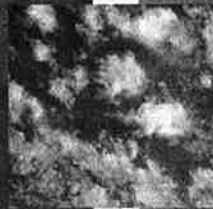
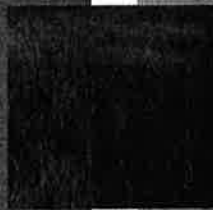


AECOM

Overview of the Remedial Action
Cost Engineering Requirements
(*RACER*[™]) System



For More Information, Please Contact
John Claypool
RACER Product Line Manager
5575 DTC Parkway, Suite 200
Greenwood Village, CO 80111
303.771.3103
RACER@aecom.com

1. INTRODUCTION

RACER is a cost estimating system that was developed under the direction of the U.S. Air Force for estimating environmental investigation and cleanup costs for the annual budgeting and appropriations process. The system initially was released for government use in 1992, and seven subsequent versions have been released since that time¹. The Air Force and Army currently use the system for developing major parts of their estimates and annual Cost to Complete (CTC) budgets. Other branches and offices within the Department of Defense and other Federal agencies also use the system to prepare individual project cost estimates and to evaluate the reasonableness of cost estimates and proposals. In addition to users within the Federal government, *RACER* is used by a variety of state regulatory agencies, engineering consultants, facility owners and operators, financial institutions and law firms.

As indicated above, *RACER* currently addresses environmental investigations and cleanup projects. The parametric estimating methodology upon which *RACER* is based also can be applied to other environmental cost estimating needs. For example, a streamlined version of the system, called Tank *RACER*, was developed specifically for petroleum contamination. Over the last several years, *RACER* has been modified to include models for addressing ordnance and explosive waste ("OEWS"), now MEC. The system also has been modified to address remediation of radiological contamination.

AECOM uses *RACER* in a variety of capacities. A prime area where *RACER* is used within the firm is to develop cost estimates for cleanup scenarios on feasibility studies (FS) for hazardous waste sites, Corrective Measures studies under RCRA, etc. Given the limited data inputs required and the structured estimating process, *RACER* is an ideal tool for developing cost estimates for multiple cleanup approaches consistent with RCRA, CERCLA, UST and other environmental regulatory programs.

RACER also has been used within AECOM to value environmental liabilities in connection with corporate transactions. AECOM evaluates environmental liabilities at contaminated properties for numerous private sector clients who are engaged in or contemplating mergers, acquisitions, divestitures, restructurings, etc. The role of our firm involves identifying the nature and extent of contamination, typically via the Phase I and Phase II site assessment processes. Once the contamination and risks have been evaluated, AECOM uses *RACER* to quantify the financial liability associated with various cleanup scenarios. The *RACER* cost estimates we produce enable our clients to evaluate contractual structures, insurance, and other means of managing the financial risk associated with the pending transaction.

AECOM also uses *RACER* to support clients involved in legal disputes. An example involves quantifying future cleanup costs to facilitate cash outs and settlements at sites having multiple potentially responsible parties (PRPs). We recently used *RACER* to value Kuwait's claim for legal damages against Iraq due to groundwater contamination resulting from the Gulf war. *RACER* also has been used to value legal claims in litigation involving insurance coverage, allocation among PRPs, etc.

¹ The most recent version, *RACER* 10.3, was released in October 2009.

2. OVERVIEW OF THE RACER SYSTEM

The Remedial Action Cost Engineering and Requirements (*RACER*) system is a parametric, integrated cost estimating software system that was developed specifically for estimating costs associated with environmental investigation and cleanup projects. The system provides the detail of a definitive engineers' estimate, but it also can be used at early order-of-magnitude stages of cost estimating. Using *RACER* to prepare cost estimates provides the detail and accuracy of manual estimates, but it is faster, less error prone, and more efficient in comparing engineering alternatives. *RACER* has been used to estimate over \$10 billion of environmental projects and is currently used by hundreds of users including DOD, DOE, DOI, EPA, engineering consultants, contractors, state regulatory agencies, and the private sector. The accuracy of the *RACER* system has been proven to be within 10% of actual completed project costs.

2.1 Multi-Level Estimating Hierarchy

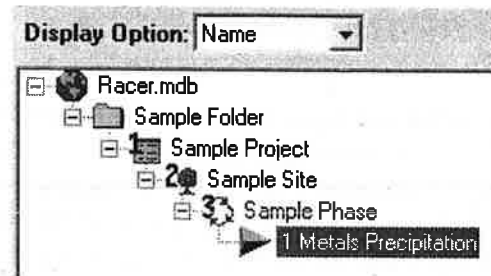
RACER was designed to support cost estimates for large complicated sites with work occurring in multiple phases. Due to the large size of many contaminated facilities, environmental remediation projects are commonly divided into a number of sub-sites called "Operable Units" or "Areas of Concern". Each of these sub-sites must progress through a series of phases dictated by the regulatory program to which the site is subject. In general, the phases include a series of investigations to define the nature and extent of contamination, an evaluation of engineering alternatives, construction of the selected alternative, and performance of operations and maintenance. The complexity of a cost estimate is directly related to the number and complexity of the sub-sites and the number and timing of the phases for each sub-site.

To address complex sites, *RACER* provides the user with the ability to divide cost estimates into a virtually unlimited number of projects, sites, and phases. *RACER* currently uses an estimating hierarchy that has five levels:

- Level 0 – Folder (for storing estimates)
- Level 1 – Project (contains project definitional data)
- Level 2 – Site (contains definitional data for one or more sites that make up the overall project)
- Level 3 – Phase (contains definitional data for each phase of work to be conducted for a site).
- Level 4 – Technology (contains engineering data about the approach, configuration and materials of construction for a technology)

This hierarchy provides users with a large degree of flexibility in storing and organizing their estimates to suit the particular needs of their projects. *RACER* uses a tree structure to organize and depict the user's estimates. The tree structure enables the user to move, copy, paste, and delete estimates (or portions of estimates) at any level in the hierarchy. A portion of the estimating hierarchy for a large industrial facility is shown in Figure 1.

Figure 1: The RACER Estimating Hierarchy



The user can change the names for any or all of the phases to suit the terminology used in the regulatory program to which their project is subject.

2.2 Parametric Methodology

RACER uses a patented estimating methodology that is based on generic engineering solutions for environmental cleanup projects. To generate cost estimates, RACER has two components that work in tandem:

1. An expert system that estimates the quantities of specific work elements required for the various phases of remediation.
2. A detailed database of unit prices for remediation work items.

This methodology uses generic engineering solutions and corresponding equations that are applied based on certain parameters that reflect project conditions and quantities. Entering site-specific information allows the user to customize the generic engineering solutions to reflect conditions at their sites. Based on the engineering solution, as modified by the user, RACER then calculates the quantities of labor, equipment, and materials necessary to perform the work. Once the quantities are calculated, the system uses the quantities in conjunction with the database of unit prices to calculate costs.

The RACER system currently consists of over 130 individual technologies that fall into the following general categories: Pre-Study, Study, Design, Removal/Interim Action, Remedial Action, Long Term Monitoring, and Site Close-out. The Remedial Action models include capital costs, as well as long-term operation and maintenance costs. The user prepares the overall cost estimate by selecting technologies and then entering information for each selected technology. For each technology, the parametric estimating methodology works as follows:

1. Each technology has a group of "required" parameters that must be entered to generate an estimate. An example required parameter screen for the Metals Precipitation technology is shown in Figure 2.

Figure 2: RACER generates detailed cost estimates using minimal required information.

Metals Precipitation

System Definition | Other Sludge Components | Comments | Reports |

Required

Flow Rate GPM

Influent pH

Effluent pH

Heavy Metals Concentration mg/L

Safety Level

2. Once the required parameters are entered, engineering equations are applied within the system to automatically select or calculate default values for various "secondary" parameters. Secondary parameters consist of additional items that specify the materials of construction, configuration, size, or components of the technology. The user can accept the default values or modify them based on knowledge about the project. The secondary parameters screen for the Metals Precipitation technology is shown in Figure 3. The secondary parameters shown in Figure 3 are based on the user's inputs to the required parameter shown in Figure 2.

Figure 3: Modifying secondary parameters increases the accuracy of the estimate.

Metals Precipitation

System Definition | Other Sludge Components | Comments | Reports |

Secondary

	Default	User
Influent Total Suspended Solids	100.00	<input type="text" value="100.00"/> mg/L
Other Precipitating Anions & Cations	1,000.00	<input type="text" value="1,000.00"/> mg/L

3. Once the secondary parameters have been accepted or modified by the user, the system uses algorithms to calculate quantities of one or more components (called "assemblies") that comprise the technology. Each assembly has a unique material, labor, and equipment cost which comes from the underlying database. The user can accept these assemblies or modify each assembly's quantity or cost. In addition, the user can delete the default assemblies or add additional assemblies. An example assembly detail screen for the Metals Precipitation technology is shown in Figure 4.

Figure 4: Users may change the quantity and unit cost data for each assembly.

Assembly Quantities/Costs

Sort Assemblies By: ☒ Assembly ☐ Description

Assembly Quantities and Costs

Assembly	Description	Qty	UM	Material	Labor	Equipment	SubBid	Extended Cost	Cost Override	Apply Markups?
18020322	8" Structural Slab on Grade	1050	SF	4.62	3.94	0.15	0.00	9,152.27	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021514	pH/ORP Output Card Dual	1	EA	77.00	42.63	0.00	0.00	119.63	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021515	pH/ORP Input Card Isolated	1	EA	124.00	42.63	0.00	0.00	166.63	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021518	pH Controller with Isolated 4-20	1	EA	891.00	42.63	0.00	0.00	933.63	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021519	pH Pump Pulsar Board for	1	EA	403.00	42.63	0.00	0.00	445.63	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021520	Analog pH Analyzer with 2 - 12	2	EA	891.00	42.63	0.00	0.00	1,867.27	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021523	12" pH Coax Cable	2	EA	8.10	31.65	0.00	0.00	79.51	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33021524	Submersion Assembly	2	EA	150.00	170.54	0.00	0.00	641.08	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33120606	Pumping System	1	EA	2,100.00	0.00	0.00	0.00	2,100.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33120611	100 GPM Continuous	1	EA	89,000.00	0.00	0.00	0.00	89,000.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33130404	20" Diameter, 130 GPM, Waste	1	EA	74,500.00	60,381.62	10,131.44	0.00	145,013.06	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33260303	3" Polypropylene Pipe Including	50	LF	4.28	19.87	0.00	0.00	1,207.52	<input type="checkbox"/>	<input checked="" type="checkbox"/>
33290123	100 GPM, 5 HP, Transfer Pump	1	EA	3,470.00	1,567.09	0.00	0.00	5,037.09	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Delete Assemblies Add Assemblies View Line Items Marked-up Cost Reset Cost Close

Total: \$255,763.34

4. After calculating direct costs for construction, the user can develop an estimate of the costs associated with operating and maintaining the constructed system. RACER provides the user with an 11-step wizard to calculate long-term O&M costs. The wizard includes costs for operating labor, maintenance labor, oversight labor, heating, consumables (chemicals, energy, parts & supplies), and laboratory analyses. After calculating the annual O&M costs, RACER extends the O&M costs over time according to the schedule defined by the user. A portion of the O&M wizard is shown in Figure 5.

Figure 5: RACER uses a wizard to calculate long-term Operation & Maintenance costs.

Operations & Maintenance

System Definition | Labor | Analytical | Heating | Cost Over Time | Comments | Reports

Current Year Dollar Distribution - Fiscal Year Format

	2008	2009	2010	2011
Miscellaneous Support	\$2,853	\$15,645	\$15,645	\$15,645
1 Metals Precipitation	\$3,059	\$36,712	\$36,712	\$36,712
Direct Cost Total	\$5,912	\$52,357	\$52,357	\$52,357

Total Direct: **\$1,522,705**

Startup Costs: **\$1,549**

Total Direct O&M Costs: **\$1,524,254**

☒ Accept

- After the user calculates the direct costs for a project, RACER applies mark-ups for general conditions, overhead, profit, and owner cost.
- After an estimate has been completed, the user can print their results in a variety of reports. RACER provides a number of reporting formats at each level in the estimating hierarchy. RACER reports can be saved and opened using a variety of word processing applications, Microsoft Excel format, or Adobe Acrobat.
- After completing an estimate, the user can export the estimate for archiving. Exported files also can be shared with other RACER users for further analysis and/or for QA/QC review.

2.3 Unit Price Database

RACER relies upon a database of assemblies containing unit prices for materials, labor, and equipment. The unit price data contained in the database is updated annually through a survey of contractors, suppliers, laboratories, and engineering/consulting firms. This survey takes the form of an input index of unit costs for labor, material, equipment, and supplies and services that are used commonly for environmental restoration projects. The assemblies in the RACER database include items for site studies, design, construction, and long-term operations and maintenance.

2.4 Location-Specific Estimates

When defining a project, the location of the project must be specified. *RACER* uses the project location information to adjust unit prices for labor, materials and equipment contained in the *RACER* database to reflect unit prices prevailing at the project location. *RACER* contains location-specific cost adjustments for over 1,500 cities and a number of foreign countries. An example of the location definition and cost modifiers is shown in Figure 6.

Figure 6: *RACER* uses project location information to modify unit prices.

Location	
State / Country	City
US	US 96 CITY AVERAGE

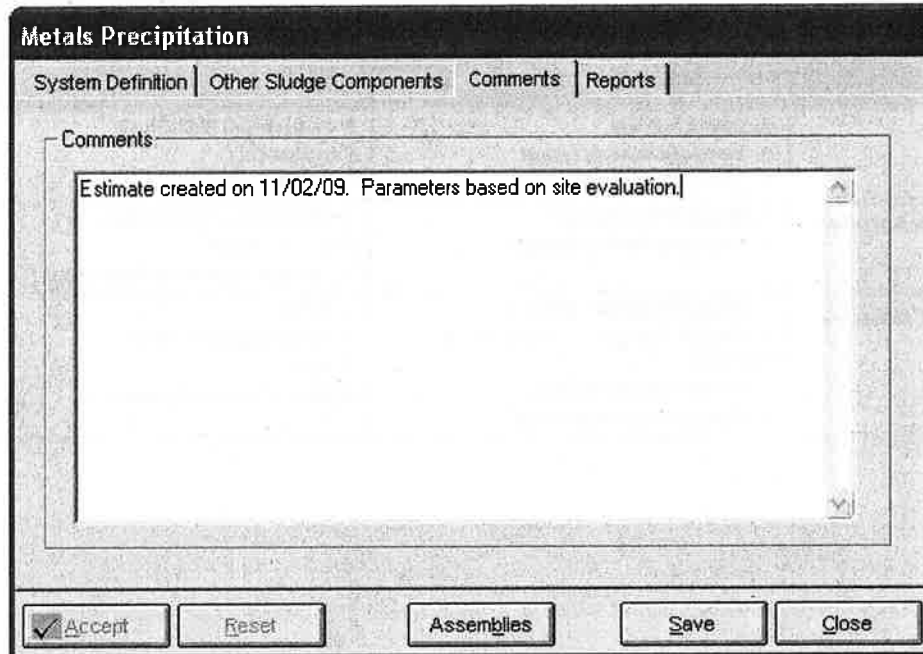
Modifiers		
	Default	User
Location Modifier	1.000	1.000

2.5 Documented/Auditable Estimates

RACER provides users with the ability to document their estimates at every level of the estimating hierarchy. This capability has been included in the system so that the rationale for estimates can be documented and understood by others, or reconstructed later. Examples of how *RACER* estimates can be documented:

- Details about the nature or scope of a project can be captured in the "Project" worksheet in Level 1.
- Assumptions about why a site was divided into multiple sub-areas, or when work would begin in a particular portion of a site can be documented in the "Site" worksheet in Level 2.
- The user can describe the rationale for including or excluding particular technologies in the "Phase" worksheet in Level 3.
- Changes to default values, quantity calculations, changes to unit prices to reflect vendor quotes, or inclusion of additional assemblies can be documented in the comment screens for individual technologies (Level 4). Every technology has a screen similar to the one depicted in Figure 6 where comments and other annotations can be documented.

Figure 7: The Comments tab is available in every technology.



This documentation capability also can be used to establish an auditable record of changes as estimates are revised to reflect new information about the project being estimated.

2.6 Accuracy/Validation

The accuracy of the *RACER* system has been evaluated rigorously several times during the initial development and modification of the system. The system accuracy evaluation consists of three parts:

1. How well does the system methodology predict the actual scope of work?
2. How accurate is the unit price database for labor, material, and equipment items?
3. How accurately do the combined components predict final remediation costs?

The first step in ensuring system accuracy is to apply proven standards and processes during system development. For *RACER*, these include:

- Compliance with the Development, Review, and Verification Process
- Concurrence with Regulatory Policy and Guidance
- Concurrence with Appropriate Technical Standards

RACER has undergone significant QC and validation, as summarized in Table 1.

Table 1: Summary of RACER Validation Process

VALIDATION COMPONENT	VALIDATION ACTIVITIES	
	System Development QC and Validation	Independent External Validation
Expert System Methodology	<ul style="list-style-type: none"> ■ Delphi Surveys ■ Technical Review Group ■ Tank RACER User Group 	<ul style="list-style-type: none"> ■ Department of Defense ■ CH2M HILL ■ Dynamac Corporation
Cost Database Accuracy	<ul style="list-style-type: none"> ■ Annual Price Surveys ■ Technical Review Group 	<ul style="list-style-type: none"> ■ Army Corps of Engineers ■ EJOC Market ■ Georgia Institute of Technology
Overall Output Accuracy	<ul style="list-style-type: none"> ■ AECOM Internal Validation ■ RACER Technical Review Group Validation ■ Private Industry Review ■ Tank RACER User Group 	<ul style="list-style-type: none"> ■ CH2M HILL ■ Dynamac Corporation ■ MTC ■ Army Corps of Engineers

RACER™ 2006 Technologies

Site Work & Utilities

Access Roads
Cleanup and Landscaping
Clear and Grub
Fencing
Load and Haul
Overhead Electrical Distribution
Parking Lots
Resurfacing Roadways/Parking Lots
Sanitary Sewer
Sprinkler System
Storm Sewer
Water Storage Tanks

Studies

Archives Search Report
Corrective Measures Study
Feasibility Study
Final Status Survey
Groundwater Monitoring Well
MEC Site Characterization & Removal Assessment
Monitoring
Petroleum UST Site Assessment
Preliminary Assessment
Professional Labor Management
RCRA Facility Investigation
Remedial Investigation
Site Characterization Survey
Site Inspection
Special Well Drilling & Installation
MMRP Supplemental Investigation (for USAF users)
User Defined Estimate

Treatment

Advanced Oxidation Processes
Air Sparged Hydrocyclone
Air Sparging
Air Stripping
Bioslurping
Bioventing
Carbon Adsorption (Gas)
Carbon Adsorption (Liquid)
Coagulation/Flocculation
Composting
Dewatering (Sludge)
Ex-situ Bioreactors
Ex-situ Land Farming
Ex-situ Solidification/Stabilization
Ex-situ Vapor Extraction
Heat Enhanced Vapor Extraction
In-situ Biodegradation (Saturated Zone)
In-situ Land Farming
In-situ Solidification
Low Level Rad Soil Treatment
Media Filtration
Metals Precipitation
Neutralization
Off-site Transportation and Thermal

Treatment Continued

Treatment
Oil/Water Separation
On-site Incineration
On-site Low Temp. Thermal Desorption
Passive Water Treatment
Phytoremediation
Soil Flushing
Soil Vapor Extraction
Soil Washing
Solvent Extraction
Thermal & Catalytic Oxidation

RACER™ 2006 Technologies

Containment

Capping
In-situ Biodegradation (Saturated Zone)
Permeable Barriers
Slurry Walls
Storage Tank Installation
UST Closure / Removal

Demolition

Demolition, Buildings
Demolition, Catch Basins/Manholes
Demolition, Curbs
Demolition, Fencing
Demolition, Pavements
Demolition, Pipes
Demolition, Sidewalks

Discharge

Discharge to POTW
Infiltration Gallery
Injection Wells

Disposal

Off-site Transportation and Waste Disposal
Residual Waste Management

Documentation

Administrative Land Use Controls
Administrative Record
Five-Year Review
Restoration Advisory Board
Site Close-Out Documentation

Ordinance

Archives Search Report
MEC Institutional Controls
MEC Monitoring
MEC Removal Action
MEC Site Characterization & Removal Assessment
MEC Sifting
UXO Active Range Clearance Planning
UXO Active Target Clearance

Radioactive

D&D Contaminated Building Materials
D&D Sampling and Analysis
D&D Conduit, Pipe, & Ductwork
D&D Specialty Process Equipment
D&D Rad Contaminated Building
D&D Final Status Survey
D&D Removal, Attached Hazardous Materials
D&D Removal, Unattached Hazardous Materials
D&D Size Reduction
In-situ Vitrification
D&D Site Characterization Survey
D&D Surface Decontamination

Remediation Support

Bulk Material Storage
D&D Sampling and Analysis
Decontamination Facilities
Groundwater Monitoring Well
MEC Institutional Controls
MEC Monitoring
Miscellaneous Field Installation Monitoring
Natural Attenuation
Professional Labor Management
Remedial Design
Residual Waste Management
Trenching/Piping
User Defined Estimate
Administrative Land Use Controls

Removal

Asbestos Removal
Contaminated Building Materials
Drum Staging
Excavation
Free Product Removal
French Drain
Groundwater Extraction Wells
Residual Waste Management
Special Well Drilling & Installation
Surface Decontamination
Transportation
UST Closure / Removal