Public Works Canada
Design and Construction
Technology

EASI:
USER'S MANUAL

Version 1.0
July 1980

Computer-Aided Design (CAD)

Information, assistance, and
user feedback:

CAD Centre
Public Works Canada
7E, Sir Charles Tupper
Building
Ottawa, Ontario K1A 0M2
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I. INTRODUCTION

This report describes a prototype version of the EASI program. This program is presently under development. It is not in its final form and has not yet been thoroughly tested; therefore it is not intended to be relied upon as a design tool at this time. The purpose of this prototype version is to obtain some user feedback which will influence the final form of the program.

II. OBJECTIVES OF THE EASI PROGRAM

The ultimate objective is to provide a fast easy-to-use means of performing energy systems analysis inexpensively on the CAD minicomputer design station. This process involves calculation of building (zone) thermal loads & simulation of HVAC system and equipment such as chillers, boilers, etc. The program described in this report is only one part of this analysis system; it performs the thermal load calculations for one zone and stores these on a file for use by the (yet to be developed) systems simulation phase.

A more immediate objective is to provide a stand-alone capability for evaluation of energy consequences of architectural designs. The program described here may be considered to be an enhanced ABC [1] program with the following improvements over the table lookup approach.

- thermal mass of the building is considered.
- the zone may have windows facing different directions (maximum 10)
- the exact orientation of the window (azmith & tilt) may be specified. This permits consideration of skylights, clerestory, etc.

- exterior shading devices (overhang and side fins) may be considered.
- time scheduling capability is more flexible than ABC.
- heating/cooling peaks, as well as consumptions are computed.
- output is by month as well as annual.

A primary consideration in EASI is that it be easy-to-use, even though this may require compromises in the capability and accuracy. (The underlying philosophy is that the user can always use one the very sophisticated and detailed energy programs which are available when greater capability is required). EASI utilizes a conversational interactive format similar to that of ABC but with type-ahead and units conversion features.

Like ABC (and probably all other energy programs), this program is best used for comparison of alternatives, rather than "predictions of performance".

Before learning how to use EASI it may be worthwhile to examine the results of a zone calculation. Referring to Table Ib (see page 25) it can be seen that the output consists of 6 quantities.:

- Heating energy consumption.
- Heating peak
- Cooling energy consumption - this is the room cooling load. If the system uses outdoor air for free cooling this value has little meaning; however, if the system is fixed outdoor air (specified in ventilation) this value indicates cooling energy required.
- Cooling peak - this is of interest as an indication of terminal unit size (ex. air flow rate)

- "Reference Consumption" is the cooling required by an idealized VAV system which uses outdoor air for free cooling. This ideal system is the same as that in ABC.
- "Reference Peak" is the peak cooling for the ideal system. This is an indication of chiller capacity required.

The above values are based upon a constant indoor temprature of 70°F. (Room temperature variations would be considered in the systems phase of the analysis).

III USER INSTRUCTIONS

1. Initiating the Program:

The EASI program requires an IM70 minicomputer with 4 floppy disk drives, line printer and CRT Terminal. This manual assumes some familiarity with using the IM70 system. The inexperienced are referred to "An Introduction to Running Fortran Programs on the IM70" for instruction on starting up, etc.

The EASI program uses 3 floppy diskettes. The working file disk is mounted in drive 1; the program disk is mounted in drive 2; the weather data disk is mounted in drive 3. A separate weather data disk is required for each location. At present the choice is limited to Vancouver and Montreal weather.

To execute the EASI program type /BA F2.EASI (followed by carriage return) It takes approximately 1 minute for the program to load. After this you will be prompted for input as described below.

2. Overview of Input Procedure

The first time through the program you will be prompted for basic zone data. This basic data is that which might apply to all zones, whether they are internal or external zones; this is discussed in Section 3.

After the basic data has been input, it will be displayed on the screen and you are given the option of adding surface data. A surface is a wall/window combination. Each surface faces one direction, but there may be as many as 10 surfaces in one zone. If the zone is interior there would be no surfaces. (i.e. reply NO).

If the zone is perimeter you must add a surface (reply ADD). Again you are prompted for input values to describe the surface. If the zone has more than one exposure you may add more surfaces in the same way; reply NO when no more surfaces are to be added. Note that there will be a few seconds pause after adding each surface; during this time the solar modifiers for that surface are being calculated and filed.

After replying NO to the surface prompt you return to command mode, as indicated by the COMMAND? prompt. You have the option of displaying your input data, editing your input data if you notice some errors, or of requesting the program to calculate using your input data. These options are discussed in section 4.

One of the commands (SURF or SURFACE) permits you to indicate that you wish to add, delete, or change a surface. This procedure is described in section 5.

The normal procedure for using EASI would be to

- enter basic data for first zone.
- enter surfaces (if any) for first zone.
- display data and check for errors.
- use editing procedures to change data if necessary.
- perform calculation.
- edit input data for any alternative to be evaluated and perform calculation for alternative.
- edit data to describe second zone, and repeat as above, etc.

3. First Time Input:

After initiating the program as described in section 1 you are prompted as follows:

UNITS? [IM OR SI] DEFAULT = IM

- reply IM (or return) if you wish to use imperial units; reply SI if you wish to work in SI units.

ZONE DESCRIPTION?

- enter a 1 line description to identify the zone.

FLOOR AREA? DEFAULT= 1.000(Sq.Ft.)

- enter the floor area of the zone.

Volume

BUILDING THERMAL RESPONSE? DEFAULT = L

- valid responses are:
  - X = instantaneous (i.e. no thermal mass)
  - L = light ~~(i.e. 2" concrete floor)~~ wood Frame, ½" gyproc walls & ceiling
  - M = medium ~~(i.e. 4" concrete floor)~~ 2" (4 layers) gyproc " & ceiling
  - H = heavy ~~(i.e. 6" concrete floor)~~ 4" Brick (interior surface) walls
  - V = very heavy (i.e. 8" concrete floor)

TIME SCHEDULE IDENTIFIER? DEFAULT = ~~OFFI~~ HOUSE

- time variations for lights, people and infiltration are specified by giving values for "occupied", "unoccupied" and "part occupied" periods. These time periods are defined for different types of building use in a library (see Appendix A for description of time schedules in library). You must enter one of these identifiers; choose that which best describes your application.

  Ex. OFFI - for tyical office
  SCHO - for school
  SHOP - for shopping centre
  HOUS - for residence

INPUT TO LIGHTS: OCCUPIED? DEFAULT= 0.000(WATTS/SQ.FT.)

- enter power input (~~per unit area~~) to lights during "unoccupied" period.

INPUT TO LIGHTS: UNOCCUPIED? DEFAULT= 0.000(WATTS/SQ.FT.)

- ditto during "unoccupied" period.

INPUT TO LIGHTS: PART OCCUPIED? DEFAULT=0.000(WATTS/SQ.FT.)

- ditto during "part occupied" period.

% OF LIGHTS HEAT TO RETURN AIR? DEFAULT=0.000(%)

- enter the percent of heat from lights which does not heat the space, but rather raises the return air temperature. (Caution: this would seldom exceed 15% except when return air is ducted through light troffers)

% OF LIGHTS HEAT WHICH IS RADIANT DEFAULT = 55.000(%)

- enter the percent of heat from lights which is transferred by radiation.
  (typical values - fluorescent lights 50%
  - incandescent lights 80%

PEOPLE DENSITY: OCCUPIED? DEFAULT=0.000(FT/PERSON)
- enter floor area/person during "occupied" period (Note: 0 means no people in space).

PEOPLE DENSITY: UNOCCUPIED: DEFAULT=0.000(FT/PERSON)
- ditto "unoccupied" period

PEOPLE DENSITY: PART OCCUPIED? DEFAULT=0.000(FT/PERSON)
- ditto "part occupied" period

INFILTRATION RATE: OCCUPIED? DEFAULT=0.000(ACH)
- enter infiltration rate (per unit floor area) during "occupied" period.

INFILTRATION RATE: UNOCCUPIED? DEFAULT=0.000(ACH)
- ditto "unoccupied" period

INFILTRATION RATE: PART OCCUPIED? DEFAULT=0.000(ACH)
- ditto "part occupied" period

ROOF AREA? DEFAULT=0.000(SQ.FT)
- enter roof area.

ROOF R-VALUE? DEFAULT=(BTU/HR-SQ.FT-DEG.F) inverse
- enter roof U-value

This completes input of the basic data. This input data will now be displayed on the screen. Then the following prompt will appear:

ADD, DELETE, OR CHANGE A SURFACE? DEFAULT = NO

We will assume that this is an interior zone, therefore the appropriate response would be NO. This results in the following prompt:

COMMAND? DEFAULT=LIST

In the "command" mode you have the option of editing your input data, or of executing a number of commands. These will be discussed in the following section.

An example of first time input is shown in Table (Ia). Note that the convention used in examples is to underline the users input (I.E. from keyboard). Note that a blank line indicates that carriage return was pressed to indicate that the default value is to be used.

4. Command Mode:

In response to the "command" prompt you may either edit input data or execute commands. The valid responses are summarized in Section IV.

In order examine your basic input data, type LIST. The basic input data will be displayed on the screen. You can now examine your input to determine if it is what you want to input. If there are any errors you may change the input, as will be described later.

If you are satisfied with the input data, type PRIN to perform the load calculation. The input data will be printed

on the line printer, followed by the results of the calculations. This takes approximately 30 seconds. An example for an interior zone is shown on Table Ib.

Let us now suppose that you wish to change some basic input data, either because you noticed a mistake, or because you wish to try an alternative. LIST to display the data. Notice that data is arranged in groups (which we will call data groups) which have a 4 character identifier. To change data, type in the appropriate identifier; you will then be prompted for the input data in that data group. Simply press return for any data which you don't want to change.

For example, to change the roof U-value to 0.1, leaving roof area unchanged.

```
COMMAND?                    DEFAULT = LIST
?ROOF
ROOF AREA?                  DEFAULT = 1,000.000 (SQ.FT).
?
ROOF U-VALUE?               DEFAULT = .070(BTU/HR-SQ.FT.-DEG.F)
?.12
COMMAND?                    DEFAULT = LIST
?
```

To convince yourself that it is changed, type LIST; to calculate loads using new U-value type PRIN.

The commands which apply to surfaces (SURF,SHOW) will be described in the following section.

The BEGI command causes you to be prompted for all input from the beginning (like first time through). This may be useful if there are a lot of changes and you are afraid of forgetting something.

The STOP command is used to terminate the program when you are finished. It is important to STOP because, this cleans up the scratch files (i.e. don't just take out your disks & shut off machine).

.5 Adding Surfaces

If the zone is a perimeter zone then you must define at least one surface in addition to the basic data.

To do this from command mode, type SURF. You will then be in "surface mode" as indicated by the following prompt:

To add a surface, reply ADD. You will then be prompted for the surface identifier; this may be any (maximum 4 character) name you like.

You are then prompted for the following information (which will be discussed in more detail in section 6):

- gross area of surface
- ~~U-value~~ of opaque wall
- window area
- window ~~U~~-value
- window shading coefficient
- orientation

When this information has been entered, the surface data is displayed on the screen, and the surface mode prompt appears.

If you wish to add another surface reply ADD and respond to the prompts. If you are finished reply NO; this returns to command mode.

You may display all the surface data (from either command mode or surface mode) by using the SHOW command.

Table II shows an example of converting the interior zone input to a south perimeter zone by adding a 800 ft^2 wall containing 250 $ft.^2$ of single glazed window.

.6 Changing Surfaces;

To change surface data you must be in "surface mode" (i.e. type SURF if you are in "command mode").

Reply CHAN (or CHANGE) to the surface prompt. You will be asked which surface you wish to change; reply with the surface identifier. You are then asked if you wish to change wall data, window data, or orientation. You may display the surface by typing SHOW. When you have finished making changes, reply NO. The surface data is displayed on the screen; if you have changed orientation (DIRX) or window (WIND) there will be a pause while solar modifiers are calculated and stored on the file. Table III illustrates the use of CHANGE to convert the south perimeter zone of example II to a west perimeter zone having a glass area of 400 ft^2.

.7 Deleting Surfaces:

To delete a surface, enter surface mode and reply DELE (or DELETE) to the prompt. You are then asked which zone you wish to delete.

.8 Input Options

Up to this point we have discussed the simplest form of input. There are a number of optional features which increase the capability and convenience of the EASI program.

.1 Percent Glass Option:

You may wish to express the glass area as a percent of the gross surface area. To do this reply % to the window area prompt; you will then be prompted for the percent glass - enter value between 0 and 100.

Example

```
CHANGE? (WALL,WIND,DIRX,SHOW,NO)                DEFAULT = NO
?WIND
WINDOW AREA?                          DEFAULT=400.000(SQ.FT)
?%
ENTER AS % OF GROSS SURFACE AREA:   DEFAULT= 0.000(%)
?25
WINDOW U-VALUE?                  DEFAULT=1.000(BTU/HS-SQ.FT-DEG.F)
?25
WINDOW SHADING COEFFICIENT?      DEFAULT = 1.000
?
CHANGE? (WALL,WIND,DIRX,SHOW,MO)  DEFAULT = NO
```

.2 Window Shading Option:

EASI simulates overhang and side fin shading of windows. This requires that window dimensions be specified, rather than window area.

To use this option, reply # (for number) to the window area prompt. You will then be asked the number of windows and the window height and width (area equals product of these three).

You are then asked for the depth of the overhang; reply 0 if no overhang. If you specified a depth of overhang you are prompted for other dimensions pertaining to the overhang.

You are then asked for depth of right side fin; reply 0 if no right side fin. If you specified a depth you are prompted for other dimensions pertaining to right side fin.
The above process is then repeated for the left side fin. An example is shown in Table IV.

.3 Azmith and Tilt Option:
An optional input permits you to specify the exact orientation of a surface (really the window). To do this reply AZMI (or AZMITH) to the orientaton prompt. You will be asked for the azmith (in degrees from south with west positive and east negative) and then for the tilt angle (degrees from horizontal, facing sky).

Example:

```
ADD,DELETE,OR CHANGE A SURFACE?        DEFAULT=NO
?CHANGE
SURFACE IDENTIFIER?(4CHARACTERS)
?SS1
CHANGE? (WALL,WIND,DIRX,SHOW,NO)       DEFAULT=NO
?DIRX
ORIENTATION?                           DEFAULT=WEST
?AZMITH
WALL AZMITH?(DEGREES FROM SOUTH)       DEFAULT=90.00(DEGREES)
?81
TILT ANGLE? (0-HORIZ,90=VERT)          DEFAULT=90.00(DEGREES)
?60
CHANGE?(WALL,WIND,DIRX,SHOW,NO)        DEFAULT=NO
?
SURFACE: ID=SSI
   WALL: GROSS AREA= 800 SQ.FT. U-VALUE-.110 BTU/HR-SQ.FT.°F
   WIND: AREA = 400 SQ.FT.
         SHADING COEFFICIENT=1.00: U-VALUE=1.000 BTU/HR-SQ.FT.-DEG.F
   DIRX: AZMITH = 81. DEGREES:     TILT= 60. DEGREES
```

.4 Units Conversion:

The first time input (or BEGIN) permits you to specify the system of units (Imperial or SI) to be used for input and output. However, there is an option which permits you to enter a value in the "other" system of units and have the program convert it for you. To use this option reply UNIT to the prompt for a value; you are then prompted in the "other" system of units. Enter the value and it will be converted.

Example: Suppose that SI units are being used, and you wish to enter 0.1 cfm/sq.ft. for the infiltration rate.

```
INFILTRATION RATE: OCCUPIED     DEFAULT=0.000(L/SEC-SQ.M)
?UNIT
ENTER IN (CFM/SQ.FT.)
?.1                             CONVERTED TO   .047
INFILTRATION RATE: UNOCCUPIED?  DEFAULT= 0.000(L/SEC-SQ.M)
?UNIT
ENTER IN (CFM/SQ.FT.)
?.1                               CONVERTED TO .047
INFILTRATION RATE: PART OCCUPIED  DEFAULT=0.000(L/SEC-SQ.M)
?UNIT
ENTER IN (CFM/SQ.FT.)
?.1                               CONVERTED TO .047
COMMAND?                          DEFAULT =LIST
```

.5 Type-Ahead feature:

After becoming familiar with the use of the program you may become impatient waiting for prompts. If you are able to anticipate the next required input(s) you may type them on one line separated by either comma(,) or equal sign(=). The prompts will be inhibited. For example.

- to change building thermal response type RESP=H or RESP,H
- to change roof u-value, leaving roof area unchanged type
  ROOF=, .08 (the comma indicates no entry for area).
- to perform both changes above and then print results:
  RESP=H, ROOF=,.08,PRIN

  You may combine commands, inputs, and option specifications - example - to specify direction
  DIRX = AZMI = 81,60

- To use units conversion in changing floor area
  AREA = UNIT = 100

This feature can be very convenient. Remember, however that it is intended to simplify and speed up input. Don't allow yourself to become confused by trying to get too far ahead!

IV. REFERENCE MANUAL

1. Command Mode: (COMMAND?)

In command mode you may either edit basic input data, or execute commands.

.1 Editing Basic Input:

Input data is organized into groups called data-groups. Each data-group has a 4 character identifier. To edit data enter the identifier for the data-group for which you wish to make a change. The program will prompt you for input. If you do not wish to enter a new value hit carriage return and data will remain unchanged. (The default value is shown at the right side of the screen).

The data groups are:

ZONE: This permits you to supply a label to identify the zone. The label may be up to 72 characters (one line).

AREA: Enter floor area (range 1. to 9999999.)

RESP: Enter thermal response of building:
X - instantaneous (no thermal mass)
L - light construction
M - medium construction
H - heavy construction
V - very heavy construction

TIME: Enter identifier of time schedule which describes your application (See Appendix A for time schedules which are defined in library).

LITE: Enter power input to lights for occupied, unoccupied and part occupied periods.
Enter % of heat of lights to return air.
Enter % of heat of lights which is radiant. (Typical values are 50% for fluorescent and 80% for incandescent)

PEOP: Enter people density expressed as floor area per person for occupied, unoccupied and part occupied periods. Enter 0 to indicate no people in the room.

INFL: Enter infiltration rate (expressed as flow rate per unit floor area) for occupied, unoccupied and part occupied periods.

.2 Commands:

LIST: Displays basic input data on screen in data-group format.

CALC: Calculates zone heating/cooling loads and displays results on screen. (Note: the present format does not fit on the screen, therefore recommend using PRINT instead if you wish the "reference" values).

PRIN: Prints input data (both basic and surface) on the line printer, then performs heating/cooling load calculation and prints result on line printer.

SURF: Enters "Surface mode". This permits adding, deleting or changing surface data (see section 2)

SHOW: Displays surface data (for all surfaces) on the screen.

BEGI: Starts from beinning with prompts for all input.

STOP: Terminates execution.

2. Surface Mode:

The surface mode is entered from Command Mode by the command SURF. In this mode you may add, delete, or change surface data. Valid commands in surface mode are:

NO: Means you do not wish to add, delete, or change a surface. This returns you to command mode.

SHOW: Displays on the screen the data for all surfaces presently defined.

DELE: Deletes the specified surface. You are prompted for the surface identifier.

ADD: Adds a new surface. You are prompted for surface identifier. Then you are prompted for wall, window and orientation information in a manner similar to that described for the change command below.

CHAN: Changes data in a specified existing surface. You are prompted for surface identifier, then prompted for the data-group which you wish to change in that surface.

Valid responses are:

NO: Means you do not want to make any more changes to this surface. Returns you to surface mode.

SHOW: Displays surface data (for the surface which you are changing) on the screen.

WALL: Enter the gross surface area (i.e. sum of wall and window).
Enter U-value of the opaque wall.

WIND: There are 3 options to specify window area:

a) enter the window area (in sq.ft. or sq.m.)
b) enter %. You will then be prompted for the window area as a percent of the gross area (specified under wall).
c) enter #. You will then be prompted for:

- number of windows
- height of window
- width of window
- depth of shading overhang

Enter 0 if no overhang. The following are required only if overhang is specified:

i) dimension from top of window to overhang
ii) extent of overhang beyond left edge of window(left looking from outside).
iii) extent of overhang beyond right edge of window (right looking from outside).
iv) depth of "eyebrow" projection on overhang. (Note: see figure Ia for further clarification of above dimensions).

- depth of left side fin (left looking from outside). Enter 0 if no left fin. The following must be entered only if left fin is specified:

i) distance from fin to left edge of window.
ii) distance from bottom of window to bottom of fin. (Note: see figure Ib for further clarification of above dimensions.)

- depth of right side fin (right looking from
- outside).
  Enter 0 if no right fin.

  The following must be entered only if right fin is specified:

  i) distance from fin to right edge of window.
  ii) extent of fin above top of window.
  iii) distance from bottom of window to bottom of fin. (Note: see figure Ic for further clarification of above dimensions).

- Following window area (and shading information if appropriate), enter window shading coefficient and window U-value.

DIRX: The surface orientation may be specified as:

- One of the cardinal directions (NORTH, N.E., EAST, S.E., South, S.W., WEST, N.W.), or horizontal (HORI)
- The keyword AZMI which will result in you being prompted for azmith angle (degrees from south, west positive, east negative) & tilt angle (degrees from horizontal, i.e. 0 = horizontal facing skyward, 90 = vertical wall).

3. Error Messages:

All input is checked for validity and allowable range; should an error be detected a message will be displayed on the screen and you will be prompted to re-enter the data. Most of the error messages should be self-explanatory.

(Take care to distinguish between the numeral 0 and the letter O).

The following error messages may occur in the Surface Mode:

*** WINDOW AREA MAY NOT EXCEED GROSS AREA***

- If you are in the change mode, change either gross area (WALL) or window area (WIND). You will not be permitted out of the change mode until you correct the input.
- If you are in add mode you will be prompted for all surface input from beginning. You must make the correction before you will be allowed to proceed.

*** SHADING ONLY PERMITTED ON VERTICAL SURFACE***

- If you are in change mode, change either to remove shading (WIND) or to set tilt angle to 90 degrees (DIRX). Note that this might no longer describe your application.
- If you are in add mode you will be prompted for all surface input from beginning.

4. Advanced Input Features

.1 Type-ahead capability:

Once you become familiar with the program you will be able to anticipate what it will ask for next. If you are impatient and would rather not wait for the prompts, you can enter a number of inputs or commands on one line separated by either comma(,) or equal sign (=).

ex. to change thermal response to heavy:
RESP = H

ex. to change roof area to 1200 and u-value to .1
ROOF = 1200, .1

ex. to leave roof area unchanged but change u-value to .05
ROOF = ,.05

ex. to run (on printer) the zone for light, medium and heavy construction

RESP=L, PRINT, RESP=M, PRINT, RESP=H, PRINT

ex. to change direction of wall W1 to 10° east of south (notice it gets complex so don't go to far!)
SURF, CHAN, W1, DIRX = AZMI=10, 90, NO

.2 Units Conversion

It may sometimes be convenient to specify an input value in the "other" system of units. The program permits you to do this by replying UNIT to a prompt for a numerical value. You will then be prompted in the other system of units, and the value will be converted.

ex. to enter roof area in sq. meters.

```
? ROOF
ROOF AREA?                          DEFAULT = 1000 SQ.FT.
? UNIT
ENTER IN (SQ.M.)
? 100
                                    CONVERTED TO 1076.39
```

Note that the type-ahead capability can be combined with units conversion. The above could be accomplished by:
ROOF = UNIT = 100

V. DEFICIENCIES AND SUGGESTIONS FOR IMPROVEMENTS

This section is to be written by users of the EASI program. The only way to get the program you want is to communicate your complaints and your needs. However, keep in mind the objectives of the EASI program.

The author will begin with a few items, just to get you started:

- program should indicate what weather data is being used; needs more locations.

- should be more descriptive labels available for project, surface, etc.

- need more time schedules in library. Probably need a method for the user to define non-standard schedules.

- could have more load components (ex. equipment, misc.)

- could have more input options
  ex. KW = to specify total lights load rather than watt/sq.ft.
  PERS = to specify number of people in space, rather than sq.ft./person.

  QTY = to specify total infiltration instead of cfm/sq.ft.

  DIMS = to specify dimensions rather than area for floor area, surface area, etc.

  R = to specify R-value instead of U-value.

- Could specify window type rather than shading coef and U-value. This would require a library of window types with transmittance and absorbtion coefficients).
- Could use tranfer function for heat gain through walls and roof. (Would increase execution time and require library of wall/roof types).
- Could have mechanizm for saving and recalling zone input data on disk files.

- Lots more!

TABLE I(a): Example I - first time input

```
UNITS? (IM OR SI)                          DEFAULT =IM
?
ZONE DESCRIPTION?
?EXAMPLE # 1:  INTERIOR ZONE OF VANCOUVER OFFICE BUILDING
FLOOR AREA?                                DEFAULT =      1,000(SQ.FT.)
?1000
BUILDING THERMAL RESPONSE?                 DEFAULT =L
?
TIME SCHEDULE IDENTIFIER?                  DEFAULT=OFFI
?
TIME: ID=OFFI:   TYPICAL OFFICE: OCCUPIED 8-5 WEEKDAYS,
                                 PARTLY OCCUPIED 7-8 AM & 5-7 WEEKDAYS,
                                 UNOCCUPIED OTHER TIMES.
INPUT TO LIGHTS: OCCUPIED?                 DEFAULT =      0.000(WATTS/SQ.FT.)
?2.5
INPUT TO LIGHTS: UNOCCUPIED?               DEFAULT =      0.000(WATTS/SQ.FT.)
?.25
INPUT TO LIGHTS: PART OCCUPIED?            DEFAULT =      0.000(WATTS/SQ.FT.)
?1.5
% OF LIGHTS HEAT TO RETURN AIR?            DEFAULT =      0.000(%)
?
% OF LIGHTS HEAT WHICH IS RADIANT          DEFAULT =     55.000(%)
?
PEOPLE DENSITY: OCCUPIED?                  DEFAULT =      0.000(SQ.FT/PERSON)
?200
PEOPLE DENSITY: UNOCCUPIED?                DEFAULT =      0.000(SQ.FT/PERSON)
?
PEOPLE DENSITY: PART OCCUPIED?             DEFAULT =      0.000(SQ.FT/PERSON)
?20000
INFILTRATION RATE: OCCUPIED?               DEFAULT =      0.000(CFM/SQ.FT)
?.1
INFILTRATION RATE: UNOCCUPIED?             DEFAULT =      0.000(CFM/SQ.FT)
?.1
INFILTRATION RATE: PART OCCUPIED?          DEFAULT =      0.000(CFM/SQ.FT)
?.1
ROOF AREA?                                 DEFAULT =      0.000(SQ.FT)
?1000
ROOF U-VALUE?                              DEFAULT =      0.000(BTU/HR-SQ.FT-DEG.F)
?.07
ZONE: EXAMPLE # 1:  INTERIOR ZONE OF VANCOUVER OFFICE BUILDING
AREA: FLOOR AREA=    1000.0 SQ.FT
RESP: THERMAL RESPONSE=L
TIME: ID=OFFI:   TYPICAL OFFICE: OCCUPIED 8-5 WEEKDAYS,
                                 PARTLY OCCUPIED 7-8 AM & 5-7 WEEKDAYS,
                                 UNOCCUPIED OTHER TIMES.
LITE: OCCUPIED=  2.50 WATT/SQ.FT;      UNOCCUPIED=   .25 WATT/SQ.FT;
                                       PARTLY OCCUPIED=  1.50 WATT/SQ.FT
     % RADIANT=55.0;                   % TO R.A.= 0.0
PEOP: OCCUPIED=    200. SQ.FT/PERSON;  UNOCCUPIED=      0. SQ.FT/PERSON;
                                       PARTLY OCCUPIED=  20000. SQ.FT/PERSON
INFL: OCCUPIED=     .10 CFM/SQ.FT;     UNOCCUPIED=     .10 CFM/SQ.FT;
                                       PARTLY OCCUPIED=     .10 CFM/SQ.FT
ROOF: AREA=    1000.0 SQ.FT;           U-VALUE=   .070 BTU/HR-SQ.FT-DEG.F
ADD, DELETE, OR CHANGE A SURFACE?       DEFAULT =NO
?
COMMAND?                                DEFAULT =LIST
?PRINT
```

TABLE I(b) : Example I - results of PRINT

```
ZONE: EXAMPLE # 1.  INTERIOR ZONE OF VANCOUVER OFFICE BUILDING
AREA: FLOOR AREA=    1000.0 SQ.FT
RESP: THERMAL RESPONSE=L
TIME: ID=OFFI:   TYPICAL OFFICE. OCCUPIED 8-5 WEEKDAYS,
                                 PARTLY OCCUPIED 7-8 AM & 5-7 WEEKDAYS,
                                 UNOCCUPIED OTHER TIMES.
LITE: OCCUPIED=  2.50 WATT/SQ.FT        UNOCCUPIED=   .25 WATT/SQ.FT;
                                        PARTLY OCCUPIED=  1.50 WATT/SQ.FT
      % RADIANT=55.0;                   % TO R.F. = 0.0
PEOP: OCCUPIED=    200. SQ.FT/PERSON;   UNOCCUPIED=      0. SQ.FT/PERSON;
                                        PARTLY OCCUPIED=  20000. SQ.FT/PERSON
INFL: OCCUPIED=     .10 CFM/SQ.FT.      UNOCCUPIED=     .10 CFM/SQ.FT;
                                        PARTLY OCCUPIED=     .10 CFM/SQ.FT
ROOF: AREA=    1000.0 SQ.FT;            U-VALUE=   .070 BTU/HR-SQ.FT-DEG.F
```

	********HEATING*********		********COOLING*********		*******REFERENCE********	
MONTH	CONSUMPTION (MBTU)	PEAK (MBTU/HR)	CONSUMPTION (MBTU)	PEAK (MBTU/HR)	CONSUMPTION (MBTU)	PEAK (MBTU/HR)
1	2671.	9.80	479.	4.62	0.	0.00
2	2227.	6.55	355.	4.00	0.	0.00
3	2114.	6.54	568.	4.91	0.	0.00
4	1703.	5.80	751.	5.61	0.	0.00
5	1194.	4.37	1120.	8.87	184.	7.39
6	529.	2.63	1521.	8.10	530.	4.95
7	589.	3.33	1804.	9.95	1114.	9.95
8	618.	2.57	1470.	8.10	441.	5.83
9	991.	4.16	1094.	6.88	49.	1.15
10	1395.	5.19	841.	5.68	0.	0.00
11	2065.	6.30	528.	4.34	0.	0.00
12	2282.	6.67	390.	3.83	0.	0.00
ANNUAL	18377.	9.80	10921.	9.95	2317.	9.95

TABLE III(a): Example II - adding a surface

```
SURF
ADD, DELETE, OR CHANGE A SURFACE?          DEFAULT =NO
?ADD
SURFACE IDENTIFIER? (4 CHARACTERS)
?SS1
GROSS AREA OF SURFACE?                     DEFAULT =     0.000(SQ.FT)
?800
U-VALUE OF OPAQUE WALL?                    DEFAULT =     0.000(BTU/HR-SQ.FT-DEG.F)
?.11
WINDOW AREA?                               DEFAULT =     0.000(SQ.FT)
?250
WINDOW U-VALUE?                            DEFAULT =     0.000(BTU/HR-SQ.FT-DEG.F)
?1
WINDOW SHADING COEFFICIENT?                DEFAULT =     0.000
?1
ORIENTATION?                               DEFAULT =NORT
?SOUTH

SURFACE: ID=SS1
   WALL: GROSS AREA=      800. SQ.FT;    U-VALUE=  .110 BTU/HR-SQ.FT-DEG.F
   WIND: AREA=      250. SQ.FT
         SHADING COEFICIENT=1.000;        U-VALUE= 1.000 BTU/HR-SQ.FT-DEG.F
   DIRX: ORIENTATION=SOUT
ADD,DELETE, OR CHANGE A SURFACE?           DEFAULT =NO
?NO
COMMAND?                                   DEFAULT =LIST
?ZONE
ZONE DESCRIPTION?
?EXAMPLE # 2: SOUTH PERIMETER ZONE OF VANCOUVER OFFICE BUILDING
COMMAND?                                   DEFAULT =LIST
?PRINT
```

TABLE II b: Example II - results of print

```
ZONE: EXAMPLE # 2: SOUTH PERIMETER ZONE OF VANOUVER OFFICE BUILDING
AREA: FLOOR AREA=    1000.0 SQ.FT
RESP: THERMAL RESPONSE=L
TIME: ID=OFFI;   TYPICAL OFFICE: OCCUPIED 8-5 WEEKDAYS,
                                 PARTLY OCCUPIED 7-8 AM & 5-7 WEEKDAYS,
                                 UNOCCUPIED OTHER TIMES.
LITE: OCCUPIED=  2.50 WATT/SQ.FT;      UNOCCUPIED=   .25 WATT/SQ.FT;
                                       PARTLY OCCUPIED=  1.50 WATT/SQ.FT
      % RADIANT=55.0;                  % TO R.A. = 0.0
PEOP: OCCUPIED=    200. SQ.FT/PERSON;  UNOCCUPIED=      0. SQ.FT/PERSON;
                                       PARTLY OCCUPIED=  20000. SQ.FT/PERSON
INFL: OCCUPIED=     .10 CFM/SQ.FT;     UNOCCUPIED=     .10 CFM/SQ.FT;
                                       PARTLY OCCUPIED=     .10 CFM/SQ.FT
ROOF: AREA=    1000.0 SQ.FT;           U-VALUE=   .120 BTU/HR-SQ.FT-DEG.F

SURFACE:  ID=SS1
   WALL:  GROSS AREA=      800. SQ.FT;    U-VALUE=  .110 BTU/HR-SQ.FT-DEG.F
   WIND:  AREA=      250. SQ.FT
          SHADING COEFICIENT=1.00;        U-VALUE= 1.000 BTU/HR-SQ.FT-DEG.F
   DIRX:  ORIENTATION=SOUT
```

	********HEATING********		********COOLING********		********REFERENCE********	
MONTH	CONSUMPTION (MBTU)	PEAK (MBTU/HR)	CONSUMPTION (MBTU)	PEAK (MBTU/HR)	CONSUMPTION (MBTU)	PEAK (MBTU/HR)
1	8128.	29.56	1596.	19.62	0.	0.00
2	6272.	20.11	1267.	23.12	0.	0.00
3	5461.	18.95	1967.	22.05	0.	0.00
4	4672.	17.68	2776.	26.45	0.	0.00
5	3279.	13.75	2902.	27.27	543.	22.10
6	1572.	8.56	3705.	21.77	1592.	13.30
7	1432.	10.31	6228.	31.56	3940.	31.56
8	1563.	8.64	5280.	33.57	1984.	23.99
9	2510.	13.14	4081.	31.69	329.	5.53
10	3412.	15.22	3012.	23.50	0.	0.00
11	6022.	19.02	1781.	24.08	0.	0.00
12	7288.	21.64	767.	16.60	0.	0.00
ANNUAL	51612.	29.56	35363.	33.57	8388.	31.56

FORM

TABLE III(a): Example III - changing a surface

```
COMMAND?                                    DEFAULT =LIST
?SURF
ADD,DELETE, OR CHANGE A SURFACE?            DEFAULT =NO
?CHANGE
SURFACE IDENTIFIER? (4 CHARACTERS)
?SS1
CHANGE?  (WALL,WIND,DIRX,SHOW,NO)           DEFAULT =NO
?WIND
WINDOW AREA?                                DEFAULT =   250.000(SQ.FT)
?400
WINDOW U-VALUE?                             DEFAULT =     1.000(BTU/HR-SQ.FT-DEG.F)
?
WINDOW SHADING COEFFICIENT?                 DEFAULT =     1.000
?
CHANGE?  (WALL,WIND,DIRX,SHOW,NO)           DEFAULT =NO
?DIRX
ORIENTATION?                                DEFAULT =SOUT
?WEST
CHANGE?  (WALL,WIND,DIRX,SHOW,NO)           DEFAULT =NO
?NO

SURFACE: ID=SS1
  WALL: GROSS AREA=      800. SQ.FT;    U-VALUE=  .110 BTU/HR-SQ.FT-DEG.F
  WIND: AREA=      400. SQ.FT
        SHADING COEFICIENT=1.00;        U-VALUE= 1.000 BTU/HR-SQ.FT-DEG.F
  DIRX: ORIENTATION=WEST
ADD,DELETE, OR CHANGE A SURFACE?            DEFAULT =NO
?NO
COMMAND?                                    DEFAULT =LIST
?ZONE
ZONE DESCRIPTION?
?EXAMPLE # 3:  WEST PERIMETER ZONE OF VANCOUVER OFFICE BUILDING
COMMAND?                                    DEFAULT =LIST
?PRINT
COMMAND?                                    DEFAULT =LIST
?
```

TABLE III(b): Example III – results of print

ZONE: EXAMPLE # 3: WEST PERIMETER ZONE OF VANCOUVER OFFICE BUILDING
AREA: FLOOR AREA= 1000.0 SQ.FT
RESP: THERMAL RESPONSE=L
TIME: ID=OFFI; TYPICAL OFFICE: OCCUPIED 8-5 WEEKDAYS,
PARTLY OCCUPIED 7-8 AM & 5-7 WEEKDAYS,
UNOCCUPIED OTHER TIMES.
LITE: OCCUPIED= 2.50 WATT/SQ.FT; UNOCCUPIED= .25 WATT/SQ.FT;
PARTLY OCCUPIED= 1.50 WATT/SQ.FT
% RADIANT=55.0; % TO R.A. = 0.0
PEOP: OCCUPIED= 200. SQ.FT/PERSON; UNOCCUPIED= 0. SQ.FT/PERSON;
PARTLY OCCUPIED= 20000. SQ.FT/PERSON
INFL: OCCUPIED= .10 CFM/SQ.FT; UNOCCUPIED= .10 CFM/SQ.FT;
PARTLY OCCUPIED= .10 CFM/SQ.FT
ROOF: AREA= 1000.0 SQ.FT; U-VALUE= .120 BTU/HR-SQ.FT-DEG.F

SURFACE: ID=SS1
WALL: GROSS AREA= 800. SQ.FT; U-VALUE= .110 BTU/HR-SQ.FT-DEG.F
WIND: AREA= 400. SQ.FT
SHADING COEFICIENT=1.00; U-VALUE= 1.000 BTU/HR-SQ.FT-DEG.F
DIRX: ORIENTATION=WEST

	********HEATING*********		********COOLING*********		*******REFERENCE********	
MONTH	CONSUMPTION (MBTU)	PEAK (MBTU/HR)	CONSUMPTION (MBTU)	PEAK (MBTU/HR)	CONSUMPTION (MBTU)	PEAK (MBTU/HR)
1	13666.	37.93	46.	3.74	0.	0.00
2	10671.	26.19	268.	16.57	0.	0.00
3	8642.	24.96	839.	20.15	0.	0.00
4	5123.	19.62	4103.	40.90	0.	0.00
5	2727.	15.28	5850.	49.02	861.	40.85
6	983.	7.60	8157.	46.45	3314.	34.76
7	1006.	10.50	10875.	56.86	6845.	56.86
8	1369.	9.34	7159.	49.15	2707.	36.23
9	3636.	16.38	2596.	35.34	296.	5.86
10	6092.	18.98	892.	21.32	0.	0.00
11	10891.	24.52	80.	5.42	0.	0.00
12	13060.	27.97	2.	.46	0.	0.00
ANNUAL	77865.	37.93	40867.	56.86	14023.	56.86

TABLE IV. Example of input for window shading

```
?0.0
SURFACE IDENTIFIER? (4 CHARACTERS)
?0.1
CHANGE?  (WALL,WIND,DIRX,SHOW,NO)      DEFAULT =NO
?0.2
WINDOW AREA?                           DEFAULT =   800.000 SQ.FT
?1
NUMBER OF WINDOWS?                     DEFAULT =     4
?1.1
WINDOW HEIGHT?                         DEFAULT =    10.000 FT
?1.2
WINDOW WIDTH?                          DEFAULT =    10.000(FT)
?1.3
DEPTH OF OVERHANG?                     DEFAULT =    0.000(FT)
?1.5
   ABOVE TOP OF WINDOW?                DEFAULT =    0.000(FT)
?2
   BEYOND LEFT EDGE?                   DEFAULT =    0.000(FT)
?4
   BEYOND RIGHT EDGE?                  DEFAULT =    0.000(FT)
?4
   DEPTH OF EYEBROW?                   DEFAULT =    0.000(FT)
?
DEPTH OF LEFT FIN?                     DEFAULT =    0.000(FT)
?2
   FROM LEFT EDGE OF WINDOW?           DEFAULT =    0.000(FT)
?4
   ABOVE TOP OF WINDOW?                DEFAULT =    0.000(FT)
?2
   ABOVE BOTTOM OF WINDOW?             DEFAULT =    0.000(FT)
?
DEPTH OF RIGHT FIN?                    DEFAULT =    0.000(FT)
?2
   FROM RIGHT EDGE OF WINDOW?          DEFAULT =    0.000(FT)
?4
   ABOVE TOP OF WINDOW?                DEFAULT =    0.000(FT)
?2
   ABOVE BOTTOM OF WINDOW?             DEFAULT =    0.000(FT)
?
WINDOW U-VALUE?                        DEFAULT =    1.000(BTU/HR-SQ.FT-DEG.F)
?
WINDOW SHADING COEFFICIENT?            DEFAULT =    1.000
?
CHANGE?  (WALL,WIND,DIRX,SHOW,NO)      DEFAULT =NO
?
```

```
SURFACE:  ID=SS1
  WALL:   GROSS AREA=      800. SQ.FT;    U-VALUE=  .110 BTU/HR-SQ.FT-DEG.F
  WIND:   NUMBER OF WINDOWS=   4
          WIDTH=   10.00 FT;              HEIGHT=   10.00 FT
          SHADING OVERHANG:
          DEPTH=    3.50 FT               ABOVE WINDOW=    2.00 FT
          BEYOND LEFT=    4.00 FT         BEYOND RIGHT=    4.00 FT
          EYEBROW=    0.00 FT
          LEFT SIDE FIN:
          DEPTH=    2.00 FT               FROM LEFT=    4.00 FT
          ABOVE TOP=    2.00 FT           ABOVE BOTTOM=    0.00 FT
          RIGHT SIDE FIN:
          DEPTH=    2.00 FT               FROM RIGHT=    4.00 FT
          ABOVE TOP=    2.00 FT           ABOVE BOTTOM=    0.00 FT
          SHADING COEFICIENT=1.00;        U-VALUE= 1.000 BTU/HR-SQ.FT-DEG.F
  DIRX:   ORIENTATION=WEST
```

APPENDIX A

Time Schedule Library

OFFI TYPICAL OFFICE: OCCUPIED 8-5 WEEKDAYS;
PARTLY OCCUPIED 7-8 AM & 5-7 WEEKDAYS;
UNOCCUPIED OTHER TIMES.

SCHO SCHOOL: OCCUPIED 9-4 MON-FRI SEPT-JUNE;
PARTLY OCCUPIED 8-9, 4-6 AS ABOVE;
UNOCCUPIED OTHER (ALL OF JULY & AUG)

SHOP SHOPPING: OCCUPIED 10-5 MON-SAT, EXCEPT 10-10 THURS;
PARTLY OCCUPIED 8-10AM, 5-7PM MON-SAT EXCEPT 8-10AM,
10-12PM THUR; UNOCCUPIED OTHER TIMES

HOUS HOUSE: OCCUPIED 7-8AM, 6-12PM EVERY DAY;
PARTLY OCCUPIED 8AM-6PM EVERY DAY;
UNOCCUPIED 11PM-7AM EVERY DAY