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COSTSAFR 3.0 — User's Manual
(Conservation Optimization Standard
for Savings in Federal Residences)

U.S. Department of Energy
Assistant Secretary
Conservation and Renewable Energy
Office of Buildings and Community Systems
Building Systems Division

In Support of Proposed Modifications to Interim
Energy Conservation Standards for New Federal
Residential Buildings

June 1988

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SUMMARY

This document describes how to use the computer program developed under the Federal Residential Standard Project funded by the Department of Energy. The computer program provides an analysis of specific housing projects at a given site, using alternative fuel types, and considering alternative housing types. Designed around the concept of minimizing overall costs through energy conservation design--including first cost and future utility costs--the computer program establishes a standard design to which proposed housing designs are compared. It then provides a point table, for each housing type, that can be used to determine whether a proposed design meets the standard and how a design could be modified to meet the standard.

The computer program has been designed for IBM-PC or compatible computers and is recorded on a floppy disk. This manual describes how to use the program and how to read the information that appears on the screen during program operation. It describes the inputs required and the various options presented to the user. The appendices provide more detailed information related to the output produced by the program. This output consists of point tables presenting points for each energy conservation option, and a point total that must be met to comply with the standard.

The technical support document and economic analysis are separate documents that provide more information about the specifics of the standard.

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1.0 INTRODUCTION

The COSTSAFR computer program is part of the Interim Energy Conservation Standards for New Federal Residential Buildings. The program generates a set of compliance forms which will be attached to housing Request for Proposals (RFPs) issued by Departments or Agencies of the Federal government. The compliance forms, which take the form of a point system, will then be completed by each proposer in order to demonstrate that their specific design proposals comply with the Energy Standard. The compliance forms also provide a uniform method for estimating the total yearly energy cost for each proposal as a whole. This estimate can then be used by evaluators to compare the total energy performance of competing proposals.

Read This First!

The purpose of this computer program is to ensure that the compliance forms are always tailored to the specific circumstances of each RFP. In order to accomplish this objective, the program will be run separately for each RFP, and the compliance forms generated by each run will be useful ONLY for the RFP for which they were created.

For detailed information on the methods and data used in the calculations in COSTSAFR, refer to Interim Energy Conservation Standards for New Federal Residential Buildings-Technical Support Document, Department of Energy, July 1986.

Further Information
on Methods and Data

IF YOU ARE UNFAMILIAR WITH THIS PROGRAM, YOU SHOULD READ AT LEAST THE INTRODUCTION AND GENERAL OVERVIEW OF THIS USER'S MANUAL BEFORE YOU USE THE PROGRAM. The General Overview describes each of the six sections of the program, giving the purpose and general structure of each. The Overview also provides general instructions on the use of the program.

In order to run this program you will need the following equipment:

- * an IBM-PC, -XT, -AT, or a COMPAQ or other truly IBM-PC compatible computer with:
 - o at least 256K memory; optimum configuration has 640K RAM
 - o two double sided, double density floppy disk drives or a double sided, double density floppy disk drive and a hard disk
- * a monochrome or color monitor

Computer Hardware
Requirements

- * a printer (to print out the compliance forms)
- * MS-DOS or PC-DOS operating systems; 2.0 or later version
- * the two COSTSAFR disks: the Analyzer disk and the Data disk
- * an 8087, 8287, or 8387 math coprocessor chip

The instructions in this manual are valid only for the computer software and hardware described above. Using other equipment is likely to result in improper operation or complete failure and is highly discouraged. Note that a machine with an APL character generating chip will produce screens that appear slightly different.

1.1 USING COSTSAFR DISKS FOR THE FIRST TIME

To "boot up", or start the computer, you must insert the disk operating system (DOS) disk into drive A and turn the computer on. It is not necessary to insert the DOS disk if your computer has a hard disk with DOS already installed. As the computer is booting up, the date and time may be requested. The "A>" prompt will appear on the screen when the computer has completed the startup process and ready to receive commands.

Starting the Computer

When you first receive the program disks, you should copy the operating system file COMMAND.COM onto your Analyzer disk. The COMMAND.COM file is used by the COSTSAFR program to provide a list of the files on the disk when you restore a Project Description (see Section 7.0). For a system with two disk drives, insert the DOS disk in drive A: and the COSTSAFR Analyzer disk in drive B:. With the A> prompt on the screen, type "COPY COMMAND.COM B:" and hit the carriage return key. For single disk drive systems, insert the DOS disk into drive A and enter "COPY COMMAND.COM B:". At this point a message will tell you to "insert disk into drive B:". Replace the DOS disk with the Analyzer disk and strike any key to copy the file.

Copy COMMAND.COM
Onto Analyzer Disk

The COSTSAFR Analyzer Disk and Data Disk should be copied onto backup disks immediately in case the originals become damaged or lost. Two blank formatted disks are needed to copy the originals onto. You should follow the procedure in your DOS manual to

Backup COSTSAFR
Disks

make a copy of both COSTSAFR disks and save the originals in a safe place.

1.2 THE BATCH INSTALLATION PROGRAM: INSTALL

To assist in the installation and operation of the COSTSAFR, a file called INSTALL is included on the Analyzer disk. This program will only be run one time. It is not necessary to use the INSTALL program, but it is helpful in copying files to a hard disk, and will simplify the COSTSAFR startup command. The command for starting the program initially consists of the name "COSTSAVE" followed by a blank and either B: or C: (the drive specification for the data disk), followed by another blank and the letter C or M (for color or monochrome screen). The INSTALL program will change this command to simply "COSTSAFR".

For computers with a hard disk, all the files used by COSTSAFR must be copied to your hard disk. The INSTALL program will do this and will also create a batch file for the startup of COSTSAFR. For all subsequent runs you will then follow the startup procedure in Section 1.3. To run INSTALL, first obtain the A> prompt. Insert the COSTSAFR Analyzer disk into disk drive A: and type "INSTALL" followed by a space and the letter designation of the hard disk, followed by another space and either "C" or "M" (for color or monochrome screen). For example, if you want to set up COSTSAFR on the C: drive, type

Using INSTALL For
Users with a Hard
Disk Drive

INSTALL C M (for monochrome screens)

or

INSTALL C C (for color screens)

followed by a carriage return. Letters can be typed in either uppercase or lowercase. The INSTALL program will first copy all files on the Analyzer disk to the C: (hard disk) drive. After all the files have been copied, a message will appear telling you to "insert disk into drive A:". Replace the Analyzer disk with the Data disk and strike any key to copy the Data disk files to the hard disk.

The INSTALL program creates a subdirectory on the C: drive called COSTSAFR. To enter this subdirectory from the C> prompt type in "CD COSTSAFR". If the install program is not used, it is still advised that a subdirectory be created on the hard disk for COSTSAFR files. This will make it simpler to keep track of files related to COSTSAFR.

For users with two floppy disks the only function of the INSTALL program is to reduce the length of the command entered to start COSTSAFR. After the computer is started up and the A> prompt is obtained insert the COSTSAFR analyzer disk into the A: disk drive and type either:

INSTALL A M (for monochrome screens)

or

INSTALL A C (for color screens)

followed by a carriage return. This will change the startup command from "COSTSAVE B: M" (or "COSTSAVE B: C") to simply "COSTSAFR". The program will now expect the Analyzer disk to be in drive A: and the Data disk to be in drive B: when the COSTSAFR program is used.

The Analyzer disk has a limited amount of space for saving the output from the COSTSAFR program. Each output file uses about 20K of disk space per prototype, except Apartments and Townhouses which use 40K. If you are saving the output to the Analyzer disk, you will not be able to run all the prototypes because of a lack of disk space. Type the DOS command "DIR" to keep track of the available disk space. If the space left on the disk is low, any output files already produced should be moved to another disk or deleted to make more space.

Using INSTALL For
Users With Two
Floppy Disks Drives

Analyzer Disk
has Limited Space

1.3 STARTING THE COSTSAFR PROGRAM

If the INSTALL program has not yet been run, please read Section 1.2 for instructions on starting COSTSAFR. After the INSTALL program has been implemented, the program will start when the following command is typed in:

COSTSAFR

This should be entered on the A: drive if two floppy drives are used, or from the COSTSAFR subdirectory on the C: drive if a hard disk is used. For the two floppy system, the Analyzer disk must be in the A: drive and the Data disk must be in the B: drive. After this command is completed successfully the first screen of the program will appear.

2.0 GENERAL OVERVIEW OF THE PROGRAM

2.1 PROGRAM STRUCTURE

COSTSAFR is divided into six main sections, each of which is accessible from a screen called the Main Menu. Before reaching the Main Menu the user passes through two initial screens.

This screen always appears when the program first starts. Figure 2.1 shows this screen. It has directions at the bottom and a short description of the purpose and operation of the program. When you are finished with the first screen, strike the carriage return key "<cr>" (see Section 2.2 for explanation of "<cr>") to proceed.

Introduction
Screen

FIGURE 2.1. Introduction Screen

The second COSTSAFR screen displays the date of the last change in the cost data base and comments

Cost Data Base
Notice Screen

entered at that time. You cannot change anything on the screen, but you should read it to make sure that you are using the proper version of the cost data. If the cost data base has not been modified this screen will not contain any comments. See Section 5.4 for more information on this screen. Strike the return key to enter the Main Menu.

This program is divided into six major functions, each of which can be selected from the Main Menu (Figure 2.2). Of these six functions, only the first and last are necessary to run the program:

Main Menu

1. Project Description
2. Set Minimum Values (optional)
3. Change Cost Factors (optional)
4. Save Project Description (optional)
5. Restore Project Description (optional)
6. Generate Compliance Point System

To select one of the six functions listed on this screen, move the cursor until it is on the function you want and strike "<cr>". (Moving the cursor and other editing/selecting procedures are described in Section 2.2.) This will start the process you have selected. Normally you will want to enter "Project Description" first.

MAIN MENU - SELECT OPTION

Step 1: Enter Project Description

Step 2: Select Minimum Values (Optional)

Step 3: Change Cost Factors (Optional)

Step 4: Save Project Description (Optional)

Step 5: Restore Project Description (Optional)

Step 6: Generate Compliance Point System

ESC to see prev.
display.

↵ to select.

↑↓ moves cursor

FIGURE 2.2. Main Menu Screen

Each of the six functions is discussed briefly below. A more in depth description of each function is given in Sections 3-8 of the manual.

1. The Project Description function is required in order for the program to run. It describes the location of the project, the number and types of units, the fuel types to be used, seasonal electricity rates, etc. The correct information must be entered here to produce valid compliance forms for a specific project.
2. The Set Minimum Values function allows you to exclude specific items from consideration in the Energy Standard. However, excluding items from the Energy Standard is equivalent to forbidding them, since any item which is not included in the Energy Standard cannot be included in the final building design. This will restrict the proposers' possibilities, and the intention of this Standard is to increase rather than restrict proposers' flexibility. For this reason **EXTREME CARE SHOULD BE EXERCISED** when you are considering excluding items from the Standard.

Project
Description

Set Minimum
Values
(optional)

Items should be excluded only if they are truly unacceptable for reasons **OTHER THAN ENERGY USE**. The energy consequences of each of the items will be considered automatically by the Standard: items which use large amounts of energy will be penalized, and items which are energy misers will be rewarded.

Moreover, one of the ways that this Standard increases proposers' flexibility is by allowing them to use inefficient items in one portion of their design and compensate by using extremely energy-efficient items somewhere else. However, this flexibility is possible only if there is a range to choose from. In order to provide proposers with maximum flexibility, you should try to retain as many options on the list as possible. Items might be excluded for comfort reasons, safety reasons, or for any other non-energy reason that makes them unacceptable, but **THEY SHOULD NOT BE EXCLUDED BECAUSE THEY USE TOO MUCH ENERGY**. The program and standard will take care of these energy issues.

3. The Change Cost Factors function allows you to change the data base which contains the costs for the various conservation measures. Changing these costs might be desirable in order to keep the program's data base current. In order to use the new costs in the Standard, you must save the new costs when the screen asks if you want to save them. If you elect to save the costs, they will be changed on a permanent basis in the cost data base and used for all subsequent runs until changed again.

Change Cost
Factors
(optional)

Note, however, it is essential that the various costs used by the program remain consistent with each other. Within the structure of the program itself, the costs and benefits for all of the items are compared, and the best ones are selected based on this comparison. Changing the cost data base can have a major impact on this process, therefore all costs must be calculated using the same assumptions. For this reason it is imperative that ALL costs be reviewed whenever any of them are changed, in order to ensure that the cost data base remains consistent and accurate. A procedure for printing the existing cost data base has been provided to simplify this process.

IT IS STRONGLY SUGGESTED THAT A NEW COPY OF THE DATA DISK BE MADE BEFORE ANYTHING IN THE COST DATA BASE IS CHANGED. The cost changes can then be made on the new copy, and the changes can be saved. This will permanently change the cost data base on the new copy, but the old copy will still contain the original data base to be used as a record or for future RFPs. See your DOS manual for disk copying procedures.

This procedure of copying the program software and changing the cost data base on the new copy also allows the cost data base to be customized for specific regions or for other specific applications without destroying the original cost data base.

4. The Save Project Description function allows you to save all the data entered in the Project Description function on a disk file for later use. This will also save any changes made to the Set Minimum Values function. It allows you to save your work should the power

Save Project
Description
(optional)

fail or if you need to modify the Project Description in the future.

5. The Restore Project Description function allows you to restore all Project Description and Minimum Values data from input data files created and saved on a previous session in COSTSAFR.

Restore Project
Description
(optional)

6. This is the main section in the program, and it starts the process in which the computer reads the project description and the data bases, performs the cost/benefit calculations, and creates the point systems for this particular case. See Section 8.0 for further details on this part of the program.

Generate
Compliance
Point System

After any of the six functions has been completed, you will always be returned to the main menu. You can exit the program from the Main Menu after you have finished. This is done by typing "<esc>" once to go back to the Cost Data Base Notice Screen, then typing "<esc>" again to go back to the First Screen. Type "<esc>" once more, and you will be asked "Do you really want to exit?". Type a "Y" for yes, and you will see the DOS prompt (like A>), indicating that you are out of COSTSAFR.

Exiting From
COSTSAFR

2.2 ON-SCREEN DIRECTIONS AND CURSOR CONTROLS

Each program menu is accompanied by directions at the bottom of the screen. Only the following six keys are needed for input, modifications and output, and they will be referred to as the "cursor controls":

1. "Carriage return", which is used to select an option and simultaneously advance through the program's menus. When a number of alternatives are offered, a "carriage return" means "choose the one marked by the cursor." As explained at points 3 and 4 below, the "up" and "down" arrows can be used to bring the cursor to the desired selection. The carriage return is the large key between the alphabetic keys and the number pad. On IBM keyboards it is labeled with a bent arrow, and this label is also the symbol used to refer to a carriage return in the directions at the bottom of the screens. A carriage return will be referred to in this Manual by "<cr>".

"Carriage Return"

2. "escape", which moves you one menu back.
The "escape" key is typically in the upper left portion of the keyboard, just to the left of "1".
Escape will be referred to in this Manual by "<esc>".

"escape"

3. "up arrow", which moves the cursor up one line each time you strike it. The program menus have a wrap-around feature, which permits using the "up arrow" to move directly from the top to the bottom of the screen. The "up arrow" key is one of the keys on the number pad typically to the right of the alphabetic keys. It is marked with an upward pointing arrow.

"up arrow"

4. "down arrow", which moves the cursor down one line each time you strike it. The down arrow also has the wrap-around feature, which permits using the "down arrow" to move directly from the bottom to the top of the screen. The "down arrow" key is typically two keys below the "up arrow" key, on the number pad. It is marked with a downward arrow.

"down arrow"

5. "left arrow", which moves the cursor one item to the left each time you strike it. The left arrow also has the wrap-around feature, which allows moving the cursor to the left one space or one item. The left arrow key is normally on the number pad, and is marked with a leftward arrow.

"left arrow"

6. "right arrow", which moves the cursor one item to the right each time you strike it. The right arrow also has the wrap-around feature, which allows moving the cursor to the right one space or one item. The right arrow key is normally on the number pad, and is marked with a rightward arrow.

"right arrow"

The arrow keys on the numeric pad also can type in numbers (2, 4, 6, and 8). When you are editing in COSTSAFR you will want to use the arrow function, not the number function. The "Num Lock" key, located above the number pad, controls this. If the keys on the number pad are producing numbers and not the "arrow" cursor movements, strike the "Num Lock" key.

The "Num Lock"
Key

When you strike certain keys you may hear a beep. This will not change any of the input, or affect the program in any way: the program simply beeps each time it does not understand a command, then waits for you to give legal instructions. This usually

Invalid Input

occurs when the program is expecting a number but receives a letter, or vice versa.

There are also some "split screens" in the program, where the screen is split into two or sometimes three sections. Each section will display different information, and may require somewhat different responses. The response given on one section of the screen will sometimes change what appears in the other side of the split screen.

Split Screens

Split screens are described in the User's Manual whenever they occur. Each section of these split screens also has separate directions that will appear under the portion that is currently being used. This should help avoid confusion about which section of the screen is being used at any specific time.

2.3 A WARNING ABOUT ERROR CHECKING

A Warning About Error Checking

COSTSAFR does not check your input to make sure that it is reasonable: as long as your input fits the correct format it will be accepted, whether appropriate or not. In light of this fact you should be very careful that you check the input to make sure that all of it is reasonable and logical.

COSTSAFR does check input data for completeness. If any input data that the program needs have not been entered, a warning message will appear on the screen after "Generate Compliance Forms" has been selected. The warning indicates the nature of the missing data and returns the user to the Main Menu so that the data can be entered.

3.0 ENTER PROJECT DESCRIPTION FUNCTION

3.1 PROJECT DESCRIPTION SCREEN - OVERVIEW

This is the first split screen in the program, and it appears if you select the "Project Description" function from the Main Menu. Figure 3.1 is the initial screen in the Project Description section. The right side will be blank initially, but information will appear there when you move the cursor into the lower section of the left hand screen, which is the part that starts with: "A. Project Location."

Project
Description
Screen -
Overview

The figure shows a terminal window with a split-screen layout. The top section contains input fields for RFP No., Current Year (1987), Area Cost Multiplier (1.000), 1987 Base Price Esc. Index (1.000), and Appliances included in RFP? (y). Below this is a prompt to press the left arrow key to select from a menu of available choices. The menu lists six options: A. Project Location, B. Acceptable Foundation Types, C. Acceptable Building Types, D. Heating Equipment Types, E. Cooling Equipment Types, and F. DHW Fuel Types. At the bottom, two callout boxes provide instructions: 'ESC to main menu' and 'Fill in blank. ↑↓ moves cursor'.

```
>RFP No:
Current Year:      1987
Area Cost Multiplier: 1.000
1987 Base Price Esc. Index: 1.000
Appliances included in RFP?: y

      PRESS ← TO SELECT FROM
      MENU OF AVAILABLE CHOICES

A. Project Location:
B. Acceptable Fndation Types:
C. Acceptable Building Types:
D. Heating Equipment Types:
E. Cooling Equipment Types:
F. DHW Fuel Types:

ESC to main menu  Fill in blank.
                  ↑↓ moves cursor
```

FIGURE 3.1. Initial Project Description Screen

If you want to modify any of your entries anywhere on this screen, you can return to the appropriate line using the cursor controls and simply type the correct information directly over the old.

3.2 UPPER SECTION - DIRECTIONS FOR DATA ENTRY

Use the up and down arrow keys to select the items you wish to enter or change.

1. RFP No: Type in the RFP number, followed by "<cr>". Use the backspace, the right arrow, and the left arrow keys to correct any typing errors.
2. Current Year: Enter the current calendar year, followed by "<cr>".
3. Area Cost Multiplier: Type in the latest Area Cost Multiplier for the Area in which the housing project is located. This number is used to adjust the cost data (based upon a national average) to reflect local costs. For example, a multiplier of 1.10 increases all costs by 10%. The default value is 1.0. Follow with "<cr>". These multipliers can be obtained by requesting AR 415-17 from the NTIS:

RFP No.

Current Year

Area Cost
Multiplier

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

4. 1987 Price Esc. Index: The building costs and other non-fuel costs in the data base are based on 1987 prices. In other years, these costs must be adjusted for the change in prices due to inflation since 1987. Inflation is assumed to have a uniform effect on all non-energy costs. For example, an index of 1.05 increases all 1987 costs by 5%. Type in the mid-1987 based Price Escalation Index, followed by "<cr>". The Price Escalation Index, used to make this inflation adjustment, has a default value of 1.0. The escalation rates for residential construction costs are available in the Survey of Current Business.

Price Escalation
Index

Survey of Current Business,
Department of Commerce
Bureau of Economic Analysis
Washington D.C., 20230

Please note that changes in the real cost (excluding the effects of inflation) of an item are made through modification of the cost data base (see Section 5).

5. Appliances included in RFP?: Enter "Y" for yes or "N" for no, followed by "<cr>". (For the purposes of this Standard, "Appliances" refers to refrigerators/freezers only.)

Appliances
Included?

3.3 LOWER SECTION - DIRECTIONS FOR DATA ENTRY

Use the up and down arrow keys to select the items you wish to enter or change.

- A. Project Location: Figure 3.2 shows the screen that appears when the cursor is on Project Location. When the cursor is on this line, strike "<cr>" to move the cursor to the right hand screen.

<p>RFP No: _____</p> <p>Current Year: 1987</p> <p>Area Cost Multiplier: 1.000</p> <p>1987 Base Price Esc. Index: 1.000</p> <p>Appliances included in RFP?: y</p> <p>PRESS <u>↵</u> TO SELECT FROM MENU OF AVAILABLE CHOICES</p> <p>>A. Project Location: B. Acceptable Fndation Types: C. Acceptable Building Types: D. Heating Equipment Types: E. Cooling Equipment Types: F. DHW Fuel Types:</p> <p>ESC to main menu ↵ to select.</p> <p>↑↓ moves cursor</p>	<p>ENTER ACTUAL NAME OF PROJECT LOCATION</p> <p>City: _____</p> <p>ENTER 2 LETTER POSTAL CODE FOR PROJECT STATE</p> <p>Project - State: _____</p> <p>ENTER 2 LETTER POSTAL CODE FOR CLIMATE STATE</p> <p>Climate - State: _____</p> <p>Select climate city:</p>
--	---

FIGURE 3.2. Project Location Screen

Enter the name of the project location followed by "<cr>". This entry should be the name on the RFP itself. It is used for identification purposes only, and will not affect the operation of the program.

Project
Location

Enter the state where the project is located,

Project State

followed by "<cr>". Use the 2-letter Post Office code. Again, this entry is for identification only.

Enter the 2-letter code for the location of the state for the climate city. This will normally be the same as the project state, but can be different if the most appropriate climate city is located in a different state. At this point a list of the available climate cities for the state will appear on the right screen.

Climate State

Use the up and down arrow keys to move the cursor through the list of cities, and strike "<cr>" to select the city closest in climate to the project location. Note that this will not necessarily be the city which is physically closest to the project, particularly in mountainous or coastal areas. Guidance in this selection may be obtained by consulting NOAA data, National Weather Bureau data, the "Air Force, Army and Navy Engineering Weather Data" manual, or the local meteorological station.

Climate City

When the climate city has been selected, review the information on the right half of the screen, correct it if necessary, and return to the left screen by striking "<esc>".

- B. Acceptable Foundation Types: Strike "<cr>" to move the cursor to the right screen. The default for each of the foundations (slab, crawlspace, or basement) is "Y". If any of the foundation types are to be excluded from the RFP, move the cursor to that foundation type and enter "n" or "N", followed by "<cr>". Figure 3.3 shows the Foundation types screen. Note that the instructions have moved from the left half of the screen to the right half. This is because this copy of the screen was produced when the cursor was in the right half.

Acceptable
Foundation
Types

Please note that only the crawl foundation is available for Single-Section and Multi-Section Manufactured Homes. Crawlspace foundations must be included if either type of manufactured home is selected as an Acceptable Building Type (see the next item). Similarly, basement foundations are not available in the data base for apartments.

When you are finished with the right side of the screen strike "<esc>" to return to the left screen.

<p>RFP No: _____</p> <p>Current Year: 1987</p> <p>Area Cost Multiplier: 1.000</p> <p>1987 Base Price Esc. Index: 1.000</p> <p>Appliances included in RFP?: y</p> <p style="text-align: center;">PRESS ↵ TO SELECT FROM MENU OF AVAILABLE CHOICES</p> <p>A. Project Location:</p> <p>>B. Acceptable Fndation Types:</p> <p>C. Acceptable Building Types:</p> <p>D. Heating Equipment Types:</p> <p>E. Cooling Equipment Types:</p> <p>F. DHW Fuel Types:</p>	<p style="text-align: center;">FOUNDATION TYPES INCLUDED IN RFP</p> <table style="width: 100%;"> <tr> <td>Slab on grade</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Crawl space</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Basement</td> <td style="text-align: right;">y</td> </tr> </table> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">ESC when done</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">Fill in blank. ↑↓ moves cursor</div> </div>	Slab on grade	y	Crawl space	y	Basement	y
Slab on grade	y						
Crawl space	y						
Basement	y						

FIGURE 3.3. Acceptable Foundation Types Screen

- C. Acceptable Building Types: Strike "<cr>" to move the cursor to the right screen. There are 7 building types analyzed by the Standard:
- Acceptable Building Types
- 1) Single-Section Manufactured Homes, 2) Multi-Section Manufactured Homes, 3) Ranch houses, 4) Split-level houses, 5) Two-story houses, 6) Townhouses, and 7) Apartments. Note that you will generate two compliance forms for Townhouses and Apartments, one for end units and one for middle units. For Duplexes use the Ranch house selection. If you plan to save the output from COSTSAFR on the Analyzer disk, you will not be able to run all prototypes at one time because of disk space limitations. See Section 1.2 for more information on disk space. Figure 3.4 shows what the building types screen looks like. The default for the Ranch, Multi-section and Single-section building types is "Y". If any of these building types are not acceptable for this RFP, move the cursor to that building type and enter "n" or "N", followed by "<cr>". Similarly, enter a "y" or "Y" following any of the other

<p>RFP No: _____</p> <p>Current Year: 1987</p> <p>Area Cost Multiplier: 1.000</p> <p>1987 Base Price Esc. Index: 1.000</p> <p>Appliances included in RFP?: y</p> <p style="text-align: center;">PRESS ↵ TO SELECT FROM MENU OF AVAILABLE CHOICES</p> <p>A. Project Location:</p> <p>B. Acceptable Fndation Types:</p> <p>>C. Acceptable Building Types:</p> <p>D. Heating Equipment Types:</p> <p>E. Cooling Equipment Types:</p> <p>F. DHW Fuel Types:</p>	<p style="text-align: center;">BUILDING TYPES TO BE INCLUDED IN THIS RFP</p> <table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 80%;">>Single Story Ranch?</td><td style="width: 20%; text-align: right;">y</td></tr> <tr><td>Split Level?</td><td style="text-align: right;">n</td></tr> <tr><td>Two Story?</td><td style="text-align: right;">n</td></tr> <tr><td>Townhouse?</td><td style="text-align: right;">n</td></tr> <tr><td>Apartment?</td><td style="text-align: right;">n</td></tr> <tr><td>Sngle Sec Manuf?</td><td style="text-align: right;">y</td></tr> <tr><td>Multi Sec Manuf?</td><td style="text-align: right;">y</td></tr> </table> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; text-align: center;">ESC when done</div> <div style="border: 1px solid black; padding: 5px; text-align: center;">Fill in blank. ↑↓ moves cursor</div> </div>	>Single Story Ranch?	y	Split Level?	n	Two Story?	n	Townhouse?	n	Apartment?	n	Sngle Sec Manuf?	y	Multi Sec Manuf?	y
>Single Story Ranch?	y														
Split Level?	n														
Two Story?	n														
Townhouse?	n														
Apartment?	n														
Sngle Sec Manuf?	y														
Multi Sec Manuf?	y														

FIGURE 3.4. Acceptable Building Types Screen

building types that are acceptable. A compliance form will be generated for each acceptable building type.

When you are finished with the right side of the screen, strike "<esc>" to return to the left screen.

- D. Acceptable Heating Equipment Types: The right hand screen that appears here is shown in Figure 3.5. Strike "<cr>" to move the cursor to the right screen. The default for each type of heating equipment is "y" or "Y". To eliminate the unacceptable equipment type(s) for this RFP, move the cursor to each type that is not acceptable and type "n" or "N".

Heating
Equipment
Types

For each acceptable equipment type, you should also enter the fuel price for that type of equipment. Make sure to pay attention to the units for the fuel prices. Oil and LP gas are priced per gallon, natural gas by therm, and electricity by kWh.

Fuel Prices

RFP No: _____ Current Year: 1987 Area Cost Multiplier: 1.000 1987 Base Price Esc. Index: 1.000 Appliances included in RFP?: y <p style="text-align: center;">PRESS ← TO SELECT FROM MENU OF AVAILABLE CHOICES</p> A. Project Location: B. Acceptable Fndation Types: C. Acceptable Building Types: >D. Heating Equipment Types: E. Cooling Equipment Types: F. DHW Fuel Types:	<div style="text-align: center; border-bottom: 1px solid black; margin-bottom: 10px;">HEATING EQUIPMENT SELECTIONS</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td>Oil Furnace</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Current Oil Price</td> <td style="text-align: right;">1.000</td> </tr> <tr> <td colspan="2" style="padding-left: 20px;">(units: \$/gal)</td> </tr> <tr> <td>LP Gas Furnace</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Current LP Price</td> <td style="text-align: right;">1.000</td> </tr> <tr> <td colspan="2" style="padding-left: 20px;">(units: \$/gal)</td> </tr> <tr> <td>Nat Gas Furnace</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Current Gas Price</td> <td style="text-align: right;">1.000</td> </tr> <tr> <td colspan="2" style="padding-left: 20px;">(units: \$/Therm)</td> </tr> <tr> <td>Elec Basebrd/Furnace</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Current Winter Elec Price</td> <td style="text-align: right;">0.100</td> </tr> <tr> <td colspan="2" style="padding-left: 20px;">(units: \$/kWh)</td> </tr> <tr> <td>Elec Heat Pump</td> <td style="text-align: right;">y</td> </tr> <tr> <td>Current Winter Elec Price</td> <td style="text-align: right;">0.100</td> </tr> <tr> <td colspan="2" style="padding-left: 20px;">(units: \$/kWh)</td> </tr> </table> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 2px 5px;">ESC when done</div> <div style="border: 1px solid black; padding: 2px 5px;">Fill in blank. ↑↓ moves cursor</div> </div>	Oil Furnace	y	Current Oil Price	1.000	(units: \$/gal)		LP Gas Furnace	y	Current LP Price	1.000	(units: \$/gal)		Nat Gas Furnace	y	Current Gas Price	1.000	(units: \$/Therm)		Elec Basebrd/Furnace	y	Current Winter Elec Price	0.100	(units: \$/kWh)		Elec Heat Pump	y	Current Winter Elec Price	0.100	(units: \$/kWh)	
Oil Furnace	y																														
Current Oil Price	1.000																														
(units: \$/gal)																															
LP Gas Furnace	y																														
Current LP Price	1.000																														
(units: \$/gal)																															
Nat Gas Furnace	y																														
Current Gas Price	1.000																														
(units: \$/Therm)																															
Elec Basebrd/Furnace	y																														
Current Winter Elec Price	0.100																														
(units: \$/kWh)																															
Elec Heat Pump	y																														
Current Winter Elec Price	0.100																														
(units: \$/kWh)																															

FIGURE 3.5. Acceptable Heating Equipment Types Screen

(A therm is 100,000 Btus and may not equal a cubic foot of gas. Gas companies can supply the number of therms in a cubic foot of their gas if they price it by the cubic foot.) The fuel price entered on this screen is the true fuel price which the utilities or fuel suppliers will charge for additional fuel needed to heat or cool the newly constructed units. Fuel prices should be for the current year.

The computer program requires the user to enter a single price per unit of fuel for heating and cooling. While this may reflect the actual utility charges for oil, LP gas or natural gas, electricity rate schedules are becoming more complex. Time-of-day rates, block rates, etc. may affect the marginal electricity rate that applies to a new housing project. The user should consult the local utility to determine the appropriate rates. The computer program accommodates some of this variation by requiring the user to input two constant electricity prices for space conditioning: one for the heating season and another for the cooling season. Yearly average

rates for appliance calculations and a yearly rate specifically for domestic hot water are entered in part F of the Project Description.

When you are finished with the right side of this screen, strike "<esc>" to return to the left screen.

<p>RFP No: _____ Current Year: 1987 Area Cost Multiplier: 1.000 1987 Base Price Esc. Index: 1.000 Appliances included in RFP?: y</p> <p>PRESS ← TO SELECT FROM MENU OF AVAILABLE CHOICES</p> <p>A. Project Location: B. Acceptable Fndation Types: C. Acceptable Building Types: D. Heating Equipment Types: >E. Cooling Equipment Types: F. DHW Fuel Types:</p>	<p>COOLING EQUIPMENT SELECTION</p> <p>Are Units Air Conditioned? y Curr. Summer Elec Price: 0.100 (units: \$/kWh)</p> <p>ESC when done</p> <p>Fill in blank. ↑↓ moves cursor</p>
---	--

FIGURE 3.6. Acceptable Cooling Equipment Types Screen

- E. Acceptable Cooling Equipment Types: Strike "<cr>" to move the cursor to the right side of the screen. Enter a "y" or "Y" after "Cooling Required?" to indicate that air conditioning is required for this project. Figure 3.6 is the cooling equipment type screen. The default for air conditioning is "Y". If air conditioning is not required, enter "n" or "N". If air conditioning is required, enter the SUMMER electric fuel price. As with the heating fuel prices, the summer electric price should be the price per kWh for additional electricity needed to air condition the new units. When you are finished with the right side of this screen, strike "<esc>" to return to the left screen.
- Cooling Equipment Types

F. DHW Fuel Types: Strike a "<cr>" to move the cursor to the right side of the screen. Enter "y" or "Y" for each domestic hot water (DHW) fuel that is acceptable, followed by the fuel price. The default for each fuel type is "Y". Enter "n" or "N" for each DHW fuel that is unacceptable. A specific electricity rate for water heating is requested. If no special rate for water heating is available then enter the general yearly average electricity rate. Figure 3.7 shows the DHW fuel type screen.

DHW Fuel Types

RFP No: Current Year: 1987 Area Cost Multiplier: 1.000 1987 Base Price Esc. Index: 1.000 Appliances included in RFP?: y PRESS ← TO SELECT FROM MENU OF AVAILABLE CHOICES A. Project Location: B. Acceptable Fndation Types: C. Acceptable Building Types: D. Heating Equipment Types: E. Cooling Equipment Types: >F. DHW Fuel Types:		DHW FUEL TYPES Elec Resistance DHW? y Current DHW Elec Price 0.100 (Units: \$/kwh) Gas DHW? y Current Gas Price 1.000 (Units: \$/Therm) THE FOLLOWING VALUE IS REQUIRED FOR ALL ACTIVITIES Current Avg Elec Price 0.100 (units: \$/kwh)	
		ESC when done	Fill in blank. ↑↓ moves cursor

FIGURE 3.7. DHW Fuel Types Screen

COSTSAFR is designed for natural gas heating of domestic hot water, because water heater labels use natural gas ratings on their labels. To use COSTSAFR for LP gas water heating, divide the LP gas costs (\$/gallon) by 0.91 therm/gallon to get an equivalent cost for LP gas in \$/therm. Enter this figure for the Gas DHW Fuel Cost. YOU WILL NEED TO CHANGE THE COMPLIANCE FORMS BY WRITING "LP" IN FRONT OF "GAS DHW HEATERS" ON THE DOMESTIC HOT WATER AND REFRIGERATOR POINT SYSTEM.

Adjustments For Propane Domestic Hot Water Heating

Also input the average electricity price. This is the 12-month average price for electricity purchased continuously throughout the year, and will be used for appliance energy calculations. As with all of the fuel prices used in this program, it should be the true price that will be paid for the fuel.

When you are finished with the right side of this screen, strike "<esc>" to return to the left screen.

3.4 REVIEW

When you are finished with the Project Description screen, review each of the sections for correct information by moving the cursor up the left side of the screen. When the Project Description screen is completed correctly, strike "<esc>" to return to the Main Menu.

Review Data
Before
Proceeding

4.0 SELECT MINIMUM VALUES FUNCTION (OPTIONAL)

Select Minimum Values is an optional function of COSTSAFR. It is not required to generate compliance forms. If this is your first time running the program, it is suggested that you go directly to the "Save Project Description" function described in Section 6.0 of this manual.

Please remember that Minimum Values for insulation levels and equipment efficiency should NOT be changed for energy-related reasons. This section of the program allows exclusion of items which are unacceptable for reasons OTHER than energy issues. Note that minimum values do not affect the number of compliance points required. The minimum values only restrict the ways that the designer/builder complies with the Standard. See Part 2.1 of this manual for further discussion.

4.1 SELECT MINIMUM VALUES SCREEN

This screen works in a similar fashion to the Project Description Screen. As you move the cursor to each line on the left side of the screen, the right side of the screen will display the available choices. The highlighting always indicates the option which has been selected, whether it is the default or whether the default has been changed.

Select Minimum
Values Screen

"No Minimum Value" means that all of the values in each of the data bases will be used. If you wish to change the minimum value, strike "<cr>" to move to the right side of the screen, move the cursor to the choice you want, and strike "<cr>". The cursor will move back to the left side of the screen, and the right side will now show your choice as the minimum value.

When you are finished with this screen, check the entries by moving the cursor up and down the left side, then hit "<esc>" to return to the main menu.

5.0 CHANGE COST FACTORS FUNCTION (OPTIONAL)

Change Cost Factors is an optional function of COSTSAFR; it is not required to generate compliance forms. If this is your first time running the program, it is suggested that you go directly to the "Save Project Description" function described in Section 6.0 of this manual.

YOU MUST SAVE YOUR CHANGED COST DATA OR IT WILL NOT BE USED WHEN YOU GENERATE COMPLIANCE FORMS. Please note that after you have changed cost data using this function and are escaping from the section, you must respond with a "Y" when asked if you want to change the data permanently. If you make changes without saving them and then Generate Compliance Forms, you will find that COSTSAFR has read in the old cost data from the disk and used it for the calculations.

Important Notice!

Please note that all costs in the data base are contractor's prices (or manufacturer's prices in the case of single-section and multi-section homes). Take care that all prices you enter in the Cost Data Bases are contractor's prices, not retail prices. A factor accounting for profit and overhead is applied to all costs automatically during the calculations.

YOU SHOULD BE VERY CAREFUL ABOUT CHANGING THE COST DATA. If you are not familiar with the way costs are treated in this program, read Section 9.0 of this manual before you proceed. It is extremely important that the cost data base remains internally consistent because each of the items in the data base is compared with all of the others within the program. Whenever ANY of the costs are changed, ALL of the costs should be reviewed to ensure that changes are being made consistently. In addition, it is strongly recommended that the data disk which contains the cost data be copied before any costs are changed. This will ensure that a copy of the original cost data always exists in case of mistakes or disasters.

CAUTION!

There are three cost data bases used by COSTSAFR for site-built, single-section, and multi-section homes. See Part 9.0 of this Manual, for specific descriptions of the items in the cost data bases and an example illustrating the need for consistency in any cost changes.

Three Cost
Data Bases

5.1 CAUTION SCREEN

When you select "Change Cost Data" on the Main Menu, a "CAUTION" screen will appear first. All costs you enter must come from the same year because the Life Cycle Cost calculations that occur within the program must be performed on a consistent basis. You must tell the program what that year is. The program then automatically makes the new cost data you enter compatible with the existing cost data that are already stored within the program. The year you enter on this screen will be referred to as the "base year" in the rest of this section.

CAUTION Screen

Year of Costs

You must also enter the Price Escalation Index for the base year relative to 1987 to account for inflation since mid-1987. Like the Price Escalation Index (PEI) which you enter on the Project Description screen, the Price Escalation Index used here assumes 1987 as the year of all costs in the cost data base. For example, if costs have risen 15% from mid-1987 to the base year, the Price Escalation Index you should enter is 1.15. Procurement officials should have access to these indexes.

Price Escalation Index

On this screen you must also supply the Area Cost Multiplier (ACM) to be used in updating the costs. The ACM allows you to use correct cost data for any region of the country. If the costs represent national average costs, the multiplier is 1.0. If the costs you are entering are from a region with prices 20% higher than the national average, for example, then you would enter a multiplier of 1.2. Procurement officials should have access to these multipliers.

Area Cost Multiplier

Note that the Price Escalation Index and Area Cost Multiplier in the "CAUTION" screen perform a different function than the ones in the Project Description screen. The PEI and ACM in the "CAUTION" screen escalate the cost data base for visual inspection and printing only. The Price Escalation Index and Area Cost Multiplier entered in the "CAUTION" screen will have no permanent effect on the data base. However, if any costs are changed, the costs will be divided by the PEI and ACM entered on this screen to obtain 1987 national average prices. In this way, the program user can enter current regional prices that will be consistent with the data base.

Refer to Part 9.0 of this Manual for a more extensive discussion of the Area Cost Multiplier and the Price Escalation Index.

When you have entered the year for the cost changes, the Price Escalation Index for that year, and the Area Cost Multiplier, strike "<cr>" to proceed to the next screen.

5.2 COST CHANGE MENU

This screen allows you to print or modify the cost data base. You can modify only one cost data base at a time, but you can modify any or all of them by returning to this menu. Choose one by moving the cursor and striking "<cr>".

Cost Change
Menu

If you elect to print the current costs, the program will proceed to the Print Cost Data Menu, described in section 5.5 below.

If you choose to change the costs for one of the cost data bases the program will proceed to the "Change Cost Data" screen, described in section 5.3 below.

5.3 CHANGE COST DATA SCREEN

The operation of this screen is similar to the operation of the Project Description screen, except that the Change Cost screen has three sections rather than two. The first section, where the cursor starts, runs across the top of the screen and it lists the various cost data categories, such as Ceiling Insulation, Wall Insulation, etc. The abbreviations used are described in Section 9. Move the cursor through this section using the right and left arrow keys.

Change Cost
Data Screen

As you move through the first section you will see the second section on the lower left side of the screen display the list of items in each category. Select the category you wish to modify, and move to the second section of the screen by striking "<cr>".

You can now move through the second (lower left side) section by using the up and down arrows. As you move the cursor, the third section will display the costs for each item (first cost, operations and maintenance, capital replacements and salvage value) on the lower right side of the screen. If you want to change any of the costs, strike "<cr>" to move to the third section on the right side of the screen.

In the third section, you can modify any or all of the costs by moving the cursor to the proper place and simply typing the new cost over the old one. When you are finished modifying the costs for an item, strike "<esc>". The cursor will move back to the left side, and the newly entered costs will now appear on the right side of the screen. For information on the specifics of each cost, see Section 9 of this Manual, which describes the basis for the cost data.

The cost data base is used by COSTSAFR in determining the optimal design. Since some conservation measures are not used in the optimization process, their costs are not included in the cost data base. Moveable insulation is in this category. The lower right side screen will be blank for moveable insulation options as costs have been set to a null value.

Null Costs

It is important to note the costs for window options are repeated. For example, the costs for clear glass with the three sash types are repeated four times for the four window areas in the site built data base. The window costs are on a square foot basis and will be the same regardless of the window area. However, COSTSAFR requires cost data for each area. Repeated costs also exist for heat absorbing glass and reflective glass. Be careful that all the repeated costs are changed when changing window costs.

Repeated Costs

By repeating the same process for the rest of the data base, you can review and/or modify all of the costs in this data base. When you are finished, strike "<esc>" until you return to the Cost Change Menu. Remember, IF ANY COSTS ARE CHANGED ALL OF THE DATA BASES SHOULD BE REVIEWED to make sure that all of the cost data are consistent. When you are finished reviewing all three cost data bases, return to the Main Menu by striking "<esc>".

5.4 WARNING AND COMMENT SCREEN

If you have changed any of the costs in any of the three data bases, the program will not let you proceed directly to the Main Menu; instead the Warning and Comment Screen will appear. You will be asked if you want to permanently save the changes you have made; answer with a "y" or "Y" for yes or "n" or "N" for no. If you elect to save the changes, the program will make a permanent change in the cost data bases by changing the information on the data disk. Anytime

Warning and Comment

this data disk is used in the future, the cost data bases will exist only in the changed form.

If the user wants to use the new cost data, the user must request that the new cost data be saved. Then the cursor will automatically be positioned at the line where the user types the current date. The up and down arrows can be used to record up to three lines of comments about changes to the cost data base. You should always insert comments that describe any changes you have made for future reference. The date and the comments will then be displayed on the second screen of the program whenever the revised data disk is used. This will enable future users of the program to know that they are using an updated cost data base. When you are done, press the "<esc>" key. The program then returns you to the Change Cost Factors menu.

Always Insert
Comments

5.5 PRINT COST DATA MENU

The Print Cost Data menu allows you to print one or all of the three cost data bases. Move the cursor using the up and down arrows to make your selection, and then type "<cr>" to proceed.

Print Cost
Data Menu

The next screen asks you to prepare the printer, and you type "<cr>" when it is ready. The cost data are typed out on the printer only, not the screen. When the printer is finished or if you want to abort the printout, type "<esc>" and the program returns to the Print Cost Data menu.

Ready Printer

All cost data bases will be printed using the Price Escalation Index and Area Cost Multiplier which you entered on the "CAUTION" screen. The year of the costs, the Price Escalation Index, and the Area Cost Multiplier will appear on the printout. The data in the program will remain the 1987 national average prices.

Printed Costs
Use the Price
Escalation Index
and Area Cost
Multipliers

6.0 SAVE PROJECT DESCRIPTION FUNCTION (OPTIONAL)

The Save Project Description function is used to save on a disk file all the Project Description data you have previously entered. It is suggested that you save your input data before proceeding to the Generate Compliance Forms function, so that you can easily make any changes required for another run.

When you select the Save Project Description function, you will see a screen by that name that asks you to enter a filename in which the data will be stored. You should type in a name that is descriptive of the project (no more than eight characters, followed by a period and up to three more characters) in the space provided on the screen. Use the cursor control keys to correct any errors. It is suggested that the file names be given the extension ".inp" to help identify these files as input files. Note that if you use a filename that has been used previously, the old data will be erased. When you are finished typing the name, type a "<cr>". Typing "<esc>" returns you to the main menu.

Save Project
Description Screen

The project description data will be saved on the same disk with the COSTSAFR program, in a file with the name you have given it. Appendix C contains the Project Description File Table, which can be used to keep track of all input files. You should periodically delete the saved data files when the information is no longer required. This will prevent filling your program disk. See your DOS manual for instructions on deleting files. The following section explains how to retrieve these data.

7.0 RESTORE PROJECT DESCRIPTION (OPTIONAL)

Restore Project Description is an optional function; it is not required to generate compliance forms. If this is your first time through the program, it is suggested that you proceed to section 8.0 of this manual.

The Restore Project Description function is used to retrieve Project Description data that have previously been saved using the Save Project Description function. When you select the Restore Project Description function, you will see a screen by that name that asks you to type in the name of the file on which the data was stored. If the COMMAND.COM file has been stored on your disk a list of all files on the disk will be at the top of the screen. This filename must be typed in exactly as it was when the data was saved, followed by a "<cr>". Use the cursor control keys to correct any errors. Type "<esc>" to return to the main menu. If a file with that name cannot be found, the program will print a message to that effect. Otherwise it will read the project description into the program just as if you had typed in the data. You can then change the data, generate compliance forms, or use any of the other functions in the normal manner.

Restore Project
Description Screen

There is another way to view the Project Description data without using the COSTSAFR program. You can also print the Project Description with this procedure. The DOS command "TYPE L:filename" will show the data on the computer screen, where "L:" is the designation of the disk drive (such as a: for the A drive) that contains the COSTSAFR program and "filename" is the name of the file you gave COSTSAFR when you saved the Project Description. Typing the "ctrl" key and the "PrtSc" key simultaneously before using the above DOS command will send a copy of the file to the printer as well.

Viewing Saved
Project Description
Data Without
Using COSTSAFR

8.0 GENERATE COMPLIANCE POINT SYSTEM

8.1 GENERATING AND PRINTING COMPLIANCE FORMS

It is suggested that you save the data you entered by selecting "Save Project Description" function from the Main Menu before proceeding. (See Section 6.0 of the User's Manual).

Suggestion: Save
Input Data First

If you want to run the program using the project description that you have entered, move the cursor to the "Generate Compliance Point System" function on the Main Menu, and strike "<cr>".

You may either send the output of the program directly to the printer or save it in a file. If the file option is chosen, you will be prompted for a file name for the compliance forms. The file name can be up to 8 characters followed by a period and an extension of up to 3 characters. Choose a descriptive name that will indicate what the file contains. If you wish to send the file to a disk other than the default disk enter the letter assigned to that drive followed by a colon and the file name. For example, a COSTSAFR output with the name ranch.pts can be sent to the A drive by entering "a:ranch.pts".

Output File Name

After either the printer option is chosen or a file name is entered, the input is complete and the COSTSAFR program will begin to run. Because of the large number of calculations involved in the economic analysis, the run time can be considerable. The program will take an especially long time to run when more than one fuel type has been chosen because it must do all of the cost/benefit calculations separately for each fuel type. The execution speed also varies with the hardware configuration. For a complete analysis, with all fuel, building and foundation types, the run time may vary between 30 minutes to 1 hour. A simpler analysis may take as little as 5 minutes or less.

When the program has finished all of its calculations, it will stop flashing "Performing Life Cycle Cost Analysis" and return you to the Main Menu.

8.2 VIEWING AND PRINTING THE POINT SYSTEM

At this point, you can exit the program and view the point system compliance forms on the screen, and have

Exiting From
COSTSAFR

them printed. To do so, press "<esc>" until you get to the first screen and respond with a "y" when the screen asks if you really want to exit.

The point system is created in a file with the file name entered by the user in "Generate Compliance Point System" function. If you want to see the point system on the screen enter the word "type" followed by a space and the "file name". For example, if the file was named "ranch.pts" you would enter "type ranch.pts" followed by a carriage return. If you want to keep part of the point system on the screen, press the "CTRL" and "NUMLOCK" keys together; type any key to continue. To print out the point system on the printer, type the "CTRL" and "PRTSC" keys together followed by "type file name". Press the "CTRL" and "BREAK" keys together to interrupt typing the point system to either the screen or the printer and return to the DOS.

Typing Out The Point System

The point system consists of a set of compliance points for each prototype selected in the Project Description section. Directions for its use and compliance criteria are included in the Appendices.

Issuing Compliance Forms in RFP

A copy of the compliance forms (point system) and the directions (Appendices A and B) should be attached to each RFP issued for the housing project. The echo of the Project Description data at the end of the compliance forms should be removed by the procurement official and retained for future reference.

9.0 DERIVATION OF COST DATA

9.1 CAUTIONS ABOUT COST CHANGES

You should be extremely careful about changing the cost data used in this program. This Energy Standard uses a Life Cycle Cost analysis and the cost data form the basis for this calculation. It is important that all costs be created using consistent assumptions because all ECOs are compared against each other within the economic analysis. The Standard can only function effectively if the consistency of the cost data is not compromised.

Caution!

YOU SHOULD BE CAREFUL TO CHECK ALL COSTS THAT YOU DO NOT CHANGE, AS WELL AS THE ONES YOU DO, to make sure that they are compatible with the new costs you have just entered.

If you do not check all costs, you may be creating incorrect relationships. For example, suppose that you have the information that the per square foot cost of R-19 walls has increased. Before implementing the new costs in the data base, an investigation will be required on the cause of this higher price. If 2x6 studs have become more expensive, the R-24 and R-26 walls will also cost more. On the other hand, if the cost increase results from the price of fiberglass insulation going up, then the R-7, R-11 and R-13 walls will also be affected. At the same time, floor and ceiling insulation costs also have to be changed. If this latter change is not performed, the program may incorrectly decide that adding insulation in ceiling and floors is more cost effective than adding it to walls. Finally, if the R-19 wall price increase is due to higher labor costs, all costs have to be reviewed (e.g. windows, infiltration, equipment, etc.). The Cost Change Menu provides a way to print all of the cost data in order to make this review process easier.

Examples of
Inconsistent Cost
Data Changes

As a further safeguard, whenever you change the cost data base you will be required to leave a comment which will alert future users that the costs have been modified.

9.2 AREA COST MULTIPLIERS AND PRICE ESCALATION INDEX

Because of the way the cost data are stored in the program, it is very important that you understand these values and the ways they are used by the program. No matter what is displayed on the computer screens, and no matter how you input new data, the cost data are always stored on the data disk as 1987 national average costs.

Cost Data Base
Uses 1987 National
Average Costs

However, RFPs should use proper costs related to the Project, i.e. the correct local and current prices. These calculations require local costs for the time when the project will be built. The Price Escalation Index modifies the data base costs to account for the change in prices since 1987, and the Area Cost Multiplier accounts for the difference between national average prices and local prices. The PEI and ACM are entered in the Project Description step.

Current Local Costs
Are Used For
Compliance Forms

The Area Cost Multiplier and Price Escalation Index are also requested on the "CAUTION" screen which appears when you enter the Change Costs Factors Menu. The ACM and PEI in the Project Description are used to correct the cost data base when COSTSAFR is run. Area Cost Multipliers and Price Escalation Indexes on the "CAUTION" screen in the Change Cost Factors are not used when the program is run, but perform two functions: 1) to modify the cost data for visual inspection (either on-screen or printed), and 2) to maintain the compatibility of any costs changes with the unchanged costs. These two functions are discussed below.

Why There Are Two
Locations for the
ACM and PEI

When you look at the costs on the screen in the Change Cost Factors Function, the program takes the 1987 national average costs and multiplies them by both the Area Cost Multiplier and the Price Escalation Index, both of which were input on the "CAUTION" screen. The modified numbers are the ones that appear on the screen. The screen that displays the costs will also display the year that is being used, and it will remind you that the Price Escalation Index and the Area Cost Multiplier are included in the cost values which are displayed.

On-Screen Costs

The same process occurs if you print the current cost data: the 1987 national average data on the disk is multiplied by the Area Cost Multiplier and by the Price Escalation Index before it is printed.

Printed Costs

The Area Cost Multiplier and Price Escalation Index are used in a similar manner when you change the existing cost data. The proper ACM and PEI entered on the "CAUTION" screen allow you to include current, regionally correct costs into the data base. The new data are divided by the Area Cost Multiplier and the Price Escalation Index to convert it to 1987 national average cost data. At that point the new data are compatible with the unchanged portion of the cost data, and they can be combined to create a new, updated cost data base.

Cost Changes

9.3 DATA BASE STRUCTURE

There are three separate cost data bases within the program: one for Site-Built construction, one for Single-Section Manufactured construction, and one for Multi-Section Manufactured construction. The Site-Built data base covers traditional "site-built" construction and modular or penalized construction techniques. The two Manufactured construction data bases cover units that are also known as "mobile homes". In Section 9.4 below, the costs will be described separately for each of the three cost data bases.

3 Construction Types in Data Bases

In all three of the cost data bases, for each construction item there are nine separate pieces of information:

9 Costs per Item

1. Initial cost. The initial cost is always the installed cost of the item to the contractor: Profit, overhead and general administrative costs are accounted for elsewhere in the program.
2. Annual Operating and Maintenance costs. (These do NOT include the cost of fuel.)
3. The First Capital Replacement cost. Like the initial cost, this is the contractor's cost.
4. The year in which the First Capital Replacement occurs.

This must be a number between 1 and 25 if capital replacement occurs during the analysis timeframe. "1" is the year when the project is first occupied, and "25" is 25 years later. The economic analysis assumes a 25 year life for all housing projects.

5. The Second Capital Replacement cost: This is the contractor's cost.
6. The year in which the Second Capital Replacement occurs.
7. The Third Capital Replacement cost: This is the contractor's cost.
8. The year in which the Third Capital Replacement occurs.
9. The Salvage Value after 25 years.

The program automatically accounts for inflation during the life of the building, and for the fact that some costs will not be incurred until many years after the buildings are occupied. This means that you should list all of the costs as though they were paid today, even though some of them occur many years in the future. The salvage value, for instance, is listed as though the money were to be received today, even though it will be 25 years before any of the items in the program will be "salvage". (The program assumes a 25 year useful economic life for all housing.) In addition, the salvage value, which is actually a "negative cost", should be listed as a positive number: the program knows that salvage value is a benefit rather than a cost.

9.4 DESCRIPTION OF SITE-BUILT COST DATA

The abbreviations used on the Change Factor screen are shown in the right margin.

9.4.1 Ceiling Insulation (Units: \$/sq.ft. of ceiling) Ceiling

All insulation levels are achieved using unfaced fiberglass batts. The cost of roof trusses is included, using the following construction assumptions:

- o Manufactured roof trusses, 24" on center, 2x6 chords, certified for 30 psf loading; 12-inch overhangs at all eaves. For insulation levels of R-38 or more, the height of the roof trusses at exterior walls is increased by eliminating top chord extensions at overhangs and increasing the overall truss length by 12 inches at each end, creating flat soffit overhangs.

9.4.2 Wall Insulation (Units: \$/sq.ft. of wall) Wall

All insulation is kraft-faced fiberglass batt, with the facing installed on the inside. The cost of wall framing is included using the following construction assumptions:

- o Exterior wall construction consists of 2x4 studs, 16 inches on center or 2x6 studs, 24 inches on center, both with 1/2" fiberboard sheathing. Stud depth varies with level of insulation. Other framing considerations include three-stud corners, double 2x4 or 2x6 top plates, single 2x4 or 2x6 bottom plates, double studs at openings, 2-2x8 headers, and an additional stud at intersections with interior walls.

The following finishes, also included in the cost of the wall, were assumed:

- o Interior: 1/2" gypsum wall board
- o Exterior: Aluminum lap siding

Insulation options include:

- R-11: Fiberglass batt insulation within 2x4 framing cavity.
- R-13: Dense fiberglass batt insulation within 2x4 framing cavity.

- R-19: Fiberglass batt insulation within 2x6 framing cavity.
- R-24: Fiberglass batt insulation within 2x6 framing cavity, with 1-inch (R-5) rigid polystyrene insulation board instead of standard sheathing.
- R-26: Fiberglass batt insulation within 2x6 framing cavity with 7/8-inch (R-6.3) rigid isocyanurate insulation board instead of standard sheathing.

9.4.3 Foundations

Site-built houses have 3 foundation types: basement, crawl-space and slab-on-grade. During the economic analysis performed by the computer program, all foundation types, with their various energy conservation measures, are compared in order to select the configuration which is most cost-effective from an energy conservation standpoint.

However, the foundation types also differ significantly in aspects other than energy conservation. For example, basements offer more usable space than crawl or slab; also, structural conditions can strongly impact the cost of any of the 3 foundations.

The cost of an uninsulated foundation is therefore determined by non-energy related considerations, and is addressed elsewhere in the Military Construction procurement process. For the purpose of the Energy Standard, only the cost of the insulation applied to a foundation is taken into account. The costs of uninsulated basement, crawl-space, and slab-on-grade are set to \$0.00, and must not be modified.

9.4.3.1 Basement Insulation (Units: see below)

Basement

Two types of basement insulation techniques are listed on this screen.

BASEMENT_RIGID_INSULATION refers to rigid insulation applied to the exterior of the foundation wall. Cost units are \$/linear foot of basement wall.

Options include:

- R-0: uninsulated basement
- R-5_4FT: 1" rigid polystyrene applied to top 4 feet of wall.

- R-5_8FT: 1" rigid polystyrene applied to the full 8 foot height of the wall.
 R-10_8FT: 2" rigid polystyrene applied to the full 8 foot height of the wall.

BASEMENT CEILING INSULATION refers to fiberglass batts installed between the first floor joists, (framing not included). The joists are 2x10s at 16-inches on center. Cost units are \$/sq.ft. of floor.

9.4.3.2 Crawl Space Insulation: (Units: \$/sq.ft. of floor) Crawl

The cost refers to the batt insulation only (framing not included.) The insulation is placed within the floor cavity between joists and behind the rim joist. All batt insulation is kraft-faced, with the facing installed to the inside. Refer to discussion on air infiltration for optional vapor barrier technique.

9.4.3.3 Slab-on-Grade (Units: \$/linear foot of slab edge) Slab

Costs reflect only the insulation incorporated at the perimeter of the slab (vertically or horizontally.)

- R-0 : uninsulated slab
 R-5_2FT : a 2-foot wide application of 1" thick polystyrene.
 R-10_2FT: a 2-foot wide application of 2" thick polystyrene.
 R-5_4FT : a 4-foot wide application of 1" thick polystyrene.
 R-10_4FT: a 4-foot wide application of 2" thick polystyrene.

9.4.4 Infiltration (Units: \$/sq.ft. of gross wall area) Infiltration

- o AVERAGE: The AVERAGE house is platform framed. Interior surfaces are finished with gypsum drywall on a room by room basis. Exterior wall framing cavities are filled with kraft-faced fiberglass batt insulation. Roof cavities are vented to the outside above fiberglass batt insulation. In the case of vented crawl spaces, faced fiberglass batt insulation is used in the floor framing cavities with the kraft-faced surface on the warm side. Doors and windows are installed

with weatherstripping as installed by manufacturer. Adequate fiberglass sill sealer is applied at the foundation. Since the AVERAGE house is the basis for comparison with the TIGHT and VERY TIGHT houses, its cost is set to \$0.00.

- o TIGHT: The following improvements are made on the AVERAGE house:
 1. A continuous 6 mil polyethylene vapor barrier is applied to the inside surface of all framing members which separate conditioned from unconditioned spaces. Where interior walls intersect exterior walls or ceilings, a 12" width of this vapor barrier is applied to the interior wall framing member along its entire length prior to erection, and the seam is well sealed. Vapor barriers in floors are installed between the floor framing and sub floor sheathing.
 2. At electrical boxes, several steps are taken to ensure an adequate seal. First, the vapor barrier is cut in an "x" over the box; then the flaps are folded into the box. Second, the edge of the box is caulked so as to form a seal against the gypsum wallboard finish. Third, the box is caulked where the wire enters, using caulk which is able to bond to the plastic box and to the rubber wire coating. Finally, foam gaskets are installed beneath switch/receptacle plates.

An alternative to this procedure would be the proper installation of specifically designed and tested electrical boxes which are sealed to restrict air and vapor flow.

3. All seams created by platform framing techniques are sealed by applying a minimum 1/4-inch bead of acrylic latex caulk prior to installation of the adjacent component. Such seams are found between the sill plate and the perimeter joist, at splices in the sill plate, at splices in the perimeter joist (behind solid blocking), between the perimeter floor joist and the floor deck, between the floor deck and the sole plate of the exterior wall, between the top plate of the exterior wall and the ceiling or

floor joist perimeter, at corners formed where exterior walls meet, and so on.

4. A bead of acrylic latex caulk is also used to seal the exterior window/door trim. The void between window/door jambs and rough framing is filled with polyurethane foam.
5. Vents, utility inlets and other miscellaneous thermal envelope penetrations (eg. air conditioners) are sealed with butyl caulk around each penetration. Vents are assumed to be installed with adequate flashing and hoods.

Penetrations considered when calculating prices are: water inlet, gas inlet, electrical box, combustion air inlet, dryer vent, bath fan, range vent, water heater and furnace flue (galvanized steel with framed-in chase).

The cost associated with the TIGHT house is the cost of improvements made over the AVERAGE house.

- o VERY TIGHT: The following improvements are made on the AVERAGE house:
 1. Improvements 1, 2, 3 & 5 from "Tight" above, plus:
 4. No recessed lighting fixtures installed in ceilings.
 6. Non-ducted space conditioning system (electric baseboard, hydronic baseboard) or location of all ductwork within conditioned space.
 7. A heat exchanger with 75% recovery rate is used to provide adequate fresh air to the occupied space.
 8. A continuous air infiltration barrier is applied to the outside surface of exterior wall sheathing, covering the area from below the top of foundation up to the bottom of the roof framing. The air infiltration barrier is cut in an "X" at the openings, with the flaps folded back to seal off all edges. All overlaps in the barrier are sealed using tape and staples.

The cost associated with the VERY TIGHT house is the cost of the improvements made over the AVERAGE house.

9.4.5 Windows (Units: \$/sq. ft. of window)

Window

Options include:

- 1) single, double or triple glazing.
- 2) aluminum, aluminum with thermal break, or wood sashes.
- 3) reflective glazing film applied by the window manufacturer to the exterior pane of the prime window.
- 4) heat absorptive glazing: one layer of tinted glass replacing the exterior clear glass pane.

Costs for heat absorbing and reflective glass represent the cost increase over clear glass. All window options include the cost of gypsum jamb finish, corner bead and wood sill. Wood windows have wood trim moulding on 4 sides.

9.4.6 Natural Gas Furnace (Units: \$/furnace)

Gas Frn

Each housing unit is assumed to have one furnace. The costs are for the installed cost of furnace only: ductwork and other HVAC system components are not included. The AFUE* values listed also refer only to the efficiency of the furnace itself.

9.4.7 Oil Furnace (Units: \$/furnace)

Oil Frn

Each housing unit is assumed to have one furnace. The costs are for the installed cost of furnace only: ductwork and other HVAC system components are not included. The AFUE* values listed also refer exclusively to the efficiency of the furnace itself.

* AFUE is the Annual Fuel Utilization Efficiency rating of the equipment, based on Gas Appliance Manufacturers Association testing, and included in the literature of the equipment manufacturer.

9.4.8 Liquid Petroleum Gas Furnace (Units: \$/furnace) LPG Frn

Each housing unit is assumed to have one furnace. The costs are for the installed cost of furnace only: ductwork and other HVAC system components are not included. The AFUE* values listed also refer only to the efficiency of the furnace itself.

9.4.9 Electric Resistance Furnace (Units: \$/furnace) Elec Res

Since all electric furnaces have the same efficiency, there is only one efficiency listed (100%). Duct costs, and duct efficiency losses are not included.

9.4.10 Air-Source Heat Pump (Units: \$/HP) Ht Pmp

Each housing unit is assumed to have one Heat Pump. The costs are for the installed cost of the heat pump only: ductwork and other HVAC system components are not included. The HSPF** values listed also refer only to the efficiency of the heat pump itself.

9.4.11 Non-Ducted Heating Systems

Changing Costs
to Include Non-
Ducted Heating
Systems

All heating (and cooling) systems currently in the COSTSAFR program are centralized equipment. The costs of the distribution systems are assumed to be approximately the same and are neglected in the cost data base. To accurately consider heating and cooling equipment with no distribution systems, the cost of the ducting should be added into the first cost of the ducted heating systems. A typical value for distribution system cost is \$0.79 per square foot of conditioned area. This cost was obtained from ASHRAE Standard 90.2 related research: "An Economic Data Base in Support of SPC 90.2: Costs of Residential Energy, Thermal Envelope and HVAC Equipment". To make comparisons with systems that require no distribution related costs, multiply the conditioned floor area by \$0.79 and add this cost to all the systems that are ducted. This applies only if the proposed heating and cooling equipment have no ducting systems.

** HSPF is the Heating Seasonal Performance Factor rating of the heat pump, based on American Refrigeration Institute (ARI) testing, and included in the literature of the heat pump manufacturer.

9.4.12 Central Air Conditioner (Units: \$/AC Unit)

Air Cnd

Each housing unit is assumed to be air conditioned. The costs refer to installed central Air Conditioners only: ductwork and other HVAC system components are not included. The SEER* values listed also refer only to the efficiency of the Air Conditioner itself.

9.4.13 Roof Color (Units: \$/sq.ft. of roof)

Color

This item quantifies the cost of changing the solar absorptance of the roof from 0.7 ("dark") to 0.3 ("light"). The cost data base assumes white semi-gloss paint applied to a metal roof or concrete roof tiles.

9.4.14 Refrigerator/Freezers (Units: \$/refrigerator-Freezer)

Ref/Fr

Each dwelling unit is assumed to have one 17 cubic foot refrigerator-freezer**. Costs in the data base are taken from the Federal Energy Guide labels.

9.4.15 Gas Fired Domestic Hot Water Heaters (Units: \$/water heater)

Gas DHW

Each dwelling unit is assumed to have one DHW heater. Costs are extracted from the Federal Energy Guide labels for gas water heaters.

9.4.16 Electric Resistance Domestic Hot Water Heaters (Units: \$/water heater)

Elec DHW

Each dwelling unit is assumed to have one DHW heater. Costs are extracted from the Federal Energy Guide labels for electric resistance water heaters.

* SEER is the Seasonal Energy Efficiency Rating of the air conditioner, based on ARI testing, and included in the literature of the air conditioner manufacturer.

** Although the actual size of refrigerator-freezers may vary, a 17 cu.ft. unit satisfactorily approximates the range, given the small variation in energy use.

9.5 DESCRIPTION OF SINGLE-SECTION AND MULTI-SECTION COST DATA

The abbreviations used on the Change Cost Factors screen are shown in the right hand margin.

9.5.1 Ceiling Insulation (Units: \$/sq.ft. of ceiling) Ceiling

All insulation levels are achieved using 24" wide fiberglass batts placed between the bottom chords of manufactured roof trusses. The cost of roof trusses is included, using the following assumptions: A 2-1/2" truss heel height is used when insulation levels are R-19 or less. A 5-1/2" heel height is assumed for insulation levels above R-19.

9.5.2 Wall Insulation (Units: \$/sq.ft. of gross wall area) Wall

The cost of wall framing is included, using the following construction assumptions:

Single section framing consists of 2x4 studs at wall openings and corners, with 2x3 studs, 16" oc elsewhere. A 1x2 belt rail is applied at midheight. Multi section framing consists of 2x4 studs, 16" in center.

Insulation levels of R-7, R-11 and R-13 are achieved by using kraft faced fiberglass batts placed between the framing described above. An R-18 option is achieved by adding 1" extruded polystyrene rigid insulation as exterior sheathing to the R-13 option. Both the R-19 and R-24 options involve fiberglass batts with kraft-facing in a 2x6 wall, with a 1" extruded polystyrene rigid insulation applied to obtain the R-24 option.

The following finishes, also included in the cost of the wall, were assumed:

- Interior: 5/32" Luaun paneling, glued and stapled
- Exterior: Aluminum vertical siding

9.5.3 Floor Insulation (Units: \$/sq.ft. of gross floor area)

Crawl

All insulation levels are achieved using unfaced fiberglass batts. Floor framing is included in all cost values, and consists of 2x6 joists, 16" on center, set transverse to the frame. 2x8 joists are required for the R-28 insulation level.

9.5.4 Infiltration (Units: \$/sq.ft. of gross wall area)

Infiltration

- o AVERAGE: A standard HUD-Code unit is enclosed such that all interior finishes are installed on subassemblies (ceiling, exterior walls and floor) and all exterior skins/finishes are applied after the subassemblies have been attached. Exterior wall subassemblies typically use faced batt insulation as a vapor barrier, while a polyethylene sheet is used between the ceiling board and the trusses. Floor subassemblies are enclosed with asphalt impregnated bottom board. Doors and windows are manufactured with weather stripping.

Since the AVERAGE house constitutes the basis for comparison with the TIGHT and VERY TIGHT houses, its cost is set to \$0.00.

- o TIGHT: The following improvements are made on the average house to reduce the air change rate:
 1. A continuous vapor barrier, in the form of polyethylene sheet plastic, is applied to exterior wall and floor subassemblies between the interior skin and framing members. Unfaced batt insulation is now used in the exterior walls.
 2. Several steps are taken to ensure an adequate seal at electrical boxes. First, the vapor barrier is cut in an "X" over the box; then the flaps are folded into the box. Second, the edge of the box is caulked so as to form a seal against the gypsum wallboard finish. Third, following proper wiring, the box is caulked where the wire enters, with caulking that is able to bond to both the plastic box and the wire insulation.

Finally, foam gaskets are installed beneath switch receptacle plates.

3. All seams created by platform framing are sealed by applying a foam gasket strip or 1/4" bead of caulk prior to installation of the adjacent component.
4. A bead of acrylic latex caulk is used to seal the exterior windows or doors. Where appropriate, the void between jamb and rough frame is filled with polyurethane foam.
5. All penetrations through the thermal envelope are well taped or caulked. Drops through the bottom board and plumbing/heat risers through the floor/vapor barrier are taped. Exterior wall penetrations are taped at the vapor barrier and caulked at the exterior siding. Roof vents and flues are taped at the vapor barrier and caulked at the roof skin.

The cost associated with the TIGHT house is the cost of improvements made over the AVERAGE house.

- o VERY TIGHT: The following improvements are made on the average house to reduce the air change rate:
 1. A continuous vapor barrier is applied to exterior wall and floor subassemblies, as well as the ceiling.
 2. A continuous air infiltration barrier is applied to the outside surface of the exterior wall and roof framing. These two separate applications are overlapped and taped at the eaves.
 3. All penetrations through the thermal envelope are well taped or caulked.
 4. An air-to-air heat exchanger with 75% recovery rate is provided.
 5. No recessed lighting fixtures installed in ceilings.
 6. Non-ducted space conditioning system (electric baseboard, hydronic baseboard) or location of all ductwork within conditioned space.

The cost associated with the VERY TIGHT house is the cost of improvements made over the AVERAGE house.

9.5.5 Windows (Units: \$/sq.ft. of window)

Window

Options include:

- 1) 1/8" clear single glass clear double glass (single and storm) clear triple glass (insulating glass and storm)
- 2) Aluminum, aluminum with thermal break, or wood frames.
- 3) Reflective glazing, replacing the clear glass exterior layer of the prime window.
- 4) Heat absorptive glazing, in the form of tinted glass replacing the clear glass exterior layer of the prime window.

All window costs assume jamb paneling on 4 sides and vinyl trim on 4 sides. Wood windows are supplied with brick mould on top and sides.

9.5.6 Natural Gas Furnace (Units: \$/furnace)

Gas Frn

Each housing unit is assumed to have one furnace. The costs are for the installed cost of furnace only: ductwork and other HVAC system components are not included. The AFUE* values listed also refer only to the efficiency of the furnace itself.

9.5.7 Oil Furnace (Units: \$/furnace)

Oil Frn

Each housing unit is assumed to have one furnace. The costs are for the installed cost of furnace only: ductwork and other HVAC system components are not included. The AFUE* values listed also refer exclusively to the efficiency of the furnace itself.

* AFUE is the Annual Fuel Utilization Efficiency rating of the equipment, based on Gas Appliance Manufacturers Association testing, and included in the literature of the equipment manufacturer.

9.5.8 Liquid Petroleum Gas Furnace (Units: \$/furnace) LPG Frn

Each housing unit is assumed to have one furnace. The costs are for the installed cost of furnace only: ductwork and other HVAC system components are not included. The AFUE* values listed also refer only to the efficiency of the furnace itself.

9.5.9 Electric Resistance Furnace (Units: \$/furnace) Elec Res

Since all electric furnaces have the same efficiency, there is only one efficiency listed (100%). Duct costs, and duct efficiency losses are not included.

9.5.10 Air-Source Heat Pump (Units: \$/HP Unit) Ht Pmp

Each housing unit is assumed to have one Heat Pump. The costs are for the installed cost of the heat pump only: ductwork and other HVAC system components are not included. The HSPF** values listed also refer only to the efficiency of the heat pump itself.

* AFUE is the Annual Fuel Utilization Efficiency rating of the equipment, based on Gas Appliance Manufacturers Association testing, and included in the literature of the equipment manufacturer.

** HSPF is the Heating Seasonal Performance Factor rating of the heat pump, based on American Refrigeration Institute (ARI) testing, and included in the literature of the heat pump manufacturer.

9.5.11 Non-Ducted Heating Systems

Changing Costs
to Include Non-
Ducted Heating
Systems

All heating (and cooling) systems currently in the COSTSAFR program are centralized equipment. The costs of the distribution systems are assumed to be approximately the same and are neglected in the cost data base. To accurately consider heating and cooling equipment with no distribution systems, the cost of the ducting should be added into the first cost of the ducted heating systems. A typical value for distribution system cost is \$0.79 per square foot of conditioned area. This cost was obtained from ASHRAE Standard 90.2 related research: "An Economic Data Base in Support of SPC 90.2: Costs of Residential Energy, Thermal Envelope and HVAC Equipment". To make comparisons with systems that require no distribution related costs, multiply the conditioned floor area by \$0.79 and add this cost to all the systems that are ducted. This applies only if the proposed heating and cooling equipment have no ducting systems.

9.5.12 Central Air Conditioner (Units: \$/AC Unit)

Air Cnd

Each housing unit is assumed to be air conditioned. The costs refer to installed central Air Conditioners only: ductwork and other HVAC system components are not included. The SEER* values listed also refer only to the efficiency of the Air Conditioner itself.

9.5.13 Roof Color (Units: \$/sq.ft. of roof) Color

This item quantifies the cost of changing the solar absorptance of the roof from 0.7 ("dark") to 0.3 ("light"). The cost data base assumes white semi-gloss paint applied to asphalt shingles.

9.5.14 Refrigerator/Freezers (Units: \$/refrigerator- freezer

Ref/Fr

Each dwelling unit is assumed to have one 17 cubic foot refrigerator-freezer**. Costs in the data base are taken from the Federal Energy Guide labels.

* SEER is the Seasonal Energy Efficiency Rating of the air conditioner, based on ARI testing, and included in the literature of the air conditioner manufacturer.

9.5.15 Gas Fired Domestic Hot Water Heaters (Units: Gas DHW
\$/water heater)

Each dwelling unit is assumed to have one DHW heater. Costs are extracted from the Federal Energy Guide labels for gas water heaters.

9.5.16 Electric Resistance Domestic Hot Water Heaters Elec DHW
(Units: \$/water heater)

Each dwelling unit is assumed to have one DHW heater. Costs are extracted from the Federal Energy Guide labels for electric resistance water heaters.

** Although the actual size of refrigerator-freezers may vary, a 17 cu.ft. unit satisfactorily approximates the range, given the small variation in energy use.

10.0 ENERGY ESCALATION RATES

Energy escalation rates are used by the COSTSAFR program to calculate the future cost of energy consumption. These escalation rates change with time, and should be updated periodically. The escalation rates used by COSTSAFR are contained in a file named "ESCALRAT.DAT". This file contains the projected fuel price escalation rates for electricity, distillate fuel (oil), liquified petroleum gas (LPG), and natural gas. This file is in the ASCII character set and can be viewed from the disk operating system (DOS) by entering "type escalrat.dat". The escalation rates are divided into six periods over 25 years into the future. Separate rates are given for each energy type and for each of ten DOE regions.

Viewing the
Escalation Rates

10.1 EDITING THE ESCALATION RATES

The National Bureau of Standards (NBS) document Energy Prices and Discount Factors for Life-Cycle Cost Analysis contains the projected average escalation rates that are used by the COSTSAFR program. These rates are updated on a yearly basis.

A word processor must be used to edit the ESCALRAT.DAT file. Before changing any data make sure you copy the original file to a file with a different name. If new data is entered, the numbers must be in the exact same format as the original data. The escalation rates must be right justified. Also, the COSTSAFR program requires that there be exactly six years with six columns of escalation rates.

Copy ESCALRAT.DAT
To Another File

The rates in the ESCALRAT.DAT file are 100 times the true escalation rate. For example, if the escalation rate is 3.27%, the number entered should be 327. If you are only using locations in one or two of the DOE regions it is only necessary to change those regions. The escalation rate file must be saved with the name "ESCALRAT.DAT" and be on the same drive as the Analyzer disk for COSTSAFR to operate.

APPENDIX A

INSTRUCTIONS FOR POINT SYSTEM AND POINT SYSTEM EXAMPLE

INSTRUCTIONS FOR POINT SYSTEM

This Appendix describes the components of the point system used to demonstrate compliance with the standard. The proposer selects energy conservation measures and obtains the points assigned to those measures. The main part of the point system is the heating and cooling points, which consists of pages 1 to 5. Points for water heating and refrigerator/freezer energy are determined on page 6. Page 7 of the point system has the required point total that the proposer must meet and the estimated energy cost.

Under most of the sections in the point system there is a line stating the optimal selection for that category. The set of all the optimal selections forms the design with the lowest possible life cycle cost for first costs and energy related costs of the optimized categories in COSTSAFR. The optimal selections establish the required point total on page 7. This means that the sum of the points for the optimized selection should be close to the required point total but may be slightly different. The water heating and refrigerator/freezer optimums are not given, but typically the most efficient levels are the optimums. Also, the optimal window area is not available, though it is normally 12% of the floor area. Options such as thermal mass walls, low-e glass, and moveable insulation are not optimized on. The optimal selections are provided only to give the proposer guidance on the conservation levels needed to meet the point total. The proposer should select options that minimize his or her costs, and is not encouraged to simply choose the optimized selections.

Optimized
Selection

The proposer uses the point system to determine if the design meets the energy standard. The proposer selects the level of each conservation option in his or her proposed design. The point system indicates the number of points corresponding to that level for both heating (H) and cooling (C). If the proposed level falls between levels in the point system, the proposer can either linearly interpolate to calculate the appropriate points, or can select the lower of the two point values that correspond to the two levels in the point system that are on either side of the proposed level. For example, if a wall insulation level of R-16 is proposed and only R-13 and R-19 appear in the point system the proposer can either

Interpolate
Between Levels

average the point values for R-13 and R-19, or use the point value for R-13. The proposer must use one method consistently throughout the point system. If the proposed level for a particular option is tighter than the tightest level in the point system, the proposer should use the highest point value listed for that option.

The proposer determines the number of points for each design option covered in the point system and determines the total number of points. If the total equals or exceeds the required total, then the proposed design meets the standard. If the total is less than the required total, then the proposer must go back to the design options and decide which one(s) to tighten. The proposer recalculates the point total with each design change and continues until the point total equals or exceeds that required.

The following sections provide more information on how to read the point system and do the necessary calculations.

DIRECTIONS FOR SPACE CONDITIONING POINTS

A. CEILING INSULATION:

The R-values listed refer to the R-value of the insulation only.

B. WALL INSULATION:

Choose between either wood frame walls or thermal mass walls.

Wood Frame Walls

The R-values listed refer to the R-value of the insulation only.

Thermal Mass Walls

A wall can be considered a thermal mass wall if it contains materials with a heat capacity of a minimum of 4 BTU/ft²*°F. Calculate the total wall R-value and the heat capacity of the massive material with the work sheet in Appendix B. These two values are then used in the point system table to determine the heating and cooling points for the thermal mass wall. Properties of typical materials used in wall

construction are given in the table below to assist in determining the proper values. This information is from the ASHRAE 1985 Fundamentals Handbook. Actual test data should be used for the R-values and heat capacities when available.

Log walls and concrete blocks with filled cores can be considered integral walls. Walls built with both an outside and inside layer of massive material with an air space or insulation in the cavity in between should be considered as the outside insulation configuration with only the inside mass contributing to the heat capacity.

R-values and heat capacities are per inch thickness unless a thickness is specified.

R-VALUES AND HEAT CAPACITIES FOR WALL MATERIALS

	<u>R-Value</u> <u>(h*ft²*°F/Btu)</u>	<u>Heat Capacity^a</u> <u>(Btu/ft²*°F)</u>
Lightweight aggregates, including expanded shale, clay or slate; expanded slags; cinders; pumice; vermiculite; cellular concretes		
Density (lb/ft ³) = 40	0.86	0.70
60	0.59	1.05
80	0.40	1.40
100	0.28	1.75
120	0.19	2.10
Concrete Blocks (3 oval core)		
Sand and gravel Aggregate		
4 in.	0.71	
8 in.	1.11	
8 in. (2 core)	1.04	
12 in.	1.28	
Cinder Aggregate		
4 in.	1.11	
8 in.	1.72	
12 in.	1.89	
Lightweight Aggregate (Expanded shale, clay slate or slag; pumice)		
4 in.	1.50	
8 in.	2.00	
12 in.	2.27	
Brick		
Common, 4 in.	0.80	7.6
Face, 4 in.	0.44	8.2
Woods		
Hardwoods		

Oak	0.85	1.43
Birch	0.84	1.43
Maple	0.91	1.36
Ash	0.91	1.31
Softwoods		
Southern Pine	0.95	1.25
Douglas fir-Larch	1.02	1.13
Southern Cypress	1.10	1.03
Hem-Fir,	1.23	0.91
Spruce-Pine-Fir		
Cedars	1.30	0.86
Calif. Redwood	1.28	0.85
Gypsum Wallboard	0.45	-
Expanded Polystyrene		
Cut Cell Surface	4.00	-
Smooth Skin Surface	5.00	-
Polyisocyanurate	7.20	-
1 in.*3 in. Vertical Furring	0.94	-
Nonreflective Air space ^b	1.01	-
Reflective Air Space ^c	2.01	-

a) Heat Capacity of concrete blocks depends on the density. Determine the mass of the blocks per square foot (lb/sq. ft.) of wall area and multiply by the specific heat (0.21) to determine the heat capacity.

b) For vertical airspace, horizontal heat flow, 50 degree F mean temperature, 10 degree F temperature difference, 0.75 inch space, emittance=0.82.

c) For vertical airspace, horizontal heat flow, 50 degree F mean temperature, 30 degree F temperature difference, 0.75 inch space, emittance=0.2.

C. FLOOR INSULATION:

Crawl Space:

The R-values listed under "Crawl Space" refer to the R-value of the insulation only. For example, R-11 means that the crawl space has R-11 insulation.

Split-level homes are assumed to have slab under the lower level and either crawlspace or basement under the upper level. For the crawlspace option, "R-11 CS R-5 2FT" means that the crawl space has R-11 insulation and that the slab has 2 foot wide R-5 insulation placed under, or along, the slab edge.

Slab on Grade:

"R-5_2FT" refers to a 2 foot wide strip of R-5 rigid insulation placed under, or along, the edge of a concrete slab. "R-5_4FT", "R-10_2FT" and "R-10_4FT" have similar definitions.

Basement:

a) Rigid Insulation

"R-5_4FT" refers to R-5 insulation placed on the outside of the basement wall, extending 4 feet below the first floor.

"R-5_8FT" and "R-10_8FT" have similar definitions. No insulation is assumed in the basement ceiling (i.e., first floor).

b) Batt Insulation

"R-11" and "R-19" refer to R-11 and R-19 batt insulation placed in the basement ceiling joists, i.e., between the house floor and the basement. No insulation is considered for the basement walls.

When the basement option for the Split-level home is chosen, the house has a basement under the upper, one story, level. Slab is the only choice for the lower, two story, level. For this case, "R-5_4FT_B_R-5_2" indicates a basement with 4 foot wide R-5 insulation, as described above, and a slab with 2 foot wide R-5 insulation placed under, or along, the slab edge.

Split-level homes can also have batt insulation in the basement ceiling with no insulation along the slab or basement perimeter. An example of this is "R-11_BC_R-0_S", with R-11 insulation in the basement ceiling and an uninsulated slab at the lower level.

D. INFILTRATION

Select between "Average", "Tight" and "Very Tight" based on the following criteria:

Very Tight: minimum of 35 points on the following point scale. Also, an air to air heat exchanger is required.

Tight: minimum of 15 points on the following point scale.

Average: fewer than 15 points on the following point scale.

Copy and fill out the Infiltration point form in Appendix B and attach it to the compliance forms.

Note that the point scale listed below is used only to determine the applicable infiltration option, and has no other connection to the COSTSAFR point system.

<u>Points</u>	<u>Construction</u>
0 (Required)	All doors and windows caulked and weatherstripped.
0 (Required)	Cover, caulk, seal, or weatherstrip all envelope joints around windows, between wall panels and between floor/wall and wall/ceiling surfaces.
0 (Required)	Cover, caulk, seal, or weatherstrip all envelope penetrations for plumbing, space conditioning ducts, electricity, telephone, and utility services.
0 (Required)	Provide backdraft or automatic dampers on all exhaust systems.
0 (Required)	Fireplaces must have tight-fitting door covering opening, and a tight-fitting flue damper.
13	a) Continuous air infiltration barrier installed on exterior side of exterior walls, with all joints in the barrier and all penetrations through the barrier sealed; barrier must cover all joints in the building envelope, from sill to top plate, and must act as a gasket or be sealed to all window and door frames;
	or
	b) Continuous vapor retarder sheet (e.g., polyethylene sheeting) installed on heated-in-winter side of exterior walls, sealed at all penetrations

(electrical outlets, window and door frames); retarder must be continuous over all envelope joints and junctions (corners, band joist, interior partition meeting exterior wall, etc.), and must be lapped and sealed with acoustical sealant at all retarder joints; electrical outlets and switches in exterior wall must be gasketed with foam inserts, or of a proven airtight design.

- 20 Air infiltration barrier (item a above) plus a vapor retarder sheet (item b above). The combined system yields 20 points.
- 1 All electrical outlets and switches in exterior walls gasketed with foam inserts (0 points if credit taken for an air infiltration barrier or continuous vapor retarder).
- 4 Interior partitions, duct drops and cabinet soffits framed after installation of continuous vapor barriers (e.g., polyethylene sheeting) and continuous drywall on ceiling.
- 3 No recessed lighting fixtures installed in ceilings between conditioned or unconditioned spaces, or specification of "IC" (insulated ceiling) recessed light fixtures.
- 3 Windows and doors certified to have infiltration rates equal to or less than 0.25 cfm per foot of crack (windows) or per square foot (doors).
- 2 Windows and doors certified to have infiltration rates from 0.26 to 0.34 cfm per foot of crack (windows) or per square foot (doors).
- 1 Windows and doors certified to have infiltration rates from 0.35 to 0.5 cfm per foot of crack (windows) or per square foot (doors).
- 1 Storm doors and windows provided.

- 10 Specification of non-ducted space conditioning system (electric baseboard, hydronic), or location of all ductwork within the conditioned space.
- 5 Sealed and taped ductwork specified for all supply and return air ducts located in unconditioned space, if a duct system is used.
- 2 Specification of non-combustion heating equipment (e.g., electric furnace or heat pump), or sealed combustion furnace, (for gas or oil heating systems); or location of combustion furnace in unconditioned space.

E. WINDOWS:

Percentages at the top of the chart refer to the total window area as a percentage of the conditioned floor area (NOT of the net floor area). "Window Area" refers to the actual area of the windows - not to rough opening dimensions. The only glazed area to be excluded when calculating the total window area is any glazed area which will be considered as a sunspace. All other glass should be counted in the calculation of window percentage, including any glass between a sunspace and the main living spaces.

"10%" means 10% and below.

"20%" means 20% and above.

When using the window points chart, select the column for percent of window area which comes closest to the actual window percentage of the proposed unit design.

The options on the left side of the window points chart refer to the type of glass and the type of sash:

"Single Glass" = one layer of glass.

"Double Glass" = either double insulating glass or single glass with a storm window.

"Triple Glass" = either triple insulating glass or double insulating glass with a storm window.

"Alum." = Metal sash (Aluminum or Steel),

"Al & TB" = Metal sash with a Thermal Break,

"Wood" = Wood sash.

F. HEAT ABSORBING (or tinted) GLASS:

Credit is allowed for heat absorbing glass if the shading coefficient of the glass in the proposed unit is:

0.77 or less for single glass,
0.64 or less for double glass,
0.56 or less for triple glass,

or if the unit has shades or screens which block at least 32% of the sunlight.

The shading coefficient is defined as the ratio of the solar heat gain through the glazing system of interest to the solar heat gain of a single pane of clear glass.

G. REFLECTIVE GLASS:

Credit is allowed for reflective glass only if the shading coefficient of the glass in the proposed unit is:

0.41 or less for single glass,
0.31 or less for double glass,
0.30 or less for triple glass,

or if the unit has shades or screens which block at least 64% of the sunlight.

Note that the heating season points for either heat absorbing or reflective glass are negative because they result in a loss of energy over clear glass.

H. LOW-EMISSIVITY GLASS:

Credit is allowed if glass has a surface coating with an emissivity of 0.4 or less.

I. SUN TEMPERED:

To determine the points for a sun tempered design, a series of three equations must be completed for both heating and cooling season. Note this section is done in addition to section E. In equation A, the area of each orientation as a fraction of total window area is entered. For example, if 20% of the windows are on the north side then the entry above the letter N is 0.20.

Equation B takes the quantity X calculated in equation A and multiplies it by the shading coefficient (SC) and the window area percentage. Use the table below for values of the shading coefficients of various glass types. This percentage area is a fraction of one. If the window area is 10% of the heated floor area then the entry above %AREA is 0.10.

SHADING COEFFICIENTS

<u>Glass Type</u>	<u>Layers</u>		
	<u>Single</u>	<u>Double</u>	<u>Triple</u>
Clear	1.00	0.88	0.79
Heat Absorbing	0.77	0.64	0.56
Reflective	0.40	0.31	0.30
Low-E	-	0.78	0.70

Equation C uses the quantity Z from equation B in two different locations. This equation will determine the heating and cooling points for the Sun Tempered Section.

In order to take credit for this section, a proposed design must meet these criteria:

- * North facing glass must be less than 1/4 of the total window area. Windows must face within 15 degrees of true North to be counted as North facing.
- * South facing glass must be more than 1/4 of the total window area. Windows must face within 15 degrees of true South to be counted as South facing.
- * There must be sufficient thermal mass exposed within the living space to absorb the additional solar gain from the added South facing glass. This is defined as a minimum of 4" thick masonry wall or floor slab, in the direct sun and equal in area to the south window area. The floor slab may be covered with tile, but not vinyl or carpeting.

J, K & L. MOVABLE INSULATION:

The R-values listed in the titles of these three sections include the insulating effects of any trapped air spaces. They do not include the R-value of the window.

M. SUNSPACES:

In order to take credit for this section a proposed design must meet the following criteria:

- * The outside wall of the sunspace must face within 15 degrees of true South.
- * The South wall of the sunspace must be at least 60% glazed.
- * The end walls must be eight feet or less in length.
- * The south outside wall must be at least eight feet long.
- * The end walls must be unglazed, and insulated to the same level as the main walls of the house.
- * The walls between sunspace and house must have the same insulation as the exterior walls.
- * The sunspace must have provision for powered venting to the outside, to prevent overheating in the summer.

N. LIGHT COLORED ROOF:

In order to take credit for this section the roofing material must have a solar absorptance of 0.4 or less (i.e., be white or reflective). Also, the category selected in this section must match the category selected in section A. CEILING INSULATION.

IMPORTANT NOTE: The totals after section N on page 5 are the Space Conditioning Points. Add up all points on the first four pages and the top of page 5 separately for heating and cooling. Section O uses the Space Conditioning Points in equations for the HVAC equipment to determine the Total Heating and Cooling Points.

O. HVAC EQUIPMENT:

For this section, use the AFUE, SEER and HSPF values from the Federal Energy Label which is required for all residential furnaces, air conditioners and heat pumps. For this section, "SEER" applies both to air conditioners and to heat pumps in cooling mode. Every heat pump has both an AFUE for heating and a SEER for cooling. Refer to the Air-Conditioning and Refrigeration Institute (ARI) Unitary Directory for the proper AFUE-SEER relationship.

In parts A and C, use the Space Conditioning Points to determine the quantities X and Y. These numbers are then used in parts B and D along with the selected efficiency to determine the points.

The Total Heating and Cooling Points on the bottom of page 5 are only the points from section 0.

DIRECTIONS FOR DOMESTIC HOT WATER AND REFRIGERATOR/FREEZER POINTS

There is a single, one-page DHW and Refrigerator/Freezer Point System (page 6) which applies to all equipment types.

For this section, use the baseline estimate of yearly energy cost from the Federal Hot Water Heater Label or the Refrigerator/Freezer label for the proposed unit. The baseline estimate is the large number which appears near the middle of the Energy Label. Insert this value in the appropriate equations for DHW and Refrigerator/Freezer form. For water heating, select the proper equation based on the number of bedrooms in the housing unit. The hot water usage varies with the number of occupants in the unit, and the number of bedrooms is used to predict the number of occupants.

DIRECTIONS FOR DETERMINING POINT TOTAL AND COMPLIANCE

The total points obtained for the proposed design are added up and compared to the required total on page 7.

To determine the Total Points, copy the Heating Point Total and Cooling Point Total from the bottom of page 5 for the unit under consideration. Also, copy the Total DHW and Refrigerator/Freezer Points from page 6. Calculate the Total Points by adding the three together. The Total Points must be equal to or greater than the Minimum Required Total shown just beneath the Total Points. Note that the required points vary with the number of bedrooms because of varying hot water usage. If your point total is less than is required for compliance, adjust your design until compliance is achieved.

ESTIMATED UNIT ENERGY COST

The last calculation done in the point system is the Estimated Unit Energy Cost at the bottom of page 7. The floor area used in this calculation is the conditioned floor area, not the net floor area. The conditioned floor area includes all spaces which will be heated and/or cooled, whether or not they count towards the net unit floor area.

The Estimated Unit Energy Cost uses the Space Conditioning Points from the bottom of page 5 and the DHW/RFR Points from page 6. This cost represents the discounted cost in hundreds of dollars of running the heating and cooling equipment, the refrigerator/freezer, and the hot water heater of the proposed unit design for 25 years, at local fuel prices and projected fuel escalation rates. The discount rate is 7%. The point system for apartments considers energy costs for two units (upstairs and downstairs).

Appendix B of the User's Manual contains a form called the Estimated Total Project Energy Cost. This Form should be copied and filled out once for each proposal. Instructions for this form are in Appendix B.

A.1 POINT SYSTEM EXAMPLE

The Point System is a compliance form generated by the Federal Agency and filled out by proposers to determine the design of energy related components of a housing project. Note that only a federal agency user has to run the program while the proposer only has to fill out the Point System form. This form is seven pages long and is generated for each housing type specified in the Project Description of the COSTSAFR input. For the purpose of this example, those seven pages will be referenced as pages A.20 through A.26. The proposer simply chooses a desired level for each Energy Conservation Option (ECO), copies the points onto the right hand side of the page, and adds up the points at the bottom of the page for heating and cooling separately.

Proposer uses
only Compliance
Form, not the
COSTSAFR Program

The input for this example into COSTSAFR consists of the following:

Location.....	Denver
House Type.....	Split-Level (3 bedroom)
Heating Energy Price (FEMP 1987 regional averages)	
Electricity.....	0.0727 \$/kWh
Oil.....	0.617 \$/Gal
LPG.....	0.453 \$/Gal
Natural Gas.....	0.455 \$/Therm
Cooling Energy Price	
Electricity.....	0.0727 \$/kWh
DHW Energy Price	
Electricity.....	0.0727 \$/kWh
Natural Gas.....	0.455 \$/Therm

The different ECO categories and the ECOs chosen for this example are:

```

Ceiling Insulation .....R-19
Wall Insulation .....R-19
Floor Type & Insulation .....Slab-on-grade
                                   R-5 2ft deep
Infiltration .....Tight
Window Type & Area .....Double glass,
                                   Aluminum Sash
                                   10% window area
Sun Tempered .....Yes
Heat Absorbing Glass .....No
Reflective Glass .....No
R-1, R-3, R-5 Moveable Insulation..No
Sunspace .....No

```

Light Roof Color	No
Heating Equipment	Nat. Gas Furnace, AFUE=0.70
Cooling Equipment	Air Conditioner, SEER, 8.0
DHW Heater	Gas, Energy Guide Label = \$176
Refrigerator/Freezer	Energy Guide Label = \$61

Each point represents one hundred dollars of energy savings discounted over a twenty-five year life cycle period. The number of points corresponding to specific levels of an ECO are calculated as savings relative to an inefficient base level of energy consumption. Therefore, a category like floor insulation which has an energy consumption base level corresponding to an uninsulated crawl space will tend to give many points to higher R-value ECOs. Since the base level used for each ECO category directly affects the number of points awarded to each ECO level in that category, the point values do not indicate how much energy one ECO, for example wall insulation, saves compared to another ECO in a different category, for example floor insulation.

What Points
Represent

The Point System begins with the ceiling, wall, and floor insulation levels (Sections A, B, and C). In section B, either the wood frame wall or thermal mass wall option should be selected. Section D presents the infiltration points based upon average, tight, or very tight construction (see pages A.6-A.9). Section E displays the window points and is based upon three factors: window area, glazing layers, and sash type. The window area is the percentage of window area as compared to the total conditioned floor area. For example a 1000 square foot house with 120 square feet of window area has 12% window area. The sash type can be either aluminum, aluminum with thermal break, or wood. An option from Section E must always be chosen.

Parts F through L cover window options that can then be used to modify the absolute contribution of the windows to the point total. Note that heat absorbing glass (Section F) and reflective glass (Section G) have negative points for heating load over clear glass. Sections J, K and L present the points for moveable night insulation for windows.

All heating points and all cooling points from pages A.20, A.21, A.22, A.23 and the top half of page A.24

are now added up for the Heating and Cooling Space Conditioning Totals at the center of Page A.24. These points are then adjusted according to the HVAC equipment efficiencies in Section O. First enter the appropriate Space Conditioning Total into the parentheses in Step A and Step C of Section O for heating and cooling.

After the heating and cooling numbers in Step A and Step C are calculated they are inserted into the parentheses above the letters X and Y in Steps B and D in section O. The proposer may choose any of the different types of heating equipment listed in Step B. It is advised that all applicable equipment be tried and the heating points compared. Equipment with higher fuel costs will often make it extremely difficult to meet the required point total. The efficiency of the heating and cooling equipment must be entered in Step B. The different types of efficiencies and ranges of their values are:

- . The Annual Fuel Utilization Efficiency (AFUE) for natural gas, LPG, and oil furnaces typically ranges from 0.50 to 0.95.
- . The Heating Season Performance Factor (HSPF) for air-source heat pumps has typical values from about 5.0 to 9.0.
- . The Seasonal Energy Efficiency Ratio (SEER) for central air conditioning and heat pumps in the cooling mode typically ranges from about 7.0 to 12.0.

Heat pumps act as both heaters and air conditioners, and have both an HSPF for heating and a SEER for cooling season. The various efficiencies are indicated by labels on the equipment. Catalogs providing equipment efficiency values can be obtained from the sources indicated below:

- . Furnaces:
ETL Testing Laboratories, Inc.
Attention: GAMA Efficiency Certification
Program
Industrial Park, Route 11
Cortland, New York 13045
(The furnace directory costs \$7.50)

- . Air Conditioners and Heat Pumps
Air Conditioning and Refrigeration Institute
(ARI)
1501 Wilson Boulevard, Suite 600
Arlington, Virginia 22209

(The directory of certified unitary products costs \$6.00)

The numbers obtained from Steps B and D for both heating and cooling in Section O are the final Heating and Cooling Points and are rewritten at the bottom of page A.24.

Page A.25 provides the points for the gas and electric domestic hot water (DHW) heaters and for refrigerators/freezers. The equations for the DHW heaters are based on the number of bedrooms in the house. To calculate the points for this page, enter the Federal Energy Guide labels into the parentheses above the word "label". The label value represents the estimated yearly energy use for the equipment. Therefore, a lower label number is more energy efficient than a higher one. Typical values for these labels are:

DHW Points

- . \$176 to \$266 for gas DHW heaters.
- . \$406 to \$536 for electric DHW heaters.
- . \$61 to \$120 for refrigerator/freezers.

The efficiency ratings can be obtained from the following sources:

- . DHW Heaters:
ETL Testing Laboratory
Attention: GAMA Efficiency Certification
Program
Industrial Park, Route 11
Cortland, New York 13045

(The DHW directory costs \$5.00)

- . Refrigerator/Freezers
Association of Home Appliance Manufacturers
(AHAM)
20 N. Wacker Drive
Chicago, Illinois 60606

(The Refrigerator/Freezer directory costs \$1.50)

The total DHW heater and refrigerator/freezers points are added up at the bottom of this page. These points are then added to the final heating and cooling points

to get the Total Points on the page A.26. If the points are less than the Minimum Required Point Total (listed on this page) the proposer must make adjustments to meet the criterion. If the points are greater than the minimum total, the proposer can stay with the selected ECOs or adjust ECO selections to lower their costs.

The Required Point
Total

The Estimated Unit Energy Cost at the bottom of page A.26 is the total discounted energy cost for a 25 year life, based on a discount rate of 7%. This number has units of hundreds of dollars.

After the end of the Point System the echoes of the information input for that COSTSAFR run are printed out. This information is for the federal official to keep and is not needed for the proposer to fill out the point system.

POINT SYSTEM FOR:
Split Level Houses
FEDERAL HOUSING PROCUREMENT
Denver, CO
RFP# Example

pg. 1

Design #: _____
Unit type: _____
Proposer: _____

A: CEILING INSULATION POINTS

	Heating	Cooling
R-11	0.0	0.0
R-19	3.3	0.0
R-30	5.9	0.0
R-38	6.9	1.1
R-49	7.7	1.3
R-60	8.2	1.4

The Optimized Selection: R-19

Points for A: 3.3 0
H C

B: WALL INSULATION POINTS (Select either Wood Frame or Thermal Mass Walls)

Wood Frame Walls

	H	C
R-11	0.0	0.0
R-13	1.3	0.0
R-19	5.2	0.0
R-24	7.3	0.0
R-26	8.0	0.0

The Optimized Selection: R-19

Points for B: 5.2 0
H C

Thermal Mass Walls (Outside, Inside, Mixed: location of insulation)

		R value									
		4		8		12		16		20	
Heat Capacity		H	C	H	C	H	C	H	C	H	C
4	Outside	-27.8	-1.3	-6.5	0.8	0.8	1.3	4.5	1.6	6.7	1.7
	Inside	-27.9	-2.5	-6.6	-0.3	0.7	0.3	4.3	0.5	6.6	0.7
	Mixed	-27.0	-2.8	-6.0	-0.1	1.2	0.7	4.8	1.0	6.9	1.2
6	Outside	-27.4	-0.4	-6.2	1.3	1.0	1.7	4.6	1.9	6.8	2.0
	Inside	-27.6	-1.9	-6.5	-0.1	0.8	0.4	4.4	0.6	6.6	0.7
	Mixed	-26.7	-1.7	-5.8	0.4	1.3	0.9	4.9	1.2	7.0	1.3
8	Outside	-27.1	0.3	-6.1	1.7	1.1	2.0	4.7	2.1	6.9	2.2
	Inside	-27.4	-1.4	-6.4	0.1	0.8	0.5	4.4	0.6	6.6	0.7
	Mixed	-26.4	-0.9	-5.7	0.7	1.4	1.1	4.9	1.3	7.1	1.4
10	Outside	-26.9	0.7	-6.0	1.9	1.2	2.1	4.8	2.2	7.0	2.3
	Inside	-27.2	-1.0	-6.3	0.3	0.9	0.5	4.5	0.6	6.6	0.7
	Mixed	-26.2	-0.4	-5.6	1.0	1.5	1.2	5.0	1.3	7.1	1.4
12	Outside	-26.8	1.0	-5.9	2.1	1.2	2.3	4.8	2.3	7.0	2.4
	Inside	-27.1	-0.6	-6.2	0.4	0.9	0.6	4.5	0.7	6.7	0.7
	Mixed	-26.1	0.1	-5.5	1.1	1.5	1.3	5.1	1.4	7.2	1.4
14	Outside	-26.7	1.2	-5.8	2.2	1.3	2.3	4.9	2.4	7.0	2.4
	Inside	-26.9	-0.4	-6.2	0.5	0.9	0.7	4.5	0.7	6.7	0.7
	Mixed	-26.0	0.4	-5.4	1.3	1.6	1.4	5.1	1.5	7.2	1.5

Points for B: 0 0
H C

C: FLOOR INSULATION POINTS

	H	C
Crawl Space		
R-0 CS R-0 S	0.0	0.0
R-11 CS R-5 2FT	21.0	2.8
R-19 CS R-5 4FT	23.5	3.0
R-30 CS R-5 4FT	25.2	3.3
Slab on Grade		
R-0	13.9	3.5
R-5 2FT	26.3	3.6
R-10 2FT	27.1	3.6
R-5 4FT	27.5	3.5
R-10 4FT	28.5	3.5

The Optimized Selection: R-5 2FT

Basements

R-0 B R-0 S	15.7	3.8
R-5 4FT B R-5 2	23.8	4.1
R-5 8FT B R-5 4	26.0	4.2
R-10 8FT B R-10 4	28.2	4.2
R-0 BC R-0 S	15.7	3.8
R-11 BC R-0 S	19.1	3.8
R-19 BC R-0 S	19.9	3.8

Points for C: $\frac{26.3}{H} \quad \frac{3.6}{C}$

D: INFILTRATION POINTS

	H	C
AVERAGE	0.0	0.0
TIGHT	9.1	0.0
VERY TIGHT	18.2	0.0

The Optimized Selection: TIGHT

Points for D: $\frac{9.1}{H} \quad \frac{0}{C}$

E: WINDOW TYPE AND AREA ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
Single Glass	H	C	H	C	H	C	H	C	H	C	H	C
Alum.	10.3	9.6	7.1	7.3	4.7	5.6	2.0	3.8	0.0	1.9	-3.7	0.0
AL & TB	12.0	9.6	9.4	7.4	7.3	5.7	5.0	3.9	2.5	1.9	0.0	0.0
Wood	12.9	9.6	10.5	7.4	8.6	5.7	6.5	3.9	4.2	2.0	1.9	0.0
Double Glass												
Alum.	17.2	10.4	16.4	8.5	15.7	7.2	14.9	5.7	13.8	4.1	12.8	2.6
AL & TB	19.1	10.4	19.0	8.6	18.7	7.2	18.3	5.8	17.6	4.2	17.0	2.7
Wood	20.1	10.4	20.3	8.6	20.2	7.2	20.0	5.8	19.6	4.2	19.2	2.7
Triple Glass												
Alum.	19.1	10.9	19.1	9.3	19.0	8.2	18.8	6.9	18.4	5.6	18.0	4.3
AL & TB	20.9	10.9	21.6	9.4	21.9	8.2	22.0	7.0	22.1	5.7	22.1	4.4
Wood	21.9	10.9	22.9	9.4	23.5	8.2	23.9	7.0	24.1	5.7	24.3	4.5

The Optimized Selection: Double Glass with ALUMINUM

Points for E: $\frac{17.2}{H} \quad \frac{10.4}{C}$

Split Level Houses

POINT SYSTEM FOR:
Denver CO

pg. 3

F. HEAT ABSORBING GLASS ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
	H	C	H	C	H	C	H	C	H	C	H	C
Single Glass	-1.6	2.5	-1.6	3.1	-1.6	3.9	-1.4	4.6	-1.1	5.5	0.0	6.4
Double Glass	-2.1	2.3	-2.3	2.9	-2.3	3.6	-2.3	4.3	-2.2	5.1	-2.0	6.0
Triple Glass	-2.3	2.1	-2.5	2.6	-2.7	3.2	-2.8	3.8	-2.8	4.5	-2.7	5.2
Points for F:										<u>○</u>	<u>○</u>	
										H	C	

G. REFLECTIVE GLASS ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
	H	C	H	C	H	C	H	C	H	C	H	C
Single Glass	-2.7	5.5	-2.7	6.9	-2.4	8.5	-2.0	10.2	-1.3	12.0	0.0	13.9
Double Glass	-5.2	4.8	-5.7	6.0	-6.1	7.4	-6.3	8.8	-6.4	10.4	-6.3	12.0
Triple Glass	-5.7	4.1	-6.5	5.1	-7.1	6.2	-7.6	7.5	-7.9	8.8	-8.1	10.1
Points for G:										<u>○</u>	<u>○</u>	
										H	C	

H. LOW-E GLASS ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
	H	C	H	C	H	C	H	C	H	C	H	C
Single Glass	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Double Glass	3.3	1.1	4.0	1.4	4.8	1.7	5.7	2.0	6.6	2.4	7.5	2.8
Triple Glass	1.3	0.0	1.6	1.1	2.0	1.4	2.4	1.7	2.9	2.0	3.4	2.3
Points for H:										<u>○</u>	<u>○</u>	
										H	C	

I. SUN TEMPERED (Calculate points by using equations A,B and C)
Heating Points

A: (Enter fraction of total window area for the 4 orientations: N,E,S,W)

$$(50.9 \times \frac{0.1}{N} + 122.7 \times \frac{0.2}{E} + 195.7 \times \frac{0.5}{S} + 98.8 \times \frac{0.2}{W}) - (117.1) = \frac{30.1}{X}$$

B: (%Area = 0.10 for window area 10% of heated floor area)

$$\frac{X}{Z} \times \frac{0.88}{SC} \times \frac{0.1}{\%AREA} \times 1.90 = \frac{5.0}{Z}$$

C:

$$\frac{5.0}{Z} \times [0.882 + (0.006 \times \frac{5.0}{Z})] = \frac{4.6}{H}$$

Cooling Points

A: (Enter fraction of total window area for the 4 orientations: N,E,S,W)

$$(-8.6 \times \frac{0.1}{N} - 17.1 \times \frac{0.2}{E} - 14.9 \times \frac{0.5}{S} - 19.5 \times \frac{0.2}{W}) + (15.0) = \frac{-0.6}{X}$$

B: (%Area = 0.10 for window area 10% of heated floor area)

$$\frac{-0.6}{X} \times \frac{0.88}{SC} \times \frac{0.1}{\%AREA} \times 1.90 = \frac{-0.1}{Z}$$

C:

$$\frac{-0.1}{Z} \times [1.085 + (0.221 \times \frac{-0.1}{Z})] = \frac{-0.1}{C}$$

POINT SYSTEM FOR:
Split Level Houses Denver CO

pg. 4

J. R-1 MOVEABLE INSULATION ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
Single Glass	H	C	H	C	H	C	H	C	H	C	H	C
Alum.	4.2	0.0	5.0	0.0	5.9	0.0	6.7	0.0	7.6	0.0	8.4	0.0
AL & TB	3.7	0.0	4.4	0.0	5.2	0.0	5.9	0.0	6.6	0.0	7.4	0.0
Wood	3.5	0.0	4.2	0.0	4.9	0.0	5.6	0.0	6.3	0.0	7.1	0.0
Double Glass												
Alum.	1.7	0.0	2.0	0.0	2.4	0.0	2.7	0.0	3.0	0.0	3.4	0.0
AL & TB	1.3	0.0	1.6	0.0	1.9	0.0	2.1	0.0	2.4	0.0	2.7	0.0
Wood	1.2	0.0	1.4	0.0	1.6	0.0	1.9	0.0	2.1	0.0	2.4	0.0
Triple Glass												
Alum.	0.0	0.0	1.0	0.0	1.2	0.0	1.3	0.0	1.5	0.0	1.7	0.0
AL & TB	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.2	0.0	1.3	0.0
Wood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0

Points for J:

○
H
○
C

K. R-3 MOVEABLE INSULATION ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
Single Glass	H	C	H	C	H	C	H	C	H	C	H	C
Alum.	6.2	0.0	7.5	0.0	8.7	0.0	9.9	0.0	11.2	0.0	12.4	0.0
AL & TB	5.5	0.0	6.6	0.0	7.8	0.0	8.9	0.0	10.0	0.0	11.1	0.0
Wood	5.2	0.0	6.2	0.0	7.3	0.0	8.3	0.0	9.4	0.0	10.4	0.0
Double Glass												
Alum.	3.0	0.0	3.6	0.0	4.2	0.0	4.8	0.0	5.4	0.0	6.0	0.0
AL & TB	2.4	0.0	2.8	0.0	3.3	0.0	3.8	0.0	4.2	0.0	4.7	0.0
Wood	2.0	0.0	2.4	0.0	2.8	0.0	3.2	0.0	3.6	0.0	4.0	0.0
Triple Glass												
Alum.	1.8	0.0	2.2	0.0	2.6	0.0	3.0	0.0	3.3	0.0	3.7	0.0
AL & TB	1.3	0.0	1.6	0.0	1.9	0.0	2.1	0.0	2.4	0.0	2.7	0.0
Wood	1.2	0.0	1.4	0.0	1.6	0.0	1.9	0.0	2.1	0.0	2.4	0.0

Points for K:

○
H
○
C

L. R-5 MOVEABLE INSULATION ('10%' = 10% of heated floor area)

Window Area:	10%		12%		14%		16%		18%		20%	
Single Glass	H	C	H	C	H	C	H	C	H	C	H	C
Alum.	6.9	0.0	8.3	0.0	9.6	0.0	11.0	0.0	12.4	0.0	13.8	0.0
AL & TB	6.0	0.0	7.3	0.0	8.5	0.0	9.7	0.0	10.9	0.0	12.1	0.0
Wood	5.9	0.0	7.1	0.0	8.2	0.0	9.4	0.0	10.6	0.0	11.8	0.0
Double Glass												
Alum.	3.5	0.0	4.2	0.0	4.9	0.0	5.6	0.0	6.3	0.0	7.1	0.0
AL & TB	2.9	0.0	3.4	0.0	4.0	0.0	4.6	0.0	5.1	0.0	5.7	0.0
Wood	2.5	0.0	3.0	0.0	3.5	0.0	4.0	0.0	4.5	0.0	5.0	0.0
Triple Glass												
Alum.	2.4	0.0	2.8	0.0	3.3	0.0	3.8	0.0	4.2	0.0	4.7	0.0
AL & TB	1.7	0.0	2.0	0.0	2.4	0.0	2.7	0.0	3.0	0.0	3.4	0.0
Wood	1.3	0.0	1.6	0.0	1.9	0.0	2.1	0.0	2.4	0.0	2.7	0.0

Points for L:

○
H
○
C

POINT SYSTEM FOR:
Split Level Houses Denver CO

pg. 5

M. SUNSPACES w/ Glass Roof w/ Solid Roof
 and Single Glass: 22.9 and Single Glass: 11.5
 and Double Glass: 33.5 and Double Glass: 17.6

Heating:

$$\left(\frac{\text{factor from above}}{\text{factor from above}} \right) \times 0.01 \times \left(\frac{\text{sunspace length (ft)}}{\text{sunspace length (ft)}} \right) = \frac{0}{H}$$

Cooling:
 No Cooling points for sunspaces

N. LIGHT ROOF COLOR

Heating:
 No heating points given for roof color

Cooling:
 For roof R-values below R-30 0.0
 For roof R-values R-30 and above 0.0 Points:

$\frac{0}{C}$

SPACE CONDITIONING TOTAL (Total Sections A to N)..... $\frac{65.7}{\text{HEATING}}$ $\frac{13.9}{\text{COOLING}}$

O. HVAC EQUIPMENT

Heating Equipment Total: (Insert HEATING SPACE CONDITIONING TOTAL)

A: $117 - \left[1.134 \times \left(\frac{65.7}{\text{TOTAL}} \right) \right] = \frac{42.5}{X}$

Note: Set all negative values for X to 0.0

B: Oil furnaces and boilers:

$130 - \left[0.838 \times \left(\frac{42.5}{X} \right) / \left(\frac{0.80}{\text{AFUE}} \right) \right] = \frac{85.5}{H}$

Natural gas furnace and boilers:

$130 - \left[0.740 \times \left(\frac{42.5}{X} \right) / \left(\frac{0.70}{\text{AFUE}} \right) \right] = \frac{85.1}{H}$

LPG furnaces and boilers:

$130 - \left[0.900 \times \left(\frac{42.5}{X} \right) / \left(\frac{0.80}{\text{AFUE}} \right) \right] = \frac{82.2}{H}$

Electric furnaces and baseboards:

$130 - \left[2.226 \times \left(\frac{42.5}{X} \right) \right] = \frac{35.4}{H}$

Electric heat pumps:

$130 - \left[7.698 \times \left(\frac{42.5}{X} \right) / \left(\frac{7.5}{\text{HSPF}} \right) \right] = \frac{86.4}{H}$

Nat. Gas
Furnace
Chosen
for this
Example

The Optimized Selection: Oil furnaces and boilers: efficiency = 0.950

Cooling Equipment Total: (Insert COOLING SPACE CONDITIONING TOTAL)

C: $16 - \left[0.921 \times \left(\frac{13.9}{\text{TOTAL}} \right) \right] = \frac{3.2}{Y}$

Note: Set all negative values for Y to 0.0

D: $17 - \left[7.598 \times \left(\frac{3.2}{Y} \right) / \left(\frac{\text{SEER}}{\text{SEER}} \right) \right] = \frac{14.0}{C}$

The Optimized Selection: SEER = 7.00

TOTAL HEATING AND COOLING POINTS

(Rewrite selected points from section O) $\frac{85.1}{\text{Heating}}$ $\frac{14.0}{\text{Cooling}}$

Insert value from Federal DHW and Refrigerator/Freezer Labels

GAS DHW HEATERS:

$$1 \text{ BR Units: } 16 - [0.07(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$2 \text{ BR Units: } 20 - [0.08(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$3 \text{ BR Units: } 36 - [0.15(\frac{176}{\text{label}})] = \frac{9.6}{\text{DHW points}}$$

Gas DHW is
Chosen for
This Example

$$4 \text{ BR Units: } 44 - [0.18(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$5 \text{ BR Units: } 52 - [0.21(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

ELECTRIC DHW HEATERS

$$1 \text{ BR Units: } 16 - [0.05(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$2 \text{ BR Units: } 20 - [0.07(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$3 \text{ BR Units: } 36 - [0.12(\frac{406}{\text{label}})] = \frac{-12.7}{\text{DHW points}}$$

$$4 \text{ BR Units: } 44 - [0.15(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$5 \text{ BR Units: } 52 - [0.18(\frac{\quad}{\text{label}})] = \frac{\quad}{\text{DHW points}}$$

$$\frac{9.6}{\text{DHW points}}$$

REFRIGERATOR/FREEZERS:

$$12 - [0.10(\frac{61}{\text{label}})] = \frac{5.9}{\text{points}}$$

$$\frac{5.9}{\text{RFR points}}$$

TOTAL DHW HEATER AND REFRIGERATOR/FREEZER POINTS

$$\frac{15.5}{\text{=====}}$$

TOTAL POINTS:

$$\begin{array}{rcccc} (& 15.5 &) + (& 85.1 &) + (& 14.0 &) = & 114.6 \\ \hline \text{DHW/RFR TOTAL} & & \text{HEATING TOTAL} & & \text{COOLING TOTAL} & & \text{TOTAL POINTS} \\ \text{(from p 6)} & & \text{(from p 5)} & & \text{(from p 5)} & & \end{array}$$

MINIMUM REQUIRED POINT TOTAL:

Appliance	Space	Total	Required Point Total is Met for the Three Bedroom Unit
	1-BR Units:	109	
	2-BR Units:	110	
	3-BR Units:	114	
	4-BR Units:	117	
	5-BR Units:	119	

ESTIMATED UNIT ENERGY COST:

$$\begin{array}{l} 1 \text{ BR: } [(148 - \text{ }) \times (\text{ })/1904] + (28 - \text{ }) = \text{ } \\ 2 \text{ BR: } [(148 - \text{ }) \times (\text{ })/1904] + (32 - \text{ }) = \text{ } \\ 3 \text{ BR: } [(148 - 99.1) \times (2000)/1904] + (48 - 15.5) = 83.9 \\ 4 \text{ BR: } [(148 - \text{ }) \times (\text{ })/1904] + (56 - \text{ }) = \text{ } \\ 5 \text{ BR: } [(148 - \text{ }) \times (\text{ })/1904] + (64 - \text{ }) = \text{ } \end{array}$$

heating & cooling points
conditioned floor area
DHW and appliance points

APPENDIX B
SUPPLEMENTAL COMPLIANCE FORMS

USING THE ESTIMATED TOTAL PROJECT ENERGY COST FORM

Estimated Total Project Energy Cost Form

This form should be photocopied and filled out by the contractor upon completion of the compliance forms. It's purpose is to total The Estimated Unit Energy Costs for all proposed building types. The Estimated Unit Energy Cost is calculated on page 6 of the compliance forms. This cost is multiplied by the number of units to obtain the total life-cycle energy cost in hundreds of dollars. If more than one building type is planned, the totals for each type are added together to determine the Estimated Total Project Energy Cost at the bottom of the page.

USING THE INFILTRATION POINT TABLE

Infiltration Point Table

This table demonstrates the proposed design meets the criteria for either "average", "tight", or "very tight" infiltration control designs. The table should be photocopied and completed by the contractor, and attached to the compliance forms.

For required construction measures, a check should be entered in the points column. An air to air heat exchanger is required for the "very tight" infiltration design.

USING THE THERMAL MASS WALL WORK SHEET

Thermal Mass Wall Work Sheet

This work sheet is used to calculate the heat capacity and R-value for walls with massive construction. Heat capacity has the units of Btu / sq. foot * degree Fahrenheit. R-value has the units hour * sq. foot * degree Fahrenheit / Btu. Appendix A contains information on thermal mass walls and common properties for wall materials.

Add up the R-values for each layer of material from outside to inside to calculate the total wall R-value.

Add up the heat capacities for layer of massive materials to determine total heat capacity.

ESTIMATED TOTAL PROJECT ENERGY COST

RFP# _____

Proposer: _____

Design #1: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #2: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #3: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #4: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #5: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #6: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #7: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

Design #8: _____; _____ x _____ = _____ (100\$)
Unit Building Number Estimated Unit
Type Type of Units Energy Cost Type
Total

ESTIMATED TOTAL PROJECT ENERGY COST = _____ (100\$)

INFILTRATION POINT TABLE

Complete this table and attach to Compliance Forms.

Points	Construction	Points
0 (Required)	All doors and windows caulked and weatherstripped.	
0 (Required)	Cover, caulk, seal, or weatherstrip all envelope joints around windows, between wall panels and between floor/wall and wall/ceiling surfaces.	
0 (Required)	Cover, caulk, seal, or weatherstrip all envelope penetrations for plumbing, space conditioning ducts, electricity, telephone, and utility services.	
0 (Required)	Provide backdraft or automatic dampers on all exhaust systems.	
13	<p>a) Continuous air infiltration barrier window installed on exterior side of exterior walls, with all joints in the barrier and all penetrations through the barrier sealed; barrier must cover all joints in the building envelope, from sill to top plate, and must act as a gasket or be sealed to all window and door frames;</p> <p>or</p> <p>b) Continuous vapor retarder sheet (e.g., polyethylene sheeting) installed on heated-in-winter side of exterior walls, sealed at all penetrations (electrical outlets, window and door frames); retarder must be continuous over all envelope joints and junctions (corners, band joist, interior partition meeting exterior wall, etc.), and must be lapped and sealed with acoustical sealant at all retarder joints; electrical outlets and switches in exterior wall must be gasketed with foam inserts, or of a proven airtight design.</p>	

20	Air infiltration barrier (item a above) plus a vapor retarder sheet (item b above). The combined system yields 20 points.	_____
1	All electrical outlets and switches in exterior walls gasketed with foam inserts (0 points if credit taken for an air infiltration barrier or continuous vapor retarder).	_____
4	Interior partitions, duct drops and cabinet soffits framed after installation of continuous vapor barriers (e.g., polyethylene sheeting) And continuous drywall on ceiling.	_____
3	No recessed lighting fixtures installed in ceilings between conditioned or unconditioned spaces, or specification of "IC" (insulated ceiling) recessed light fixtures.	_____
3	Windows and doors certified to have infiltration rates from 0.25 cfm per foot of crack (windows) or per square foot (doors).	_____
2	Windows and doors certified to have infiltration rates from 0.26 to 0.34 cfm per foot of crack (windows) or per square foot (doors).	_____
1	Windows and doors certified to have infiltration rates from 0.35 to 0.5 cfm per foot of crack (windows) or per square foot (doors).	_____
1	Storm doors and windows provided.	_____
10	Specification of non-ducted space conditioning system (electric baseboard, hydronic), or location of all ductwork within the conditioned space.	_____
5	Sealed and taped ductwork specified for all supply and return air ducts located in unconditioned space, if a duct system is used.	_____

2	Specification of non-combustion heating equipment (electric furnace or heat pump), or sealed combustion furnace, (for gas or oil heating systems); or location of combustion furnace in unconditioned space.	<hr/>
		<hr/>
		Total Points
Infiltration Level		
Average:	less than 15 points	
Tight:	15 to 35 points	
Very Tight:	35 points + Heat Exchanger.	

THERMAL MASS WALL WORK SHEET

WALL R-VALUE

-Sum layer R-values to determine total wall R-value

<u>Layer</u>	<u>Material</u>	<u>R-value (hr*sq ft*F/Btu)</u>
1	Outside air film	0.17
2	_____	_____
3	_____	_____
4	_____	_____
5	_____	_____
6	_____	_____
7	Inside air film	<u>+ 0.68</u>

Total Wall R-value = _____

HEAT CAPACITY OF MASSIVE MATERIAL

-Sum massive material heat capacities to determine total heat capacity

<u>Massive Material</u>	<u>Heat Capacity (Btu/sq. ft*F)</u>
_____	_____
_____	_____
_____	+ _____

Heat Capacity Per Square Foot of
Wall Area of Massive Material = _____

APPENDIX C
PROJECT DESCRIPTION FILE TABLE

USING THE PROJECT DESCRIPTION FILE TABLE

The Project Description File Table

When you use COSTSAFR you may choose to save the information you input on specific housing projects. This information might be useful in future runs where, for example, you may want to repeat the same input conditions except for location of the housing. Using the "Save Project Description" and "Restore Project Description" functions (see Sections 6 and 7, respectively), you can save input information in files and restore it for subsequent runs (as described in those sections). The Project Description File Table at the end of this section provides a format for describing the information you have saved. Make several copies of this form and keep it up to date.

Page_____

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