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|---|------------------------------------|---|---------------------------------------|
| 2. AMENDMENT/MODIFICATION NO. P00008 | 3. EFFECTIVE DATE See Block 16C | 4. REQUISITION/PURCHASE REQ. NO. RES-22-0427 | 5. PROJECT NO. (If applicable) EWC |
| 6. ISSUED BY US NRC - HQ ACQUISITION MANAGEMENT DIVISION MAIL STOP TWFN-07B20M WASHINGTON DC 20555-0001 | CODE NRCHQ | 7. ADMINISTERED BY (If other than Item 6) | CODE |

| | | |
|---|---------------|---|
| 8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code) SOUTHWEST RESEARCH INSTITUTE ATTN PAUL MALDONADO 6220 CULEBRA RD SAN ANTONIO TX 782385166 | (x) | 9A. AMENDMENT OF SOLICITATION NO. |
| | | 9B. DATED (SEE ITEM 11) |
| | x | 10A. MODIFICATION OF CONTRACT/ORDER NO. 31310018D0002 31310020F0081 |
| CODE PB11V1KH3KV4 | FACILITY CODE | 10B. DATED (SEE ITEM 13) 09/10/2020 |

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 8 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 electronic communication 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 letter or electronic communication, provided each letter or electronic communication makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

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| 12. ACCOUNT NG AND APPROPRIATION DATA (If required) 2022-X0200-FEEBASED-60-60D003-60B306-1003-11-6-182-255B-11-6-182-1003 | Net Increase: | \$152,475.00 |
|--|---------------|--------------|

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

| | |
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| 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 data, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b). |
| | C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: |
| X | D. OTHER (Specify type of modification and authority) 52.243-2 Changes-Cost-Reimbursement |

E. IMPORTANT Contractor is not is required to sign this document and return 1 copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)
PLEASE SEE PAGE TWO (2) FOR DESCRIPTION OF MODIFICATION TO REVISE THE STATEMENT OF WORK, INCREASE THE CEILING, PROVIDE FUNDING, AND EXTEND THE PERIOD OF PERFORMANCE.

Task Order Obligated Amount: \$588,641.00 (Changed)
 Task Order Exercised Ceiling Amount: \$588,641.00 (Changed)
 Task Order Ceiling Base and All Options: \$588,641.00 (Changed)
 Period of Performance: 09/10/2020 to 10/31/2023

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.

| | |
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| 15A. NAME AND TITLE OF SIGNER (Type or print) | 16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) JENNIFER A. DUDEK |
| 15B. CONTRACTOR/OFFEROR <i>(Signature of person authorized to sign)</i> | 15C. DATE SIGNED |
| | 16B. UNITED STATES OF AMERICA <i>(Signature of Contracting Officer)</i> |
| | 16C. DATE SIGNED 08/30/2022 |

The purpose of this task order modification is to: 1) revise the statement of work to continue additional benchmarking, testing, technical assessment, and review using MACCS 4.2; 2) increase the task order ceiling by \$152,475.00, from \$436,166.00 to \$588,641.00; 3) provide incremental funding in the amount of \$152,475.00, thereby, increasing the total obligated amount from \$436,166.00 to \$588,641.00; and 4) extend the period of performance from 10/31/2022 to 10/31/2023.

Accordingly, the task order is revised as follows:

Section B - Supplies or Services/Prices was revised as follows.

Summary of Clause Changes:

Clause titled **CONSIDERATION AND OBLIGATION-TASK ORDERS** is incorporated as follows:

CONSIDERATION AND OBLIGATION-TASK ORDERS

(a) The ceiling of this order for services is \$588,641.00 (Cost of [REDACTED] and Fee of [REDACTED]) for the base tasks and the exercised optional task.

(b) This order is subject to the minimum and maximum ordering requirements set forth in the contract.

(c) The amount presently obligated with respect to this order is \$588,641.00 of which [REDACTED] represents Costs and [REDACTED] represents Fixed-Fee. The obligated amount shall, at no time, exceed the order ceiling as specified in paragraph (a) above. When and if the amount(s) paid and payable to the Contractor hereunder shall equal the obligated amount, the Contractor shall not be obligated to continue performance of the work unless and until the Contracting Officer shall increase the amount obligated with respect to this order, in accordance with FAR Part 43 - Modifications. Any work undertaken by the Contractor in excess of the obligated amount specified above is done so at the Contractor's sole risk and may not be reimbursed by the Government.

(d) The Contractor shall comply with the provisions of FAR 52.232-22 - Limitation of Funds, for incrementally-funded delivery orders or task orders.

Clause titled **PRICE/COST SCHEDULE** is incorporated as follows:

PRICE/COST SCHEDULE

Total Estimated Cost and Fixed-Fee breakdown by CLIN is presented below.

| CLIN | Description | Est Cost | Fixed Fee | Total Cost Plus Fixed Fee |
|-------|-----------------------------|----------|-----------|---------------------------|
| 00001 | Estimated Cost - Base Tasks | | | |
| 00002 | Fee - Base Tasks | | | |
| TOTAL | | | | |
| 10001 | Optional Task (Exercised) | | | |
| TOTAL | | | | \$588,641.00 |

Total Estimated Cost and Fixed-Fee breakdown by cost element for the base and optional task is presented below.

| DESCRIPTION | Estimated Amount Base Tasks (Task 1-3) | Estimated Amount Optional Task (Task 4) Exercised | Estimated Amount P00008 (Task 5) | Total Estimated Costs Inclusive of Options |
|---|---|---|----------------------------------|--|
| Labor | | | | |
| Indirect Cost Pool (includes Fringe, Overhead, G&A, Facilities Capital, and Material Handling on Subcontractor) | | | | |
| Total Estimated Costs | | | | |
| Fixed-Fee | | | | |
| Total Estimated Costs and Fixed-Fee | | | | \$588,641.00 |

Section C - Description/Specifications was revised as follows.

Summary of Clause Changes:

Clause titled **STATEMENT OF WORK** is incorporated as follows:

STATEMENT OF WORK

TASK ORDER STATEMENT OF WORK

1. PROJECT TITLE

MELCOR Consequence Analyses Code System (MACCS) Code Assessment: Testing

Benchmarking, Verification, Validation, and Confirmatory Analyses

2. BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Regulatory Research, Division of System Analysis, Accident Analysis Branch (RES/DSA/AAB) plans, develops, and manages analytical and experimental research projects on the progression, response, and offsite consequences of postulated severe accidents; and performs safety analyses of nuclear power plant systems. This work includes safety and security analyses; including postulated severe accident analyses of accident progression in reactor vessel, containment, and postulated accidents from spent fuel storage and transportation. State-of-the-art analytical techniques are used to develop realistic best estimates of the potential effects (consequences) to the public of low-likelihood nuclear power plant and spent fuel storage and transportation accidents which could release radioactive material into the environment. AAB models accident progression in order to estimate the magnitude and timing of radioactive release into the environment to estimate site-specific consequences (e.g. health effects). The experimental research projects support NRC's knowledge and understanding of severe accidents, and they support NRC's models with experimental data. AAB provides consultation to other NRC offices regarding safety or licensing decisions, development of guidance, or other regulatory needs, and partners with the U.S. Department of Energy (USDOE), universities, laboratories, and other national and international research centers. AAB also manages the Agency long-term research program and research for advanced reactor designs.

To accomplish regulatory research tasks, AAB use various computer codes including MELCOR Consequence Analyses Code System (MACCS). MACCS suite of computer codes is used to evaluate the impacts of atmospheric releases of radioactive aerosols and vapors on human health and the environment. MACCS model include radionuclide release, atmospheric transport and dispersion, site data, weather data, emergency response and protective actions, exposure pathways, health effects, and offsite costs.

3. OBJECTIVE

The main objective of this task order is to document a user oriented MACCS assessment using test cases. This work includes reviewing the existing test cases and improving the reviewed test cases, if required, and developing new test cases. Similar work limited to ATMOS and EARLY modules of MACCS have been complete or in progress at NRC and Sandia National Laboratories. The major focus of this work is on remaining modules such as CHRON modules.

This task order includes optional work of providing technical support in the area of emerging work related to reviewing reports or documents in the areas of MACCS codes including benchmarking and confirmatory analysis using MACCS code where needed.

4. SCOPE OF WORK

Task 1: Kick-off Meeting

The Contractor shall participate in an online kick-off meeting with the COR and other NRC technical staff to discuss the scope of work, expectations, project management, deliverables, and performance requirements of the task order. The kick-off meeting shall be held via

teleconference within 10 working days after task order award.

The Contractor shall prepare a written summary of the meeting that includes, at a minimum, the following information: (1) identification of meeting participants from the NRC and Contractor, (2) minutes of the meeting that clearly describe the substance of the meeting, and (3) any action items and decisions from the meeting.

Task 2: Review and Update Existing Test Cases or Develop New Test Cases and Test Plans

The Contractor shall perform MACCS Code assessment, verification, and validation testing. This can be accomplished by developing test cases and comparing MACCS output results with data obtained from various methods, such as:

1. Analytic results using calculators or software like spreadsheets, and engineering equation solvers etc.
2. Results of other comparable proven computer programs.
3. Empirical data and information from real-life events published in technical literature.

The contractor shall review existing test cases for adequacy and update or enhance these test cases as needed. The contractor shall propose in the test plan which of the above 3 methods will be used in verification and validation testing. The contractor shall develop additional test cases if existing test cases are insufficient to adequately cover the software functional requirements as described in theory and user's manuals and approved by the COR during a review meeting. The contractor shall seek approval from the COR if additional cases, are needed, prior to developing the final input deck and making MACCS runs to generate output.

The contractor shall document the results of verification with the identification of the verifier. The verification method applied to the computer program results shall be shown to produce correct solutions for the applied mathematical model within defined limits for each parameter employed by the verifier.

The applied mathematical model shall be shown to produce a valid solution to the physical problem associated with the application, by the verifier

Test plans and test cases shall be documented by the contractor and reviewed and approved by the COR before the execution of the test cases.

(a) The test plans shall specify the following, as applicable and directed by the COR:

- (1) planned testing activities and progression
- (2) identification of the stages at which testing is required
- (3) requirements for testing logic branches
- (4) requirements for hardware and system integration
- (5) requirements for input simulation
- (6) criteria for accepting the software
- (7) reports, records, standard formatting, and conventions

(b) The test cases shall specify the following, as applicable and directed by the COR:

- (1) prerequisites for performing the test case
- (2) steps to be performed including the steps to restore the system or data to its original before to the test case
- (3) required ranges of input parameters
- (4) expected results

- (5) acceptance criteria for the test case
- (6) reports, records, standard formatting, and conventions

The contractor shall develop additional tests using MACCS version 4.1. Prior to starting work on the test plan for the additional tests, the contractor shall develop a draft project plan with descriptions of test cases and schedule for additional tests. The draft project plan shall be presented and discussed at a meeting with the COR.

One of the test problems shall include comparing MACCS near field effluent air concentrations (Chi/Q) with the Computation Fluid Dynamics (CFD) model based on using, Ansys CFX or FLOW-3D Code as agreed upon with the COR. Implementation of near field modeling for MACCS bases consequence analysis is described in the Sandia Reports, SAND2020-2609, February 2020, "Assessment of the MACCS Code Applicability for Nearfield Consequence Analysis," and SAND2021-6924, June 2021, "Implementation of Additional Models into the MACCS Code for Nearfield Consequence Analysis." The test problem shall compare CFD results with selected MACCS results as presented in SAND2021-6924. The contractor shall supply all input files and output files (if possible) and figures, where MACCS nearfield results are compared to the CFD, and explain any difference in the results with concluding remarks.

Other test problems may check figures of merits often used in NRC licensing and regulatory activities

such as:

- Early Fatalities
- Latent Cancers Fatalities
- Dose and Dose rates
- Impact of shielding factor for protective actions/evacuation modeling.
- Long term contamination, economic consequences, and cost models

The contractor may suggest additional areas of testing, not listed above, to the COR.

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such as:

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- Latent Cancers Fatalities
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- Impact of shielding factor for protective actions/evacuation modeling.
- Long term contamination, economic consequences, and cost models

The contractor may suggest additional areas of testing, not listed above, to the COR.

Task 3: Reporting Results and Continue with New Test Cases

The Contractor shall document test results in a formal technical report similar to NUREG/CR. Observations of unexpected or unintended results shall be documented and dispositioned before the test result final approval by the COR. Test results shall be reviewed to ensure that test requirements have been satisfied.

Test reports shall include:

- (a) computer program tested including system software used
- (b) computer hardware used

- (c) test equipment and calibrations, where applicable
- (d) date of test performed
- (e) name of the tester or data recorder
- (f) simulation models used, where applicable
- (g) test problems and traceability to requirements
- (h) results
- (i) action to be taken in connection with any deviations noted
- (j) name of the person evaluating test results
- (k) acceptability

Computer program test reports shall be controlled and maintained as records of software documentation and turned over to NRC. Test records shall be established and maintained to indicate that the computer program adequately and correctly implemented the approved software requirements.

The contractor shall prepare a draft final report documenting each test case and associated code assessment and evaluation of results. The final report shall be written for MACCS users, who are technical staff with diverse science and engineering background. This report is expected to become a living document to be periodically updated and maintained as new test cases are identified to support MACCS maintenance, version upgrades, and user's needs for new applications. The draft report shall be delivered to COR for review and comment. The final report will be issued after resolving comments on the draft test cases.

Task 4: Additional Benchmarking, Testing, Technical Assessment, & Review (OPTIONAL TASK) (Exercised)

The NRC may require additional support for benchmarking, testing, technical assessment, and review of MACCS related documents as needed to support, rulemaking, licensing, and regulatory research and analyses. This include testing MACCS for new reactors application, reviewing MACCS related licensing or regulatory analyses reports and documents, or resolving issues identified by NRC staff or intervener related to MACCS areas of analyses. The discrepancies identified in the draft report under task 3 are expected to be resolved in the new release of MACCS (Version 4.1 or 3.X) by August 15, 2021. The contractor shall update the results of the draft report completed in task 3 using the new version 4.X of the MACC code and issue MACCS Code Assessment Report for public and the MACC users, upon approval from the COR. This includes repeating all tests of the current MACCS Verification Report for MACCS Version 4.0 (assuming previous inputs file can be efficiently re-used), discussing results of re-testing with NRC staff, initiating a revision of the MACCS Verification Report to apply to the newest MACCS version.

Task 5: Continue Additional Benchmarking, Testing, Technical Assessment, & Review using MACCS 4.2 (Release date expected Sept 30, 2022)

The contractor shall continue Tasks 1 to 4 to identify and develop additional cases for testing and technical assessment using MACCS 4.2 and MACCS suit of codes used in consequence analyses such as SecPop, MELMACCS, and COMIDA. The version of MACCS has additional features, updates, and corrections of identified issues. The contractor shall develop 3-6 additional cases and present those for acceptance from NRC COR as part of Task 1. Contractor shall develop revised draft and final reports as applicable and stated in Tasks 2, 3, and 4.

5. APPLICABLE DOCUMENTS AND STANDARDS

Additional guidance on technical computer code testing may be found in:

(1) NRC NUREG/BR-0167 defines three levels of software used by the NRC. Level 1 software represents technical application software used in a safety decision by the NRC and Level 2 software is technical or non-technical software not used in safety decision. The guidelines in NUREG/BR-0167 apply to Level 1 and Level 2 software only.

(2) NRC Office of Regulatory Research (RES), Office Instruction OI-PRN-012 Software Quality Assurance.

(3) IEEE Std 1012, IEEE Standard for Software Verification and Validation.

(4) EPRI Technical Report 1025243, Guideline for the Acceptance of Commercial-Grade Design and Analysis Computer Programs

Listing of MACCS document that may be used to support this work include:

Please note older version of same of similar report may be needed if newer version has missing information.

(1) MACCS draft User's Manual (available), Draft Theory Manual work in progress, several chapters are available, complete document will be available by the end of CY-2020.

(2) ML17047A450, 2016 DRAFT MACCS User's Guide and Reference Manual (2020 version available with MACCS 4.0)

(3) ML17174A930, 2016 MACCS output error notification (FORTRAN code)

(4) MLI4234A148, 2014 MACCS Best Practices as Applied in the State-of-the-Art Reactor Consequence Analyses (SOARCA) Project, NUREG/CR-7009

(5) ML17047A457, 2013 MACCS2 Consequence Code Set Version Control Matrix DRAFT

(6) ML17047A449, 2009 Benchmarking Upgraded HotSpot Dose Calculations Against MACCS2 Results

(7) ML072350221, 2007 Draft WinMACCS User's Manual (superseded set above)

(8) ML043240034, 2004 Comparison of Average Transport and Dispersion Among a Gaussian, a Two-Dimensional, and a Three-Dimensional Model NUREG/CR-6853

(9) ML17047A443, 1998 Code Manual for MACCS2: User's Guide NUREG/CR-6613, Vol. 1 SAND97-0594,

(10) ML17047A444, 1998 Code Manual for MACCS2: preprocessor codes COMIDA2, FGRDCF, IDCF2 NUREG/CR-6613, Vol. 2 SAND97-0594

(11) ML063560409, 1990 MELCOR Accident Consequence Code System (MACCS): Model Description NUREG/CR-4691 SAND86-1562 Vol. 2

(12) ML063560409, 1990 MELCOR Accident Consequence Code System (MACCS): Model Description NUREG/CR-4691 SAND86-1562 Vol. 2

(13) NUREG/CR-5376, TI90 007219 Quality Assurance and Verification of the MACCS Code, Version 1.5

6. DELIVERABLES AND DELIVERY SCHEDULE

| Deliverable No. | Deliverable | Due Date |
|------------------------|--|---|
| 1 | Kickoff Meeting Summary | Sep 25, 2020 |
| 2.1 | Draft test plan MACCS document, test cases, literature review and review meeting with COR(online) | Nov 20, 2020 |
| 2.2 | Revised test plan, listing of test cases, format of draft report | Dec 17, 2020 |
| 2.3 | Description of test case 1 with input deck | Jan 29, 2021 |
| 2.4 | Draft project plan with descriptions of test cases and schedule for additional tests and review meeting with the COR | No later than two months after award of Modification No. P00003 |
| 2.5 | Test Plan (additional test cases) | No later than monthly after completion of Deliverable No. 2.4, as directed by the COR |
| 3.1 | Draft report test case 1 and description of test case 2 and 3 | March 2, 2021 |
| 3.2 | Draft report test case 2 and 3, and description of test case 4 to 6, etc. | March 26, 2021 |
| 3.3 | Draft Final Report | May 2021 |
| 3.4 | Final Report | November 5, 2021 |
| 3.5 | Draft report (additional test cases) | As directed by the COR |
| 3.6 | Draft Final Report (additional test cases) | August 30, 2022 |
| 3.7 | Final Report (additional test cases) | No later than September 30, 2022 |
| 4.0 | Optional Task Report | September 30, 2021 |
| 5.0a | Develop new test case hold kickoff meeting | No later than Nov 4, 2022 |
| 5.0b | Issue draft Report for NRC review | April 30, 2023 |
| 5.0c | Issue Final Report | Sept 30, 2023 |

The final due dates can be adjusted with the written approval of the NRC COR via emails.

7. REQUIRED LABOR CATEGORIES

It is expected that staff performing technical work or key personnel will have background and experience in the following areas:

Nuclear Engineering

Radiation Protection and Health Physics
Dose assessment
Radioecology
Radiological Engineering
Consequence Analysis
MACCS computer code

This evaluation requires an understanding of MACCS as well as offsite consequence analysis phenomenology. Knowledge in all technical elements of offsite consequence modeling including radionuclide release, atmospheric transport and dispersion, site data, weather data, emergency response and protective actions, exposure pathways, health effects, and offsite costs is required to perform analyses with MACCS code.

The Contractor shall also provide a Program Manager who shall be responsible for the performance of the work. The Program Manager shall have full authority to act for the Contractor on all contract/order matters relating to daily operation of this order. The Program Manager shall have at a minimum, B.S. in science or engineering. The Program Manager shall also have significant experience with program or project management and NRC regulatory requirements. The Program Manager will support all of the Tasks.

8. GOVERNMENT-FURNISHED PROPERTY

It is understood that SWRI has access to MACCS computer code. A copy of the code and associated documentation will be provided by the COR if requested.

9. PLACE OF PERFORMANCE

The work to be performed under this task order shall be performed at the Contractor's site.

10. SPECIAL CONSIDERATIONS

10.1 TRAVEL

No travel is anticipated for this requirement.

10.2 SECURITY

The work expected under this task order is unclassified and not sensitive.

10.3 LICENSE FEE RECOVERABLE

Work under this task order is not license fee recoverable.

Section F - Deliveries or Performance was revised as follows.

Summary of Clause Changes:

Clause titled **TASK/DELIVERY ORDER PERIOD OF PERFORMANCE (SEP 2013)** is incorporated as follows:

TASK/DELIVERY ORDER PERIOD OF PERFORMANCE (SEP 2013)

This order shall commence on September 10, 2020 and will expire on October 31, 2023.