

STATEMENT OF WORK

NRC Agreement Number NRC-HQ-25-14-D-0005	NRC Agreement Modification Number	NRC Task Order Number (If Applicable) NRC-HQ-60-15-T-0006	NRC Task Order Modification Number (If Applicable)
Project Title MACCS Code Development and Applications			
Job Code Number	B&R Number	DOE Laboratory Sandia National Laboratories	
NRC Requisitioning Office RES			
NRC Form 187, Contract Security and Classification Requirements <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> Not Applicable		<input type="checkbox"/> Involves Proprietary Information <input type="checkbox"/> Involves Sensitive Unclassified	
<input checked="" type="checkbox"/> Non Fee-Recoverable		<input type="checkbox"/> Fee-Recoverable (If checked, complete all applicable sections below)	
Docket Number (If Fee-Recoverable/Applicable)		Inspection Report Number (If Fee Recoverable/Applicable)	
Technical Assignment Control Number (If Fee-Recoverable/Applicable)		Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)	

1.0 BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) developed the MELCOR Accident Consequence Code System (MACCS) specifically to evaluate offsite consequences from a hypothetical release of radioactive material into the atmosphere. The code models atmospheric transport and deposition (ATD), emergency response actions, exposure pathways, health effects, and economic costs.

The MACCS code, its WinMACCS user interface, and utility codes (MELMACCS and SECPOP) have been continuously developed, maintained, and improved by Sandia National Laboratories (SNL) under direction of the NRC through contracts N6159 and V6227.

This task order adds additional work related to MACCS code development, maintenance, and applications. Additional areas of code development include further improvements to atmospheric transport and dispersion modeling, dosimetry and health effects modeling, and economic consequence modeling. Validation efforts are planned to assess MACCS against data from the Fukushima plants. MACCS applications include analyses recommended to the Commission (and agreed to in SRM-SECY-12-0092) after completion of the SOARCA project including the Surry uncertainty analysis and the Sequoyah station blackout consequence analysis. Additional applications include support for the Level 3 PRA project and Fukushima response work as needed.

2.0 OBJECTIVE

The objective of this agreement is to provide support for development, maintenance, analysis, applications, and general support for the MACCS code suite.

3.0 SCOPE OF WORK

The scope of work for this task order include the development and maintenance of the MACCS suite of computer codes which evaluate the impacts of atmospheric releases of radioactive aerosols and vapors on human health and the environment. This includes the MACCS code, the WinMACCS user interface, and all of the preprocessor codes including SecPop, MELMACCS, COMIDA, LHS, and others. The development of specific technical advances in the MACCS code include areas such as atmospheric transport and deposition, emergency response and protective actions, radiation exposure pathways, health effects, and economic impacts and others.

The scope of work for this task order also includes the application, analysis, and technical review of the MACCS code and related projects. Applications, technical review, and knowledge transfer of MACCS analysis requires a unique combination of demonstrated expert knowledge and experience in the required technical areas listed below:

- Source Term and Radionuclide Release Atmospheric transport and dispersion
- Exposure Assessments
- Emergency Preparedness and Protective Actions Consequence Quantification and Reporting
- Dosimetry and Health Effects
- Economic Consequences
- Risk and Uncertainty

All changes to the MACCS code shall be in conformance with formal Quality Assurance (QA) procedures.

4.0 SPECIFIC TASKS

Sandia National Laboratory must perform the following tasks:

Task 1: Code Development/Maintenance

Task 1.1 Consolidated Model Documentation: Develop a series of NUREG reports which documents the use, theory, and validation of the MACCS suite of codes. Review existing documentation as well as new subject-specific documentation and consolidate all sources such that there is no repetition and all current model features are appropriately discussed. The NUREG reports should be updated and a revision published each time a major modeling capability is added to the code (e.g., alternative economic consequence model and new ATD model).

Completion Date: 1/31/2019

Task 1.2 New Alternative Economic Consequence Model: Conduct a peer review of the current GDP-REAcct based economic consequence (EC) model with 3-4 subject matter experts from academia, government, or industry. Identify peer review candidates, prepare briefing materials, attend meetings, and support logistical needs of the peer reviewers as needed. Following insights gained from the peer review process, revise the GDP-REAcct EC model and conduct testing and validation. Complete documentation of the model in the NUREG/CR user manual. Provide training workshops to NRC staff and other stakeholders as needed. If a Commission paper is written to inform the NRC Commission of the status of the GDP-REAcct EC model, provide input to the paper and conduct technical reviews as needed.

Completion Date: 1/31/2019

Task 1.3 SecPop and Related Databases: Adapt SecPop to use the most recent data sources for its underlying databases. For example, update the SecPop county file when all 2012 data is available. Complete development and testing of the new code version(s) and document the model theory, use, and validation in the NUREG/CR user manual.

Completion Date: 1/31/2019

Task 1.4 Input Parameter Guidance: Assist the development of a NUREG report on the quantification of input parameters for the MACCS Code, appropriate for severe accident analyses, severe accident mitigation design alternative analyses (SAMDA), and severe accident mitigation alternative (SAMA) analyses necessary to meet National Environmental Protection Act (NEPA) requirements. Review and assess prior documentation for consolidation and for their potential inclusion. Conduct necessary research for improvements to quantification of MACCS input parameters. Provide a draft letter report for RES and NRO staff review and comments. Incorporate RES and NRO staff comments into a final revision of the letter report.

Develop an electronic environmental radiological consequence assessment toolbox for severe accidents (EaRCAT-SA) that will provide a means for NRC staff to quickly access the necessary non-site-specific input parameters and datasets with associated references and pedigrees and that allows for the exporting of tabular data to an Excel worksheet for further calculations.

Completion Date: 6/30/2017

Task 1.5 New Atmospheric Transport and Dispersion (ATD) Model: Complete the integration of HYSPLIT with MACCS that was started under Agreement No. V6227. Identify and carry out solutions to reduce the computational intensity of calculations while ensuring sufficient modeling fidelity. Complete testing and validation of the model. Present the model to NRC staff and stakeholders in a workshop. Document the theory, use, and validation of the model in the NUREG/CR user manual.

Completion Date: 12/31/2016

Task 1.6 Dosimetry and Health Effects Modeling: Complete the modeling effort that was started under Agreement No.V6227 to enhance the MACCS code suite to more accurately model dosimetry and health effects. This includes the modeling of more organs/tissues, cancer types, and demographic subsets (child vs. adult, man vs. woman) as well as modeling needed to address any updated federal guidance for estimating cancer risk from radiation exposure. Complete testing and validation of the updated models and document the theory, use, and validation in the NUREG/CR user manual.

Completion Date: 12/31/2017

Task 1.7 Animations: Develop animations that visually display time-dependent MACCS data on a polar grid. These should include plumes, contamination, dose contours, population movement, etc. Complete testing and validation of the animations and incorporate them into WinMACCS. Develop documentation of the animations to describe all features shown.

Completion Date: 12/31/2016

Task 1.8 Validation against Fukushima Data: Validate the MACCS ATD module against Fukushima release and environmental monitoring data. Validate the MACCS economic consequence models against cost information available from Fukushima. Document the results of validation in a technical letter report. Collaborate with external partners such as DOE as appropriate.

Completion Date: 12/31/2017

Task 1.9 General Maintenance and Improvements: Evaluate MACCS suite code bugs submitted through the Bugzilla website, phone calls, or email and implement updates to the codes to address them. Provide an updated itemized list of all code bugs submitted to Bugzilla in the MLSR. The COR shall approve which code bugs are addressed and which are of lower priority. Update user, theory, and validation reports appropriately. Also implement code improvements including but not limited to the following:

- Unique long-term phase dose criteria for habitability, reoccupation, and cleanup
- Unique parameter instead of just DSRATE for the discount rate and the rate of return for the capital utility loss
- Expand range of allowable values for decontamination costs and times
- Create duration-specific costs for long-term phase
- Create a variable for condemnation period that is a user input
- Increase the number of land use categories
- Create a property value adjustment factor to account for the stigma of residual radiation
- Create a model to estimate TIMDEC and DUR_INTPHAS based on extent of land contamination
- Create cohort for transient population
- Integrate MACCS with a separate decontamination code such as CONDO or DECON

- Report generic dose projections and contours
- Adapt MACCS to allow a more detailed breakdown of costs into their subcomponents (e.g., cohort-specific costs, type of compensation, etc.)
- Improve computational speed by utilizing parallel processing
- Improve the network evacuation input windows to address slow loading issue
- Change WTRAC to be “not required” when SUMPOP is selected
- Change ACTHRE, DOSEFA, and DOSEFB to be “not required” when LNT is selected

Completion Date: 1/31/2019

Task 1.10 GUI Update: Evaluate alternatives for improving the graphical user interface (GUI) for both pre- and post-processing for all MACCS suite codes. Based on pros, cons, and costs of the different alternatives, recommend solutions. Following approval from the COR, implement the GUI updates to allow for a better and more user-friendly flow of information within the codes. Conduct validation testing to ensure GUI updates work as intended. Document the GUI user manual in a NUREG/CR report.

Completion Date: 1/31/2019

Task 1.11 Aqueous Pathway Modeling: Evaluate alternatives for adding an aqueous pathway model to MACCS. Identify pros, cons, and costs of each alternative and make a recommendation to NRC. Following approval from the COR, implement the modeling update. Conduct validation testing and document the model theory, use, and validation in a NUREG/CR report.

Completion Date: 1/31/2019

Task 2: Code Applications/Analysis

Task 2.1 Level 3 PRA Project – General Support: Support NRC staff in the completion of Level 3 PRA analyses by providing assistance as requested and by providing internal review of reports and associated MACCS project files developed by NRC staff. Deliverables include written review of specific NRC reports and MACCS project files and informal technical support as requested.

Completion Date: 3/31/2018

Task 2.2 Level 3 PRA Project – EP Modeling: Develop emergency phase models for MACCS parameters to support Level 3 PRA offsite consequence analyses, including analyses for internally and externally initiated reactor and spent fuel pool accidents. Deliverables include technical letter reports documenting recommended values and technical bases for MACCS EP model parameters.

Completion Date: 12/31/2016

Task 2.3 Fukushima/NTTF Support: Provide technical support for offsite consequence calculations to evaluate Fukushima Near Term Task Force (NTTF) recommendations including containment protection and release reduction alternatives at U.S. nuclear plants including the effects of hydrogen on containment. Review documents and presentations and answer NRC staff questions via email, phone calls, and in-person meetings. Provide a technical letter report which documents the review process of the MACCS model, makes recommendations for different parameter values, and describes the technical basis for the recommended changes.

Completion Date: 12/31/2017

Task 2.4 Surry Uncertainty Analysis: Develop and recommended uncertain MACCS parameters and their distributions for the Surry UA. Document the parameters, distributions, and technical basis in a letter report. Conduct UA calculations, analyze results, and document the process and insights in a NUREG/CR report. Review and address NRC staff and ACRS comments on the analysis and NUREG/CR report.

Completion Date: 1/31/2019

Task 2.5 Sequoyah Consequence Analysis: Provide technical support for MACCS calculations to evaluate the offsite consequences of the most important accident scenarios at the Sequoyah nuclear plant. Review and develop parameter values and justification, input models, and results and provide feedback to NRC. Review and develop documents and presentations and answer NRC staff questions via email, phone calls, and in-person meetings. Provide a technical letter report which documents the review process of the MACCS model, makes recommendations for different parameter values, and describes the technical basis for the recommended changes.

Completion Date: 1/31/2019

Task 2.6 RTR Consequence Analysis: Perform security-related consequence assessment for research and test reactors. Given a set of hypothetical source terms, use the MACCS code to calculate the consequences of potential cyber-security events at research and test reactors. Provide a draft letter report documenting the analysis and incorporate NRC comments into a final letter report.

Completion Date: 6/30/2017

Task 3: General Support

Task 3.1 Project Support: Prepare and lead bi-monthly project review meetings via conference call. These meetings should cover the technical progress made and project plans for all MACCS code development and applications tasks. Conduct in person semi-annual program review meetings to brief senior management on the status of all MACCS tasks.

Completion Date: 1/31/2019

Task 3.2 User Support and Code Distribution: Provide limited assistance to NRC-specified users, both domestic and international, by responding to their queries regarding the use of the code or its installation on computers. The DOE Laboratory shall maintain a log of all instances in which user support is provided and this information (date, code and version, name, company/organization, and topic) shall be included in each MLSR. Distribute MACCS suite codes to approved users, collect fee when applicable, and document this information (date, code and version, name, company/organization, and fee) in each MLSR.

Completion Date: 1/31/2019

Task 3.3 Meetings and Workshops: Support meetings, both domestic and international, and provide various training sessions and workshops on the MACCS code suite, models, and use in various offsite consequence analyses. Estimated travel occurrences are documented in Section 8 of this SOW.

Completion Date: 1/31/2019

5.0 DELIVERABLES AND/OR MILESTONES SCHEDULE

Task Number	Title	Deliverables	
		Draft	Final
1.1	Consolidated Model Documentation	12/31/2015	01/31/2019
1.2	New Alternative Economic Consequence Model	12/31/2015	01/31/2019
1.3	SecPop and Related Databases	12/31/2015	01/31/2019
1.4	Input Parameter Guidance	12/31/2016	06/30/2017
1.5	ATD Modeling	12/31/2015	12/31/2016
1.6	Dosimetry and Health Effects Modeling	12/31/2016	12/31/2017
1.7	Animations	06/30/2015	12/31/2016
1.8	Validation against Fukushima Data	12/31/2016	12/31/2017
1.9	General Maintenance and Improvements	N/A	01/31/2019
1.10	GUI Update	12/31/2016	01/31/2019
1.11	Aqueous Pathway Modeling	12/31/2016	01/31/2019
2.1	Level 3 PRA Project – General Support	12/31/2015	12/31/2018
2.2	Level 3 PRA Project – EP Support	12/31/2015	12/31/2016
2.3	Fukushima/NTTF Support	12/31/2015	12/31/2017
2.4	Uncertainty Analysis	12/31/2015	01/31/2019
2.5	Sequoyah Analysis	12/31/2015	01/31/2019
2.6	RTR Consequence Analysis	09/30/2016	06/30/2017
3.1	Consulting Support	N/A	01/31/2019
3.2	User Support and Code Distribution	N/A	01/31/2019
3.3	Meetings and Workshops	N/A	01/31/2019

6.0 TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED

This work requires an in-depth understanding of MACCS, WinMACCS, and their utility codes as well as offsite consequence analysis phenomenology. Expertise is required in all technical elements of offsite consequence modeling including radionuclide release, atmospheric transport and dispersion, site data, weather data, exposure pathways, protective actions, health effects, and offsite costs. Experience developing, maintaining, and performing QA on MACCS for the NRC is needed. Expertise in uncertainty analysis is also required as is access to high performance computer clusters for running computationally intensive calculations.

7.0 MEETINGS AND TRAVEL

Meetings and travel related to subtask 1.2 and 1.5 are described above in those specific sections. The following travel occurrences are covered by subtask 4.3:

- 10 person-days per year of travel by SNL staff members to NRC headquarters for periodic status review meetings and to discuss code changes and demonstrate use
- 24 person-days per year of travel by SNL staff members to NRC headquarters or to domestic or international meetings, conferences, and workshops including IMUG
- 6 person-days per year of travel by SNL staff members to NRC headquarters to support NRC public meetings and ACRS meetings

8.0 REPORTING REQUIREMENTS

Sandia National Laboratory is responsible for structuring the deliverable 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.

Monthly Letter Status Reports

In accordance with Management Directive 11.7, NRC Procedures for Placement and Monitoring of Work with the U.S. Department of Energy, Sandia National Laboratory must electronically submit a Monthly Letter Status Report (MLSR) by the 20th day of each month to the Contracting Officer Representative (COR) with copies to the Contracting Officer (CO) and the Office Administration/Division of Contracts to 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.

9.0 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 Sandia National 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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Alternate Contracting Officer's Representative

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10.0 MATERIALS REQUIRED

N/A

11.0 NRC-FURNISHED PROPERTY/MATERIALS

N/A

12.0 RESEARCH QUALITY (TYPE N/A IF NOT APPLICABLE)

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 Sandia National Laboratory to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC COR will review all research products with these criteria in mind.

13.0 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 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 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.

14.0 OTHER CONSIDERATIONS

N/A