Final Verification and Validation (V&V) Report

for

RACER Services and Verification and Validation (V&V)

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1. PROBLEM STATEMENT

U.S. Government agencies use parametric models to estimate future environmental cleanup costs; these cost estimates are then used as the basis for reporting outstanding environmental liabilities, as well as program and budget requirements. Defense Environmental Restoration Program (DERP) Management Guidance (September 2001), requires that computer models used for estimating costs for environmental liabilities are verified, validated, and accredited in accordance with the requirements specified in Department of Defense Instruction (DoDI) 5000.61, "DoD Modeling and Simulation (M&S) Verification, Validation and Accreditation" (13 May 2003).

The Remedial Action Cost Engineering and Requirements (RACER) cost estimating system is a parametric cost estimating tool used to develop estimates of outstanding environmental liabilities. RACER was originally developed in 1991 in response to the 1990 Chief Financial Officer's (CFO) Act, which, along with subsequent legislation, required federal agencies to improve financial management and reporting, and to provide accurate, complete, reliable, timely, and auditable financial information.

Enhancements and new technologies have been added to the RACER system over the past 18 years.[1] The version of RACER proposed for accreditation, RACER 2008, is a single-user desktop application developed using Microsoft® (MS) Visual Basic (VB) 6.0 and MS Access.

M&S tools are classified by DoDI 5000.61 as either Common-use, General-use, or Joint-use. Additionally, DoDI 5000.61 states:

> *"Each DoD Component shall be the final authority for validating representations of its own forces and capabilities in common-, general-, or Joint-use M&S applications and shall be responsive to the other DoD Components to ensure its forces and capabilities are appropriately represented."*

DoDI 5000.61 defines three categories of M&S tools:

- Common-use M&S tools are *"M&S applications, services, or materials provided by a DoD Component to two or more DoD Components."*
- General-use M&S are *"Specific representations of the physical environment or environmental effects used by, or common to, many models and simulations; e.g., terrain, atmospheric, or hydrographic effects."*
- Joint-use M&S are *"Abstract representations of joint and Service forces, capabilities, equipment, materiel, and services used in the joint environment by two, or more, Military Services."*

[1] *Final Software Testing Plan, RACER 2008 Maintenance and Support, Earth Tech, Inc., Greenwood Village, CO, August 2007*

The RACER software is categorized as a "Common-use M&S," and is subject to Verification, Validation, and Accreditation (VV&A) standards of the funding Department of Defense (DoD) component. In the case of RACER, VV&A activities are dually funded by the Army and Air Force, thus the following three regulations apply[2] to RACER Verification and Validation (V&V) activities:

- Air Force Instruction (AFI) 16-1001
- Army Regulation (AR) 5-11
- DoDI 5000.61.

The purpose of this V&V report is to document verification and validation activities for the RACER 2008 system in accordance with DoDI 5000.61, AFI 16-1001, and AR 5-11.

1.1 Intended Use

U.S. Government agencies are required to develop estimates of outstanding environmental liabilities. RACER is a parametric cost estimating tool used to create these estimates. The benefit of using RACER to create environmental liability estimates is that it provides an automated, consistent, and repeatable method.

In 2001, the Government engaged PricewaterhouseCoopers LLP to verify and validate RACER 2001, Version 3.0.0. Based on the 2001 V&V evaluation, Headquarters (HQ) Air Force Civil Engineer Support Agency (AFCESA) accredited RACER for the following intended use:

> *"To provide an automated, consistent, and repeatable method to estimate and document the program cost for the environmental cleanup of contaminated sites and to provide a reasonable estimate for program funding purposes consistent with the information available at the time of the estimate preparation."*

In the 1990s, Congress passed sweeping financial management reform legislation including the CFO Act of 1990, the Government Performance and Results Act (GPRA) of 1993, the Government Management Reform Act (GMRA) of 1994, and the Federal Financial Management Improvement Act (FFMIA) of 1996. Such legislation aims to improve financial management, promote accountability and reduce costs, and emphasize results-oriented management. These Acts require each executive agency to prepare and submit to the Director of the Office of Management and Budget a complete, accurate, and auditable financial statement for the preceding fiscal year. Environmental liability estimates are one source of the financial information reported on agencies' annual financial statements as well as on the DoD Annual Report to Congress. As such, the environmental liability estimates must be accurate, complete, reliable, timely, and auditable.

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[2] *AFI 16-1001 and AR 5-11 are nearly identical to DoDI 5000.61; there are no conflicting instructions. The Performance Work Statement (PWS) for this TO identifies requirements as written in AFI 16-1001; therefore, the standards, definitions, and processes as documented in AFI 16-1001 are referenced throughout this report.*

Cost-to-complete (CTC) estimates form the basis of the environmental liability line items reported in the annual financial statements and must be updated annually. Environmental liabilities are reported on "Environmental Liabilities and Environmental Disposal Liabilities," Note 14 to each Agency's balance sheets. For the DoD agencies, RACER is one of the primary methods used to create standardized cost estimates for current and future environmental liabilities.

1.2 Model Overview

RACER employs a patented parametric cost modeling methodology using over 113 technology-specific cost models (technologies) that represent various applications related to site remediation.[3] Each of the technologies is based on generic engineering solutions for environmental projects, technologies, and processes. These generic engineering solutions were derived from historical project information, industry data, government laboratories, construction management agencies, vendors, contractors, and engineering analysis. When creating an estimate in RACER, the user enters site-specific information to tailor the generic engineering solutions to reflect project-specific conditions and requirements. The tailored design is then translated into specific quantities of work, and the quantities of work are priced using current price data. Assemblies in the RACER database correlate with costs reported in the Government Cost Book, published by the Tri-Service Automated Cost Engineering Systems (TRACES) Committee.

To aid in localizing RACER estimates, national average unit costs for assemblies in the RACER database are derived primarily based on the Government Cost Book (formerly the Unit Price Book, or UPB). The area cost factor (ACF) for the estimate and a safety level cost adjustment are applied to calculate the adjusted unit price for each assembly to arrive at the adjusted direct cost. Direct costs are marked up using a series of factors relating to various aspects of the work.

Suggested changes to RACER are considered and processed according to the following two plans: the Software Configuration Management Plan for RACER Software System (Version 4.0, dated February 26, 2003 - DRAFT) and the RACER Change Management Plan (Version 2.01, dated July 2007). The Configuration Management Plan applies to changes to the structure of the software (source code, underlying data, requirements, model algorithms, software versioning, etc.), whereas the Change Management Plan describes the relevant parties and their roles and responsibilities. The Change Management Plan is one of three documents that describe the overall business management of RACER.[4]

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[3] *There are 113 RACER cost models available to the standard RACER user. U.S. Air Force users that are approved to use the Military Munitions Response Program (MMRP) Supplemental Investigation technology have 114 cost models available.*

[4] *The three documents are (1) RACER Change Management Plan, (2) RACER Business Management Plan, and (3) RACER Quality Management Plan. Complete reference information is provided in Section 7 of this document.*

Changes that have been approved are included in the annual software update. The Change Management Plan provides a process where all participating federal agencies have involvement and RACER continues development in a consistent manner to fulfill the needs of actively participating agencies. All enhancements and revisions to software, systems, processes, and documentation can be fully coordinated with participating federal agencies through use of the Change Management Plan.

For RACER, Change Management involves identifying the configuration of work products and their descriptions at given point in time, employing a process to systematically control changes to the configuration, and maintaining the integrity and traceability of the configuration throughout the entire project lifecycle.

1.3 Model Application

The RACER system is a cost estimating tool that can be applied to all phases of remediation. It operates through a number of technology-specific cost models which allow the user to input data which correlates with the anticipated work, resulting in assembly quantity calculations.

The categories of remediation which can be estimated using the RACER system are:

- Pre-Studies
- Studies
- Removal Action/Interim Corrective Measures
- Remedial Design/Corrective Measures Design
- Remedial Action/Corrective Measure Implementation
- Operations and Maintenance
- Long Term Monitoring
- Site Close-out

After completing the estimate, users can generate a wide variety of reports documenting the estimated cost for the project. Additionally, estimates can be imported into the U.S. Army Environmental Command (USAEC) and the U.S. Army Corps of Engineers (USACE) management systems. Generating reports and importing estimate information into management systems are the two most common methods used by agencies for documenting and tracking CTC information.

1.4 Accreditation Scope

The following excerpt from the *RACER V&V Plan*[5] *prepared by Earth Tech, Inc. (May 2008)* provides the following justification for accreditation of RACER:

[5] *RACER Verification & Validation Plan, Earth Tech, Inc., Greenwood Village, CO, May 2008*

"There are four primary reasons for getting RACER Accredited. The first three reasons listed deal with meeting regulatory requirements. The final reason listed deals with increasing confidence in decision making.

- *The Air Force Audit Agency found that RACER did not conform to DoDI 5000.61 – DoD Modeling and Simulation Verification, Validation, and Accreditation".*
- *DoDI 5000.61 requires that M&S used to support the major DoD decision making organizations and processes… (DoD Planning, Programming, and Budgeting System) shall be accredited for that use.*
- *(AF) 16-1001 requires accreditation.*
- *Increases credibility in the M&S outputs and reduces the risk of using the M&S. Overall this increases the confidence level of decisions made based on the outputs."*

The RACER system has undergone a number of changes since the 2001 V&V evaluation and system accreditation. A listing of the changes to the RACER system from 2002 to 2008 is included in Appendix B of this document, and in Appendix B of the *Final RACER V&V Plan*.[5] The *Final RACER V&V Plan* also focuses on the current state of the cost models and other RACER functionality.

Recent RACER releases have included the elimination of obsolete cost models and the development of new cost models. Available reports have also been expanded. The most frequently used models were re-engineered for RACER 2008 based on the collection of and comparison to historical project cost data. The default markup template and the markup process were completely redefined as well.

Each release of RACER includes updated assembly prices, area cost factors, per diem rates, and escalation factors. The RACER 2008 release includes extensive redefinition and updating of assembly costs using information from the 2006 version of the Government Cost Book. Each assembly has been defined using Cost Book line items that improve documentation and maintainability of cost data. Except for assemblies for which costs are provided by USACE or the Air Force, all assemblies were defined using Cost Book line items. Previous RACER releases included a mix of assemblies defined using the Cost Book and assemblies that relied on other data sources. Some assemblies have no pre-defined unit cost, but were priced when used in a model (for example, Other Direct Costs and per diem).

1.5 V&V Scope

V&V activities, their results, and recommendations are included in this report. This document will be maintained by the V&V Manager as part of the M&S VV&A history, and used to support current and future accreditation decisions, feasibility assessments, and future enhancements to RACER.

The following definitions, presented by the DoD M&S Coordination Office (M&S CO), are utilized in DoDI 500.61, AFI 16-1001, and AR 5-11.

Verification

1. The process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications.
2. The process of determining that a model or simulation faithfully represents the developer's conceptual description and specifications. Verification evaluates the extent to which the model or simulation has been developed using sound and established software and system engineering techniques.

Verification is performed by the Verification Agent. For RACER, this is the Army RACER Point of Contact (POC).[6]

The goal of the Verification portion of the V&V was to evaluate RACER and its underlying cost models to determine whether it correctly and completely represents the developer's conceptual description and specifications. Verification activities for the 2008 version of the RACER software were performed by the software development contractor, Earth Tech, Inc. with oversight and approval provided by the RACER Technical Review Group (TRG). Earth Tech, Inc.[7] was awarded two task orders through the U.S. AFCESA which included annual maintenance and support as well as reengineering of thirteen cost models. Under these task orders Earth Tech, Inc. also maintained and updated the internal control documents listed in Section 7.0 of this report. Both task orders included verification activities.

Validation

1. The process of determining the degree to which a model and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model.
2. The process of determining the fitness of a model or simulation and its associated data for a specific purpose.

Validation is performed by the Validation Agent. For RACER 2008, this is the Army RACER POC.[6]

The primary objective of the validation portion of the V&V was to provide sufficient documentation to support validation of the RACER 2008 cost models and underlying databases by documenting a comparison of RACER-generated costs against associated actual historical costs for current technologies. On September 25, 2008, USAEC

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6 *Guidance for Verification and Validation (V&V) of Remedial Cost Engineering and Requirements Software, March 2006*

7 *The RACER 2008 software developer was Earth Tech, Inc.; Earth Tech, Inc. is now known as AECOM.*

awarded a contract to Booz Allen Hamilton (Booz Allen) (W91ZLK-07-D-0002, Task Order (TO) 0008) to "validate the RACER 2008 (version 10.0.2) cost models and underlying databases." The contract directs Booz Allen to "document comparison of RACER-generated costs with associated actual project costs on present models and once comparisons are completed, a new V&V report will be developed."[8] The opportunity to compare actual project costs with RACER cost estimates represents a best practice in the development of parametric models and will allow continued enhancement of RACER as a calibration tool.

To compare RACER 2008 cost models (technologies) against actual project cost data, project information was collected from a variety of Government offices. The types of project information collected included technical reports and contracting documents for environmental remediation projects executed by the Government within the past five years. Under the USAEC TO, and in support of Validation activities, Booz Allen traveled to four Government offices to collect project information. In addition, Booz Allen conducted similar visits in 2007 and 2008 under a TO of a contract issued by the Air Force Center for Engineering and the Environment (AFCEE).[9]

8 *Contract Order W91ZLK-07-D-000 TO 0008 page 5, dated September 25, 2008*

9 *Global Engineering, Integration, and Technical Assistance 2005 (GEITA05), FA8903-05-D-8729 TO 0372 (Mod 2, dated 19 August 2008))*

2. MODEL REQUIREMENTS AND ACCEPTABILITY CRITERIA

Verification

Software testing must follow approved methods and standards; also, when tested, the models must meet these design specifications. For RACER, the Software Testing Plan[10] describes the testing process for the software; the Software Test Results Report[11] describes the results of the three phases of testing (alpha, beta, and final acceptance). The testing goals, as outlined in the Software Testing Plan, are shown in Table 2.0 below. These goals also serve as acceptability criteria for the verification portion of the V&V.

Defect Classification	# Allowed in Alpha Build	# Allowed in Beta Build	# Allowed in Released Version
Critical	3	2	0
Necessary	No stated goal	No stated goal	0
Cosmetic	12	6	3

Table 2.0. Defect Goals for RACER testing, as Stated in the Software Testing Plan[12]

Validation

The Tri-Service Parametric Model Specification Standard's[13] purpose is to establish criteria and standards for developing and updating parametric cost models like those used in RACER. The ranges of accuracy, as stated by the Association for the Advancement of Cost Engineering (AACEI), and as also reported in the Tri-Service Parametric Model Specification Standard, for preliminary (order of magnitude), secondary (budget), and definitive estimates are displayed in the Table 2.1, below.

Description	Range		
Preliminary (Order of Magnitude)	+ 50%	to	- 30%
Secondary (Budgetary)	+ 30%	to	- 15%
Definitive	+ 15%	to	- 5%

Table 2.1. AACEI Ranges of Accuracy

10 *Final Software Testing Plan, RACER 2008 Maintenance and Support, Earth Tech, Inc., Greenwood Village, CO, August 2007*

11 *Software Test Results Report for RACER 2008, Final Acceptance Testing Results, Earth Tech, Inc., Greenwood Village, CO, October 2007*

12 Section 3.1.2 of the *Final Software Testing Plan*

13 *Tri-Service Parametric Model Specification Standard, Project Time & Cost, Inc., April 1999*

Per the Tri-Service Parametric Model Specification Standard:

> "*Due to the lack of information in environmental remediation work a parametric cost model would be used as a Preliminary or Order of Magnitude Estimate and should be evaluated as such. However, in some instances, including more complicated models that involve secondary parameters, it may be contained in the Secondary or Budget Estimate category."*[13]

Therefore, the acceptability criteria for the validation portion of the V&V are that RACER estimates should fall within -30% and +50% of actual costs.

3. MODEL ASSUMPTIONS, CAPABILITIES, LIMITATIONS, & RISKS/IMPACTS

3.1 Model Assumptions

The system uses a patented methodology to generate parametric cost estimates. RACER technologies are based on generic engineering solutions for environmental projects, technologies, and processes. These solutions, and the resulting RACER estimates, are constrained by the amount and the accuracy of the project data gathered to create each of the cost models in the software. The project data used to support model (technology) development ("Historical Cost Data") is collected by the software development contractor, reviewed by the RACER TRG, and incorporated into a "technology addendum." A "technology addendum" is created by the software development contractor for each RACER cost model, and reviewed for accuracy by the RACER TRG.

The accuracy of RACER estimates is further constrained by several additional factors:

- **The User.** The user preparing the estimate must be knowledgeable (i.e., officially trained) in the use of the RACER software.
- **What Was Known About the Project.** The user must know, at a minimum, all of the "required parameters" to be entered into each cost model. If assumptions are made about the values of required parameters, the accuracy of the assumptions will impact the accuracy of the resulting estimate.
- **Inaccurate Use of the Software.** Individual users will inevitably segregate project components differently. One user might, for example, add individual assemblies to account for waste disposal; a different user might employ the Residual Waste Management technology to account for these costs; a third user might employ the Load & Haul technology. Agencies can increase consistency amongst estimates by ensuring all of its users are uniformly trained and knowledgeable about the RACER software.
- **Changes in Project Scope.** RACER estimates are designed to be point-in-time estimates. If the project scope changes between estimate preparation and project execution, the accuracy of the estimate may be subject to change.
- **Changes in Design Standards.** The RACER software is continually updated to incorporate field-proven techniques for environmental remediation. Newer technologies, unique approaches, and experimental methods are not available as parametric models in RACER. If a project employs such techniques, the project may not accurately be estimated in RACER.

3.2 Model Capabilities

In 2001, the Government engaged PricewaterhouseCoopers LLP to verify and validate RACER 2001, Version 3.0.0. Based on the 2001 V&V evaluation, HQ AFCESA accredited RACER for the following intended use:

"To provide an automated, consistent, and repeatable method to estimate and document the program cost for the environmental cleanup of contaminated sites and to provide a reasonable estimate for program funding purposes consistent with the information available at the time of the estimate preparation."

For the 2008 version of the software addressed in this report, the intended use remains the same.

3.3 Model Limitations

The accuracy of the RACER models is constrained by the following:

- The amount of project data gathered to create each of the cost models in the software
- The accuracy of project data gathered to create each of the cost models in the software
- The accuracy of the algorithms employed in each RACER model
- The accuracy of the data used to populate the parameters of each cost model
- The training level/knowledge of the user preparing the estimate
- The methodology employed by the user to segregate project components and correlate those components to individual RACER cost models
- Whether the remediation technologies employed in the actual project are available for cost modeling in the RACER software.

RACER creates a point-in-time estimate based on generic engineering solutions that is known at the time. Unknowns can contribute to decreased accuracy.

3.4 Model Risks/Impacts

The risk associated with developing and utilizing RACER for its intended use (creation of parametric cost estimates) is that the estimates will not be accurate enough to meet the standard for a preliminary estimate (-30%/+50%), as described in Section 2 of this document.

Verification involves testing the software to ensure that it is functioning as intended and producing the associated documentation defining procedures, algorithms, etc. The risk associated with not performing this testing is that problems will be difficult to identify and correct without the proper testing and documentation.

Validation allows the opportunity to compare actual project costs with RACER cost estimates, and to verify the soundness of the generic engineering solutions presented in the algorithms of the RACER software. The risk associated with not performing validation activities is that there is then no benchmark to be used to evaluate the accuracy of the system.

Overall, VV&A represents a best practice in the development of parametric models and will allow continued enhancement of RACER as a calibration tool.

4. V&V TASK ANALYSIS

4.1 Data V&V Task Analysis

The documents listed in Section 7.0 of this document are used as internal controls to guide design, development, revisions, verification, and validation of the RACER software. These documents are updated and revised on an ongoing basis; the documents listed in Section 7.0 are the versions current at the time of release of RACER 2008. The V&V tasks described below are found to be in conformance with these documents.

4.1.1 Data Verification

All underlying costs utilized in the RACER System correlate with costs reported in the Government Cost Book, published by the TRACES Committee. Area cost factors (ACFs), a separate type of underlying data, are published by the Office of the Secretary of Defense (OSD). Values for Markups (including General Conditions, Overhead, Profit, Prime Markup on Sub, Risk, and Owner Cost) are described in the *Final Technical Memorandum Evaluation of the Markup Template for RACER 2008.*[14]

4.1.2 Data Validation Task Analysis

All underlying costs utilized in the RACER System correlate with costs reported in the Government Cost Book, published by the TRACES Committee. Area cost factors ACFs, a separate type of underlying data, are published by OSD. Values for Markups (including General Conditions, Overhead, Profit, Prime Markup on Sub, Risk, and Owner Cost) are described in the *Final Technical Memorandum Evaluation of the Markup Template for RACER 2008.*[14]

4.2 Conceptual Model Validation Task Analysis

As part of the validation activities, RACER technologies were evaluated to determine cost reasonableness. This was accomplished by reviewing the assembly information to determine if the assemblies used coincided with current best environmental engineering practices. Results of this analysis are listed in Section 6.5 of the *Final Validation Report (Version 3.0) for RACER Services and V&V dated September 23, 2009*.

4.3 Design and Implementation Verification Task Analysis

The RACER system is tested annually on a variety of operating systems and office suites including MS Windows XP and MS Windows 2000 operating systems, and MS Office 2000 and XP Suites. The test plans are organized by functional areas such as installation, general functionality, and compatibility. The testing performed as part of each release:

[14] *Final Technical Memorandum Evaluation of the Markup Template for RACER 2008, Earth Tech, Inc., Greenwood Village, CO, 7 May 2007*

1. Ensures a system release that meets or exceeds all functional and technical requirements specified in the project Statement(s) of Work (SOWs) and the design documents that were produced pursuant to those project SOWs, and
2. Provides a high-quality system that provides defensible and consistent estimates.

The entire testing procedure that is performed as part of each RACER software release is documented in the *Final Software Testing Plan, RACER Maintenance and Support*.

For each new release of RACER, design testing is performed at the alpha stage of testing, and implementation testing is performed at the beta, and final acceptance stages. At each stage of the process, a set of comprehensive test scripts details the tests to be performed. Testers for the software development contractor perform each test and record the results; independent verification testing is performed by the Government. Any test that fails is remedied by the software development team and prepared for retesting. Each iteration of the software (alpha, beta, final acceptance) is rebuilt until the stated goals are met for that iteration. For example, there can be a final acceptance 1, final acceptance 2, final acceptance 3 builds until the goals stated for the final acceptance build are met. The release version is not built until the final acceptance version meets the stated goals for release. Ad hoc testing is also performed. As part of each RACER release, a Software Test Results Report (STRR) is produced, detailing the testing process and the results of testing at the alpha, beta, and final stages. For the RACER 2008 software release, the following STRRs were prepared:

1. *Software Test Results Report for RACER 2008, Alpha Testing Results, prepared by Earth Tech, Inc., August 2007*
2. *Software Test Results Report for RACER 2008, Beta Testing Results, prepared by Earth Tech, Inc., September 2007*
3. *Software Test Results Report for RACER 2008, Final Acceptance Testing Results, prepared by Earth Tech, Inc., October 2007.*

Additional testing, including Unit testing, Functional testing, Deployment testing, and Ad Hoc testing are defined in the *Final Software Testing Plan, RACER 2008 Maintenance and Support*, prepared by Earth Tech, Inc. (August 2007).

Detailed testing results are included in the Alpha, Beta, and Final Acceptance STRRs. An overview of software testing results as presented in the Final Acceptance STRR is provided below.

Earth Tech, Inc. compiled the final alpha version of the RACER 2008 system on 1 August 2007. This version was subjected to each of the 67 test scripts in the approved Software Testing Plan. The defects that were found are summarized in the following table:

Defect Classification	Number Found
Critical	6
Necessary	27
Cosmetic	56
TOTAL	**89**

Table 4.0. Defect Goals for RACER Alpha Build

Earth Tech, Inc. compiled the final beta version of the RACER 2008 system on 31 August 2007. This version was subjected to each of the 67 test scripts in the final Software Testing Plan. The defects that were found are summarized in the table below:

Defect Classification	Number Found
Critical	7
Necessary	24
Cosmetic	30
TOTAL	**61**

Table 4.1. Defect Goals for RACER Beta Build

Earth Tech, Inc. compiled the final acceptance version of the RACER 2008 system on 1 October 2007. This version was subjected to each of the 67 test scripts in the final Software Testing Plan. The defects that were found are summarized in the table below:

Defect Classification	Number Found
Critical	6
Necessary	6
Cosmetic	25
TOTAL	**37**

Table 4.2. Defect Goals for RACER Final Acceptance Build

Appendix C of the Final Acceptance STRR lists every defect found during final acceptance testing and documents the software development contractor's resolution prior to release. This Appendix details the defects that were allowed in the release version: all defects identified as "critical" and "necessary" were corrected and resolved by Earth Tech, Inc. programmers prior to release. The defects documented in the final released version of the software, along with the testing goals for each category as stated in Section 2 above, are summarized in the following table:

Defect Classification	Testing Goal	Actual Number Found
Critical	0	0
Necessary	0	0
Cosmetic	3	3
TOTAL	**3**	**3**

Table 4.3. Defect Goals Defects Reports for RACER Release Version

4.4 Results Validation Task Analysis

The objective of the statistical evaluation portion of the validation task was to document comparison of RACER-generated costs with associated actual historical project costs. Based on the level of detail found in the historical cost documentation, analyses were performed in support of Validation at both the project and technology level. Once project estimates were created using each of the four different "scenarios"[15] for each project, the difference in cost (the percent difference between the estimated and actual cost) was analyzed to determine how RACER performed at the project level. Technology-level analysis was conducted by isolating, where feasible, the portions of the historical costs applicable to specific RACER technologies and comparing these costs to RACER-generated costs at the technology level. In addition, RACER estimates created during the 2004 RACER Assessment[16] were upgraded, where possible, and included in the technology-level analysis.

The validation team evaluated each project's RACER output against historical project cost data by comparing the ratio of the cost difference [(RACER – historical estimate) / (historical costs)]. Specifically, the team computed the true mean value of the cost difference ratio for each of the four scenarios.

The team then aggregated project and technology outputs in appropriate data sets by scenario to produce comparable data sets for statistical analysis. This activity confirmed the utility of the modified scenario approach used to identify and isolate cost drivers.

The results from each project were reviewed considering the following criteria:

Cost Reasonableness

The RACER-generated costs were reviewed for reasonableness. The statistical analysis of cost differentials between historical costs and RACER-estimated costs was performed at both the project and technology levels. In the cumulative analysis, once a sufficient number of estimates were completed, the difference in cost was analyzed statistically to

15 *See Section 2.3 of the* Final Validation Report for RACER Services and V&V dated June 2009 *for a description of the four scenarios.*

16 *Assessment of RACER Cost Models and Database Project, (DACA45-03-F-0010 under Contract GS-10F-0090J)*

evaluate the true mean cost difference between estimated and historical project cost at the project and technology level (referred to as average percent difference).

Default Parameter Reasonableness and Accuracy
This review was conducted by comparing RACER outputs in Scenarios 1 and 2. The greater the difference in estimated costs from Scenario 1 to Scenario 2, the farther from historical project data the secondary default parameters were. For all projects, Scenario 1 had an average percent difference in estimated cost of 28%; by changing default secondary parameters to site-specific values (Scenario 2), the difference in estimated cost was reduced to 7%. This significant improvement from Scenario 1 to Scenario 2 indicates that utilizing default values for RACER secondary parameters leads to estimates with higher inaccuracy.

Overall findings presented in the *Final Validation Report (Version 3.0) for RACER Services and V&V dated September 23, 2009* are summarized in Section 5 of this document.

4.5 V&V Reporting Task Analysis

Documents related to V&V activities are listed in Table 4.6 below.

Document Title	Prepared By	Prepared for	Date
RACER System Contingency Plan and Operating Procedures, Version 2002	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	April 2002
Guidance for Verification and Validation of RACER Software, Version 2.0	Booz Allen Hamilton	HQ AFCESA/CESC, Tyndall AFB, FL	March 2006
Final Software Requirements Document For RACER 2008 Enhancements	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	February 2007
Final Technical Memorandum Evaluation of the Markup Template for RACER 2008	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	May 2007
RACER Business Management Plan, Version 3.01	Booz Allen Hamilton, San Antonio, TX	USAEC	July 2007
RACER Change Management Plan, Version 2.01	Booz Allen Hamilton, San Antonio, TX	USAEC	July 2007
RACER Quality Management Plan, Version 2.01	Booz Allen Hamilton, San Antonio, TX	USAEC	July 2007
Final Software Testing Plan, RACER 2008 Maintenance and Support	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	August 2007
Software Test Results Report for RACER 2008, Final Acceptance Testing Results	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	October 2007
Revised Final Database Update Report for RACER 2008	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	November 2007
Revised Sensitivity Analysis Report for Final Version of RACER 2008	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	November 2007
RACER Verification & Validation Plan	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	May 2008
RACER 2008 Final Technology History Report	Earth Tech, Inc., Greenwood Village, CO	U.S. AFCESA, Technical Support Directorate, Tyndall AFB, FL	July 2008
Final Validation Report for RACER Services and Verification and Validation	Booz Allen Hamilton, San Antonio, TX	USAEC	June 2009

Table 4.4. Documents Related to V&V Activities

5. V&V RECOMMENDATIONS

This section describes the major findings of the V&V activities.

Verification

The list presented below identifies the key findings and comments made during the Final Acceptance Testing.

- **Cost Models** – Testing verified that all RACER cost models open within the RACER 2008 system, indicating no compilation or build errors. Testing of the RACER 2008 Final Acceptance version revealed a significant amount of minor individual cost model programming errors. Twenty six occurrences of minor cost model errors were found. All identified errors were documented and submitted for revision in the Final RACER 2008 Final Acceptance software build which was delivered to the Government.

- **Help System Changes –**Testing exposed many instances of improperly linked Help Topics, non-active links, and valid range data that did not match the model addendum or screen functionality. All inconsistencies have been submitted for redevelopment and included in the Final RACER 2008 Final Acceptance software build which was delivered to the Government.

- **RACER Software Programming Code –** Testing verified that all RACER general functionality was available, functioned, and produced expected results. Testing exposed instances of software programming deficiencies. Minor deficiencies were found in the upgrade parameter mapping within the Feasibility Study technology, minor formatting issues with the Preference reports, and clarifying the upgrade log file. All instances were submitted for redevelopment to be included in the Final RACER 2008 Final Acceptance software build which was delivered to the Government.

Validation

The overall findings for the validation are based on historical cost benchmarks used to analyze the performance of RACER technologies. Refer to the *Final Validation Report (Version 3.0) for RACER Services and V&V dated September 23, 2009* for a detailed discussion regarding the methodology employed in Validation activities.

1. The historical data collection was successful in developing a sample population of sufficient size and diversity to portray the performance of RACER relative to actual DoD remediation experience.

2. The accuracy of the data analysis was limited by the quality of the data gathered during the data collection effort, the ability of the validation team to break out the historical costs into segments that correlate to RACER technologies, the accuracy and applicability of the RACER algorithms to the project being estimated, and the accuracy of the unit prices employed in the RACER assemblies. The segregation of project components into useable pieces correlating with RACER technologies was dependent on the level of detail present in the contract documents (SOW/PWS), contractor's proposal, IGE, etc.). The trend of Government contracting is towards Performance-Based Contracting (PBC) and Firm Fixed Price (FFP) awards, resulting in contract documents which provided very little project-specific detail, as the emphasis is on overall project performance.
3. Statistical results for the projects estimated as part of this analysis indicate that RACER exceeds the acceptability criteria, performing within the range of accuracy for secondary, or budget, estimates per the Tri-Service Parametric Model Specification Standard (-15% to +30%).
4. The statistical analysis demonstrates a significant improvement in the difference between historical costs and the RACER-estimated costs when secondary parameters or assemblies are modified. In Scenario 1, using default values for secondary parameters, the true mean difference is approximately 28%. In Scenario 2, using modified primary and secondary parameters, the true mean difference is approximately 7%. The standard deviation is reduced from 71% in Scenario 1 to 45% in Scenario 2. This finding, based on over 80 historical projects and their corresponding RACER estimates, clearly demonstrates the advantage of entering accurate secondary parameter information.
5. The 14 most frequently occurring technologies were analyzed statistically to determine how the technology-level costs compared to actual costs. Eight of those technologies had negative true mean cost differences, indicating that the average RACER-estimated cost for that technology is lower than actual costs. Six of those technologies have positive true mean cost differences, indicating that the average RACER-estimated cost for that technology is higher than actual costs. The absolute mean cost difference for the fourteen technologies ranges from -44%to 56%. Figure 5.0 below displays the results for Scenario 1, using default values for secondary parameters. At Scenario 1, ten of the 14 technologies analyzed are within the range of accuracy for preliminary, or order of magnitude, estimates per the Tri-Service Parametric Model Specification Standard. However, only preliminary conclusions should be drawn from the technology-level cost analysis due to the small data sets available for this analysis.[17]

[17] *Refer to Section 5.0 of the Final Validation Report (Version 3.0) for RACER Services and V&V dated September 23, 2009 for a full discussion of limitations of the study responsible for the small data sets.*

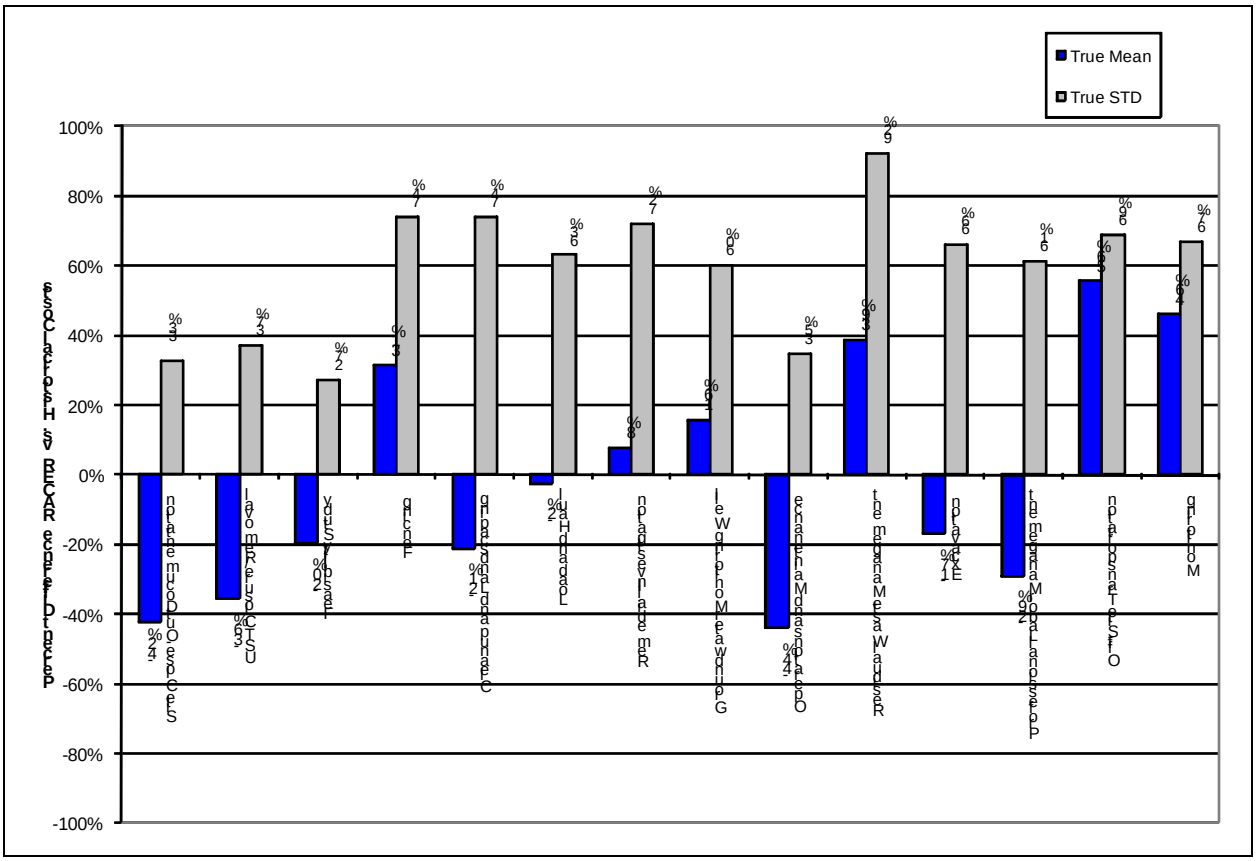

Figure 5.0. Fourteen Most Frequently Occurring Technologies – Scenario 1 Percent Difference in Cost

6. Significant recommendations for improved performance of the 14 most frequently occurring RACER technologies (and well abandonment) are provided in Section 5.0 of the *Final Validation Report for RACER Services and V&V dated June 2009*; recommendations for additional technologies are presented in Appendix C of the *Final Validation Report for RACER Services and V&V dated June 2009.*

6. KEY PARTICIPANTS

6.1 Accreditation Participants

Per Section 4 of the *Guidance for Verification and Validation of RACER Software, Version 2.0,* the following are roles, assignments, and key responsibilities:

Role: Accreditation Authority
Assignment: The Environmental Program Manager, HQ U.S. Air Force (USAF)/A7CAN. The Accreditation Authority may utilize contract support to fulfill responsibilities.
Key Responsibilities:

- Identifies pertinent parameters and constraints that impact the V&V planning and implementation process, including M&S acceptance and accreditation measures of effectiveness/measures of performance (MOEs/MOPs).
- Determines the need to form a Technical Review Group (TRG) for review of V&V plans and results.
- Selects or approves personnel that are involved in the M&S VV&A activities; i.e., verification, validation, or accreditation Agents, optional TRWG members, other subject matter experts (SMEs), etc.
- Approves, funds, and monitors the implementation of all V&V activities that directly support the upcoming accreditation decision.
- Documents M&S application accreditation decisions after review of supporting accreditation reports.
- Ensures completion and dissemination of appropriate V&V or accreditation reports.
- Makes and documents the model accreditation decision.

Role: Accreditation Agent
Assignment: The Environmental Program Manager, HQ USAF/A7CAN. The Accreditation Agent will utilize contract support to fulfill responsibilities.
Key Responsibilities:

- Serves as a source of advice and expertise to the accreditation authority concerning VV&A issues.
- Assists accreditation authority in identifying M&S acceptance and accreditation MOEs/MOPs.
- Performs M&S accreditation assessment and determines any deficiencies between documented M&S capabilities and accreditation requirements which require further V&V.
- Assists accreditation authority in determining the need to form a TRWG and, as the accreditation authority's representative, chairs subsequent TRWG proceedings.

- Ensures, as the accreditation authority's representative during the V&V planning and implementation process, that the approved plan will provide sufficient V&V to support the accreditation decision while remaining within accreditation authority-established constraints.
- Prepares accreditation report documentation, based on the accreditation assessment, along with any additional V&V and Independent Verification and Validation (IV&V) activities and independent endorsements from bodies with appropriate technical/domain expertise, for accreditation decision, and afterwards disseminates the completed accreditation report.
- Forwards a copy of the accreditation report to the appropriate M&S V&V Manager for update and archiving purposes.

6.2 V&V Participants

Per Section 4 of the *Guidance for Verification and Validation of RACER Software, Version 2.0,* the following are roles, assignments, and key responsibilities:

Role: V&V Manager
Assignment: The RACER system program manager. The V&V Manager may utilize contract support to fulfill responsibilities.
Key Responsibilities:

- Oversees all executed V&V activities supporting the model acceptance/accreditation requirements defined by the accreditation authority.
- Provides expertise on current and previous V&V efforts and baseline V&V status (established for legacy models), to all HQ Air Force, Major Command (MAJCOM), Forward Operating Area (FOA), or any other DoD, federal component, or model's user community.
- Develops a long-range plan that prioritizes V&V activities for known model deficiencies and upcoming model enhancements/upgrades.
- Coordinates the V&V requirements related to proposed model maintenance, upgrade, and configuration changes.
- Establishes, operates, or maintains a repository of all current and historic V&V information and provides V&V status updates.
- Acts as advocate for resources needed to carry out the previously described V&V management responsibilities. This could include some "cost sharing" arrangements with the model's user community.
- Maintains all V&V results in a centralized location available via the M&S Resource Repository (MSRR).
- Ensures the MSRR is consistent and compatible to the DoD MSRR and available to all model users. Repository operations must facilitate M&S community queries and data access to establish the current model version's baseline V&V status, model VV&A, and usage history.

Role: Verification Agent and/or Validation Agent
Assignment: The U.S. Army RACER POC is assigned. The U.S Army RACER POC will utilize USACE Hazardous, Toxic, and Radioactive Waste Cleanup (HTRW) Center of Expertise (CX) Omaha support to fulfill responsibilities. For RACER 2008, USACE HTRW CX Omaha is the Verification Agent. The Validation Agent is the Army RACER POC.
Key Responsibilities:

- Serves as a source of advice and expertise to the accreditation authority and accreditation agent concerning V&V issues.
- Develops a plan, including resource requirements, that addresses the V&V deficiencies identified by the accreditation agent while remaining within the accreditation authority-identified constraints. If this is not possible, the agent(s) will work with the accreditation agent to develop risk reduction and V&V plans that together will meet accreditation authority acceptance criteria and constraints.
- Provides a suggested list of TRWG members to the accreditation authority and accreditation agent, and actively participates in any subsequent TRWG meetings.
- Performs all V&V activities and prepares the final V&V report for submission to the accreditation agent and the V&V Manager.
- Forwards the V&V report and supporting documentation to the accreditation agent for inclusion into the accreditation report. A copy of this report and documentation is forwarded to the appropriate M&S V&V Manager for update and archiving purposes.

6.3 Other Participants

Application Sponsor/User: U.S. Army, U.S. Air Force, USACE (Omaha), U.S. Department of Energy (DOE), U.S. Navy

RACER Developer: Earth Tech, Inc.[18]

Data Source: USACE (Huntsville)

Technical Review Group: U.S. Army, U.S. Air Force, USACE (Omaha), DOE, Environmental Protection Agency (EPA), U.S. Navy

SMEs: U.S. Army, U.S. Air Force, USACE (Omaha), DOE, EPA, NAVFAC

[18] *The RACER 2008 software developer was Earth Tech, Inc.; Earth Tech, Inc. is now known as AECOM.*

7. ACTUAL V&V RESOURCES

All internal controls documents as listed in this section guide design, development, revisions, verification, and validation of the RACER software. These documents are updated and revised on an ongoing basis; the documents listed in this section are the versions current at the time of release of RACER 2008. The V&V tasks described below are found to be in conformance with these documents.

7.1 Planned V&V Tasking and Funding

The resources use to accomplish the V&V activities are listed in Table 7.1 below.

Document/Deliverable	Required Resources	Delivery Date	POC
RACER System Contingency Plan and Operating Procedures, Version 2002	SMEs and contractor support	April 2002	Earth Tech, Inc., Greenwood Village, CO
Guidance for Verification and Validation of RACER Software, Version 2.0	SMEs and contractor support	March 2006	Booz Allen Hamilton, San Antonio, TX
Final Software Requirements Document For RACER2008 Enhancements	SMEs and contractor support	February 2007	Earth Tech, Inc., Greenwood Village, CO
Final Technical Memorandum Evaluation of the Markup Template for RACER 2008,	SMEs and contractor support	May 2007	Earth Tech, Inc., Greenwood Village, CO
RACER Business Management Plan, Version 3.01	SMEs and contractor support	July 2007	Booz Allen Hamilton, San Antonio, TX
RACER Change Management Plan, Version 2.01	SMEs and contractor support	July 2007	Booz Allen Hamilton, San Antonio, TX
RACER Quality Management Plan, Version 2.01	SMEs and contractor support	July 2007	Booz Allen Hamilton, San Antonio, TX
RACER 2008 Alpha Build	SMEs and contractor support, TDY Funding	August 2007	Earth Tech, Inc., Greenwood Village, CO
Final Software Testing Plan, RACER 2008 Maintenance and Support	SMEs and contractor support	August 2007	Earth Tech, Inc., Greenwood Village, CO

Document/Deliverable	Required Resources	Delivery Date	POC
RACER 2008 Beta Build	SMEs and contractor support, TDY Funding	September 2007	Earth Tech, Inc., Greenwood Village, CO
Software Test Results Report for RACER 2008, Final Acceptance Testing Results	SMEs and contractor support	October 2007	Earth Tech, Inc., Greenwood Village, CO
RACER 2008 Final Release	SMEs and contractor support	November 2007	Earth Tech, Inc., Greenwood Village, CO
Revised Final Database Update Report for RACER 2008	SMEs and contractor support	November 2007	Earth Tech, Inc., Greenwood Village, CO
Revised Sensitivity Analysis Report for Final Version of RACER 2008	SMEs and contractor support	November 2007	Earth Tech, Inc., Greenwood Village, CO
RACER Verification & Validation Plan	SMEs and contractor support	May 2008	Earth Tech, Inc., Greenwood Village, CO
RACER 2008 Final Technology History Report	SMEs and contractor support	July 2008	Earth Tech, Inc., Greenwood Village, CO
Final Validation Report for RACER Services and Verification and Validation	SMEs and contractor support	September 2009	Booz Allen Hamilton, San Antonio, TX

Table 7.0. V&V Resources

7.2 Actual V&V Timeline

The timeline for accomplishing the V&V activities is listed in Table 7.2 below.

Document/Deliverable	Delivery Date
RACER System Contingency Plan and Operating Procedures, Version 2002	April 2002
Guidance for Verification and Validation of RACER Software, Version 2.0	March 2006
Final Software Requirements Document For RACER2008 Enhancements	February 2007
Final Technical Memorandum Evaluation of the Markup Template for RACER 2008,	May 2007

Document/Deliverable	Delivery Date
RACER Business Management Plan, Version 3.01	July 2007
RACER Change Management Plan, Version 2.01	July 2007
RACER Quality Management Plan, Version 2.01	July 2007
RACER 2008 Alpha Build	August 2007
Final Software Testing Plan, RACER 2008 Maintenance and Support,	August 2007
RACER 2008 Beta Build	September 2007
Software Test Results Report for RACER 2008, Final Acceptance Testing Results	October 2007
RACER 2008 Final Release	November 2007
Revised Final Database Update Report for RACER 2008	November 2007
Revised Sensitivity Analysis Report for Final Version of RACER 2008	November 2007
RACER Verification & Validation Plan	May 2008
RACER 2008 Final Technology History Report	July 2008
Final Validation Report for RACER Services and Verification and Validation	September 2009

Table 7.1. V&V Timeline

APPENDIX A MODEL DESCRIPTION

A.1 Model Overview, Development, and Structure

Model development and structure are described in the *Technology Addendum* for each RACER cost model, in the *Final Software Requirements Document for RACER 2008 Enhancements, February 2007*, and in the *RACER 2008 Final Technology History Report, 24 July 2008.* These documents are prepared and maintained by the software development contractor.

A.2 Model Use History

Model use history is described in the *RACER 2008 Final Technology History Report, Earth Tech, Inc., 24 July 2008*.

A.3 Data

A.3.1 Input Data

Data entered as model input ("parameters") are described in the *Technology Addendum* for each RACER cost model. These documents are prepared and maintained by the software development contractor. The actual values to be entered for these parameters are based on best available site information maintained by individual U.S. Government installations.

A.3.2 Output Data

Model output data are costs. The costs are derived from the algorithms utilized in each technology. The algorithms utilize user input data to define which assemblies are to be used, and the quantities of these assemblies. The algorithms that generate the costs are described in the *Technology Addendum* for each RACER cost model. These documents are prepared by the software development contractor and maintained by the Air Force.

A.4 Configuration Management

Details of RACER configuration management are described in the Software Configuration Management Plan for RACER Software System (Version 4.0, dated February 26, 2003 - DRAFT).

APPENDIX B SIGNIFICANT CHANGES TO THE RACER SYSTEM SINCE RACER 2002

This appendix is an excerpt from the RACER V&V Plan, prepared by Earth Tech, Inc, (May 2008).

New Features and Changes in *RACER* 2002

- Ability for users to easily use multiple databases
- New stand-alone Operations & Maintenance phase
- Per diem rates adjusted for location
- New Unexploded Ordnance (UXO) Active Range Planning technology model
- New UXO Active Range Clearance technology model
- New UXO Scrap Recovery and Disposal technology model (available only to authorized United States Air Force users)
- New Residual Waste Management technology model
- New Administrative Record technology model
- New Five-Year Review technology model
- New Restoration Advisory Board technology model
- New Site Close-out Documentation technology model
- New UXO (Ordnance) Sifting technology model
- Major re-engineering of the Munitions and Explosives of Concern (MEC) Site Characterization and Removal Assessment technology model (formerly named Engineering Evaluation/Cost Analysis [EE/CA])
- Major re-engineering of the MEC Removal Action technology model
- Updated Contaminated Building Materials technology model
- Updated Final Status Survey technology model
- Updated Site Characterization Survey technology model
- Updated Surface Decontamination technology model
- Updated Underground Storage Tank (UST) Closure Removal (previously UST Closure) technology model
- Updated Drum Staging (previously Drum Removal) technology model
- Updated Off-Site Transport and Waste Disposal technology model

New Features and Changes in *RACER* 2003

- New Bioslurping technology model
- New MEC Sifting technology model
- Updated MEC Institutional Controls technology model
- Updated Site Inspection technology model
- New feature allows users to run reports without escalation
- Update of the Interim & Remedial Action Wizard
- Added technical drawings to the *RACER* help system for 14 existing technologies
- Addition of the Conversion Calculator to *RACER*

- New Tab Notes Functionality
- New No Markup Assembly Preference
- New Template Updater Utility

New Features and Changes in *RACER* 2004

- New Decontamination and Decommissioning (D&D), Conduit, Pipe & Ductwork technology model
- New D&D, Rad Contaminated Building technology model
- New D&D, Removal, Attached Hazardous Materials technology model
- New D&D, Removal, Unattached Hazardous Materials technology model
- New D&D, Size Reduction technology model
- New D&D, Specialty Process Equipment technology model
- Updated MEC Site Characterization and Removal Assessment technology model
- Updated MEC Removal Action technology model
- Updated Remedial Investigation technology model
- Updated Resource Conservation & Recovery Act (RCRA) Facility Investigation technology model
- Updated Site Inspection technology model
- Updated Capping technology model
- Updated Bioslurping technology model
- Updated Restoration Advisory Board technology model
- Updated UXO Active Range Planning technology model
- Updated Remedial Design (Detail Method) technology model
- Updated Residual Waste Management technology model
- Updated Demolition, Buildings technology model
- Updated Demolition, Pavements technology model
- Updated Parking Lots technology model
- Updated Resurfacing Roadway/Parking Lots technology model
- Updated Sanitary Sewer technology model
- Updated Trenching/Piping technology model
- 150 new assemblies

New Features and Changes in *RACER* 2005

- New Composting Technology
- Updated In-situ Biodegradation technology model
- Updated Five-Year Review technology model
- Updated Bioslurping technology model
- Updated Bioventing technology model
- Updated Soil Vapor Extraction technology model
- New Estimator Information and Reviewer Information
- New functionality to use estimating templates to set up estimates at Level 2 (Site)

- Made descriptions mandatory at Level 1 (Project), Level 2(Site) and Level 3 (Phase)
- Integration of the stand-alone Formerly Used Defense Sites (FUDS) Post Processor and Army Interface Utilities into the *RACER* system
- New Folder Level Batch Cost Over Time Report
- New Phase Level Technology Cost Detail Report (With Markups)

New Features and Changes in *RACER* 2006

- New Estimate Documentation Report
- New Administrative Land Use Controls Technology
- New Estimating Templates
- New MMRP Supplemental Investigation Technology (for Air Force users)
- Sonic Drilling added as a drilling method
- Conversion of the Operations & Maintenance Wizard to a technology model
- New functionality to allow users to create multiple Remedial Design (percent method) phases
- New functionality to allow users to include both the Remedial Design (percent method) phase and the Remedial Design (detail method) phase in an estimate
- New functionality to display the file path and file name for the database currently in use on the main screen
- Level 1 screen converted to a tabbed format
- New functionality to require an explanation if the user changes a location modifier
- New required fields on the Level 2 (Site) screen for documentation of reference sources and the estimator's support team
- New functionality for all technologies that have fields for analytical templates will base the default analytical template on the Primary Contaminant selected on the Level 3 (Phase) screen; technologies that include secondary analytical templates will use the Secondary Contaminant to set the default template
- New column on the Assembly Qty / $ screen to designate whether the assembly is marked up
- Standardized Levels 1, 2, and 3 report headings for reports run at all levels
- More Level 3 reports made available for the Remedial Design (RD) (Percent) Phase

New Features and Changes in *RACER* 2007

- Minor changes to the Army Interface Utility
- Automatic conversion of Operations and Maintenance run in Remedial Action or Removal/Interim Action phases to a new stand-alone Operations and Maintenance phase

New Features and Changes in *RACER* 2008

- New functionality to display direct and marked up costs at each level on the main screen
- New File menu items for "Save As" and "Copy Database"
- New File menu items listing up to four recently used databases
- Completely revised markup process and markup template format
- New comments fields added to Location Modifiers, Safety Levels, Productivity, Markup Template, Analysis Rate, Analytical Template, and Professional Labor Rate preferences screens
- Default values added to the Level Names, Safety Level, and Productivity preferences screens
- New report including all preferences
- Preferences reports available on the main reports screen
- System rate added to Analysis Rates Group and Professional Labor Rate Groups Preferences reports
- Added eight new analytical templates
- Updated 21 analytical templates
- Eliminated the obsolete Army Analytical Suite analytical templates
- Added Select All and Deselect All buttons to the technologies that include numerous checkboxes for task selection
- Re-engineered Capping technology model
- Re-engineered D&D, Contaminated Building Materials technology model
- Re-engineered D&D, Surface Decontamination technology model
- Re-engineered Excavation technology model
- Re-engineered Feasibility Study technology model
- Re-engineered In-Situ Biodegradation technology model
- Re-engineered Monitoring technology model
- Re-engineered Operations & Maintenance technology model
- Re-engineered Off-Site Transportation & Disposal technology model
- Re-engineered Professional Labor Management technology model
- Re-engineered Remedial Investigation technology model
- Re-engineered Residual Waste Management technology model
- Re-engineered UST Closure & Removal technology model
- New Well Abandonment technology model
- New Buried Drum Recovery technology model
- New functionality to encrypt files exported by the Army Interface Utility
- Revised functionality to prevent de-selection of Cost Database if Analysis Rates, Professional Labor Rates, and/or Analytical Templates are being imported or exported

- Completed conversion of assemblies with defined costs (except for those priced by USACE and the Air Force) to definition using Government Cost Book (formerly the UPB) line items and crews.
- New functionality to display crews when viewing assembly line items
- New assembly level data reports at the Folder level, Level 1, Level 2, and Level 3
- New Work Breakdown Structure (WBS) report at Level 1 and Level 2
- New WBS Environmental Cost Element Structure (WBS-ECES) report at Level 1 and Level 2
- Elimination of the obsolete Folder Cost Summary report
- Elimination of the obsolete Independent Government Estimate report
- Elimination of the obsolete DD1391 Detail report
- Elimination of the obsolete DD1391 Summary report
- Elimination of the obsolete Air Sparged Hydrocyclone technology model
- Elimination of the obsolete In-Situ Vitrification technology model
- Elimination of the obsolete Solvent Extraction technology model
- Elimination of the obsolete Professional Labor Template preference
- Addition of the Sub Bid field to assembly unit prices
- Use of a single location adjustment factor; prior *RACER* versions used separate factors for materials, labor, and equipment

APPENDIX C BASIS OF COMPARISON

The basis of comparison is described in detail in Section 2 of the *Final Validation Report for RACER Services and Verification and Validation, June 2009.*

APPENDIX D REFERENCES

Final Software Requirements Document for RACER2008 Enhancements, Earth Tech, Inc., Greenwood Village, CO, February 2007

Final Software Testing Plan, RACER 2008 Maintenance and Support, Earth Tech, Inc., Greenwood Village, CO, August 2007

Final Technical Memorandum Evaluation of the Markup Template for RACER 2008, Earth Tech, Inc., Greenwood Village, CO, May 2007

Final Validation Report for RACER Services and Verification and Validation, Booz Allen Hamilton, San Antonio, TX, September 2009

Guidance for Verification and Validation of RACER Software, Version 2.0, Booz Allen Hamilton, March 2006

RACER 2008 Final Technology History Report, Earth Tech, Inc., Greenwood Village, CO, July 2008

RACER Business Management Plan, Version 3.01, Booz Allen Hamilton, San Antonio, TX, July 2007

RACER Change Management Plan, Version 2.01, Booz Allen Hamilton, San Antonio, TX, July 2007

RACER Quality Management Plan, Version 2.01, Booz Allen Hamilton, San Antonio, TX, July 2007

RACER System Contingency Plan and Operating Procedures, Version 2002, Earth Tech, Inc., Greenwood Village, CO, April 2002

RACER Verification & Validation Plan, Earth Tech, Inc., Greenwood Village, CO, May 2008

Revised Final Database Update Report for RACER 2008, Earth Tech, Inc., Greenwood Village, CO, November 2007

Revised Sensitivity Analysis Report for Final Version of RACER 2008, Earth Tech, Inc., Greenwood Village, CO, November 2007

Software Test Results Report for RACER 2008, Final Acceptance Testing Results, Earth Tech, Inc., Greenwood Village, CO, October 2007

APPENDIX E ACRONYMS

This appendix will identify all acronyms used in this document.

AACEI	Association for the Advancement of Cost Engineering
ACF	Area Cost Factor
AFCEE	Air Force Center for Engineering and the Environment
AFCESA	Air Force Civil Engineer Support Agency
AFI	Air Force Instruction
AR	Army Regulation
CFO	Chief Financial Officer
COR	Contracting Officer's Representative
CTC	Cost to Complete
CX	Center of Expertise
D&D	Decontamination and Decommissioning
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOE	Department of Energy
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
FFMIA	Federal Financial Management Improvement Act
FOA	Forward Operating Area
FUDS	Formerly Used Defense Sites
GMRA	Government Management Reform Act
GPRA	Government Performance and Results Act
HQ	Headquarters
HTRW	Hazardous, Toxic, and Radioactive Waste Cleanup
IV&V	Independent Verification and Validation
M&S	Modeling and Simulation
M&S CO	Modeling and Simulation Coordination Office
MAJCOM	Major Command
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MOE	Measure of Effectiveness
MOP	Measure of Performance
MS	Microsoft®
MSRR	M&S Resource Repository
NAVFAC	Naval Facilities Engineering Command
OSD	Office of the Secretary of Defense
POC	Point of Contact
PWS	Performance Work Statement
RACER	Remedial Action Cost Engineering and Requirements
RCRA	Resource Conservation & Recovery Act

RD	Remedial Design
SME	Subject Matter Expert
SOW	Statement (or Scope) of Work
STRR	Software Test Results Report
TO	Task Order
TRACES	Tri-Service Automated Cost Engineering Systems
TRG	Technical Review Group
U.S.	United States
UPB	Unit Price Book
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USAF	United States Air Force
UST	Underground Storage Tank
UXO	Unexploded Ordnance
V&V	Verification and Validation
VB	Visual Basic
VV&A	Verification, Validation and Accreditation
WBS	Work Breakdown Structure
WBS-ECES	Work Breakdown Structure-- Environmental Cost Element Structure

APPENDIX F DISTRIBUTION LIST

This distribution includes the funding and participating agencies for this TO:

1. **U.S. Army Environmental Command**

   Chief, Program Management Branch
   ATTN: IMAE-CDP
   5179 Hoadley Road, Bldg E-4480
   Aberdeen Proving Ground, MD 21010-5401

2. **Air Force Center for Engineering and Environment:**

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3. **U.S. Army Corps of Engineers**

   EM-CX FUDS Program Manager
   U.S. Army Corps of Engineers – HTRW CX, Omaha District
   Omaha, NE 68144

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APPENDIX G V&V PLAN

The V&V Plan, *RACER Verification & Validation Plan, May 2008*, begins on the next page of this document.

RACER™

Verification & Validation Plan

Prepared for:
U.S. Air Force Civil Engineer Support Agency
Technical Support Directorate
Tyndall Air Force Base, Florida

Contract No. F08637-03-D-6996
Task Order No. 0026

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1. Introduction

Purpose

The purpose of this Verification & Validation (V&V) Plan is defined in the Statement of Work (SOW) for Contract # F08637-03-D-6996, Task Order 0026, as follows:

Subtask 7.3 – 5-Year V&V Plan. The contractor shall develop a long-range plan that prioritizes V&V activities for known model deficiencies and upcoming model enhancements/upgrades.

Specifically, this V&V Plan discusses known issues and potential enhancements that may affect the internal consistency and correctness of data within the Remedial Action Cost Engineering and Requirements (*RACER*™*)* system and validation that the data represents real-world entities (i.e., estimated costs) appropriately for the intended purpose/use of *RACER*. This V&V Plan also includes information about potential future enhancements and modifications to the system, as the result of discussions at various contractual meetings and *RACER* user input and comment.

References

AFI 16-1001, Verification, Validation, and Accreditation (VV&A), June 1996, USAF Headquarters – XIW.

Tri-Service Parametric Model Specification Standard, April 1999, Project Time & Cost for US Army, US Air Force, US Navy.

Memorandum from HQ AFCESA/CD dated July 11, 2001 re: Accreditation of the Remedial Action Cost Engineering and Requirements (*RACER*) System in Accordance with DoD Instruction 5000.61, DoD Modeling and Simulation Verification, Validation and Accreditation (VV&A).

Department Of Defense Instruction (DODI) 5000.61, May 2003, Department of Defense (DoD)

Final Project Report, Assessment of *RACER* Cost Models and Database, November 2004, Booz Allen Hamilton for U.S. Army Corps of Engineers

Contract No. F08637-03-D-6996 Task Order 0026 Statement of Work. Remedial Action Cost Engineering and Requirements (*RACER*) System Support (2006), September 2006, Air Force Civil Engineer Support Agency (AFCESA).

Guidance for Verification and Validation (V&V) of Remedial Cost Engineering and Requirements Software, Version 2.0, March 2006, HQ AFCESA/CESC, Tyndall AFB, FL

RACER Change Management Plan, Version 2.01, July 2007, *RACER* Steering Committee

Final Software Test Plan for *RACER* 2008 Maintenance and Support, August 2007, Earth Tech, Inc.

2. Background/Reasons for Development of the Verification and Validation Plan

Preparation of a V&V Plan is the first step in the Verification, Validation and Accreditation (VV&A) process. In 2001 the government engaged PricewaterhouseCoopers LLP to verify and validate (V&V) *RACER* 2001, Version 3.0.0. Based on the 2001 V&V evaluation, Headquarters Air Force Civil Engineer Support Agency (HQ AFCESA) accredited *RACER* for the intended use:

> "To provide an automated, consistent, and repeatable method to estimate and document the program cost for the environmental cleanup of contaminated sites and to provide a reasonable estimate for program funding purposes consistent with the information available at the time of the estimate preparation."

The following excerpt from *RACER* Accreditation Recommendation prepared by PricewaterhouseCoopers LLP provides information concerning the reasons for development of this report:

> "There are four primary reasons for getting *RACER* Accredited. The first three reasons listed deal with meeting regulatory requirements. The final reason listed deals with increasing confidence in decision making.
>
> - The Air Force Audit Agency found that RACER did not conform to Department of Defense (DoD) Instruction 5000.61 – DoD Modeling and Simulation Verification, Validation, and Accreditation".
> - DoD Instruction 5000.61 requires that models and simulations (M&S) used to support the major DoD decision making organizations and processes… (DoD Planning, Programming, and Budgeting System) shall be accredited for that use.
> - Air Force Instruction (AFI) 16-1001 requires accreditation.
> - Increases credibility in the M&S outputs and reduces the risk of using the M&S. Overall this increases the confidence level of decisions made based on the outputs."

The *RACER* system has undergone a number of changes since the original V&V evaluation and system accreditation. A listing of the changes by *RACER* version is included in Appendix B.

The annual *RACER* release also includes updated information for assembly prices, area cost factors, per diem rates and escalation factors, using information provided by the government.

This report focuses on the current state of the cost models and other *RACER* functionality.

Overview of RACER

RACER is a single-user desktop application developed using Microsoft® (MS) Visual Basic (VB) 6.0 and MS Access. The *RACER* system is a cost estimating tool that accurately estimates costs for all phases of remediation. It does so through a number of cost models which allow the user to enter parameters describing the work, resulting in assembly

quantity calculations. These processes are outlined in the Tri-Service Parametric Model Specification Standard.

The Tri-Service Parametric Model Specification Standard's purpose is to establish criteria and standards for developing and updating parametric cost models like those used in *RACER*.

Due to the lack of information in environmental remediation work and per the Tri-Service Parametric Model Specification Standard, a parametric cost model should be used as a preliminary or order of magnitude estimate and should be evaluated as such. In some instances, including more complicated models that involve secondary parameters, the estimate may be contained in the secondary or budget estimate category. The ranges of accuracy, as stated by the Association for the Advancement of Cost Engineering (AACEI), for preliminary (order of magnitude), secondary (budget), and definitive estimates are displayed in Table 2-1.

Table 2-1: AACEI Estimate Accuracy

Description	Range		
Preliminary	+ 50%	to	- 30%
Secondary	+ 30%	to	- 15%
Definitive	+ 15%	to	- 5%

To aid in localizing *RACER* estimates, national average unit costs for assemblies in the *RACER* database are derived primarily based on the Government Cost Book (formerly the Unit Price Book, or UPB). The area cost factor (ACF) for the estimate and a safety level cost adjustment are applied to calculate the adjusted unit price for each assembly to arrive at the adjusted direct cost. Direct costs are marked up using a series for factors relating to various aspects of the work. The routines used to derive direct and marked-up costs are shown in Appendices C and D.

After completing the estimate, users can generate a wide variety of reports documenting the estimated cost for the project. Additionally, estimates can be prepared for uploading into the US Army Environmental Command (USAEC) and the United States Army Corps of Engineers (USACE) management systems.

Cost model parameters and the calculated costs are stored in a MS Access database. Users can share estimates with others through the import/export functionality. Since *RACER* is a desktop application, many users maintain their estimates using a database stored on their individual computers.

Existing estimates can be brought to current costs by upgrading them as new versions of *RACER* become available. The price leveling functionality allows users to easily recalculate unit costs using current unit prices.

Recent *RACER* releases have included the elimination of obsolete cost models and the development of new cost models. Available reports have also been expanded. The most frequently used models were re-engineered for *RACER* 2008; this exercise included the collection of and comparison to historical project cost data. The default markup template and the markup process were completely redefined as well.

Each release of *RACER* includes updated assembly prices, area cost factors, per diem rates and escalation factors. The *RACER* 2008 release includes extensive redefinition and updating of assembly costs using information from the 2006 version of the Government Cost Book. Each assembly has been defined using Cost Book line items that improve documentation and maintainability of cost data. Except for assemblies for which costs are provided by USACE or United States Air Force (USAF), all assemblies were defined using Cost Book line items. Previous *RACER* releases included a mix of assemblies defined using the Cost Book and assemblies that relied on other data sources. Some assemblies have no defined unit cost, but were priced when used in a model (for example, Other Direct Costs).

Testing Process

The *RACER* system is tested on a variety of operating systems and office suites including MS Windows XP and MS Windows 2000 operating systems, MS Office 2000 and XP Suites. The test plans are organized by functional areas such as installation, general functionality and compatibility. The testing performed as part of each release:

1. Ensures a system release that meets or exceeds all functional and technical requirements specified in the SOWs and the design documents that were produced pursuant to those SOWs, and
2. Provides a high-quality system that provides defensible and consistent estimates.

The entire testing procedure that is performed as part of each *RACER* software release is documented in the Final Software Testing Plan, *RACER* Maintenance and Support.

Testing is performed at the alpha, beta and final acceptances stages of development for each new release of *RACER*. At each stage of the process, a set of comprehensive test scripts detail the tests to be performed. Testers perform each test and record the results. Any test that fails is remedied by the software development team and prepared for retesting. Ad hoc testing is also performed. As part of each *RACER* release a Software Test Results (STR) report details the testing process and the results of testing at the alpha, beta, and final stages.

3. General System Deficiencies

While *RACER* continues to meet the estimating needs of its users, it is a legacy system that is currently configured using technology that is nearing the end of its life cycle. To ensure its continued functionality, it is recommended that consideration be given to conversion of the system to a contemporary configuration. Specific items for consideration and recommendations for addressing deficiencies are listed below:

- MS support for VB 6.0 ceased in April 2008. It is unknown how much longer *RACER* will continue to function in its current configuration.

It is recommended the government determine the future configuration of *RACER* and establish a time table for its implementation.

- *RACER* has not been tested on the MS Windows Vista operating system. It is not known whether it will function as intended.

It is recommended that testing be conducted in anticipation of government users upgrading to the MS Windows Vista operating system.

The remainder of this section provides recommendations for deficiencies that are organized as related to database, reports, and cost models.

The bases for the recommendations that follow were from two primary sources:

1. Discussions that occurred during meetings that were conducted as part of *RACER* maintenance and support and development task orders.
2. Engineering Change Proposals (ECPs) (suggestions or reports) made by users to the *RACER* technical support desk as described in section 2.5.1 of the *RACER* Change Management Plan (v 2.0 dated July 2007).

Database Deficiencies

The MS Access database is known to operate more slowly the larger it becomes. Recent cost model additions and assembly redefinition has increased the size of the database.

In conjunction with a possible future conversion of the *RACER* system to a new configuration, it is recommended that a more robust database product (such as MS SQL Server or Oracle®) be used. As a desktop system, *RACER* has the inherent risk of loss of data. Computers may malfunction, or be lost or stolen. Data that has not been backed up could be lost. It is recommended that *RACER*'s future configuration include use of a data source that is maintained on a server that is backed up in order to assure better control of data.

Report Deficiencies

A Microsoft security patch which makes MS Excel incompatible with *RACER* Active Reports Version 1.1 currently prohibits *RACER* reports exported directly to MS Excel to be opened. *RACER* reports must be exported to an .rtf format and then manually copied and pasted to MS Excel.

In conjunction with a possible future conversion of the *RACER* system to a new configuration, an upgrade to reporting software such as Crystal Reports that is compatible with the security patch is recommended.

Cost Model Deficiencies

Except for the models listed in Appendix B as being updated or re-engineered since *RACER* 2001, the models have not been updated recently and may differ from current remediation practice. Some of the less-frequently used models have not been revised since *RACER* was converted to run on the MS Windows platform in 1999. While historical cost data was collected at the time of each model's original development, in some cases the cost data used to calibrate a specific model is no longer available or is in need of

update. The accuracy of other *RACER* cost models could be improved through a similar process.

The applicability of some models to the current state of remediation practice and the accuracy of the results could be improved through incorporation of existing methodologies employed elsewhere within the *RACER* system. The use of mini-models in *RACER* is one such example. These mini-models were developed for use in multiple cost models. Their use promotes consistency within cost models that use like methodologies. The use of mini-models also provides greater ease in maintenance by allowing all changes or updates to flow through all cost models that use the mini-model by updating just one part of *RACER*. For example, the Drilling mini-model could be used in *RACER* technologies that require the wells be drilled or installed. Currently, the Drilling mini-model is used in several cost models that require well installation. Another example would be the use of the Monitoring mini-model which provides consistency related to estimating sampling and analysis tasks in *RACER*. Table 3-1 provides recommendations for cost models that would benefit from the use of the Drilling and Monitoring mini-models or other mini-models. The recommendations come as the result of review of meeting minutes from technical review group (TRG) and technical user group (TUG) meetings as well as the responses from 66 *RACER* users who participated in a survey administered in 2006. The survey looked strictly at the frequency that the respondent used particular parts (including cost models) of *RACER*.

Table 3-1: Recommendations for *RACER* Technology Cost Models

Name of Cost Model	Potential Consistency Changes	Frequently Used?
Access Roads		Requires Further Research
Administrative Land Use Controls		Yes
Administrative Record		Yes
Advanced Oxidation Processes		Requires Further Research
Air Sparging	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling	Yes
Air Stripping		Yes
Asbestos Removal		Yes
Bioslurping	Re-engineer to use Drilling Mini-model and revise to use Monitoring mini-model for sampling & analysis	Yes
Bioventing	Re-engineer to use Monitoring mini-model for Sampling & Analysis	Requires Further Research
Bulk Material Storage		Requires Further Research
Carbon Adsorption (Gas)		Yes
Carbon Adsorption (Liquid)		Yes
Cleanup and Landscaping		Yes
Clear and Grub		Yes
Coagulation/Flocculation		Requires Further Research
Composting	Re-engineer to use Monitoring mini-model for Sampling & Analysis during treatment	Requires Further Research

Name of Cost Model	Potential Consistency Changes	Frequently Used?
Corrective Measures Study	Re-engineer to include "data gap sampling & analysis" similar to Feasibility Study model (use Monitoring mini-model to do this)	Yes for RCRA actions
D&D, Conduit, Pipe & Ductwork		Yes
D&D, Contaminated Building Materials		Yes
D&D, Final Status Survey	Re-engineer to Use Current Weighted Productivity Loss Factor (WTPLF) Methodology	Yes
D&D, Rad Contaminated Building		Yes
D&D, Removal, Attached Hazardous Materials		Yes
D&D, Removal, Unattached Hazardous Materials		Yes
D&D, Sampling and Analysis	Re-engineer to Use Current WTPLF Methodology	Yes
D&D, Site Characterization Survey	Re-engineer to Use Current WTPLF Methodology	Yes
D&D, Size Reduction		Yes
D&D, Specialty Process Equipment		Yes
D&D, Surface Decontamination		Yes
Decontamination Facilities		Yes
Demolition, Buildings	Re-engineer to use Load & Haul mini-model	Yes
Demolition, Catch Basins/Manholes		Occasionally in FUDS BD/DR
Demolition, Curbs		Occasionally in FUDS BD/DR
Demolition, Fencing		Occasionally in FUDS BD/DR
Demolition, Pavements		Occasionally in FUDS BD/DR
Demolition, Sidewalks		Occasionally in FUDS BD/DR
Demolition, Underground Pipes		Occasionally in FUDS BD/DR
Dewatering (Sludge)		Yes
Discharge to POTW		Yes
Drum Staging	Re-engineer to use Monitoring mini-model for Sampling & Analysis for characterizing drummed wastes	Requires Further Research
Ex Situ Bioreactors		Requires Further Research
Ex Situ Land Farming		Requires Further Research
Ex Situ Solidification/Stabilization		Requires Further Research
Ex Situ Vapor Extraction		Requires Further Research
Fencing		Requires Further Research
Five-Year Review		Yes
Free Product Removal		Yes
French Drain		

Name of Cost Model	Potential Consistency Changes	Frequently Used?
Groundwater Extraction Wells	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling and the Drilling mini-model	Yes
Groundwater Monitoring Well	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling	Yes
Heat Enhanced Vapor Extraction	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling and the Drilling mini-model	Requires Further Research
In Situ Land Farming		Requires Further Research
In Situ Solidification		Requires Further Research
Infiltration Gallery	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling and the Drilling mini-model (and to interact with Well Abandonment)	Requires Further Research
Injection Wells	Re-engineer to use Monitoring mini-model for Sampling & Analysis for characterizing drummed wastes	Requires Further Research
Load and Haul		Yes (as a mini-model in numerous other "parent" models)
Low Level Rad Soil Treatment		Requires Further Research
MEC Archives Search Report		Requires Further Research
MEC Institutional Controls	Determine whether this model should be consistent with the Administrative Land Use Controls model	Yes
MEC Monitoring		Yes
MEC Removal Action		Yes
MEC Sifting		Yes
MEC Site Characterization & Removal Assessment		Yes
Media Filtration		Requires Further Research
Metals Precipitation		Yes
Miscellaneous Field Installation		Requires Further Research
MMRP Supplemental Investigation	Restricted to authorized users	No
Natural Attenuation	Revise to use Monitoring Mini-model	Yes
Neutralization		Requires Further Research

Name of Cost Model	Potential Consistency Changes	Frequently Used?
Off-site Transportation and Thermal Treatment	Re-engineer to use T&D logic and algorithms as in the Residual Waste Management model	Requires Further Research
Oil/Water Separation		Yes
On-site Incineration		Requires Further Research
On-site Low Temp. Thermal Desorption		Requires Further Research
Operations & Maintenance		Yes
Overhead Electrical Distribution		Yes
Parking Lots		Requires Further Research
Passive Water Treatment		Requires Further Research
Permeable Barriers		Yes
Petroleum UST Site Assessment	Re-engineer to use Monitoring mini-model, and Drilling mini-model and interaction with Well Abandonment model)	Yes
Phytoremediation	Re-engineer to use Monitoring mini-model for Sampling & Analysis	Yes
Preliminary Assessment		Requires Further Research
RCRA Facility Investigation	Re-engineer to use Monitoring mini-model for Sampling & Analysis	Yes for RCRA actions
Remedial Design		Requires Further Research
Restoration Advisory Board		Requires Further Research
Resurfacing Roadways/Parking Lots		Requires Further Research
Sanitary Sewer	Consider retiring since system includes Discharge to POTW	No
Site Close-Out Documentation		Yes
Site Inspection	Re-engineer to use Monitoring mini-model for Sampling & Analysis	Yes
Slurry Walls		Yes
Soil Flushing		Requires Further Research
Soil Vapor Extraction	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling	Yes
Soil Washing		Requires Further Research
Special Well Drilling & Installation	Re-engineer to use Monitoring mini-model for Sampling & Analysis during drilling and the Drilling mini-model	Requires Further Research
Sprinkler System		Requires Further Research
Storage Tank Installation		Requires Further Research
Storm Sewer		Requires Further Research

Name of Cost Model	Potential Consistency Changes	Frequently Used?
Thermal & Catalytic Oxidation		Yes
Transportation	A number of technologies in the *RACER* system include the need for transportation of wastes. Each model handles that need in a differing manner, although the requirements are very similar or identical. Transportation is currently available as a technology and is in use as a mini-model in the Storage Tank Installation technology. A number of other models would benefit from a consistent approach to use of Transportation as a mini-model so that a consistent methodology is used throughout the *RACER* system.	Requires Further Research
Trenching/Piping		Yes (as a mini-model in numerous other "parent" models
User Defined Estimate		Yes
UXO Scrap Removal	Determine whether this model is used by the USAF	Restricted to Authorized USAF Users
UXO Active Range Clearance Planning	Determine whether this model is used by the USAF	Requires Further Research
UXO Active Target Clearance	Determine whether this model is used by the USAF	Requires Further Research
Water Storage Tanks		Requires Further Research

4. Suggested Enhancements

In addition to the deficiencies in *RACER* there are opportunities for enhancements which would provide improved functionality. While the enhancements discussed in the section would allow for improved functionality, it is Earth Tech's opinion that the deficiencies discussed in sections 3-3.3 of this plan should receive priority over the enhancements listed in this section.

Export Capabilities

Currently *RACER* does not allow for export of estimates to detailed estimating software programs such as Micro-Computer Aided Cost Estimating System (M-CACES) Second Generation (MII) and SuccessEstimator. The capability that has been proposed in the past remains the same: to develop an interface that sends assembly level data from the *RACER* database to an intermediary file that can be imported into the detailed estimating software to allow for further refinement of the

estimate. This capability presently exists within the PArametric Cost Estimating System (*PACES*™) that is maintained by Earth Tech; allowing for easy access to the applicable software code and design information.

Agency Information Management Systems Interface

RACER provides a valuable means by which a number of governmental agencies develop budgetary cost estimates, and in some cases, upload their estimates into information management systems. *RACER* meets agency-specific cost estimation needs through a wide variety of cost models that allow estimators to develop estimates based on descriptive parameters.

Two groups of users, the USAEC and USACE currently are able to transfer cost data from *RACER* into data files that can be uploaded into their respective information management systems. Such an interface previously existed for the USAF. USAF *RACER* users who use the Air Force Restoration Information Management System (AFRIMS) system currently enter data into the system manually. A capability similar to what is available to USAEC and USACE users could be redeveloped to prepare data for uploading to AFRIMS. An interface capability provides automated quality control (QC) checks, consistency with agency business processes, an audit trail, and reduced human error.

5. Suggested Prioritization of Deficiency Remedies

Below is a table which displays a suggested prioritization for implementation of *RACER* deficiencies and enhancements discussed in this V&V Plan. Deficiencies are prioritized as high, moderate, and low. The designations have been made based on whether the deficiency would prohibit *RACER* operability and/or number of users who would benefit from a remedy for each respective deficiency.

Table 5-2: Suggested Prioritization of Remedies for *RACER* Deficiencies

Deficiency	Priority	Rationale
Unsupported Configuration (VB 6)	High	Potentially prohibits operability Potentially impacts all users (DoD and other)
Compatibility with MS Windows Vista	High	Potentially prohibits operability Potentially impacts only MS Windows Vista users
Limitations of MS Access Database Backend	High	Potentially prohibits operability Potentially impacts all users (DoD and other)
MS Excel incompatible with *RACER* Active Reports	High	Prohibits operability Impacts all users (DoD and other)

Deficiency	Priority	Rationale
Lack of Consistency in Cost Models that use Like-Methodologies	Moderate	Use of mini-models provides greater ease in maintenance by allowing all changes or updates to flow thorough all cost models that use the mini-model by updating just one part of *RACER*

Appendix A - Acronyms

AACEI	Association for the Advancement of Cost Engineering
ACF	Area Cost Factor
AFCESA	U.S. Air Force Civil Engineer Support Agency
AFI	U.S. Air Force Instruction
AFRIMS	Air Force Restoration Information Management System
D&D	Decontamination and Decommissioning
DoD	Department of Defense
DODI	Department of Defense Instruction
ECP	Engineering Change Proposal
EE/CA	Engineering Evaluation/Cost Analysis
HQ AFCESA	Headquarters, Air Force Civil Engineer Support Agency
LLP	Limited Liability Partnership
M-CASES	Micro-Computer Aided Cost Estimating System
MII	Micro-Computer Aided Cost Estimating System, Second Generation
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MS	Microsoft®
M&S	Models and Simulations
PACES	PArametric Cost Estimating System
POTW	Publicly Owned Treatment Works
QC	Quality Control
RACER	Remedial Action Cost Engineering & Requirements
Rad	Radioactive
RCRA	Resource Conservation and Recovery Act
SOW	Scope of Work
STR	Software Test Report
TRG	Technical Review Group
TUG	Technical Users Group
TWG	Technical Working Group
UPB	Unit Price Book

USAEC	U.S. Army Environmental Command
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
UST	Underground Storage Tank
UXO	Unexploded Ordnance
VB	Visual Basic®
V&V	Verification & Validation
VV&A	Verification, Validation and Accreditation
WBS	Work Breakdown Structure
WBS-ECES	Work Breakdown Structure - Environmental Cost Element Structure
WTPLF	Weighted Productivity Loss Factor

Appendix B - Significant Changes to the *RACER* System Since *RACER* 2002

New Features and Changes in *RACER* 2002

- Ability for users to easily use multiple databases
- New stand-alone Operations & Maintenance phase
- Per diem rates adjusted for location
- New UXO Active Range Planning technology model
- New UXO Active Range Clearance technology model
- New UXO Scrap Recovery and Disposal technology model (available only to authorized United States Air Force users)
- New Residual Waste Management technology model
- New Administrative Record technology model
- New Five Year Review technology model
- New Restoration Advisory Board technology model
- New Site Close-out Documentation technology model
- New UXO (Ordnance) Sifting technology model
- Major re-engineering of the MEC Site Characterization and Removal Assessment technology model (formerly named EE/CA)
- Major re-engineering of the MEC Removal Action technology model
- Updated Contaminated Building Materials technology model
- Updated Final Status Survey technology model
- Updated Site Characterization Survey technology model
- Updated Surface Decontamination technology model
- Updated UST Closure Removal (previously UST Closure) technology model
- Updated Drum Staging (previously Drum Removal) technology model
- Updated Off Site Transport and Waste Disposal technology model

New Features and Changes in *RACER* 2003

- New Bioslurping technology model
- New MEC Sifting technology model
- Updated MEC Institutional Controls technology model
- Updated Site Inspection technology model
- New feature allows users to run reports without escalation
- Update of the Interim & Remedial Action Wizard
- Added technical drawings to the *RACER* help system for fourteen (14) existing technologies
- Addition of the Conversion Calculator to *RACER*
- New Tab Notes Functionality
- New No Markup Assembly Preference
- New Template Updater Utility

New Features and Changes in *RACER* 2004

- New D&D, Conduit, Pipe & Ductwork technology model

- New D&D, Rad Contaminated Building technology model
- New D&D, Removal, Attached Hazardous Materials technology model
- New D&D, Removal, Unattached Hazardous Materials technology model
- New D&D, Size Reduction technology model
- New D&D, Specialty Process Equipment technology model
- Updated MEC Site Characterization and Removal Assessment technology model
- Updated MEC Removal Action technology model
- Updated Remedial Investigation technology model
- Updated RCRA Facility Investigation technology model
- Updated Site Inspection technology model
- Updated Capping technology model
- Updated Bioslurping technology model
- Updated Restoration Advisory Board technology model
- Updated UXO Active Range Planning technology model
- Updated Remedial Design (Detail Method) technology model
- Updated Residual Waste Management technology model
- Updated Demolition, Buildings technology model
- Updated Demolition, Pavements technology model
- Updated Parking Lots technology model
- Updated Resurfacing Roadway/Parking Lots technology model
- Updated Sanitary Sewer technology model
- Updated Trenching/Piping technology model
- 150 new assemblies

New Features and Changes in *RACER* 2005

- New Composting Technology
- Updated In-situ Biodegradation technology model
- Updated Five-Year Review technology model
- Updated Bioslurping technology model
- Updated Bioventing technology model
- Updated Soil Vapor Extraction technology model
- New Estimator Information and Reviewer Information
- New functionality to use estimating templates to set up estimates at Level 2 (Site)
- Made descriptions mandatory at Level 1 (Project), Level 2(Site) and Level 3 (Phase)
- Integration of the stand-alone FUDS Post Processor and Army Interface Utilities into the *RACER* system
- New Folder Level Batch Cost Over Time Report
- New Phase Level Technology Cost Detail Report (With Markups)

New Features and Changes in *RACER* 2006

- New Estimate Documentation Report
- New Administrative Land Use Controls Technology
- New Estimating Templates

- New MMRP Supplemental Investigation Technology (for USAF Users)
- Sonic Drilling added as a drilling method
- Conversion of the Operations & Maintenance Wizard to a technology model
- New functionality to allow users to create multiple Remedial Design (percent method) phases.
- New functionality to allow users to include both the Remedial Design (percent method) phase and the Remedial Design (detail method) phase in an estimate.
- New functionality to displays the file path and file name for the database currently in use on the main screen
- Level 1 screen converted to a tabbed format
- New functionality to require an explanation if the user changes a location modifier
- New required fields on the Level 2 (Site) screen for documentation of reference sources and the estimator's support team.
- New functionality for all technologies that have fields for analytical templates will base the default analytical template on the Primary Contaminant selected on the Level 3 (Phase) screen. Technologies that include secondary analytical templates will use the Secondary Contaminant to set the default template
- New column on the Assembly Qty / $ screen to designate whether the assembly is marked up
- Standardized Levels 1, 2 and 3 report headings for reports run at all levels.
- More Level 3 reports made available for the RD (Percent) Phase

New Features and Changes in *RACER* 2007

- Minor changes to the Army Interface Utility
- Automatic conversion of Operations and Maintenance run in Remedial Action or Removal/Interim Action phases to a new stand-alone Operations and Maintenance phase.

New Features and Changes in *RACER* 2008

- New functionality to display direct and marked up costs at each level on the main screen
- New File menu items for "Save As" and "Copy Database"
- New File menu items listing up to four recently used databases
- Completely revised markup process and markup template format
- New comments fields added to Location Modifiers, Safety Levels, Productivity, Markup Template, Analysis Rate, Analytical Template and Professional Labor Rate preferences screens
- Default values added to the Level Names, Safety Level, Productivity preferences screens
- New report including all preferences
- Preferences reports available on the main reports screen
- System rate added to Analysis Rates Group and Professional Labor Rate Groups Preferences reports
- Added 8 new analytical templates
- Updated 21 analytical templates

- Eliminated the obsolete Army Analytical Suite analytical templates
- Added Select All and Deselect All buttons to the technologies that include numerous checkboxes for task selection
- Re-engineered Capping technology model
- Re-engineered D&D, Contaminated Building Materials technology model
- Re-engineered D&D, Surface Decontamination technology model
- Re-engineered Excavation technology model
- Re-engineered Feasibility Study technology model
- Re-engineered In Situ Biodegradation technology model
- Re-engineered Monitoring technology model
- Re-engineered Operations & Maintenance technology model
- Re-engineered Off-Site Transportation & Disposal technology model
- Re-engineered Professional Labor Management technology model
- Re-engineered Remedial Investigation technology model
- Re-engineered Residual Waste Management technology model
- Re-engineered UST Closure & Removal technology model
- New Well Abandonment technology model
- New Buried Drum Recovery technology model
- New functionality to encrypt files exported by the Army Interface Utility
- Revised functionality to prevent de-selection of Cost Database if Analysis Rates, Professional Labor Rates and/or Analytical Templates are being imported or exported
- Completed conversion of assemblies with defined costs (except for those priced by USACE and USAF) to definition using Government Cost Book (formerly the Unit Price Book, or UPB) line items and crews.
- New functionality to display crews when viewing assembly line items
- New assembly level data reports at the Folder level, Level 1, Level 2 and Level 3
- New WBS report at Level 1 and Level 2
- New WBS-ECES report at Level 1 and Level 2
- Elimination of the obsolete Folder Cost Summary report
- Elimination of the obsolete Independent Government Estimate report
- Elimination of the obsolete DD1391 Detail report
- Elimination of the obsolete DD1391 Summary report
- Elimination of the obsolete Air Sparged Hydrocyclone technology model
- Elimination of the obsolete In Situ Vitrification technology model
- Elimination of the obsolete Solvent Extraction technology model
- Elimination of the obsolete Professional Labor Template preference
- Addition of the Sub Bid field to assembly unit prices
- Use of a single location adjustment factor. Prior *RACER* versions used separate factors for materials, labor and equipment.

Appendix C - Direct Cost Calculations

Assembly prices in the Assembly Cost Database have four cost components – material, labor, equipment and sub bid costs. The cost is the national average cost.

To adjust the cost for the locality selected on the Level 1 (Project) screen, *RACER* multiplies each component of the national average cost by a factor related to the selected location. This may result in a location-adjusted cost that is higher or lower than the national average cost. The location adjustment factor is provided by the government. If the user has overridden the assembly cost in the Assembly Cost Database preference, location adjustment factors are not applied. A few assemblies never have area cost factors applied. Examples include the per diem rate, which is adjusted for locality using other means, and the mileage reimbursement rate, which does not vary by locality.

Every technology in *RACER* utilizes safety level cost adjustments as well. Each safety level has an associated productivity adjustment factor, which can be viewed and modified using the Safety Productivity preference screen. Safety level adjustments apply to the labor and equipment cost components. The material and sub bid cost components are not adjusted for safety productivity.

Some technologies that include analytical templates include adjustments for turn around time and quality control. These adjustments apply to only to assemblies in the selected analytical templates. Each selection has an associated adjustment factor. The more quickly the testing must be completed the higher the cost. Likewise, the higher level of quality control that is required, the higher the cost.

Direct costs are calculated individually for each assembly when technology is run to cost. The following example illustrates the direct cost calculations:

National Average assembly cost:

Material	$10.00
Labor	$15.00
Equipment	$20.00
Sub Bid	$10.00
Total	$55.00

The location adjustment factor 1.05

Safety Level C

Safety Productivity Adjustment:

Labor Productivity	55
Equipment Productivity	75

Turn Around Time

4 to 7 Days = 1.5

Quality Control

Level 2 = 1.1

The calculation for the direct assembly cost if it IS NOT in the selected analytical template would be:

Material Cost = National Average Cost x Location Adjustment Factor
= $10.00 * 1.05
= $10.50

Labor Cost = National Average Cost x Location Adjustment Factor * (100 / Labor Productivity)
= $15.00 * 1.05 * (100/55)
= $28.64

Equipment Cost = National Average Cost x Location Adjustment Factor * (100 / Equipment Productivity)
= $20.00 * 1.05 * (100/75)
= $28.00

Sub Bid Cost = National Average Cost x Location Adjustment Factor
= $10.00 * 1.05
= $10.50

Total Assembly Cost = Material Cost + Labor Cost + Equipment Cost + Sub Bid Cost
= $10.50 + $28.64 + $28.00 + $10.50
= $77.64

The calculation for the direct assembly cost if it IS in the selected analytical template would be:

Material Cost = National Average Cost x Location Adjustment Factor * Turn Around Time Factor * Quality Control Factor
= $10.00 * 1.05 * 1.5 * 1.1
= $17.33

Labor Cost = National Average Cost x Location Adjustment Factor x (100 / Labor Productivity) * Turn Around Time Factor x Quality Control Factor
= $15.00 * 1.05 * (100/55) * 1.5 * 1.1
= $47.25

Equipment Cost = National Average Cost x Location Adjustment Factor x (100 / Equipment Productivity) x Turn Around Time Factor x Quality Control Factor
= $20.00 * 1.05 * (100/75) * 1.5 * 1.1
= $46.20

Sub Bid Cost = National Average Cost x Location Adjustment Factor x Turn Around Time Factor x Quality Control Factor
= $10.00 * 1.05 * 1.5 * 1.1
= $17.33

Total Assembly Cost = Material Cost + Labor Cost + Equipment Cost + Sub Bid Cost
= $17.33 + $47.25 + $46.20 + $17.33
= $128.10

Appendix D - Marked-up Cost Calculations

Markup calculations most often performed at Level 3 (Phase) using the total costs of all the assemblies included in the technologies included in that phase. Some reports also show marked up costs for assemblies or technologies. The calculation process is the same in each instance.

The following example illustrates markup calculations for a phase.

Step 1: Preliminary Calculations

The total cost to be excluded from the markup routine is calculated by summing the direct cost for assemblies on the No-Markup list in all technologies in the Phase. If you used the Technology Markups window to exclude one or more technologies from the markup routine, the cost for those technologies are summed and added to the No-Markup assemblies. The equation is as follows:

Total Cost Excluded from Markup Routine = (Direct Cost for No-Markup Assemblies) + (Direct Cost for No-Markup Technologies)

For example:

Total Direct Cost of No-Markup Assemblies	=	$1,000
+ Total Direct Cost for No-Markup Technology	=	$2,000
Total Direct Cost Excluded from Markup	=	**$3,000**

The cost subject to the markup routine is calculated by summing the direct cost for assemblies not on the No-Markup list in all technologies in the Phase. For example:

Total Direct Cost for Phase	=	$40,000
- Total Direct Cost Excluded from Markup	=	$3,000
Total Direct Cost to be Marked Up	=	**$37,000**

If you used the Technology Markups window to apportion costs for a technology between the Prime Contractor and Subcontractors, the technology costs are split between the Prime and Subcontractor. For example:

Total Cost for Technology to be Marked Up	=	$10,000
x Percentage of Work by Subcontractors	=	40%
Value of Work by Subcontractors	=	**$4,000**

Value of Work by Prime Contractor	=	$10,000 - $4,000
	=	**$6,000**

Step 2: Professional Labor Overhead/G&A

The Total Direct Cost for professional labor assemblies in the Phase is calculated by summing the direct cost for each assembly in Section 332201 of the *RACER* database. The total is split between the Prime Contractor and Subcontractors using the percentages on the Technology Markups window. The Professional Labor Overhead/G&A percentage is applied to the prime and subcontractor portions of the total direct professional labor cost for the phase to determine the prime and subcontractor professional labor overhead/G&A costs. For example:

Total Direct Cost for Section 332201 Assemblies	=	$2,000
x Percentage of Work by Subcontractors	=	40%
Subcontractor Professional Labor Work	=	**$800**

Prime Contractor Professional Labor Work	=	$2,000 – $800
	=	**$1,200**

Subcontractor Professional Labor Work	=	$800
x Professional Labor Overhead/G&A Markup	=	132%
Subcontractor Professional Labor Overhead/G&A	=	**$1,056**

Prime Contractor Professional Labor Work	=	$1,200
x Professional Labor Overhead/G&A Markup	=	132%
Prime Contractor Professional Labor Overhead/G&A	=	**$1,584**

Step 3: Field Office Overhead/G&A

The Field Office Overhead/G&A percentage is applied to the prime and sub contractor portions of the total direct cost for the phase, excluding the total direct professional labor costs, to determine the prime and subcontractor field office overhead/G&A costs. Overhead markups are not applied to SubBid items because costs for overhead are already be included in the SubBid cost. For example:

Total Direct Cost to be Marked Up	=	$37,000
- Total Direct Cost for Section 332201 Assemblies	=	$2,000
- Total SubBid Cost	=	$1,000
Total Direct Cost	=	**$34,000**

Total Direct Cost	=	$34,000
x Percentage of Work by Subcontractors	=	40%
Subcontractor Direct Cost	=	**$13,600**

Prime Contractor Direct Cost	=	$34,000 – $13,600
	=	**$20,400**

Subcontractor Direct Cost	=	$13,600
x Field Office Overhead/G&A Markup	=	25%
Subcontractor Field Office Overhead/G&A	=	**$3,400**

Prime Contractor Direct Cost	=	$20,400
x Field Office Overhead/G&A Markup	=	25%
Prime Contractor Field Office Overhead/G&A	=	**$5,100**

Step 4: Subtotal Subcontract Costs

The subcontractor professional labor overhead/G&A cost and the subcontractor field office overhead/G&A cost are added to the subcontractor total direct cost, excluding SubBid costs, to determine a subtotal subcontract cost for the phase. For example:

Subcontractor Direct Cost	=	$13,600
+ Subcontractor Professional Labor Overhead/G&A	=	$1,056
+ Subcontractor Field Office Overhead/G&A	=	$3,400
Subtotal Subcontract Cost	=	**$18,056**

Step 5: Subcontractor Profit

The Subcontractor Profit percentage is applied to the subtotal subcontract cost to determine the subcontractor profit. For example:

Subtotal Subcontract Cost	=	$18,056
x Subcontractor Profit Markup	=	8%
Subcontractor Profit	=	**$1,444**

Step 6: Total Subcontract Costs

The subcontractor profit, subtotal contract cost, and SubBid costs are summed to determine the total subcontract cost. Subcontractor profit markups are not applied to subcontractor SubBid items because subcontractor profit is already included in the SubBid cost. For example:

Subcontractor Profit	=	$1,444
+ Subtotal Subcontract Cost	=	$18,056
+ Total SubBid Cost	=	$1,000
Total Subcontract Cost	=	**$20,500**

Step 7: Subtotal Prime Contractor Cost

The subtotal prime contractor project cost for the phase is determined by summing the prime contractor total direct costs, the prime contractor professional labor overhead/G&A cost, the prime contractor field office overhead/G&A cost, and the total subcontract cost. For example:

Prime Contractor Direct Cost	=	$20,400
+ Prime Contractor Professional Labor Overhead/G&A	=	$1,584
+ Prime Contractor Field Office Overhead/G&A	=	$5,100
+ Total Subcontract Cost	=	$20,500
Subtotal Prime Contractor Cost	=	**$47,584**

Step 8: Prime Contractor Profit

The Prime Profit percentage is applied to the subtotal prime contractor cost to determine the prime contractor's profit. For example:

Subtotal Prime Contractor Cost	=	$47,584
x Prime Contractor Profit Markup	=	8%
Prime Contractor Profit	=	**$3,807**

Step 9: Total Contract Cost

The prime profit is added to the subtotal prime contractor cost to determine the total contract cost. For example:

Prime Contractor Profit	=	$3,807
+ Subtotal Prime Contractor Cost	=	$47,584
Total Contract Cost	=	**$51,391**

Step 10: Contingency Allowance

The Contingency percentage is applied to the total contract cost to determine the contingency allowance. For example:

Total Contract Cost	=	$51,391
x Contingency Markup	=	5%
Contingency Allowance	=	**$2,570**

Step 11: Owner Cost

The Owner Cost percentage is applied to the total contract cost, including the contingency allowance, to determine the owner costs for the phase. For example:

Total Contract Cost	=	$51,391
+ Contingency Allowance	=	$2,570
x Owner Cost Markup	=	11%
Owner Cost	=	**$5,936**

Step 12: Total Estimated Cost

The total contract cost, contingency allowance, owner cost, and total no-markup costs are summed to determine the total marked-up (fully-burdened) cost for the phase. For example:

Total Contract Cost	=	$51,391
+ Contingency Allowance	=	$2,570
+ Owner Cost	=	$5,936
+ Total No-Markup Cost	=	$3,000
Total Marked-Up Cost	=	**$62,897**

Appendix E - Responses to Government Comments on Draft V&V Plan

Reviewing Party:	**USACE**
Discipline:	
Date:	
Project Location:	
Document Names:	*Draft RACER V&V Plan_4-21-08.doc*
Reviewer Name:	Jeff Lester

Example: 1. Section 2 (Page 2-1, Item #1):

COMMENTS

General Comments:

1. Para. 1.1 (page 1) Purpose : Suggest that the contract # and T.O. be removed, as this information is on the cover sheet, also it is not the purpose, of the V & V.

Earth Tech Response: The change has been made as suggested.

Reviewing Party:	**USACE**
Discipline:	
Date:	**May 1, 2008**
Project Location:	
Document Names:	*Draft RACER V&V Plan_4-21-08.doc*
Reviewer Name:	**Rick Osborn**

Example: 1. Section 2 (Page 2-1, Item #1):

COMMENTS

General Comments:

Specific Comments:

1.) Reference Paragraph 2.2 Testing Process. The last sentence talks about adding discussion of pre-alpha, alpha, beta, and final testing. This information was not included in the draft report was it intentionally left out? If so, please be sure to include in next submittal.

Earth Tech Response: Discussion has been added to describe the *RACER* testing procedures.

2.) Reference paragraph 3.1 Interface Deficiencies. The first paragraph talks about the USACE and AEC utilities for uploading into their appropriate financial management system. The paragraph also goes on to say the Air force users do not have such a utility. I don't view this discussion as it is written a deficiency of RACER. I would recommend not including this discussion in this section. Because Air Force does not have this utility is not a reflection of RACER a deficiency. This discussion could be reworded and used somewhere else in the document for future enhancements to the system.

Earth Tech Response: Reference to an upload utility for the USAF as a deficiency has been removed from Section 3. The discussion now occurs in Section 4, Suggested Enhancements.

3.) Reference the Paragraph 1.1 Purpose. It is stated here that this plan is to provide a prioritization and a long-range plan for V&V activities for known deficiencies and enhancements. The document does not provide a plan as to how, or a schedule for fixing deficiencies that are listed in Table 3-1. The document does not address future enhancements to the system and a plan for incorporating them. ET has a list of enhancements from previous RACER Technical User Group meeting that could be used as a basis of what needs to be enhanced in the system. Not saying you have to use all of them but you could reasonably assess which are most important, and that would help the

functionality of the system and include them in this report. As an example the discussion about including an Air Force utility for uploading into their financial management system would be a good example of an enhancement. To help in determining the schedule for model fixes and system fixes you could look at most used to least used models and schedule things that way, or look at the priority for urgent need, etc. Also with schedule considerations if you do something one model of RACER that has an affect on another model of you would want schedule that together. Bottom line here is that I think the document needs to better define and schedule a long range plan for fixing true deficiencies and incorporating needed enhancements to better support the purpose of the plan.

Earth Tech Response: Reference to an upload utility for the USAF as a deficiency has been removed from Section 3. The discussion now occurs in Section 4, Suggested Enhancements. Additionally, a table has been included in Section 5, Suggested Prioritization of Deficiency Remedies, which prioritizes the implementation of the deficiencies discussed in Section 3, General System Deficiencies.

Reviewing Party:	**USAEC**
Discipline:	
Date:	
Project Location:	
Document Names:	*Draft RACER V&V Plan_4-21-08.doc*
Reviewer Name:	**Consolidated**

General Comments:

2. Table 3-1 (Pages 7 to 10): What criteria were used to categorize the frequency of use and the users of the respective cost models?

Earth Tech Response: To address this comment, the following sentence has been added to Section 1.1 of the Introduction, "This V&V Plan also includes information about potential future enhancements and modifications to the system, as the result of discussions at various contractual meetings and *RACER* user input and comment." And this sentence has been added to Section 3.3, "The recommendations come as the result of review of meeting minutes from technical review group (TRG) and technical user group (TUG) meetings as well as the responses from 66 *RACER* users who participated in a survey administered in 2006. The survey looked strictly at the frequency that the respondent used particular parts (including cost models) of *RACER*."

Specific Comments:

1. Section 2.0 (Page 2, paragraphs 1): Replace "as follows" with "for the intended use".

Earth Tech Response: Change made as suggested.

2. Section 2 (Page 2, paragraph 2, 2nd bullet): Insert "*DoD decision*" after *"…used to support the major "*

Earth Tech Response: Change made as suggested.

3. Section 2.1 (Page 3, paragraph 1): Recommend replacing "The purpose of the RACER system is to develop cost estimates for environmental investigation and remediation projects pursuant to various regulatory programs and processes. " with "The RACER system is a cost-estimating tool that accurately estimates costs for all phases of remediation." This statement is consistent with the Help Topic and is used in many DoD RACER presentations.

Earth Tech Response: Change made as suggested.

4. Section 2.1 (Page 3, paragraph 3): Text states: *"The ranges of accuracy, as stated by the Association for the Advancement of Cost Engineering (AACEI), for preliminary, order of magnitude, and definitive estimates…"* yet the ranges listed in the accompanying table are *"preliminary (order of magnitude)," "secondary (budget),"* and *"definitive."* Revise the text to read: *"preliminary, secondary, and definitive."*

Earth Tech Response: The text has been revised to state, "The ranges of accuracy, as stated by the Association for the Advancement of Cost Engineering (AACEI), for preliminary (order of magnitude), secondary (budget), and definitive estimates are displayed in Table 2-1.

5. Section 2.1 (Page 3, Table 3-1): The Table in Section 2 is numbered *"3-1"* but it should be numbered *"2-1"* (there is a Table 3-1 in Section 3.4). Also, change any references to the mis-numbered Table.

Earth Tech Response: The table reference has been changed to 2-1 and references to the table in the text have been changed to reflect the new number.

Also, the referenced table on page 3 (to be Table 2-1) also carries Section *"2.1.1"* as its header. Revise the table so that this section heading is deleted.

Earth Tech Response: The first column header has been revised and is now titled, "Description".

6. Section 2.1 (Page 3, paragraph 5): Reference should be revised from *"Army Environmental Command (AEC)"*to *"US Army Environmental Command (USAEC)."* Ensure that the change from *AEC* to *USAEC* is carried throughout the document.

Earth Tech Response: References to AEC have been changed to USAEC throughout the document as suggested.

7. Section 2.2 (Page 4, last paragraph): The text reads: *"Need to include a discussion of testing at pre-alpha, alpha, beta and final acceptance stages, with preparation and delivery of a Software Test Results (STR) report."* This paragraph should include this discussion; revise accordingly.

Earth Tech Response: Discussion has been added to describe the *RACER* testing procedures.

8. Section 3 (Page 5, paragraph 2, items numbered *"2"*): Suggest modifying the reference to *"the RACER customer tracker"* to reference the formal system for RACER changes (i.e., "engineering change proposals" (ECPs)) as described in the RACER Change Management Plan (v. 2.0, dated July 2007).

Earth Tech Response: The text in item 2 has been revised to state, "Engineering Change Proposals (ECPs) (suggestions or reports) made by users to the *RACER* technical support desk as described in section 2.5.1 of the *RACER* Change Management Plan (v 2.0 dated July 2007).

9. Section 3.1 (Page 5, paragraph 1): Replace "AEC" with "Army". Recommend referring to *"management systems"* as "information management systems."

Earth Tech Response: References to AEC have been changed to USAEC throughout the document as suggested. All references to *"management systems"* have been changed to "information management systems" as suggested.

10. Section 3.3 (Page 5, paragraph 1): Recommend adding a clarifying statement to the end of the last sentence, "in order for an MS Excel report to be generated for the user." The paragraph as it stands seems to indicate that the user must perform this copy/paste action.

Earth Tech Response: For *RACER* reports that currently export directly to MS Excel, the user must perform a copy/paste action. The text has been revised to state, "*RACER* reports must be exported to an .rtf format and then manually copied and pasted to MS Excel."

11. Section 3.4 (Page 6, paragraph 2): The text in Section 3.4 refers to Table *"4-1,"* but the table below is *"3-1."* Revise the text to properly reference Table 3-1.

Earth Tech Response: The text has been changed to properly reference the table as Table 3-1.

12. Section 3.4 (Page 6, Table 3-1): How is *"Frequently Used?"* determined? See General Comment 1 (above) for further discussion.

Earth Tech Response: Please refer to response to General Comment 1.

13. Section 3.4 (Page 6, Table 3-1): How are *"Potential Consistency Changes"* determined? Are these based on Technical Working Group (TWG) meetings and/or ECPs?

Earth Tech Response: Text has been added to Section 3.3 which states, "The recommendations come as the result of review of meeting minutes from technical review group (TRG) and technical user group (TUG) meetings as well as the responses from 66 *RACER* users who participated in a survey administered in 2006. The survey looked strictly at the frequency that the respondent used particular parts (including cost models) of *RACER*."

14. Table 3-1 (Page 7, Table Items in Column *"Potential Consistency Changes"*): Define the acronym *"WTPLF."*

Earth Tech Response: The acronym has been defined in the text as well as in Appendix A.

15. Acronyms (Page 11, Item 1): Change *"Munitions and Explosive of Concern"* to "Munitions and Explosives of Concern."

Earth Tech Response: The text has been revised as suggested.

APPENDIX H TEST INFORMATION

RACER testing information can be found in the *Final Software Testing Plan, RACER 2008 Maintenance and Support, August 2007,* as well as in individual test scripts prepared by the software development contractor and reviewed by the RACER TRG.