------------------|---|-------------------------------------|
| Laboratory Equipment, Software, and Collaboration Upgrade ¹ | REAL, CBL, and BeLab in Oak Ridge | \$1M | Eliminates expense of updates to DOE and accomplishes needed upgrades to achieve vision | Will be complete by March 31, 2018. |

| NAME | ESTIMATED COST | LAB | WHAT IT IS USED FOR | HOW IT HELPS ACHIEVE STRATEGIC VISION |
|---|----------------|-----------|---|---------------------------------------|
| Liquid Scintillation Counter (TopCount 12 Model) | \$100,000 | Beryllium | Generates the data (Counts per minute) used to calculate the Lymphocyte Proliferation Test (LPT) | Update system for efficiency gains |
| Centrifuge (ST40 - 28 conical tube capacity) | \$10,000 | Beryllium | Separate and wash lymphocytes | Update system for efficiency gains |
| CO2 Incubators (x2) | \$20,000 | Beryllium | Cell culture plates must be stored with perfect conditions to provide cells opportunity to grow during 5 and 7 day incubation. | Increase throughput |
| Biological Safety Cabinets (Class II Type A2) "Hood" - 6 foot | \$11,000 | Beryllium | Provides a sterile environment for cell culture to be processed and protects technical staff. | Increase throughput |
| Biological Safety Cabinets (Class II Type A2) "Hood" - 4 foot | \$9,000 | Beryllium | Provides a sterile environment for cell culture to be processed and protects technical staff. | Increase throughput |
| AcT diff Cell Counter | \$25,000 | Beryllium | Counts each blood sample. Total cell counts & lymphocyte percentages are used to determine exact number of cells per well in culture plates. This allows optimal cell recognition of Beryllium. | Increase throughput |
| Harvester (TomTec) | \$30,000 | Beryllium | Cell culture plates are transferred onto Unifilter plates. Filter plates are then counted for increase in | Increase throughput |

¹ The specific pieces of equipment listed herein are those that ORAU proposes to purchase as of March 27, 2017. ORAU has the latitude to substitute and/or replace items listed herein so long as the total laboratory upgrades provided by ORAU are valued in an amount of not less than \$1,000,000. In the event ORAU determines that more value can be provided by substituting, removing, or adding specific items on this list, ORAU will notify the Contracting Officer of the change and the rationale for the change in writing.

Contract No. DE-SC0014664

Section J – Attachment K

Modification 0046

| NAME | ESTIMATED COST | LAB | WHAT IT IS USED FOR | HOW IT HELPS ACHIEVE STRATEGIC VISION |
|--|----------------|-----------|---|--|
| | | | radioactive counts indicating cell growth or response to Beryllium. Each cell culture plate requires a unifilter plate. | |
| Liquid Handling System (LSH) | \$100,000 | Beryllium | Manual pipetting is used to add cells and reagents to culture plates. Mid to High throughput LSH needed to introduce automation into process. | Automatic pipetting will increase efficiency, reduce ergonomic strain and increase number of samples processed. |
| M-FISH and M-Band probes | \$7,600 | CBL | M-FISH and M-Band analyses | Analysis of stable chromosomal aberrations for retrospective biodosimetry |
| Hybridization chamber | \$4,476.67 | CBL | FISH based applications | Needed for efficient M-FISH and M-band hybridizations in situ |
| Chromosome Spreader (Hanabi-PII) | \$66,000 | CBL | Cytogenetic analysis | Facilitate dicentric analysis |
| Materials and supplies | \$83,750 | CBL | Cytogenetic analysis | Facilitate dicentric analysis |
| Senior Laboratory Technician | \$123,525 | CBL | Cytogenetic analysis | Facilitate dicentric analysis and promote integration of Oak Ridge and Yale CBLs |
| Travel between Oak Ridge CBL and Yale CBL | \$16,050 | CBL | CBL merger into a single functional CBL having twice the capacity with access to leading edge university research facilities | Promote CBL integration and increase capacity to perform analyses |
| One meeting per year per person | \$2,675 | CBL | Cytogenetic analysis and research productivity | Promote CBL integration and increase capacity to perform analyses; develop new technologies to facilitate rapid TAT for an IND event |
| Alpha spectroscopy system (complete 36 detector system without software) | \$176,345 | REAL | Sample analysis for alpha emitters | Update system for efficiency gains |
| New Hybrid dewars for gamma detectors (x4) | \$85,000 | REAL | Used to cool the gamma detectors. These would replace the older-type dewars that require weekly filling with liquid nitrogen. | The dewars will to nearly eliminate the need for liquid nitrogen, providing safer working conditions and eliminating the need for weekly delivery of liquid nitrogen. |
| Lynx digital signal analyzer for gamma detectors (x4) | \$47,661 | REAL | The Lynx system would replace the electronics used for the gamma spec systems. | The current electronic systems are antiquated and may not be serviceable by the vendor in the near future. This purchase will prevent a potential interruption in service. |
| Liquid Scintillation Counter | \$82,019.49 | REAL | Count samples for beta emitting radionuclides (Tc- | Update system for efficiency gains |

**Contract No. DE-SC0014664
Section J – Attachment K
Modification 0046**

| NAME | ESTIMATED COST | LAB | WHAT IT IS USED FOR | HOW IT HELPS ACHIEVE STRATEGIC VISION |
|-------------------------|-----------------------|------|--|---|
| | | | 99, Fe-55, Ni-63, Pu-241, etc.) | |
| Auto-digester for ICPMS | \$30,753.68 | REAL | Automate digestion for metals analysis | Reduce labor considerably for metal digestions |
| 3 Platinum dishes | \$11,821.10 | REAL | Sample dissolution | Needed for sample analysis. More dishes = more throughput |
| Centrifuge | \$8,664.96 | REAL | Sample analysis for all procedures | Increase capacity |
| Intern | \$30,000 | REAL | University student | Help train new radiochemists |
| TOTAL COMMITMENT | \$1,081,341.90 | | | |

There is no anticipated liability to the government incurred because of these investments. In addition, no government action is required to receive these upgrades. ORAU commits to make investments in an amount of at least \$1,000,000 to upgrade laboratory capabilities so that (1) we can potentially decrease the per-sample analysis cost in any of these laboratories, (2) we can test new methods to improve throughput and reduce human health risks, and (3) we can leverage collaborative relationships to improve practices. All of these benefit DOE directly with no adverse impact or requirement to provide resources or services. As stated in the note above, ORAU has the latitude to substitute and/or replace items listed herein so long as the total laboratory upgrades provided by ORAU are valued in an amount of no less than \$1,000,000. In the event ORAU determines that more value can be provided by substituting, removing, or adding specific items on this list, ORAU will notify the Contracting Officer of the change and the rationale for the change in writing.

2. Design, Development, and Implementation of the Virtual Institute

| NAME | LOCATION | DATE OF COMMITMENT |
|---|------------------------|---|
| Design, development, and implementation of the virtual Institute | Developed in Oak Ridge | Will be implemented by March 31, 2017. |
| NAME | ESTIMATED COST/YEAR | HOW IT HELPS ACHIEVE STRATEGIC VISION |
| First year commitment: ORAU Labor to design, develop, and implement the Institute in first year | \$500,000 first year | Completely revamps both the look and the intent of the current ORISE web site so that we are actually making the Institute a "destination" for participants, teachers, students, program managers. By doing so, we globalize ORISE to reach the widest possible audience of STEM researchers and scientists to support the nation's science and technology mission. |
| OUT-YEAR COMMITMENTS | | |
| Funded during the out-years will be provided for items such as education interns; teacher fellowships; grants, scholarships, and prizes; programmatic content development; content strategist; technology upgrades; advertising and outreach, etc.. | \$500,000 | Funding will be used for activities that improve the virtual Institute. This includes, but is not limited to, creating content to populate the virtual Institute, driving traffic to the virtual Institute, funding programmatic personnel time to write white papers, journal article, or programmatic summaries of interest to the Institute; obtaining feedback from users; furthering ORISE branding initiatives; upgrading the technology that supports the system; etc. |
| TOTAL COMMITMENT: \$500,000 first year, \$500,000 each remaining year for a total of \$5 million over the life of the contract. | | |

There is no anticipated liability to the government incurred because of this investment. In addition, no government action is required to implement this commitment.