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## **Economic Analysis for Minimizing Hazardous Wastes, Version 2.1: User's Manual**

by  
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All Army Major Commands (MACOMs) are required to develop hazardous waste (HW) minimization programs as part of the Army's effort to reduce the amount of waste generated. This program is to include, among other aspects, a comparative economic analysis to determine the most cost-effective minimization alternatives. The results of this analysis can be used to justify requests for funding specific minimization projects.

The U.S. Army Construction Engineering Research Laboratory (USACERL) has developed a computer program called CERL Economic Analysis for Minimizing Hazardous Wastes (CEAMHW). This program is designed to help installation managers perform economic analysis of HW minimization options by taking them through a step-by-step procedure. This report is the user's manual for CEAMHW.

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## FOREWORD

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The period was conducted by the Environmental Division of the U.S. Army Construction Engineering Research Laboratory (USACERL-EN). Principal Investigators were Mr. Bernard Donahue and Dr. Keturah Reinbold. The USACERL technical editor was Ms. Diane P. Mann, Information Management Office.

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# ECONOMIC ANALYSIS FOR MINIMIZING HAZARDOUS WASTES, VERSION 2.1: USER'S MANUAL

## 1 INTRODUCTION

### Background

An Army-wide hazardous waste minimization policy was established in July 1987 to reduce by half the amount of wastes being generated by calendar year 1992 (from the 1985 baseline data). This policy requires all Major Commands (MACOMs) to develop waste minimization programs (e.g., emphasizing source reduction and routine audits) that among other aspects requires comparative economic evaluation of proposed waste minimization alternatives (e.g., onsite distillation versus full-service contract recycling of solvents).

To help installation environmental managers assess minimization alternatives for a variety of wastes, the U.S. Army Construction Engineering Research Laboratory (USACERL) has developed a computer model for conducting economic analyses. The computer package, called the CERL Economic Analysis for Minimizing Hazardous Wastes (CEAMHW), provides a standard procedure for determining the life-cycle costs of proposed alternatives which can then be compared with the costs of current operating practices.<sup>1</sup> Installation managers can use results of the economic analyses to obtain funding for specific waste minimization projects.

This report is the user's manual for CEAMHW. CEAMHW is designed to minimize the amount of time the user needs to spend reading a manual. It is completely menu-driven, contains context-sensitive help, and displays status lines for each screen to guide the user through each step of the analysis process. This manual describes the program in its entirety to help the user to take full advantage of the program's features.

### Objective

The objective of this work is to provide complete instructions for using the CEAMHW program.

### Contacts

Should you encounter difficulties in the structure of the model, please contact Mr. Bernard Donahue (217) 373-6733 or Dr. Keturah Reinbold (217) 373-6742. For problems related to the mechanics of the computer model or for difficulties in running the program, please contact Mrs. Kathy Chylla at (217) 352-6511 extension 601, or send E-mail to boka@osiris.cso.uiuc.edu. We hope you find the program helpful and welcome your comments and suggestions. Thank you for your patience and we wish you the best of luck!

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<sup>1</sup>J.B. Mount, S. Dharmavaram, K.A. Reinbold, and B.A. Donahue, *Economic Analysis of Hazardous Waste Minimization Alternatives*, Draft Technical Report N-89/xx(U.S. Army Construction Engineering Research Laboratory, Champaign, IL, 1989).

### **Mode of Technology Transfer**

The CEAMHW software is being transferred directly to installations upon request. USACERL is providing initial support through training programs and consultation.

## 2 INSTALLATION

### Procedure

Currently, the program is distributed on six diskettes. It is designed for an IBM PC, or compatible, with a DOS operating environment. It requires a little over 4 Mb of hard disk space to store the files, and requires 410 Kb of random access memory (RAM) to run. If the computer has less than the required space needed to store the files, the program can still be used. Temporarily create enough space to install the files and follow the installation procedure. Next delete the files in the directories of the waste streams not needed. You can then restore anything temporarily removed before installation. If a deleted waste stream is chosen in the program, a warning message will appear, but the program will continue to run.

As an example, the following installation instructions assume that the floppy drive is drive A, and the hard disk on which the program will be installed is drive C. It also assumes that you wish to install the program in a directory called WASTES.

1. The first step is to move into the root directory and copy the install file from the floppy disk onto the hard disk.

```
CD\ <ENTER>  
COPY a:\install.bat <ENTER>
```

2. Now, simply use the install file to move the files from the floppy disks onto the hard drive of the computer.

```
INSTALL A C WASTES <ENTER>
```

The install procedure requires a drive symbol for the floppy drive, a drive symbol for the hard drive, and finally a directory to which the files will be copied. First, the procedure creates eight directories: the directory specified above and seven subdirectories for each waste stream. These sub-directories will be called data directories. Then, the procedure will move files from the floppies to the hard drive, instructing the user when to change floppies.

3. When the installation procedure is complete, the install file can be deleted from the hard drive by typing:

```
DEL install.bat <ENTER>
```

4. To run the program, move into the wastes directory and type the name of the program.

```
CD WASTES <ENTER>  
CEAMHW <ENTER>
```

(CEAMHW /noc) if the monitor does not have color capabilities

5. If the above instructions are followed, the program is now ready to use. However, if changes have been made to the directory structure after installation, or WASTES has not been used as the install directory, warning messages will appear when you first run the program. The Setup option in the main menu will need to be used to describe the new directory structure so the program can find the appropriate files.

During the installation procedure, errors may occur. For example, there may not be enough space on the hard drive, and the procedure will print: "Disk full." If problems occur, try to correct them and then rerun the installation procedure. Messages will appear such as: "Unable to create directories," but this means the directories have to be created the first time and you can continue. Also, the procedure will ask if it is all right to overwrite files already installed. This is fine since they are the same files.

### User-Defined Directories

If the directory structure provided is unsatisfactory, a new structure can be created. To coordinate the directories with the program, the following files are associated with the following categories in the Setup option.

1. These files must be copied into a directory that will be the startup directory:

- CEAMHW.exe
- userset.cfg
- main.hlp
- main.ndx

2. These files must be copied into directories for files pertaining to a specific waste stream:

- .stl
- .def
- .hlp
- .ndx
- .exe

3. For example, if the waste stream is the general model, the following files are associated with the general model's data directory:

- general.stl
- general.hlp
- general.ndx
- general.def
- general.exe

4. Also associated with these data directories will be the data files that store saved CEAMHW work and .PRT files for reports. Two of the waste streams, Paint Stripping and Metal Plating, have more than one .exe file associated with them. Be sure to copy both into the new directory structure.

### Setup Option

The Setup option is available in the main menu of CEAMHW so the experienced DOS user can customize the program to fit a user-specific directory structure. If the directory structure is changed in any way, Setup must be used to set up the new structure in the program. The top item in the setup window is the startup directory. This directory holds the following files: CEAMHW.exe, userset.cfg, main.hlp, and main.ndx. Before changing this directory in the setup window, make sure that the new directory exists and contains these files. An error message will appear if a directory that does not exist is entered.

The next group of entries consists of file name extensions for CEAMHW data files. These extensions should be descriptive so that the waste stream from which the file was created is

evident. These can be changed at any time; however, remember that they tell the computer which data files to load for a particular waste stream. If this extension is changed, the program will no longer load previously saved data files for this waste stream unless those files' extensions are changed also.

The last group of entries in the Setup window are the data directories. These directories contain the data and print files for the separate waste streams, along with the waste stream's .exe, .hlp, .ndx, and .def files. To avoid confusion, it is recommended that the data files for each waste stream be kept in separate directories.

### 3 KEY EXPLANATIONS

Throughout this manual, special keystrokes will be represented by enclosing them in < >. This convention may represent one keystroke or the combination of holding down two keys at the same time. The following are general concepts used throughout the entire program.

<CTRL-ENTER>: Holding down the CTRL key, and pressing ENTER. This is used to save newly changed data in cost, information, and default screens, and then exit the screen.

<ESC>: Pressing the ESCAPE key. This is used to exit from a screen without saving any changes.

Menu Selection: Use either the arrow keys or the first letter of the menu option to make a menu selection and press <ENTER>. Use <ESC> to move to the previous menu.

At any time during the execution of the program, the last line of the screen will display a status line describing the currently available function keys. The second to last line of the screen will be used to display a brief, helpful message concerning the currently active field. Refer to both of these lines for guidance throughout the program. The following are descriptions of the keys that will appear in the status line.

<F1>: Pressing function key number 1. Opens a help screen for the currently active field, whether it be a menu option or an input field.

<F2>: Pressing function key number 2. Saves data in a data file. The user will be requested to name the file and provide a brief description to serve as a reminder of the contents of the file.

<F4>: Pressing function key number 4. Prints the active window. This can be used at any time to print a paper copy of the screen.

<F5>: Pressing function key number 5. Toggles between the two comparison windows. This key can be used in the detailed comparison to toggle between alternative windows.

<F8>: Pressing function key number 8. Reinstates default values. This can be used inside a cost screen to bring back a default cost when it has been changed by the user.

<F9>: Pressing function key number 9. Enters an escalation rate. This can be used inside the cost screens to assign an escalation rate to a specific cost.

## 4 PROGRAM FLOW

This chapter describes the typical program order for examining a problem and determining its most economical solutions using CEAMHW.

1. Choose a Waste Stream: Choose the appropriate waste stream, and press <ENTER>. If the problem is not a member of one of the listed waste streams, then the general model should be used.

2. Assumptions Window: Before any costs are entered or calculated, the Defaults option should be selected to verify known values of items such as specific equipment costs, discount rates, or adjustment percentages. Since these values are used to calculate suggested costs later in the program, accurate default values will result in more accurate defaulted costs.

3. Choose a File: After the defaults have been viewed, a work file must be opened. Previously entered files will be listed along with a New Problem option. One of these files must be selected. This menu is the only one for which the <ESC> key cannot be used to move to the previous menu. A file must be opened. If the user wants to exit the program at this point, he can choose the New Problem menu option, and use <ESC> to exit from that menu.

4. Define Problem: After a file has been chosen, a new menu will appear that includes: Problem Information, Comparisons, and the three waste minimization techniques (Source Reduction, Recovery/Reuse, and Treatment.) Choose the Problem Information option first, and enter the appropriate information.

5. Input Alternatives: After the problem has been defined, choose a waste minimization technique and a specific alternative to consider. The alternatives provided are minimization techniques suggested for reducing, reusing, or treating the waste described in the previous steps. The first thing to do after selecting an alternative is enter the alternative-specific information. There are usually two pages of information, and both should be completed before any other information about the alternative is entered.

6. Enter Costs: First enter any nonrecurring costs. If there are research and development (R&D) costs, enter the yearly totals. If there are investment costs, enter the yearly investment costs, major replacement costs, and a terminal value. Then, enter the operations and maintenance (O&M) costs.

7. Totals: After all of the costs have been entered, the totals screen can display the alternative's costs by year. This display will include yearly present values for the alternative for each year of its project life.

8. Comparison: After at least two alternatives have been entered, comparisons can be made to determine which alternative is more economically feasible.

10. Printing: These alternatives may also be printed on paper in report format.

11. Saving: It is wise to press <F2> at any time to save any data that have been entered. A brief description of this file will be requested to be used later as a reminder of the file's contents. The Save option is not available at all times, so refer to the status line for information on when saving is available.

12. Exiting: To exit, press <ESC> enough times to reach the main menu. Then choose the Quit option to exit the program.

## **5 COST SCREENS OPERATION**

The CEAMHW program contains many detailed cost screens. To take full advantage of these features, the operation of information and cost screens should be reviewed. The important concepts are outlined below.

### **Storing vs. Aborting**

As described in Chapter 3, using <CTL-ENTER> will save any changes made to a screen, and <ESC> will abort any changes to a screen while restoring the changed values.

### **Installing Default Values**

As described above, the program often provides default values or default calculations for certain cost entries. It is important to realize that these values can be installed only when you have entered the cost screen where the default is used. Therefore, if values that affect another cost are changed, the cost is recalculated only when the cost screen containing that cost is reentered.

### **Entering Values**

Although the program provides default values for certain costs, you can enter your own values by simply typing them in the cost screens. To enter a cost, move to the field associated with that cost and type in the new value. Whether or not a default value is provided for this field, the new value will be stored when <ENTER> is used to terminate the input. Once you have entered a value for a cost, that cost will no longer be affected by the defaults provided.

### **Reinstalling Default Values**

In some situations, you may want to bring back a default calculated cost after you have changed the value for that cost. As stated in Chapter 3, the <F8> key will recalculate the cost and display the new value immediately on the screen.

### **Escalating a Cost**

In each O&M cost screen, you have the option of assigning an escalation rate to each individual cost. When a cost input field is highlighted, press <F9> and an escalation window will appear. Here, you can assign an escalation rate to that cost. The effects of this assignment can be seen in the Totals window as the cost is escalated each year.

## 6 DESCRIPTION OF SCREENS

### Assumptions Window

This is a set of pages containing the default values for a waste stream. The defaults are a set of numbers used in internal calculations and as suggested values for certain entries in the cost and information screens. The default calculations and suggested values are included so the novice can use the program right away; however, the true power of the program lies in your ability to change the default values. The values provided are nationwide approximations and may not produce results that are as accurate as defaults reflecting local operating conditions and costs. Therefore, it is important to update the assumptions window with values that reflect local conditions.

When the Default menu option has been chosen, the assumptions window appears on the screen. To the left of the window is a description of the value. The actual value is on the right side. By placing the cursor on a desired value (using the <UP/DN> arrows) and entering a new value, the old default is replaced. There are quite a few defaults, so the assumptions window consists of many pages that can be reached by using the <PG UP/DN> keys. Finally, as in the other screens, changes can be saved permanently by typing <CTRL-ENTER> or aborted by pressing <ESC> .

It is important for you to realize that changes made in the assumptions window are permanent. Once the old value is overwritten and the new value is saved, the old value is irrevocably lost. For this reason, the originally suggested defaults are permanently recorded on the left side of the screen under the description line. If the suggested value is desired after some change has occurred, simply copy the value in parentheses into the input field.

### Information Screens

Information screens ask specific questions about a problem or alternative and are unique to each waste stream and each alternative. Example problem information questions include the number of gallons of waste produced per year and whether or not the waste is hazardous. These screens operate in the same manner as these cost screens described in Chapter 5.

The alternative information is often divided into two pages. The first page asks specific questions about the project life, number of research and development years, and number of investment years required. The first entry in this screen, labeled as INFORMATION, also allows you to see a help window describing the alternative being examined. If a second page exists, it often asks for information about the chemical solutions used in the alternative and about specific operating methods.

### Research & Development Costs

Depending on the number of R&D years specified in the Alternative Information screen, this screen allows you to input the total R&D costs for each year. The costs are not separated into categories as in other screens--they are total yearly costs. This screen also operates like those described in Chapter 5.

## **Investment Cost Screens**

Investment costs are those costs incurred before operation. Included are costs for items such as major equipment, shipping, permits, and startup. Inside the Investment menu selection, the costs are divided into yearly investment costs, replacement costs, and a terminal value. It is assumed that the maximum number of years needed for investment is two. Therefore, two screens are provided for inputting the investment costs for each year. These screens operate in the same manner as the cost screens described in Chapter 5.

Replacement costs are those costs incurred by replacing equipment that has worn out during operation. Since replacement costs do not occur each year of operation, they are not recurring costs. This window not only asks for the replacement cost, but also for the number of years between replacement.

The terminal value is the value of the equipment after it is no longer needed to implement the alternative. A positive terminal value implies that the equipment is still useful and may be either sold to outside buyers or used in a different capacity. A negative terminal value implies that the equipment is useless, and some cost is incurred to remove it from the installation.

## **Operations & Maintenance Cost Screens**

In the Operations and Maintenance menu option, there are two cost screens: Labor Calculations and Annual Recurring Costs. The Labor Calculations screen is a worksheet that aids in calculating the labor costs for an alternative. The value calculated here appears in the Annual Recurring Cost Screen in the labor field. If the total labor cost for the alternative is known, then these costs can be entered directly into the Annual Recurring Cost screen and there is no need to use the labor calculation screen.

**NOTE:** If several labor totals are created in the labor screen and the Recurring Cost Screen is entered each time the new labor total is created, it may be necessary to install the new labor total into the Recurring Cost Screen by using the 'F8' key. This is the only place where this restoring problem can occur. In all other cases, values are automatically updated when a screen is entered.

The Annual Recurring Costs screen displays costs incurred during each year of operation, including the total labor cost that was calculated on the previous screen. Common entries for annual recurring costs include electricity, labor, equipment, and transportation expenses. Both of these screens operate in the same manner as the cost screens described in Chapter 5.

## 7 COMPARISONS

The comparison option allows you to evaluate different alternatives to determine which is more cost-effective. There are two types of comparisons in the CEAMHW program: coarse and detailed. The coarse comparison displays up to six different alternatives along with their respective investment costs, O&M costs, net present value (NPV) of investment, and NPV of O&M. The detailed comparison displays a closer comparison between two specific alternatives, including a yearly breakdown of costs, the savings-to-investment ratio (SIR), discounted payback period (DPP), and uniform annual cost (UAC).

The coarse comparison is used mainly to select alternatives for a detailed comparison. After looking at the costs provided by the coarse comparison, select the first alternative by using the arrow keys to highlight the alternative and press <ENTER>. A box will appear at the bottom of the screen displaying the alternative that has been selected. When both alternatives have been chosen, the detailed comparison can be initiated by typing <CTRL-ENTER>. It may take a few seconds for the data to be prepared. The detailed comparison screen will consist of a small window that displays the more costly alternative, overlapping a large window that displays the less expensive of the two. It is important to note that the order in which the two alternatives are chosen is unimportant; the less expensive of the two will automatically be placed in the large window.

To view all of the information in these two windows, use the <F5> key to toggle between the windows, and the <PG UP> and <PG DN> keys to see the entire contents of each window. Pressing the toggle key will bring the big window (for the other, less costly alternative) to the front of the screen. If it is pressed again, the smaller window will return to the foreground. The information at the bottom of the larger window includes: the DPP, SIR, and, where appropriate, the UAC. Below these data, a small explanation describing the results will appear. For example, if both the investment costs and the O&M costs are lower for one alternative than the other, then that alternative is obviously less costly before even beginning operation. A detailed help window providing information on the figures as well as other general economic information is available by pressing the <F1> key.

The Comparison option is available at a lower level (inside a specific waste minimization technique), and at a higher level (before a minimization technique has been selected). Both of these levels lead to the coarse comparison screen. At the lower level, all of the alternatives that have been explored in the minimization technique are provided to the coarse comparison screen. At the higher level, however, you must select the alternatives via menus similar to those originally used to input each alternative's costs. As each alternative is selected on the menu, a window will appear to the right of the screen displaying the alternatives that have been selected. Up to six different alternatives can be chosen in this way. When the last desired alternative has been selected, choose the comparison option from the bottom of the menu. This will initiate a coarse comparison between these alternatives that, in turn, can lead to a detailed comparison.

## 8 PRINTING

To make paper copies of a CEAMHW analysis, two methods of printing information have been provided: the function print key <F4>, and the print menu selection. When function key <F4> is pressed, the currently active window will be sent, in its entirety, to the printer. This option is particularly useful for obtaining a copy of a comparison or totals window.

The Print menu option is used for printing to a file information about one or more alternatives. This information can then be printed out on paper using the DOS PRINT command. When the Print option is selected from the menu, a series of menus similar to those originally used to define the alternative will guide you in selecting alternatives to print. A window will appear to the right of the screen, displaying the alternatives that have been selected. This format is the same for the high-level comparisons selection routine, except that the print option has no limit to the number of alternatives chosen. When the last alternative has been selected, choose the Print option from the bottom of the menu. This will bring up a screen that asks for a file name for the printable file. A .PRT (PRinT) extension will automatically be added to the end of the file name given, so do not include an extension. Files created by the print option may become quite lengthy, so try to minimize the number of alternatives printed in one file. The newly created file will include:

- 1 ) Table of contents
- 2 ) Problem information
- 3 ) Alternative information for each alternative
- 4 ) R&D costs
- 5 ) Investment costs
- 6 ) O&M costs
- 7 ) Totals.

The most common use of the Print option is to generate a complete analysis of two alternatives. To print all of the appropriate information, the Print menu option can be used to print the detailed costs of each alternative, and then the <F4> key can be used to print the comparison between the two. An example follows.

Suppose you want to print a complete analysis of two alternatives. You choose the Print option and follow the correct menu paths to these two alternatives. After the second alternative is chosen, you move the selection bar to the Print option at the bottom of the menu and press <ENTER>. A window appears asking for a file name. You type LEAK, knowing that the .PRT extension will be automatically added. Now that a file has been created, you decide to print the comparison screens. You use the Comparison menu option to select the two alternatives again. When the detailed comparison appears, you press <F4> to print the small comparison window. While this window is printing, you press <F5> to toggle to the larger window. You then press <F4> once again to print the big window. Now that the comparison windows have been printed, you can leave the CEAMHW program and use the DOS PRINT command to print the file created with the Print option.

First, you must move into the appropriate waste stream's data directory. For example, if the alternatives printed were from the General model and the directory structure has not been changed, you would type:

```
CD \wastes\general <ENTER>
```

You then type the following to print the file:

```
PRINT leak.prt <ENTER>
```

You now have all of the cost information about the two alternatives and the detailed comparison on paper.

## 9 TUTORIAL

To clarify the instructions in Chapters 2 through 8, a detailed example is provided for entering two alternatives, comparing them, and printing the results. To benefit fully from the tutorial, you should perform all of the actions yourself.

To run the program, move to the startup directory (wastes) using the DOS CD command. Now, type CEAMHW to begin the program. A menu will appear that looks like this:

|                 |
|-----------------|
| Waste Types     |
| Solvents        |
| Paint Stripping |
| Metal Plating   |
| IWTP Sludges    |
| Used Oil        |
| Batteries       |
| General Model   |
| Setup           |
| Quit            |

This example involves the problem of reducing the cost of distilling PD-680 solvents. Since this is a solvents problem, choose the Solvents option from the main menu. A box containing the following message will appear:

|                                           |
|-------------------------------------------|
| Reading<br>\\wastes\solvents\solvents.def |
|-------------------------------------------|

When the file has been read completely, the defaults will have been loaded and the box will disappear. The following menu will then appear:

|             |
|-------------|
| File Menu   |
| New Problem |
| Defaults    |

This is the solvents file menu. Since you are beginning a new problem, the defaults should be checked to see if any need to be updated. Select the Defaults option, and look at the first page.

Since the only default that you are going to change is on page 14, press the <PG DN> key to reach that page. The page should look like this:

| Assumptions window           |                            |
|------------------------------|----------------------------|
| Defaults window page: 14     |                            |
| Utilities - Cost Per Unit    |                            |
| Electricity                  | (\$0.05 per kilowatt hour) |
| Cooling Water                | (\$0.70 per 1,000 gallons) |
| Diesel Fuel                  | (\$1.45 per gallon)        |
| Natural Gas                  | (\$0.27 per therm)         |
|                              | (\$2.65 / 1,000,000 Btu's) |
| Utilities, Usage Per Process |                            |
| Electricity:                 |                            |
| Vapor degreasing             | (30,000 kilowatt hrs / yr) |
| Aqueous cleaners             | (25,000 kilowatt hrs / yr) |
| 15-gal still                 | (2.2 kilowatt / hr)        |
| 55-gal still                 | (7.7 kilowatt / hr)        |
| 110-gal still                | (12.2 kilowatt / hr)       |
| 250-gal still                | (16.1 kilowatt / hr)       |
| 360-gal still                | (28.3 kilowatt / hr)       |
| 500-gal still                | (32.2 kilowatt / hr)       |

The value you will change is the electricity cost. The current value is \$0.050 per kilowatt hour. For this example, change it to \$0.055 by using the arrow keys to move the cursor to that field and typing .055. Now, press <ENTER> and go through the rest of the defaults to see if anything else needs to be updated. For this example, no other defaults need updating, so you can leave the defaults window by pressing <CTL-ENTER> to save the changes. This will take us back to the File menu. If it is necessary to prove to yourself that the values were saved, reenter the Defaults option and check that the value was modified.

Next, the problem must be defined. Since no work has been done previously on this problem, select the New Problem option. This will cause the following menu to appear:

| SOLVENTS                                                            |
|---------------------------------------------------------------------|
| PD-680/Mineral Spirits                                              |
| Xylene                                                              |
| Toluene                                                             |
| Trichloroethylene                                                   |
| 1,1,1-Trichloroethane                                               |
| For analysis of solvents not listed<br>please use the General Model |

This menu asks for the type of solvent you are using. In this example, you will explore PD-680/Mineral Spirits costs, so choose this option and press <ENTER>. The Waste Minimization Technique Menu should now appear:

|                               |  |
|-------------------------------|--|
| Cleaning with Mineral Spirits |  |
| Solvents Problem Info.        |  |
| Source Reduction              |  |
| Recovery/Reuse                |  |
| Treatment                     |  |
| Comparison                    |  |
| Print                         |  |

The first option in this menu to be explored is Solvents Problem Info. Problem Information should always be entered first because it affects many calculations in the cost screens.

|                                                                                                   |   |
|---------------------------------------------------------------------------------------------------|---|
| Solvents Waste Information                                                                        |   |
| Please type the amount of solvents used annually                                                  | 0 |
| Please type the amount of waste produced annually                                                 | 0 |
| Are the wastes to be produced considered Hazardous or Nonhazardous?                               |   |
| <p>REMINDER: The values entered on this screen affect future calculations for default values!</p> |   |

This screen is unique to the solvents waste stream. The first value requested is the amount of solvents used annually. For this example, type 91,300 and press <ENTER>. A selection box will appear asking whether the value is in gallons or pounds. Since this value is in gallons, press <ENTER> to choose the highlighted gallons choice (if pounds were the desired unit, the <END> key would be used to highlight that choice, and the <HOME> key would be used to move back to the gallons unit). A number should now appear in the next input field. This number was calculated by a default calculation. The value is 63,910 gal and represents the amount of waste produced by using 91,300 gallons of PD-680 in a year. Since this value is reasonable, pass it by pressing <ENTER>, and press <ENTER> again to select gallons as the unit. The only item left to enter now is whether the wastes produced are hazardous or non hazardous. For this example, assume that the wastes produced are hazardous, so press <ENTER> on the highlighted Hazardous choice. To exit this screen, type <CTRL-ENTER> to save the values.

You will now be back at the Waste Minimization Technique menu. Note that the Source Reduction technique cannot be selected for PD-680 solvents because no source reduction methods apply to this solvent.

Now you need to choose your waste minimization technique. For this example, two types of distillation are going to be compared: onsite and offsite. Distillation is a type of recovery/reuse technique, so use the arrow keys to choose the Recovery/Reuse option, and press <ENTER>. This brings up a new menu:

|                                   |
|-----------------------------------|
| Recovery/Reuse of Mineral Spirits |
| Onsite Centralized Distillation   |
| Full Service Contractor           |
| Other Recovery/Reuse #1           |
| Other Recovery/Reuse #2           |
| Comparison                        |

The first option in this menu is Onsite Centralized Distillation, which is the first of your two options. Select this option to call the following menu:

|                          |
|--------------------------|
| Onsite Distillation      |
| Alternative Information  |
| Research & Development   |
| Investment Costs         |
| Operations & Maintenance |
| Totals                   |

Now you need to enter information about a specific alternative. The first thing to enter is the alternative information. Choose the Alternative Information menu option, and then choose Page One from the small menu that appears.

**INFORMATION**

Please type the economic life of equipment to be used in NPV calculations  
0

Please type the years of Research & Development required  
before the alternative is implemented 0

Please type the number of years over which nonrecurring costs are present  
0

Please type the year in which recurring (O & M) costs begin 0

In the upper left-hand corner, the word **INFORMATION** appears, and is currently highlighted. Pressing <F1> when this word is highlighted will open a help window describing the current alternative. You will notice that default values for all of the input fields appear. These values are as follows:

Economic Life = 10 years

R&D Years = 0

Investment Years = 1

Recurring Costs Begin in Year 2

For this example, you will keep these defaults, so type <CTRL-ENTER> to exit the screen while storing the data. This will take you back to the Alternative Information menu. Now choose Page Two to reach the following page:

Desired still backup capacity : 10.00 %

Still bottoms are considered to be Hazardous or Nonhazardous

**REMINDER:** The values entered on this screen affect future calculations  
for default values!

Once again, the first default value is correct, so press <DN ARROW> to skip it and enter whether the still bottoms are hazardous or nonhazardous. Since they are hazardous, press <ENTER> to select the highlighted Hazardous option, and <CTRL-ENTER> to exit the screen. A

warning window will appear concerning the effects of a change made in this window and its impact on default calculations in the cost screens. If you intend for these changes to affect those calculations, the cost screen must be reentered to recalculate the necessary values. Since the cost screens have not yet been entered, this warning message can be ignored. Press any key to exit the warning window, and press <ESC> to leave the Information Menu. Since distillation is a common process, no R&D costs should be incurred, so you can ignore this choice and proceed directly with investment costs. Upon choosing the Investment Costs option, the Investment Menu should appear:

|                   |
|-------------------|
| Investment costs  |
| Year One          |
| Year Two          |
| Replacement Costs |
| Terminal Value    |

Since only one year of investment costs were chosen in the Alternative Information Screen, choose the Year One menu option.

| Investment Costs Year - 1           |              |
|-------------------------------------|--------------|
| Major Equipment                     | \$88,600.00  |
| Storage Tanks                       | \$0.00       |
| Feed Lines                          | \$0.00       |
| HW Handling Equipment               | \$0.00       |
| Freight/Shipping                    | \$0.00       |
| <hr/>                               |              |
| Subtotal-Equipment costs:           | \$88,600.00  |
| Property Acquisition                | \$0.00       |
| Site Preparation and Installation   | \$13,290.00  |
| <hr/>                               |              |
| Subtotal-Installed Equipment Costs: | \$101,890.00 |
| Other Investment Costs(\$/year):    |              |
| Startup Expenses                    | \$132,385.00 |
| One-time Personnel                  | \$0.00       |
| Permit Fees                         | \$0.00       |
| Logistics & Procurement             | \$7,132.30   |
| Contingencies                       | \$10,189.00  |
| Value of Existing Assets Employed   | \$0.00       |
| Value of Existing Assets Replaced   | \$0.00       |
| <hr/>                               |              |
| Subtotal-Other Investment Costs:    | \$149,706.30 |
| <hr/>                               |              |
| Total-Major Nonrecurring Costs:     | \$251,596.30 |

This screen appears with some defaults already calculated. In this case, the defaults do not agree with your example costs, so you must change them. Enter the following costs in their appropriate fields: \$31,021 for equipment cost, \$200 for storage tanks, \$1000 for freight and shipping, and \$5000 for startup expenses. As these values are entered, other

costs are calculated by the program. These calculated costs are as follows: Subtotal-Equipment Costs is \$32,221.00, Site Preparation and Installation is \$4833.15, Logistics and Procurement is \$2593.79, and Contingencies is \$3705.41. You are now finished with the investment costs for year one, so type <CTRL-ENTER> to exit the screen and store the data.

Since there are no Year Two investment costs, move down to Replacement Costs. Upon selecting this option, the following screen will appear:

| Major Replacement Costs      |          |
|------------------------------|----------|
| Major Replacement Cost:      | \$450.00 |
| Occurs every how many years? | 4        |

These values are defaults and seem reasonable, so press <CTRL-ENTER> to leave this screen while saving the default values. The last investment cost to enter is the Terminal Value. Choose this option and enter \$-1000.00 for the terminal value. This means that it costs about \$1000 to remove the equipment needed for this alternative.

Investment costs are now all complete, so exit the investment menu by pressing <ESC>. We must now enter the O&M costs for this alternative. To do so, choose the operations and maintenance option to bring up the following menu:

| Operations & Maintenance |
|--------------------------|
| Labor Calculations       |
| Recurring Annual Costs   |

The first option in this menu is Labor Calculations. Since we do not know the yearly labor cost, we calculate it using the Labor Calculations option. Choose Labor Calculations to bring up the labor worksheet.

—Annually Recurring Personnel Costs (\$/yr) —

LABORERS:

|                                                   |                          |
|---------------------------------------------------|--------------------------|
| Labor Rate (\$/hr)                                | \$11.00                  |
| # of Personnel per shift                          | 1.00                     |
| Labor time per individual<br>(man hours per year) | 390.56 manhours per year |
| # of shifts per day                               | 1.00 shifts per day      |

Supervisors/Manager

|                                                   |                        |
|---------------------------------------------------|------------------------|
| Labor Rate (\$/hr)                                | \$16.00                |
| # of Personnel per shift                          | 1.00                   |
| Labor time per individual<br>(man hours per year) | 0.00 manhours per year |
| # of shifts per day                               | 0.00 shifts per day    |

|                             |            |
|-----------------------------|------------|
| Subtotal Direct Labor Costs | \$6,904.61 |
|-----------------------------|------------|

When the labor screen appears, some defaults are shown. All of the defaults are correct for our example so we will keep them. The total at the lower right-hand corner of the screen displays the correct total labor cost: \$6,904.61.

Now that you have calculated the yearly labor costs, you need to enter the recurring annual costs. First, type <CTRL-ENTER> to exit the Labor calculation screen and then choose the Recurring Annual Cost menu option.

| Operation & Maintenance Costs (\$/yr) |        |             |
|---------------------------------------|--------|-------------|
| Labor                                 |        | \$6,904.61  |
| Raw Materials/Replacement Materials   |        | \$6,428.94  |
| Maintenance and Repair                |        | \$1,852.70  |
| Liability                             |        | \$335.52    |
| Disposal                              |        | \$6,950.21  |
| Other Materials & Supplies            |        | \$0.00      |
| Sampling/Testing                      |        | \$207.13    |
| Transportation & Warehousing/Storage  |        | \$0.00      |
| Logistics & Procurement               |        | \$473.33    |
| Program Administration                |        | \$0.00      |
| Utilities:                            |        |             |
| Electricity                           | \$0.00 |             |
| Natural Gas                           | \$0.00 |             |
| Water                                 | \$0.00 |             |
| Steam                                 | \$0.00 |             |
| Compressed Air                        | \$0.00 |             |
|                                       |        |             |
| Subtotal-Utilities                    |        | \$0.00      |
| Wastewater Treatment Cost/Savings     |        | \$0.00      |
| Sewer Fees                            |        | \$0.00      |
| Other O & M Costs                     |        | \$0.00      |
|                                       |        |             |
| Total Operation & Maintenance Costs:  |        | \$23,152.44 |

This is the recurring annual cost entry screen. For this example, you need to add an electricity cost. Move down to the electricity field and enter \$1000. Since utilities have a known escalation rate, you will need to escalate this cost. While the cursor is still on \$1000, press <F9>. This will bring up a screen asking for an escalation rate. Enter 4.0% and press <ENTER>. The effects of this escalation will be noticed in the Totals Window, where the costs are shown for each year of operation. Since you are now done with the Operations and Maintenance Costs, type <CTRL-ENTER> to store the values and exit the screen. This returns you to the O&M menu. Since you have explored both options, press <ESC> to return to the previous menu.

You have now entered all of the costs for this alternative and can look at the yearly breakdown of the cost totals. Choose the Totals option to produce the following window:

| Results of Economic Analysis       |      |                |            |               |            |
|------------------------------------|------|----------------|------------|---------------|------------|
| Year                               | R&D  | Net Investment | O&M        | PV Investment | PV O&M     |
| 1                                  | -    | \$ 48,353      | -          | \$ 46,120     | -          |
| 2                                  | -    | -              | \$ 24,192  | -             | \$ 20,977  |
| 3                                  | -    | -              | 24,234     | -             | 19,249     |
| 4                                  | -    | -              | 24,277     | -             | 17,676     |
| 5                                  | -    | 450            | 24,322     | 293           | 16,244     |
| 6                                  | -    | -              | 24,369     | -             | 14,941     |
| 7                                  | -    | -              | 24,417     | -             | 13,755     |
| 8                                  | -    | -              | 24,468     | -             | 12,676     |
| 9                                  | -    | 450            | 24,521     | 200           | 11,676     |
| 10                                 | -    | -              | 24,575     | -             | 10,798     |
| 11                                 | -    | -              | 24,632     | -             | 9,983      |
| 12                                 | -    | 1,000          | -          | 334           | -          |
|                                    | \$ 0 | \$ 50,253      | \$ 244,010 | \$ 46,948     | \$ 147,996 |
| Total Net Present Value: \$194,945 |      |                |            |               |            |

After examining this screen, press <ESC>. You have now entered a complete alternative. It is wise to save your work often, so press <ESC> to move back to the Minimization Technique Menu and press <F2>. A box will appear asking for the problem:

| Saving Problem        |  |
|-----------------------|--|
| Save this problem as: |  |
| Information line:     |  |

At the "Save this problem as" prompt, type TUTOR and press <ENTER>. Now an information line is requested. This line is used to help remind you what type of information is stored in the file. For this problem, the Information line should be: "Data entered during tutorial session". Type this line and press <ENTER>.

The next step is to enter a second alternative to compare with the first. Choose Recovery/Reuse again, and then choose the Full Service Contractor option. This will bring up an alternative menu that you have seen before. Choose the Alternative Information option, and then select Page One. The only field that needs to be changed in this window is the number of years required for nonrecurring costs. It will be zero because all of the overhead will be the contractor's responsibility. Change the value to 0, and press <ENTER>. This will cause the current value for the year that recurring costs begin to be recalculated to one. Since this is correct, type <CTRL-ENTER> to save the values and exit the screen.

This returns us to the Page One/Page Two menu. Choose Page Two to bring a cost screen that looks like this:

Alternative Information Page 2

  

|                                 |        |
|---------------------------------|--------|
| Full-Service Contracting Costs: | \$3.25 |
|---------------------------------|--------|

  

Is there a setup charge for washer parts? (Y/N) ?

  
  

REMINDER: The values entered on this screen affect future calculations for default values!

The contracting costs seem reasonable, so press <ENTER> to store this value. The next input field asks about a setup charge for washers. Press <N> for no and <CTRL-ENTER> to exit and save the window. Once again, the warning message appears concerning the effect that this screen has on future calculations. Since you have not entered any costs for this alternative yet, the message can be ignored. You are now ready to begin entering the costs for the second alternative. Press <ESC> to return to the Full Service Contracting menu. Since there will be no R&D or Investment costs, choose the Operations & Maintenance option. There are also no direct labor costs, so choose the Recurring Annual Costs option. This will bring up the same Recurring Annual Cost Screen, except the default values will be different. The only nonzero entries should be:

|                                     |              |
|-------------------------------------|--------------|
| Raw Materials/Replacement Materials | \$290,725.00 |
| Liability                           | \$2,739.00   |
| Logistics & Procurement             | \$2,739.00   |

To understand how these costs were calculated, position the cursor on the Raw Materials input field and press <F1>. This will open a help screen describing how the value was calculated. Read the help and press <ESC> when you have finished. Since the Materials cost covers the entire contract with the offsite contractor, only the liabilities and contract procurement costs need to be considered. Since these costs have been provided by the program, save the values by typing <CTRL-ENTER>. You have now finished entering the second alternative.

Now it is possible to perform a comparison between the two alternatives. Press <ESC> to return to the Recovery/Reuse menu, and then choose the Comparison option. This will bring up the Coarse Comparison Window:

| Coarse Comparison                                                                                |                     |              |                  |                 |
|--------------------------------------------------------------------------------------------------|---------------------|--------------|------------------|-----------------|
| Alternative                                                                                      | Investment<br>Costs | Costs<br>O&M | PV Inv.<br>Costs | PV O&M<br>Costs |
| <b>RECOVERY/REUSE</b>                                                                            |                     |              |                  |                 |
| Onsite Centralized Dist                                                                          | \$50,253            | \$244,010    | \$46,948         | \$147,996       |
| Full Service Contractor                                                                          | 0                   | 3,022,030    | 0                | 1,948,277       |
| <div> <div>Selected</div> <div>Onsite Centralized Dist      Full Service Contractor</div> </div> |                     |              |                  |                 |

This Coarse Comparison lists all of the Recovery/Reuse alternatives that have been explored. Since only two have been explored, only those two alternative titles appear. To select these two for the detailed comparison, first press <ENTER> when the Onsite Centralized Dist. alternative is highlighted. This will cause a small box titled "Selected" to appear at the bottom of the screen. This box will contain the first alternative that has been selected (namely, Onsite Centralized Dist.). Now, to select the other alternative, use the <DN ARROW> to highlight the Full Service Contractor alternative, and press <ENTER>. This alternative title will also appear in the "Selected" box. To begin the detailed comparison, press <CTRL-ENTER>.

This will bring up two windows that overlap each other. The smaller window is titled "Recovery/Reuse Full Service Contracting", and looks like this:

| Recovery/Reuse |             | Full Service Contracting |                     |
|----------------|-------------|--------------------------|---------------------|
| Year           | R&D         | Net Invest.              | O&M                 |
| 1              | -           | -                        | -                   |
| 2              | -           | -                        | \$ 302,203          |
| 3              | -           | -                        | 302,203             |
| 4              | -           | -                        | 302,203             |
| 5              | -           | -                        | 302,203             |
| 6              | -           | -                        | 302,203             |
| 7              | -           | -                        | 302,203             |
| 8              | -           | -                        | 302,203             |
| 9              | -           | -                        | 302,203             |
| 10             | -           | -                        | 302,203             |
| 11             | -           | -                        | 302,203             |
| 12             | -           | (0)                      | -                   |
|                | <u>\$ 0</u> | <u>\$ 0</u>              | <u>\$ 3,022,030</u> |
|                | =====       | =====                    | =====               |

The larger of the two windows represents the costs/savings for the Onsite Distillation alternative and appears as follows:

| Recovery/Reuse                  |      |             | Onsite Distillation      |              |              |
|---------------------------------|------|-------------|--------------------------|--------------|--------------|
| Year                            | R&D  | Net Invest. | O&M                      | Savings      | PV Savings   |
| 1                               | -    | \$ 48,353   | -                        | -            | -            |
| 2                               | -    | -           | \$ 24,192                | \$ 278,010   | \$ 241,066   |
| 3                               | -    | -           | 24,234                   | 277,968      | 218,972      |
| 4                               | -    | -           | 24,277                   | 277,925      | 198,888      |
| 5                               | -    | 450         | 24,322                   | 277,880      | 180,632      |
| 6                               | -    | -           | 24,369                   | 277,883      | 164,037      |
| 7                               | -    | -           | 24,417                   | 277,785      | 148,952      |
| 8                               | -    | -           | 24,468                   | 277,734      | 135,240      |
| 9                               | -    | 450         | 24,521                   | 277,681      | 122,776      |
| 10                              | -    | -           | 24,575                   | 277,627      | 111,447      |
| 11                              | -    | -           | 24,632                   | 277,570      | 101,148      |
| 12                              | -    | 1,000       | -                        | -            | -            |
|                                 | \$ 0 | \$ 50,253   | \$ 244,010               | \$ 2,778,019 | \$ 1,623,164 |
| Net Present Value of Savings:   |      |             |                          |              |              |
| Recovery/Reuse                  |      |             | Onsite Distillation      |              |              |
| compared to Recovery/Reuse      |      |             | Full Service Contracting |              |              |
|                                 |      |             | \$ 1,623,164             |              |              |
| Net Present Value of Investment |      |             | \$ 46, 948               |              |              |
| Savings to Investment Ratio     |      |             | 34.57                    |              |              |
| Discounted Payback Period       |      |             | 1.21 years               |              |              |

The two windows are overlapped, with the smaller one in the foreground and the larger in the background. The larger window holds information for the less costly alternative: On-site Distillation. To view both alternatives, press <F5> to toggle between the two. Since you also want a paper copy of this analysis, press <F5> to toggle to the smaller window and press <F4> to print it. To obtain a printout of the other alternative, press <F5> to toggle the screens, and then <F4> to print the larger window. Now that you have examined and printed the comparisons, you need to use the Print menu option for a detailed report containing the costs for each alternative. To exit the comparison windows and return to the Recovery/Reuse menu, press <ESC>. Press <ESC> again to get back to the Minimization Technique Menu that contains the Print option. Choose the Print option and a new menu will appear, displaying the waste minimization techniques. Since both alternatives were from the Recovery/Reuse technique, choose this option. Now choose Onsite Centralized Dist. A box will appear on the right of the screen displaying the alternatives that have been selected. The next alternative to be selected should be Full Service Contractor. Since these are the only two alternatives to be

printed, choose the Print option on this same menu to write the data to disk. When the Print option has been chosen, the following window will appear:

Printing Problem

Print this problem to:

Depending on the number of alternatives chosen, this may take a minute.

Type the name "TUTOR" for this file also, and a .PRT extension will be automatically added. A message will appear when the file has been created in the /wastes/solvents directory. The only task left is to exit the program and print the file. To exit the program, press <ESC> to leave the Print menu, and press <ESC> again to return to the main menu. A window asking if you want to exit without saving will appear. Type <N> for no. Now, press <F2> to save the data. Once in the window, press <ENTER> twice to accept the name you previously used to save the file. If doubt ever arises as to whether or not to save a problem, ALWAYS DO! Now that the Problem has been saved, press <ESC> to return to the main menu, and select Quit to exit the program.

Now you are ready to print the file created by the Print option. Use the DOS CD command to move to the \wastes\solvents directory, and use the DOS PRINT command to print the Tutor.prt file.

```
CD \wastes\solvents
PRINT TUTOR.PRT
```

Hopefully, this tutorial has given you some insight into the workings of the CEAMHW program. If there are points in the tutorial you find confusing, please consult the relevant chapter.

## GLOSSARY

**Alternative:** a method of dealing with a particular problem.

**Alternative Information:** includes various costs and time spans for different periods of development, such as the economic life of the equipment.

**Assumptions Window:** holds variables that have assumed values. These assumed values are called defaults.

**<CTRL-ENTER>:** pressing the ENTER key while holding down the CTRL key. Its function is to exit a window while storing any values that have been modified.

**Cursor:** the small flashing dash that indicates where the current input is expected. The cursor is generally manipulated using the arrow keys.

**Data File:** information stored on disk in the form of a file; includes the problem title, problem information, and alternative information and costs for each alternative explored in the problem.

**<ESC>:** a key used to escape from a window without saving any changes, thus restoring the changed values.

**Input Field:** area on the screen that, when highlighted, will accept data from the keyboard. The input data must be terminated with an <ENTER> to be accepted as the new value.

**Menu:** a list of options that can be chosen by using a selection bar. When the <ENTER> key is pressed, the currently highlighted option is followed. A menu option can also be selected by typing the first letter of its name followed by <ENTER>.

**Product Substitution:** is a source reduction technique used for replacement of hazardous materials/products with less hazardous chemicals/products (e.g., substitution of aqueous cleaner for organic hazardous solvents in vapor degreasing).

**Recovery/Reuse:** a hazardous waste minimization technique where a waste is used or reused as an effective substitute for a commercial product. Recycling or reclamation of useful ingredients from a waste is included in this definition.

**Selection Bar:** a highlighted bar that appears in all menus. It highlights the currently active menu selection.

**Setup:** a menu option that allows the user to define directories and file name extensions.

**Status Line:** the last line of the screen. It displays special keys that are currently active for the screen.

**Source Control:** a source reduction technique that employs technology modification to control the amount of wastes generated.

**Source Reduction:** a method of minimizing or eliminating waste generation at the source or within a process.

**Treatment:** destruction or degradation which reduces the volume and/or toxicity with minimal generation of residual hazardous materials.

**Waste Minimization Technique:** a way of reducing the net outflow of hazardous waste effluents or air emissions from a given source or generating process.

**Window:** a rectangular box in the screen outlined with bold faced borders. Windows either accept numerical input or display a message.

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