COMPUTER ASSISTED RESIDENTIAL ENERGY AUDIT

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The 1973 oil embargo focused this Nation's attention on its energy resources and precipitated increased costs for energy. The increased costs for energy resulted in monthly fuel bills for home owners which were twice that of previous years. A study in 1974 by the Department of Health Education and Welfare in cooperation with the Federal Energy Administration indicated that those hardest hit by the rising prices of home heating fuel were the poor who lived in single-family homes in the colder parts of the country and heated their homes with fuel oil. As a result the Community Services Administration (CSA) initiated in 1974 an energy conservation program via weatherization of homes. This program was delivered to low-income home owners by local community Action Agencies (CAA). It became apparent as a function of time that this program would be more effective if technical assistance could be provided to the weatherization crews, education to the home owners and management capabilities to the administrators of the program. As a result CSA provided funds for the development of a computer assisted energy audit management program. The program described in this paper is a spin-off of the program developed for CSA. The authors wish to thank Miriam Charnow at CSA National and Carl Saueressig at West CAP for their assistance and the personnel at West CAP for their cooperation in the development of the program.

The energy conservation awareness created by the 1973 oil embargo has somewhat dissipated. There are no long lines at service stations and there appears to be ample fuel for heating homes. The severe winter of 1976-77 is long forgotten and to some extent the glamour of solar energy and other alternate energy sources has attracted the general publics' interest instead of something as mundane as insulating a home. However, energy conservation must still remain as one of the most important objectives of any energy program for this country. The problem is to keep the concept of energy conservation in focus. Energy conservation requires a conscious effort and it seems as though the majority of adults react to it only via a catastrophe or a series of catastrophies; OPEC embargo, severe 1976-77 winter, etc. This is a difficult and traumatic way to maintain energy conservation awareness. Perhaps a more rationale way is to build the awareness in from the very beginning.

The United States has in place an elaborate education system and this system can be used to create an energy ethic. However, this mechanism still presents some problems. The energy problem is a social-cultural problem as well as a technical problem. Most teachers do not have the necessary information base to effectively build an energy ethic into their students. An even more important consideration is that most teachers are so overburdened with the existing curriculum that there may be little or no room for energy to be added. This is further compounded by the back to the basic demands currently being placed upon school curriculums. The time element also becomes a factor. It is perhaps most rationale to begin at the beginning, kindergarten, and create a process such that the ultimate result at grade 12 would be an energy conscious responsive individual. However, the developmental time and implementation time is too long for immediate results and may be too long to be sustained. Subsequently, there may be more cycles of energy catastrophe, reaction, etc. With all these factors in mind, it seemed apparent that if something was going to be done in the energy conservation area via students, it would have to compensate for all the factors indicated above. The interactive audit is a mechanism to do just that.

The audit is designed for use by students, grades 7-12. However, it can be used with college students and adults. Students using the audit are required to perform a series of activities. These activities can be coordinated very easily with the existing curriculum or can be done totally independent of the curriculum. The first activity requires the student to perform a structural assessment of his home with respect to energy efficiency. This assessment requires either a booklet or a data sheet as an explanatory device. West CAP is using the audit as a part of a youth energy conservation program and has developed a booklet and summary data sheet. Appendix A is a copy of the data sheet used by West CAP. The audit can be described most efficiently via a discussion of the questions involved in the

assessment. Note that the fact that the student is required to perform an assessment of his home builds in an opportunity for parent-student-teacher interaction with respect to energy conservation.

The program can be used in a no instruction or instruction mode for data entry. In the instruction mode the entire question is printed by the computer, while in the no instruction mode only the line number and a question mark is printed. For all inputs the number entered is checked to see if it corresponds to reality where possible. Items two and three of Appendix A show sample data entries in each mode.

Question 1.: Date
As has been indicated some mechanism is needed to create awareness with respect to energy conservation. The mechanism in this case is the interactive capability of the audit. However, even the use of a computer is insufficient to maintain interest if the time to get results is too long. The time to enter the data and get a complete output ranges from 10 minutes for very few system users to 20 plus minutes if the system is saturated and the no instruction mode is used. Of this time,3 to 5 minutes are required to enter the data. In order to increase the flexibility the management portion of the program contains a file to temporarily store the answers needed to print the output. The status of this file is indicated when the user elects to use the audit program. If the file is not full (50 jobs currently allowed), the user can elect to enter the data and obtain his output up to 3 days later. If the file is full the user must obtain his output immediately after the data is entered. If this is impossible for him he need not initiate the program. The file is checked daily as a part of system back up and any data stored in excess of the three day limit is purged. The data is automatically purged after an output is obtained. The date is required to incorporate this feature.

Question 2.: YOU I.D. Number
The program is designed to store the energy conservation results of all the audits performed. In order to identify the audits performed by users on an individual basis a unique number can be assigned to identify their data. If this is not essential or desired the YOU I.D. number can be any number the user elects to enter.

Question 3.: House Number
The house number is computer assigned. This number is used to keep track of the total audits as well as allow the user to obtain his data at a later date.

Question 4.: Number of Home Occupants
The number of occupants is used to obtain an estimate of the hot water requirements.

Question 5.: Age of Home
This data is useful to State and Federal Agencies.

Question 6: Roof Condition
The condition of the roof is critical with respect to adding insulation to the attic.

Question 7.: Heating System Condition
The condition of the heating system is critical with respect to energy efficiency. Most if not all students do not have the skills to assess the condition of the heating system. However, the students can make the homeowner (their parents) aware of the fact that it should be checked. If the heating system has been serviced recently (2 to 3 years), it is considered to be in good condition; if not repairs may be needed. If it doesn't work it needs to be replaced.

Question 8.: Home Temperature-Day and Night
The average temperature of the home is needed in order to obtain the heatloss. The average temperature is computed assuming a weighted average of the day and night temperatures; 1/3 for night and 2/3 for day. The design temperature of home is assumed to be $70^{o}F$ and the heatloss is adjusted at 3% per degree. The temperatures input can be determined by asking the homeowner or by measurement.

Question 9.: Degree Day Zone
The heatloss is determined on an annual basis using degree days. In most states degree day data is available as a function of geographical area. For example, the State of Wisconsin is divided into 11 degree day zones. Usually the degree day data is available for a $65^{o}F$ base. Recent data from the National Bureau of Standards (NBS) indicates that a $55^{o}F$ base may be more appropriate. This is consistent with UW River Falls fuel bill analysis and hence the 65 base data has been adjusted to 55 base data. All degree day data used should be adjusted to the 55 base. In addition a 242 day, September 15 to May 15, heating season is assumed.

Question 10.: Type of Fuel and Fuel Cost
Nine types of fuel are allowed; gallons of #1 oil, gallons of #2 oil, kilowatt-hours of electricity, cubic feet of gas, therms of gas, gallons of LP, tons of coal, gallons of kerosene, and full cords of wood. The energy content of the fuels and efficiencies assumed are documented in the program and are consistent with latest NBS data. The fuel cost can be input or if it is unknown an average value is assigned by the computer. The average values used for the cost of fuel as well as all other standards must be determined regionally and periodically updated by systems staff. The rationale on the design is to place responsibility for parameters on a systems individual rather than on a sub routine built for all regions for

all time. That is, decisions on prices, standards, etc. are best made by an informed individual rather than by a complex subroutine designed to guess the future.

Questions 11. to 14.: House Structure
The program has been field tested for 1,2 and 3 story homes. The data entered for these questions is used in the heatloss calculations as well as to provide checks on reality. For example, the wall area is calculated from the data of questions 12. to 14. and is used to check the data entered in questions 27. and 28. to ensure a reasonable value for the wall area. In addition, the first floor area is used to check the ceiling area and floor area for the attic and basement heatloss calculations.

Questions 15. to 17. and 20. and 21.: Basement Heatloss
An explanation of the methodology of how the basement heatloss is calculated is beyond the scope of this paper. What is needed is the type of basement and associated dimensions such as the floor area (from question 12.), perimeter, amount exposed above ground and composition of the floor with respect to R-value. The R-value of a material is a necessary concept and either the user must have a working knowledge of it or obtain it by reading accompanying material. It is a simple concept and poses no problem if a small amount of time is devoted to it. The program is most accurate for homes with basements followed by homes with crawl spaces and then walkout basement homes. The answers obtained for trailer homes skirted and unskirted are very crude. This is because there is very little data available to check the methodology for trailers.

Questions 18. and 26.: Infiltration-Foundation and Walls.
Infiltration is an important consideration in heatloss. What is required is to assess the extent of air leakage into or out of the home. This is usually done by rating the structural components 1,2 or 3; that is good, mediocre, or bad. The resulting heatloss is then computed by using infiltration functions for the various components. In this program infiltration functions have been derived for the foundation, crack length, the wall crack length and the window and door crack lengths. The wall crack length refers to the crack length associated with the window and door frames where they join the wall siding. The rationale is that the crack lengths to be considered must correspond to those places that leak and are caulked, weatherstripped or sealed in some fashion. A major source of infiltration is associated with opening and closing windows and doors and/or leaving them open. There is no way to account for this in this model and this loss is not related to the structure but to the occupants behavior.

Questions 22. and 23.: Ceiling Area and R-Value
The program allows for two types of ceiling areas. The rationale is that a reasonably large number of homes have an addition which

has a different ceiling R-Value. In all cases the R-Values entered are for structural components only and R-Values for air films, etc. are assigned internally in the program.

Questions 19., 24. and 25.: Windows and Doors
The windows and doors of a home can represent a large heatloss. What is required is the direction, area, an infiltration judgement and whether or not there is a storm. The direction is not critical because it is used only to identify the window or door. The degree day concept contains the heat gain or loss due to sunshine. The window and door areas are computed from length and width measurements. The criteria for judging the infiltration are included in the data summary sheet. The window or door either has a good tight fitting storm or it is considered not to have a storm. An allowance is made for windows of the same size, direction and condition. The infiltration functions have been designed for double hung windows and are approximate for other types of windows. Question 25. requires the user to indicate whether or not the windows are double hung. This information is used to check the validity of the infiltration functions.

Questions 27. and 28.: Wall Area and R-Value
As in the ceiling case, two wall areas are allowed to account for the fact that a large number of homes may have a part of the home with insulated walls and a part of the home with uninsulated walls. The area to be entered is the area associated with the living space. The program checks this entered area against the area computed from the earlier structural data. The R-values entered are for the wall materials only.

As can be seen from the brief description of the questions, the assessment activity can be used to enhance the existing curriculums in both the mathematics and science areas. In addition, energy concepts such as R-values can be added with a minimum of time.

The second activity of the audit consists of entering the data either via the instruction or no instruction mode. This can be an enhancing activity for a class which does not have usual access to a terminal or it can be just another program execution. Item four of Appendix A contains an example of the output. The output is reasonably self-explanatory and need not be discussed with the exception of the opening paragraph. While the computer community has the utmost confidence in output, the general public does not necessarily share this confidence, particularly if energy is involved. Therefore, a check on reality is built in via the total fuel bill. That is, the homeowners faith in the results increases as the computer guesses more accurately his total heating bill. This mechanism provides a reality check on the output.

The third activity can consist of the interaction of the student and the homeowner via the audit output. This interaction can be kept minimal or expanded depending upon the use of the audit and the time and energy of the participants.

The audit has the potential to be very useful depending upon its implementation. The program including the management aspects is reasonably large. It consists of 15 segments written in HP-3000 Basic and 1 segment written in HP-3000 SPL. All segments are less than 8K words. The temporary output file with a 50 job limit requires 4500 sectors. The management file on school use has a 100 sector limit and the information from the audit which is stored permanently occupies 1/2 a sector per job. The correct time to run the program ranges from 10 to 20 minutes plus depending upon the volume of users. The CPU time is about 5 seconds.

The program currently stores permanently the following information:

YOU I.D. Number
Age of the Home
Type of Fuel
Attic Insulation Standard
Total Floor Area and Volume of Home
Average Temperature of the Home
Total Ceiling Area and Weighted R-Value
Total Wall Area and Weighted R-Value
Infiltration Judgement for the Walls and Foundation
Average Infiltration Judgement for the Doors and Windows
Window and Door Area
Heatloss in Fuel Units and Dollars
Potential Heat Savings in Fuel Units and Dollars
Percent of the Heatloss Due to Infiltration and Conduction

While the implementation of the program would require very little effort from one HP-3000 to another, some training with respect to the energy and heatloss aspects would greatly enhance the effectiveness of the audit. Because the audit can generate data related to residential energy use, there is a possibility that Federal funds can be obtained to provide some training. If you are interested in implementing the audit please contact one of the authors of this paper.

APPENDIX A

A sample data summary sheet is included to illustrate the technique used to increase the efficiency of data entry. This sample data sheet consists of one folded piece of paper but is displayed here as four separate sheets.

Sample data entries are enclosed in both the no instruction and instruction modes. For some entries errors have been made to illustrate the kinds of data checks built into the program.

A copy of the output is enclosed. Note the narrative form of the output. This enhances the ability of the homeowner to read and understand the results. The sample data entry in the instruction mode and the output required 22 minutes of connect time and 7 seconds of CPU time. There were 23 users and the data entry and output were obtained via DSLINE communication. In the no instruction mode with no DSLINE the typical data in output out connect time is less than 15 minutes with a CPU time of 4 to 5 seconds.

Housing & Energy
West CAP
525 Second Street
Glenwood City, WI 54731

VISIT
#1 _____
#2 _____

19. _____ DATA ON BACK

20. _____

NAME OF HOMEOWNER_____ Telephone # _____

1. DATE: MONTH, DAY, YEAR (E.G. 1,10,78) 1. ___,___,___ 21. _____

2. Y.O.U. ID NUMBER 2. _____

3. Assigned House Number (computer assigned, if you wish to recall program record here) 3. _____ 22. ____, ____

4. Number of Individuals Occupying Home 4. _____ 23. ____, ____

5. AGE OF HOME (YEARS) 5. _____

24. ____, ____ DATA ON BACK

6. CONDITION OF ROOF? 6. _____
   1=Tight Roof - no leaks, good condition
   2=Needs Minor Repair - missing shingles, cracks, possible leaks
   3=Needs Replacing - bad condition, major leaks

25. _____ DATA ON BACK

7. CONDITION OF HEATING SYSTEM? 7. _____ 26. _____
   1=serviced within 1 year
   2=serviced 1-5 years - owner can recollect it's having worked better
   3=can't recollect last date of service

27. ____, ____

28. ____, ____

8. AVERAGE HOME TEMPERATURE (FARENHEIT) 8. ____, ____
   Day Time _____, Night Time _____

9. DEGREE DAY ZONE (SEE PAGE 2) 9. _____

10. FUEL NUMBER AND COST (SEE PAGE 2) 10. ____, ____ _____

11. NUMBER OF STORIES IN HOME 11. _____ TO CONDUCTION

12. 1st FLOOR AREA (SQ.FT.), AVG. WALL HT. (FT.) 12. ____, ____

13. 2nd FLOOR AREA (SQ.FT.), AVG. WALL HT. (FT.) 13. ____, ____ _____

14. 3rd FLOOR AREA (SQ.FT.), AVG. WALL HT. (FT.) 14. ____, ____ _____

15. FLOOR EXPOSURE FACTOR 15. _____
   1=Basement
   2=Crawl Space
   3=Walkout
   4=Skirted Trailer/Building on posts
   5=Unskirted Trailer/Building on posts

   Are the basement walls insulated? 1=Yes 2=No _____
   Walkout wall area (sq.ft.) and R-value ____, ____

16. FOUNDATION PERIMETER (FT) 16. _____

17. AMOUNT FOUNDATION EXPOSED ABOVE GROUND (inches)? 17. _____

18. FOUNDATION CONDITION NUMBER 18. _____
   1=no cracks or settling, very clean
   2=minor cracks, loose morter
   3=major cracks and settling

FUEL (circle one or more, enter major fuel on item 10).	FUEL COST
1= #1 Fuel Oil	_____ (cents per gallon)
2= #2 Fuel Oil	_____ (cents per gallon)
3= Electricity	_____ (cents per kwhr)
4= Natural Gas by Cu. Ft.	_____ (cents per cubic foot)
5= Natural Gas by Therm	_____ (cents per therm)
6= Bottled Gas (LP Propane)	_____ (cents per gallon)
7= Coal, Coke	_____ (dollars per ton)
8= Kerosene	_____ (cents per gallon)
9= Wood	_____ (dollars per full cord, 4x4x8 Ft.)

If fuel cost is unknown, computer will assign an average cost.

COUNTY DEGREE DAY ZONES Enter on item 9

Chippewa, Barron, Polk = 4
St. Croix, Dunn, Pierce, Pepin = 7

CRITERIA FOR DETERMINING THE CONDITION OF DOORS, WIDOWS AND WALLS

Condition 1= DOORS, WINDOWS- good fit, no draft is felt, caulk and weatherstripping are in good shape.
WALLS- finish in good shape.

Condition 2= DOORS- loose or missing weatherstripping.
WINDOWS- loose fit, no weatherstripping, caulk and glazing cracked and missing in sections, storm open or cracked.
WALLS- caulking between wall and frames is cracked, shrunk or nonexistant.
WALL EDGE AT FOUNDATION- shows minor deterioration.

Condition 3= DOORS- large gaps between door and jamb. Door cracked, sagging on hinges.
WINDOWS- very loose, window glass broken or missing. Frame shows rotted areas.
WALLS- rotted areas, large gaps between wall and frames.
WALL EDGE AT FOUNDATION- show deterioration, missing siding and holes. Foundation has many cracks or holes.

19. BASEMENT WINDOWS: HOW MANY LINES FILLED IN? 19. _____
ENTER BASEMENT WINDOW DATA FROM REVERSE SIDE DATA ON BACK

20. CARPETED FIRST FLOOR AREA (SQ.FT) 20. _____
INSULATED 1=Yes 2=No _____
R-Value if Yes _____

21. First Floor Area NOT CARPETED (SQ.FT.) 21. _____
Insulated 1=Yes 2=No _____
R-Value if Yes _____

22. UNINSULATED CEILING AREA (SQ.FT.) AND R-VALUE 22. ____, ____

23. INSULATED CEILING AREA (SQ.FT.) AND R-VALUE 23. ____, ____
MATERIAL_____ DEPTH_____

24. WINDOWS: HOW MANY LINES FILLED IN? 24. ____, ____
DOUBLE HUNG 1=Yes 2=No DATA ON BACK
ENTER WINDOW DATA FROM THE REVERSE SIDE

25. DOORS: HOW MANY LINES FILLED IN? 25. _____
ENTER DOOR DATA FROM THE REVERSE SIDE DATA ON BACK

26. WALL CONDITION NUMBER (1, 2 or 3) 26. _____

27. TOTAL OUTSIDE WALL AREA INSULATED (SQ.FT.) AND R-VALUE
MATERIAL_____ 27. ____, ____

28. TOTAL OUTSIDE WALL AREA UNINSULATED (SQ.FT.) AND R-VALUE 28. ____, ____

COMPUTER OUTPUT

HEAT LOSS _____ FUEL COST _____

_____% DUE TO INFILTRATION _____% DUE TO CONDUCTION

POTENTIAL SAVINGS
HEAT LOSS _____ FUEL COST _____

SQ.FT. _____ VOLUME _____

COMPUTATION SPACE

BASEMENT WINDOW DATA

See second page to determine condition number for windows and doors.

Direction N,S,E,W	Width Inches	Height Inches	Condition 1,2 or 3	Good Storm 1=Yes, 2=No	Number of Windows

WINDOW DATA

Direction N,S,E,W	Width Inches	Height Inches	Condition 1,2 or 3	Good Storm 1=Yes, 2=No	Number of Windows

DOOR DATA

Direction N,S,E,W,	Width Inches	Height Inches	Condition 1,2 or 3	Good Storm 1=Yes, 2=No

```
UW - River Falls HEATLOSS Program : TUE, OCT  3, 1978, 11:16 AM

Enter two (2) digit code for desired option :
  01 Home energy audit              02 Output stored audit information
  99 Stop
 %01


Storage space on file is available at this time, you may be able to
store your audit information and receive output at a later time.



NEED INSTRUCTIONS (1=YES OR 2=NO) ? 2



 1. ? 10,3,78
 2. ? 2
 3.   100013
 4. ? 1
 5. ? 25
 6. ? 1
 7. ? 1
 8. ? 68,66
 9. ? 4
10. ? 1
??,100
BAD INPUT--RETYPE FROM ITEM 1
??1,100

* * ENTRY NOT REALISTIC * * FUEL COST FOR TYPE OF FUEL INDICATED MUST
BE BETWEEN 30 AND 65 CENTS INCLUSIVE.  PLEASE REENTER DATA.

    DO YOU KNOW THE APPROPRIATE FUEL COST (1=YES OR 2=NO) ? 2
11. ? 1
12. ? 543,8
15. ? 1
      INSULATED ? 2
16. ? 94
17. ? 6
18. ? 1
19. ? 0
20. ? 180
      INSULATED (1=YES OR 2=NO) ? 2
21. ? 363
      INSULATED (1=YES OR 2=NO) ? 2
22. ? 0,0
23. ? 543,24
24. ? 0,1

* * ENTRY NOT REALISTIC * *A HOME MUST HAVE AT LEAST ONE (1) WINDOW.
PLEASE REENTER DATA.
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24. WINDOWS : NUMBER OF LINES FILLED IN (1-45) AND DOUBLE HUNG (1=YES
    OR 2=NO) ? 3,1
    ? W,30,50,1,2,1
    ? S,30,50,1,1,3
    ? W,30,60,1,2,1
25. ? 1
    ? E,31,84,1,1
26. ? 3
27. ? 0,0
28. ? 752,3


DO YOU WISH TO STORE INFORMATION UNTIL LATER (1=YES 2=NO) ? 1

Enter two (2) digit code for desired option :
  01 Home energy audit              02 Output stored audit information
  99 Stop
 %99


HEATLOSS RUN TERMINATED.


READY
#BYE
CPU=3. CONNECT=10. TUE, OCT  3, 1978, 11:24 AM
* * * GOOD-BYE FROM WACC I * * * A SERVICE OF UW-RIVER FALLS * * *
END OF SESSION
@:

:BYE

CPU=3. CONNECT=11. TUE, OCT  3, 1978, 11:25 AM
* * * GOOD-BYE FROM WACC II * * * A SERVICE OF UW-RIVER FALLS * * *
END OF SESSION
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UW - River Falls HEATLOSS Program : TUE, OCT  3, 1978, 10:47 AM

Enter two (2) digit code for desired option :
  01 Home energy audit              02 Output stored audit information
  99 Stop
 %01


Storage space on file is available at this time, you may be able to
store your audit information and receive output at a later time.



NEED INSTRUCTIONS (1=YES OR 2=NO) ? 1

     THIS PROGRAM IS DESIGNED TO SAVE COMPUTER TIME.  THEREFORE ANSWER
THE QUESTIONS AS ACCURATELY AS POSSIBLE.  PLEASE READ THE BOOKLET CARE-
FULLY AND USE THE DATA SUMMARY SHEET.  IF YOU DO NOT KNOW AN ANSWER, DO
NOT GUESS THE ANSWER.  IF YOU ARE UNSURE AND HAVE A CHANCE TO ANSWER NO,
THE COMPUTER WILL ASSIGN A REASONABLE VALUE WHERE POSSIBLE.  YOU WILL BE
GIVEN ONLY  4  CHANCES TO ENTER THE CORRECT INFORMATION (WITH HINTS) BE-
FORE BEING TERMINATED.



 1. DATE (MONTH, DAY, YEAR) ? 10,3,78
 2. Y.O.U. I.D. NUMBER ? 2
 3. HOUSE NUMBER : 100012
 4. NUMBER OF INDIVIDUALS OCCUPYING HOME ? 1
 5. AGE OF HOME (YEARS) ? 25
 6. CONDITION OF ROOF : 1 = TIGHT ROOF  2 = MINOR REPAIRS NEEDED
    3 = NEW ROOF NEEDED  ? 1
 7. CONDITION OF HEATING SYSTEM : 1 = GOOD CONDITION  2 = NEEDS REPAIR
    3 = NEEDS REPLACEMENT ? 1
 8. AVERAGE HOME TEMPERATURE (FAHRENHEIT) : DAYTIME AND NIGHTTIME.
    SEPARATE EACH ENTRY WITH A COMMA. FOR EXAMPLE: 68,66 ? 70,70
 9. ENTER THE ZONE NUMBER WHERE HOME IS LOCATED ? 7
10. ENTER FUEL NUMBER ? 5
    DO YOU KNOW THE FUEL COST (1=YES OR 2=NO) ? 1
    ENTER FUEL COST ? 25
11. ENTER NUMBER OF STORIES ? 1
12. ENTER FIRST FLOOR AREA (SQ.FT.) AND AVERAGE WALL HEIGHT
    (FT.) ? 543,8
15. ENTER FLOOR EXPOSURE FACTOR ? 1
    ARE THE BASEMENT WALLS INSULATED (1=YES OR 2=NO) ? 2
16. ENTER FOUNDATION PERIMETER IN FEET ? 94
17. ENTER AMOUNT FOUNDATION IS EXPOSED IN INCHES ? 6
18. ENTER FOUNDATION CONDITION NUMBER ? 2
19. HOW MANY LINES FILLED IN FOR BASEMENT WINDOWS ? 2
    ENTER BASEMENT WINDOW DATA AS FOLLOWS : ENTER DIRECTION (N, S, E OR
    W), WIDTH (INCHES), HEIGHT (INCHES), CONDITION (1, 2 OR 3), GOOD
    STORMS (1=YES OR 2=NO), NUMBER OF WINDOWS OF SAME DIRECTION, CONDITION,
    ETC.  SEPARATE EACH ENTRY BY A COMMA.  FOR EXAMPLE : N,24,16,1,1,2
    ? E,30,12,1,2,1
    ? N,30,12,1,2,1
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20. IS ANY OF THE FIRST FLOOR AREA CARPETED (1=YES OR 2=NO) ? 1
    ENTER CARPETED FIRST FLOOR AREA IN SQ. FT. ? 180
      INSULATED (1=YES OR 2=NO) ? 2
21. IS ANY OF THE FIRST FLOOR NOT CARPETED (1=YES OR 2=NO) ? 1
    ENTER FIRST FLOOR AREA NOT CARPETED IN SQ.FT. ? 363
      INSULATED (1=YES OR 2=NO) ? 2
22. ENTER UNINSULATED CEILING AREA (SQ.FT.) AND R-VALUE.  SEPARATE EACH
    NUMBER BY A COMMA.  IF THERE IS NO UNINSULATED CEILING AREA, ENTER
    A 0 FOR THE CEILING AREA AND A 0 FOR THE R-VALUE ? 0,0
23. ENTER INSULATED CEILING AREA (SQ.FT.) AND R-VALUE.  SEPARATE EACH
    NUMBER BY A COMMA.  IF THERE IS NO INSULATED CEILING AREA, ENTER A
    0 FOR THE CEILING AREA AND A 0 FOR THE R-VALUE ? 643,24

* * ENTRY NOT REALISTIC * *TOTAL CEILING AREA DOES NOT EQUAL INSULATED
PLUS UNINSULATED CEILING AREA (WITHIN 10%).  PLEASE REENTER DATA.

22. ENTER UNINSULATED CEILING AREA (SQ.FT.) AND R-VALUE.  SEPARATE EACH
    NUMBER BY A COMMA.  IF THERE IS NO UNINSULATED CEILING AREA, ENTER
    A 0 FOR THE CEILING AREA AND A 0 FOR THE R-VALUE ? 0,0
23. ENTER INSULATED CEILING AREA (SQ.FT.) AND R-VALUE.  SEPARATE EACH
    NUMBER BY A COMMA.  IF THERE IS NO INSULATED CEILING AREA, ENTER A
    0 FOR THE CEILING AREA AND A 0 FOR THE R-VALUE ? 543,24
24. WINDOWS : NUMBER OF LINES FILLED IN (1-45) AND DOUBLE HUNG (1=YES
    OR 2=NO) ? 7,1
    ENTER WINDOW DATA AS FOLLOWS : ENTER DIRECTION (N, S, E OR W), WIDTH
    (INCHES), HEIGHT (INCHES), CONDITION (1, 2 OR 3), GOOD STORMS (1=YES
    OR 2=NO), NUMBER OF SAME DIRECTION, CONDITION, ETC.  SEPARATE EACH
    ENTRY WITH A COMMA.  FOR EXAMPLE : N,28,53,2,1,3
    ? S,63,51,1,2,1
    ? N,2
        36,33,3,1,1
    ? N,48,33,1,1,1
    ? N,48,33,1,1,2
    ? E,54,33,1,1,1
    ? W,48,36,1,1,1
    ? W,39,33,2,2,1
25. DOOR DATA : HOW MANY LINES FILLED IN ? 2
    ENTER DOOR DATA AS FOLLOWS : DIRECTION (N, S, E OR W), WIDTH (IN
    CHES), HEIGHT (INCHES), CONDITION (1, 2 OR 3), STORMS (1=YES
    OR 2=NO).  SEPARATE EACH ENTRY WITH A COMMA.  FOR EXAMPLE : N,36,
    84,1,1
    ? S,36,84,2,2
    ? W,72,84,1,1
26. WALL CONDITION NUMBER ? 1
27. ENTER TOTAL OUTSIDE WALL AREA INSULATED AND R-VALUE ? 0,0
28. ENTER TOTAL OUTSIDE WALL AREA UNINSULATED AND R-VALUE ? 752,3


DO YOU WISH TO STORE INFORMATION UNTIL LATER (1=YES 2=NO) ? 2
```

TO DETERMINE THE ACCURACY OF THE COMPUTER RESULTS, COMPARE THE COMPUTED FUEL BILL TO THE ACTUAL FUEL BILL. THE CLOSER THE MATCH THE MORE ACCURATE THE RESULTS. THE POTENTIAL SAVINGS INDICATED ARE FOR THE FIRST COMPLETE HEATING SEASON. POTENTIAL DOLLAR SAVINGS ASSUME THAT THE PRICE OF FUEL REMAINS THE SAME. MATERIAL COSTS VARY A GREAT DEAL AND SHOULD BE CHECKED LOCALLY.

* * * SURVEY QUESTION 8. * * *

AVERAGE HOME TEMPERATURE IS 70

YOU SHOULD LIVE AT A LOWER TEMPERATURE, 68 DEGREES FAHRENHEIT OR LESS.

* * * SURVEY QUESTION 7. * * *

HEATING EFFICIENCIES ASSUMED ARE : 65% OIL, LP AND NATURAL GAS, 100% ELECTRIC, 60% COAL AND 50% WOOD.

YOUR FURNACE IS IN GOOD CONDITION - YOUR EFFICIENCY IS PROBABLY AS STATED.

YOUR HEATLOSS IS 1111.7 THERMS GAS
ASSUMING THAT YOUR FUEL COSTS ARE 25.00 CENTS PER THERM YOUR FUEL BILL SHOULD BE ABOUT $ 277.91.
OF THIS HEATLOSS 26 % IS DUE TO INFILTRATION LOSSES
74 % IS DUE TO CONDUCTION LOSSES.

* * * INFILTRATION LOSSES SHOULD BE CONSIDERED FIRST * * *

* * * SURVEY QUESTIONS 19. & 24. * * *

WINDOW DATA : ONLY WINDOWS NEEDING WORK OR WITH TRIPLE GLAZED
############## SAVINGS GREATER THAN $2 ARE LISTED
HEATLOSS = 12.1 THERMS GAS $ 3.03 (CONDUCTION) - BASEMENT
HEATLOSS = 1.4 THERMS GAS $ .36 (INFILTRATION) - BASEMENT
HEATLOSS = 177.1 THERMS GAS $ 44.28 (CONDUCTION)
HEATLOSS = 80.1 THERMS GAS $ 20.02 (INFILTRATION)

DIRECTION	WIDTH INCHES	HEIGHT INCHES	STORM NEEDED	WEATHER STRIPPING NEEDED	POTENTIAL SAVINGS IF WEATHER STRIPPED (ONLY)	POTENTIAL SAVINGS IF WEATHER STRIPPED AND STORM	POTENTIAL SAVINGS IF WEATHER STRIPPED AND TRIPLE GLAZED
B-EAST	30	12	YES	NO	$ .01	$ .64	$ .94
B-NORTH	30	12	YES	NO	$ .01	$ .64	$ .94
SOUTH	63	51	YES	NO	$ .12	$ 7.24	$ 9.94
NORTH	36	33	NO	YES	$ 4.72	$ 4.72	$ 5.72
WEST	39	33	YES	YES	$ 1.56	$ 4.41	$ 5.49
				TOTALS	$ 6.43	$ 17.65	$ 30.00

2 BASEMENT STORM WINDOWS NEEDED
USING ALUMINUM STORMS AVG. RETAIL PRICE = $ 24.00

29 LINEAR FEET OF WEATHERSTRIPPING
NEEDED FOR WINDOWS AVG. RETAIL PRICE = $ 2.97

2 STORM WINDOWS NEEDED
USING ALUMINUM STORMS AVG. RETAIL PRICE = $ 100.00

* * * SURVEY QUESTION 25. * * *

DOOR DATA : ONLY DOORS NEEDING WORK ARE LISTED.
##########
HEATLOSS = 119.4 THERMS GAS $ 29.86 (CONDUCTION)
HEATLOSS = 101.8 THERMS GAS $ 25.44 (INFILTRATION)

DIRECTION	WIDTH INCHES	HEIGHT INCHES	STORM NEEDED	WEATHER STRIPPING NEEDED	POTENTIAL SAVINGS IF WEATHER STRIPPED (ONLY)	POTENTIAL SAVINGS IF WEATHER STRIPPED AND STORM
SOUTH	36	84	YES	YES	$ 16.70	$ 23.06
				TOTALS	$ 16.71	$ 23.07

20 LINEAR FEET OF WEATHERSTRIPPING NEEDED FOR DOORS AVG. RETAIL PRICE = $ 2.00
1 STORM DOORS NEEDED USING ALUMINUM STORMS AVG. RETAIL PRICE = $ 75.00

* * * SURVEY QUESTION 18. * * *

FOUNDATION INFILTRATION DATA:
##############################
HEATLOSS = 30.3 THERMS GAS $ 7.57 (INFILTRATION)

FOUNDATION NEEDS SOME WORK, PARTICULARLY CAULKING
CRACK LENGTH ASSOCIATED WITH SILL AND FOUNDATION IS 94 LINEAR FEET
9 TUBES OF CAULKING MAY BE NEEDED *** AVG. RETAIL PRICE = $ 13.50

POTENTIAL SAVINGS: 20.6 THERMS GAS $ 5.14

* * * SURVEY QUESTION 26. * * *

WALL INFILTRATION DATA:
########################
HEATLOSS = 59.8 THERMS GAS $ 14.94 (INFILTRATION)

WALL CONDITION IS GOOD, NO WORK NEEDED; NO POTENTIAL SAVINGS.

CONDUCTION LOSSES SHOULD BE CONSIDERED SECOND.

```
 * * * SURVEY QUESTIONS 6.,22. & 23. * * *

CEILING DATA:
##############
HEATLOSS =         .0     THERMS GAS     $    .00 (UNINSULATED)
HEATLOSS =       55.8     THERMS GAS     $ 13.96 (INSULATED)

INSULATED CEILING AREA =     543  SQUARE FEET CURRENT R-VALUE =  24.0
ADDITIONAL INSULATION NEEDED TO ACHIEVE AN R-VALUE OF ABOUT R= 33
  2  SETTLED INCHES OF BLOWN CELLULOSE R=3.7/IN.
  8   30 LB BAGS OF CELLULOSE              AVG. RETAIL PRICE = $  40.00

***** OR *****

ASSUME ONLY 3 AND 6 INCH BATTS ARE EASILY AVAILABLE

  6  ROLLS OF 6.0 X 23 FIBER GLASS BATTS  AVG. RETAIL PRICE = $ 173.76

WITH THIS FIBER GLASS ADDED TOTAL R-VALUE = 43.0

VENTILATION REQUIREMENTS (ASSUMES NO VAPOR BARRIER EXISTS)
ABOUT  1.8 SQ.FT. INLET  AVG. RETAIL PRICE = $  3.75 USING ATTIC VENTS
ABOUT  1.8 SQ.FT. OUTLET AVG. RETAIL PRICE = $ 12.00 USING ROOF VENTS

POTENTIAL SAVINGS:      16.0     THERMS GAS     $    3.99

* * * SURVEY QUESTIONS 27. & 28. * * *

WALL DATA:
###########

* * * WALL INSULATION STANDARD USED IS R-11* * *
* * * TOTAL WALL R-VALUE STANDARD IS R-15  * * *

HEATLOSS =     287.4     THERMS GAS     $ 71.85 (CONDUCTION)

TOTAL WALL AREA =     752  SQUARE FEET
TOTAL WINDOW AND DOOR AREA =     159  SQUARE FEET
NET WALL AREA =     592  SQUARE FEET

100 % OF THE NET WALL AREA IS NOT INSULATED R-VALUE =   3.0
ADDITIONAL INSULATION NEEDED TO ACHIEVE AN R-VALUE OF ABOUT R=15
 3.5 INCHES OF BLOWN CELLULOSE R=3.7/IN.
 19   30 LB BAGS OF CELLULOSE              AVG. RETAIL PRICE = $  94.00

POTENTIAL SAVINGS UNINSULATED WALLS:    204.4     THERMS GAS     $  51.11
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* * * SURVEY QUESTIONS 12.,15.,16.,17.,20. & 21. * * *

BASEMENT DATA :
##################
HEATLOSS =     186.4     THERMS GAS     $ 46.60 (CONDUCTION)


OF THE HEAT LOST TO YOUR BASEMENT  72% IS LOST THROUGHTHE EXPOSED PART
OF THE BASEMENT WALL, 19% IS LOST THROUGH THE PART NOT EXPOSED AND  9%
IS LOST THROUGH THE BASEMENT FLOOR.

IF YOU INSULATE THE BASEMENT WALLS, THE HEAT LOST TO THE BASEMENT IS :

INSULATION TYPE       CALCULATED HEATLOSS            POTENTIAL SAVINGS
---------------       THERMS GAS     DOLLARS       THERMS GAS     DOLLARS

   R- 4 WALL              134.0       $ 33.51          52.4        $ 13.10
   R-11 WALL              115.0       $ 28.75          71.4        $ 17.85


HOT WATER DATA:
################

FOR THE   1      INDIVIDUALS OCCUPYING THE HOME
THE HOT WATER COSTS PER YEAR ARE ABOUT

          $  63   IF ELECTRIC AT $.03/KWHR
          $  20   IF NATURAL GAS AT $.25/THERM
          $  35   IF LP AT $.40/GALLON
          $  28   IF OIL AT $.47/GALLON


IF YOU WISH ADDITIONAL INFORMATION CONTACT:
WESTCAP HOUSING AND ENERGY, GLENWOOD CITY, WI. 715-265-4271.
UW RIVER FALLS, PHYSICS/ENERGY, RIVER FALLS, WI. 715-425-3196.
WISCONSIN OFFICE OF STATE PLANNING AND ENERGY
MADISON, WI. 608-266-6850.

################################################################################

TOTAL POTENTIAL SAVINGS:    475.2     THERMS GAS     $118.80

################################################################################

Enter two (2) digit code for desired option :
  01 Home energy audit              02 Output stored audit information
  99 Stop
 %09


HEATLOSS RUN TERMINATED.
```