Overview of the Remedial Action Cost Engineering Requirements (RACER®) Software

Introduction

RACER is a cost estimating software 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 software initially was released for government use in 1992, and nine subsequent versions have been released since that time[1]. The Air Force and Army currently use the software 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 RACER 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 munitions and explosives of concern (MEC). The software 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. AECOM's role 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

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[1] *The most recent version, RACER 11.3, was released in March, 2016*

having multiple potentially responsible parties (PRPs). AECOM 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.

Overview of the RACER Software

The Remedial Action Cost Engineering and Requirements (RACER) software is a parametric, integrated cost estimating program that was developed specifically for estimating costs associated with environmental investigation and cleanup projects. The software 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, engineering consultants, contractors, state regulatory agencies, and the private sector. The accuracy of the RACER software has been proven to be within 10% of actual completed project costs.

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 grid structure to organize and depict the user's estimates. The grid 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 is shown in Figure 1.

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.

	Project ID	Project Name	Direct Cost	Marked-up Cost
View	01	Sample Project	$196,264,209	$273,732,798
Add			---	---

	Site ID	Site Name	Direct Cost	Marked-up Cost
View	01	Sample Site	$196,264,209	$273,732,798
Add			---	---

	Phase Name	Direct Cost	Marked-up Cost
View	Pre-Study Phase	$1,038	$2,860
View	Study Phase	$4,483	$12,355
View	Design Phase	$7,266,838	$7,266,838
View	Remedial Action Phase	$188,991,850	$266,450,744
Add		---	---

	#	Technology Name	Direct Cost	Marked-up Cost
Run	1	Excavation	$2,004,797	$3,006,977
Run	1	On-site Low Temp. Thermal Desorption	$7,632,214	$10,293,185
Run	1	Decontamination Facilities	$544,524	$1,292,820
Run	1	Professional Labor Management	$24,222,795	$24,222,795
Run	1	Residual Waste Management	$154,587,519	$227,634,967

Figure 1: RACER Hierarchy

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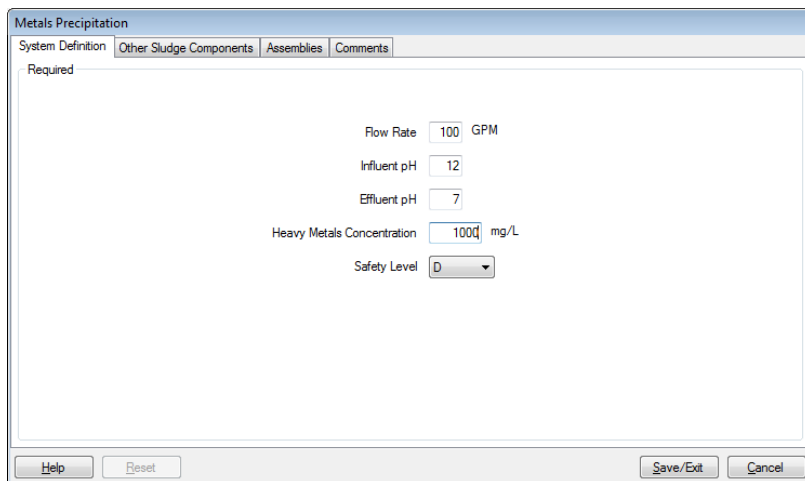
Each technology has a group of "required" parameters that must be entered to generate an estimate. An example required parameter screen for the Metals Precipitation technology is shown in Figure 2.

Figure 2: RACER Generates Detailed Cost Estimates Using Minimal Required Information

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
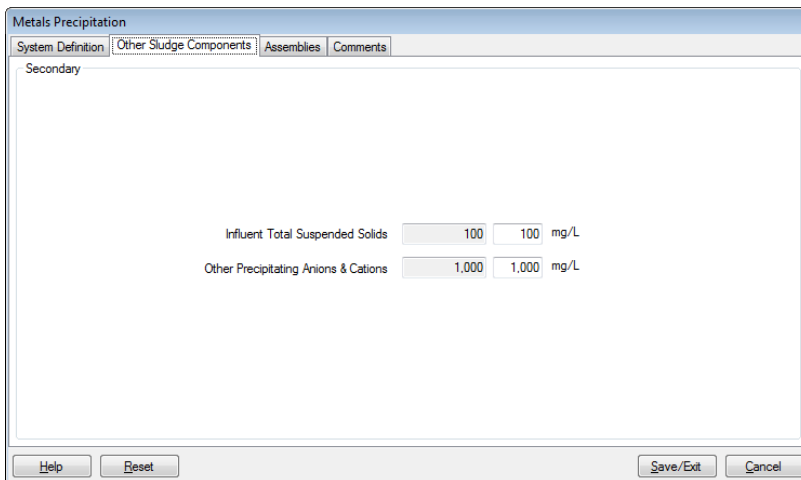

Figure 3: Modifying Secondary Parameters Increases the Accuracy of the Estimate

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 4: Users May Change the Quantity and Unit Cost Data for Each Assembly

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.

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,

Figure 5: RACER Uses a Wizard to Calculate Long-Term Operations & Maintenance Costs

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.

After the user calculates the direct costs for a project, RACER applies mark-ups for general conditions, overhead, profit, and owner cost. Once the estimate has been completed, the user can print the 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. The user can also export the estimate for archiving.

Exported files also can be shared with other RACER users for further analysis and/or for QA/QC review.

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.

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

Figure 6: RACER Uses Project Location Information to Modify Unit Prices

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.
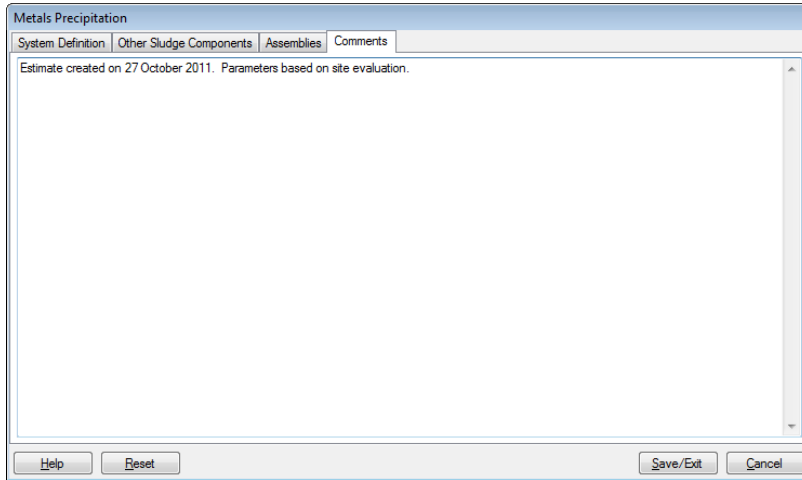
Documented/Auditable Estimates

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 7 where comments and other annotations can be documented.

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.

Figure 7: The Comments Tab is Available in Every Technology