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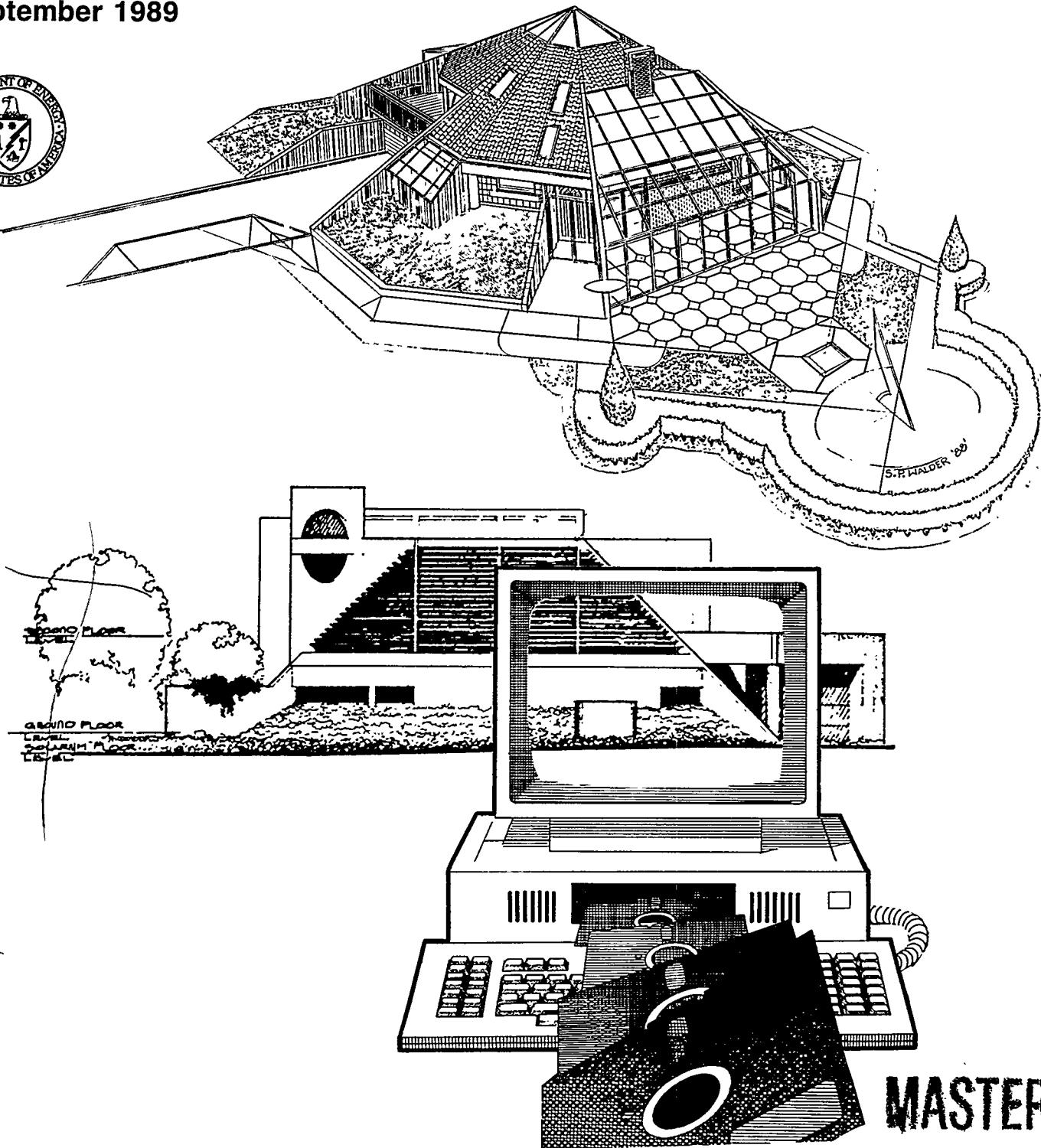
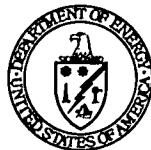
Assistant Secretary

Conservation and Renewable Energy  
Office of Buildings and Community Systems  
Buildings Systems Division

## ARES 1.2—User's Guide (Automated Residential Energy Standard)

In Support of Proposed Interim Energy Conservation Voluntary  
Performance Standards for New Non-Federal Residential Buildings

September 1989





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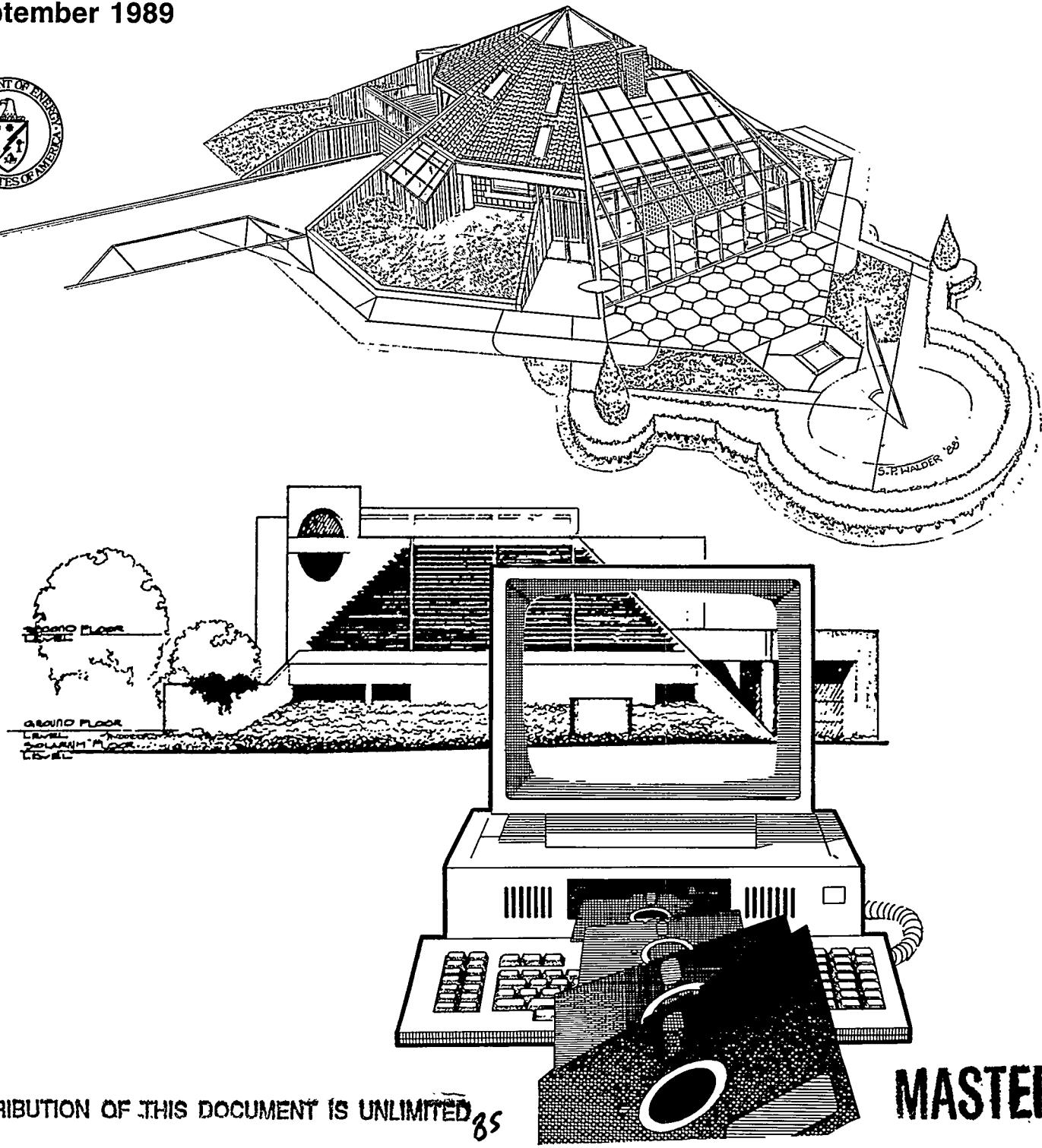
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22

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Faye C. McQuiston (chairman), Oklahoma State University, Stillwater  
M. Emanuel Levy (vice-chairman), The Levy Partnership, New York  
Robert D. Busch, R.D. Busch & Associates, Albuquerque  
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L.M. Holder III, L.M. Holder III, Inc., Austin  
Daniel Hugh Nall, Jones Nall & Davis, Atlanta  
Glen A. Raymond, Carrier Corporation, Syracuse  
Richard Tracy, Ryan Homes, Pittsburgh

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Michael R. Brambley and, previously, Raymond Reilly and Allen Lee served as project manager for the Voluntary Residential Standards Project at Pacific Northwest Laboratory (PNL). Victor Lortz wrote the software which embodies the proposed Standard and was primary author of the accompanying User's Guide. Z. Todd Taylor provided overall guidance and technical support for the analysis of the standard and assisted in preparation of the software User's Guide.

The software for this proposed voluntary standard has been used by the U.S. Department of Housing and Urban Development (HUD) in developing proposed new HUD mandatory standards for new manufactured housing. HUD funded work at PNL that was used jointly in HUD's new standard and in updates to the proposed DOE Voluntary Residential Standard.

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## PREFACE

The Energy Conservation for New Buildings Act of 1976, as amended, 42 U.S.C Section 6831 et. seq. requires the U.S. Department of Energy (DOE) to issue energy conservation standards for the design of new residential and commercial buildings. The standards will be mandatory only for the design of new federal buildings and will serve as voluntary guidelines for the design of new non-federal buildings.

The original recommendations for the non-federal residential standards were produced by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) Special Projects Committee No. 53 under contract to Pacific Northwest Laboratory (PNL). Those recommendations were published in four volumes entitled Recommendations for Energy Conservation Standards for New Residential Buildings. DOE modified the original recommendations to accommodate an optional, more flexible economic analysis procedure. DOE also directed PNL to produce additional technical documentation for the software that embodies the standards and to assess the economic and environmental effects of the standards.

The final standards are documented in six publications in support of the Proposed Interim Energy Conservation Voluntary Performance Standards for New Non-Federal Residential Buildings:

- ARES 1.2 User's Guide (Automated Residential Energy Standard) - Explains the use of the ARES program to develop location-specific energy conservation requirements.
- Technical Support Documentation for the Automated Residential Energy Standard (ARES) - Explains the data and algorithms used by the ARES program to optimize energy-related features of new residences.
- Background to the Development Process for the Automated Residential Energy Standard (ARES) - Explains the background and philosophy of the standard development process.
- Technical Support Documentation for the Automated Residential Energy Standard (ARES) Data Base - Documents the assumptions and procedures used to develop the residential energy consumption data base in ARES.
- Description of the Testing Process for the Automated Residential Energy Standard (ARES) - Describes the process used by the development committee to initially test the ARES computer program.
- Economic Analysis - Describes an assessment of the likely impacts of the new standards on the nation's economy.
- Environmental Assessment - Describes an assessment of the likely impacts of the new standards on new home habitability, on institutions associated with residential construction, and on the economy in general.

## CONTENTS

PREFACE . . . . .	iv
ABOUT THIS GUIDE . . . . .	vii
1.0 INTRODUCTION . . . . .	1
1.1 What ARES Does . . . . .	1
1.2 Overview of How to Run ARES . . . . .	2
1.3 Who to Call for Assistance . . . . .	3
2.0 INSTALLING THE ARES PROGRAM . . . . .	4
2.1 Without the INSTALL Command (For Experienced PC Users) . . . . .	4
2.2 With the INSTALL Command . . . . .	5
2.3 Hardware Requirements . . . . .	6
3.0 USING THE ARES MENUS . . . . .	7
3.1 What is a Menu? . . . . .	8
3.2 Diagram of the Menu System . . . . .	8
3.3 Moving The Cursor . . . . .	9
3.4 Entering Information . . . . .	10
3.5 Performing Operations . . . . .	12
3.6 Obtaining On-Line Help . . . . .	13
3.7 Quitting . . . . .	13
4.0 RUNNING THE ARES PROGRAM . . . . .	14
4.1 Starting the Program . . . . .	14
4.2 Using the Main Menu . . . . .	15
4.3 Creating the Standard . . . . .	16
4.3.1 Retrieving saved inputs: . . . . .	18
4.3.2 Using the Choose Location Menu . . . . .	19
4.3.3 Choosing energy types and prices . . . . .	21
4.3.4 Setting minimum levels (optional) . . . . .	23
4.3.5 Creating packages and points . . . . .	25
4.3.6 Saving the inputs: . . . . .	25



## 1.0 INTRODUCTION

### Contents

- 1.1 What ARES does
- 1.2 Overview of how to run ARES
- 1.3 Who to call for assistance

#### 1.1 What ARES Does

The ARES computer program was designed to assist building code officials in creating a residential energy standard based on local climate and costs.

How the program creates a standard:

The program uses climate data for a selected location, along with economic variables, energy prices, and construction cost information to determine the most economical way to insulate a house from a consumer's viewpoint. Once the program has determined the optimal house, it uses the yearly energy cost of that house as the target energy budget for the Standard. The output of ARES is a set of tables which is used by builders for compliance.

Important:

The program is not intended to be used by builders, and is not a tool for demonstrating compliance with the Standard. It is not possible to enter the dimensions or characteristics of a particular house to this program. However, a builder does use the printed output of this program, along with forms included in the text of the Standard, to demonstrate compliance.

Information you can input to the program:

- climate reference location (described in section 4.3.2)
- housing and foundation types (described in section 4.3.2)
- local fuel prices (described in section 4.3.3)
- minimum ECM levels (described in section 4.3.4)
- current economic factors (described in section 5.1)
- ECM construction costs (described in section 5.2)
- alternative package specifications (described in section 4.4.1).

**Note:**

Defaults for all inputs are provided with the ARES program. These defaults are read each time the program is run. You can change the defaults if you save your inputs with the name "DEFAULTS." Please see section 4.3.6 for further explanation.

**Output of the program:**

- basic prescriptive packages (described in section 6.1)
- alternative prescriptive packages (described in section 6.2)
- point system (described in section 6.3).

## **1.2 Overview of How to Run ARES**

This overview is intended to give you a general idea of how to run the program. More detailed explanations are provided in later chapters of this guide.

- **To start the program**

- 1) Complete the installation procedure (first time only)
- 2) Type ARES at the DOS prompt: C> ARES
- 3) Verify the current date and time
- 4) Wait until the Main Menu appears

- **To set up the inputs**

- 1) Retrieve saved inputs, and/or
- 2) Choose the location
- 3) Select the housing type
- 4) Choose energy types
- 5) Verify or change energy prices
- 6) Set minimum ECM levels (optional)
- 7) Change economic variables (optional)
- 8) Change cost data for ECMs (optional)
- 9) Save the economic and cost data (optional).

- **To generate the point system and basic packages**

- 1) Select the "Create Packages and Points" option
- 2) Wait while the program determines the Standard

- **To create alternative packages**

- 1) Select the "Create Alternative Packages" option
- 2) Choose the package's HVAC system
- 3) Choose an existing package or create a new one
- 4) Specify desired ECM levels
- 5) Select the "Generate Package" option
- 6) Wait while the package is generated

- 7) Save the package
- 8) Exit the Alternative Package Menu and print the output.

- To view the packages before printing
  - 1) Select the "Display Completed Packages" option
  - 2) Highlight the package you want to see and press <Return>
  - 3) Press <Esc> to exit.
- To print the output
  - 1) Choose option "Output to Printer" or "Output to File"
  - 2) Choose to print packages only, points only, or both
  - 3) If saving output to file, choose the file name.
- To quit the program
  - 1) Save inputs (optional)
  - 2) Press <F1> Q from any menu or
  - 3) Press <Return> Q on the Main Menu "Quit" option.

### **1.3 Who to Call for Assistance**

The ARES program is supported by Pacific Northwest Laboratory. If you need assistance, call Pacific Northwest Laboratory, Energy Sciences Department between 8:00 a.m. and 4:00 p.m. (PDT) at the following number: (509)375-3615.

## 2.0 INSTALLING THE ARES PROGRAM

### Contents

2.1 Without the INSTALL Command (For Experienced PC Users)

2.2 With the INSTALL Command

2.3 Hardware Requirements

#### 2.1 Without the INSTALL Command (For Experienced PC Users)

If you are installing ARES on a hard disk, the INSTALL command creates a subdirectory (called \ARES unless you specify another name.) If you are an experienced PC user and want to install the program on your hard disk manually, here is the information you need:

All of the files on the "Program Disk" must be together in a directory. All of the files on the "Data Disk" must be together in a directory. The "Data Disk" files can either be in the same directory as the "Program Disk" files or in a different directory. The same directory is recommended unless disk space limitations require that they be on separate drives.

The "Installation Disk" contains twelve sets of regional cost data files. The cost data files are named so that you can identify the regions. For instance, the set of cost data files for the Southwest region are named "SWEST." The files for the national average are named "NATLAVG." Each set of regional cost data consists of three files, one for each of the ARES housing types. The file name extensions for the cost data files are ".SF" for single-family detached, ".MF" for multifamily attached, and ".MH" for manufactured housing. Only one file, the national average, exists for the manufactured housing costs. Thus, the file "NATLAVG.MH" is used for all regions.

You must copy the three cost data files for one of the regions to the same directory as the "Data Disk" files. Rename the files as you copy them, so that the single-family file is called "SINGLE.DA\$," the multifamily file is called "MULTI.DA\$," and the manufactured housing file is called "MANUF.DA\$."

For example, suppose you have created a directory on your hard disk called C:\PROGRAMS\ARES. Suppose also that you want to use the cost data files for the Southwest region:

- Insert the "Program Disk" into drive A
- *COPY A:.\* C:\PROGRAMS\ARES\*
- Insert the "Data Disk" into drive A
- *COPY A:.\* C:\PROGRAMS\ARES\*
- Insert the "Installation Disk" into drive A
- *COPY A:SWEST.SF C:\PROGRAMS\ARES\SINGLE.DA\$*
- *COPY A:SWEST.MF C:\PROGRAMS\ARES\MULTI.DA\$*
- *COPY A:NATLAVG.MH C:\PROGRAMS\ARES\MANUF.DA\$.*

To run ARES once the installation procedure is completed, set the default directory to the one containing the program files and type *ARES*.

## 2.2 With the INSTALL Command

- **Installation on dual floppies**

- 1) Make backup copies of your ARES disks. This is not required, but it is strongly recommended. To make backup copies of your disks:
  - a) Place the ARES disk into drive A.
  - b) Place a blank, formatted disk into drive B. (Please see your DOS reference manual for information about formatting floppy disks.)
  - c) Type *COPY A:.\*.\* B:* (Press *<Return>*.)
  - d) Perform steps a, b, and c for the ARES disks labeled "Installation Disk," "Program Disk," and "Data Disk."
- 2) Copy the file named *COMMAND.COM* from your DOS disk onto the "Program Disk." This is not required, but it will save you from having to place a disk containing *COMMAND.COM* into drive A when you quit ARES.
  - a) Insert your DOS disk into Drive A
  - b) Insert the disk labeled "Program Disk" into Drive B
  - c) Type *COPY A:COMMAND.COM B:* (press *<Return>*).
- 3) Insert the disk labeled "Installation Disk" into Drive A.
- 4) Type *A:* (press *<Return>*).
- 5) Type *INSTALL* (press *<Return>*).
- 6) Follow the instructions that appear on the screen.
- 7) To run ARES once the installation procedure is completed
  - a) Remove the "Installation Disk" from drive A
  - b) Place the "Program Disk" into drive A
  - c) Place the "Data Disk" into drive B
  - c) Type *ARES* (press *<Return>*).

- **Installation onto a hard disk**

- 1) Insert the disk labeled "Installation Disk" into floppy drive A.
- 2) Type *A:* (press *<Return>*).
- 3) Type *INSTALL C* (If your hard disk drive letter is not C, type your hard disk drive letter instead of C. Notice that you type ONLY the letter of the drive. Do NOT type a ":". Press *<Return>*).
- 4) Follow the instructions that appear on the screen.

- 5) To run ARES once the installation procedure is completed
  - a) remove the "Installation Disk" from drive A.
  - b) type *C:* (If your hard disk drive letter is not C, type your hard disk drive letter instead of the C. Press *<Return>*.)
  - c) type *cd \ARES* (substitute the directory name you selected during installation if it is different from ARES) and press *<Return>*.
  - c) type *ARES* (press *<Return>*).

### **2.3 Hardware Requirements**

- **To run this program you need:**

- 1) an IBM compatible computer that runs MS or PC DOS
- 2) at least 256K bytes of memory
- 3) one of the following:
  - a) two floppy disk drives
  - b) two floppy disk drives and a hard disk
  - b) one floppy disk drive and a hard disk

- **To print the output:**

To print output directly from ARES, your computer must be connected to a printer. If you have no printer, you can direct the output to a disk file and print it later on another computer.

### **3.0 USING THE ARES MENUS**

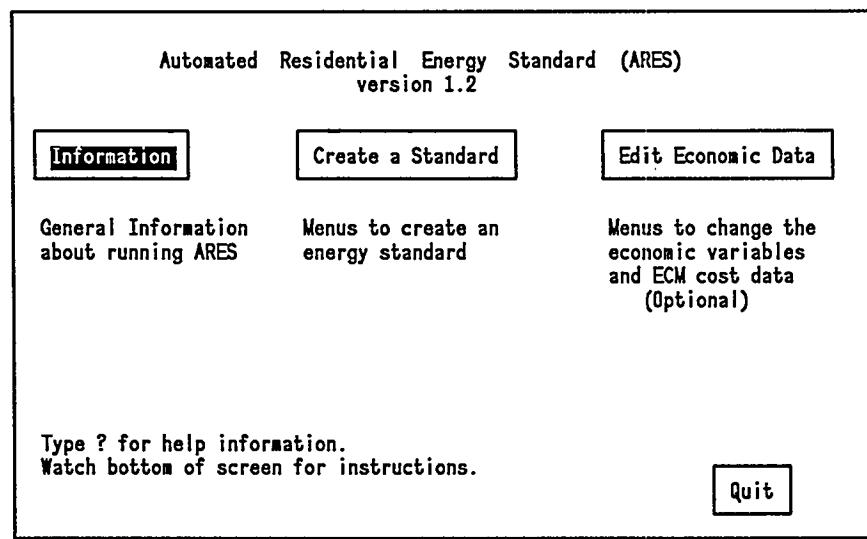
#### **Contents**

- 3.1 What is a Menu?**
- 3.2 Diagram of the Menu System**
- 3.3 Moving the Cursor**
- 3.4 Entering Information**
- 3.5 Performing Operations**
- 3.6 Obtaining On-line Help**
- 3.7 Quitting**

### 3.1 What is a Menu?

A menu is a set of options that appears on the computer screen. Menus allow you to provide information to the computer program and to tell it what you want it to do next.

For example, Figure 3.1 shows the Main Menu for the ARES program. The four options available in this menu are: "Information," "Create a Standard," "Edit Economic Data," and "Quit." To select one of these options, move the cursor to the option and press *<Return>*. Notice that just beneath the menu is an instruction line that tells you what key to press and how to move the cursor to a different option.



Press *<Return>* to select, use Arrows or Tab to move, ? for help.

Figure 3.1. The Main Menu

If you are uncertain about menus, just experiment with running the program and do not worry about making mistakes. Read the instruction line at the bottom of the screen.

### 3.2 Diagram of the Menu System

Figure 3.2 is a map diagramming the ARES menu structure. Study it briefly now and refer back to it when the individual menus are discussed later in this guide. The numbers to the right of the menus in Figure 3.2 are the section numbers in this guide where you can find explanations of the individual menus.

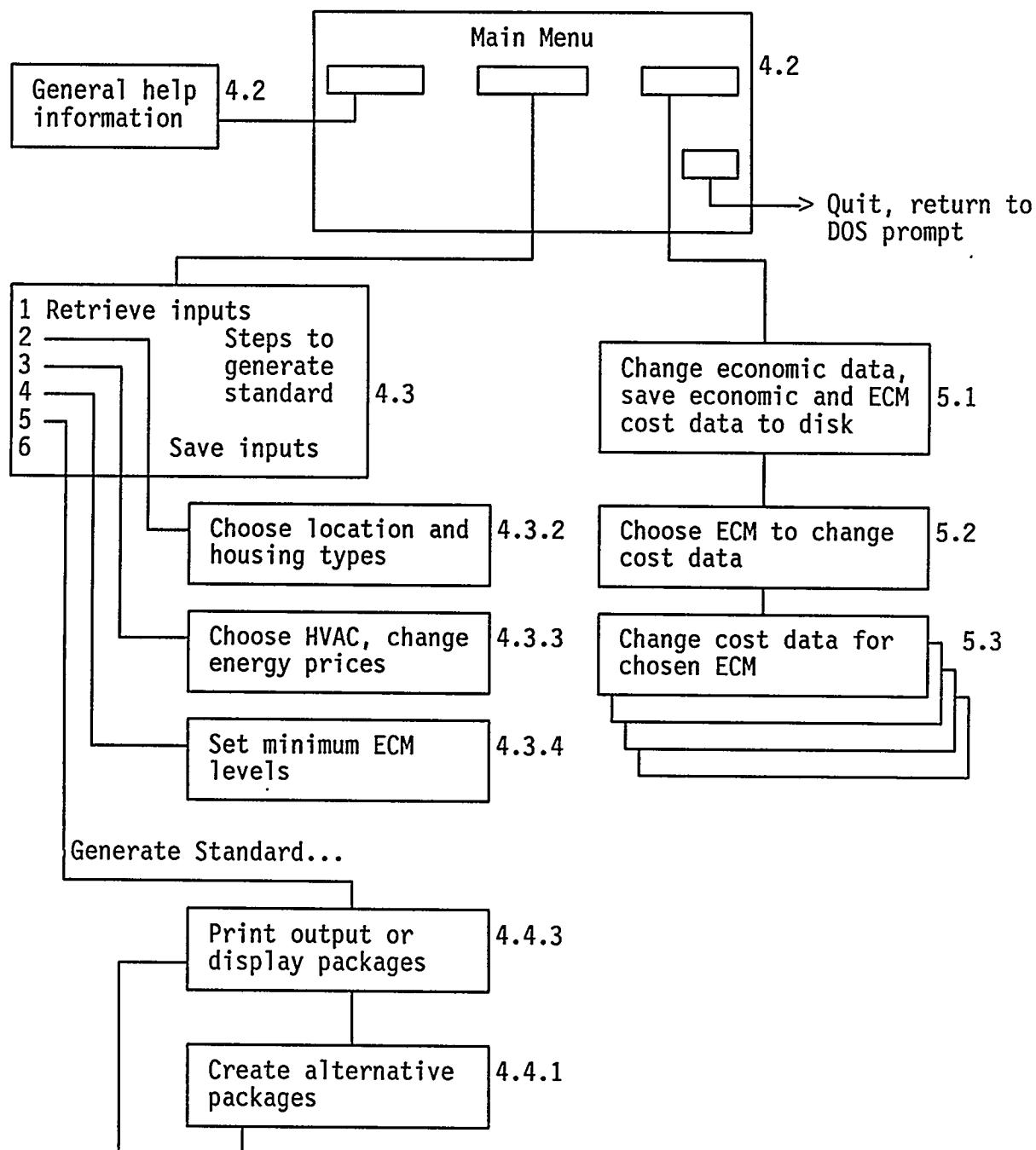


Figure 3.2. Diagram of the Menu System

### 3.3 Moving The Cursor

The cursor is the blinking bar which marks the current position for typing on the computer screen. This section describes how to move the cursor from option to option inside a menu and how to move from menu to menu.

- **Moving the cursor from option to option within a menu**

The cursor will move when you press the tab key, the shifted tab, or one of the arrow keys.

The cursor's position inside a menu is marked by one of the options being highlighted in reverse-video. (Reverse-video means that the color of the letters and the color of the background on the screen are reversed.)

If it is not obvious to you which option is highlighted, press one of the arrow keys or the tab key several times, and watch the changes on the screen.

If you wish to use the arrow keys and they do not seem to work, make sure that the Num Lock feature is set so that the keys work as arrows and not as numbers. Pressing the <Num Lock> key once should fix the problem.

- **Moving from one menu to another menu**

To move from one menu to another, move the cursor to an option which describes the destination menu, and press <Return>. All menus have an EXIT option which will return you to the previous menu. (The EXIT option in the Main Menu is called "Quit," which will stop the program and return you to DOS.)

- **The <Esc> key**

You can also return to the previous menu by pressing the <Esc> key. Pressing <Esc> is often more convenient than using a menu's EXIT option. If you find yourself lost in the menus, press the <Esc> key several times until the Main Menu reappears.

**Exceptions:** The program prevents you from inadvertently exiting some of the menus with the <Esc> key; namely, the Main Menu, the ECM Cost Menu, the Create Energy Standard Menu, and the Alternative Package Menu. In these menus, pressing <Esc> will cause the cursor to move to the EXIT option in the menu. If you are sure you want to exit one of these menus, press <Return> when EXIT is highlighted. This feature prevents accidental loss of data by exiting without saving to disk.

### **3.4 Entering Information**

To enter information in a menu, move the cursor to an input option, and type the appropriate information. When you move to an input option, you will notice that the cursor on the screen moves to the left side of the input field. The input field will be highlighted in reverse-video, and you can only type as much information as will fit in the highlighted input field.

Once you begin to type an input, the arrow keys and escape keys will work in a different manner. The up and down arrow keys will have no effect at all, and the right and left arrow keys will move the cursor within the input field. Pressing the <Esc> key will cause the original contents of the field to be restored, and you can either type the input again or go on to a different input field.

The six different categories of input to the program are described below:

- **Decimal number inputs**

Decimal number inputs are used to type numbers that may contain a decimal. For instance, if the price of electricity is 7.5 cents/Kwh, you can enter this information by moving to the decimal input option corresponding to the price of electricity and typing 0.075. Then press <Return>. If the number has no fractional part, it is not necessary to type the decimal. (Typing 1 is the same as typing 1.0.) Notice that when you begin to type, the number previously in the field disappears. If you want to restore the old contents of the field, press <Esc>. If you make a mistake and do not enter a legitimate number, the program will beep and restore the number that was originally in the field. Re-enter the correct number.

The following message will appear at the bottom of the screen for decimal number inputs:

Type a decimal number, use Arrows or Tab to move, ? for help.

- **Integer number inputs**

Integer number inputs are the same as decimal number inputs, except that they are for whole numbers (0,1,2, etc.). The program will not allow decimal points in integer number inputs.

The following message will appear at the bottom of the screen for integer number inputs:

Type an integer number, use Arrows or Tab to move, ? for help.

- **Text inputs**

Text inputs allow you to enter words or letters to the program. To enter text, move to a text input field, type the information, and press <Return>. Examples of text inputs include the jurisdiction of the Standard and the labels describing the ECM levels.

The following message will appear at the bottom of the screen when you move to a text input field:

Type in text, use Arrows or Tab to move, ? for help.

- **Yes/No inputs**

Yes/No inputs are like toggle switches that are either on or off. You change the "position" of the switch by pressing the space bar when the field is highlighted. Sometimes these inputs say "YES" or "NO" and sometimes they say "ALLOW" or "DISALLOW." For instance, a set of Yes/No inputs are used to determine which of the possible energy types will be included in the current standard.

The following message will appear at the bottom of the screen when you move to a Yes/No input field:

Press space bar to toggle, use Arrows or Tab to move, ? for help.

- **Pop-up menus**

A pop-up menu allows you to select an item from a list. For example, in selecting the climate reference location, you choose a city from a list of cities in a state. The list of cities will be in a pop-up menu that appears after you choose the state and disappears after you select one of the cities.

To select an item in a pop-up menu, use the tab, the up and down arrow keys, or the `<PgUp>` and `<PgDn>` keys to highlight the item of the list that you want to select. Once the desired item is highlighted, press `<Return>` to select it. To exit the pop-up menu without selecting one of the items, press `<Esc>`. Some pop-up menus allow you to perform more options than just selecting the highlighted item. Watch the bottom of the screen for instructions in these menus.

Pop-up menus appear when you move the cursor to an option that describes the pop-up and press `<Return>`. The following message will appear at the bottom of the screen when you move to an option that describes a pop-up:

Press `<Return>` to enter pop-up menu, Arrows or Tab to move, ? for help.

- **Bottom-of-screen inputs**

Bottom-of-screen inputs are questions that appear at the bottom of the screen (outside of the menu). Respond to these questions by typing the appropriate response. For example, when you save the inputs to disk with the same name as an existing disk file, the program asks you with a bottom-of-screen input if you want to overwrite the file.

### **3.5 Performing Operations**

Some options tell ARES to perform a task such as "save inputs" or "send output to a file." To make ARES perform a task, move to the option that describes the task, and press `<Return>`.

The following message will appear at the bottom of the screen when you move to a Perform Operation option:

<Return> to perform, Arrows or Tab to move, ? for help.

### 3.6 Obtaining On-Line Help

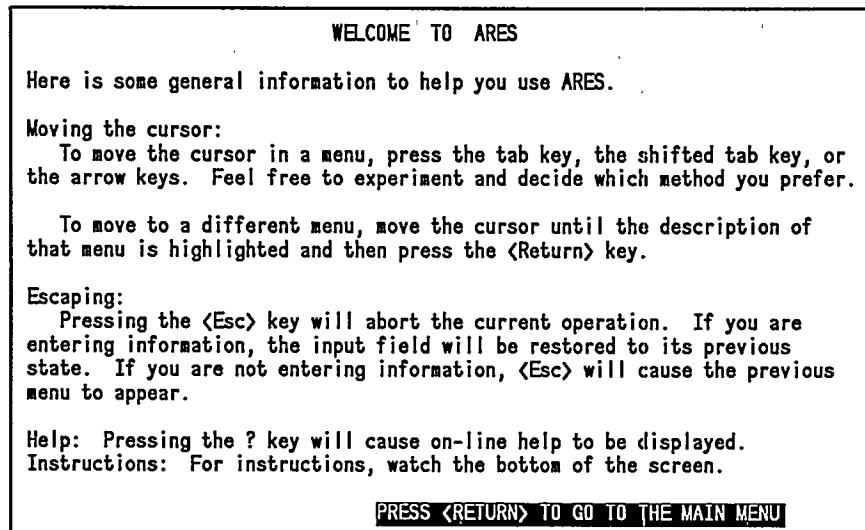
The ARES program provides help information when you press the ? key. The help information is appropriate to the menu option that is currently highlighted. The help information will stay on the screen until you press a key (any letter or the space bar). If more help information is available than will fit on the screen, the information will be displayed one page at a time. To go to the next page of help, press the space bar.

For example, suppose you are not sure what the "Create a Standard" option means on the Main Menu. Move to "Create a Standard" with the arrow keys or tab key and press the ? key. There will be a brief pause while the program finds the help information about this option. Read the help information, and then press any key to continue.

### 3.7 Quitting

To quit and return to the DOS prompt:

- move to the "Quit" option in the Main Menu and press *<Return> Q*
- press the *<F1>* key and then press *Q* in any menu. An alternative to *<F1>* is *<Control Z>*. (Hold down the "Ctrl" key and press "Z")
- to avoid quitting once you have pressed *<F1>* or "Quit", press *R* instead of *Q*.



Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure 4.2. The Information Menu

- To exit and go to the Main Menu:

Press <Return>.

- To go to the Steps to Create Standard Menu:

Move the cursor to the "Create a Standard" option, and press <Return>.

- To go to the Economic and ECM construction cost Menus:

Move the cursor to the "Edit Economic Data" option, and press <Return>.

- To quit:

Move the cursor to the "Quit" option, and press <Return> Q. You will be returned to the DOS prompt. If you press <Esc> in this menu, the cursor will automatically move to the "Quit" option.

#### 4.3 Creating the Standard

When you select the "Create a Standard" option in the Main Menu, the Steps to Create a Standard Menu (Figure 4.3) appears.

The six options in Figure 4.3 labeled Step 1, Step 2, Step 3, Step 4, Step 5, and Step 6 represent the six steps you perform to create the energy Standard. Step 1 retrieves inputs previously saved to disk. When the program starts, it automatically reads inputs from a file called DEFAULTS.PR\$. If you perform Step 1 and choose a different file, the inputs will be retrieved from that file. You can perform steps 2, 3, and 4 in any order. These steps represent the inputs required before creating the packages and points in Step 5. Step

6 allows you to optionally save the inputs to disk. The inputs saved in Step 6 include all of the inputs in the other steps, plus the alternative package specifications and the economic variables (but not the ECM cost data).

When you perform Step 5, ARES creates the basic packages and points based upon all of the inputs. Once the basic packages are created, you can create alternative prescriptive packages (these are optional). Please refer to Section 4.4 for an explanation of alternative packages.

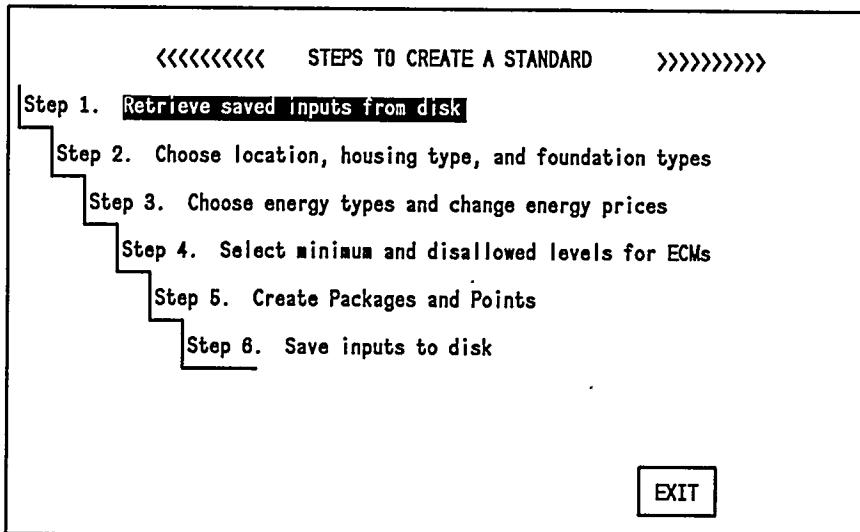


Figure 4.3. The Steps to Create a Standard Menu

- **To retrieve saved inputs from disk:**

Move to Step 1 and press **<Return>**. Section 4.3.1 explains how to retrieve saved inputs.

- **To go to the Choose Location Menu:**

Move to Step 2 and press **<Return>**. Section 4.3.2 explains how to use the Choose Location Menu.

- **To go to the Choose Energy Types Menu:**

Move to Step 3 and press **<Return>**. Section 4.3.3 explains how to use the Choose Energy Types Menu.

- **To go to the Select Minimum and Disallowed Levels Menu:**

Move to Step 4 and press *<Return>*. Section 4.3.4 explains how to use the Select Minimum Levels Menu.

- **To cause the program to create the basic packages and points:**

Move to Step 5 and press *<Return>*. Section 4.3.5 provides further explanation of the "Create Packages and Points" option.

- **To save your inputs to disk:**

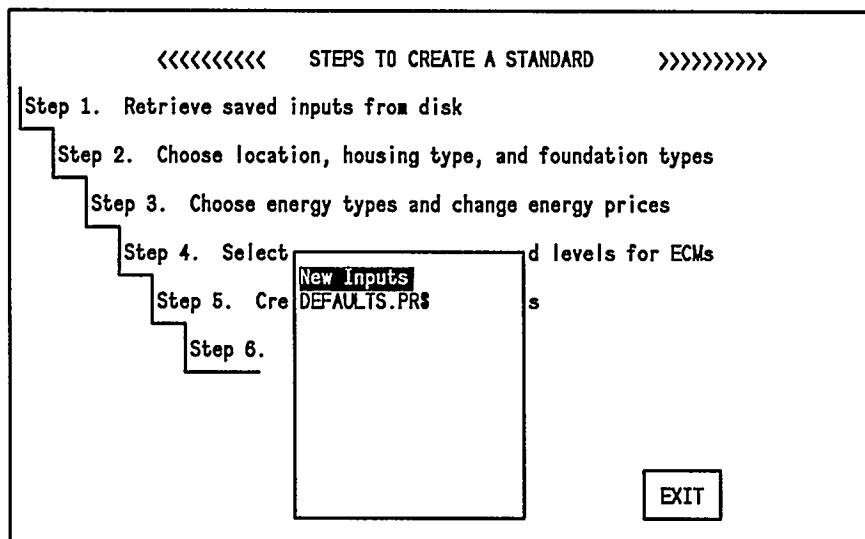
Move to Step 6 and press *<Return>*. Section 4.3.6 provides further explanation of the "Save inputs to disk" option.

- **To exit and go to the Main Menu:**

Move to the "Exit" option and press *<Return>*.

#### 4.3.1 Retrieving saved inputs:

- 1) Move to Step 1 and press *<Return>*. A list of saved input files in a pop-up menu will appear.
- 2) Use the arrow or tab keys to highlight one of the file names.
- 3) Examine the saved comment for the highlighted file (OPTIONAL)
  - a) Press *V* (for "View comment")
  - b) Examine the comment, which will appear at the bottom of the screen
  - c) Press the space bar to continue.
- 4) Delete the highlighted file (OPTIONAL):
  - a) Press *D*
  - b) Press *Y* to verify that you want to delete the file.
- 5) Read in the highlighted input file by pressing *<Return>*. For a new set of inputs, select "New Inputs" instead of a file.
- 6) Exit without doing anything by pressing *<Esc>*.



Use up and down arrows to highlight one of the saved input files  
 Press <Return> to read inputs, V to View comment, D to Delete, <Esc> to exit

Figure 4.4. Retrieving Saved Inputs

Figure 4.4 shows an example of the pop-up menu containing the list of input files. In this example, only the DEFAULTS file is present. However, if you save your inputs to different file names, they will appear in the pop-up menu, as well. If you wish to create a new set of inputs, choose "New Inputs" instead of one of the file names.

#### 4.3.2 Using the Choose Location Menu

When you move to Step 2 in the Steps to Create a Standard Menu and press <Return>, the Choose Location Menu (Figure 4.5) appears. The Choose Location Menu allows you to type the jurisdiction of the Standard, choose the reference location for climate data, and choose the housing type and foundations to be considered.

The jurisdiction will be printed on the program's output. The reference location will not.

Choose the reference location by entering the postal abbreviation for a state (or DC for Washington) and then choosing a city from a pop-up list of cities in the state.

ARES creates an energy standard for one housing type at a time. Select from single-family detached, multifamily attached, or manufactured housing types in this menu.

If you do not want the Standard to include one or more of the defined foundation types, set its Yes/No option to "NO."

<b>&lt;&lt;&lt;&lt; STEP 2. CHOOSE LOCATION, HOUSING TYPE AND FOUNDATIONS &gt;&gt;&gt;&gt;</b>	
Jurisdiction: <b>District of Columbia</b>	
Reference Location	State: DC      City: WASHINGTON
CHOOSE HOUSING TYPE: Single Family	
Foundations to be considered:	
CrawlSpace:	YES
Unheated Basement:	YES
Heated Basement:	YES
Slab on grade:	YES
<b>EXIT</b>	

Type in text, use Arrows or Tab to move, ? for help.

Figure 4.5. Choose Location Menu

- To enter the jurisdiction:
  - 1) Move the cursor to the "Jurisdiction" field
  - 2) Type the jurisdiction of the Standard (this will be printed on the output forms)
  - 3) Press <Return>.
- To choose the energy reference location:
  - 1) Move the cursor to the "State" field
  - 2) Type the two-character postal code of the state in which you want to find a reference location, and press <Return>
  - 3) Wait for a pop-up menu of city names to appear
  - 4) Use the tab, arrows, or PgUp and PgDn to highlight the city you choose
  - 5) Press <Return>.

The name of the chosen city will automatically be displayed on the menu to the right of "City:". The city name will not be printed on the output forms.
- To choose the housing type:
  - 1) Move the cursor to the "CHOOSE HOUSING TYPE" option
  - 2) Press <Return>
  - 3) Use tab or arrow keys in the pop-up menu to highlight the housing type you want to choose
  - 4) Press <Return>.

- To choose which foundations will be included:
  - 1) Move the cursor to the Yes/No fields for the foundations
  - 2) Use the space bar to choose which foundation types will be included in the Standard.

If you include all of the foundation types, the resulting Standard may be slightly different than if you include only some of them. For example, if you create a standard for all foundations and then create another standard with identical inputs except that you include only the slab foundation type, the ECM levels for ceiling, windows and walls in the first standard may differ from those in the second standard. These differences occur because ARES adjusts the non-foundation ECMs so that they fit as accurately as possible all of the included foundations.

Notice that if the current housing type is manufactured, the program automatically sets "Slab on grade," "Basement," and "Unheated Basement" to "NO." If you change from manufactured to one of the other housing types, be sure to change these foundation types to "YES" if you want them to be considered. The program will not automatically reset them to "YES."

- To exit and go to the Steps to Create a Standard Menu:

- 1) Move the cursor to the "EXIT" option
- 2) Press *<Return>*.

#### 4.3.3 Choosing energy types and prices

When you move the cursor to Step 3 in the Steps to Create a Standard Menu and press *<Return>*, the Choose Energy Types and Change Energy Prices Menu (Figure 4.6) appears.

The ARES program will generate separate standards for as many as five different energy/equipment combinations. These five are:

- electric furnace with direct expansion air conditioning
- electric heat pump
- oil furnace or boiler with direct expansion air conditioning
- LPG furnace or boiler with direct expansion air conditioning
- natural gas furnace or boiler with direct expansion air conditioning.

Notice that four different energy sources are included: electricity, oil, LPG, and natural gas.

This menu allows you to decide which of the defined energy types should be included in the Standard. A separate Standard is created for each energy type marked "YES" in this menu. The more energy types included, the longer the program takes to generate the packages and points.

Both electric resistance and heat pump HVAC systems use electricity as their energy source. The menu allows you to individually set electric resistance and

heat pump HVAC systems to "YES" or "NO" if the energy type electricity is set to "YES."

<<<<< STEP 3. CHOOSE ENERGY TYPES AND CHANGE ENERGY PRICES >>>>>						
Energy Type	Include	Unit of Price	Winter	Summer		
Electricity *	<input checked="" type="checkbox"/> YES	(\$/kWh)	0.070	0.070		
Oil	<input type="checkbox"/> NO	(\$/gal)	1.150	-----		
Nat. Gas	<input type="checkbox"/> YES	(\$/therm)	0.550	-----		
LPG	<input type="checkbox"/> NO	(\$/gal)	0.900	-----		

\* Include Electric Resistance heating?  YES  
Include Heat Pump?  YES

EXIT

Press space bar to toggle, use Arrows or Tab to move, ? for help.

Figure 4.6. Choose Energy Types and Change Energy Prices Menu

- **To select the HVAC/fuel types:**

- 1) Move the cursor to the Yes/No fields for the fuels
- 2) Use the space bar to set them as you choose.

If you change the "Electricity" option to "NO," both "Include Electric Resistance" heating and "Include Heat Pump" automatically change to "NO." If you change the "Electricity" option back to "YES," the program will leave both electric resistance and heat pump options set to "NO." You must move the cursor down and individually reset these options in this case. Notice also that if "Electricity" is set to "NO," you will be unable to set either of the electric HVAC systems to "YES."

Regardless of the Yes/No position of "Electricity," the program will use electricity as the fuel for cooling.

- **To change the energy prices:**

- 1) Move to the fields under "Winter" or "Summer"
- 2) Type the appropriate energy prices for those fuels.

Notice that all prices are expressed in dollars, not cents. Also notice there are two electricity prices, one for winter and one for summer. The program uses the summer price for calculating air-conditioning costs regardless of the heating fuel. Therefore, you must enter a summer

electricity price, even if you are not creating a separate standard for electric heating.

Fuel prices often vary as the total amount used per month varies. The price you enter should be the average price for the heating or cooling season, not the marginal price for the highest rate block.

Domestic water heating costs are calculated using the winter fuel prices.

- To exit and go to the Steps to Create Standard Menu:

- 1) Move the cursor to the "EXIT" option
- 2) Press <Return>.

#### 4.3.4 Setting minimum levels (optional)

When you move the cursor to Step 4 in the Steps to Create a Standard Menu and press <Return>, the Minimum Levels Menu (Figure 4.7) appears.

The Minimum Levels Menu allows you to specify minimum efficiency levels for the ECMS so that less efficient levels will not be included in the energy standard.

<<<< STEP 4. SELECT MINIMUM AND DISALLOWED LEVELS FOR ECMS >>>>	
Housing Type: Single Family	
Required Minimum	
Ceiling Insulation:	
Wall Insulation:	
Crawlspac Ins.:	
Unheated Bsmt Ins.:	
Basement Insulation:	
Slab Insulation:	
Window Type:	Minima Specified
Oil Furnace:	
Gas Furnace:	
LPG Furnace:	
Electric Furnace:	
Heat Pump:	
Air Conditioner:	
EXIT	

Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure 4.7a. Minimum Levels Menu

- To set a minimum level for all ECMS except Window Type, Heated Basement, and Slab Insulation:

- 1) Move the cursor to highlight the ECM and press <Return>
- 2) Highlight the desired minimum level in the pop-up that appears
- 3) Press <Return>.

The pop-up menu will list the levels for that ECM in order of energy efficiency.

When you choose a minimum level for an ECM, ARES will not include in the Standard any levels for that ECM that are less energy efficient than the minimum level. Choosing the least efficient level as the minimum causes ARES to include in the Standard all of the levels defined for that ECM. A level is defined if it is present in the ECM's cost data.

One of the items in the pop-up list will be "Do not Specify." Choosing the "Do not Specify" option is functionally the same as choosing the least efficient level in the list, but the name of the level will not appear in the "Required Minimum" column on the menu.

<<<< STEP 4. SELECT MINIMUM AND DISALLOWED LEVELS FOR ECMs >>>>	
Housing Type: Single Family	
Required Minimum	
Ceiling Insulation:	-----
Wall Insulation:	-----
Crawlspac Ins.:	-----
Unheated Bsmnt Ins.:	-----
Basement Insulation:	-----
Slab Insulation:	-----
Window Type:	Minima Specified
Oil Furnace:	-----
Gas Furnace:	-----
LPG Furnace:	-----
Electric Furnace:	-----
Heat Pump:	-----
Air Conditioner:	-----
No specified minimum	
R-11	
R-19	
R-30	
R-38	
R-49	
R-60	

Use up and down arrows to highlight, press <Return> to select, ESC to exit.

Figure 4.7b. Minimum Levels Menu

- To set minimums for Window, Heated Basements, and Slabs:

Window, Basement, and Slab ECMs do not have a single basis upon which to rank the levels. Instead of using the pop-up menu, a menu of Yes/No options for each level will appear.

- 1) Highlight the ECM name and press <Return>
- 2) Use the space bar to individually allow or disallow levels
- 3) Move to Exit in the Yes/No menu and press <Return>

If you have set one or more of the levels to "DISALLOW," the program will display "Minima Specified" in the Required Minimum column for that ECM.

<<< STEP 4. SELECT MINIMUM AND DISALLOWED LEVELS FOR ECMs >>>		
Housing Type: Single Family		
Required Minimum	Minima Specified	
Ceiling Insulation:	Single_w/o_TB	ALLOW
Wall Insulation:	Double_w/o_TB	ALLOW
CrawlSpace Ins.:	Triple_w/o_TB	DISALLOW
Unheated Bsmnt Ins.:	Single_TB	DISALLOW
Basement Insulation:	Double_TB	ALLOW
Slab Insulation:	Triple_TB	ALLOW
Window Type:	Single_Heat_abs	ALLOW
Oil Furnace:	Double_Heat_abs	ALLOW
Gas Furnace:	Triple_Heat_abs	ALLOW
LPG Furnace:	Double_Low-E	ALLOW
Electric Furnace:	Double_Low-E_sun	DISALLOW
Heat Pump:	Triple_Low-E	ALLOW
Air Conditioner:		

Exit

Press space bar to toggle, use Arrows or Tab to move, ? for help.

Figure 4.7c. Minimum Levels Menu

- To exit and go to the Steps to Create Standard Menu:

- 1) Move the cursor to the "EXIT" option
- 2) Press <Return>.

#### 4.3.5 Creating packages and points

When you are satisfied with the economic variables and have made sure that all inputs to the Location, Fuel, and Minimum Levels menus are as you want them, move to the "Create packages and points" option and press <Return>.

ARES will automatically read the climate data for the location you have chosen in the Choose Location Menu and perform the economic analysis to create the Standard. Depending upon how many different heating fuels you allowed in the Choose Energy Types Menu and how fast your computer is, creation of packages and points could take several minutes. A bar chart will move across the bottom of the screen, indicating how close ARES is to completion. Once the program is finished, the Create the Energy Standard Menu will appear.

#### 4.3.6 Saving the inputs:

The "Save inputs" option on the STEPS TO CREATE A STANDARD Menu allows you to save all of the inputs from steps two to five. The economic variables and the ECM cost data are NOT saved when you perform Step 6. To save changes to

the ECM or economic data, use the separate "Save" option on the Change Economic Variables Menu.

Specifications for alternative packages you may have defined in Step 5 will be saved, along with the inputs from steps 2 to 4, but the generated packages (the set of prescriptive requirements) for the alternative packages are not saved.

To save the inputs to disk:

- 1) Move the cursor to the "Save input" option and press <Return>
- 2) Type at most eight characters for the name and <Return>
- 3) Type a comment and <Return>
- 4) Type *Y* to verify that you want to save the inputs.

ARES will automatically append the characters ".PR\$" to the name you type and will save the inputs to the resulting file name. If the name you type already exists on the disk, the program will ask you if you want to overwrite the file. If you respond with "Y", the old file will be erased and the new inputs will be saved. If you respond with "N", the old file will be left untouched and the new inputs will not be saved. In this case, choose a different name and try again. To see which names have already been used, use the "Retrieve saved inputs from disk" option (Step 1) to see the names, and press <Esc> to avoid reading one of them.

If you want the current inputs to be used automatically the next time you run ARES, save the inputs with the name *DEFAULTS*.

When the menu asks you to type a comment, the screen looks like Figure 4.8. (Notice the prompt and the response at the bottom of the menu.)

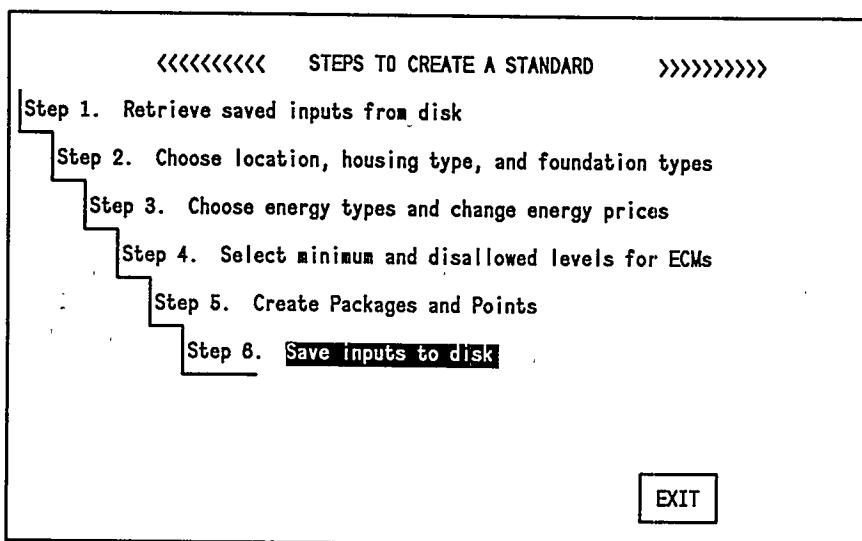


Figure 4.8. Saving a Comment with the Inputs

The comment you type is saved along with the inputs. Comments are intended to help you remember any special information about the inputs. For instance, you may want to type the date and a brief note explaining which inputs you changed since the last time you ran the program.

Each file of inputs requires at least 3,500 bytes of disk space (more if you have created alternative packages). If there is not enough disk space to save the inputs, the program gives you a warning and does not save the inputs.

#### 4.4 Creating Alternative Packages and Printing the Output

After the program has created the energy target, the Create the Energy Standard Menu (Figure 4.9) automatically appears.

This menu can be reached only after the standard generation has been performed in the Steps to Create a Standard Menu. If you exit this menu, you will have to rerun "Create Packages and Points" to return. Furthermore, if you create alternative packages, you must print them before you exit this menu.

Otherwise, only the specifications of the packages will be saved when you return, and you will have to generate the packages again to print them. These limitations are features to ensure the internal consistency of the Standard. Otherwise, it would be possible for alternative packages to be generated using different inputs from those used for the basic packages and the points.

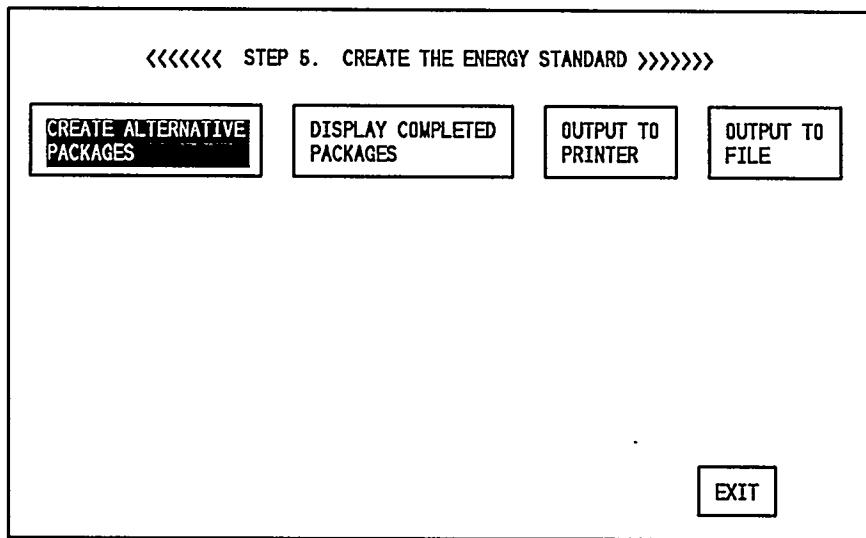


Figure 4.9. Create the Energy Standard Menu

- To create an alternative package:

See section 4.4.1.

- **To delete an alternative package:**
  - 1) Move to the "CREATE ALTERNATIVE PACKAGE" option
  - 2) Press <Return> (a pop-up menu of HVAC equipment appears)
  - 3) Select the HVAC equipment type (a pop-up menu of packages appears)
  - 4) Highlight the package you want to delete
  - 5) Press *D*
  - 6) Press *Y* to verify that you want to delete it
  - 6) Press <Esc> to exit the pop-up menu.
- **To view the packages before printing:**  
See section 4.4.2.
- **To print or save output:**  
See section 4.4.3.
- **To EXIT from this menu:**
  - 1) Move to the "EXIT" option and press <Return>.

**Important:** once you exit, you will have to run the Create Packages and Points option again to return to this menu. This is to ensure that all inputs and outputs are consistent between the standard packages and alternative packages. Therefore, be sure that you really want to exit before you use the "EXIT" option.
- **The <Esc> key in this menu:**

Pressing the <Esc> key while one of the options is highlighted in this menu will move you to the "EXIT" option. The program will not automatically return you to the previous menu. This feature is intended to prevent you from inadvertently exiting the menu and having to run the Create Packages and Points option again to return.

#### 4.4.1 Creating alternative packages

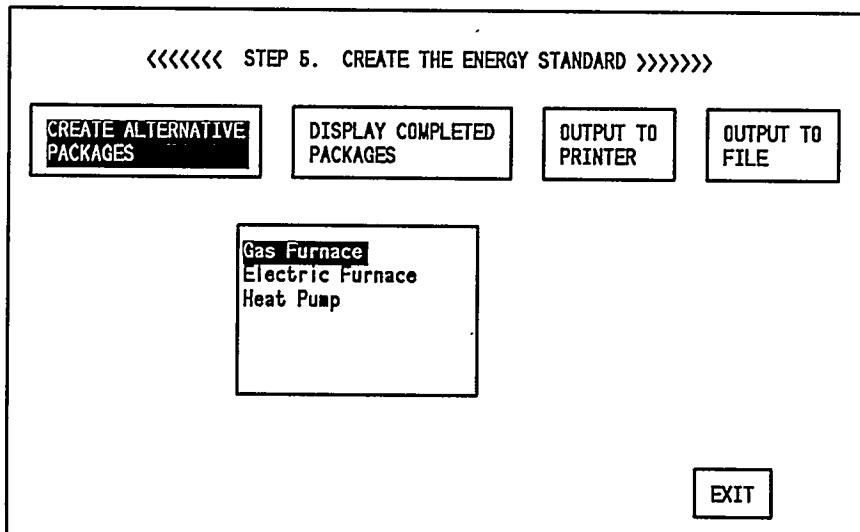
- **To go to the Alternative Package Menu:**

Before you can create an alternative package, you must tell ARES which HVAC equipment type will be used for the package. An alternative package is specific to a particular housing type and equipment type. If you want several similar packages, one for each HVAC equipment type, each must be created individually. Here are the steps necessary to go to the Alternative Package Generation Menu:

- 1) Move to the "CREATE ALTERNATIVE PACKAGES" option
- 2) Press <Return>
- 3) Select the HVAC equipment type (using a pop-up menu that appears)

- 4) Highlight either an existing package or "New package"
- 5) Press <Return>.

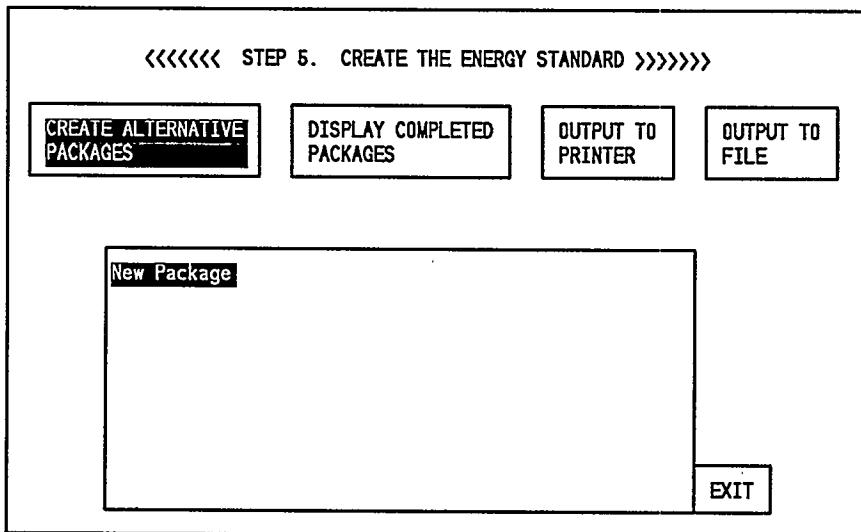
Figure 4.10a shows the pop-up menu that allows you to select the HVAC equipment type.



Highlight equipment type for package. Press <Return> to select, ESC to exit.

Figure 4.10a. Choose the HVAC type for Alternative Package

Once you choose the HVAC equipment type, a pop-up of existing packages appears. If you select the Gas Furnace fuel type, the menu will look like this Figure 4.10b.



Use arrows to highlight, press <Return> to select, (D)elete, or <Esc> to exit

Figure 4.10b. Choose the Alternative Package

- **The Alternative Package Menu:**

Once you have selected a fuel type and optional package name, the Alternative Package Menu (Figure 4.11) appears.

Jurisdiction: District of Columbia	Bldg Type: Single Family Detached
Package Name: New Package	Equipment: Gas Furnace
-----	
Basic Package      Alternative Package      Specifications	
Ceiling:	R-30
Frame Wall:	R-23
Mass Wall:	
Crawlspace:	R-30
Unheated Bsmt:	R-11
Heated Bsmt:	R-6 4ft
Slab Insul:	R-5 2ft
Window Type:	Double w/o TB
Window Area:	12% Max Total 0% Min South
Infiltration:	Normal
Heating Eff:	AFUE 85%
Cooling Eff:	SEER 10
Solar DHW:	
-----	
GENERATE PACKAGE      SAVE PACKAGE      EXIT	

Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure 4.11. Alternative Package Menu

- **Interpreting the Alternative Package Menu:**

At the top of the menu you see:

- 1) The first 30 characters of the jurisdiction and package name
- 2) The current housing and HVAC equipment type.

The Alternative Package Menu contains four columns. They are (left to right):

- 1) The list of ECMS which you can specify in an alternative package
- 2) The basic package generated for the current housing and HVAC type
  - a) This basic package will be printed with the output
  - b) It is possible to examine the basic packages before printing by entering the Alternative Package Menu for that purpose alone
- 3) The generated alternative package (a blank column if not yet generated)
- 4) The list of specifications you make to force the program to choose certain ECM levels.

At the bottom of the menu are options to:

- 1) Generate the specified package
- 2) Save the specifications and/or the generated package
- 3) Exit the menu.

You can specify any combination of different ECM levels to create a prescriptive package customized to your needs. For examples and further explanation, please refer to the remainder of this section.

- **Example: Creating a Gas Furnace package with R-19 walls**

The prescriptive package displayed in the column under "Basic Package" is the package automatically created by the program. This package is the combination of insulation and equipment efficiency which meets the energy budget of the Standard at the least initial cost (determined from the ECM cost data). One or more of the ECM levels in the Basic Package may be unacceptable for some reason, so this menu allows you to select different ECM levels and create an alternative prescriptive package around them.

Suppose that current building practices in the jurisdiction of this example are such that builders would rather have a prescriptive package that requires R-19 instead of R-23 walls.

To Specify an R-19 wall:

- 1) Move the cursor to "Frame Wall"
- 2) Press <Return> (a pop-up of defined frame-wall levels appears)
- 3) Highlight R-19 by using the tab or Down Arrow
- 4) Press <Return>
- 5) Move the cursor to GENERATE PACKAGE

- 6) Press <Return>
- 7) Wait while the bar chart indicates progress.

Once you have completed the above sequence, the menu will look similar to the one shown in Figure 4.15.

Jurisdiction: District of Columbia	Bldg Type: Single Family Detached	
Package Name: New Package	Equipment: Gas Furnace	
<hr/>		
Basic Package	Alternative Package	Specifications
Ceiling: R-30	R-30	
Frame Wall: R-23	R-19	R-19
Mass Wall:		
Crawlspace: R-30	R-30	
Unheated Bsmnt: R-11	R-11	
Heated Bsmnt: R-5 4ft	R-5 4ft	
Slab Insul: R-5 2ft	R-10 2ft	
Window Type: Double w/o TB	DoubTe Low-E	
Window Area: 12% Max Total	12% Max Total	
	0% Min South	0% Min South
Infiltration: Normal	Normal	
Heating Eff: AFUE 85%	AFUE 78%	
Cooling Eff: SEER 10	SEER 10	
Solar DHW:		
<hr/>		
<input type="button" value="GENERATE PACKAGE"/>	<input type="button" value="SAVE PACKAGE"/>	<input type="button" value="EXIT"/>

Press <Return> to perform, use Arrows or Tab to move, ? for help.

Figure 4.15. R-19 Package Generated

Notice that the column under the "Alternative Package" heading is now filled with the generated package level names. The program selected a more energy-efficient window to make up for the lower wall R-value. However, the better window overcompensated for the reduced R-Value, allowing a reduction in the efficiency of the gas furnace.

First assume that you are satisfied with the package and you want to print it.

- 1) Move to SAVE PACKAGE and press <Return>
- 2) Type a name for the package and press <Return>
- 3) Move to EXIT and press <Return>
- 4) Use the "Output to Printer" or "Output to File" option on the Print Output Menu to print packages and/or points. All of the packages, including the basic and alternative package(s), will be printed.

You must name a package to save it, and the name cannot be "New Package." If you type a package name that already exists, the program asks if you want to replace the existing package with the current package. If you type a new name, the program saves the package with the new name.

Note: The generated packages (the levels appearing under the "Alternative Package" column) will be saved only as long as you are in either the Print Output Menu or the Alternative Package Menu. Once you EXIT back to the Steps to Create a Standard Menu, the generated alternative packages are "forgotten" by the program and cannot be printed until they are generated again.

The specifications and names of the packages, however, will be saved until you quit the program. The specifications and names will not be available the next time you run ARES unless you "Save Inputs to Disk" before you quit the program. The "Save Inputs to Disk" option is in the Steps to Create a Standard Menu. See section 4.3 for details.

Now assume you are not satisfied with the Alternative Package:

- 1) Change the specifications for any of the ECMs
- 2) Generate the package
- 3) Save the package when you are satisfied with it
- 4) Exit when you are finished
- 5) Print the packages as described above.

Once you have exited the menu, any packages which you have generated and saved will be printed along with the basic packages in the output.

- **Mass walls:**

You can create a prescriptive package for a house with massive walls by selecting the "Mass Wall:" option in the Alternative Package Menu. To create a mass wall package, you specify the particular mass wall ECM level and generate the package.

- 1) Move the cursor to "Mass Wall:" and press <Return>
- 2) Select the type of mass wall in the pop-up that appears
- 3) Choose one of the levels for that type of wall and press <Return>
- 4) Move the cursor to the "GENERATE PACKAGE" option and press <Return>
- 5) Examine the levels that appear under the "Alternative Package" column
- 6) Save the package:
  - a) move the cursor to "SAVE PACKAGE" and press <Return>
  - b) type a name for the package and press <Return>
- 7) Move to "EXIT" and press <Return>
- 8) Save or print the packages in the Create the Standard Menu (see section 4.4.2 for details).

- **Window area:**

The basic packages are created assuming that the window area of the house is no more than 12% of the gross floor area. Furthermore, none of the window area is required to be on the south in the basic packages. You can create a prescriptive package that allows more or less window area than the basic package and/or that requires some of the window area to

be on the south. Requiring some of the window area to be on the south will have no effect if the housing type is Manufactured.

- 1) Move the cursor to "Window Area:" and press *<Return>*
- 2) Select the total window area as a percent of gross floor area (in the pop-up that appears)
- 3) Select the window area required on the south as a percent of the gross floor area. For instance, if the total window area is 15%, selecting 5% for the south window area will require that one-third of the window area is on the south.
- 4) Move the cursor to the "GENERATE PACKAGE" option and press *<Return>*
- 5) Examine the levels that appear under the "Alternative Package" column
- 6) Save the package:
  - a) move the cursor to "SAVE PACKAGE" and press *<Return>*
  - b) type a name for the package and press *<Return>*
- 7) Move to "EXIT" and press *<Return>*
- 8) Save or print the packages in the Create the Standard Menu (see section 4.4.2 for details).

- **Infiltration:**

The basic packages are created assuming normal infiltration measures. You can create a package requiring stricter infiltration measures by selecting "Tight" in the pop-up that appears when you select the "Infiltration:" option. The definitions of "Normal" and "Tight" infiltration measures are in the text of the Standard. The procedure for creating a tight infiltration package is very similar to that of the R-19 wall in the example above.
- **Solar DHW:**

You can create an alternative package that includes a solar-assisted hot water heater by specifying one of the solar DHW levels. The procedure for creating the package is similar to that of the R-19 wall example.
- **Packages that cannot meet the energy target:**

It is possible to specify the ECM levels such that the program cannot find a package of options that meets the energy target of the Standard. In this case, a warning message appears on the screen, and ARES does not create the package.

#### 4.4.2 Viewing the packages before printing

- 1) Move the cursor to the "DISPLAY COMPLETED PACKAGES" option
- 2) Press *<Return>*
- 3) Choose a package from the list that you want to see
- 4) Press *<Return>*
- 5) Examine the package, which will automatically appear
- 6) Press any key to return to the list of packages
- 7) Choose another package to examine, or press *<Esc>* to exit.

#### 4.4.3 Saving or printing the output

- To send output to printer:
  - 1) Make sure your printer is connected and ready to print
  - 2) Move to the "OUTPUT TO PRINTER" option
  - 3) Press *<Return>*; a pop-up menu automatically appears
    - a) You can choose to print the packages or points or both
    - b) Highlight your choice of what to print, and press *<Return>*.
- To save output to a file:
  - 1) Move to the "OUTPUT TO FILE" option
  - 2) Press *<Return>*; a pop-up menu automatically appears
    - a) You can choose to save packages or points or both
    - b) Highlight your choice of what to save, and press *<Return>*
  - 3) Type the file name (any legal DOS file name) and *<Return>*.

#### 4.5 Quitting

To quit and return to the DOS prompt:

- Move to the "Quit" option in the Main Menu and press *<Return> Q*
- Alternatively, press the *<F1>* key and then press *Q* in any menu. An alternative to *<F1>* is *<Control Z>* (hold down the "Ctrl" key and press "Z")
- To avoid quitting once you have pressed *<F1>* or "Quit," press *R* instead of *Q*.

## 5.0 CHANGING ECONOMIC VARIABLES AND ECM COST DATA (OPTIONAL)

### Contents

- 5.1 Introduction
- 5.2 Economic Variables
- 5.3 Selecting an ECM to Edit Costs and Characteristics
- 5.4 Detailed Explanation of ECM Cost Data
  - 5.4.1 Framed, Insulated Assemblies
  - 5.4.2 Mass Walls
  - 5.4.3 Perimeter Insulation
  - 5.4.4 Windows
  - 5.4.5 Fossil Fueled Furnaces
  - 5.4.6 Electric Furnaces
  - 5.4.7 Air Conditioners
  - 5.4.8 Heat Pumps
  - 5.4.9 Hot Water Heaters

### 5.1 Introduction

To determine the energy-conservation measures that are economically justified in your location, the ARES program needs some information from you. Specifically, it needs to know the prices of various fuels in your location, some information about the general economic conditions, and the costs of various conservation options.

The ARES program has "default" values for all these inputs. If you are satisfied with these, there is no need to change them. If any of them are unreasonable for your location, you are well-advised to modify the values in the program.

There are two economic methodologies to choose from. The first method assumes a homebuyer lives in a house for seven years, then sells it. All costs and benefits resulting from various ECMs are calculated over that seven-year period. The second method, an extended life cycle cost analysis, allows you to determine the number of years included in the analysis.

This chapter shows you where and how you can change the inputs and explains the meaning of each value.

### 5.2 Economic Variables

To properly determine what conservation options are cost effective, the ARES program needs information about general economic conditions. The energy standard generated for your location will be based only on those ECM levels that are good investments for the typical homeowner. By default, ARES uses a 7-year life cycle cost analysis to determine which ECMs are cost effective.

The 7-year period of analysis is intended to approximate the typical length of time the initial owner occupies a house. If local data suggest a longer period should be used, an alternative economic methodology is available to accommodate this. Figure 5.1 is the menu that contains the economic variables.

<b>&lt;&lt;&lt;&lt;&lt; CHANGE ECONOMIC VARIABLES OR GO TO ECM COST MENUS &gt;&gt;&gt;&gt;&gt;</b>		
1.	CHOOSE HOUSING TYPE:	Single Family
2.	SELECT ECONOMIC METHOD:	Default 7-year LCC
3.	GO TO ECM COST MENUS	
4.	CHANGE ECONOMIC VARIABLES	
	Inflation Rate	: 4.00 ( percent/yr )
	Alternative Investment Rate	: 5.50 ( percent/yr )
	Property Tax rate	: 1.00 ( percent/yr )
	Income Tax Rate	: 21.00 ( percent/yr )
	Mortgage Interest Rate	: 9.00 ( percent/yr )
	Points	: 1.50 ( percentage )
	Down Payment	: 10.00 ( percentage )
	Loan Fee	: 3.30 ( percentage )
	Term of Loan	: 30 ( years )
Local cost multiplier for ECMs : 1.000		
5.	SAVE ECONOMIC DATA TO DISK ( Current housing type only )	<b>EXIT</b>

Press <Return> to enter pop-up menu, use Arrows or Tab to move, ? for help.

Figure 5.1. Economic Variables Menu

- To choose the current housing type:

- 1) Move to the "CHOOSE HOUSING TYPE" option
- 2) Press <Return>
- 3) Highlight the desired housing type in the pop-up menu
- 4) Press <Return>.

<Return> to enter pop-up menu, Arrows or Tab to move, ? for help.

Notice that the current housing type is displayed on the same line as "CHOOSE HOUSING TYPE".

- To choose economic method:

- 1) Press <Return> when this option is highlighted.
- 2) Select an economic calculation technique from the pop-up menu that appears.

- To go to the EDIT ECM COST DATA Menu:

Press <Return> when this option is highlighted.

- To change the economic variables:
  - 1) Move to the field(s) you want to change
  - 2) Type the new value(s)
  - 3) Press *<Return>*.
- To save the economic and ECM cost data for the current building type:
  - 1) Move to the "SAVE ECONOMIC DATA TO DISK" option
  - 2) Press *<Return>*.

Any changes you make to the economic data will be temporary (they will be in effect during the current session but lost when you quit the program) unless you save the data to disk. If you want the changes you have made to be permanent, be sure to save the economic data to disk before you quit the program. If you save the economic data to disk, the old economic data are replaced by the new data. The program does not save multiple copies of the data.

**Important:** The "Save Economic Data" option saves different inputs from those saved by Step 6 in the Steps to Create a Standard Menu. The "Save Economic Data" option saves inputs from the Change Economic Variables Menu and the menus for changing the ECM cost data. The inputs saved by Step 6 are the specifications for individual standards to be generated.

It is possible to keep many copies of the data saved in Step 6. (Each is saved using a different file name.) In contrast, only one copy of the data for each housing type is saved with the "Save Economic Data" option. If you change the economic data for a housing type and save it to disk (so that it will be used the next time you run ARES), the original economic data for that housing type will be overwritten. If you overwrite the original economic data and then want to use the original data again, you will have to reinstall ARES.

- Pressing *<Return>* when EXIT is highlighted will return you to the Main Menu.
- Here is an explanation of the economic variable inputs:

**Inflation Rate** - Enter the expected overall rate of inflation in consumer prices over the next 7 years. Enter the number as an annual percentage.

**Alternative Investment Rate** - The ARES program considers a particular ECM to be cost effective only if it results in enough energy savings to provide an economic "return" to the homeowner at least equal to what would be available from a typical interest-bearing investment. The alternative investment rate is the annual rate of return (expressed as a percent) available to a typical homeowner who invests his or her money instead of buying conservation options for the home. For example, a typical passbook savings account will earn 5 to 7 percent.

**Property Tax Rate** - Adding conservation features to a home increases its value, which in turn increases property taxes. Enter the typical annual tax rate for your location, expressed as a percent of house value. The program assumes property taxes are income-tax deductible.

**Income Tax Rate** - Because property taxes and interest on home loans are tax deductible, the program needs to know the marginal income-tax bracket of the typical homeowner to properly account for ECM costs. Enter a typical value that includes both federal and state taxes. Express as a percent.

**Mortgage Interest Rate** - Enter the typical annual interest rate available to most home buyers. The program uses this value to properly account for the total cost of buying energy-conservation features. The number entered here should correspond to the loan term and down payment entered below.

**Points** - When obtaining a home mortgage, buyers occasionally "buy down" the interest rate by paying some "up front" interest. The Points, as these payments are called, are often lumped together with other closing costs. They must be singled out here, however, because they are tax deductible. Enter a typical value for your location, expressed as a percent of the loan amount.

**Down Payment** - Enter a typical down payment required to obtain a home loan. Express it as a percent of the value of the home. The number you enter here should correspond to the interest rate and loan term.

**Loan Fee** - Enter typical mortgage closing costs for your location. These costs include appraisal fees, title searches, etc. Express the loan fee as a percent of the loan amount. The loan fee is not tax deductible.

**Term of Loan** - Enter the typical term (in years) of home mortgages in your location. This should correspond to the interest rate and down payment you entered above.

**Lifetime of House** - This option appears on the screen only if the Extended LCC Method was selected for economic tests. It refers to the physical life (years) of the house as a whole. ARES assumes that there is no residual value beyond this period (i.e., its resale value at the end of the Lifetime is zero).

**Period of Analysis** - This option appears on the screen only if the Extended LCC Method was selected for economic tests. It refers to the period over which conservation costs and benefits are evaluated to determine cost effectiveness. The Period of Analysis must be less than or equal to the Lifetime.

**Local Cost Multiplier** - This program allows you to change the assumed costs of purchasing and installing individual energy-conservation options. (See the "Edit ECM Cost Data" option in the screen above.) The local cost multiplier allows you to raise or lower all the costs at once. You might want to do this if your location tends to have higher overall prices than the regional average.

The local cost multiplier can also be used to adjust for overall inflation in construction costs over time. For example, if the cost data were entered in 1987 and overall prices increased 6 percent by 1989, you would enter 1.06 for the local cost multiplier.

### 5.3 Selecting an ECM to Edit Costs and Characteristics

If you select the "Edit ECM Cost Data" option in the menu above, you will be allowed to modify the data base of construction costs. A menu will appear (Figure 5.2) that lists the ECMs for which costs are needed.

<<<<< EDIT COST DATA FOR ECMs >>>>>		
Envelope	HVAC Equipment	Hot Water Heater
Ceiling Insulation	Oil Furnace	Heater Efficiency
Wall Insulation	Gas Furnace	
Mass Wall Ins.	LPG Furnace	
Window Type	Electric Heat	
Crawlspac Ins.	Heat Pump	
Unheated Bsmnt Ins.	Air Conditioner	
Basement Insulation		
Slab Insulation		

EXIT

Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure 5.2. Edit Cost Data for ECMs Menu

- **To choose an ECM to edit:**

- 1) Move to the description of the desired ECM
- 2) Press <Return>.

The Change ECM Cost Data Menu appears (Figure 5.3).

If the current building type is manufactured, several of the ECMs (mass walls, slab insulation, basement insulation, and unheated basement insulation) will disappear from the list of ECMs to edit. These ECMs are not defined in ARES for manufactured homes.

- EXIT will return you to the Change Economic Data Menu.

#### 5.4 Detailed Explanation of ECM Cost Data:

Notice the list of ECMs in Figure 5.2. By moving the cursor to the desired ECM and pressing <Return>, you can modify the costs and other descriptive data for that ECM. For example, for each level of ceiling insulation, you can change the cost per square foot, the U-Value, the annual non-fuel operation and maintenance costs, and the percentage of ceiling installations that fail and require replacement within the first 7 years. This section will discuss the cost and other data for 9 generic groups of ECMs:

- framed, insulated assemblies - includes insulation in ceilings, walls, and floors over crawlspaces or basements
- mass walls - includes masonry and solid wood (log) walls
- perimeter insulation - includes slabs and heated basements
- windows
- fuel-fired furnaces - includes oil, LPG, and natural gas furnaces
- electric furnaces
- air conditioners
- heat pumps
- hot water heaters

##### 5.4.1 Framed, insulated assemblies

Figure 5.3 is the input menu for ceiling insulation. All other framed, insulated ECMs (wall, crawlspace, floor over unheated basement) have identical menus.

Current ECM: Ceiling Insulation		Housing Type: Single Family		
Level	U-Value	First Cost	O&M \$/yr	Fraction Failures
R-11	0.0670	1.26	0.00	0.00
R-19	0.0466	1.37	0.00	0.00
R-30	0.0298	1.53	0.00	0.00
R-38	0.0237	1.85	0.00	0.00
R-49	0.0186	2.01	0.00	0.00
R-60	0.0159	2.19	0.00	0.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

ADD A LEVEL

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.3. Ceiling ECM Cost Menu

The following information applies to all of the ECM cost-editing menus. It will not be repeated for the explanations of the other ECM cost menus.

- **To change the name of a level:**

Move the cursor to the level field and type the new name. For instance, you might change "R-19" to "R-19\_insulation."

- **To change any of the numbers in the menu:**

Move the cursor to the beginning of the appropriate input field, and type the correct number.

- **To delete a level from the list:**

- 1) Move the cursor to the level name
- 2) Press <sup>^</sup>E (hold down the <Ctrl> key and press "E" - the "E" stands for Erase)
- 3) Press <Return>
- 4) Move the cursor to "Keep Changes and Exit Menu"
- 5) Press <Return>.

- To add a level to the list:
  - 1) Move to the "Add a Level" option
  - 2) Press <Return>
  - 3) Type the new level name (the cursor will move to the level name field of the new level)
  - 4) Enter characteristics (efficiency and cost) for the new level
  - 5) Move to "Keep Changes and Exit Menu"
  - 6) Press <Return>.

- To save changes:

Move to "Keep Changes and Exit Menu," and press <Return>.

- To exit without keeping changes:

Move to "Ignore Changes and Exit Menu," and press <Return>.

Note:

Always remember that the changes you make in the cost data will be in effect during the current session of running the program if you use the "Keep Changes and Exit Menu" option. If you want the changes to be in effect the next time you run the program, use the "Save Economic Data to Disk" option on the Change Economic Variables Menu. "Save Economic Data to Disk" will only save the current house type's data to disk, so if you want to change and save the economic data for more than one house type, you must use "Save Economic Data to Disk" separately for each house type you change.

Here are descriptions of all the data you can modify for framed, insulated assemblies:

**Level** - This is simply a label for the defined level. It should be descriptive of the insulation level such as the R-values shown in Figure 5.3). The program does not use the labels; their only purpose is for printing on the output forms.

The "Level" field has the same meaning for all ECMs.

**U-Value** - This is the effective overall conductance (Btu/hr-sf-F) through the component. It should include the effects of framing members, but not subassemblies such as windows, doors, or skylights.

**First Cost** - This is the installed cost (\$/gross square foot) to the consumer. The default costs (the costs that are already there) are intended to be consistent between levels of a single ECM, but may not be correct in an overall sense. For example, if interior finishing costs are identical regardless of the insulation thickness, they might not be included in the default numbers. The important thing is to be sure the cost of each level relative to the other levels is correct.

**O&M** - These are all non-fuel operation and maintenance costs associated with the ECM (\$/year). It is important that the relative O&M costs between levels are correct. If all levels have the same O&M costs, you can just enter zero for all of them.

**Fraction Failures** - This option appears on the screen only if the default 7-year LCC economic method was selected. It is the percentage of installations that fail and require replacement within 7 years. The program uses this number to assign a replacement cost to the ECM based on its probability of failure. Insulation assemblies generally do not fail, so this entry will probably be zero.

**Lifetime** - This option appears on the screen only if the extended LCC economic method was selected. It is the physical life of the individual ECM. ARES uses this to determine how often and when the ECM will require replacement, and to calculate a resale value for the option when the house is sold at the end of the Period of Analysis.

#### 5.4.2 Mass walls

Figure 5.4 is the input menu for masonry and log walls.

Current ECM: Mass Wall		Housing Type: Single Family			
Level	U-Value	Type	First Cost	O&M \$/yr	Fraction Failures
R-0 Medium Wt	0.2955	1.000			
R-5 Medium Wt	0.1355	1.000			
R-10 Medium Wt	0.0807	1.000			
R-15 Medium Wt	0.0576	1.000			
R-30 Medium Wt	0.0309	1.000			
R-0 Heavy Wt	0.2955	2.000			
R-5 Heavy Wt	0.1355	2.000			
R-10 Heavy Wt	0.0807	2.000			
R-15 Heavy Wt	0.0576	2.000			
R-30 Heavy Wt	0.0309	2.000			
6 inch Log	0.1201	3.000			
8 inch Log	0.0925	3.000			
10 inch Log	0.0751	3.000			
12 inch Log	0.0633	3.000			
KEEP CHANGES AND EXIT MENU			ADD A LEVEL		
IGNORE CHANGES AND EXIT MENU					

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.4. Mass Wall ECM Cost Menu

Notice the "First Cost," "O&M," and "Fraction Failures" columns are blank. The program does not do any economic calculations for mass walls, so the costs are not needed. The inputs unique to this menu are described below.

**U-Value** - This is the effective overall conductance of the wall assembly (Btu/hr-sf-F), excluding window and door subassemblies.

**Type** - This refers to the type of material in the wall. Enter one of the following:

- 1 = Medium weight (up to 110 lb/sf) masonry
- 2 = Heavy weight (greater than 110 lb/sf) masonry or
- 3 = Solid wood (logs).

Refer to section 5.4.1 for explanation of the **Level** input and the other options in this menu.

#### 5.4.3 Perimeter Insulation

The input menu for basement wall insulation is shown in Figure 5.5. The slab insulation menu is identical.

Current ECM: Basement Wall Insulation		Housing Type: Single Family		
Level	F-Value	First Cost	O&M \$/yr	Fraction Failures
R-8	1.8460	25.28	0.00	0.00
R-6_4ft	1.3980	27.84	0.00	0.00
R-5_8ft	1.2900	32.48	0.00	0.00
R-10_4ft	1.2650	28.84	0.00	0.00
R-10_8ft	1.1000	36.32	0.00	0.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

Type a decimal number, use Arrows or Tab to move, ? for help.

Figure 5.5. Heated Basement ECM Menu

Because of the complexity of energy calculations involving heat flow through the ground, the program can analyze only a few predefined foundation assemblies. Therefore, you cannot add any levels or change the labels of those that are already defined. The inputs unique to this menu are described below.

**F-Value** - This is the effective, or average, steady-state conductance (Btu/hr-linear foot-F) between the conditioned space and the outdoor air. The program only uses this number to do design load calculations and not energy calculations.

**First Cost** - This is the installed cost (\$/linear foot of perimeter) to the consumer. The default costs (the costs that are already there) are intended to be consistent between levels of a single ECM, but may not be correct in an overall sense. For example, if foundation and soil preparation costs are identical regardless of the insulation thickness, they might not be included in the default numbers. The important thing is to be sure the cost of one level relative to the next lower level is correct.

Refer to section 5.4.1 for explanation of the other options in this menu.

#### 5.4.4 Windows

Figure 5.6 is the input menu for window options.

Current ECM: Window Type			Housing Type: Single Family		
Level	U-Value	Shading Coefficient	First Cost	O&M \$/yr	Fraction Failures
Single_w/o_TB	1.1400	1.000	6.03	0.00	0.00
Double_w/o_TB	0.8200	0.880	7.72	0.00	0.00
Triple_w/o_TB	0.4700	0.740	9.03	0.00	0.00
Single_TB	1.1000	1.000	8.42	0.00	0.00
Double_TB	0.4700	0.880	10.44	0.00	0.00
Triple_TB	0.3700	0.740	12.11	0.00	0.00
Single_Heat_abs	1.1400	0.750	8.90	0.00	0.00
Double_Heat_abs	0.8200	0.680	10.89	0.00	0.00
Triple_Heat_abs	0.4700	0.560	12.44	0.00	0.00
Double_Low-E	0.3200	0.710	11.49	0.00	0.00
Double_Low-E_sun	0.3200	0.380	11.49	0.00	0.00
Triple_Low-E	0.2500	0.600	13.18	0.00	0.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

ADD A LEVEL

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.6. Window ECM Menu

The inputs unique to this menu are:

**U-Value** - This is the effective overall conductance (Btu/hr-sf-F) through the window assembly. It should include the effects of the sash and air films.

**Shading Coefficient** - This is as defined by ASHRAE. A shading coefficient of 1.0 corresponds to clear 1/8" glass. For other glass types, the shading coefficient gives the amount of solar radiation striking the window that eventually becomes heat in the building, relative to what would get in through the standard reference glass. Do not include the effects of draperies or other shading devices.

**First Cost** - This is the installed cost (\$/square foot) to the consumer. The default costs (the costs that are already there) are intended to be consistent between levels, but may not be correct in an overall sense. For example, if installation costs are identical regardless of the number of panes, they might not be included in the default numbers. The important thing is to be sure the cost of each level relative to the others is correct.

Refer to section 5.4.1 for explanation of the other options in this menu.

#### 5.4.5 Fuel-Fired Furnaces

Figure 5.7 is the input menu for gas furnaces. All other fossil fuel-fired furnaces have identical screens.

Current ECM: Gas Furnace		Housing Type: Single Family			
Level	AFUE	Capacity kBtu/hr	First Cost	O&M \$/yr	Fraction Failures
AFUE 78%	78.0000	80.0	660.00	0.00	3.00
AFUE 80%	80.0000	80.0	750.00	0.00	3.00
AFUE 85%	85.0000	80.0	1015.00	0.00	3.00
AFUE 90%	90.0000	80.0	1340.00	0.00	3.00
AFUE 95%	95.0000	80.0	1680.00	0.00	3.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

ADD A LEVEL

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.7. Gas Furnace ECM Menu

The inputs unique to this menu are:

**AFUE** - This is the rated seasonal efficiency of the furnace as determined by standard DOE test procedures. The AFUE of a furnace is available either from the manufacturer's literature or from the Gas Appliance Manufacturer's Association (GAMA) directory.

**Capacity** - This is the maximum heating output of the furnace (kBtu/hr). The capacity must be entered as a reference for the "First Cost". The program assumes the first cost applies to a furnace of the given capacity, and adjusts the cost for other furnace sizes. This lets the program account for possible cost reductions due to smaller heating equipment when a building is very heavily insulated.

**First Cost** - This is the installed cost (\$) to the consumer. The default costs (the costs that are already there) are intended to be consistent between levels, but may not be correct in an overall sense. For example, if installation costs are identical regardless of the furnace efficiency, they might not be included in the default numbers. The important thing is to be sure the cost of each level relative to the others is correct. The "first cost" should be for a furnace of the size given in the "Capacity" column.

Refer to section 5.4.1 for explanation of the other options in this menu.

#### 5.4.6 Electric Furnaces

Figure 5.8 is the input menu for electric resistance heaters.

Current ECM: Electric Furnace		Housing Type: Single Family			
Level	% Eff.	Capacity kBtu/hr	First Cost \$/yr	O&M \$/yr	Fraction Failures
Elec Resistance	95.0000	80.0	634.90	0.00	3.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

ADD A LEVEL

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.8. Electric Furnace ECM Menu

Notice that this menu is very similar to that of the fossil-fueled furnaces. They differ only in:

% Eff. - This is the rated seasonal efficiency of the furnace. This will generally be close to 100%. The efficiency you enter should account for system "inefficiencies" due to fan and other auxiliary energy consumption that does not contribute to heating the air. The efficiency you enter should NOT account for duct losses. The program deals with those separately.

Refer to sections 5.4.1 and 5.4.5 for explanation of the other inputs and the other options in this menu.

#### 5.4.7 Air Conditioners

Figure 5.9 shows the input menu for air conditioners.

Current ECM: Air Conditioner		Housing Type: Single Family			
Level	SEER	Capacity kBtu/hr	First Cost	O&M \$/yr	Fraction Failures
SEER 10	10.0000	38.0	1450.00	0.00	3.00
SEER 11	11.0000	38.0	1900.00	0.00	3.00
SEER 12	12.0000	38.0	2450.00	0.00	3.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

ADD A LEVEL

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.9. Air Conditioner ECM Menu

The inputs unique to this menu are:

SEER - This is the rated seasonal "efficiency" of the air conditioner in units of Btu/W-hr. It is the ratio of total seasonal cooling (Btu) provided by the unit to the total seasonal electricity consumption (W-hr). The SEER of a particular air conditioner is available either from the manufacturer's literature or from the Gas Appliance Manufacturer's Association (GAMA) directory.

**Capacity** - This is the maximum cooling provided by the air conditioner at rated outdoor conditions. It should be entered in units of kBtu/hr. The capacity of air conditioners is generally given in units of tons in the manufacturer's literature. One ton is equivalent to 12 kBtu/hr. The capacity must be entered as a reference for the first cost. The program assumes the first cost applies to an air conditioner of the given capacity, and adjusts the cost for other sizes. This lets the program account for possible cost reductions due to smaller cooling equipment when a building is very heavily insulated or has very little solar gain.

**First Cost** - This is the installed cost (\$) to the consumer. The default costs (the costs that are already there) are intended to be consistent between levels, but may not be correct in an overall sense. For example, if installation costs are identical regardless of the SEER, they might not be included in the default numbers. The important thing is to be sure the cost of each level relative to the others is correct. The "first cost" should be for an air conditioner of the size given in the "Capacity" column.

Refer to section 5.4.1 for explanation of the other inputs and other options in this menu.

#### 5.4.8 Heat pumps

Figure 5.10 shows the input menu for heat pumps.

Current ECM: Heat Pump			Housing Type: Single Family			
Level	SEER	HSPF	Capacity kBtu/hr	First Cost	DM \$/yr	Fraction Failures
SEER 10 HSPF 7.3	10.0000	7.300	36.0	1800.00	0.00	3.00
SEER 11 HSPF 8.5	11.0000	8.500	36.0	2800.00	0.00	3.00
SEER 12 HSPF 9.8	12.0000	9.800	36.0	3600.00	0.00	3.00

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

ADD A LEVEL

Type in text, use Arrows or Tab to move, ? for help.

Figure 5.10. Heat Pump ECM Menu

The inputs you may modify are described below:

**SEER** - This is the rated seasonal cooling "efficiency" of the heat pump in units of Btu/W-hr. It is the ratio of total seasonal cooling (Btu) provided by the unit to the total seasonal electricity consumption (W-hr). The SEER of a particular heat pump is available either from the manufacturer's literature or from the Gas Appliance Manufacturer's Association (GAMA) directory.

**HSPF** - This is the rated seasonal heating "efficiency" of the heat pump in units of Btu/W-hr. It is the ratio of total seasonal cooling (Btu) provided by the unit to the total seasonal electricity consumption (W-hr). The SEER of a particular heat pump is available either from the manufacturer's literature or from the Gas Appliance Manufacturer's Association (GAMA) directory. The HSPF you enter should be representative of heat pumps having the SEER entered in the column to the left. This does not imply that builders will be restricted to using heat pumps with a similarly matching SEER and HSPF.

**Capacity** - This is the maximum COOLING provided by the heat pump at rated outdoor conditions. It should be entered in units of kBtu/hr. The cooling capacity of a heat pump is generally given in units of tons in the manufacturer's literature. One ton is equivalent to 12 kBtu/hr. The capacity must be entered as a reference for the "First Cost". The program assumes the first cost applies to an air conditioner of the given capacity, and adjusts the cost for other sizes. This lets the program account for possible cost reductions due to smaller cooling equipment when a building is very heavily insulated or has very little solar gain.

**First Cost** - This is the installed cost (\$) to the consumer. The default costs (the costs that are already there) are intended to be consistent between levels, but may not be correct in an overall sense. For example, if installation costs are identical regardless of the SEER, they might not be included in the default numbers. The important thing is to be sure the cost of each level relative to the others is correct. The "first cost" should be for an air conditioner of the size given in the "Capacity" column.

Refer to section 5.4.1 for explanation of the other inputs and the other options in this menu.

#### 5.4.9 Hot Water Heaters

Figure 5.11 shows the input menu for domestic hot water heaters.

Current ECM: Hot Water Heater		Housing Type: Single Family	
Level	Energy Factor	Fuel Type	
Federal Minimum Oil	0.4940	1.000	
Federal Minimum Gas	0.5440	2.000	
Federal Minimum LPG	0.5440	3.000	
Federal Minimum Elec	0.9447	4.000	

KEEP CHANGES AND EXIT MENU  
IGNORE CHANGES AND EXIT MENU

Type a decimal number, use Arrows or Tab to move, ? for help.

Figure 5.11. Hot Water Heater ECM Menu

Notice there are only three columns. No costs are needed for hot water heaters. This standard requires only that hot water heaters meet the minimum requirements of the federal appliance standard. The only hot water heater data you can change are the "Energy Factors", which correspond to the federal appliance standard. These must correspond exactly. The ability to modify them is provided to allow easy updating as the appliance standard's requirements change.

## **6.0 INTERPRETING THE OUTPUT**

The energy standard produced by ARES includes prescriptive packages and a point system. ARES automatically creates a basic prescriptive package for each of the included HVAC/fuel combinations. You can create alternative prescriptive packages, which are printed along with the basic packages. ARES automatically creates the point system when it creates the basic packages. A lengthy explanation of the point system is included in the text of the Standard.

When you print the output from the Create the Standard Menu, you can choose to print the packages, points, or both. The points output is lengthy. At least twenty pages will be printed for the points output. The package output is shorter, and its length depends upon if and how many alternative packages you have created.

### **6.1 Basic Prescriptive Packages**

Basic prescriptive packages are sets of R-values and equipment efficiencies that a builder must meet or exceed to demonstrate compliance with the Standard. The basic packages are intended to be conservative. That is, the packages are designed to be more stringent than the average house would need to be if it were using the point system to demonstrate compliance. For example, the "target" energy budget is determined assuming equal window areas on all orientations (north, south, east, and west). However, the basic packages are created assuming a less efficient distribution, with half of the window area on the east and half on the west. The inefficient window distribution in the basic packages causes ARES to select higher ECM efficiencies to make up the difference.

### **6.2 Alternative Prescriptive Packages**

One of the special features of this program is its alternative prescriptive package generator. If you are not satisfied with one or more of the specific ECM levels chosen by ARES as part of the basic packages, you can use the alternative package generator to set those ECMs to more acceptable levels, and then let the ARES choose the rest of the ECMs. ARES will attempt to find the least expensive house that meets the energy budget of the Standard and uses the levels you have specified.

You are encouraged to experiment with the alternative package generator. Alternative packages allow you to try "what if" scenarios (e.g., what if the builder wanted to use R-19 in the ceiling... What level of insulation would have to be used in the rest of the house for compliance?). The alternative packages that you create (and save) will be printed out along with the basic prescriptive packages.

### **6.3 The Point System**

The point system is a flexible method of allowing a builder to trade lower efficiency in one part of the house for higher efficiency in another part, while maintaining equivalence in overall energy efficiency with the

Standard. The point system also allows the builder to receive credit for energy-efficient placement of windows, solar-assisted hot water heaters, and tight infiltration measures. The point system is explained in detail in the text of the standard, and blank point forms are provided in that document. The points output of ARES is a set of tables that a builder uses with the forms from the Standard's text to demonstrate compliance with the Standard.

## APPENDIX - EXAMPLE

This example will help you learn to use the ARES program and verify that your printed output is correct. The example assumes you have installed ARES with the national average cost data files. If you have not yet installed your copy of ARES, see Chapter 2. If you have installed ARES with one of the regional cost data files, you can still work through the example, but the output may be different. If you want to verify your output, reinstall ARES with the national average cost data.

- **Start the ARES program:**

If you have installed ARES on your hard disk:

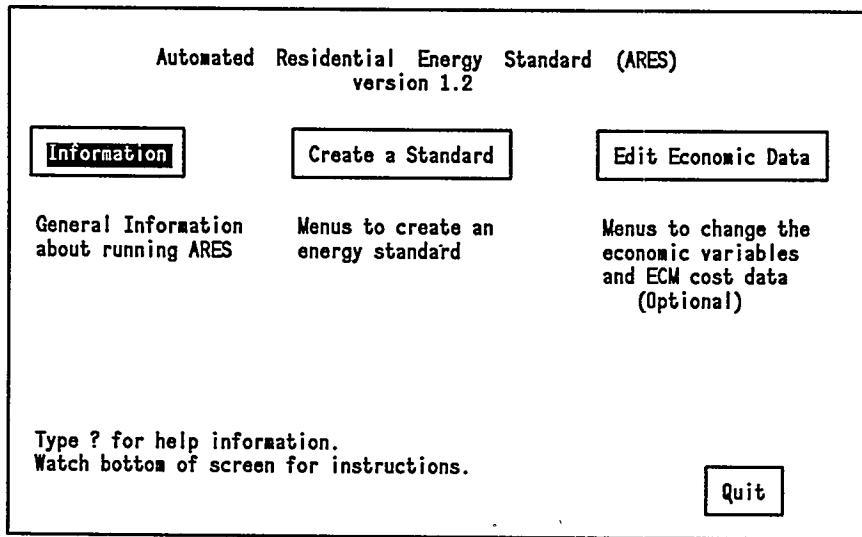
- 1) Make the \ARES subdirectory your default directory by typing `cd \ARES` then pressing *<Return>*
- 2) Start the program by typing *ARES*, then pressing *<Return>*.

If you are working from floppies:

- 1) Place the ARES Program Disk in drive A:
- 2) Place the ARES Data Disk in drive B:
- 3) Make drive A: your default drive by typing `A:` then pressing *<Return>*
- 4) Start the program by typing *ARES*, then pressing *<Return>*.

ARES will now begin running. The current date and time will appear in the middle of your screen. ARES will ask you if these are correct. If they are not, answer "No" by pressing the *N* key. ARES will return you to the DOS prompt. Use the DATE and TIME functions provided by DOS to reset your computer's date and time before restarting ARES. (See your DOS Reference Manual for details on how to do this.) This is important because all output produced by ARES is stamped with the current date and time.

If the date and time are correct, answer the question with a "Yes" by pressing the *Y* key. The ARES program will start running. While it is busy loading data files, you will see a brief disclaimer on the screen. When the program is loaded (about 15 to 45 seconds), the main menu (Figure A.1) will appear.



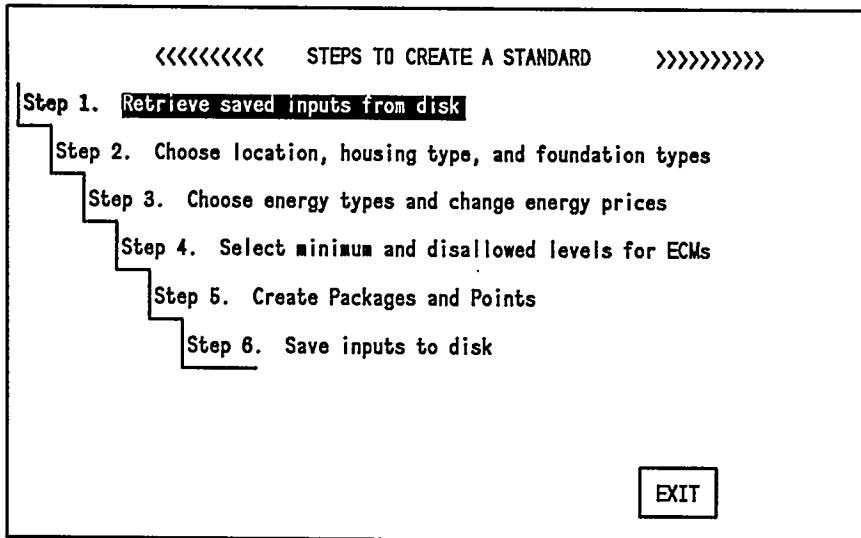
Press **<Return>** to select, use Arrows or Tab to move, ? for help.

Figure A.1. Main Menu

Before beginning the example, take note of two important items on the screen:

- 1) In the lower left portion of the menu, you are told that the ? key will provide you with help. Anytime you don't understand what ARES needs, just press the ? key.
- 2) Also in the lower left, you are told to watch the bottom of the screen for instructions. The bottom line of the screen always contains a brief explanation of what you should do.

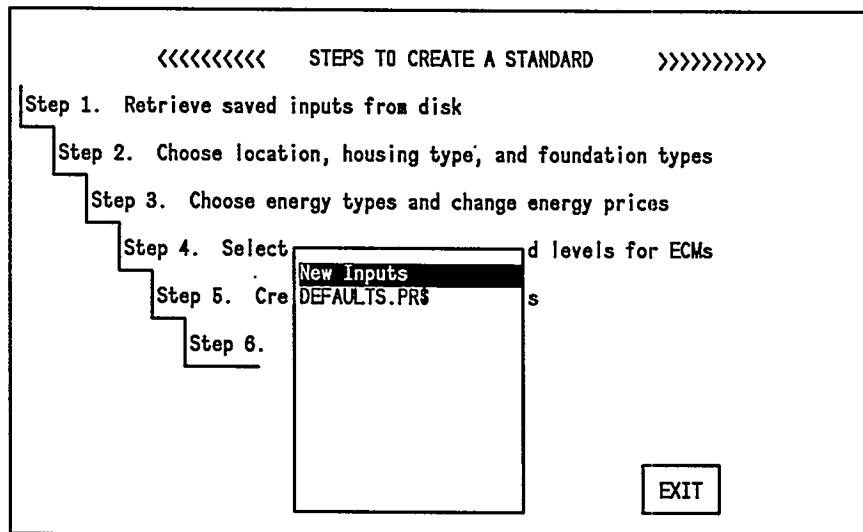
- Select the "Create a Standard" option:
  - 1) Press the right arrow key to move the highlighted block to the "Create a Standard" option.
  - 2) (Optional) Press the ? key to see an explanation of what this option is, and what it requires of you.
  - 3) Press **<Return>**. The menu shown in Figure A.2 will appear.



Press **<Return>** to perform, use Arrows or Tab to move, ? for help.

Figure A.2. Steps to Create a Standard Menu

- Specify an input filename:
  - 1) Step number one should be highlighted. If it is not, use the up and down arrow keys to move the highlighted block to Step 1.
  - 2) Press **<Return>**.
  - 3) A menu of available files will appear. If you have not previously saved any files, only the file named DEFAULTS.PR\$ will be available. Your screen should look like Figure A.3.



Use up and down arrows to highlight one of the saved input files  
 Press <Return> to read inputs, V to View comment, D to Delete, <Esc> to exit

Figure A.3. List of Previous Input Files

- 4) Use the up and down arrow keys to move to the desired file. For this example, move to the "New Inputs" option.
- 5) Press <Return>.
- Tell ARES what location, housing type, and foundations you are interested in:
  - 1) Move the highlighted block to Step 2.
  - 2) Press <Return>.
  - 3) The screen shown in Figure A.4 will appear.

<<<<< STEP 2. CHOOSE LOCATION, HOUSING TYPE AND FOUNDATIONS >>>>>

Jurisdiction: **District of Columbia**

Reference Location State: DC City: WASHINGTON

CHOOSE HOUSING TYPE: Single Family

Foundations to be considered:

Crawlspace: YES  
Unheated Basement: YES  
Heated Basement: YES  
Slab on grade: YES

EXIT

Type in text, use Arrows or Tab to move, ? for help.

Figure A.4. Location, Housing Type, and Foundations Menu

- 4) The "Jurisdiction" option is highlighted. You may change it from "District of Columbia" by typing something else. For this example, we'll leave it as it is.
- 5) Move to the "State" option by pressing the down arrow key.
- 6) Type in the two-letter postal abbreviation for your state. For this example, type "DC".
- 7) When the list of cities appears, use the up and down arrow keys to move to the one nearest your jurisdiction. For the District of Columbia, only one city, Washington, is available. Select it by pressing <Return>.
- 8) Move to the "CHOOSE HOUSING TYPE" option by pressing the down arrow key. Select it by pressing <Return>.
- 9) When the list of available housing types appears, use the up and down arrow keys to move to the one you want. For this example, move to "Single Family" and press <Return>.
- 10) Move to the "Crawlspace" option by pressing the down arrow key. Press the space bar once to toggle the response from "YES" to "NO". Press the space bar again to return it to "YES". This allows you to suppress output for one or more foundation types if you wish. For this example, we will leave all foundations set to "YES".
- 11) Move to the "EXIT" option by pressing the down arrow key until the highlighted block is on that option.

12) Press *<Return>* to move back to the previous menu.

- Tell ARES what heating equipment types you are interested in, and enter your local fuel prices:
  - 1) Move the highlighted block to Step 3 by pressing the down arrow key. Then press *<Return>*.
  - 2) The menu shown in Figure A.5 will appear.

***** STEP 3. CHOOSE ENERGY TYPES AND CHANGE ENERGY PRICES *****						
Energy Type	Include	Unit of Price	Winter	Summer		
Electricity *	YES	(\$/kWh)	0.070	0.070		
Oil	NO	(\$/gal)	1.150	-----		
Nat. Gas	YES	(\$/therm)	0.550	-----		
LPG	NO	(\$/gal)	0.900	-----		

\* Include Electric Resistance heating? YES  
 Include Heat Pump? YES

EXIT

Press space bar to toggle, use Arrows or Tab to move, ? for help.

Figure A.5. Energy Types and Prices Menu

- 3) Press the right arrow key to move to the winter electricity price. You can change the price by typing in a new one and then pressing *<Return>*. For this example, leave the prices as they are.
- 4) Press the down arrow key until the EXIT option is highlighted.
- 5) Press *<Return>* to move back to the previous menu.

- Specify minimum levels of conservation options:
  - 1) Move to Step 4 by pressing the down arrow key.
  - 2) Press *<Return>*. The menu shown in Figure A.6 will appear.

<<<< STEP 4. SELECT MINIMUM AND DISALLOWED LEVELS FOR ECMs >>>>	
Housing Type: Single Family	
Required Minimum	
Ceiling Insulation:	
Wall Insulation:	
Crawlspac Ins.:	
Unheated Bsmnt Ins.:	
Basement Insulation:	
Slab Insulation:	
Window Type:	Minima Specified
Oil Furnace:	
Gas Furnace:	
LPG Furnace:	
Electric Furnace:	
Heat Pump:	
Air Conditioner:	
EXIT	

Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure A.6. Minimum Levels Menu

3) The "Ceiling Insulation" block should be highlighted. Select this ECM by pressing <Return>. A list of ceiling options will appear on the right of the screen, as shown in Figure A.7.

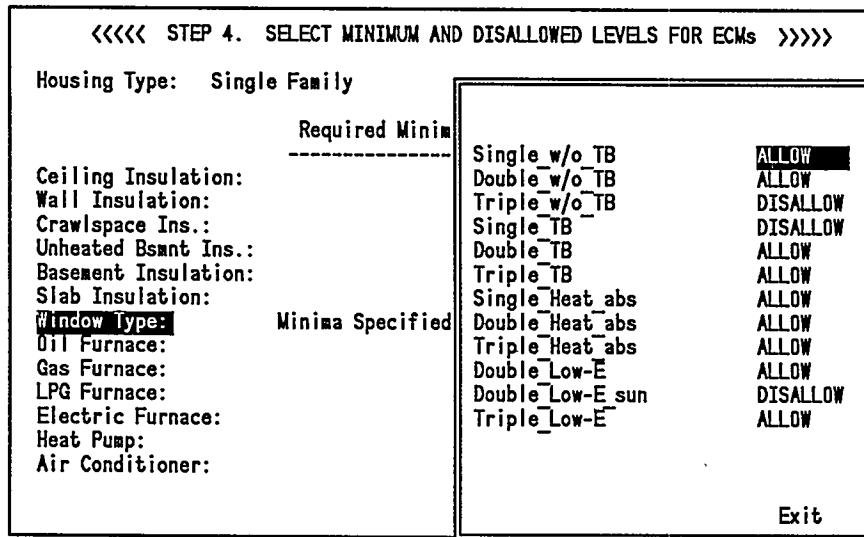
<<<< STEP 4. SELECT MINIMUM AND DISALLOWED LEVELS FOR ECMs >>>>	
Housing Type: Single Family	
Required Minimum	
Ceiling Insulation:	
Wall Insulation:	
Crawlspac Ins.:	
Unheated Bsmnt Ins.:	
Basement Insulation:	
Slab Insulation:	
Window Type:	Minima Specified
Oil Furnace:	
Gas Furnace:	
LPG Furnace:	
Electric Furnace:	
Heat Pump:	
Air Conditioner:	
Use up and down arrows to highlight, press <Return> to select, ESC to exit.	

No specified minimum  
 R-11  
 R-19  
 R-30  
 R-38  
 R-49  
 R-60

Figure A.7. Pop-up List of Ceiling Options on Minimum Levels Menu

4) You can now use the up and down arrow keys to select the minimum level of ceiling insulation that ARES will consider. For this example, move to "No specified minimum" and press <Return>.

5) Use the down arrow key to move to the "Window Type" option. Select it by pressing *<Return>*. Figure A.8 shows the menu of window options that will appear.



Press space bar to toggle, use Arrows or Tab to move, ? for help.

Figure A.8. Pop-up List of Windows on Minimum Levels Menu

6) The Single w/o TB (single-pane without thermal break) option should be set to "ALLOW." Press the space bar once to change it to "DISALLOW." Press the space bar again to return it to "ALLOW." For this example, leave all the options as they are.

7) Use the up or down arrow keys to move to "Exit". Then press *<Return>* to move out of the pop-up menu.

8) Use the down arrow key to move to "EXIT". Press *<Return>* to move back to the previous menu.

- Create the standard:
  - 1) Use the arrow keys to move to the "Create Packages and Points" option.
  - 2) Press *<Return>*.
  - 3) Wait a few minutes. A bar chart will appear on the bottom of the screen to let you know how close ARES is to finishing the task. When it is finished, the menu shown in Figure A.9 will appear.

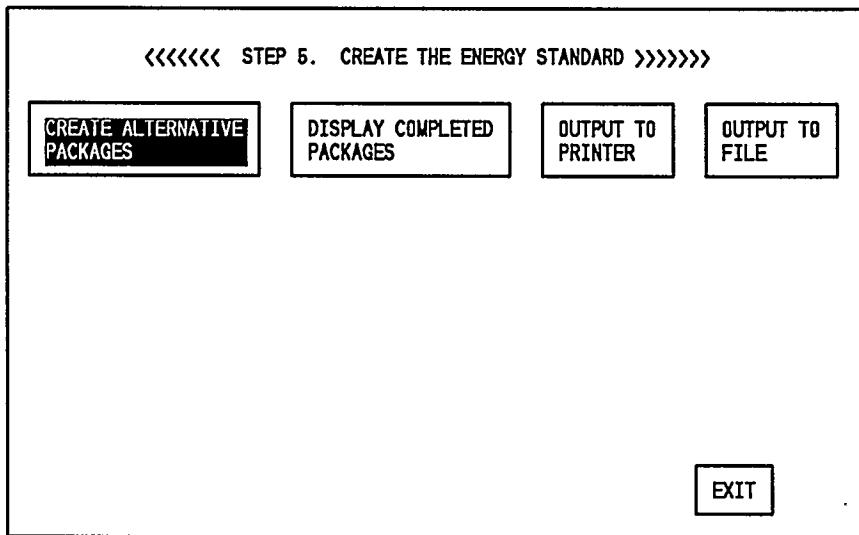


Figure A.9. Step 5 Menu

- 4) The Standard's requirements have now been determined. If you wish, you can now print the output. However, before printing, we will examine the Standard's requirements on the screen and use some of ARES's special capabilities for tailoring the Standard to your locale.
- View the prescriptive packages:
  - 1) The "CREATE ALTERNATIVE PACKAGES" option should be highlighted. Select it by pressing <Return>.
  - 2) A menu of available heating system types will appear, as shown in Figure A.10. The types included in this list were determined during Step 3 (see Figure A.5).
  - 3) Use the up and down arrow keys to move the highlighted block to the "Gas Furnace" option. Press <Return>. As shown in Figure A.11, another menu will appear that contains a list of defined prescriptive packages for gas-heated houses.

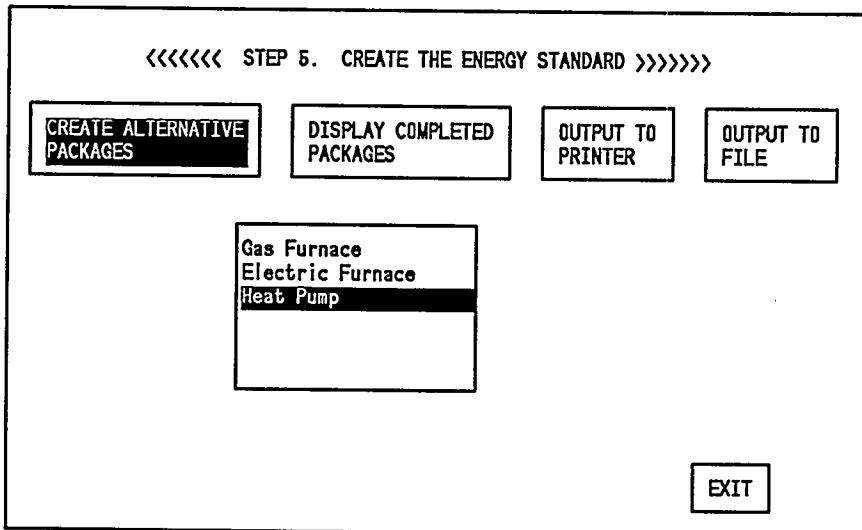


Figure A.10. List of Available Equipment Types

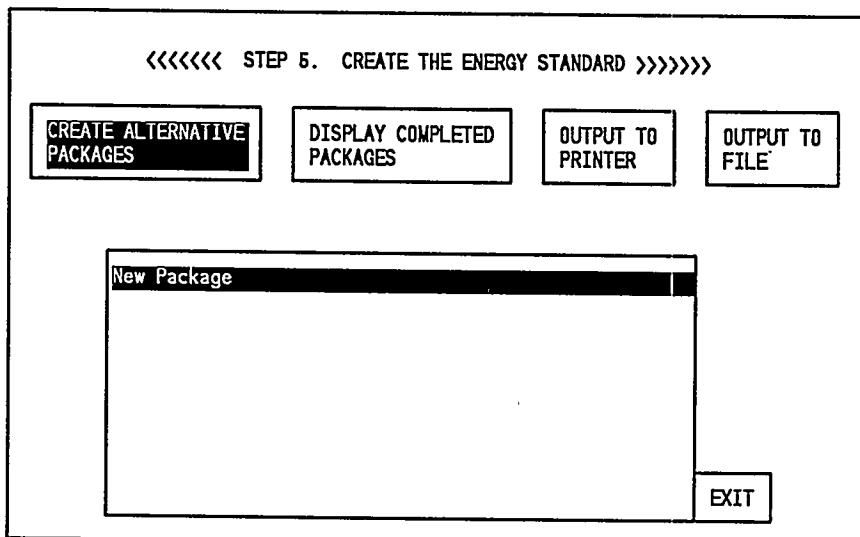


Figure A.11. List of Defined Packages Before any are Defined

- 4) Because this is the first time you have run ARES, only one package is available: "New Package." Select it by pressing <Return>. The menu shown in Figure A.12 will appear.

Jurisdiction: District of Columbia	Bldg Type: Single Family Detached
Package Name: New Package	Equipment: Gas Furnace
Basic Package      Alternative Package      Specifications	
Ceiling:	R-30
Frame Wall:	R-23
Mass Wall:	
Crawlspc:	R-30
Unheated Bsmt:	R-11
Heated Bsmt:	R-5 4ft
Slab Insul:	R-5 2ft
Window Type:	Double w/o TB
Window Area:	12% Max Total 0% Min South
Infiltration:	Normal
Heating Eff:	AFUE 85%
Cooling Eff:	SEER 10
Solar DHW:	
GENERATE PACKAGE      SAVE PACKAGE      EXIT	

Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure A.12. Basic Prescriptive Package for Gas Heating

5) The left column on the screen lists the various energy conservation measures. To the right of each ECM is the level required by the Standard. In this case, ceilings must be insulated to at least R-30, walls to R-23, floors over crawlspaces to R-13, floors over basements to R-11, at least half the depth of heated basement walls to R-4, and slabs to R-5 at least 2 feet deep. The furnace AFUE must be at least 85% and the air conditioner SEER at least 10.

- **Create an alternative package:**

Suppose you are the local code-writing official in the District of Columbia, and you know from experience that builders in the area prefer to build R-19 walls. You would like to have a prescriptive package that contains R-19 walls instead of R-23. Creating such a package is easy with ARES:

  - 1) Use the down arrow key to move the highlighted block to the "Frame Wall" option. Press <Return> to select this option. A menu of available wall levels will appear at the right of the screen.
  - 2) Use the up and down arrow keys to highlight the R-19 option. Then press <Return>. The list of options will disappear, and the R-19 specification will appear on the screen, as shown in Figure A.13.

Jurisdiction: District of Columbia	Bldg Type: Single Family Detached	
Package Name: New Package	Equipment: Gas Furnace	
Basic Package      Alternative Package      Specifications		
Ceiling:	R-30	
Frame Wall:	R-23	R-19
Mass Wall:		
Crawlspac:	R-30	
Unheated Bsmnt:	R-11	
Heated Bsmnt:	R-5 4ft	
Slab Insul:	R-5 2ft	
Window Type:	Double w/o TB	
Window Area:	12% Max Total 0% Min South	
Infiltration:	Normal	
Heating Eff:	AFUE 85%	
Cooling Eff:	SEER 10	
Solar DHW:		
GENERATE PACKAGE      SAVE PACKAGE      EXIT		

Press <Return> to select, use Arrows or Tab to move, ? for help.

Figure A.13. Specification for R-19 Wall Package

3) Now use the arrow keys to move the highlighted block to the "GENERATE PACKAGE" option. Press <Return>. After a few moments, a bar chart will appear at the bottom of the screen. When it is finished, the screen will look like Figure A.14:

Jurisdiction: District of Columbia	Bldg Type: Single Family Detached	
Package Name: New Package	Equipment: Gas Furnace	
Basic Package      Alternative Package      Specifications		
Ceiling:	R-30	R-30
Frame Wall:	R-23	R-19
Mass Wall:		
Crawlspac:	R-30	R-30
Unheated Bsmnt:	R-11	R-11
Heated Bsmnt:	R-5 4ft	R-5 4ft
Slab Insul:	R-5 2ft	R-5 2ft
Window Type:	Double w/o TB	Double Low E
Window Area:	12% Max Total 0% Min South	12% Max Total 0% Min South
Infiltration:	Normal	Normal
Heating Eff:	AFUE 85%	AFUE 78%
Cooling Eff:	SEER 10	SEER 10
Solar DHW:		
GENERATE PACKAGE      SAVE PACKAGE      EXIT		

Press <Return> to perform, use Arrows or Tab to move, ? for help.

Figure A.14. Alternative Package with R-19 Walls

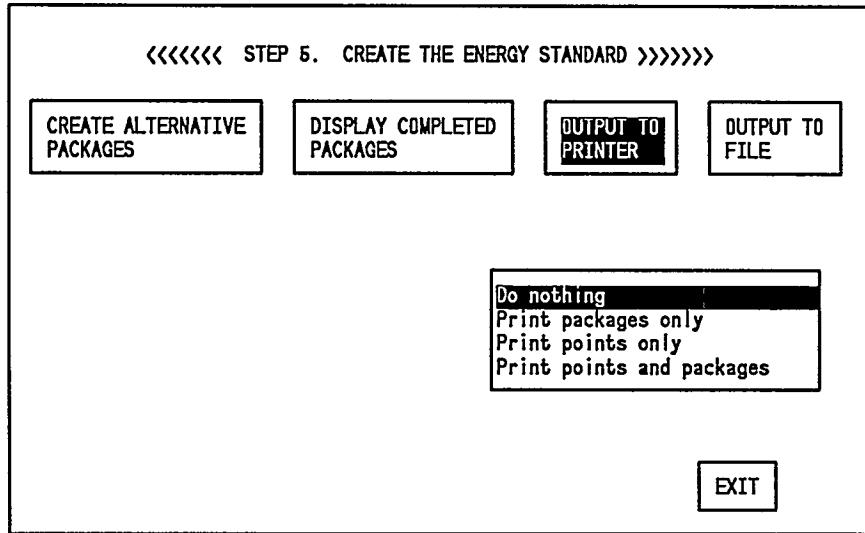
Notice that the package, as specified, contains R-19 walls. However, to make up for the resulting increase in heat loss, ARES selected a low

emissivity (low-E) glazing option. The low-E glass saved more energy than was needed to make up for the wall losses, so the furnace AFUE was reduced.

- 4) Let's assume this package is satisfactory. Use the arrow keys to move to the "SAVE PACKAGE" option. Then press <Return>.
- 5) At the bottom of the screen, ARES will ask you to type a name for the package. The name can be anything you like, but it should be a reminder of what the package is. For this example, type *R-19 Walls for Gas*. (Notice the previous package name, "New Package," disappears when you start typing.) When you are finished typing, press <Return>. ARES will ask you one more time if want to keep the package with that name. Answer "Yes" by pressing *Y*.
- 6) You may now create other packages if you wish. For now, however, we will move on. Move the highlighted block to the "EXIT" option. Press <Return>. This will return you to the Step 5 menu. (See Figure A.9.)

- Print the output:

- 1) Move the highlighted block to the "OUTPUT TO PRINTER" option.  
NOTE: If you don't have a printer attached to your computer, DON'T DO THIS. Instead, use the "OUTPUT TO FILE" option and look at the output later. If you do have a printer, be sure it is turned on and ready. Press <Return>. A small menu will pop up as shown in Figure A.15.



Use up and down arrows to highlight, press <Return> to select, ESC to exit.

Figure A.15. Output Menu

- 2) Use the arrow keys to move to the "Print points and packages" option, then press *<Return>*. Your printer should soon begin printing.
- 3) Compare your printout to the sample output listed at the end of this appendix. If you installed the national average construction costs, the two outputs should be identical.

- Save your inputs and leave ARES:
  - 1) Use the arrow keys to move to the "EXIT" option. Press *<Return>*. This will return you to the Steps menu. (See Figure A.2.)
  - 2) Step 6 should be highlighted. Select this option by pressing *<Return>*.
  - 3) At the bottom of the screen, ARES will ask you to type a name for the file that will contain your saved inputs. Type a filename of no more than eight characters, such as *EXAMPLE*. Then press *<Return>*. ARES will prompt you for a comment line. This is to help you remember what inputs are in the file when you reuse it later. For this example, type something like "Example from User's Guide" and hit *<Return>*.
  - 4) Now that your inputs are saved, you may exit the ARES program. Move the highlighted bar to the "EXIT" option, and press *<Return>*. This will take you back to the main menu. Again use the arrow keys to move down to the "QUIT" option. Press *<Return>* again. ARES will give you one last chance to change your mind. Typing an *R* will Return you to the program. Typing a *Q* will cause ARES to Quit and return you to the DOS prompt.

The remainder of this Appendix contains the output created by ARES when the previous example is run. Following the example, you should be able to duplicate these tables.

ARES Version 1.2  
Release date: 3/ 8/89

Prescriptive Compliance Packages

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Created 8/30/1989 8:13:01

---

Table 4-3a Prescriptive Compliance Package

Housing Type:	Single Family Detached
Jurisdiction:	District of Columbia
Heating Type:	Gas Furnace
Description :	Basic Single Family Gas Furnace Package
Component	Requirement
Ceiling Insulation	R-30
Wall Insulation	R-23
Floor over Crawlspace Insulation	R-30
Floor over Basement Insulation	R-11
Basement Wall Insulation	R-5_4ft
Slab Insulation	R-5_2ft
Window Type	Double_w/o_TB
Max window area/floor area	12.0% Max Total
Minimum south window area	0.0% Min South
Infiltration	Normal
Heating Efficiency	AFUE_85%
Cooling Efficiency	SEER_10

---

---

Table 4-3b Prescriptive Compliance Package

Housing Type:	Single Family Detached
Jurisdiction:	District of Columbia
Heating Type:	Electric Furnace
Description :	Basic Single Family Electric Furnace Package

Component	Requirement
Ceiling Insulation	R-38
Wall Insulation	R-26
Floor over Crawlspace Insulation	R-30
Floor over Basement Insulation	R-30
Basement Wall Insulation	R-10_4ft
Slab Insulation	R-10_4ft
Window Type	Double_Low-E
Max window area/floor area	12.0% Max Total
Minimum south window area	0.0% Min South
Infiltration	Normal
Heating Efficiency	Elec_Resistance
Cooling Efficiency	SEER_10

---

---

Table 4-3c Prescriptive Compliance Package

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

Heating Type: Heat Pump

Description : Basic Single Family Heat Pump Package

Component	Requirement
Ceiling Insulation	R-30
Wall Insulation	R-13
Floor over Crawlspace Insulation	R-30
Floor over Basement Insulation	R-13
Basement Wall Insulation	R-10_4ft
Slab Insulation	R-5_2ft
Window Type	Double_Low-E
Max window area/floor area	12.0% Max Total
Minimum south window area	0.0% Min South
Infiltration	Normal
Heating Efficiency	HSF 7.3
Cooling Efficiency	SEER 10.0

---

---

Table 4-3d Prescriptive Compliance Package

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

Heating Type: Gas Furnace

Description : R-19 Walls for Gas

Component	Requirement
Ceiling Insulation	R-30
Wall Insulation	R-19
Floor over Crawlspace Insulation	R-30
Floor over Basement Insulation	R-11
Basement Wall Insulation	R-5_4ft
Slab Insulation	R-5_2ft
Window Type	Double_Low-E
Max window area/floor area	12.0% Max Total
Minimum south window area	0.0% Min South
Infiltration	Normal
Heating Efficiency	AFUE_78%
Cooling Efficiency	SEER_10

---

ARES Version 1.2  
Release date: 3/ 8/89

Point System (Section 7)

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Created 8/30/1989 8:13:01

Table 5-2 TARGET Ceiling Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

Heating Equipment Type	Heating	Multiplier
		Cooling
Oil	N/A	N/A
Natural Gas	37	11
L. P. Gas	N/A	N/A
Electric Res.	29	9
Elec. Heat Pump	37	11

Table 5-3 DESIGN Ceiling Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

R-value		Multipler	
At least	but less than	Heating	Cooling
R-11	R-19	81	24
R-19	R-30	57	17
R-30	R-38	37	11
R-38	R-49	29	9
R-49	R-60	23	7
R-60	--	20	6

Table 5-4 TARGET Wall Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

Heating Equipment Type	Heating	Multiplier
		Cooling
Oil	N/A	N/A
Natural Gas	55	9
L. P. Gas	N/A	N/A
Electric Res.	48	8
Elec. Heat Pump	84	14

Table 5-5a DESIGN Frame Wall Insulation Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

R-value	Multiplier		
At least	but less than	Heating	Cooling
R-11	R-13	99	16
R-13	R-19	84	14
R-19	R-23	68	11
R-23	R-26	55	9
R-26	--	48	8

Table 5-5b DESIGN Mass Wall Insulation Multipliers  
Medium Weight (40 to 110 lb/sf)

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

R-value	Multiplier		
At least	but less than	Heating	Cooling
R-0_Medium_Wt	R-5_Medium_Wt	291	32
R-5_Medium_Wt	R-10_Medium_Wt	137	13
R-10_Medium_Wt	R-15_Medium_Wt	82	7
R-15_Medium_Wt	R-30_Medium_Wt	58	4
R-30_Medium_Wt	--	30	1

Table 5-5c DESIGN Mass Wall Insulation Multipliers  
Heavy Weight (greater than 110 lb/sf)

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0_Heavy_Wt	R-5_Heavy_Wt	289	29
R-5_Heavy_Wt	R-10_Heavy_Wt	136	11
R-10_Heavy_Wt	R-15_Heavy_Wt	81	5
R-15_Heavy_Wt	R-30_Heavy_Wt	57	3
R-30_Heavy_Wt	--	30	0

Table 5-5d DESIGN Solid Wood (Log) Wall Insulation Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Nominal Thickness (inches)		Multiplier	
At least	but less than	Heating	Cooling
6_inch_Log	8_inch_Log	124	17
8_inch_Log	10_inch_Log	95	13
10_inch_Log	12_inch_Log	78	11
12_inch_Log	--	66	10

Table 5-6 TARGET Floor/Foundation Insulation Multipliers

Housing Type: Single Family Detached  
 Jurisdiction: District of Columbia

Heating Equipment Type	Slab	Heating Multiplier		
		Crawl Space	Unheated Basement	Heated Basement
Oil	N/A	N/A	N/A	N/A
Natural Gas	138	0	29	452
L. P. Gas	N/A	N/A	N/A	N/A
Electric Res.	0	0	0	382
Elec. Heat Pump	138	0	20	382

Heating Equipment Type	Slab	Cooling Multiplier		
		Crawl Space	Unheated Basement	Heated Basement
Oil	N/A	N/A	N/A	N/A
Natural Gas	1	39	27	40
L. P. Gas	N/A	N/A	N/A	N/A
Electric Res.	9	39	33	28
Elec. Heat Pump	1	39	28	28

Table 5-7a DESIGN Slab Insulation Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Insulation at least 2 feet deep:

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0	R-5_2ft	375	0
R-5_2ft	R-10_2ft	138	1
R-10_2ft	--	94	2

Insulation to depth of footing:

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0	R-5_4ft	375	0
R-5_4ft	R-10_4ft	70	6
R-10_4ft	--	0	9

Table 5-7b DESIGN Floor-Over-Crawlspace Insulation Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0	R-11	208	30
R-11	R-13	39	38
R-13	R-19	26	38
R-19	R-30	18	39
R-30	--	0	39

Table 5-7c DESIGN Floor-Over-Unheated-Basement Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0	R-11	113	8
R-11	R-13	29	27
R-13	R-19	20	28
R-19	R-30	11	30
R-30	--	0	33

Table 5-7d DESIGN Basement Wall Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: District of Columbia

Insulation at least 4 feet deep:

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0	R-5_4ft	725	86
R-5_4ft	R-10_4ft	452	40
R-10_4ft	--	382	28

Insulation at least 8 feet deep:

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0	R-5_8ft	725	86
R-5_8ft	R-10_8ft	361	37
R-10_8ft	--	240	22

-----  
**Table 5-8 TARGET Air Infiltration Multipliers**

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Heating Equipment Type	Heating	Multiplier	Cooling
Oil	N/A		N/A
Natural Gas	143		17
L. P. Gas	N/A		N/A
Electric Res.	143		17
Elec. Heat Pump	143		17

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**Table 5-9 DESIGN Air Infiltration Multipliers**

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Infiltration Package *	Multiplier	
	Heating	Cooling
Normal	143	17
Tight	101	12

\*(see Section 5.2.5 of Standard)

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Table 5-10 TARGET Glazing Layers and Sash Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Heating Equipment Type	Heating	Multiplier
		Heating
Oil	N/A	N/A
Natural Gas	75	1
L. P. Gas	N/A	N/A
Electric Res.	39	1
Elec. Heat Pump	39	1

Table 5-11 DESIGN Glazing Layers and Sash Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Glazing Type	Multiplier	
	Heating	Cooling
Single_w/o_TB	1148	22
Double_w/o_TB	625	12
Double_TB	473	9
Triple_TB	373	7
Single_Heat_abs	1148	22
Double_Heat_abs	625	12
Triple_Heat_abs	473	9
Double_Low-E	322	6
Triple_Low-E	252	5

Table 5-12 TARGET Fenestration Area and Orientation Points

Housing Type: Single Family Detached  
 Jurisdiction: District of Columbia

Heated Floor Area (sf)	Points					
	Gas Furnace		Electric Furnace		Heat Pump	
	Heating	Cooling	Heating	Cooling	Heating	Cooling
Less than 500	28	24	23	19	23	19
500 to 750	42	36	34	29	34	29
750 to 1000	55	48	45	39	45	39
1000 to 1250	67	61	55	49	55	49
1250 to 1500	79	74	65	59	65	59
1500 to 1750	91	87	75	70	75	70
1750 to 2000	102	101	85	80	85	80
2000 to 2250	112	114	94	91	94	91
2250 to 2500	122	128	102	102	102	102
2500 to 2750	132	142	111	113	111	113
2750 to 3000	141	157	119	124	119	124
3000 to 3250	149	172	127	135	127	135
3250 to 3500	157	186	134	147	134	147
3500 to 3750	165	202	142	158	142	158
3750 to 4000	172	217	148	170	148	170
4000 to 4250	178	232	155	182	155	182
4250 to 4500	184	248	161	194	161	194
4500 to 4750	190	264	167	207	167	207
4750 to 5000	195	281	173	219	173	219
5000 to 5250	199	297	178	232	178	232
5250 to 5500	204	314	183	244	183	244
Greater than 5500	204	314	183	244	183	244

Table 5-13 DESIGN Fenestration Area and Orientation Multipliers

Housing Type: Single Family Detached  
Jurisdiction: District of Columbia

Orientation	Shading Coefficient					
	1.0 to 0.8		0.79 to 0.5		less than 0.5	
	Heat	Cool	Heat	Cool	Heat	Cool
North	35	26	27	21	17	13
Northeast	46	33	36	26	22	16
East	56	40	45	32	28	20
Southeast	77	40	61	32	38	20
South	98	39	77	31	48	19
Southwest	76	44	60	34	37	21
West	55	48	43	38	27	23
Northwest	45	37	35	29	22	18
Northwest	45	37	35	29	22	18

Typical Shading Coefficients:

Single_w/o_TB	1.000
Double_w/o_TB	0.880
Double_TB	0.880
Triple_TB	0.740
Single_Heat_abs	0.750
Double_Heat_abs	0.660
Triple_Heat_abs	0.560
Double_Low-E	0.710
Triple_Low-E	0.600

Table 5-14 DESIGN Overhang Multipliers

Jurisdiction: District of Columbia

	Overhang Ratio (L/H)			
	0.000 to 0.548	0.549 to 0.999	1.0 to 1.999	2.0 and above
<b>Heating</b>				
North	10	10	10	10
NorthEast	10	10	10	9
East	11	9	8	6
SouthEast	12	9	7	5
South	12	8	6	3
SouthWest	12	9	7	5
West	11	9	8	6
NorthWest	10	10	10	9
<b>Cooling</b>				
North	10	10	10	10
NorthEast	11	9	8	8
East	11	9	7	6
SouthEast	12	8	7	6
South	13	9	8	8
SouthWest	12	8	7	6
West	11	9	7	6
NorthWest	11	9	8	8

Table 5-15 DESIGN Glazing Area and Orientation Points

Housing Type: Single Family Detached  
 Jurisdiction: District of Columbia

Heating F-Factor	Heating Points	Cooling F-Factor	Cooling Points
Less than 190	19	Less than 90	9
190 to 380	40	90 to 180	18
380 to 570	61	180 to 270	28
570 to 760	83	270 to 360	37
760 to 950	105	360 to 450	47
950 to 1140	129	450 to 540	57
1140 to 1330	153	540 to 630	67
1330 to 1520	178	630 to 720	77
1520 to 1710	205	720 to 810	87
1710 to 1900	231	810 to 900	97
1900 to 2090	259	900 to 990	108
2090 to 2280	288	990 to 1080	118
2280 to 2470	317	1080 to 1170	129
2470 to 2660	347	1170 to 1260	140
2660 to 2850	378	1260 to 1350	151
2850 to 3040	410	1350 to 1440	162
3040 to 3230	443	1440 to 1530	174
3230 to 3420	476	1530 to 1620	185
3420 to 3610	510	1620 to 1710	197
3610 to 3800	545	1710 to 1800	209
3800 to 3990	581	1800 to 1890	221
3990 to 4180	618	1890 to 1980	233
4180 to 4370	656	1980 to 2070	245
4370 to 4560	694	2070 to 2160	257
4560 to 4750	734	2160 to 2250	270
4750 to 4940	774	2250 to 2340	282
4940 to 5130	815	2340 to 2430	295
5130 to 5320	856	2430 to 2520	308
5320 to 5510	899	2520 to 2610	321
5510 to 5700	942	2610 to 2700	334
5700 to 5890	987	2700 to 2790	348
Greater than 5890	987	Greater than 2790	348

Table 5-16 TARGET and DESIGN Base Load Multipliers

Housing Type: Single Family Detached  
 Jurisdiction: District of Columbia

Foundation Type	Multiplier	
	Heating	Cooling
Crawlspac	1	-27
Unheated Basement	9	-27
Heated Basement	36	-27
Slab	34	-35

Table 5-17 TARGET HVAC Equipment Points

Heating Equipment Type	Heating Multiplier			Cooling Multiplier	
	Ducted	Hydronic	Baseboard	Ducted	Hydronic
Oil	N/A	N/A	N/A	N/A	N/A
Natural Gas	67	66	N/A	67	66
L. P. Gas	N/A	N/A	N/A	N/A	N/A
Electric Res.	225	220	216	67	66
Heat Pump	95	93	N/A	67	66

Table 5-18 TARGET and DESIGN HVAC Equipment Multipliers

Housing Type: Single Family Detached  
 Jurisdiction: District of Columbia

	Heating Equipment Type					Cooling
	Oil	Gas	LPG	Elec. Res.	Heat Pump (Heating)	
Ducted	N/A	5729	N/A	21364	696	672
Hydronic	N/A	5612	N/A	20928	682	658
Baseboard	--	--	--	20510	--	--

Table 5-19 TARGET Domestic Hot Water Points

Water Heating Fuel	TARGET POINTS
Oil	27235
Gas	16406
LPG	30974
Electric	35229

Table 5-20 DESIGN Domestic Hot Water Factor

Water Heating Fuel	DESIGN DHW FACTOR
Oil	13454
Gas	8925
LPG	16850
Electric	33280

Table 5-21 TARGET and DESIGN Solar Domestic Hot Water Points

Space Heating Fuel	TARGET POINTS	DESIGN POINTS					
		Active		Integral		Thermosyphon	
		1-Panel	2-Panel	1-Panel	2-Panel	1-Panel	2-Panel
Oil	27235	24150	21708	24640	22665	24133	22038
Gas	16406	14359	12740	14685	13374	14348	12958
LPG	30974	27111	24053	27725	25251	27089	24465
Electric	35229	27598	21558	28811	23925	27556	22373

## INDEX

"Information" . . . . .	15
% Eff. . . . .	49
\ARES . . . . .	4, 14
AFUE . . . . .	47
Air Conditioners . . . . .	49
Air conditioning . . . . .	21
Alternative Investment Rate . . . . .	38
Alternative Package Menu . . . . .	31
Alternative packages . . . . .	27, 28, 53
delete . . . . .	28
equipment type . . . . .	28
Example . . . . .	31
generated . . . . .	31, 33
go to . . . . .	28
housing type . . . . .	28
Infiltration . . . . .	34
Mass Walls . . . . .	33
package name . . . . .	32
SAVE PACKAGE . . . . .	32
Solar DHW . . . . .	34
specifications . . . . .	27, 31, 33
view . . . . .	28
Viewing . . . . .	34
Window Area . . . . .	33
Basic package . . . . .	31
Basic packages . . . . .	33
Capacity . . . . .	48, 50, 51
Cost data . . . . .	
regional cost data . . . . .	4
Creating packages and points . . . . .	25
Date and time . . . . .	14
Defaults . . . . .	2, 36
DEFAULTS.PR\$ . . . . .	16
DHW . . . . .	
Solar DHW . . . . .	34
Domestic water heating costs . . . . .	23
Down Payment . . . . .	39
Economic Parameters . . . . .	36
Alternative Investment Rate . . . . .	38
Down Payment . . . . .	39
Income Tax Rate . . . . .	39
Inflation Rate . . . . .	38
Loan Fee . . . . .	39
Local Cost Multiplier . . . . .	40
Mortgage Interest Rate . . . . .	39
Points . . . . .	39
Property Tax Rate . . . . .	39
Term of Loan . . . . .	39
Economic Variables . . . . .	36
Electric furnace . . . . .	21

INDEX, cont'd.

Electric heat pump . . . . .	21
Electricity . . . . .	22
summer electricity price . . . . .	23
Energy Factors . . . . .	52
Energy Prices . . . . .	21, 23
Energy sources . . . . .	21
electricity . . . . .	21
LPG . . . . .	21
natural gas . . . . .	21
oil . . . . .	21
Energy target . . . . .	27, 34
Energy/equipment combinations . . . . .	21
Entering Information . . . . .	10
Bottom-of-screen inputs . . . . .	12
Decimal number inputs . . . . .	11
Pop-up menus . . . . .	12
Text inputs . . . . .	11
Yes/No inputs . . . . .	12
F-Value . . . . .	46
First Cost . . . . .	43, 46-48, 50, 51
Foundations . . . . .	19, 21
Fraction Failures . . . . .	44
Furnaces	
Electric . . . . .	48
Fossil-Fuel . . . . .	36, 47
Hardware Requirements . . . . .	6
Heat Pumps . . . . .	50
Help . . . . .	13
On-Line Help . . . . .	13
Hot Water Heaters . . . . .	36, 51
Housing type . . . . .	19, 20
HSPF . . . . .	51
HVAC equipment . . . . .	28
HVAC systems . . . . .	21
Income Tax Rate . . . . .	39
Infiltration . . . . .	34
Normal . . . . .	34
Tight . . . . .	34
Inflation Rate . . . . .	38
Installation . . . . .	4
backup copies . . . . .	5
Installation on dual floppies . . . . .	5
Installation onto a hard disk . . . . .	5
Jurisdiction . . . . .	19, 20
Level . . . . .	43
Loan Fee . . . . .	39
Local Cost Multiplier . . . . .	40
LPG furnace . . . . .	21
Main Menu . . . . .	15
Manufactured housing . . . . .	4

## INDEX, cont'd.

Mass Walls . . . . .	33, 44
Menu . . . . .	8
Alternative Package Menu . . . . .	30
Choose Energy Types and Change Energy Prices Menu . . . . .	22
Choose Location Menu . . . . .	19, 20
Create the Energy Standard Menu . . . . .	27
Diagram of the Menu System . . . . .	8
ECM Cost Menu . . . . .	42
Economic Variables Menu . . . . .	37
Edit Cost Data for ECMs Menu . . . . .	40
Information Menu . . . . .	16
Main Menu . . . . .	8
Minimum Levels Menu . . . . .	23
Steps to Create a Standard Menu . . . . .	17
Minimum levels . . . . .	23
DISALLOW . . . . .	25
Minima Specified . . . . .	25
Mortgage Interest Rate . . . . .	39
Moving The Cursor . . . . .	9
Natural gas furnace . . . . .	21
O&M . . . . .	44
Oil furnace . . . . .	21
Output . . . . .	35, 53
basic packages . . . . .	53
point system . . . . .	53
printing . . . . .	35
saving . . . . .	35
Packages . . . . .	53
Perimeter Insulation . . . . .	45
Point system . . . . .	53
Points . . . . .	54
Points, Mortgage . . . . .	39
Postal code . . . . .	20
Printer . . . . .	6
Property Tax Rate . . . . .	39
Quitting . . . . .	13, 35
Reference Location . . . . .	19, 20
Regional cost data . . . . .	4
national average . . . . .	4
Save input . . . . .	26
.PR\$ . . . . .	26
file of inputs . . . . .	27
Saved inputs . . . . .	18
SEER . . . . .	49, 51
Shading Coefficient . . . . .	47
Specifications . . . . .	27
Starting the Program . . . . .	14
State . . . . .	20

INDEX, cont'd.

Steps to Create a Standard . . . . .	17
Choose Energy Types . . . . .	21
Choose Location . . . . .	19
Step 1 . . . . .	16
Step 2 . . . . .	16
Step 3 . . . . .	16
Step 4 . . . . .	16
Step 5 . . . . .	16
Step 6 . . . . .	16
Term of Loan . . . . .	39
Type (Mass Walls) . . . . .	45
U-Value . . . . .	43, 45, 46
Window Area . . . . .	33
south . . . . .	34
total . . . . .	34
Windows . . . . .	36, 46

