NASA TM- 83238

NASA Technical Memorandum 83238

NECAP 4.1
NASA's Energy-Cost Analysis Program
User's Manual

Ronald N. Jensen
Robert H. Henninger
David L. Miner

July 1983

NASA

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

FOREWORD

NECAP (NASA's Energy Cost Analysis Program) is a detailed buidling energy program. It and a number of other energy calculation programs have been developed and used. They differ greatly from load calculations commonly used by HVAC engineers for building air conditioning system's design. Load programs consider the peak time heat transfer across surfaces to select equipment, whereas with energy programs, yearly building energy consumption is determined.

Early techniques of annual energy calculations were the "degree day" and the "bin" methods. These simple methods require considerable judgement and interpretation of the data. The number of building factors which could not be handled was great enough that answers were always in question.

Early hourly energy programs were used to promote a specific type of fuel or energy used by HVAC systems. They were often proprietary computer programs such as the Westinghouse program (1965), GATE program (Group to Advance Total Energy, 1967), and the BEEP program (1969). They used computers to perform the multitude of necessary calculations but there were concerns that these programs were "slanted" towards a specific sales objective.

A major change in energy calculations took place with new concepts that allowed mass thermal storage to be included in hourly calculations. In 1967, a series of papers were written by G. P. Mitalas and D. G. Stephenson, which established calculation procedures called response factors for heat transfer through "delayed" surfaces. In the summer of 1968, ASHRAE's Task Group on Energy Requirement for Heating and Cooling held a meeting in Lake Placid, NY, from which the bulletin Proposed Procedure for Determining Heating and Cooling Loads for Energy Calculations - Algorithms for Building Heat Transfer Subroutines edited by Metin Lokmenhekim was initiated. Work in refining this document continued until an approved version was published by ASHRAE in 1971. Validation work on algorithms was performed by Ohio State through 1973.

Response factor programs which calculated heat transfer through delayed surfaces, were used as early as 1967 by GARD Inc. of Niles, Illinois. GARD's thermal study program, SHEP, studied temperature responses in shelters. In 1967, a contract was issued to GARD Inc. by the Post Office to develop a building energy program, sometimes referred to as TACS. The program with complete documentation was submitted to the public in August, 1971, at a meeting in Washington, DC. Unfortunately, the acceptance of this program was poor. A principle complaint was that engineers objected to complicated input needed to define the XYZ coordinates of every point on a surface. Although these input problems were not as serious as people thought, the program had major drawbacks such as: constant temperature in spaces, limited infiltration capabilities, limited systems (only specialized post office systems were offered), and it was expensive to run. About that time, the Post Office's construction program was taken over by the Corps of Engineers and program experts were not retained; thus the program's future was never secured.

NASA started using the Post Office's program in 1971. In 1972, GARD Inc. was contracted by NASA to make major modifications to the program that would

N83-35499

allow internal temperature variations, simulation of common HVAC systems, and various other improvements. The draft version of this work, named NECAP, was issued in March 1975, and about 30 copies distributed for public review and use.

Concurrently, the TRANE Co. published their most successful TRACE program in 1973. Backed by a well established sales force, simple output, and coming in the middle of a major energy crisis, TRACE became the major energy program used. However, the program's code was proprietary, and it simulated only one typical day per month. Although it was satisfactory for energy budgets, NASA did not accept it for research oriented projects.

Tom Kasuda of the National Bureau of Standards, who was the chairman of ASHRAE's subcommittee on Heating and Cooling Load Calculations, developed a program for building thermal response in the late 1960's. It was published as NBSLD in November, 1974. Although NBSLD was only a load program, it was used extensively with system programs such as ESAS (Ross Merriweather's program).

NECAP was officially published in September, 1975, incorporating many of the public comments received and having completed verification objectives. The program was offered through the NASA data distribution service, COSMIC, at the University of Georgia. Although the program was fully usable, NASA did not provide operational services, nor versions for computers other than the CDC machines. As expected, several firms used the program with changes made to personal likes or made necessary by the computers they used. NASA did not enter into commercialization of the program.

NECAP was used by the program CALERDA (published in 1978) which evolved into the DOE programs. The system simulation portion of NECAP was also used in the development of the system portion of the Corps of Engineer's program, BLAST, published in 1979. NECAP was also used in the development of ECUBE III, ESP-I and SCOUT, although the extent is unknown because of the proprietary codes.

NECAP was put into use at NASA Langley Research Center as a research tool. Some program enhancements were incorporated into NECAP as a result of the on-going work at LaRC. NECAP was maintained at LaRC and upgraded to incorporate new features as they were developed. Computer Sciences Corporation of Hampton, Virginia under contract to LaRC, maintained NECAP and provided programming support for many of the projects run at LaRC. NECAP's execution time and versatility did improve as a result of enhancements to the program and its operating system.

Some technical limitations and input acceptance were still associated with NECAP. In 1980, a contract was entered with GARD Inc. to remove these limitations and provide a new input preprocessor. The culmination of this work resulted in NECAP 4.1. The program was installed and tested at LaRC in 1981. Some additional refinements to the program were incorporated to NECAP 4.1 and are included in these manuals.

Again, NASA does not intend to commercialize or provide service for the program other than inhouse use. Publication is offered so that the technical changes made can be available to others. NECAP's new input data will appear extremely simple,especially if the Fast Input system is used. It continues to use a data input approach preferred by engineers, instead of a language based input used by some popular programs.

There will always be limitations with building energy programs due to the long list of unresolved technical problems such as: ground heat transfer effects, infiltration between zones, program size, execution costs, and personal likes or dislikes. NASA's future efforts will continue to be directed at technical problems and inhouse use for designing, energy reduction, budgeting, and to establish a building performance guide.

ACKNOWLEDGEMENTS

Many people contributed in the development of NECAP 4.1 and its documentation. Work was accomplished by a team effort. Major contributors were:

Robert Henninger - GARD Inc., was the editor of the original NECAP published in 1975. He was also the project engineer for program modifications which led to the development of NECAP 4.1. His personal effort is a cornerstone to the NECAP effort.

Ken Spaulding - Formerly with GARD Inc., developed the NIPP Program and assisted in combining the SYSTEM and VTEMP programs.

Bob Benzuly - Formerly with GARD Inc., combined the Systems and VTEMP programs which is one of the major technical improvements of NECAP 4.1.

Ralph Wallace - Formerly with GARD Inc., developed the Variable Temperature concept used in NECAP.

Jim McNally - Formerly with GARD Inc., wrote the original Systems program of NECAP.

David Miner - Computer Sciences Corporation (CSC), is responsible for the NECAP maintenance task at Langley Research Center. He contributed to all of the documentation, particularly the FAST INPUT MANUAL and the OPERATIONS MANUAL.

Michael Wiese - CSC, made significant contributions in the Systems module of NECAP with respect to simplified input, and validation to the modified Response Factor routine.

Russ Criste - CSC, maintenance team leader who supported the NECAP Maintenance tasks.

Harry Sperry - NASA, Washington, supported the contract with GARD Inc. for NECAP 4.1 technical and input improvements.

Reamer Prince and Ann Taylor - NASA, Washington, project managers for the NECAP contract with GARD Inc.

John Hogge - NASA, Langley Research Center Analysis and Computational Division, supported the NECAP maintenance tasks with Computer Sciences Corporation.

Irv Hamlet and Charles Marushi - NASA, Langley Research Center, FENGD, immediate section heads who supported the NECAP 4.1 improvements and documentation.

Milton Lockmanhiem - Formerly with GARD Inc., helped in the early stages of the program when the Post Office program was converted to run at LaRC.

Ron Jensen - NASA, LaRC, technical project manager for NECAP.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

Section 1

INTRODUCTION

This manual is one in a set of NECAP manuals referenced below that describes the computer program NECAP - NASA's Energy cost Analysis Program. The program is a versatile building design and energy analysis tool which has embodied within it, state-of-the-art techniques for performing thermal load calculations and energy use predictions. With the program, comparisons of building designs and operational alternatives for new or existing buildings can be made.

The major feature of the program is the "response factor" technique used for calculating the heat transfer through the building surfaces and accounts for the building's mass. The program expands the response factor technique into a "space response factor" to account for internal building temperature swings; this is extremely important in determining true building loads and energy consumption when internal temperatures are allowed to drift.

The algorithms for the thermal loads portion of NECAP comes from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) manual, Procedure for Determining Heating and Cooling Loads for Computerized Energy Calculation. The original NECAP was published in 1975 and was supported by two manuals, NECAP - NASA's Energy Cost Analysis Program, NASA CR-2590 Part I User's Manual and NASA CR-2590 Part II Engineering Manual. Since that time, NASA has used NECAP for building heating and cooling design loads and energy analysis.

This version of NECAP, called NECAP-4.1, contains the following modifications and improvements:

- A NECAP input data processor (NIPP) module was developed which greatly simplifies and reduces the user input task. The original fixed format data field, suitable for punching data onto computer cards, has been eliminated in favor of a free format data field, suitable for use with computer terminals.

- Provide built in default values for most input data.

- The Response Factor module was made an integral part of the Thermal Load Analysis and Systems Energy Simulation modules.

- The Variable Temperature module and System and Equipment Simulation module were brought together into one module to allow dynamic simulation and interaction (feedback) between the space, its distribution system, and the heating and cooling plant equipment. In the previous version of NECAP, the hourly space temperatures which exceeded limits because of system heating/cooling capacities caused a "Loads-not-met" condition. "Loads-not-met" were accounted for but not the space temperature drift above or below the allowed temperature range. Combining this calculation into the program eliminates the need to use the "Loads-not-met" variable.

- Modified the thermostat and ventilation schedule input.
- Improved fan on/off code.
- Modified the weather tape system.
- Use of system component part load performance curves.
- Default CFM, chiller size, and boiler size data.
- Provides an executive summary for energy.
- Prints out a space temperature frequency chart.
- Adds more flexibility to print out.
- Changed the glass shade coefficient.
- Corrected air infiltration coefficients, fan efficiencies, and floor panel heating algorithms.

The new program is documented in the following manuals:

TM 83238, Users Manual - Describes examples and output forms.

TM 83239, Input Manual - Details the input requirements.

TM 83240, Engineering Manual - Provides the algorithms for the program.

TM 83241, Fast Input Manual and Example - Provides simple input procedures.

TM 83242, Engineering Flow Charts - Provides flow charts that supplements the Engineering Manual.

CR-165802, Operations Manual - Gives the specific operating instruction for Langley Research Center's computer system operation.

CR-165982, Thermal Response Factor Routine - Describes the hourly response factor routine.

The program runs on Langley Research Center's large computer system. Users should be cautioned that program implementation can be time consuming and costly. Although computer run costs are much lower than the original response factor programs, they are still a magnitude greater than the simple "bin method" type energy calculation. With this in mind, judgment should be exercised to assure that needs are compatible with the investment. Operational assistance in running the program cannot be provided by NASA.

NASA has limited means to update the material in the program. Comments on the program are welcomed, although the government accepts no obligation even if the suggestions are used. Send comments to:

Ronald N. Jensen
Mail Stop 453
NASA, Langley Research Center
Hampton, VA 23665

NECAP 4.1 program modules are detailed in the referred sections:

NASA 's ENERGY ANALYSIS PROGRAM

Version 4.1

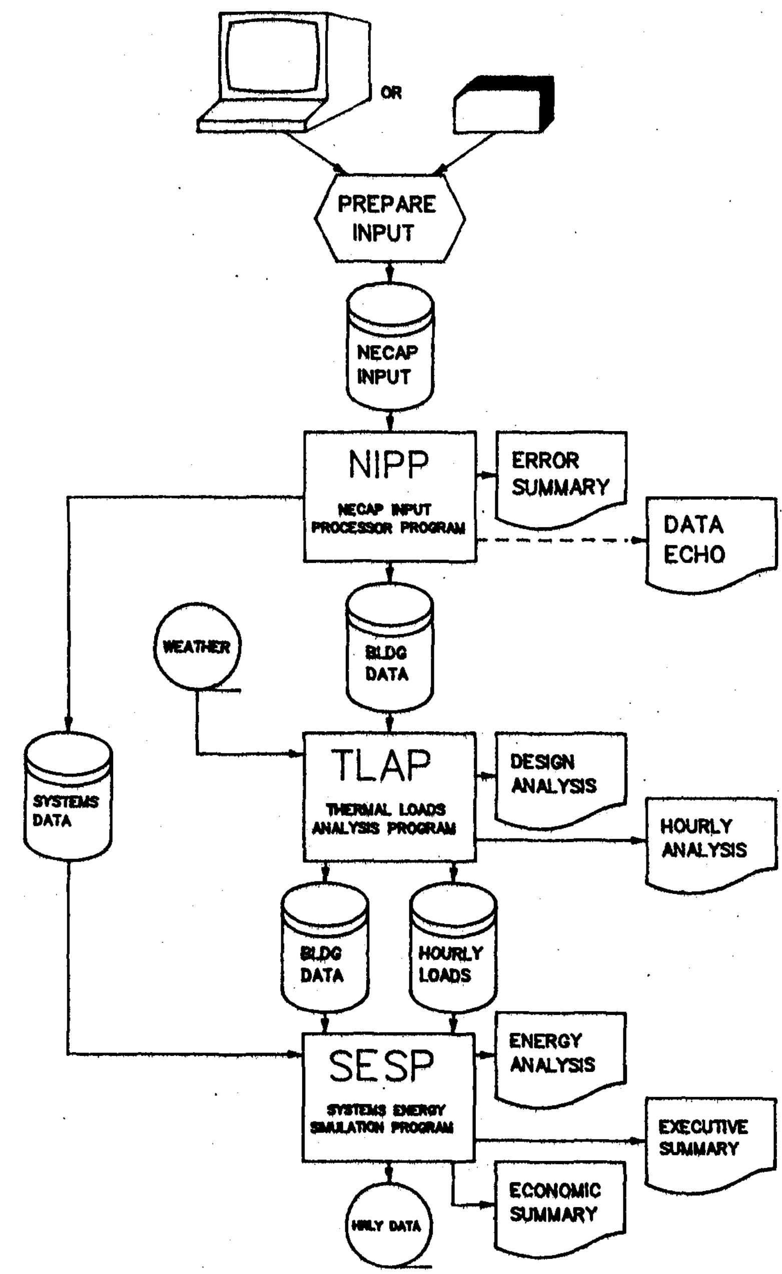


Figure 1.1

NOTES AND COMMENTS

Section 2

EXAMPLE

2.1. DESCRIPTION

An example is provided to demonstrate the use of the program. The modeled building is NASA Langley Research Center's, Systems Engineering Building, B-1209. This is a 53000 sq. ft. office building, providing office space for 300 people. A photo of the building is shown in Figure 2.1, the floor plan in Figure 2.2, and a section through the building is shown in Figure 2.3. The building is a single story structure with masonry walls, a built up roof, a variable volume air-conditioning system, an absorption chiller, and supplied with central plant steam for heating and to run the chiller.

In learning to use the program, the user should follow the input procedure as described in the <u>NECAP Input Manual</u>, TM 83239. The data shown in this example provides a good modeling technique. Program output and actual energy used by this building matches very closely.

2.2. INPUT DATA PREPARATION

To prepare the input data for NECAP the user should:

Step 1

Obtain a floor plan of the building under study. Divide the floor area into the thermal zones sufficient for energy analysis as shown in Figures 2.4, 2.5, and 2.6. In a building of this size and geometry, 5 zones will handle a detailed analysis for the building (one core zone and four exterior zones). If ceiling return air plenums are to be used, the plenum above each thermal zone should be identified as a zone. For multistory buildings, a typical floor is broken into 2 to 5 zones and an upper, middle, and lower floors are described; the repetition factors are used for the other middle floors. Whenever possible, zones having identical load characteristics should be lumped into one giant zone or described as a basic zone only once. This will keep the zones to be calculated to a minimum for low computer run cost. Each fan system must have at least one or more zones, two or more fan systems can not supply one zone.

Step 2

Once the zones have been defined, the surfaces that make up the envelope of each zone should be described. Figures 2.5 and 2.6 show the relationship of surfaces to the zones that are to be modeled in the example. Label each surface using a prefix indicating the type of surface. We suggest:

D = delayed heat transfer surface
Q = quick heat transfer surface

G = window surface
I = internal heat transfer surface
U = underground heat transfer surface
C = common shading surface

Identify, only once, surfaces that have identical characteristics (i.e., area, construction, orientation, tilt, etc.) even though they are associated with different zones. An interior partitioning wall or floor between zones needs to be identified only if there will be a temperature difference across it.

Assemble data on the location, and construction, of each shading surface, as shown in Figures 2.7, 2.9 and 2.10.

Step 3

Obtain data or perform a walk through to observe the characteristics of the activity level and number of occupants of each zone, lighting levels, lighting schedules, operation of equipment within the space, thermostat settings and location, type of lighting fixtures, and other internal characteristics which affect thermal loads in the building.

Step 4

Include characteristics such as the hours of operation and the equipment part load characteristics as shown in Figure 2.8.

Inspect fan systems to determine the type, method of operation, and the source of heating and cooling energy that is provided to each system. This step is particularly important when modeling an existing building as was done in the example.

Step 5

Organize the data into a data file in accordance with procedures outlined in the Input Manual and instructions contained on the following pages. The total number of cards in an input data deck will not be the same for every problem. They will vary with the number of spaces and number of surfaces identified in the building. Assemble the NECAP input data cards using standard computer card input forms. The input file as printed by the computer is shown in Figure 2.11.

Simpler input procedures that can be used for the same building are provided in Appendix E. This describes the same building but as a 7 zone model with many defaults used. In the NECAP Fast Input Manual a single zone of the same building is modeled.

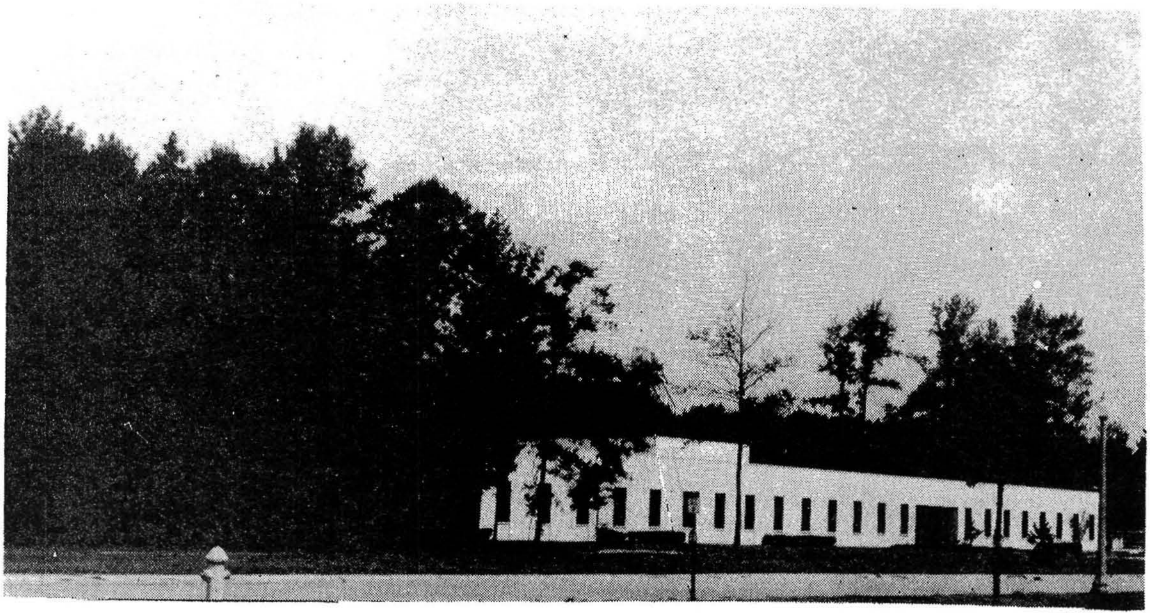


FIGURE 2.1 BUILDING 1209 LaRC

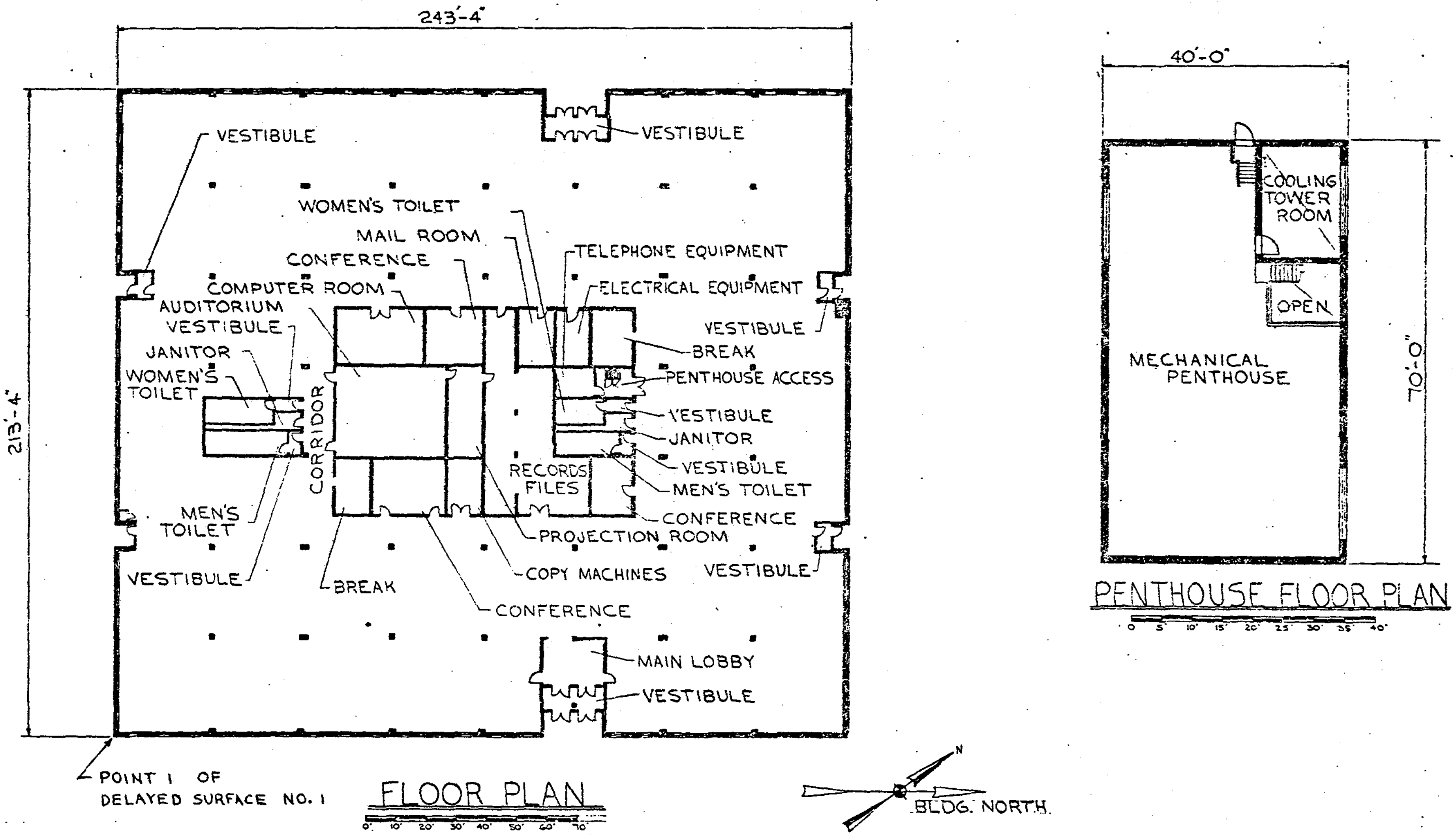
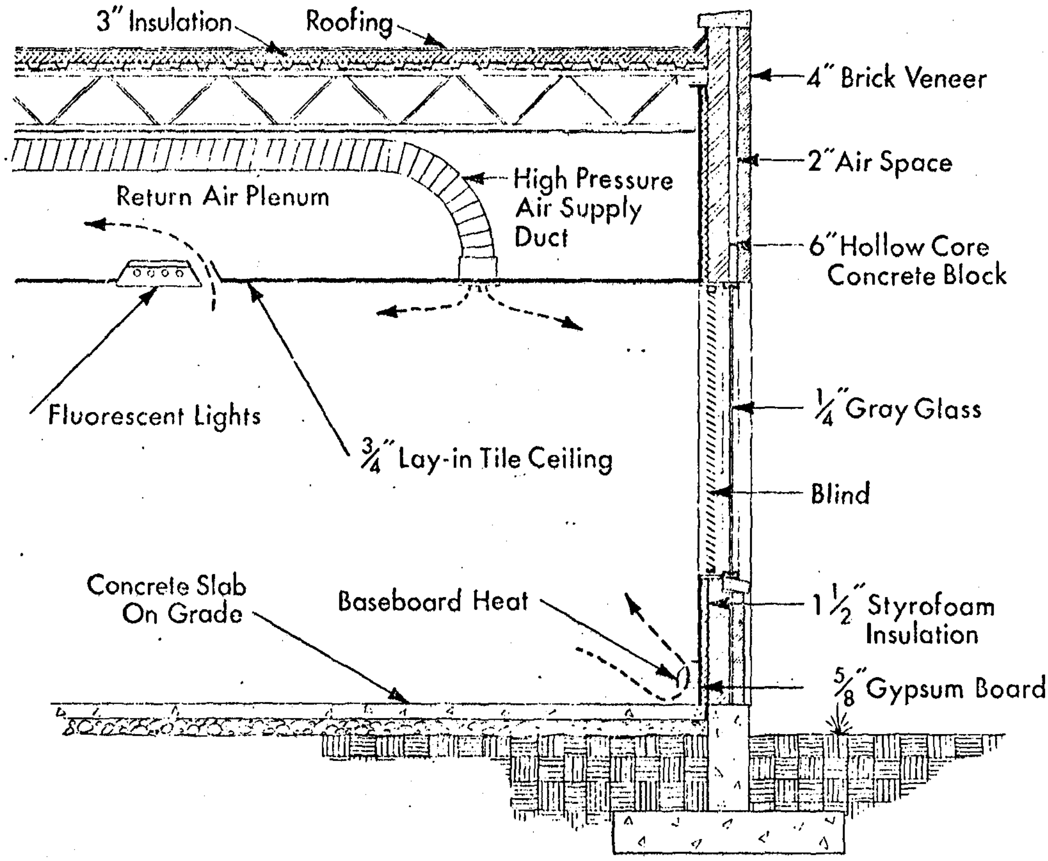
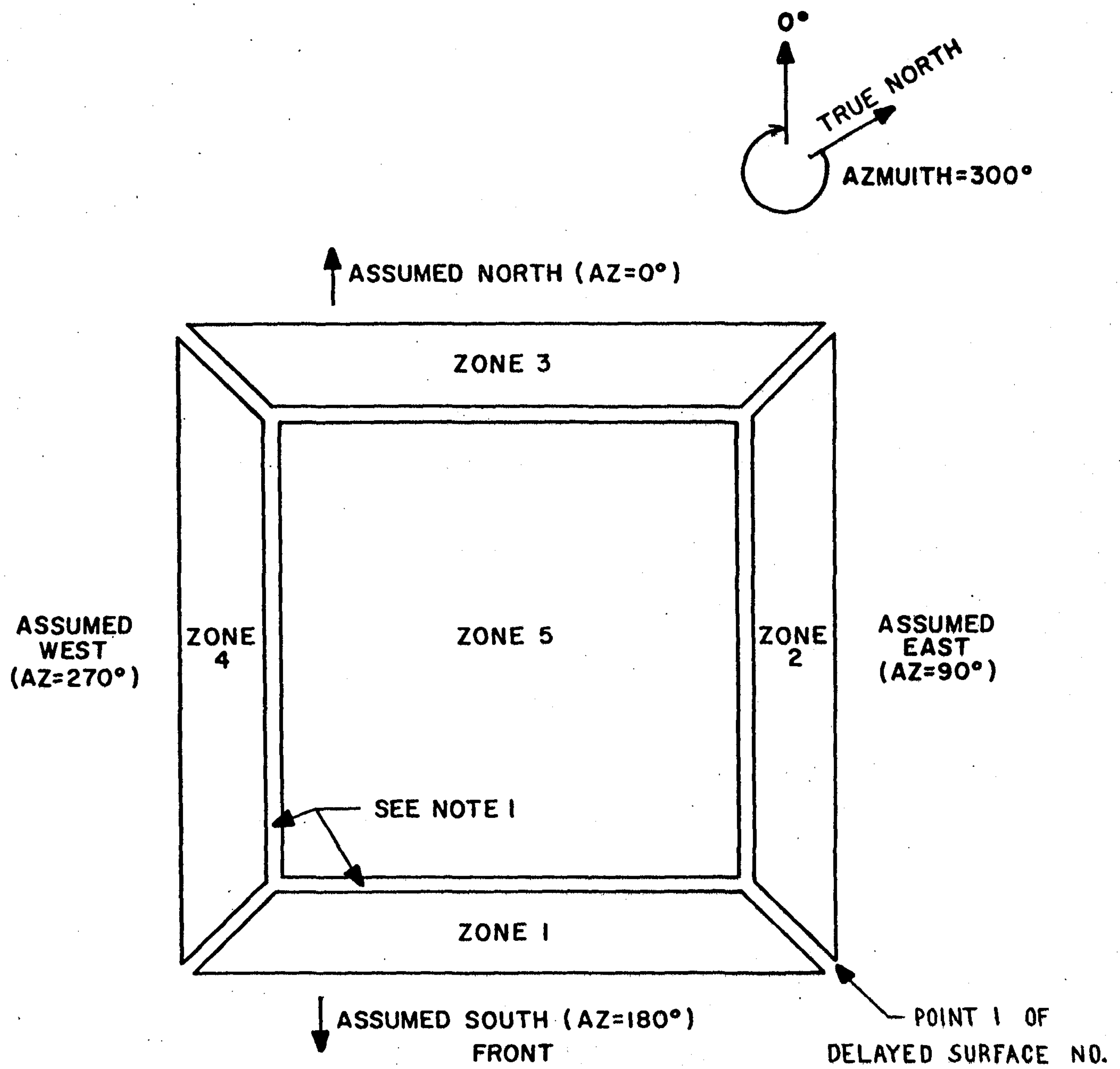


FIGURE 2.2 FLOOR PLAN



SECTION THROUGH BUILDING

FIGURE 2.3



ZONE ASSIGNMENT
FIG. 2.4

NOTE: Imaginary Internal Surfaces. Although there are no internal walls between the selected zones in this example, walls are modeled to account for the heat transfer beteen the outside and inside zones. This allows the outside thermal and solar loads to react with the air conditioning system separately from the interior zone. A very high heat transmission coefficient is assumed between the outside and inside zones (U = 50 Btu/sq ft/hr/F^{O}) so good interaction is obtained.

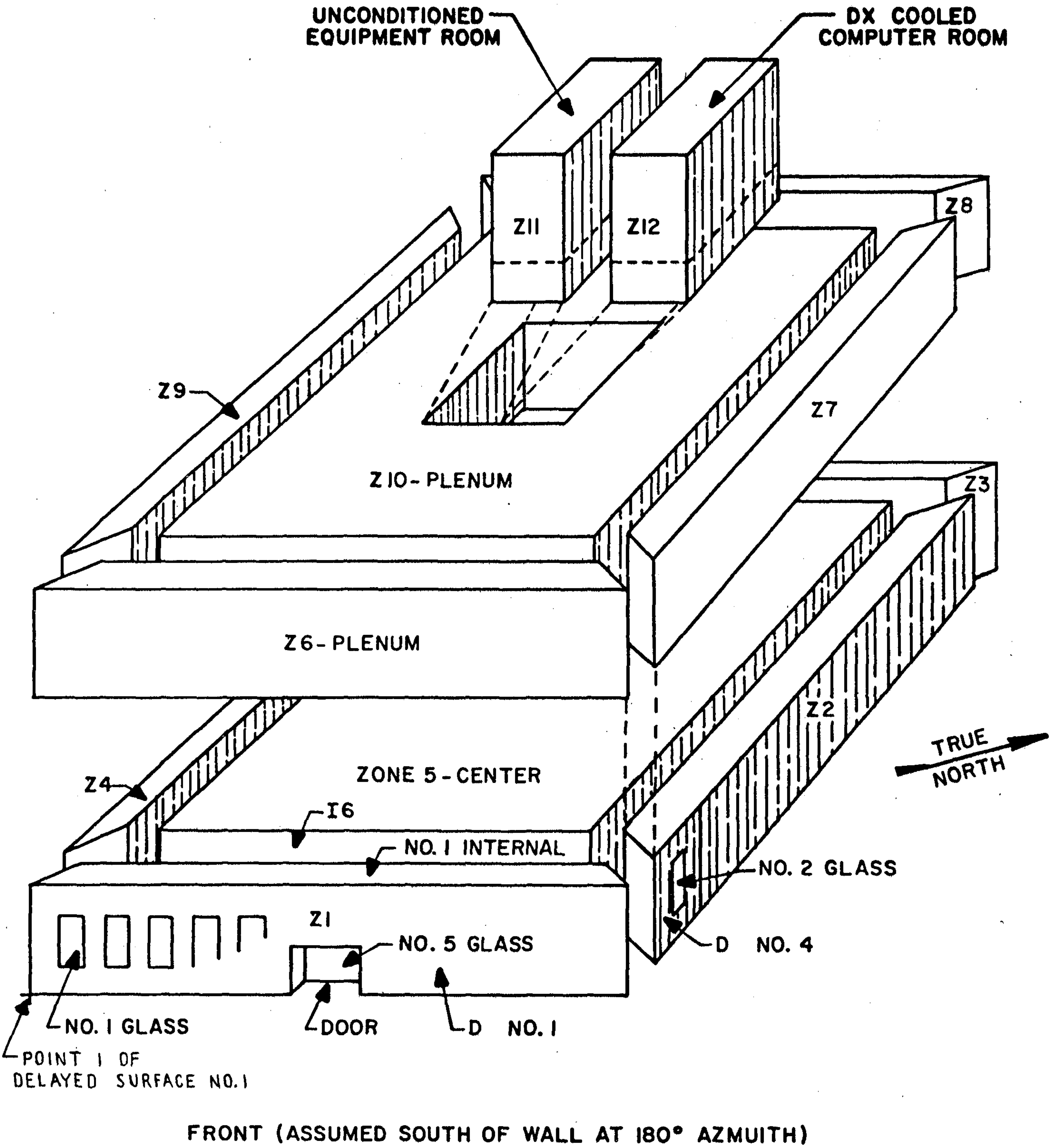
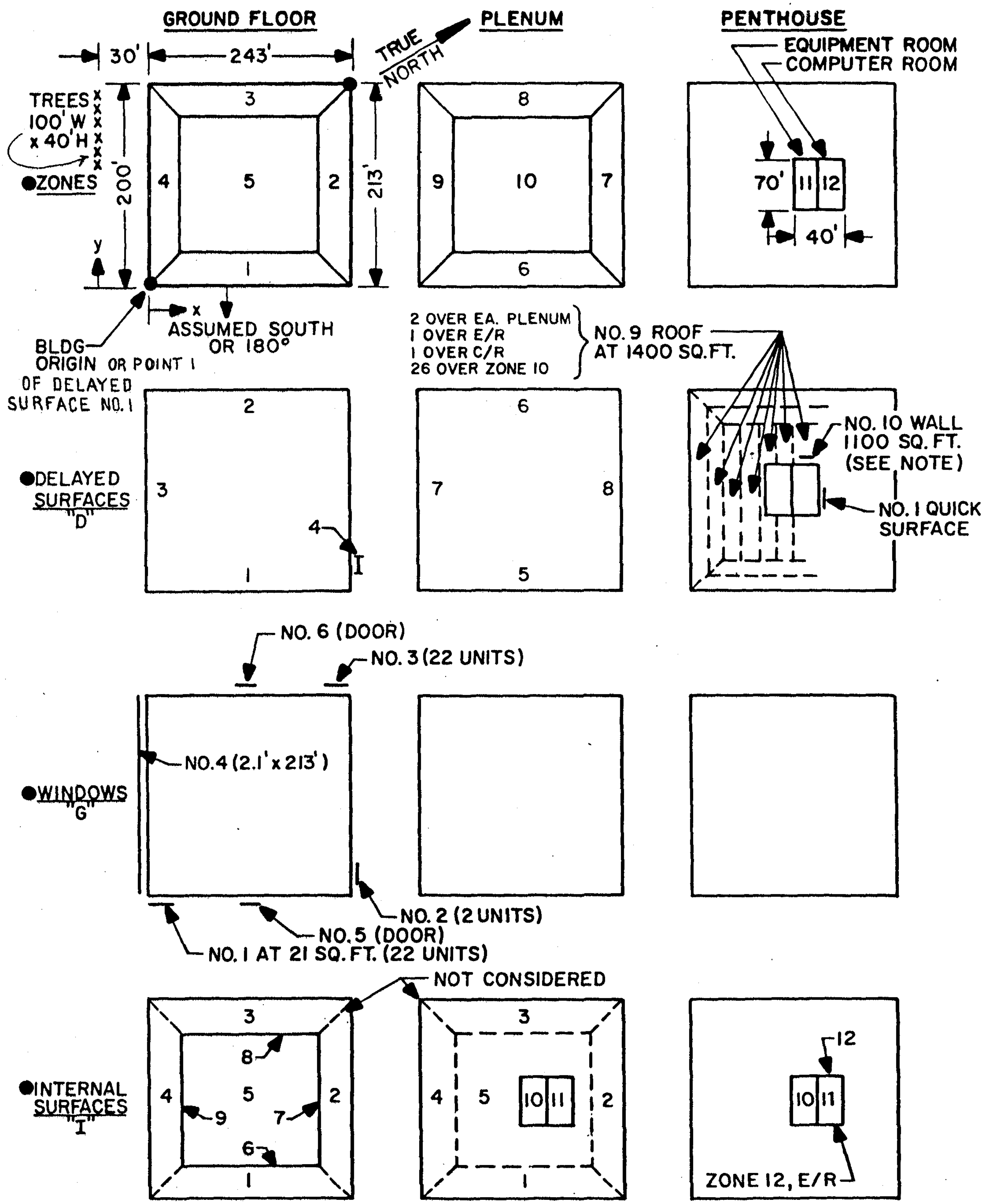
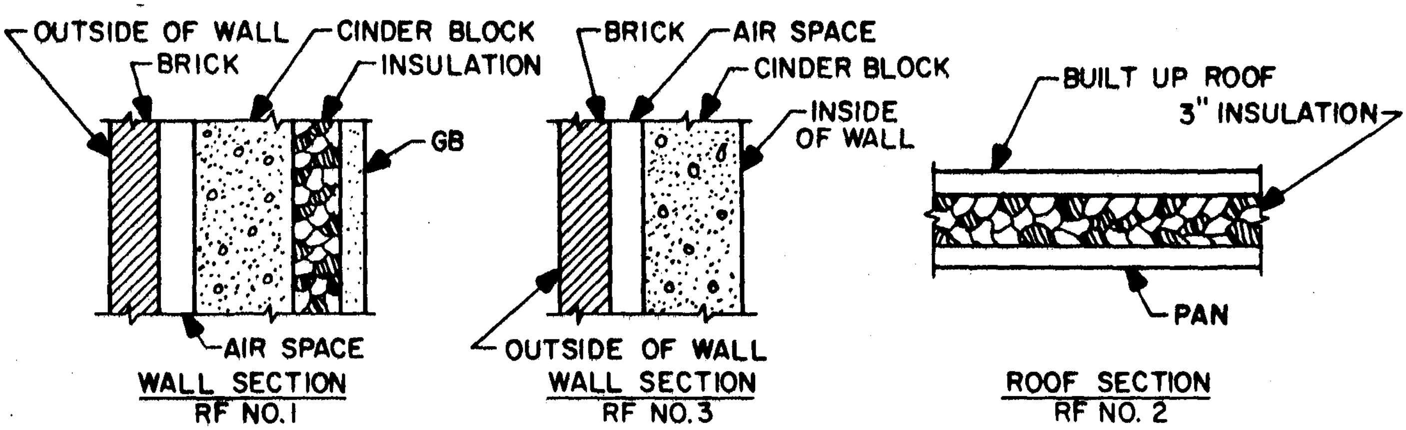


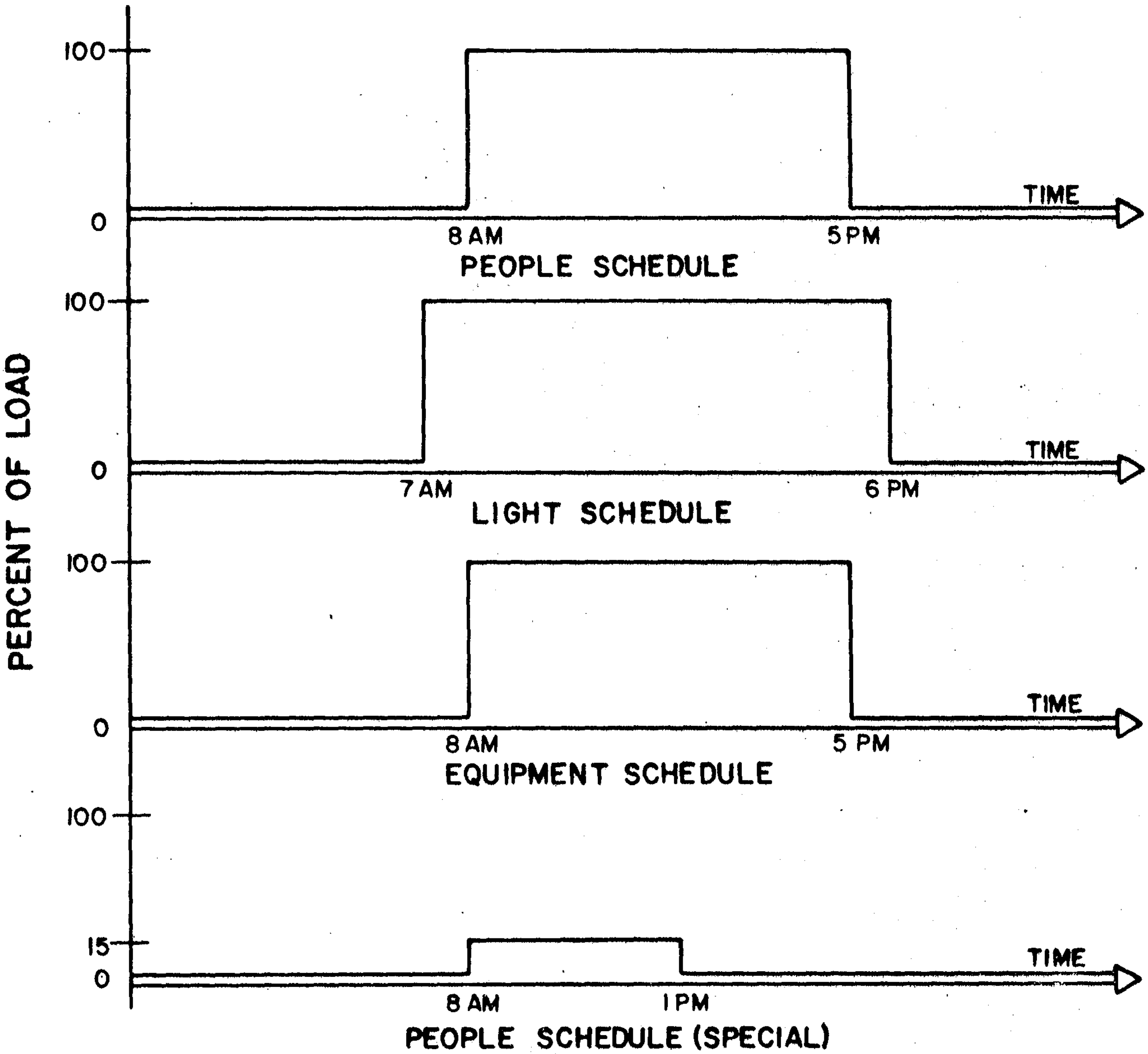
FIGURE 2.5 BUILDING ZONING



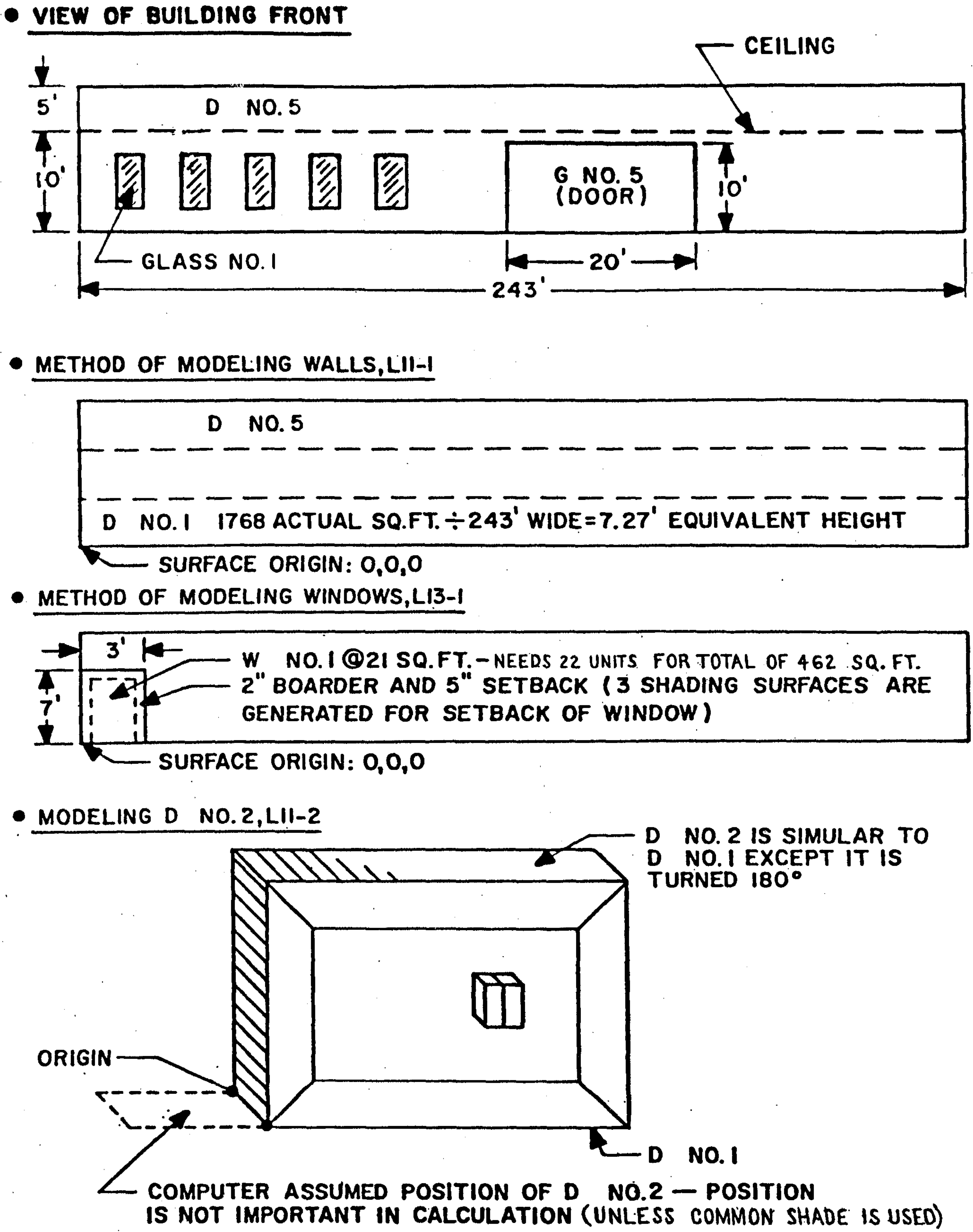
ZONE AND SURFACE ASSIGNMENTS
FIG. 2.6



MAKE-UP OF DELAYED SURFACES
FIG. 2.7



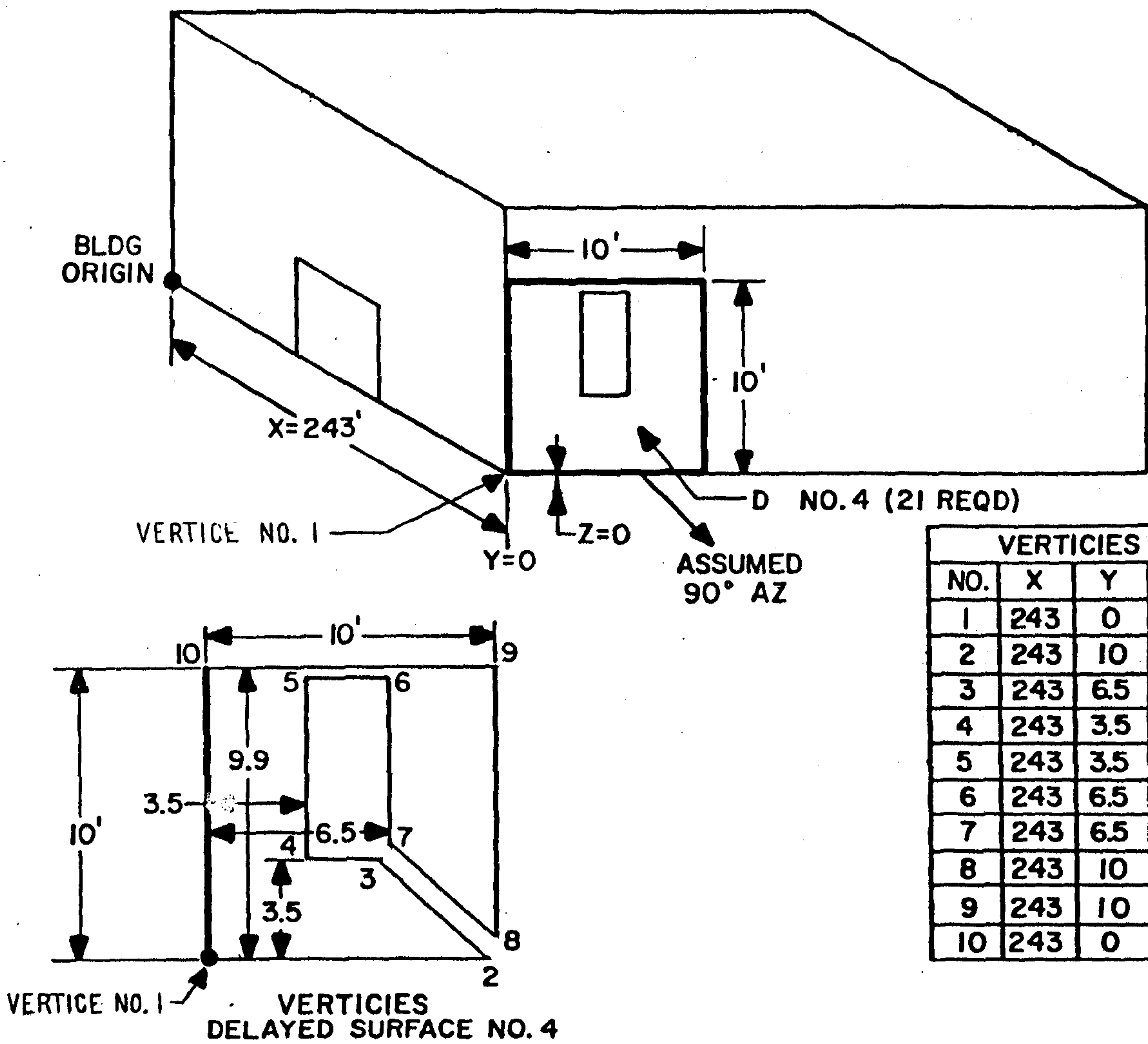
SCHEDULE
FIG. 2.8



MODELING TECHNIQUE

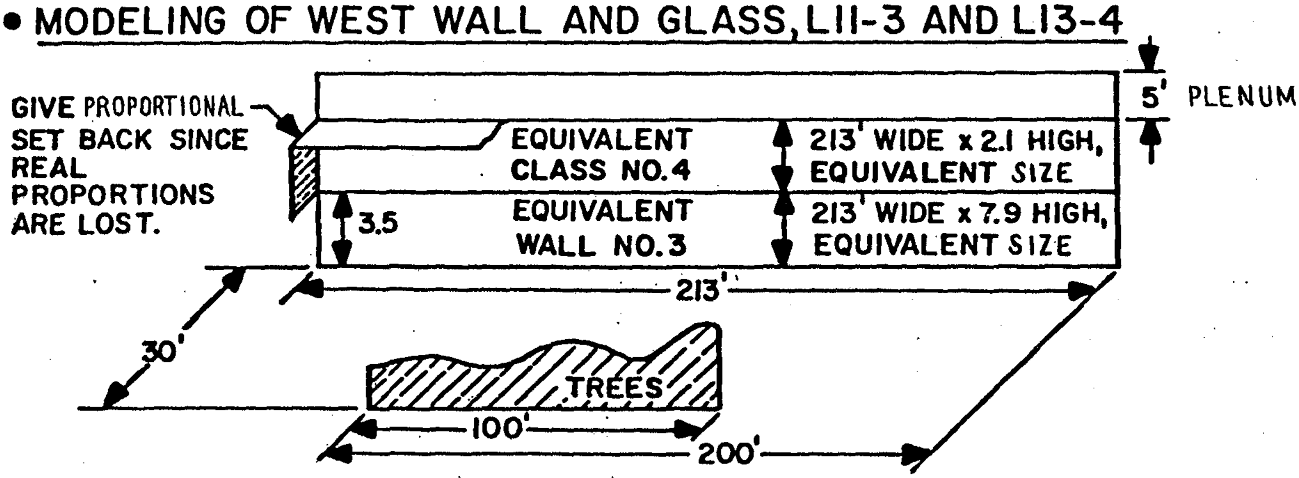
FIG. 2.9

• MODELING OF EAST WALL, L11-4



VERTICIES			
NO.	X	Y	Z
1	243	0	0
2	243	10	0
3	243	6.5	3.0
4	243	3.5	3.0
5	243	3.5	9.9
6	243	6.5	9.9
7	243	6.5	3.0
8	243	10	0
9	243	10	10.0
10	243	0	10.0

• MODELING OF WEST WALL AND GLASS, L11-3 AND L13-4



A SERIES OF WINDOWS SHOULD BE MODELED WITH AN EQUIVALENT SURFACE SO THAT ONLY ONE CALCULATION IS MADE (TO KEEP COMPUTER RUN TIME DOWN). SPREAD OVER AREA THAT WILL BE AFFECTED BY EXTERNAL SHADOWS. ALSO INCREASE INFILTRATION FACTOR TO GIVE EQUIVALENT CRACK x INFILTRATION RATE, SINCE WINDOW CRACK IS BASED ON GIVEN PERIMETER.

ALTERNATE
MODELING TECHNIQUE

FIG. 2.10

```
          2  3
    1 C                                                LOAD CARDS
 1  2 L1=SYSTEMS ENGINEERING BUILDING,LARC;            FAC.NAME
    3 L1=HAMPTON,VA.;                                4 FAC.LOCATION
    4 L1=R.N. JENSEN;                                  ENGR.NAME
    5 L1=SEB BASE-LONG;                                PROJ.NO.
    6 L1=DEC 15,1981;                                  DATE
    7 L2=300,2,0.1,2.0,55,120,37,76.0,5,0.96,        5
    7    0.96;                                         LOCATION CARD
    8 L3=1,1,12,31,0,10,95,16,76,8,18,5,13,12;         STUDY LENGTH & WEATHER
    9 L4=8,1,8,1;          6                           DATA  PRINT OUT
   10 C                                                SCHEDULE CARDS
   11 L5-1=1,4,4,4,4,4,1,1,1;                            SCH #1 (USED FOR PEOPLE) & EQUIP
   12 L5-2=1,5,5,5,5,5,1,1,1;                            SCH #2 (USED FOR LIGHTS)
   13 L5=1,4,4,4,4,4,11,1,1;     7                       SCH #3 (USED FOR SPECIAL PEOPLE)
   14 L5=9*2;  8                                         SCH #4 (USED FOR EQUIP)
   15 L6=8*0,5*0.15,11*0;  9                             SPEC. SCH#11 (SPECIAL PEOPLE ON SAT)
   16 C                                                SHADE CARD
   17 L7=0,.1,-30,200,0,40,100,270,90;                   EXTERNAL SHADE -TREES @ 90% TRANS.
   18 C                                               RESPONSE FACTOR CARD
   19 L8=8,12;  10                                       STANDARD DELAYED SURF. USED
   20 L9-1=0.33,0.742,125,0.220,BRICK 4 IN;                  1ST MATERIAL CARD
   21 L9-2=@4,0.91,AIR SPACE;                              2ND MATERIAL CARD
   22 L9-3=0.667,0.33,38,.2,BLOCK,8IN;                     3RD, LETTER B FORCES 6TH FIELD DA
   23 L9-4=@4,0.658,INSIDE AIR FILM;                       4TH MATERIAL CARD
   24 L10=1,2,3,4;                                       DELAYED SURFACE #3 MAKE-UP
```

1. Cards numbered by computer - not input.

2. Program Index. The "L" stands for the LOAD program. The "S" stands for the SYSTEM program. A "C" can be used to provide a comment to assist in data input.

3. "1" is the card index. The "=" terminates the label with data to follow.

4. Anything which appears after the data terminator (the semicolon) is used as comments.

5. More than one card may be used to present data by not using terminators.

6. Data can be defaulted.

7. Only 10 standard schedules are provided. Here, a special schedule is called for on Saturday and will be defined in the first L6 card.

8. This schedule gives 9, type 2 schedules (or 100% on). The 9* is a short cut method of duplicating data.

9. L6 is the special schedule card (called by the "11" on card L5). The card shows that the first 8 hours the load is set at 0%, etc.

10. Surface types are defined on the L8 card. The type 8 surface (a brick, air space, concrete bloack, insulation, gyp board) is defined as surface code #1.

FIGURE 2.11(a) - EXAMPLE OF INPUT DATA

```
25 C
26 L11-1=0,1,.75,.2,2,0,1,1,1,180,90,7.27,
26        243,0,0,0;  11
27 L11-2=1,@8,0,@6;                  13
28 L11-3=0,1,.75,.2,2,0,20,3,,270,90,7.9,
28        213,0,213,,1;  12
29 L11-4=0,1,.75,.2,2,0,4,4,10,243,0,0,243,
29        10,0,243,6.5,3,243,3.5,3,243,3.5,
29        9.9,243,6.5,9.9,243,6.5,3,243,10,0,
29        243,10,10,243,0,10;
30 L11-5=,3,@9,5,243,0,0,10;
31 L11-6=5,@8,0,@3;
32 L11-7=5,@8,270,@2,213;
33 L11-8=7,@8,90,@3;  14
34 L11-9=0,2,.75,,1,@5,0,1400;
35 L11-10=0,3,@9,1100;
36 C
37 L12=,.2,@7,270,90,8,16;  15
38 C   16
39 L13-1=,.8,.5,.5,.2,5,2,1.2,6,14,1,5,1,
39        180,90,7,3,3.5,0,3.5;
40 L13-2=1,@12,90,@3;
41 L13-3=1,@12,0,@3;
```

DELAYED SURFACES CARDS

FRONT WALL-ALL DATA INPUT
REAR WALL -SIMULAR SURFACE @ 0 AZ

D3- LARGER X&Y WILL ALLOW SHADOW

D4-LONG FORM W/WINDOW -NORTH
D5-DEFAULTS USED.

DOUBLE SIM. SURFACE
ROOF SECTION
E/R WALL
QUICK SURFACE CARDS
DAMPERS IN E/R
WINDOW & DOOR(GLASS) CARDS

ASSUMED SOUTH(FRONT) (22)
ASSUMED EAST(RT SIDE) (21)
ASSUMED NORTH(REAR) (22)

11. The second delayed surface, D #3, L11-2, is the same as the first delayed surface except that the assumed SOUTH (180) is changed to an assumed NORTH (0) orientation in field No. 10. Note that the "@6" is used to indicate similar data to that in L11-1, otherwise a semicolon would default data to standard values. Note that although the second surface's point of origin is on the opposite corner of the building from the first surface, the coordinates for the vertex is given as 0,0,0. The vertex is not important since no shading is involved.

12. D #3 is a shadowed wall. The trees that produce the shadow is indicated as #1 shade surface. See Card L7.
13. No data between commas indicate a defaulted value.
14. Double referencing in D #8. In some cases this does not work.
15. True size and window set back is an easy way to account for window shadow.
16. If repetition number is not given in order, the program will renumber in order. The user is cautioned to reference to the computer set numbers.

FIGURE 2.11(b) - EXAMPLE OF INPUT DATA

```
42 L13-4=,.8,.5,.5,.2,1.2,2,20.,4,20,1,5,1,
42       270,90,2.1,213,0,213,3.5,1;                ASSUMED WEST(LFT SIDE) (1)
43 L13-5=,1.0,.5,.5,.2,72,0,160.8,50,30,2,5,1,
43       180,90,10,20;                              FRONT DOOR
44 L13-6=5,@12,0,@3;                                REAR DOOR
45 C                                              SHADOW PICTURES
46 L14-G=5,2,10;
47 C                                              INTERNAL SURFACES
48 L15-I=3200,.32,1,6/2800,.32,2,7;                 CEILING # 1 & 2
50 L15-I=3200,.32,3,8/2800,.32,4,9;                 CEILING #3 & 4
52 L15-I=39000,.32,5,10;                            CENTER CEILING #5
53 L15-I=2000,50,1,5/2000,50,2,5;                   IMAGINARY INT. SURF. (NOTE HIGH U)
55 L15-I=2000,50,3,5/2000,50,4,5;                   IMAGINARY INT. SURF.
57 L15-I=2000,.3,10,11/2000,.3,10,12;               INTERNAL WALL #10 & 11
59 L15-I=700,.2,11,12;                              #12
60 C                                              UNDERGROUND SURFACE
61 L15-U=3000,0.1/39000,0.02;
63 C                                              UNDERGROUND TEMP.
64 L16=45,45,50,55,60,70,75,80,75,65,60,50;
65 C                                              SPACE CARDS
66 L17-1=0,3200,32000,60,72,25,450,1,2,.7,
66       3.0,0,2,0.4,,,,1,2,,,,,,;                  ASSUMED SOUTH(FRONT)
67 L18-1-D=1/G=22*1,5/I=1,6/U=1;
71 L17-2=1,2800,28000;                              ASSUMED EAST(RT SIDE)
72 L18-2-D=21*4/G=21*2/I=2,7/U=1;
```

17. Two surfaces are described on one card by using the slash.

18. Very low "U" factors are appropriate for underground surfaces if well within the building's border.

19. Data is defaulted.

20. A crack method is specified here for infiltration. Leakage rates must be given in appropriate surface cards.

FIGURE 2.11(c) - EXAMPLE OF INPUT DATA

```
 76 L17-3=1; <-21                                        ASSUMED NORTH(REAR)
 77 L18-3-D=2/G=22*3,6/I=3,8/U=1;
 81 L17-4=1,@6,3;                                        ASSUMED WEST(LFT SIDE)
 82 L18-4-D=3/G=4/I=4,9/U=1;
 86 L17-5=,39000,390000,60,72,200,450,1,2,
 86       .7,2.6,,2,0.4,,,,1,1,.2,,500;                  CENTER ZONE(AIRCHANGE METH)
 87 L18-5-I=5,6,7,8,9/U=2;
 89 L17-6=0,3200,15000,3,72,@18,1;  22                   ASSUMED SOUTH (FRONT) PLEN
 90 L17-7=6,2800,14000;                                  ASSUMED EAST (RT SIDE) PLEN
 91 L17-8=6;                                             ASSUMED NORTH (REAR) PLEN
 92 L17-9=7;                              23             ASSUMED WEST (LFT SIDE) PLEN
 93 L17-10=6,39000,195000;                               CENTER PLEN
 94 L17-11=0,1400,14000,40,72,0,,2,4,,1.,,1,,
 94          5,20000,,2,1,2,,,,,1;             24        EQUIP. ROOM
 95 L17-11=0,1400,14000,40,72,,,4,1,,2,,
 95          2,,5,,,4,1,.4;                              COMPUTER ROOM
 96 L18-6-D=5,2*9/I=1;
 98 L18-7-D=8,2*9/I=2;
100 L18-8-D=6,2*9/I=3;
102 L18-9-D=7,2*9/I=4;
104 L18-10-D=26*9/I=5,10,11;
106 L18-11-D=9,10/I=10,12/Q=1;                           EQUIP ROOM
109 L18-12-D=9,10/I=11,12;                               COMPUTER ROOM
111 C
```

21. Terminator here does not default data as with surface data; rather, data from referenced zone is used.
22. Air change rate.

23. It is recommended to set the unconditioned room temperature to that of the surrounding spaces. Only when a room temperature difference is consistently different (i.e., refrigerated, etc.) should a different temperature space be used. It may be necessary to reset the load values in the space card (S12) if large heat loads are anticipated from unconditioned surrounding spaces.

24. Calculated load is not included in load summation. This is important so that building load is not influenced by unconditioned space.

FIGURE 2.11(d) - EXAMPLE OF INPUT DATA

```
C                                          SYSTEM CARDS
S1=SEB EXAMPLE ;                             HEADER
S2=1,1,12,31,0;                              RUN ANALYSIS
S3=8,1,8,1,1,1; 26                           PRINT DATA
C                       25                   SCHEDULES
S4-1=6(2,95,55),1(2,80,66),
  10(1,77,73.83),7(2,95,55);                 WEEKDAY THERMOSTAT OUTSIDE ZONES
S4-2=24(2,95,55);      27                    WEEKEND THERMOSTAT
S4-3=24(2,75,72.1)/24(2,75.9,73);            SEASONAL DX THRMO. 28
S4-5=6(2,95,55),1(2,80,66),
  10(1,77,73.0),7(2,95,55);                  WEEKDAY THERMOSTAT CENTER ZONE
C                                            SCHEDULES
S5-1=7(0),10(1.0),7(0);                        VENT SCH/ EQUIP SCH
S5-2= 24(0);                                   WEEKEND VENT
S5-3=24(1.0);                                  PROCESS SCH.
S6-1=1,2,1,1,1,1,1,2,2;                        #1 THRMO SCH (WEEKLY OUTSIDE ZONES)
S6-2=1,3,3,3,3,3,3,3,3;                        #2, WINTER C/R SCH
S6-3=1,4,4,4,4,4,4,4,4;                        #3, SUMMER C/R SCH
S6-4=0,2,1,1,1,1,1,2,2;                        #4, VENTILATION & PROCESS SCH.
S6-5=0,8*3;            29
S6-6=1,2,5,5,5,5,5,2,2;                        #1 THRMO SCH (WEEKLY CENTER ZONE)
C                                            TIME OF YEAR (SEASONAL) SCHEDULES
S7-1=1,1,1;                                    YR SCH FOR OUTSIDE ZONES 30
S7-2=1,1,2,6,1,3,10,1,2;                       YEAR SCH FOR C/R DX
S7-3=1,1,6;                                     YEAR SCH FOR CENTER ZONE
S7-4=1,1,4;                                     YEAR SCH FOR VENT AND PROC
S7-5=1,1,5;                                     YEAR SCH FOR VENT AND PROC
S8-1=10,55,90,170,HOT WATER;                   RESET SCH.
```

25. A ramping thermostat is simulated to bring on equipment early if high or low night time temperatures occur.

26. Proportional thermostat.

27. Dead-Band thermostat.

28. Computer Room Thermo. (Winter Operation) Dead-Band with close tolerance.

29. S6-5 schedule - all days using S5-3 card.

30. Schedule #1, beginning 1st of year.

FIGURE 2.11(e) - EXAMPLE OF INPUT DATA

```
144 C                                             INTERNAL DELAYED SURFACE
145 S9-1=@4,0.67,CEILING AIR SURFACE/
146      0.0625,0.035,30.,0.2,,ACOUSTICAL TILE/
147      @4,0.67,INSIDE AIR SURFACE ;
148 S10-1=1,2,3;  31                              CEILING OVER SPACE
149 S10-2=1;                                      CEILING OVER PLENUM
150 S10-3=3,2,1;                                  FLOOR OF PLENUM
151 C                                             FAN SYSTEM/SPACE CARDS
152 S11-1=12,5,5,1600,2,2,,,5.,0,0.5,0,20,
152       55,,,,1,@8,3,4,1;  32                      VAV SYSTEM
153 S11-2=5,1,   ,100,,,,,1,,,@15,0,0,1,-1;          COMP.ROOM DX UNIT
154 S12-1=1,1,0,4000,0,1000,220,1,0,  33
154       80000,10,,6,@2,1,3200,FRONT ZONE(ASSUMED SOUTH);
155 S12-2=1,2,0,4000,0,1000,200,1,0,
155       80000,10,,7,@2,1,2800,RT SIDE ZONE(ASSUMED EAST);
156 S12-3=1,3,0,4000,0,1000,220,1,0,  34
156       80000,10,,8,@2,1,3200,REAR ZONE(ASSUMED NORTH);
157 S12-4=1,4,0,4000,0,1000,200,1,0,
157       80000,10,,9,@2,1,2800,LFTTSIDE ZONE(ASSUMED WEST);
158 S12-5=1,5,0,38000,550,500,100,3,200000,
158       760000,10,,10,@2,1,38000,CENTER Z;
159 S12-6=1,6,1,1,4000,4,3,3200,2,3200,PLENUM OVER FRONT ZONE;
                                         33
```

31. Special surface defined to simulate heat transfer between space and plenum puts S9 cards into order of layers found in actual surface.

32. VAV will ventilate using schedule S7-3

33. Surface index (S10 card) and square foot area are defined with each space.

34. Once the program encounters an alpha character, the remaining fields, up to the last field, will default. The alpha characters are in the last field of this card.

FIGURE 2.11(f) - EXAMPLE OF INPUT DATA

```
160 S12-7=1,7,1,2,4000,4,3,2800,2,2800,PLENUM OVER RT SIDE ZONE;
161 S12-8=1,8,1,3,4000,4,3,3200,2,3200,PLENUM OVER REAR ZONE;
162 S12-9=1,9,1,4,4000,4,3,2800,2,2800,PLENUM OVER LFT SIDE ZONE;      35
163 S12-10=1,10,1,5,38000,4,3,39000,2,39000,PLENUM OVER CENTER ZONE;
164 S12-11=2,12,0,0,0,,,2,15000,48000,,COMPUTER ROOM;
165 S14=1,2200,1,1,12,31,3,0,,6*80;                BOILER
166 S15=4,1,110,4,1,12,1,3,10,45,20.,               36
166  5 102,65 98,90 82,98 69,101 35,103,
166  5 100,65 97,90 86,98 80,101 52,103,
166  5 14,10 39,40 65,70 100,100 110,125;          CHILLER
167 S16=75,10,35;                                  COOLING TOWER
168 S17=48,4,5,
168  85,100,100
168  95, 94,105
168  100,90,107
168  105,86,110
168  110,79,115;                                   DX UNIT FOR COMP. ROOM
169 S18=50,40,30,85;                               PUMP CARD
170 S19=10,4,5;  37                                HW CIR PUMP FOR SOLAR COLL.
171 S20=12,245,,,,7;                               MISC.
```

35. Uncontrolled zones are not defined.

36. Performance curves for boiler, chillers, and DX/UNITS defined on input.

37. Process loads are defined to simulate energy required for pumps used that are for auxillary equipment

FIGURE 2.11(g) - EXAMPLE OF INPUT DATA

NOTES AND COMMENTS

SECTION 3

NECAP INPUT PROCESSOR PROGRAM

3.1. OBJECTIVE AND DESCRIPTION

The NECAP input processor program (NIPP) performs a variety of functions, all related to the revised NECAP-4 input data structure. Its basic function is to simplify input procedures. It also converts the input data from a free-format form consisting of numbers and special characters, into an all numeric fixed-format form ready for processing by the Thermal Load Analysis Program (TLAP) and the Systems Energy Simulation Program (SESP). The processor program, while it is converting the form, will also add default values where necessary, reorganize the card numbers, perform data verification, and flag errors encountered.

The program processes one record (card) at a time. It reconstructs the record as directed by the index characters, loading in default values for variables not explicity defined by the user. If a record is designated as being similar to another record, the program will copy into the undefined variable positions, their respective values from the original record instead of the normal default values. This procedure allows the user to define only those variables on a record that he feels are necessary for proper execution.

As the NIPP program executes, it maintains a record of the types of cards used and their number of occurrences. If a particular label is repeated, the program will either compute a new label for repeatable cards, or for non-repeatable ones it will retain the variables from the latest card processed. An advantage of this feature is to allow the user to change values on a non-repeatable card by just adding a new card to the end of the deck.

The second step within the NIPP program, data verification analysis, checks input values for their proper range and compatiblity with other input values. Errors are indicated on the verification output. The program may terminate prematurely if it encounters a data item which, because it is out of bounds, affects analysis of subsequent data.

The processor performs extensive error diagnosis on the input records. It flags two levels of errors - warnings and critical errors. Warnings usually designate that the program has made some modification to the data record and then continued processing the record. Critical errors on the other hand normally terminate record processing while the program moves onto following records. Errors should be corrected before TLAP or SESP are executed. If critical errors occur a message is printed onto all output files.

3.2. INPUT DATA

The basic unit of the input structure is the record (card). The record is used to define a specific set of input parameters called the variable list. The specific set to be defined is delineated by the record's label. The input method is described in the NECAP Input Manual.

The two basic components of a record are the label and the variable list. They are separated by an equal (=). The variable list is terminated by either a semi-colon (;) or a slash (/). An example of an input record is shown below.

L11-4 = 3, @ 10, 270;

The record card's label is used to define three important pieces of information: the appropriate program to be used, the particular set of variables to be defined, and the sequence of cards with similar lables. The lable may begin anywhere on a record. However, it must begin with either the letter 'L' or the letter 'S' which is immediately followed by a number, e.g. L12 is correct, T3 is incorrect. Certain cards that require a 'surface index' or 'repetition number' to complete the card label are exceptions. The 'repetition number', defines the sequence of similarly labeled cards. If the user decides to exclude this part of the label, the program will automatically sequence the cards as encountered.

The variable list of a card is composed of a set sequence of data items separated by a comma (,). The program recognizes a data item by its position within the set sequence. Every data item on a card is either explicitly defined by placing a number in a data item position or implicitly defined by skipping over a variable position.

Implicit definition is done one of 5 ways:

1. Leaving a blank or a series of blanks between two commas
2. Immediately following one comma by a second
3. Using the 'skip index' to pass over a position or a series of positions
4. Terminating the record before the position is reached
5. Omitting the card from the deck

The last method would cause the entire variable list of the omitted card to take on default values. Examples are illustrated in Section 2. Default values are given in the last column of the Input Manual instructions.

The program processes the variable list until it encounters a variable list terminator. The user can spread the input data list over several cards. This feature can also be used to enhance the input deck readability since a comment may be added to the record card after the terminator.

Certain characters can be used to simplify the key-punching of a record. Various other characters are necessary to convey the correct information. A list of these characters and rules of use are given in Section 4, of the NECAP Input Manual.

A special record, the comment card, can be used to make the input file more readable to the user. The program recognizes comment cards by the character 'C' in the first column of a record. The program will only echo the card.

3.3. OUTPUT REPORTS FOR NIPP

The processor program has three distinct output reports. They are the NIPP Diagnostic, TLAP Data Verification, and SESP Data Verification.

3.3.1. NIPP DIAGNOSTIC OUTPUT REPORT

NIPP uses the input data for diagnostics. The extent of the output is directed by using the LO and SO cards. Either a LO or a SO card is used with a normal NECAP run. When only TLAP or SESP is run, the appropriate LO or SO card is included. There are 6 items which may be requested on the LO and SO cards. These are given in Table 3.1. The use of all the diagnostics will usually generate large amounts of outputs and their use should only be for serious errors which cannot be found by other means. The LO or SO card must be the first cards in the deck so that all diagnostics printout requested may be performed. Not using a LO or SO card limits printout.

A summary explaining the processing is shown in Figure 3.1. Processing is reported as a warning so that the user is informed of the action taken. Warnings are error flags numbered 25 or less. CRITICAL errors are flags numbered 26 or greater. Error flags are given in Tables 3.2 (warning) and 3.3 (critical).

Unless a critical error has been encountered during decoding, the former two files are ready for processing by TLAP or by SESP, respectively.

The output report will always contain an echo of the input records, a fixed 80 character card image file. This is the TLAP and SESP input data. Unless the user requests diagnostic output, only critical errors are flagged with a short message printed at the end of the card image file, and the total number of errors with short descriptions of critical ones are printed onto the diagnostic file. Figures 3.2 and 3.3 show a print file which contains diagnostic information about the data contained in the TLAP and SESP input.

3.3.2. TLAP DATA VERIFICATION

The program now checks the input data deck required for the Thermal Load Analysis Program. The routine which performs the data verification is called DATAV. As each card is read, each data field is interrogated for:

1. correct sequence
2. proper range
3. insufficient or extraneous data
4. misplaced data
5. proper format

As errors are discovered, they are indicated on the output report immediately following the listing of the data cards.

Three types of errors are signaled. They are: WARNINGS, SEVERE ERRORS, and TERMINAL ERRORS.

WARNINGS are errors which are not likely to cause an unsuccessful run, but which may cause incorrect results. WARNINGS arise for the following conditions:

1. Data in columns of the card where no data is supposed to be
2. Number of surface indicators stipulated differs from the actual number given

SEVERE ERRORS result from only one kind of error; when the data is out of bounds. Every data item that has an upper and/or lower limit is checked to ensure that it obeys the limit. SEVERE ERRORS will definitely cause incorrect results, yet they may or may not cause the Thermal Load Analysis Program to terminate. These errors tend to propagate through the program and may cause quite unrealistic results.

TERMINAL ERROR will stop the Thermal Load Analysis Program instantly. The DATAV subroutine will terminate itself prematurely if it encounters a data item which, because it is out of bounds or is an error of the terminal type, affects analysis of subsequent data. Any data item which is used as a looping factor is subject to this kind of constraint. Terminal errors are caused by:

1. An alpha character in a number field
2. A special character in a number field
3. More than one decimal point in a number field
4. Trailing or embedded blanks in a number field
5. Unknown punches

Error messages, if any, are listed after each card image on the output page. Each message is identified by type, reason for error, and where on the card the error occurs. At the end of the run, whether or not the DATAV was able to fully scan the entire input deck, there is provided a summary listing of the three typs of errors that may occur. If the entire deck is scanned and there are no errors detected, the program omits the summary and prints a message that the data is error-free. The last page of output summarizes required array sizes for the particular configuration being run. Appendix A can be consulted for interpretation of these parameters. Examples of the type of output reports received from the DATAV are illustrated in figure 3.2.

3.3.3. SESP DATA VERIFICATION

After SESP data goes through diagnostics, the NIPP program will perform data verification analysis. The SESP card image output is rewound and then input quantities are checked for proper range and continuity with other input values. An example is included in Figure 3.3.

The routine which performs the SESP data verification is called SYSCHK. As each card is read, each data field is checked for:

1. correct sequence
2. proper range
3. misplaced data
4. proper format

As errors are discovered, they are indicated beside the value which is in error. If insufficient or extraneous data is encountered, the program may abort because of illegal data within a field. SYSCHK makes no distinction as to the severity of errors, and if 10 or more errors are encountered the program will abort after all cards have been checked.

If no errors are encountered a message is written to the diagnostic file stating this and data echo is suppressed. If any errors are detected, data echo will be written flagging the item that is in error. If errors are detected, they should be corrected before running SESP.

```
    THIS PAGE CONTAINS A RECORD OF THE ERRORS
 THAT WERE ENCOUNTERED DURING INPUT PROCESSING.
 IT ALSO POINTS OUT THE CARDS AND THE VARIABLES
 ON THOSE CARDS WHICH HAVE BEEN DEFAULTED.


   THE FOLLOWING CARDS CONTAIN ERRORS OF VARYING
   SEVERITY. ERROR NUMBERS GREATER THAN 25 ARE
   CONSIDERED SEVERE AND SHOULD BE CORRECTED.


     WARNING NUMBER =    3
     NUMBER OF TIMES WARNING OCCURED =    18
     WARNING DESCRIPTION: DUPLICATE REPETITION NUMBER
     ACTION TAKEN: CARD IS MODIFIED
     CARD NO.   CARD REPETITION NUMBER
          12          1
          13          1
          48          1
          49          1
          50          3
          51          1
          52          1
          53          6
          54          1
          55          8
          56          1
          57         10
          58          1
          61          1
          94         11
         122          3
         143          1
         144          2

     WARNING NUMBER =    6
     NUMBER OF TIMES WARNING OCCURED =    19
     WARNING DESCRIPTION: COMMENT CARD IN DATA DECK
     ACTION TAKEN: CARD IS SKIPPED
     CARD NO.   VARIABLE POSITION
           1          0
          10          0
          16          0
          19          0
          25          0
          36          0
          38          0
```

Data has been abbreviated for this example.

EXAMPLE OF OUTPUT FROM NIPP PROGRAM

FIGURE 3.1

```
++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++
 ++++++                                        ++++++
 ++++++   INPUT DATA VERIFICATION RESULTS      ++++++
 ++++++    FOR LOAD CALCULATION PROGRAM.       ++++++
 ++++++                                        ++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++


SUMMARY OF ERROR TYPES+

       WARNINGS            0
       SEVERE ERRORS       0
       TERMINAL ERRORS     0

THESE ERRORS SHOULD BE CORRECTED TO ENSURE SUCCESSFUL EXECUTION OF THE LOAD PROGRAM.
```

Data has been abbreviated for this example.

EXAMPLE OF OUTPUT FROM VERIFICATION FOR LOAD PROGRAM

FIGURE 3.2(a)

```
                    ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                    ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                     ++++++                                                ++++++
                     ++++++   INPUT DATA VERIFICATION RESULTS              ++++++
                     ++++++    FOR LOAD CALCULATION PROGRAM.               ++++++
                     ++++++                                                ++++++
                    ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                    ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 THE FOLLOWING FIVE LINES ARE THE PROGRAM*S DESCRIPTOR INFORMATION.

      SYSTEMS ENGINEERING BUILDING,LARC                                L1A
      HAMPTON,VA.                                                      L1B
      P.N. JENSEN                                                      L1C
      SEB BASE-LONG                                                    L1D
      DEC 15,1981                                                      L1E

 THE FOLLOWING LINES ARE SITE CHARACTERISTIC AND STUDY PARAMETER DATA.

      LATITUDE  LONGITUDE             CLEARNESS CLEARNESS BUILDING
      DEGREE    DEGREE    TIME ZONE NO. - SUM NO. - WIN AZIMUTH
        37.000    76.000     5.000      .960      .960   300.000                              L2A

      OPTION    VENT.      FAN        COLD AIR  HOT AIR
       CODE      AIR      PRESS.        TEMP      TEMP
         2.000      .100     2.000    55.000   120.000                                        L2B

      BUILDING ALTITUDE
         10.00                                                                                L 3A

      SUMMER DESIGN DAY DATA
      MAX.      DBT        AVG. DEW  WIND
      DBT       RANGE      PT. TEMP. SPEED
        95.000    16.000    76.000     8.000                                                  L3B

      WINTER DESIGN DAY DATA
      MIN.      DBT        AVG. DEW  WIND
      DBT       RANGE      PT. TEMP. SPEED
        18.000     5.000    13.000    12.000                                                  L3C

      STARTING  STARTING  STUDY     CHRISTMAS INITIAL TEMP
      DAY       MONTH     LENGTH    LENGTH    WALL + ROOF
```


EXAMPLE OF OUTPUT FROM VERIFICATION FOR LOAD PROGRAM

FIGURE 3.2(b)

```
THE FOLLOWING LINE CONTAINS THE NUMBER OF DIFFERENT TYPES OF DELAYED SURFACES AND OF STANDARD SURFACES RESPECTIVELY.

           3.00       2.00                                                                                         L87

     THE FOLLOWING LINE(S) CONTAIN STANDARD SURFACE CODES
           8.00      12.00                                                                                         L8A

     THE FOLLOWING LINES CONTAIN DATA TO BE ANALYZED FOR NON-STANDARD SURFACE     1

     THE FOLLOWING LINE CONTAINS THE NUMBER OF LAYERS FOR NON-STANDARD SURFACE     1
           4.00                                                                                                    L10A- 1

     THE FOLLOWING LINES CONTAIN LAYER DESCRIPTION DATA FOR NON-STANDARD SURFACE     1
          .33000     .74200 125.00000     .22000    0.00000BRICK 4 IN
         0.00000    0.00000   0.00000    0.00000     .91000AIR SPACE
          .66700     .33000  38.00000     .20000    0.00000BLOCK,8IN
         0.00000    0.00000   0.00000    0.00000     .65800INSIDE AIR FILM

THE FOLLOWING LINE CONTAINS THE NUMBER OF DELAYED HEAT TRANSFER SURFACES.

          10.00                                                                                                    L11Z

     THE FOLLOWING TWO LINES CONTAIN DATA ON DELAYED HEAT TRANSFER SURFACE     1

        SURFACE    GROUND     INF. FLOW
        ABSORBT-N REFLECT-N COEFF.
           .750       .200      0.000                                                                              L11A- 1

        NO. OF     NO. OF X  NO. OF Y  SHADE SUR SURFACE    SURFACE
        VERTICES  DIVISIONS DIVISIONS NOT USED  ROUGHNESS INDEX
          1.000      1.000     1.000     1.000     2.000     1.000                                                 L11B- 1

        THE FOLLOWING DATA DESCRIBES DELAYED HEAT TRANSFER SURFACE     1

        ------VERTEX COORDINATES------                     AZIMUTH   TILT      +++ DERIVED DATA +++
        X          Y          Z       HEIGHT    WIDTH     ANGLE     ANGLE     ORIENTATION    AREA
          0.000      0.000     0.000     7.270   243.000   180.000    90.000     ESE        1766.6               L11C- 1

        THIS SURFACE HAS NO SHADING
```

EXAMPLE OF OUTPUT FROM VERIFICATION FOR LOAD PROGRAM

FIGURE 3.2(c)

```
***************************************** DATA VERIFICATION OF SESP CARD DATA *******************************************

        0 ERRORS WERE DETECTED WITH THE DATA

      CARD S1: PROJECT NAME - SYSTEMS ENGINEERING BUILDING,LARC

      CARD S0: TEMPERATURE PRINT KEYS

                 0.0  BUG(4)
                 0.0  BUG(6)
                 0.0  BUG(7)
                 0.0  BUG(8)

      CARD S2: GENERAL DATA

                    1  HOUR OF YEAR AT WHICH SIMULATION MAY BEGIN
                 8760  HOUR OF YEAR AT WHICH SIMULATION MAY END

                    0  OUTPUT TAPE OPTION FLAG

      CARD S3: PRINTOUTS

                    1 - NUMBER OF PRINTOUTS DESIRED

          PRINT PERIOD NO.   1

                 5089 HOUR OF YEAR AT WHICH PRINT BEGINS.
                 5112 HOUR OF YEAR AT WHICH PRINT ENDS.

                    1  OPTIONAL PRINT FLAG: LEVEL 1 HOURLY SUMMARIES
                    1  OPTIONAL PRINT FLAG: LEVEL 2 ZONE SUMMARIES
```

Data has been abbreviated for this example.

EXAMPLE OF OUTPUT FROM VERIFICATION FOR SYSTEMS PROGRAM

FIGURE 3.3(a)

CARD S4: THERMOSTAT SCHEDULES

5 - NUMBER OF THERMOSTAT SCHEDULES

THERMOSTAT NUMBER 1

HOUR OF DAY	THERM TYPE	HI LIMIT	LOW LIMIT
1	2	95.000	55.000
2	2	95.000	55.000
3	2	95.000	55.000
4	2	95.000	55.000
5	2	95.000	55.000
6	2	95.000	55.000
7	2	80.000	66.000
8	1	77.000	73.830
9	1	77.000	73.830
10	1	77.000	73.830
11	1	77.000	73.830
12	1	77.000	73.830
13	1	77.000	73.830
14	1	77.000	73.830
15	1	77.000	73.830
16	1	77.000	73.830
17	1	77.000	73.830
18	2	95.000	55.000
19	2	95.000	55.000
20	2	95.000	55.000
21	2	95.000	55.000
22	2	95.000	55.000
23	2	95.000	55.000
24	2	95.000	55.000

EXAMPLE OF OUTPUT FROM VERIFICATION FOR SYSTEMS PROGRAM

FIGURE 3.3(b)

CARD S11: FAN CARD

2 - NUMBER OF ENERGY DISTRIBUTION SYSTEMS

FAN SYSTEM NUMBER 1

		CARD FIELD
12.0	TYPE OF DISTRIBUTION SYSTEM: VARIABLE VOLUME	1
5.0	NO. OF ZONES ON SYSTEM	2
5.0	RELATIVE HUMIDITY SETPOINT	3
1600.0	MINIMUM OUTSIDE AIR	4
2.0	MIXED AIR OPTION	5
2.0	VARIABLE VOLUME FAN CONTROL TYPE	6
5.00	SUPPLY FAN PRESSURE	9
0.00	RETURN FAN PRESSURE	10
.5	EXHAUST FAN PRESSURE	11
0.0	VAV REHEAT COIL OPTION	12
20.0	VAV BOX MINIMUM AIR (PCT)	13
55.0	HOT DECK/AHU DISCHARGE TEMP.	14
1.0	BASEBOARD RADIATION SCHEDULE	18
3.0	FAN SYSTEM SHUTOFF CODE	27
4.0	VENTILATION SCHEDULE CODES	28
1.0	HUMIDISTAT LOCATION	29
0.0	DX/HEAT PUMP INDEX	30

EXAMPLE OF OUTPUT FROM VERIFICATION FOR SYSTEMS PROGRAM

FIGURE 3.3(c)

```
CARD S12: ZONE DATA

          11 - NUMBER OF ZONES

    CARD NO.   1      0  TYPE OF ZONE (0=NON-PLENUM,1=PLENUM)

           1  FAN SYSTEM INDEX

         1.0  LOADS SPACE NO.

     4000.00  SUPPLY AIR CFM
        0.00  EXHAUST AIR CFM

     1000.00  BASEBOARD OUTPUT
      220.00  ACTIVE LENGTH OF BASEBOARD

         1.0  YEARLY THERMOSTAT SCHEDULE INDEX

          0.  SPACE DESIGN HEATING CAPACITY
      80000.  SPACE DESIGN COOLING CAPACITY

      10.000  WEIGHT OF FURNISHINGS
       1.000  MULTIPLICATION FACTOR
       6.000  PLENUM NUMBER ABOVE SPACE

         2.0  SURFACE  1 TYPE
         1.0  RESPONSE FACTOR INDEX OF SURFACE  1
     3200.00  AREA OF SURFACE  1
```

EXAMPLE OF OUTPUT FROM VERIFICATION FOR SYSTEMS PROGRAM

FIGURE 3.3(d)

LO = } NECAP DIAGNOSTICS CARDS
SO = }

Field No.	Variable Description and Comments	Limits	Default
1	Amount of diagnostic information to be printed at the end of the INPUT check 0 = No echo 1 = Print syntax error at end of INPUT process 2 = Print syntax error out when card is processed	0 to 2	2
	Print bugs for variable temperature routines in SESP to: 0 = off 1 = on		
2	SPACE RESPONSE FACTOR CALCULATIONS	0 or 1	0
3	Summary of Internal H.T.S calcualtions	0 or 1	0
4	Detailed INTERNAL SPACE TEMPERATURE CALCUALTIONS	0 or 1	0
5	Summary print of SPACE RESPONSE FACTORS	0 or 1	0
6	Print listing of default program values 0 = None 1 = Short 2 = Extended 6 = Print entire common block	0,1,2,or 6	0

NECAP DIAGNOSTICS CARDS

TABLE 3.1

Table 3.2

SUMMARY OF WARNING CONDITION CODES

WARNING NO.	WARNING DESCRIPTION	ACTION TAKEN
1	Label has too many characters.	Label is truncated.
2	Multiple non-repeatable cards.	Last processed card is kept. Others are dropped.
3	Repetition number is not unique.	The repetition number is corrected to the lowest unique value.
4	More variables on a list than allowed.	Variable list is truncated to maximum allowed.
5	Repetition number and surface index not in order.	The repetition number is corrected to the lowest unique value.
6	Comment card in data deck.	Card is ignored.
7	Card added to end of data deck.	Card is considered a default card.
25	Second thermostat card. (Because of the large number of variables needed to describe a thermostat schedule, the program uses two cards in order to save storage. This warning highlights the second card).	Card is processed as part of the thermostat description.

Table 3.3

SUMMARY OF CRITICAL ERROR CONDITION CODES

ERROR NO.	CRITICAL ERROR DESCRIPTION	ACTION TAKEN
26	First character encountered on a card is not an 'L', 'S', or 'C'.	Card is ignored.
27	Blank card in data deck.	Card is ignored.
28	Unrecognizable character embedded in card.	Card is ignored.
29	Too many title cards.	Card is ignored.
31	Card index is too large.	Program execution is terminated.
32	Unknown surface index.	Card is ignored.
33	Invalid surface index.	Card is ignored.

SECTION 4
THERMAL LOAD ANALYSIS PROGRAM

4.1 OBJECTIVE AND DESCRIPTION

The Thermal Load Analysis Program, a complex of heat transfer, psychrometric, and geometric subroutines, computes the sensible and latent loads for each space as well as the block sensible and latent loads for the building, by accounting for:

1. Transmission gains and losses through walls, roofs, floors and windows

2. Solar gains through windows

3. Internal gains from people,lights and building equipment

4. Infiltration gains and losses due to wind and thermal pressure differences across openings

5. Ventilation air gains and losses due to fresh air requirements

6. Shading effects created by the structure itself (fins, overhangs, setbacks, etc.) as well as those from adjacent buildings or structures

Using these capabilities, the Thermal Load Analysis Program can perform two types of analyses:

1. Design load analysis - Utilizing user-defined design weather data via the L3 card (see NECAP Input Manual), a 24-hour design day analysis is done for each month to determine peak heating and cooling requirements for each space, and for the instantaneous summation of the entire building. No provision is made for carrying this process on through the Systems Energy Simulation Program.

2. Hourly energy analysis - Utilizing actual hourly weather data, hourly heating and cooling requirements for each space are calculated for an entire year of building operation, and results stored on computer file for use by other programs.

The input to the Thermal Load Analysis Program reflects building architecture, building construction, building surroundings, local weather, and pertinent location of the sun. The output consists of hourly weather and psychrometric data and hourly sensible loads, latent loads, return air lighting loads, and equipment and lighting power consumption for each building space. All calculations are performed in accordance with algorithms set forth by ASHRAE in their publication "Procedures for Determining Heating and Cooling Loads for Computerized Energy Calculations" (Reference 1). The program flow chart is shown in Figure 4.1.

The calculations in the Thermal Load Analysis Program are performed for constant temperature spaces. After the Thermal Load Analysis Program results are obtained, they are combined with the Systems Energy Simulation Program, which uses thermostat schedules and generates energy consumptions for various systems. As a result, the system's energy requirements can be made without having to run the Thermal Load Analysis Program for each variable to be studied.

4.2 INPUT DATA

Before the input data can be prepared, the user must grasp the meaning of certain definitions, and toward that end he is encouraged to read the following carefully.

4.2.1 Building Coordinate System

In order to properly communicate to the computer the special relationship between shading surfaces and surfaces which are being shaded, a coordinate system can be attached to the building and used to describe the location of surfaces. Figure 4.2 shows the recommended coordinate system. In this coordinate system, the front of the building lies in the xz plane. The origin, as viewed by a person outside the building, lies at the lower left hand corner of the building front. The z-axis points straight upward. For non-rectangular surfaces, i.e., surfaces having more than 4 corners, the order in which the corners are described should follow a righthanded order about the outward normal, as shown in Figure 4.3. Counterclockwise order adds area, while clockwise subtracts area.

4.2.2 Building Azimuth Angle

Building azimuth angle expresses the orientation of the building coordinate system relative to the points of the compass. It is defined as the angle clockwise from true north to the assumed north or Y-axis, as shown in Figure 4.4. For example, a building with a NW frontal exposure would use a building azimuth angle of 135^{o}.

4.2.3 Surface Description

The user is given two methods for numerically describing a surface to the computer. The first can be used to describe any shape of surface using point coordinates. The second is a simplified method which can be used for rectangular surfaces only. Method 1 (long form) requires that the x, y, z coordinates for all surface vertices be defined. From this data, the computer internally generates the additional information it requires, i.e., surface area and orientation (tilt angle and azimuth angle). Some users may feel that this method is tedious, and may desire to use Method 2 (short form) when the surfaces are rectangular in shape. Method 2 requires entering only the following data:

1. x, y, z coordinates of the lower left hand corner
2. height
3. width
4. tilt angle
5. azimuth angle

Using this data, the computer generates the remaining sets of x, y, z coordinates and the surface area. If the surface being described with Method 2 never experiences any shading, the user needs only to enter data for items 2 through 5. The program will automatically, by default, locate the surface at the origin with the specified azimuth and tilt angles.

Since most buildings are made up of rectangular surfaces, it is expected that the user would make most use of Method 2. Method 1 would be reserved for non-rectangular surfaces, or surfaces that have special shading problems.

4.2.4 Surface Tilt Angle

Surface tilt angle is defined as the angle between a horizontal plane and the surface in consideration. The value of tilt angle changes between 0^{o} and 180^{o}. A verticle surface would use a tilt angle of 90^{o} as shown in Figure 4.5.

4.2.5 Surface Azimuth Angle

Surface azimuth angle is the angle of the surface in consideration with respect to the building. It is defined as the clockwise angle from the assumed Y-axis of the building, to the horizontal projection of the surface outward normal, as viewed from above. A surface on the front of the building would use a surface azimuth of 180^{o} as shown in Figure 4.6 and Table 4.2. For horizontal surfaces, rotate the surface up into a vertical position along any of its sides, and perform a data takeoff the same as for a vertical surface, except that the tilt angle is 0.0.

4.2.6 Choice of the First Vertex of a Heat Transfer Surface

The following is of the utmost importance:

> If a polygon boundary is concave, i.e., if it has a "dent" in it, always choose the first vertex so that the first three vertices are convex (see Figure 4.7). This means that, if you walk from vertex 1 to vertex 2 on the outside of the surface, you must make a left turn to get to vertex 3. This convention is necessary because it affects coordinate transformations inside the program. This convention applies to delayed, quick and window surfaces.

4.2.7 Types of Heat Transfer Surfaces

Spaces are surrounded by heat transfer surfaces which can be of several types.

1. Delayed Heat Transfer Surfaces

   Thick exterior aboveground surfaces (walls or roofs) that impede the flow of heat, experience hourly change in temperature, and therefore have a heat storage effect. The ASHRAE Response Factor Method is used to calculate this transient heat flow each hour.

2. Quick Heat Transfer Surfaces

   Thin exterior aboveground surfaces that experience hourly change in temperature but have little or no heat storage effect (e.g. metal doors). A steady state method is used for calculations.

3. Windows

   Clear or translucent surfaces which transfer heat through conduction as well as through transmission of solar rays.

4. Internal Heat Transfer Surfaces

   Interior walls or floors across which there is a temperature difference but experiences slight change in temperature, and is treated as a steady state heat transfer surface (e.g. partitioning walls).

5. Underground Surfaces

   Slabs on-grade, or surfaces below-grade exposed to soil. It experiences slight change in temperature, and is treated as a steady state heat transfer surface, using the given monthly ground temperature.

All of these surfaces can transfer sensible energy in or out of the space. Stored energy appears in the space sometime after it enters the outside layer of a delayed surface.

4.2.8 Surfaces with Windows

Often a hole or cutout lies in the middle of a surface. If the surface input is only described by the outside points, the hole could be counted twice; once as a glazed surface and once as a part of a heat transfer surface. This error should be avoided by one of the following methods:

1. Use a cut to convert the surface into a doughnut-shaped polygon, of ten vertices, which surrounds but does not enclose the hole (Figures 4.8 and 4.9)

2. Divide the surface into several smaller surfaces, none of which enclose the hole (Figure 4.10)

4.2.9 Shading Surfaces

All heat transfer surfaces must specifically state which shading surfaces they are to use. For example, suppose that at the end of the input form for delayed surface #1, there appears the list "2, 5, and 6;". The computer program would recognize that common shading surfaces 2, 5, and 6 are to be used for delayed surface #1.

Solar shading of windows is provided by setback of the glass into a wall, or by shade fins around the window. Generally this would require the user to define 3 added shading surfaces for each window. NECAP will automatically generate these 3 added shading surfaces, simply specifying the setback and border distances for each window. This is explained in the NECAP Input Manual in the input instructions for L13 card (Field 6 and 7).

4.2.10 HOURLY WEATHER INPUT DATA

Hourly thermal load calculations procedures require the following weather data for each hour:

1. Month
2. Day
3. Hour
4. Dry-bulb temperature
5. Wet-bulb termperature
6. Dew point termperature
7. Atmospheric pressure
8. Wind speed
9. Wind direction
10. Cloud type
11. Cloud amount

A NECAP formatted weather tape containing 63 weather stations for the U.S. mainland is available with the NECAP program.

The hourly data may also be obtained from the National Oceanographic and Atmospheric Administration (NOAA), using the 1440 format, or test reference year format. These may be obtained in the form of either punched cards or magnetic tape, from the National Climatic Center in Asheville, N.C. These will have to be processed through the NECAP Input Processor Program (NIPP) to be converted to the NECAP format.

The format of the NOAA weather data, and other detailed information, is given in Appendix F. The format of the NECAP weather tape is given in Appendix D.

4.2.11 BUILDING SIZE LIMITATIONS

The Thermal Load Analysis Program is not limited in the size of building that it can analyze. There is, however, a limitation due to the number of values that have been assigned to the dimension statements (not the measure of distance) within the program. The maximum numbers are set in the program, and are given in the NECAP Input Manual.

If any one of these limits are exceeded for the building under study, the program or the input model must be modified. The engineer can consult Appendix A and prepare the required new dimension statements to be inserted into the program's software. Using a set of dimension cards, with the smallest possible values, can reduce the core requirement of a small project considerably.

4.3 OUTPUT REPORTS

The Thermal Load Analysis Program prints several types of reports. Some of these reports are received with each execution of the program, others only if specified. The purpose of these reports is to give the user a summary of the final results, as well as an optional summary of calculations performed at various stages prior to the final results.

Eleven types of reports can be created by the Thermal Load Analysis Program. They are:

1. Report L1 - Echo of Input Data
2. Report L2 - Title Page - Design Load Analysis
3. Report L3 - Summary of Design Day Weather
4. Report L4 - Space Design Load Summary
5. Report L5 - Building Design Load Summary
6. Report L6 - Title Page - Hourly Energy Analysis
7. Report L7 - Space and Systems Load Summary
8. Report L8 - Hourly Printout Report Column Headings
9. Report L9 - Hourly Printout Data
10. Report L10 - Surface Shadow Pictures and Shadow Calculations
11. Report L11 - Summary of Recommended Space Heat Extraction and Addition Rates

For the design load analysis segment, Reports L1, L2, L3, L4, and L5 are outputs that will always be received. Reports L8, L9, and L10 are optional outputs. For the hourly energy analysis segment, Reports L1, L4, L5, L6, L7, and L11 are mandatory outputs; Reports L8, L9, and L10 are optional outputs.

4.3.1 REPORT L1 - ECHO OF INPUT DATA

To give the user a hard copy record of the input data, the first report coming out will always be a summary of input data read. An example of the first page of this report is shown in Figure 4.13.

4.3.2 REPORT L2 - TITLE PAGE - DESIGN LOAD ANALYSIS

Whenever a design load analysis is performed, Report L2 is printed to identify the type of output to follow. Printed as part of this report are the facility name, location, user's name, project number and date (Figure 4.14).

4.3.3 REPORT L3 - SUMMARY OF DESIGN DAY WEATHER

As indicated by Figure 4.15, Report L3 summarizes the monthly design day weather that was generated by the program using the provided input data. Extrapolation of this data to other months is done using Carrier temperature correction factors (Reference 2). Use of these correction factors may yield a WBT equal to or greater than the corresponding DBT. Therefore, a fix was placed in the program to set the WBT to at least $3^{o}F$ lower than the DBT. Design load calculations are performed for each space for every hour of a design day for 9 months of cooling, and 1 month of heating.

4.3.4 REPORT L4 - SPACE DESIGN LOAD SUMMARY

At the end of the design load analysis, a summary (see Figure 4.16) detailing the components of the peak heating and cooling load is printed for each building space. An explanation of each item follows:

1. Space No. - defined by order of input.

2. Space Repetition Factor - defined on input L17.

3. Area - defined on input L17.

4. Volume - defined on input L17.

5. Summer Cooling Peak - time of occurance of peak cooling load (sensible and latent) and corresponding ambient DBT and WBT. Peak load will always occur during the 5th day of the month, since the design day weather for each month is repeated five days to filter out initializing effects.

6. Winter Heating Peak - comments in item 5 also apply here except peak load is based upon low sensible load only.

4.3.5 REPORT L5 - BUILDING DESIGN LOAD SUMMARY

Report L5 (see Figure 4.17) is similar to Report L4 except results are for the time when the sum of the zones or building load has peaked. Additional items include:

1. Return Air - summation of plenum and non-space lighting loads.

2. Fan Heat - heat produced by supply and return fans.

3. Ventilation Air - heating or cooling energy for outside air taken through the air handler.

4. Supply Air - total building air delivery rates required for both constant volume and variable volume distribution systems (Variable volume air will usually be less because air flow is based on peak building loads, not peak loads of each space. This is sometimes referred to as the diversity factor).

4.3.6 REPORT L6 - TITLE PAGE - HOURLY ENERGY ANALYSIS

Report L6 (see Figure 4.18) is similar to Report L2 except that it is produced only for an hourly energy analysis. It includes weather tape data and initialization of weather factors.

4.3.7 REPORT L7 - SPACE AND SYSTEMS LOAD SUMMARY

At the end of the hourly load analysis, a summary is printed for each building space, detailing the components of the peak heating and cooling load (see Figure 4.19). This report is identical to reports L4 and L5, except that the peak cooling and heating is based upon the hourly weather data used in the analysis.

4.3.8 REPORT L8 - HOURLY PRINTOUT REPORT COLUMN HEADINGS

Reports L8 and L9 are companion reports. Report L8 (see Figure 4.20) indicates the hourly weather and space load data that is calculated by the program, and written each hour by the Thermal Load Analysis Program on an output file. This report also is an aid in interpreting the data that is printed as part of Report L9.

4.3.9 REPORT L9 - HOURLY PRINTOUT DATA

Report L9 (see Figure 4.21) is an optional output and summarizes weather data and calculated space loads for each hour of the analysis. The user is cautioned that, if requested, this report could require several hundred pages of output, depending upon the length of the study and the number of spaces in the building. Periods for which this report is required is set by use of input L4.

4.3.10 REPORT L10 - SURFACE SHADOW PICTURES AND SHADOW CALCULATIONS

At the user's option, shadow pictures similar to that shown in Figure 4.22 can be printed by the computer. The starred area indicates that portion of the surface which is shaded by added or common surfaces. The shadow picture will always be for the first day of the month desired, since the program computes the sun's location only during the first day of each month. All other days in the month are given the same shadow picture as that received for any hour of that first day.

4.3.11 REPORT L11 - SUMMARY OF RECOMMENDED SPACE HEAT EXTRACTION AND ADDITION RATES

The Systems Energy Simulation Program (Section 5) requires as input to it, the maximum heating and cooling capacities provided to each space. Report L11 (Figure 4.23) lists the recommended capacities based upon hourly energy analysis results. The heating and cooling extraction rates will be used by SESP, unless the user inputs these values. These quantities are taken directly from the total space cooling, and total space heating of Report L7 for each undivided space. This value may be too low for spaces that need fast temperature pick up or cool down when the equipment is started. It could also be too high if an unusually hot or cold day is used for the peak energy needs, or if some temperature excursions are to be allowed.

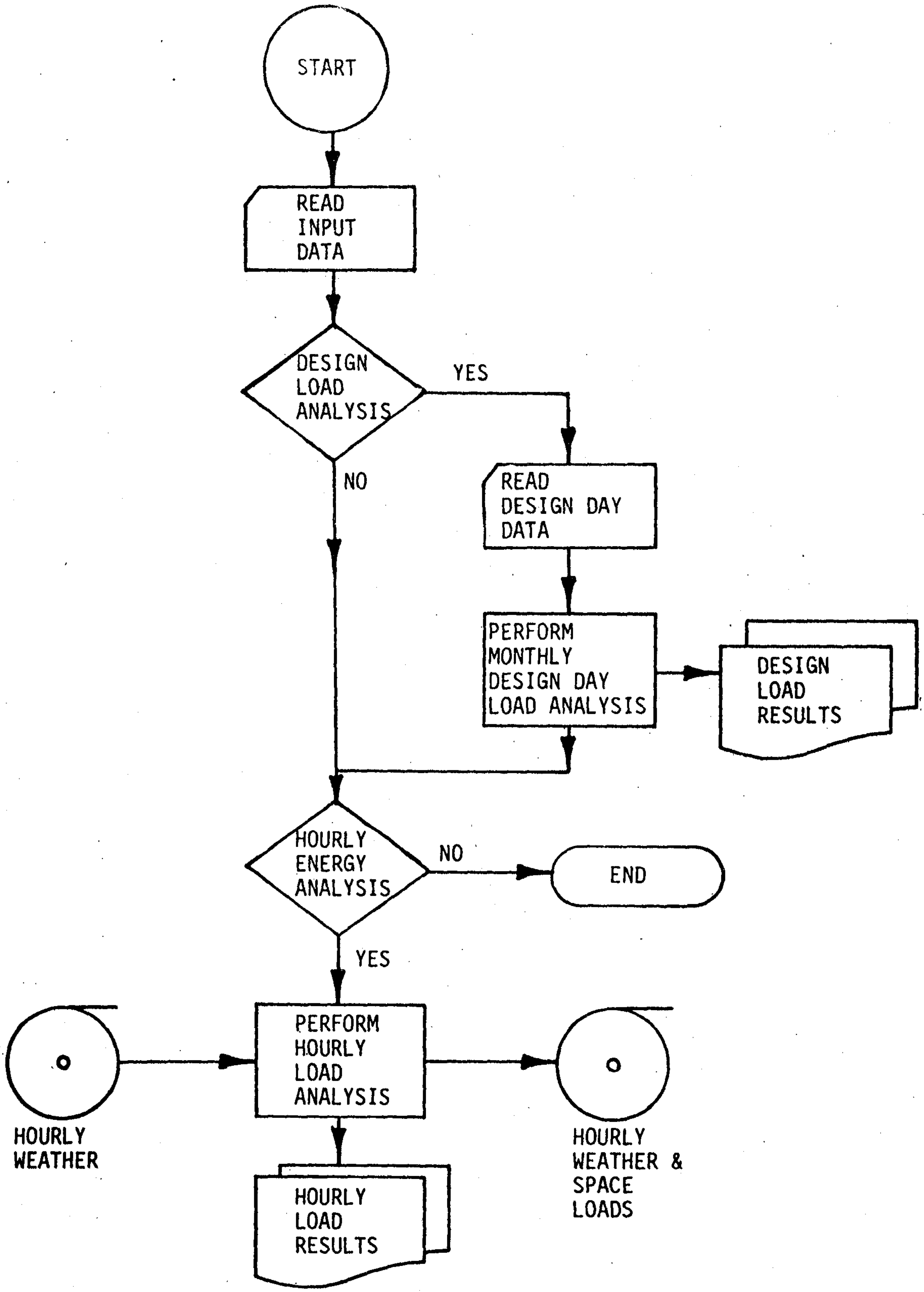


Figure 4.1 THERMAL LOAD ANALYSIS PROGRAM FLOWCHART

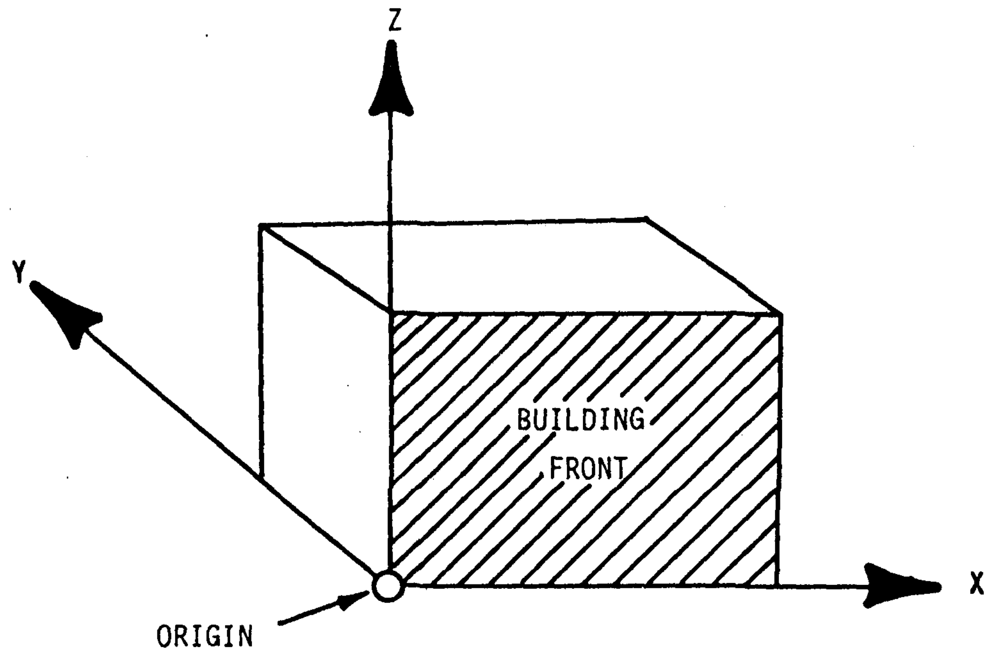


Figure 4.2 COORDINATE SYSTEM

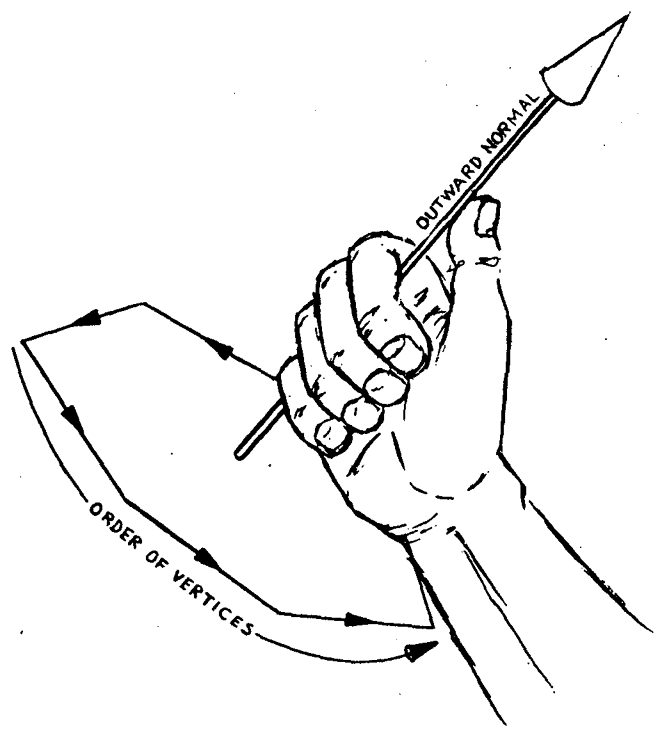
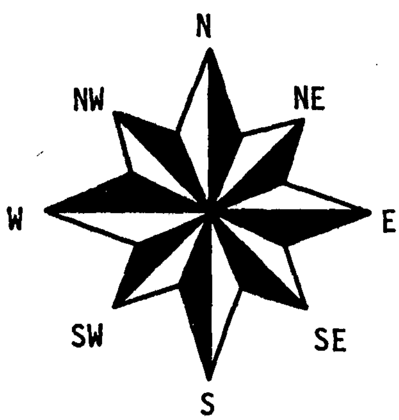


Figure 4.3 DEFINITION OF RIGHT-HANDED ORDER OF POLYGON VERTICES



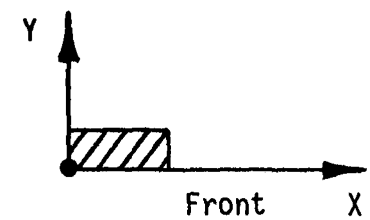
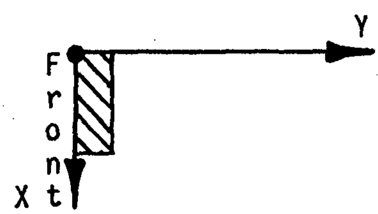
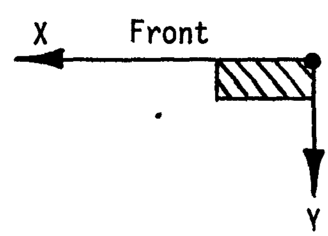
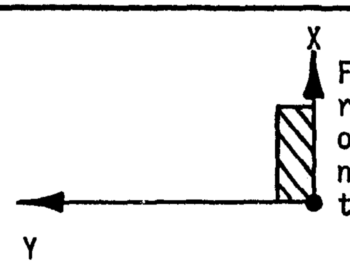
Orientation of Coordinate System relative to compass points	Value of Building Azimuth Angle (°)	Exposure of Building Front
	0	S
	90	W
	180	N
	270	E

Figure 4.4 BUILDING AZIMUTH ANGLE

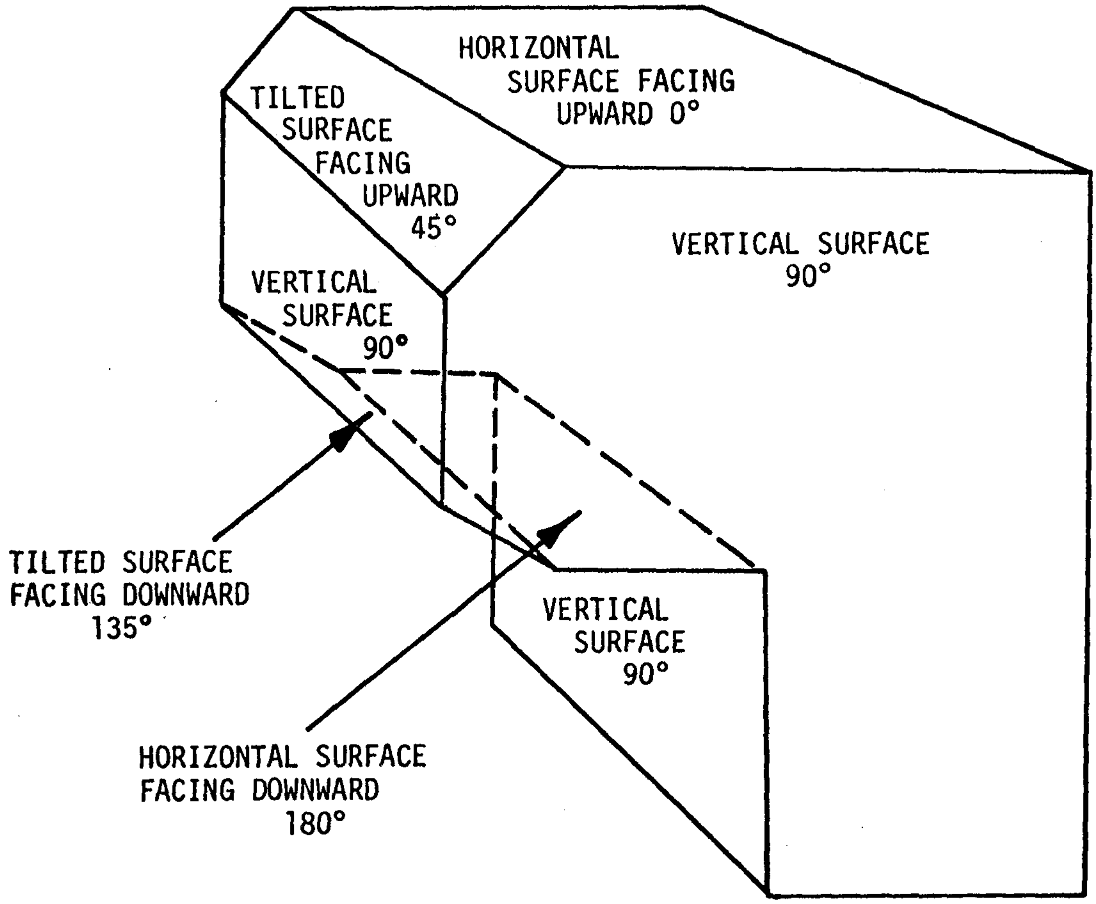


Figure 4.5 SURFACE TILT ANGLE

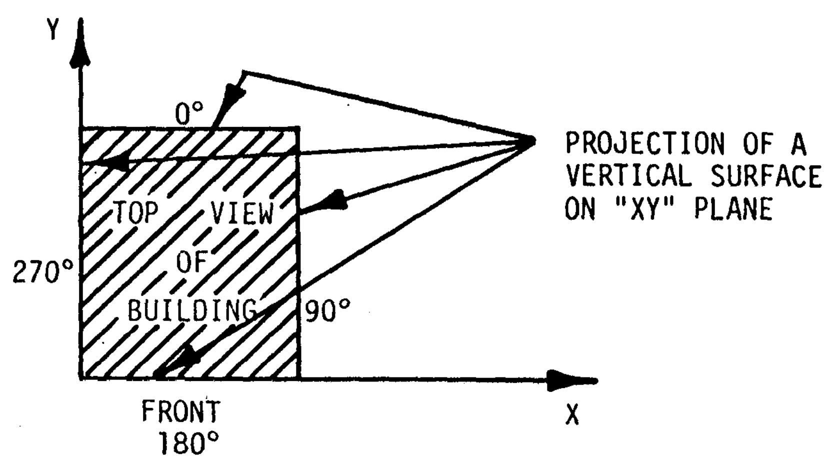


Figure 4.6 VERTICAL SURFACE AZIMUTH ANGLE

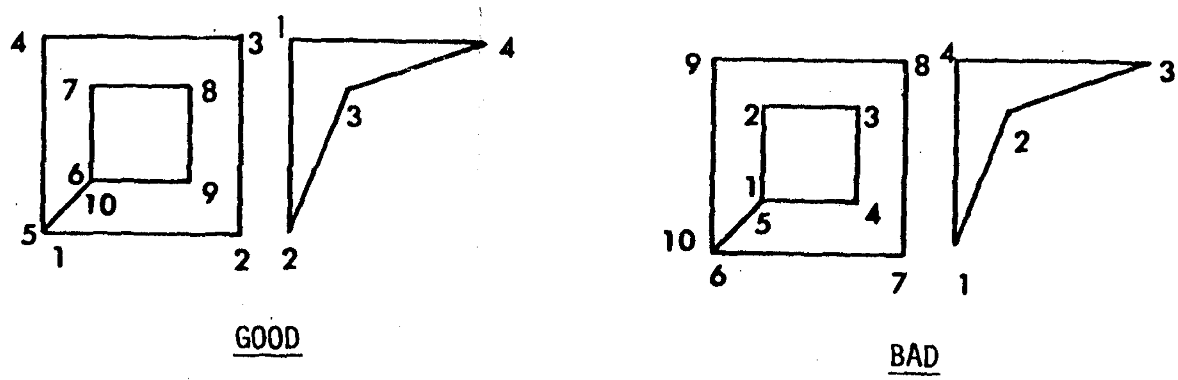


Figure 4.7 CHOICE OF FIRST VERTEX OF A HEAT TRANSFER SURFACE

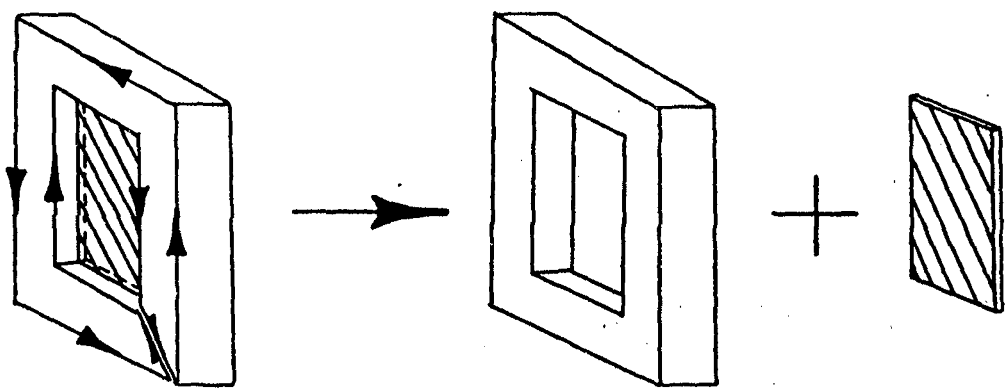


Figure 4.8 CORRECT USE OF A CUT TO REPRESENT SURFACE WITH A HOLE

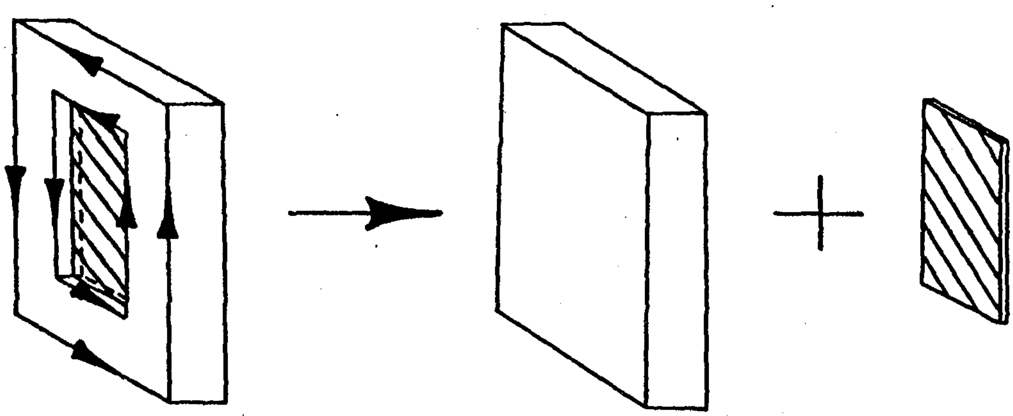


Figure 4.9 INCORRECT REPRESENTATION OF SURFACE WITH HOLE

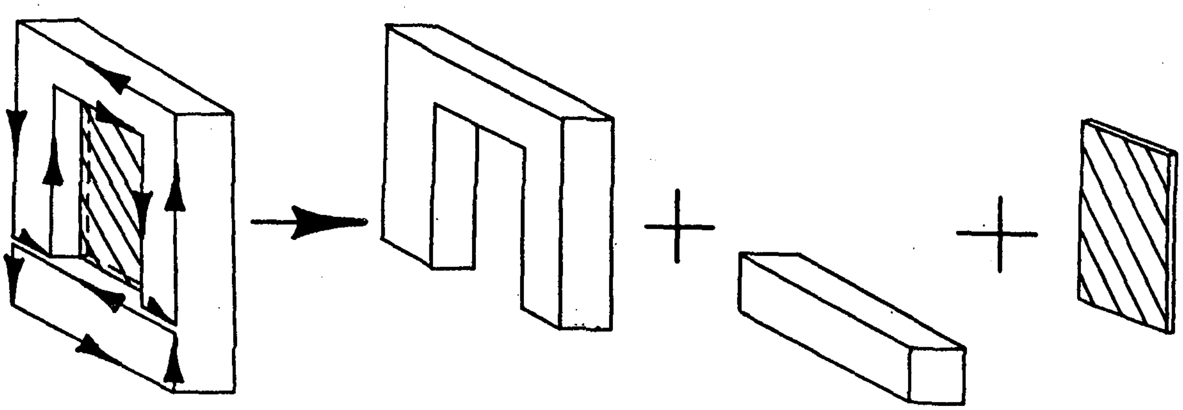


Figure 4.10 CORRECT USE OF MULTIPLE POLYGONS TO REPRESENT A SURFACE WITH A HOLE

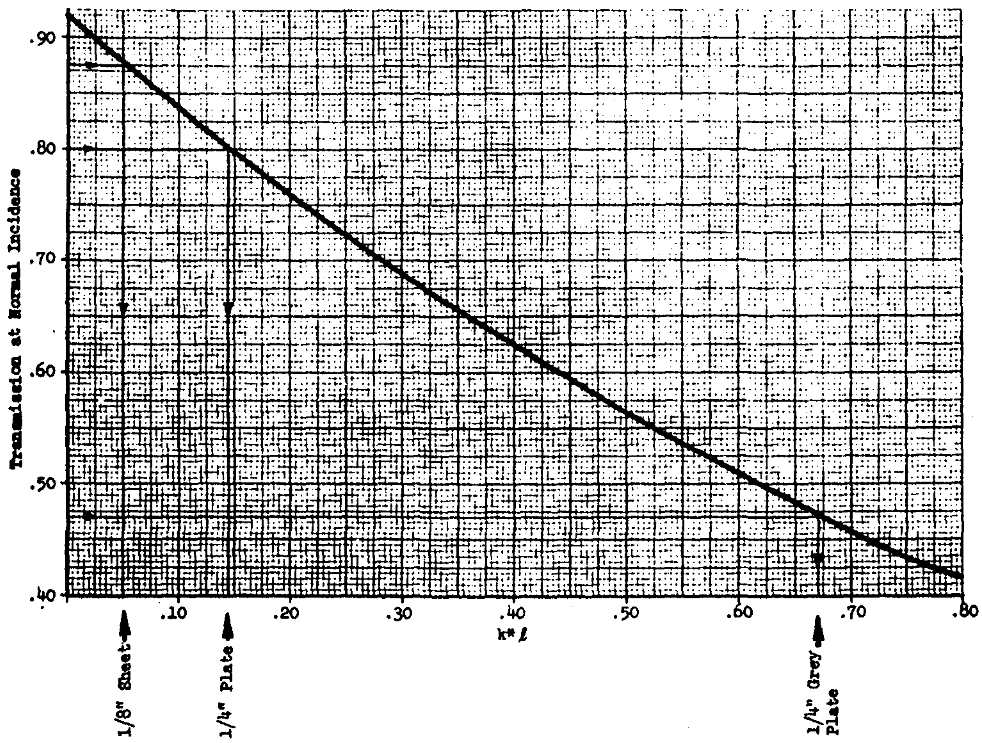


Figure 4.11 k*ℓ VS TRANSMISSION AT NORMAL INCIDENCE FOR SINGLE SHEET GLASS

Table 4.1

CODE FOR THICKNESS TIMES EXTINCTION COEFFICIENT

CODE	MEANING
1	1/8" sheet
2	k*ℓ = 0.10
3	k*ℓ = 0.15
4	k*ℓ = 0.20
5	k*ℓ = 0.40
6	k*ℓ = 0.60
7	50% transparent H.A. plate
8	k*ℓ = 1.00

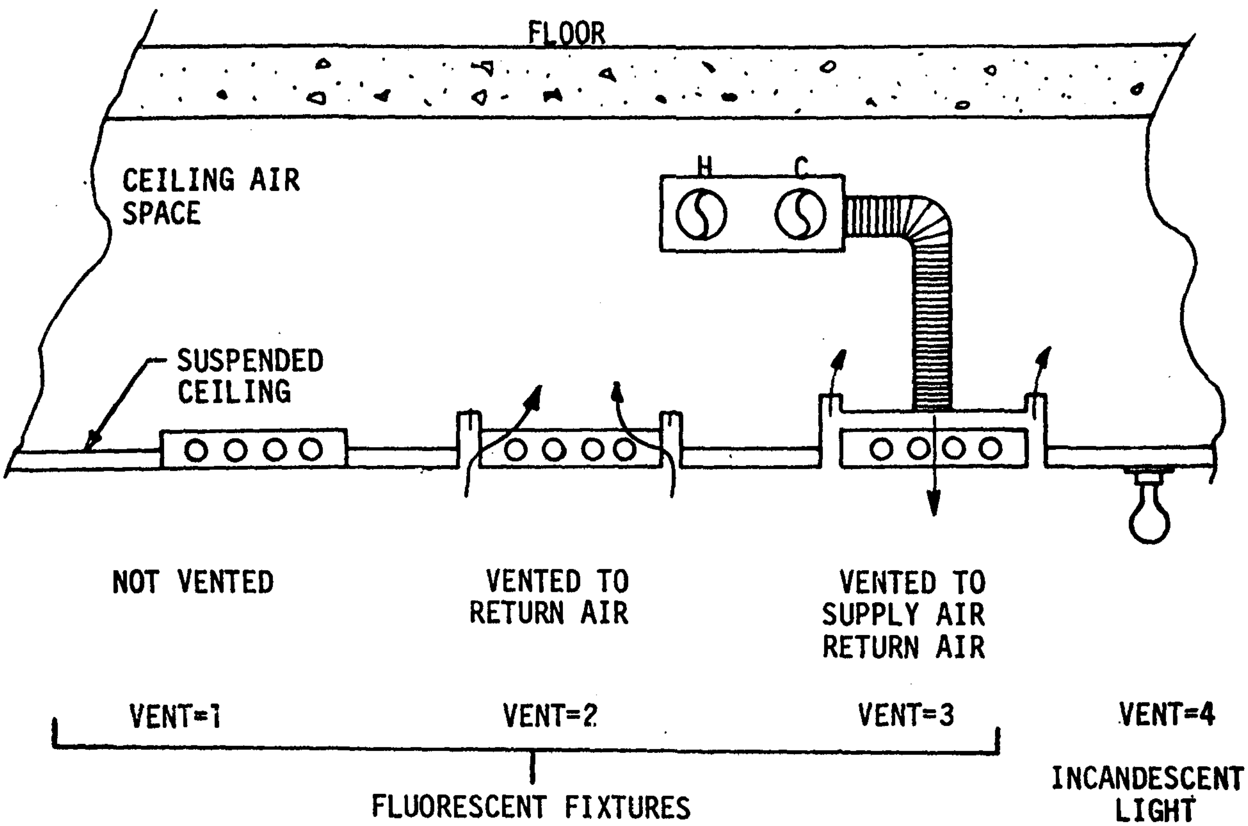


Figure 4.12 TYPES OF LIGHT FIXTURES

```
                    ***********************************
                    ***********************************
                     *****                        *****
                     *****   ECHO OF INPUT DATA   *****
                     *****  FOR THE LOAD PROGRAM  *****
                     *****                        *****
                    ***********************************
                    ***********************************


GEOGRAPHICAL DATA:

     LATITUDE  =  37.00   CLEARNESS NUMBER(SUMMER) =  .96  TIME ZONE    =   5.00
     LONGITUDE =  76.00   CLEARNESS NUMBER(WINTER) =  .96  BLDG AZMTH   = 300.00


PROCESSING PARAMETERS:

     PROCESS CODE = 2     VENT AIR RATE  =   .100  COLD SUPPLY AIR TEMP =  55.0
                          EST. FAN PRES. =  2.000  HOT  SUPPLY AIR TEMP = 120.0


DESIGN DAY PARAMETERS:

     ALTITUDE =   10.00
     SUMMER: DRY BULB =  95.0 DEW PT = 76.0 TEMP RANGE = 16.0 WIND SP =  8.00
     WINTER: DRY BULB =  18.0 DEW PT = 13.0 TEMP RANGE =  5.0 WIND SP = 12.00


HOURLY ANALYSIS PARAMETERS:

     SELECTED YEAR  = 1962 LENGTH OF STUDY = 365 DAYS
     STARTING MONTH = JAN  LNGTH OF XMAS SCHD = 0 DAYS
     EST.TEMP =  39.0


HOURLY PRINT SELECTED FROM   TO   (HOURS)
                          5089  5112

NO. OF SCHEDULE TYPES          4.00
```

REPORT L1(a) - ECHO OF INPUT DATA

Figure 4.13

SCHEDULE TYPE 1 PERCENT OF LOAD

INDICES: SUN= 1. MON= 4. TUE= 4. WED= 4. THU= 4. FRI= 4. SAT= 1. HOL= 1. XMAS= 1.

HOUR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SUN	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
MON	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
TUE	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
WED	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
THU	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
FRI	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
SAT	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
HOL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
XMS	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

SCHEDULE TYPE 2 PERCENT OF LOAD

INDICES: SUN= 1. MON= 5. TUE= 5. WED= 5. THU= 5. FRI= 5. SAT= 1. HOL= 1. XMAS= 1.

HOUR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SUN	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
MON	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03
TUE	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03
WED	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03
THU	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03
FRI	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03
SAT	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
HOL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
XMS	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

SCHEDULE TYPE 3 PERCENT OF LOAD

INDICES: SUN= 1. MON= 4. TUE= 4. WED= 4. THU= 4. FRI= 4. SAT= 11. HOL= 1. XMAS= 1.

HOUR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SUN	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
MON	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
TUE	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
WED	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
THU	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
FRI	03	03	03	03	03	03	03	03	98	98	98	98	98	98	98	98	98	03	03	03	03	03	03	03
SAT	00	00	00	00	00	00	00	00	15	15	15	15	15	00	00	00	00	00	00	00	00	00	00	00
HOL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
XMS	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

REPORT L1(b) - ECHO OF INPUT DATA

Figure 4.13

DELAYED SURFACE NUMBER 3 NON-STANDARD SURFACE NUMBER 1

DESCRIPTION OF CONSTRUCTION

LAYER NUMBER	THICKNESS FT	CONDUCTIVITY BTU PER (HR)(FT)(F)	DENSITY LB PER CU FT	SPECIFIC HEAT BTU PER (LB)(F)	RESISTANCE (HR)(SQ FT)(F) PER BTU	
1	.3300	.742	125.0	.2200	0.0000	BRICK 4 IN
2	0.0000	0.000	0.0	0.0000	.9100	AIR SPACE
3	.6670	.330	38.0	.2000	0.0000	BLOCK,8IN
4	0.0000	0.000	0.0	0.0000	.6580	INSIDE AIR FILM

THERMAL CONDUCTANCE = .248 BTU PER (HR)(SQ FT)(F)

RESPONSE FACTORS

HOUR	X	Y	Z
0	5.0825563253	.0000202218	.8609568959
1	-3.1944712761	.0033918878	-.2731387338
2	-.7312240460	.0192429044	-.1032600072
3	-.3697268902	.0331512362	-.0634600144
4	-.1989782448	.0362635744	-.0442763430
5	-.1138723029	.0330293657	-.0322669066
6	-.0693718065	.0276331228	-.0239256780
7	-.0447830492	.0221319413	-.0178898623
8	-.0303423440	.0173079378	-.0134387327
9	-.0213284375	.0133526932	-.0101225725
10	-.0153872638	.0102198913	-.0076372113
11	-.0112962872	.0077853903	-.0057678024
12	-.0083870240	.0059141383	-.0043586140
13	-.0062715442	.0044850394	-.0032949291
14	-.0047105010	.0033977874	-.0024913847
15	-.0035477035	.0025725084	-.0018840590
16	-.0026764282	.0019469469	-.0014248990
17	-.0020211969	.0014731683	-.0010776939
18	-.0015273295	.0011145266	-.0008151171
19	-.0011545744	.0008431251	-.0006165278
20	-.0008729944	.0006377808	-.0004663266
21	-.0006601795	.0004824334	-.0003527205
22	-.0004992863	.0003649179	-.0002667921
23	-.0003776242	.0002760247	-.0002017978
24	-.0002856168	.0002087842	-.0001526372
25	-.0002160309	.0001579231	-.0001154529
26	-.0001634004	.0001194517	-.0000873272

NUMBER OF HOURS REQUIRED TO REACH COMMON RATIO = 26
NUMBER OF RESPONCE FACTORS PER SET = 27
COMMON RATIO = .7563887946

REPORT L1(c) - ECHO OF INPUT DATA

Figure 4.13

```
THERE ARE   10 DELAYED SURFACES

   DELAYED SURFACE NO.  1
      ABSORBTANCE, REFLECTANCE, INF. COEFF. =        .75       .20      0.00
      INDICES =                                     1.00      1.00      1.00      1.00      2.00      1.00
      X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =       0.00      0.00      0.00      7.27    243.00    180.00     90.00

   DELAYED SURFACE NO.  2
      ABSORBTANCE, REFLECTANCE, INF. COEFF. =        .75       .20      0.00
      INDICES =                                     1.00      1.00      1.00      1.00      2.00      1.00
      X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =       0.00      0.00      0.00      7.27    243.00      0.00     90.00

   DELAYED SURFACE NO.  3
      ABSORBTANCE, REFLECTANCE, INF. COEFF. =        .75       .20      0.00
      INDICES =                                     1.00     20.00      3.00      0.00      2.00      1.00
      X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =       0.00    213.00      0.00      7.90    213.00    270.00     90.00

   DELAYED SURFACE NO.  4
      ABSORBTANCE, REFLECTANCE, INF. COEFF. =        .75       .20      0.00
      INDICES =                                    10.00      4.00      4.00      1.00      2.00      1.00
      VERTEX COORDINATES =                        243.00      0.00      0.00
                                                  243.00     10.00      0.00
                                                  243.00      6.50      3.00
                                                  243.00      3.50      3.00
                                                  243.00      3.50      9.90
                                                  243.00      6.50      9.90
                                                  243.00      6.50      3.00
                                                  243.00     10.00      0.00
                                                  243.00     10.00     10.00
                                                  243.00      0.00     10.00

   DELAYED SURFACE NO.  5
      ABSORBTANCE, REFLECTANCE, INF. COEFF. =        .75       .20      0.00
      INDICES =                                     1.00      1.00      1.00      1.00      2.00      3.00
      X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =       0.00      0.00     10.00      5.00    243.00    180.00     90.00

   DELAYED SURFACE NO.  6
      ABSORBTANCE, REFLECTANCE, INF. COEFF. =        .75       .20      0.00
      INDICES =                                     1.00      1.00      1.00      1.00      2.00      3.00
      X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =       0.00      0.00      0.00      5.00    243.00      0.00     90.00
```


REPORT L1(d) - ECHO OF INPUT DATA

Figure 4.13

```
SPACE  1 OF   12 TOTAL SPACES HAS

            1  DELAYED H.T.S.
            0  QUICK H.T.S.
           23  WINDOW H.T.S.
            2  INTERNAL H.T.S.
            1  UNDERGROUND SURFACES
            0  ADDITIONAL IDENTICAL SPACES

       3200.0  SQ FT FLOOR AREA
      32000.0  CU FT VOLUME
         60.0  LBS/CU FT FLOOR WEIGHT
         72.0  F TEMPERATURE
         25.0  PEOPLE
        450.0  BTU/HR ACTIVITY LEVEL
            0  SPACE SUMMATION PARAMETER
            0  PLENUM INDICATOR

         2.00  TYPE OF LIGHTING FIXTURE
          .70  FRACTION OF LIGHT HEAT TO SPACE
         2.00  INFILTRATION CODE
         0.00  INFILTRATION RATE
         0.00  HEIGHT FROM NEUTRAL ZONE
         0.00  EXHAUST AIR FLOW

    LIGHTING
          3.0  WATTS/SQ FT
          0.0  KW

    EQUIPMENT
           .4  WATTS/SQ FT
          0.0  KW
          0.0  BTU/HR SENSIBLE
          0.0  BTU/HR LATENT

    SCHEDULES
            1  PEOPLE
            2  LIGHTING
            1  EQUIPMENT

    INDICES OF DELAYED SURFACE
                  1

    INDICES OF WINDOW SURFACE
                  1    1    1    1    1    1    1
                  1    1    1    1    1    1    1
                  1    1    1    1    1    1    1
                  1    5

    INDICES OF INTERNAL H.T. SURFACES
                  1    6

    INDICES OF UNDERGROUND SURFACES
                  1
```

REPORT L1(e) - ECHO OF INPUT DATA

Figure 4.13

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                                                                           *
*                        DESIGN LOAD ANALYSIS FOR                           *
*                                                                           *
*                                                                           *
*                  SYSTEMS ENGINEERING BUILDING,LARC                        *
*                                                                           *
*                                                                           *
*                               BUILDING                                    *
*                                                                           *
*                                                                           *
*                             HAMPTON,VA.                                   *
*                                                                           *
*                                                                           *
*  ENGINEER    - R.N. JENSEN                                                *
*  PROJECT NO  - SEB BASE-LONG                                              *
*  DATE        - DEC 15,1981                                                *
*                                                                           *
*                                                                           *
*****************************************************************************
```

REPORT L2 - TITLE PAGE - DESIGN LOAD ANALYSIS

Figure 4.14

SUMMARY BY MONTH OF DESIGN DAY WEATHER GENERATED FOR USE IN HEATING AND COOLING CALCULATIONS

SUMMER DAY INPUT PARAMETERS

1. MONTH ASSUMED TO BE JULY OR AUGUST
2. MAXIMUM DRY-BULB TEMPERATURE = 95.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 16.
4. AVERAGE DEW-POINT TEMPERATURE = 76.
5. AVERAGE WIND SPEED = 8.

WINTER DAY INPUT PARAMETERS

1. MONTH ASSUMED TO BE DECEMBER
2. MINIMUM DRY-BULB TEMPERATURE = 18.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 5.
4. AVERAGE DEW-POINT TEMPERATURE = 13.
5. AVERAGE WIND SPEED = 12.

		A.M.												P.M.											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
MARCH																									
	DBT	67.	67.	66.	66.	66.	67.	68.	69.	70.	72.	74.	76.	78.	80.	81.	80.	79.	79.	77.	75.	73.	71.	69.	67.
	WBT	64.	64.	63.	63.	63.	64.	65.	66.	67.	69.	71.	72.	73.	73.	73.	73.	73.	73.	72.	72.	70.	68.	66.	64.
APRIL																									
	DBT	72.	72.	71.	71.	71.	72.	73.	74.	75.	77.	79.	81.	83.	85.	86.	85.	84.	84.	82.	80.	78.	76.	74.	72.
	WBT	69.	69.	68.	68.	68.	69.	70.	71.	72.	73.	73.	74.	75.	75.	75.	75.	75.	75.	74.	74.	73.	73.	71.	69.
MAY																									
	DBT	77.	77.	76.	76.	76.	77.	78.	79.	80.	82.	84.	86.	88.	90.	91.	90.	89.	89.	87.	85.	83.	81.	79.	77.
	WBT	74.	74.	73.	73.	73.	74.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	74.
JUNE																									
	DBT	80.	80.	79.	79.	79.	80.	81.	82.	83.	85.	87.	89.	91.	93.	94.	93.	92.	92.	90.	88.	86.	84.	82.	80.
	WBT	77.	77.	76.	76.	76.	77.	77.	77.	78.	78.	79.	79.	80.	80.	80.	80.	80.	80.	79.	79.	78.	78.	77.	77.
JULY																									
	DBT	81.	81.	80.	80.	80.	81.	82.	83.	84.	86.	88.	90.	92.	94.	95.	94.	93.	93.	91.	89.	87.	85.	83.	81.
	WBT	77.	77.	77.	77.	77.	77.	77.	77.	78.	78.	79.	79.	80.	80.	80.	80.	80.	80.	79.	79.	78.	78.	77.	77.
AUGUST																									
	DBT	81.	81.	80.	80.	80.	81.	82.	83.	84.	86.	88.	90.	92.	94.	95.	94.	93.	93.	91.	89.	87.	85.	83.	81.
	WBT	77.	77.	77.	77.	77.	77.	77.	77.	78.	78.	79.	79.	80.	80.	80.	80.	80.	80.	79.	79.	78.	78.	77.	77.
SEPTEMBER																									
	DBT	78.	78.	77.	77.	77.	78.	79.	80.	81.	83.	85.	87.	89.	91.	92.	91.	90.	90.	88.	86.	84.	82.	80.	78.
	WBT	75.	75.	74.	74.	74.	75.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	75.
OCTOBER																									
	DBT	74.	74.	73.	73.	73.	74.	75.	76.	77.	79.	81.	83.	85.	87.	88.	87.	86.	86.	84.	82.	80.	78.	76.	74.
	WBT	71.	71.	70.	70.	70.	71.	72.	73.	73.	74.	75.	75.	76.	76.	76.	76.	76.	76.	75.	75.	74.	74.	73.	71.
NOVEMBER																									
	DBT	66.	66.	65.	65.	65.	66.	67.	68.	69.	71.	73.	75.	77.	79.	80.	79.	78.	78.	76.	74.	72.	70.	68.	66.
	WBT	63.	63.	62.	62.	62.	63.	64.	65.	66.	68.	70.	71.	72.	72.	72.	72.	72.	72.	71.	71.	69.	67.	65.	63.
DECEMBER																									
	DBT	19.	19.	18.	18.	18.	18.	18.	19.	20.	21.	21.	22.	23.	23.	23.	23.	23.	22.	22.	21.	21.	21.	20.	20.
	WBT	16.	16.	15.	15.	15.	15.	15.	16.	17.	18.	18.	19.	20.	20.	20.	20.	20.	19.	19.	18.	18.	18.	17.	17.

NOTE - TEMPERATURE CORRECTION FACTORS BASED ON
CARRIER SYSTEM DESIGN MANUAL PGS. 1-18,19.
WBT IS SET AT LEAST 3 DEG. F BELOW DBT.

REPORT L3 - SUMMARY OF DESIGN DAY WEATHER

Figure 4.15

DESIGN LOAD CALCULATION RESULTS FOR
SYSTEMS ENGINEERING BUILDING, LARC
HAMPTON, VA.

SPACE NO.	1
SPACE REPETITION FACTOR	1
AREA (SQ.FT.)	3200.
VOLUME (CU.FT.)	32000.

SUMMER COOLING PEAK: AUG. 5 AT HOUR 15
DBT= 95 WBT= 80 WND SP= 6

WINTER HEATING PEAK: DEC. 5 AT HOUR 7
DBT= 18 WBT= 15 WND SP= 10

	***** SUMMER LOAD *****		WINTER
	SENSIBLE (BTUH)	LATENT (BTUH)	LOAD (BTUH)
WALLS	4283.	0.	-8033.
CEILINGS	0.	0.	0.
WINDOW CONDUCTANCE	13677.	0.	-38421.
WINDOW SOLAR	22867.	0.	2151.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND SURFACES	2400.	0.	-6600.
OCCUPANTS	6403.	3697.	0.
LIGHT TO SPACE	19555.	0.	0.
EQUIPMENT TO SPACE	3760.	0.	0.
INFILTRATION	0.	0.	0.
	---------	---------	---------
TOTAL	72945.	3697.	-50904.

TOTAL SPACE COOLING 76641. BTUH
TOTAL SPACE HEATING -50904. BTUH

SUPPLY AIR AT 55 F AT DIFFUSER 4158. CFM 1.30 CFM/SQ.FT.
SUPPLY AIR AT 120 F AT DIFFUSER 890. CFM .28 CFM/SQ.FT.

REPORT L4 - SPACE DESIGN LOAD SUMMARY

Figure 4.16

BUILDING DESIGN LOAD CALCULATION RESULTS FOR
SYSTEMS ENGINEERING BUILDING, LARC
HAMPTON, VA.

SPACE NOS. 1 THRU 12

TOTAL FLOOR AREA (SQ.FT.) 52800.

TOTAL VOLUME (CU.FT.) 528000.

SUMMER COOLING PEAK: AUG. 5 AT HOUR 16
DBT= 94 WBT= 80 WND SP= 6

WINTER HEATING PEAK: DEC. 5 AT HOUR 6
DBT= 18 WBT= 15 WND SP= 10

	***** SUMMER LOAD ***** SENSIBLE (BTUH)	LATENT (BTUH)	WINTER LOAD (BTUH)
WALLS	45125.	0.	-98447.
CEILINGS	255839.	0.	-313247.
WINDOW CONDUCTANCE	49510.	0.	-142350.
WINDOW SOLAR	75803.	0.	6456.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND SURFACES	15840.	0.	-43560.
OCCUPANTS	78218.	44360.	0.
LIGHT TO SPACE	296355.	0.	0.
EQUIPMENT TO SPACE	78546.	0.	17065.
INFILTRATION	46283.	92611.	-229260.
	---------	---------	---------
SUBTOTAL	941520.	136971.	-803343.
RETURN AIR	123344.	0.	0.
FAN HEAT	44055.	0.	44055.
VENTILATION AIR	119873.	236046.	-339124.
	---------	---------	---------
TOTAL	1228793.	373017.	-1098411.

TOTAL BUILDING COOLING 1601810. BTUH 133.5 TONS
TOTAL BUILDING HEATING -1098411. BTUH -1098.4 MBH

	******* VARIABLE VOLUME SYSTEM *******		******* CONSTANT VOLUME SYSTEM *******	
SUPPLY AIR AT 55 F AT DIFFUSER	53668. CFM	1.02 CFM/SQ.FT. MAX.	54877. CFM	1.04 CFM/SQ.FT. CONST.
SUPPLY AIR AT 120 F AT DIFFUSER	14043. CFM	.27 CFM/SQ.FT. MAX.	14088. CFM	.27 CFM/SQ.FT. CONST.

Report L5 - BUILDING DESIGN LOAD SUMMARY

Figure 4.17

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                                                                           *
*                     ANALYSIS OF ENERGY UTILIZATION OF                     *
*                                                                           *
*                                                                           *
*                     SYSTEMS ENGINEERING BUILDING,LARC                     *
*                                                                           *
*                                                                           *
*                                 BUILDING                                  *
*                                                                           *
*                                                                           *
*                                HAMPTON,VA.                                *
*                                                                           *
*                                                                           *
*  ENGINEER   - R.N. JENSEN                                                 *
*  PROJECT NO - SEB BASE-LONG                                               *
*  DATE       - DEC 15,1981                                                 *
*                                                                           *
*                                                                           *
*****************************************************************************
```

REPORT L6(a) - TITLE PAGE - HOURLY ENERGY ANALYSIS

Figure 4.18

```
*****************************************************************************************
*                                                                                       *
*                                                                                       *
*                                   IN THIS RUN                                         *
*                                                                                       *
*                                                                                       *
* - U. S. WEATHER BUREAU DATA FOR: LANGLEY AFB  VA       STATION #13702 IS USED         *
*                                                                                       *
*                                                                                       *
* - THIS STUDY STARTS ON THE FIRST HOUR OF JAN  1, 1962.                                *
*                                                                                       *
*                                                                                       *
* - THE LENGTH OF THIS STUDY IS 365 DAYS.                                               *
*                                                                                       *
*                                                                                       *
* - THE CONDITIONS AT THE START OF THE STUDY ARE:                                       *
*                                                                                       *
*     DRY BULB =  39          WIND SPEED =    4          PRESSURE = 3021                *
*     WET BULB =  34          WIND DIR.  = 203           CLOUD TYP=    8                *
*     DEW POINT=  26                                     CLOUD AMT=    2                *
*                                                                                       *
*                                                                                       *
*****************************************************************************************
```

REPORT L6(b) - TITLE PAGE - HOURLY ENERGY ANALYSIS

Figure 4.18

HOURLY LOAD ANALYSIS RESULTS FOR
SYSTEMS ENGINEERING BUILDING,LARC
HAMPTON,VA.

SPACE NO.	1
SPACE REPETITION FACTOR	1
AREA (SQ.FT.)	3200.
VOLUME (CU.FT.)	32000.

SUMMER COOLING PEAK: JULY 16 AT HOUR 16
DBT= 79 WBT= 76 WND SP= 10

WINTER HEATING PEAK: JAN. 19 AT HOUR 2
DBT= 35 WBT= 33 WND SP= 10

	***** SUMMER LOAD *****		WINTER
	SENSIBLE (BTUH)	LATENT (BTUH)	LOAD (BTUH)
WALLS	3326.	0.	-5509.
CEILINGS	0.	0.	0.
WINDOW CONDUCTANCE	4645.	0.	-26301.
WINDOW SOLAR	18361.	0.	3486.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND SURFACES	900.	0.	-8100.
OCCUPANTS	6304.	3697.	771.
LIGHT TO SPACE	19072.	0.	3427.
EQUIPMENT TO SPACE	3702.	0.	453.
INFILTRATION	11100.	71599.	-66566.
	---------	---------	---------
TOTAL	67411.	75296.	-98339.

TOTAL SPACE COOLING 142707. BTUH
TOTAL SPACE HEATING -98339. BTUH

SUPPLY AIR AT 55 F AT DIFFUSER 3920. CFM 1.23 CFM/SQ.FT.
SUPPLY AIR AT 120 F AT DIFFUSER 1690. CFM .53 CFM/SQ.FT.

REPORT L7(a) - SPACE AND SYSTEMS LOAD SUMMARY

Figure 4.19

```
BUILDING LOAD SUMMARY FOR
          SYSTEMS ENGINEERING BUILDING,LARC
          HAMPTON,VA.

          SPACE NOS.                                    1  THRU  12

          TOTAL FLOOR AREA (SQ.FT.)                          52800.

          TOTAL VOLUME (CU.FT.)                             528000.

           SUMMER COOLING PEAK:    AUG. 20  AT HOUR 18
                                     DBT= 89  WBT= 79  WND SP= 12

           WINTER HEATING PEAK:    DEC. 31  AT HOUR  7
                                     DBT= 15  WBT= 12  WND SP= 14

                                       ***** SUMMER LOAD *****           WINTER
                                        SENSIBLE      LATENT              LOAD
                                        (BTUH)        (BTUH)             (BTUH)
               WALLS                     33493.          0.             -91356.
               CEILINGS                 151127.          0.            -310884.
               WINDOW CONDUCTANCE        41736.          0.            -152520.
               WINDOW SOLAR              57815.          0.               3712.
               QUICK SURFACES                0.          0.                  0.
               INTERNAL SURFACES             0.          0.                  0.
               UNDERGROUND SURFACES      15840.          0.             -43560.
               OCCUPANTS                 78531.      44360.                  5.
               LIGHT TO SPACE           295949.          0.                 27.
               EQUIPMENT TO SPACE        78791.          0.              17069.
               INFILTRATION              66133.     175971.            -284218.
                                       ---------   ---------          ---------
               SUBTOTAL                 819415.     220330.            -861726.
               RETURN AIR               123130.          0.                  8.
               FAN HEAT                  48815.          0.              48815.
               VENTILATION AIR           90798.     233772.            -364801.
                                       ---------   ---------          ---------
               TOTAL                   1082159.     454102.           -1177704.

          TOTAL BUILDING COOLING      1536261. BTUH          128.0 TONS
          TOTAL BUILDING HEATING     -1177704. BTUH        -1177.7 MBH

                                          ******* VARIABLE VOLUME SYSTEM *******        ******* CONSTANT VOLUME SYSTEM *******
          SUPPLY AIR AT  55 F AT DIFFUSER     47650. CFM     .90 CFM/SQ.FT. MAX.         60806. CFM    1.15 CFM/SQ.FT. CONST.
          SUPPLY AIR AT 120 F AT DIFFUSER     14811. CFM     .28 CFM/SQ.FT. MAX.         19051. CFM     .36 CFM/SQ.FT. CONST.
```

REPORT L7(b) - SPACE AND SYSTEMS LOAD SUMMARY

Figure 4.19

```
***************************************************************************
*                                                                         *
*                                                                         *
*                           IN THE FOLLOWING PAGES                        *
*                                                                         *
*                                                                         *
*                   THE FIRST LINE OF EACH PRINTED BLOCKS GIVES           *
*                                                                         *
*   TIME             - HOURS, STANDARD TIME FROM FIRST HOUR OF JANUARY    *
*   MONTH            - MONTH OF YEAR                                      *
*   DAY INDEX 1      - DAY OF MONTH MM/DD                                 *
*   DAY INDEX 2      - DAY OF WEEK                                        *
*   HOUR             - HOUR OF DAY (1-24)                                 *
*   SUN INDEX        - IF EQUAL TO ONE SUN IS DOWN, IF EQUAL TO ZERO SUN IS UP *
*   DRY-BULB TEMP. - DEGREES FAHRENHEIT                                   *
*   WET-BULB TEMP. - DEGREES FAHRENHEIT                                   *
*   WIND VELOCITY  - KNOTS                                                *
*   HUMIDITY RATIO - LBS WATER PER LB DRY-AIR                             *
*   PRESSURE         - INCHES OF MERCURY                                  *
*   DENSITY          - LBS DRY-AIR PER CUBIC FOOT                         *
*   ENTHALPY         - BTU PER LB DRY-AIR                                 *
*   DAY INDEX 3      - TYPE OF DAY(1-9)                                   *
*   CLOUD COVER MODIFIER - FRACTION OF TOTAL SOLAR RADIATION INCIDENT     *
*                          UPON A HORIZONTAL SURFACE                      *
*   SPACE NUMBER                                                          *
*   SPACE SENSIBLE LOAD - BTU PER HOUR                                    *
*   SPACE LATENT LOAD   - BTU PER HOUR                                    *
*   PLENUM RETURN AIR LIGHTING LOAD    - BTU PER HOUR                     *
*   SPACE LIGHTING AND EQUIPMENT POWER - KILOWATTS                        *
*   SPACE SENSIBLE LOAD (INFLITRATION) - BTU PER HOUR                     *
*   SPACE LATENT LOAD (INFLITRATION)   - BTU PER HOUR                     *
*                                                                         *
*                                                                         *
***************************************************************************
*         NOTE - THE LOADS EXCLUDES OUTSIDE VENTILATION AIR LOADS         *
***************************************************************************
```

REPORT L8 - HOURLY PRINTOUT REPORT COLUMN HEADINGS

Figure 4.20

HOUR= 5100 WED AUG, 1 TIME 12:00 DBT= 81.0 WBT= 75.0 VEL= 3.0 HUMRAT= .0175 ATM PRES= 29.97 DENS= .0715 ENTH= 38.63
TYPE OF DAY- WED CC= .959 HRDN= 242.0 BS= 36.8

SPACE NO.	SENSIBLE LOAD (BTU)	LATENT LOAD (BTU)	RTN AIR LT LOAD (BTU)	LITE & EQUIP POWER (KWH)	INFILTRATION LOADS(BTU) SENSIBLE	LATENT
1	58474	3696	7446	10.662	0	0
2	39314	3696	6515	9.330	0	0
3	43828	11027	7446	10.662	1711	7331
4	42112	3696	7446	10.662	0	0
5	276502	42992	78652	114.660	3132	13418
6	14855	0	0	0.000	0	0
7	13414	0	0	0.000	0	0
8	13056	0	0	0.000	0	0
9	12759	0	0	0.000	0	0
10	151302	0	0	0.000	0	0
11	43509	4817	0	6.272	1124	4817
12	32968	963	0	7.744	224	963

HOUR= 5101 WED AUG, 1 TIME 13:00 DBT= 81.0 WBT= 76.0 VEL= 5.0 HUMRAT= .0184 ATM PRES= 29.97 DENS= .0714 ENTH= 39.61
TYPE OF DAY- WED CC= .959 HRDN= 236.6 BS= 36.6

SPACE NO.	SENSIBLE LOAD (BTU)	LATENT LOAD (BTU)	RTN AIR LT LOAD (BTU)	LITE & EQUIP POWER (KWH)	INFILTRATION LOADS(BTU) SENSIBLE	LATENT
1	58988	19788	7730	10.662	3411	16091
2	41031	3696	6764	9.330	0	0
3	46111	3696	7730	10.662	0	0
4	46853	3696	7730	10.662	0	0
5	286596	54171	81655	114.660	5213	24597
6	17733	0	0	0.000	0	0
7	15725	0	0	0.000	0	0
8	15166	0	0	0.000	0	0
9	14932	0	0	0.000	0	0
10	177222	0	0	0.000	0	0
11	46584	8830	0	6.272	1871	8830
12	35161	1766	0	7.744	374	1766

HOUR= 5102 WED AUG, 1 TIME 14:00 DBT= 81.0 WBT= 76.0 VEL= 3.0 HUMRAT= .0184 ATM PRES= 29.96 DENS= .0713 ENTH= 39.62
TYPE OF DAY- WED CC= .937 HRDN= 210.6 BS= 35.2

SPACE NO.	SENSIBLE LOAD (BTU)	LATENT LOAD (BTU)	RTN AIR LT LOAD (BTU)	LITE & EQUIP POWER (KWH)	INFILTRATION LOADS(BTU) SENSIBLE	LATENT
1	59059	9603	7977	10.662	1251	5907
2	41933	3696	6980	9.330	0	0
3	48894	3696	7977	10.662	0	0
4	51204	3696	7977	10.662	0	0

REPORT L9 - HOURLY PRINTOUT DATA

Figure 4.21

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * *                                                                                       *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

```
THE PRECEDING SHADOW PICTURE IS FOR
WINDOW NUMBER   5 OF SPACE NUMBER   1
AT 1000 HOUR OF THE FIRST DAY OF FEB

 AREA OF THE WINDOW            =     200.00 FT**2
 SHADED AREA OF THE WINDOW     =      82.67 FT**2
```

REPORT L10 - SURFACE SHADOW PICTURES AND SHADOW CALCULATIONS

Figure 4.22

SUMMARY OF RECOMMENDED HEATING AND COOLING EXTRACTION RATES

SPACE NO.	HEATING EXTRACTION RATE (BTU/HR)	COOLING EXTRACTION RATE (BTU/HR)
1	-98339.	67411.
2	-48439.	47470.
3	-241693.	49553.
4	-161024.	89387.
5	-154910.	338887.
6	-35230.	29490.
7	-33438.	26016.
8	-35366.	25494.
9	-33122.	26009.
10	-254478.	302932.
11	-62546.	57079.
12	-12403.	43003.

REPORT L11 - SUMMARY OF RECOMMENDED SPACE HEAT EXTRACTION AND ADDITION RATES

Figure 4.23

Table 4.2

AZIMUTH ANGLES OF VERTICAL SURFACES

WALL ORIENTATION	AZIMUTH ANGLE (°)
Facing direction of Y-axis	0
Facing direction of X-axis	90
Facing opposite the Y-axis	180
Facing opposite the X-axis	270

TABLE 4.3

USUAL CLASSIFICATION OF SHADING SURFACES

Type of Surface	Classification
Roof overhand	Common
Adjacent Building	Common
Window setback	Added
Window overhang	Added
Tree or water tower	Common

TABLE 4.4

INFILTRATION THROUGH WINDOWS, DOORS AND WALLS

Flow Coefficients - CINF

Suggested values to be used with NECAP Crack Method:

Delayed Surfaces

NECAP uses area of the delayed surface and sets N in the program @ 0.8.

			CINF
1.	13" brick with plastered surface	(0.01 cfh/sq.ft.)	0.004
2.	13" brick, furring, lath & plaster	(0.09)	0.025
3.	Frame wall, lath, & plaster	(0.05)	0.016
4.	4" brick-6" concrete block-painted	(0.11)	0.034
5.	8" cement block-painted both sides	(0.32)	0.095
6.	8" brick - plain-poor workmanship	(3.2)	0.949
7.	16" shingles on shiplap w/building paper	(0.71)	0.211
8.	16" shingles on shiplap	(5.3)	1.582
9.	16" shingles on 1x4 boards on 5" CT.	(23.0)	1.856

Quick Surfaces

NECAP uses perimeter of surface and sets N in the program @ 0.5.

			CINF
1.	1/8" crack	(6.5cfm/ft)	40.0
	1/4" crack	(13.1)	80.0
	1/2" crack	(26.2)	120.0
2.	Door - Residential (3x7) type		
	closed w/WS	(20cfm/unit)	6.1
	average use without WS	(100)	30.5
	average use with WS	(80)	24.4
3.	Door - Office (3.5x7) type		
	closed	(25)	7.3
	open 10% of time	(50)	14.6
	open 25% of time	(450)	90.2
	open 50% of time	(1250)	362.8
	open 10% of time and vestibule	(35)	10.2
4.	Door - Revolving type		
	average use	(100)	30.5
5.	Garage or Shipping Room Door		
	No use	(120)	12.2
	Average use	(480)	27.4

TABLE 4.4 (Continued)

Window Surfaces

NECAP uses perimeter of surface and sets N in the program @ 0.66.

		CINF
1. Casement Windows and Frame Assume 25% openable area and crack length equals 60% of perimeter		
Architectural Projected 1/64" crack	(.11cfm/ft crack)	1.2
Architectural Projected 1/32" crack	(.45)	4.9
Residential casement 1/64" crack	(.20)	2.2
2. Double-Hung (crack length equals 125% of perimeter)		
Wood		
Average with WS	(.14cfm/ft crack)	1.5
Average without WS	(.24)	2.6
Poor fitted without WS	(.75)	8.2
Metal		
Average with WS	(.22)	2.4
Average without WS	(.55)	5.9
3. Glass Door (3.5x7) Average Use	(7.4)	80.4

Values in () are infiltration values at 7½ mph wind normal to surface - see first in series for dimensions.

WS = weather stripped

Suggested References:

1972 ASHRAE Handbook of Fundamentals, Chapter 19
Carrier - Load Estimating Guide

$$CINF = \frac{\text{infiltration in cfm}}{(DP)**N*A}$$

DP = pressure difference A = area or equivalent length

NOTES AND COMMENTS

SECTION 5

SYSTEMS ENERGY SIMULATION PROGRAM

5.1 OBJECTIVE AND DESCRIPTION

The hourly space loads calculated by the Thermal Load Analysis Program are not necessarily the loads that are seen by the heating and cooling plant. Due to ventilation air requirements, equipment operating schedules, certain process loads, and inefficiencies caused by control schedules, the building's hourly heating and/or cooling requirement will be different from the summation of the hourly space transmission and internal loads. Therefore, the purpose of the Systems Energy Simulation Program is three-fold (see Figure 5.1).

1. Based upon building requirements, size boilers and chillers, size other energy-consuming equipment (i.e., pumps, fans, cooling tower)if not set by the user. Size engine/generator sets and zone supply air flows if not sized by the user.

2. Simulate each distribution system as it responds to the space thermal requirement and determine the load it is placing upon the central plant, packaged DX unit, or unitary heat pump.

3. Based upon part-load operating characteristics of all energy-consuming equipment, determine the building's hourly and monthly energy consumption, and the energy demand.

The thirteen (13) types of distribution systems that the program is capable of simulating are listed in Table 5.1. Schematic diagrams along with brief explanations of operation are illustrated in figures 5.2 through 5.14. The types of equipment that are available are described in paragraph 5.2.2.

TABLE 5.1 - ENERGY DISTRIBUTION SYSTEMS SIMULATED

SYSTEM NUMBER	SYMBOL	DESCRIPTION
1	SZFB	Single Zone Fan System with Face and By-pass Dampers
2	MZS	Multi-Zone Fan System
3	DDS	Dual Duct Fan System
4	SZRH	Single Zone Fan system with Sub-Zone Reheat
5	UVT	Unit Ventilator
6	UHT	Unit Heater
7	FPH	Floor Panel Heating
8	2PFC	Two-Pipe Fancoil System
9	4PFC	Four-pipe Fancoil System
10	2PIU	Two-pipe Induction Unit Fan System
11	4PIU	Four-pipe Induction Unit Fan System
12	VAVS	Variable Volume Fan System with Optional Reheat
13	RHFS	Constant Volumne Reheat Fan System

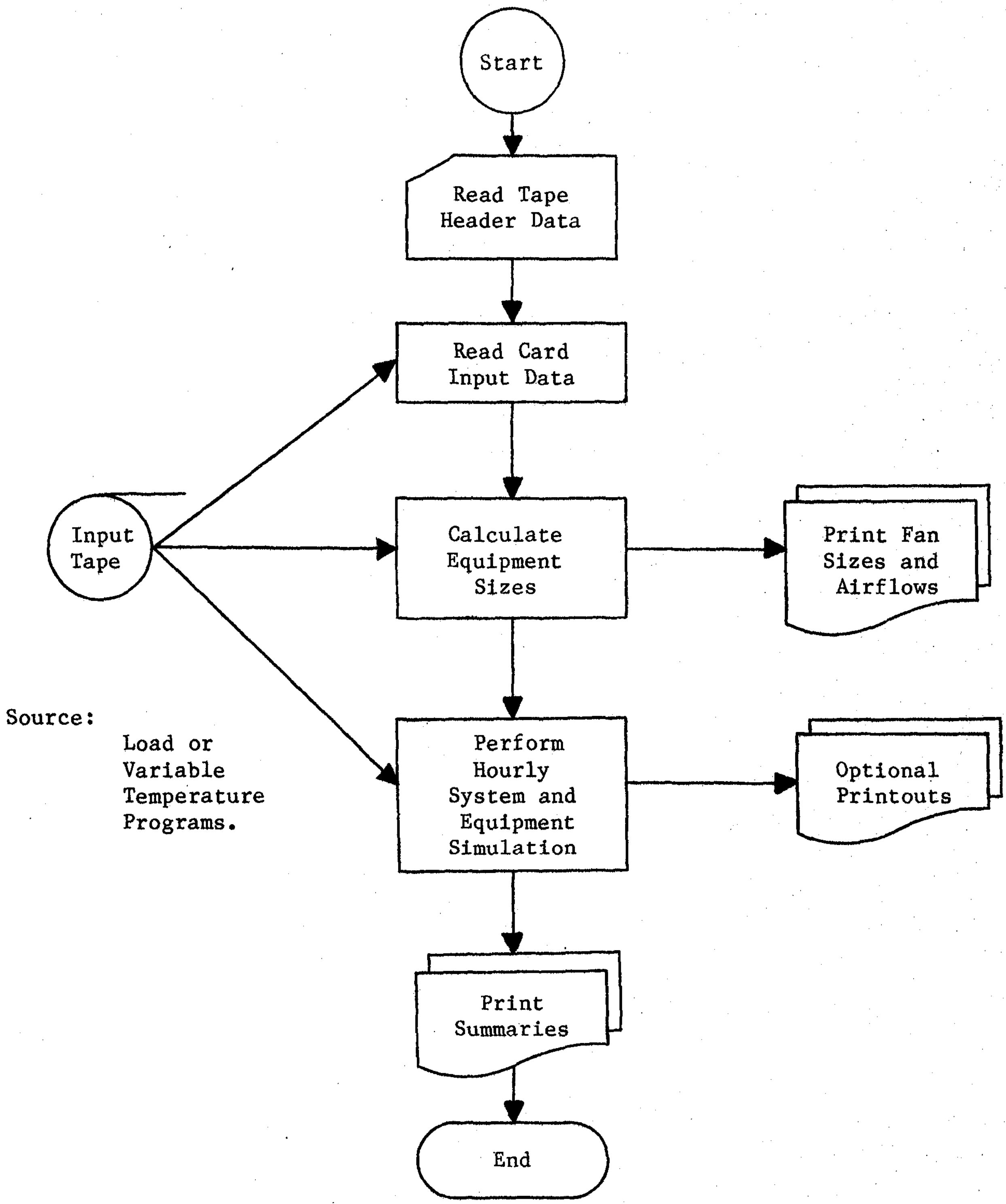


Figure 5.1 - SYSTEMS ENERGY SIMULATION PROGRAM MACRO FLOW DIAGRAM

5.2 DESCRIPTION OF SYSTEMS

5.2.1 DESCRIPTION OF ENERGY DISTRIBUTION SYSTEMS

DISTRIBUTION SYSTEM NO. 1
SINGLE ZONE FAN SYSTEM WITH FACE AND BY-PASS DAMPERS (See Figure 5.2)

This fan system consists basically of a draw-thru air handler having heating and cooling coils in series with a by-pass section around the cooling coils in the air handler. Humidification is provided at the unit. The dry-bulb temperature of air leaving the unit is controlled by a thermostat in the first space served by this fan system. The system is designed primarily to serve one zone. If it is used to condition several zones, the first zone controls air handler discharge temperature, and other zones' air may be reheated as required. Baseboard heating may also be included as a supplemental heat source.

DISTRIBUTION SYSTEM NO. 2
MULTI-ZONE FAN SYSTEM (See Figure 5.3)

The components of the multi-zone fan system include a mixed air section, preheat coil, blow-thru fan section, heating and cooling coils in parallel, and a humidifier. Hot and cold air streams are mixed as required at the unit. The specific functioning and options of this fan system are:

- o Optional return air fan simulation
- o Humidifier
- o Three outside air/return air options with the economizer attempting to equal the required cold deck temperature
- o Baseboard heating as supplement heat to each zone
- o Preheat coil - this will function to raise the mixed air dry-bulb temperature to a preset minimum of 40^{o}F
- o Temperature control options are:
  1) Fixed settings for both hot and cold decks.
  2) Fixed cold deck temperature but allows hot deck temperature to vary inversely with outside air temperature.
  3) Reset temperature control as governed by spaces. Control for this mode consists of resetting the hot deck leaving air temperature equal to that of air supplied to the space requiring the warmest air. The cold deck leaving air temperature is set equal to the temperature of air supplied to the space requiring the coolest air.

DISTRIBUTION SYSTEM NO. 3
DUAL DUCT FAN SYSTEM (See Figure 5.4)

The components, operating characteristics, and options of the dual duct system are similar to those of the multi-zone system described above. The difference between the two systems is that hot and cold air mixing takes place in a mixing box usually located near the zone it serves, and is not part of the air handling unit.

DISTRIBUTION SYSTEM NO. 4
SINGLE ZONE FAN SYSTEM WITH SUB-ZONE REHEAT (See figure 5.5)

This fan system is designed to serve a large central zone requiring cooling the entire year, and sub-zones which may require reheating. Primary air temperature is controlled by the requirement of the central zone. During the winter and intermediate seasons, the primary air is colder than that required for the sub-zones. Sub-zone all air induction boxes therefore open to mix return air with primary air. The induction boxes are designed such that up to 50% inducted air can be mixed with primary air. If further heating of primary air is required, the reheat coil is activated.

Elements and operating characteristics of this fan system include:

- o Optional return air fan simulation
- o Humidifier
- o Three outside air/return air options with the economizer attempting to equal required cold deck temperature
- o Baseboard heating as supplemental heat to each zone
- o Primary heating coil
- o Cooling coil with face and by-pass dampers
- o Air temperature leaving air handler controlled by thermal requirements of central zone
- o Fan air quantities vary: zone supply air quantities remain constant due to operation of all-air induction box
- o Reheat coils

DISTRIBUTION SYSTEM NO. 5
UNIT VENTILATOR (See Figure 5.6)

This system consists of a draw-thru air handler with a heating coil. The coil is controlled by the first zone on the system. The air handler is capable of introducing a fixed amount of outside air. Although primarily designed to serve one zone, more than one may be simulated.

DISTRIBUTION SYSTEM NO. 6
UNIT HEATER (See Figure 5.7)

This simulation is primarily designed for a unit heater serving one zone (i.e., a unit heater free-standing in a room). It may, however, be extended to simulate a number of zones (i.e., an air handler with supply and return ductwork to several zones). This system is not capable of introducing outside air.

DISTRIBUTION SYSTEM NO. 7
FLOOR PANEL HEATING SYSTEM (See Figure 5.8)

The floor panel heating system is designed to simulate either on-grade slabs or intermediate slabs as shown in the sketches in Figure 5.8. The simulation calculates the water temperature required to meet zone loads and the resultant heat loss of the system. The simulation assumes that all zones are to have the same set point temperature. Surface and edge losses are also included in the simulation of this system.

DISTRIBUTION SYSTEM NO. 8
TWO-PIPE FAN COIL SYSTEM (See Figure 5.9)

The two-pipe fan coil system consists of one distribution circuit (2 pipes) serving terminal fan coil units located in the spaces they condition. A changeover mechanism based on ambient air temperature is required to determine whether hot or chilled water is circulated. The fan coil unit, which consists of a blower and water coil, exhibits the following characteristics:

- o The blower runs continuously (unless turned off by the fan shut-off option), while a room thermostat cycles a 2-position valve for temperature control.
- o Ventilation air may enter the zone through the unit at a constant rate. Outside air flow is input to the program.

DISTRIBUTION SYSTEM NO. 9
FOUR-PIPE FAN COIL SYSTEM (See Figure 5.10)

A four-pipe fan coil system circulates water through two distribution systems (a hot and a chilled water circuit). The fan coil unit, consisting of a blower and usually two coils, is controlled by a space thermostat which regulates coil flow. A net heat gain in the space causes the thermostat to allow flow through the cooling coil and prohibit flow through the heating coil; for a net heat loss, the converse is true. Ventilation air entering the zone at a constant rate through the fan coil unit is also simulated. The simulation of this system is for a continuously running blower (unless turned off by the fan shut-off option).

DISTRIBUTION SYSTEM NO. 10
TWO-PIPE INDUCTION UNIT FAN SYSTEM (See Figure 5.11)

The two-pipe induction system utilizes air and circulated water to achieve temperature control. The induction unit itself consists of a nozzle which injects primary air into a mixing chamber. As the primary air jet which induces room air into it is a changeover type system (i.e., hot water supplied to terminal units in winter, cold water in summer), the dry-bulb temperature of air leaving the air handling unit (primary air), as well as water temperature, varies with outside air temperature. Final temperature control is achieved via a switch-over thermostat which operates a throttling valve located on the coil in the induction unit.

Air side central equipment for this system consists of an air handler having heating and cooling coils, a mixed air section, and a humidifier. Additional characteristics of the system are:

- o Three outside air/return air options
- o Optional return air fan
- o Humidifier
- o Baseboard heating as supplemental heating to each zone.

Depending on the specific design of the system, it is often possible that a building requiring nominal amounts of primary air may be moderately pressurized and the return air network eliminated. This may be simulated by not including a return air fan as input and by setting minimum outside air equal to 100%.

DISTRIBUTION SYSTEM NO. 11
FOUR-PIPE INDUCTION UNIT FAN SYSTEM (See Figure 5.12)

The four-pipe induction system is comprised of a primary supply air, and hot and chilled water distribution networks feeding air-water induction-type terminal devices. The primary air which is held at a constant temperature (at about 55°F) serves to control humidity in the space as well as provide ventilation air as required. This primary air is mixed with recirculated room air at the terminal unit. Room air is tempered by first passing it through a coil in the induction unit, which may heat or cool it as required, such that the mixed air delivered to the space satisfies thermal requirements. The coil is controlled by a thermostat which regulates the flow of either hot or chilled water through the coil.

Air side central equipment for this system consists of an air handler having heating and cooling coils, a mixed air section, and a humidifier. Additional characteristics of the system are:

- Three outside air/return air options
- Optional return air fan
- Humidifier
- Baseboard heating as supplemental heating to each zone

DISTRIBUTION SYSTEM NO. 12
VARIABLE VOLUME FAN SYSTEM WITH OPTIONAL REHEAT (See Figure 5.13)

The variable volume system simulated is a central air handling unit supplying primary air (at a temperature determined by the user) to variable air volume (VAV) terminal units. The air handling unit includes heating and cooling coils, mixed air section, supply air fan, and humidifier. The VAV boxes (controlled by a room thermostat) vary the amount of primary air to the space to achieve temperature control. When the space demands peak cooling, the VAV box allows maximum air flow. As space cooling requirments diminish, the primary air flow is reduced proportionately to a minimum flow rate defined by the user (default minimum is 40% and can result in high VAV loads). If less cooling is required than can be provided using minimum air flow, the reheat coil is activated to prevent over cooling of the space.

Other characteristics and options available with this fan system are:

- Optional return air fan
- Humidifier
- Three outside air/return air options
- Baseboard heating as supplemental heating for each zone

DISTRIBUTION SYSTEM NO. 13
CONSTANT VOLUME REHEAT FAN SYSTEM (See Figure 5.14)

The reheat fan system simulated is a central air handling unit supplying primary air at a constant rate to the spaces. Final temperature control at the space is achieved by reheating supply air as required to meet space loads. The air handling unit includes heating and cooling coils, mixed air section, supply air fan, and humidifier. Operation characteristics and options included in this system simulation are:

- o Optional return air fan
- o Humidifier
- o Three outside air/return air options
- o Baseboard heating as supplemental heating to each zone
- o Primary air temperature control options are:
  1) Fixed discharge temperature.
  2) Air temperature determined by the room requiring coolest air. This is achieved by a solid state-type temperature control system which monitors temperatures of spaces served by the unit.
  3) Reset temperature as an inverse function of outside air temperature.

5.2.2 DESCRIPTION OF ENERGY CONVERSION SYSTEMS

Thermal loads calculated by the energy destribution system segment of the program are then handled by the energy conversion system segment. The energy conversion systems available to the user are shown in Table 5.2.

There are basically two types of energy conversion systems available:

1) A central plant serving one or more distribution systems
2) Unitary equipment serving one fan system

An all-inclusive schematic diagram of the equipment simulation segment's capabilities is given in Figure 5.15. Obviously, all of the program's capabilities would not be used in one run. In modeling a system, define only those parts of the system that are required.

NECAP will determine appropriate energy conversion systems for heating and cooling for all of the distribution systems if none are input. Appropriate capacities and performance characteristics will also be provided if none are input. For buildings with no cooling equipment, a chiller card must be input with a type zero chiller (see S15 card in NECAP Input Manual).

There are differences in the handling of thermal loads by central and unitary equipment, and the method used to calculate fuel resources needed to meet these loads. Table 5.3 itemizes the load handling techniques used for central equipment, DX unitary equipment, and heat pump unitary equipment. Note that the main heating coil and central cooling coil loads are processed differently.

5.2.3 DESCRIPTION OF BUILDING CONTROLS

The thermal loads are calculated for each hour using schedules to define the levels of human activity, lighting, and internal equipment. By simulating the energy distribution systems hourly, building controls are incorporated into the energy analysis.

Types of building controls simulated in the System Energy Simulation Program (SESP) include thermostat scheduling, fan scheduling, economy cycle, outside temperature reset schedules, and process loads scheduling. Humidification, economy cycles, and various types of VAV control are included requirements for input with the fan system data.

Schedules provide flexibility to allow for fluctuations which may occur on an hourly basis. To save time and effort, the schedules are defined, then referenced by the space, fan system, or process which is controlled hourly. The Space card, Fan System card, and Process Loads card all require some type of schedule (if none is input, a default will be used).

In most buildings, the fan operation, thermostat type, thermostat settings, and process loads will be related. The most important criteria used in building schedules is the hours of occupancy or operation. NECAP also uses this technique in defining schedules so that those components which are related will use the same schedule index.

The thermostat schedule to be used is defined in field 8 of the Space card (S12). The schedule being referenced is an S7 card, where weeks are grouped to describe seasonal operation. Each week is defined by an S6 card, which describes when daily schedules are to be active. Each day is defined by an S4 card, which describes the type of thermostat, and the high and low set points for each hour.

The plenum air flow schedule is unique to each plenum, therefore, field 6 of the Space card (S12) is used to define which schedule is to be used. The schedule being referenced is an S7 card, where weeks are grouped to describe seasonal operation. Each week is defined by an S6 card, which describes which daily schedule is to be in used. Each day is defined by an S5 card, which describes the hourly fraction of the total airflow.

A fan schedule may be simulated in the Fan Description card (S11) when field 27 is set to 3, and a schedule is referenced in field 28. The schedule being referenced is an S7 card, where weeks are grouped to describe seasonal operation. Each week is defined by an S6 card, which describes which daily schedule is to be used. Each day is defined by an S5 card, which describes the hourly fraction of the ventilation.

The process loads schedule may also vary with respect to time, therefore, field 3 of the Process Loads card (S19) is used to define which schedule is to be used. The schedule being referenced is an S7 card, where weeks are grouped to describe seasonal operation. Each week is defined by an S6 card, which describes which daily schedule is to be used. Each day is defined by an S5 card, which describes the hourly fraction of the process load.

Boilers and chillers may also be operated seasonally. Heat pumps will use the boiler and chiller schedules (defined on S14 and S15 cards) and DX units will use the chiller schedules. Figure 5.16 reviews the relationship of component cards to schedules. More information is given for each component in the NECAP Input Manual.

5.2.4 DESCRIPTION OF INTERNAL COMPONENTS

Thermal loads for each space are affected by internal partitions, floors, ceilings, and furnishings. The energy that passes through a partition between two thermal zones is computed under steady state conditions. However, these surfaces may have a significant mass which would cause a delayed heat transfer effect between the zones. Internal furnishings may also cause a thermal storage effect in a given zone. Therefore, NECAP allows the user to define the thermal properties of internal surfaces and furnishings.

FLOORS

A space is considered to have an internal floor when an underground surface has not been assigned to it. NECAP makes no distinction as to whether the underground surface is a wall or a floor.

The user has two options in modeling a floor:

1. Use the default floor which has the thermal properties of heavy-weight concrete. NECAP will compute the thickness of the floor by using the weight of floor value which is entered on the L17 card in field 4. The area of the floor will be the total floor area of the space which is entered on the L17 card in field 2.

2. Define the construction and area of the floor. The construction is defined by using the S9 and S10 cards in the same manner as a delayed surface (see NECAP Input Manual). An air film should be declared on both sides of the surface. The S10 card index is assigned to a space by the S12 card in field 14 or to a plenum in field 7, and the floor area for a space is input in field 15 or for a plenum in field 8.

CEILINGS

NECAP assigns a ceiling to all spaces. Ceilings, like floors, use two methods of modeling, user defined or program default.

The user has two options in modeling an internal ceiling:

1. Use the default ceiling which has the thermal properties of heavy-weight concrete. The thickness and area are computed in the same manner as floors (see L17).

2. Define the construction and area of the ceiling. The construction is defined by using the S9 and S10 cards in the same manner as a delayed surface. An air film should be declared on both sides of the surface. The S10 card index is assigned by the S12 card in field 16 or to a plenum in field 9, and the surface area in field 17 or over a plenum in field 10.

When a ceiling is actually a roof, NECAP will compute the heat transfer across the ceiling and the roof. This configuration may be simulated by modeling a ceiling consisting of a single air layer. Thus the appropriate amount of mass is used in the heat transfer calculations for the space.

An internal surface that is a ceiling for one zone and a floor for another must be declared twice either by input or defaults. Each space computes the heat transfer properties of its envelope. Because the load is computed for each zone separately, the energy is not doubled.

FURNISHINGS

The user has three methods of modeling the space furnishing:

1. If the space has no furnishings, enter a zero in field 11 of the S12 card.

2. The surface area will be the total space floor area input in field 2 of card L17. The weight of furnishing per square feet of floor area is input using field 11 of the S12 card. The weight of furnishings, defaults to 10 lbs/sqft. A plenum uses .5 lb/sq ft.

3. Define the construction and surface area of the furnishing. The construction may be defined by using the S9 and S10 cards. An air film should be declared on both sides of the surface. The S10 card index is assigned by the S12 card in field 18 or to a plenum in field 11, and the surface area is input in field 19 or field 12 for plenums.

5.3 OUTPUT REPORTS

From the Systems Energy Simulation Program, the user will receive ten (10) types of reports summarizing the following:

1. Report S1 - Echo of Building and Systems Input Data
2. Report S2 - Title Page
3. Report S3 - Summary of Energy Distribution System Characteristics
4. Report S4 - Summary of Zone Air Flows
5. Report S5 - Summary of Hourly Calculations (Optional)
6. Report S6 - Summary of Equipment Capacities
7. Report S7 - Space Temperature Frequency Distribution Summary
8. Report S8 - Monthly and Annual Energy Summary
9. Report S9 - Executive Summary
10. Report S10 - Economic Summary

5.3.1 Report S1 - Echo of Building and Systems Input Data

Report S1 (Figure 5.17) summarizes the user input data with the default values used by the Systems Energy Simulation Program in performing each analysis. The user can quickly ascertain if output errors or peculiar results are due to improperly defined input data.

5.3.2 Report S2 - Title Page

The Title Page (Figure 5.18) indicates the facility name, location, project number, engineer and date.

5.3.3 Report S3 - Summary of Energy Distribution System Characteristics

During the first part of the energy analysis phase, the Systems Energy Simulation Program calculates the rate of supply air required by each zone to meet peak heating and cooling loads. Report S3 (Figure 5.19) summarizes these results on a per-distribution system basis. Items printed on report include:

1. System Number - defined by order of input S11.
2. Type - defined by input S11.
3. Supply Fan BHP - determined using summation of calculated air flows for each distribution system, and total supply fan pressure defined in input S11.
4. Return Fan BHP - determined using summation of calculated air flow minus summation of zone exhaust air flows (input S12) for each distribution system, and total return fan pressure defined in input S11.
5. Exhaust Fan BHP - calculated using summation of zone exhaust air flows for each distribution system, and total exhaust fan pressure defined in input S11.
6. Numer of Zones - defined by input S11.
7. Total Supply Air Flows - determined from user input (S12), or from zone peak heating and cooling loads retrieved off of input tape, and design supply air temperatures summarized in Table 5.4.
8. Minimum Outside Air Flows - Summation of zone requirements defined in input S11.
9. Exhaust Air Flows - summation of zone exhaust air quantities defined in input S12.
10. Percent of Minimum Outside Air - quantity determined in (8) divided by that determined in (7).

5.3.4 Report S4 - Summary of Zone Air Flows

Report S4 (Figure 5.20) is similar to Report S3 except results are enumerated on a zone-by-zone basis. The column explanations are:

1. Fan System - defined by order of input S11.

2. Zone Number - increases sequentially from 1 to number of zones indicated in input S11.

3. Load Space Number - defined by input S12.

4. Supply CFM - determined from user input (S12), or from peak heating and cooling loads retrieved off of input tape, and design supply air temperatures summarized in Table 5.4.

5. Exhaust CFM - defined by input S12.

6. Set Point Temperature - defined by input L17 and passed along on input tape.

7. Cooling Capacity - determined from input S12, or from defaulted values calculated in the load program.

8. Heating Capacity - determined from input S12, or from defaulted values calculated in the load program.

9. Thermostat Type - defined by input S4.

5.3.5 Report S5 - Summary of Hourly Calculations

If the user desires to track the hourly calcualtions performed by the Systems Energy Simulation Program during the simulation phase, the optional report S5 (Figure 5.21) can be asked for via the use of input S3 card. The length of this report can be considerable, depending upon the length of analysis and the number of optional print parameters turned on. The lines of output that will be printed with both hourly print parameters turned on are indicated.

5.3.6 Report S6 - Summary of Equipment Capacities

Report S6 (Figure 5.22) summarizes the equipment capacities that were calcualted by the program and used to determine the building's total hourly demand for energy. For details of algorithms used to perform sizing function, refer to Section 4 of the NECAP Engineering Manual.

5.3.7 Report S7 - Space Temperature Frequency Distribution Summary

Report S7 (Figure 5.23) gives the user a record of the temperature history for each zone for the period of analysis. The hours that the zone temperature fell within each of the given temperature bands, are indicated for occupied and unoccupied hours. A zone is considered to be occupied if hourly occupancy is greater than 25% of the total occupancy specified in the load program.

5.3.8 Report S8 - Monthly and Annual Energy Summary

At the conclusion of the analysis period, a 4-part report (Figure 5.24) is printed detailing the building's monthly and annual demand and consumption of all forms of energy. A brief explanation of items follows:

1. Monthly Btu/1000 - Consumption and Demand

   (a) Monthly Heating - heat output of central heating plant.

   (b) Monthly Cooling - cooling output of central cooling plant.

2. Electricity - Consumption and Demand

   (a) Internal Lights and Building Equipment - power used by items defined in input L17.

   (b) External Lights and Building Equipment - power used by equipment defined in input L17; external lights are provided in input S20 and are turned on whenever the sun is down.

   (c) Heat - power consumed by the boiler.

   (d) Cool - power consumed by chiller providing required cooling, chilled water pumps, condenser water pumps and cooling tower fan.

   (e) Fans - power consumed by distribution system supply and return fans and exhaust fans.

   (f) Process Electricity - Amount (Scheduled from S19 card).

   (g) Total - consumption is the summation of consumption values for (a) through (e); demand is the peak power consumed in any one hour.

3. Gas - Consumption and Demand

   (a) Heat - fuel consumed by gas-fired boiler providing required heat and/or gas heat source for reheat coils.

   (b) Cool - fuel consumed by gas-fired boiler providing steam for steam absorption chiller.

   (c) Generation - fuel consumed by gas-powered engine/generator sets.

   (d) Total - summation of items (a) through (c).

4. Steam - Consumption and Demand

   (a) Heat - purchased steam used to provide required heat or reheat.

   (b) Cool - purchased steam used by steam absorption chiller or steam turbine-driven centrifugal chiller to provide required cooling.

   (c) Total - summation of (a) and (b).

5. Oil - Consumption and Demand

   (a) Heat - fuel consumed by oil-fired boiler providing required heat and oil heat source for reheat coils.

   (b) Cool - fuel consumed by oil-fired boiler providing steam for steam absorption chiller.

   (c) Total - summation of items (a) and (b).

6. Diesel Fuel - Consumption and Demand

   (a) Generation - fuel consumed by diesel-powered engine/generator sets.

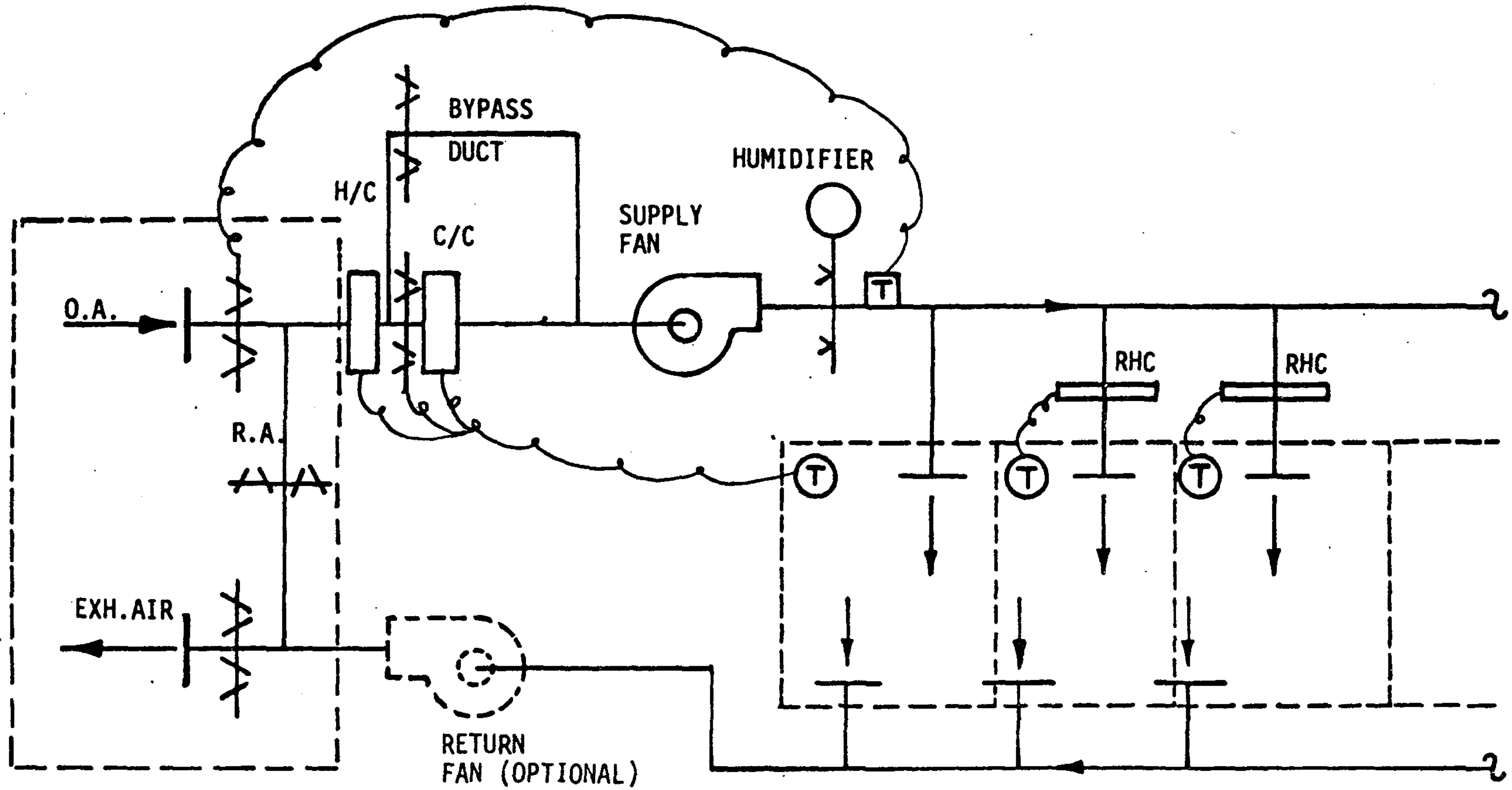
7. City Water - water required for humidification and make-up to cooling tower.

5.3.9 Report S9 - Executive Summary

This report (Figure 5.25) gives the results of the study in terms of building energy consumption. It also gives the "at the building line" and raw source energy, expressed in KBtu/sq. ft. for the period of the study. This report is especially useful as a single page summary, and to compare various runs.

5.3.10 Report S10 - Economic Summary

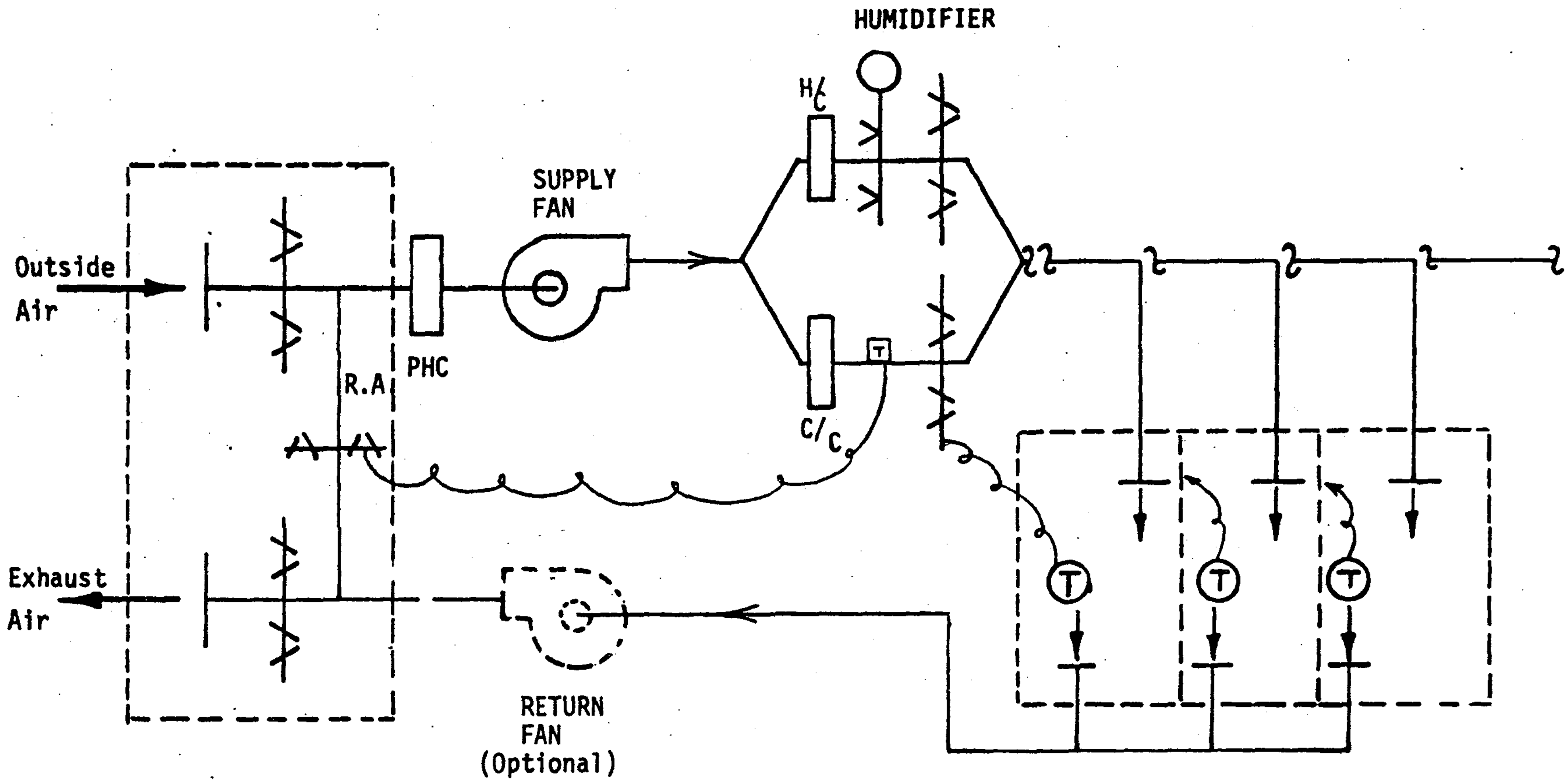
The last report (Figure 5.26) summarizes the annual cost of the building as it was modeled. It also estimates the cost of mechanical equipment. From these values, it calculates the uniform owning and operating costs. The economic analysis is the same as running program ECON (Owning and Operating Cost Analysis Program) described in Section 6. All the economic assumptions are given in the summary. These assumptions are arbitrary and should be used with caution. If input data other than that used in the assumptions are necessary, the user should continue to program ECON.



MIXED AIR
THREE OPTIONS

1. Fixed Dampers
2. Enthalpy/temp. type
   Economizer cycle
3. Temperature type
   Economizer cycle

Figure 5.2 SINGLE ZONE FAN SYSTEM WITH FACE AND BYPASS DAMPERS
(DISTRIBUTION SYSTEM NO. 1)

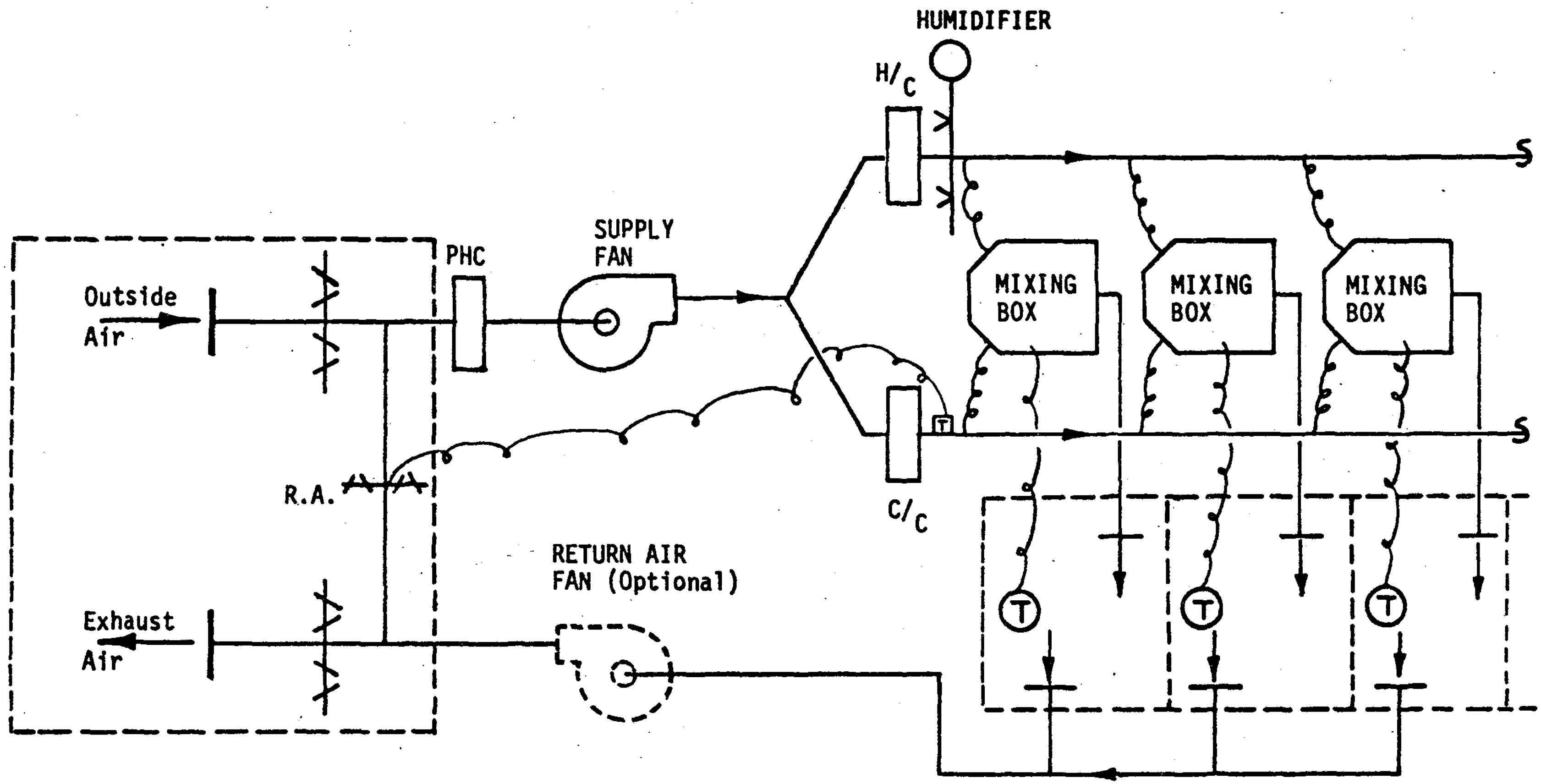


MIXED AIR

THREE OPTIONS

1. Fixed Dampers
2. Enthalpy/temp. type Economizer cycle
3. Temperature type Economizer cycle

Figure 5.3 MULTI-ZONE FAN SYSTEM (DISTRIBUTION SYSTEM NO. 2)

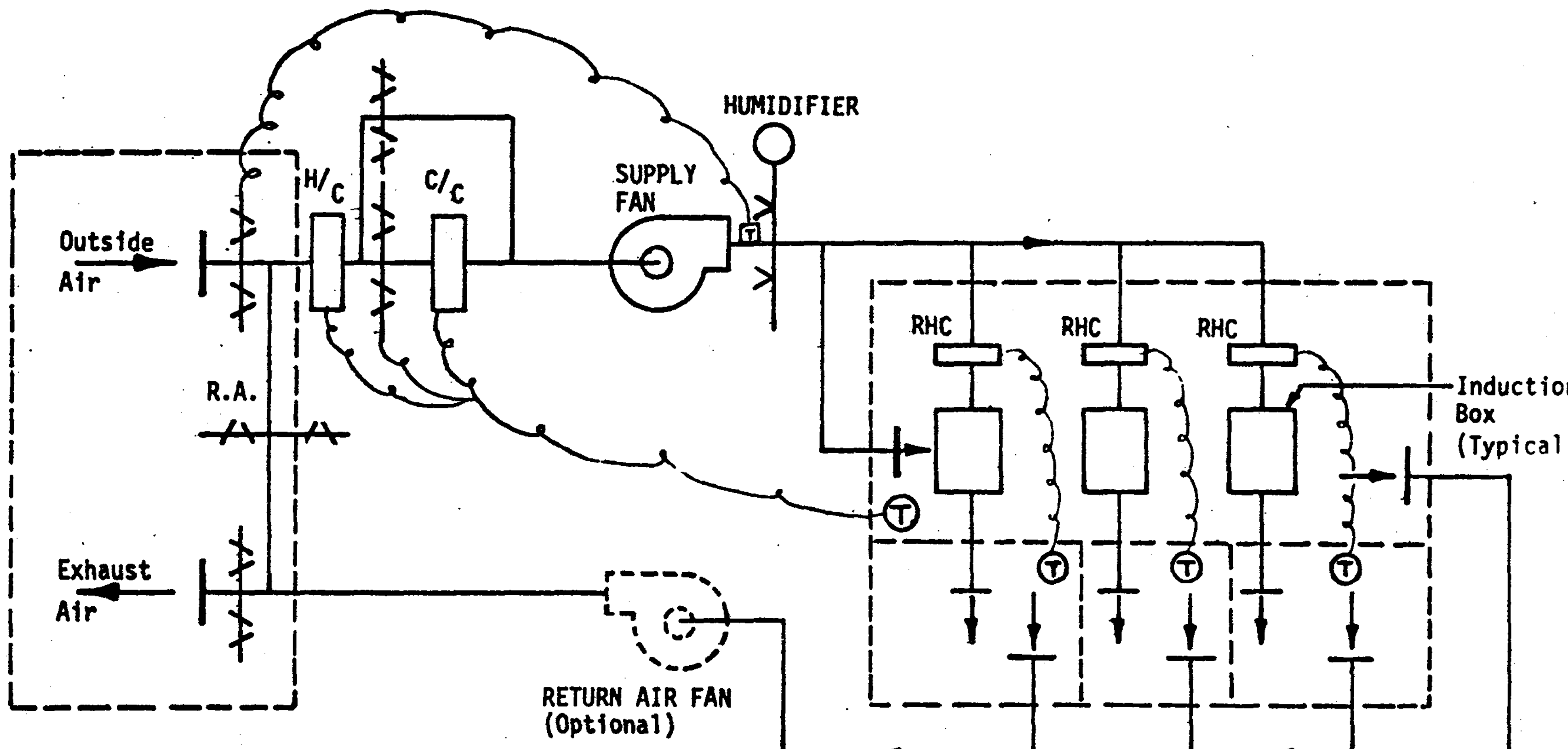


MIXED AIR

THREE OPTIONS

1. Fixed Dampers
2. Enthalpy/temp. type Economizer cycle
3. Temperature type Economizer cycle

Figure 5.4 DUAL DUCT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 3)



MIXED AIR

THREE OPTIONS

1. Fixed Dampers
2. Enthalpy/temp. type Economizer cycle
3. Temperature type Economizer cycle

Figure 5.5 SINGLE ZONE FAN SYSTEM WITH SUB-ZONE REHEAT (DISTRIBUTION SYSTEM NO. 4)

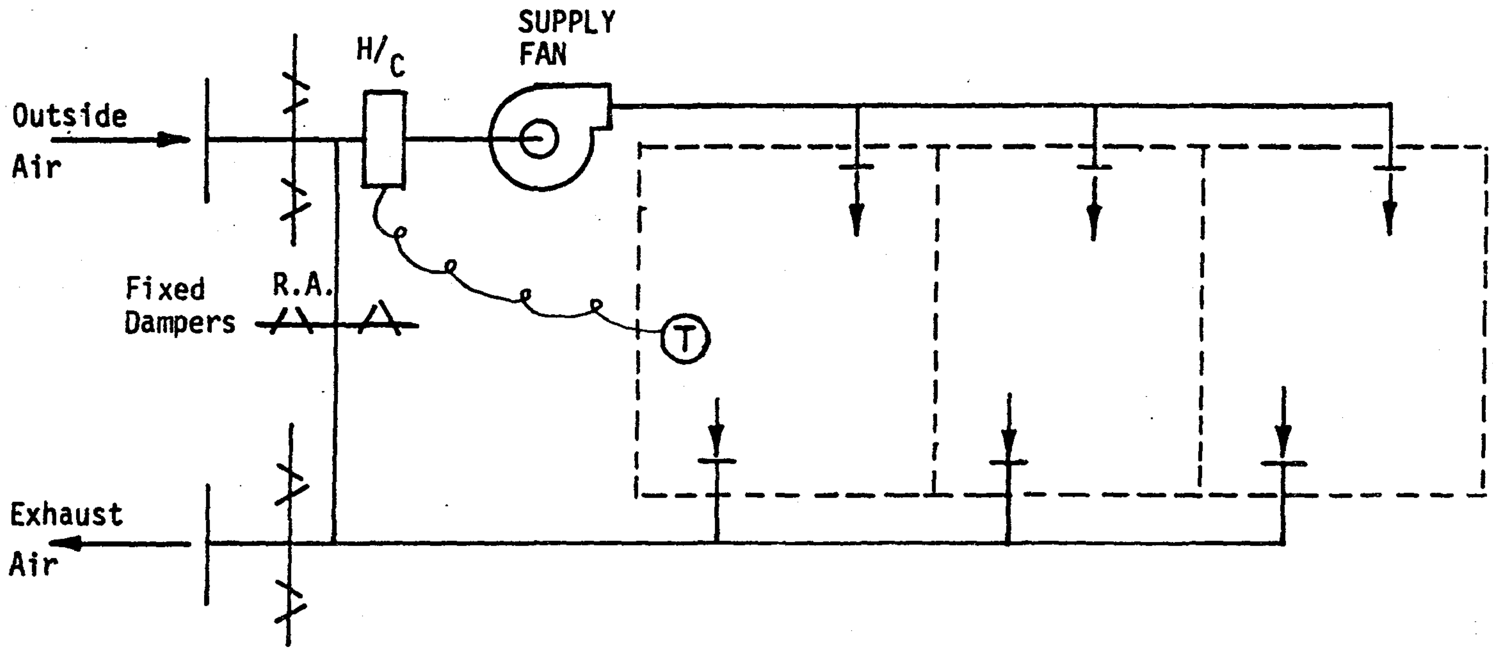
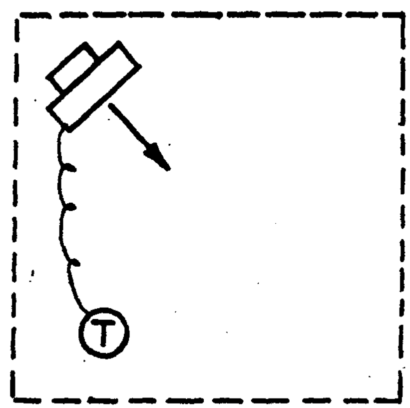
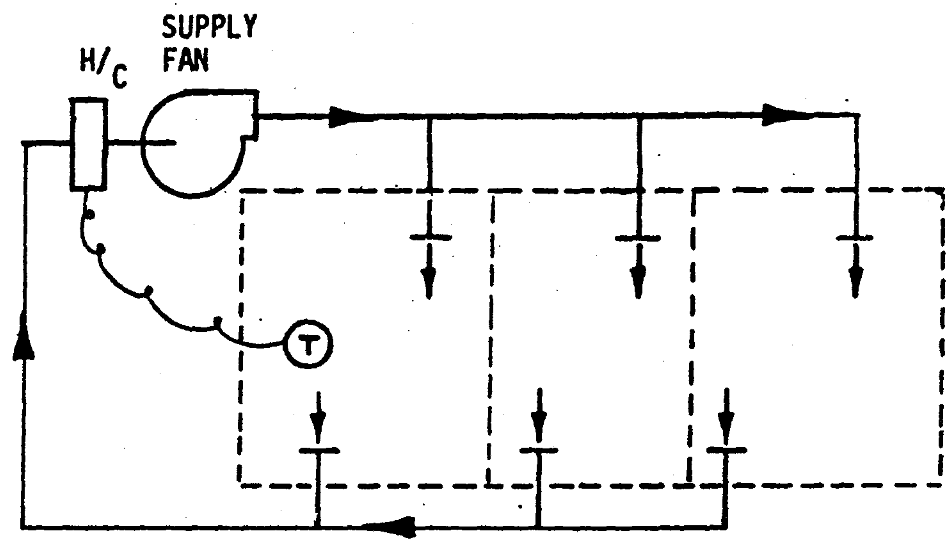


Figure 5.6 UNIT VENTILATOR (DISTRIBUTION SYSTEM NO. 5)

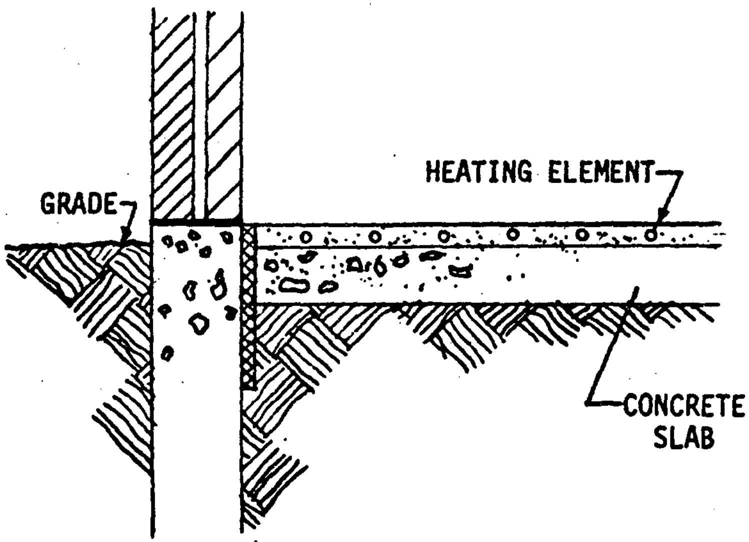


ONE-ZONE SCHEMATIC

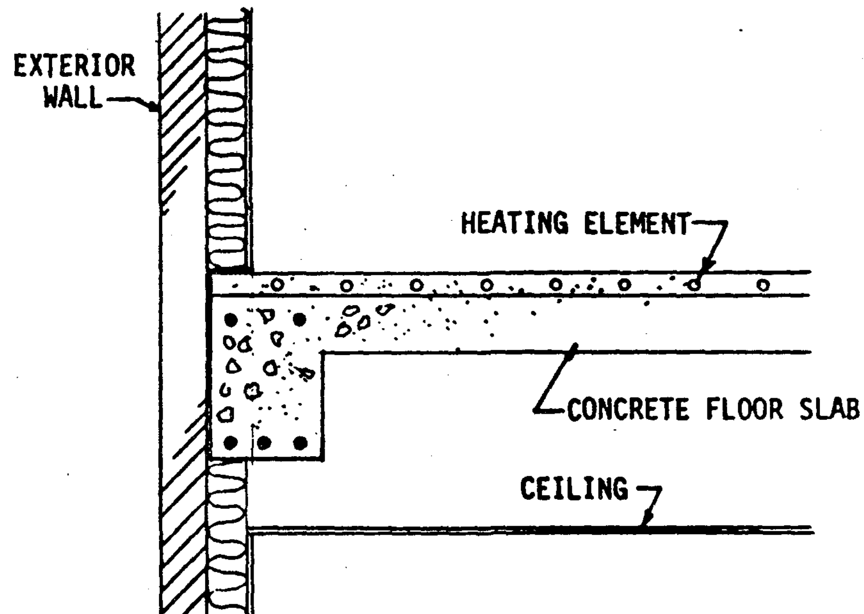


MULTIPLE-ZONE SCHEMATIC

Figure 5.7 UNIT HEATER (DISTRIBUTION SYSTEM NO. 6)



TYPE 1. ON-GRADE FLOOR SLAB



TYPE 2. INTERMEDIATE FLOOR SLAB

Figure 5.8 FLOOR PANEL HEATING SYSTEM (DISTRIBUTION SYSTEM NO. 7)

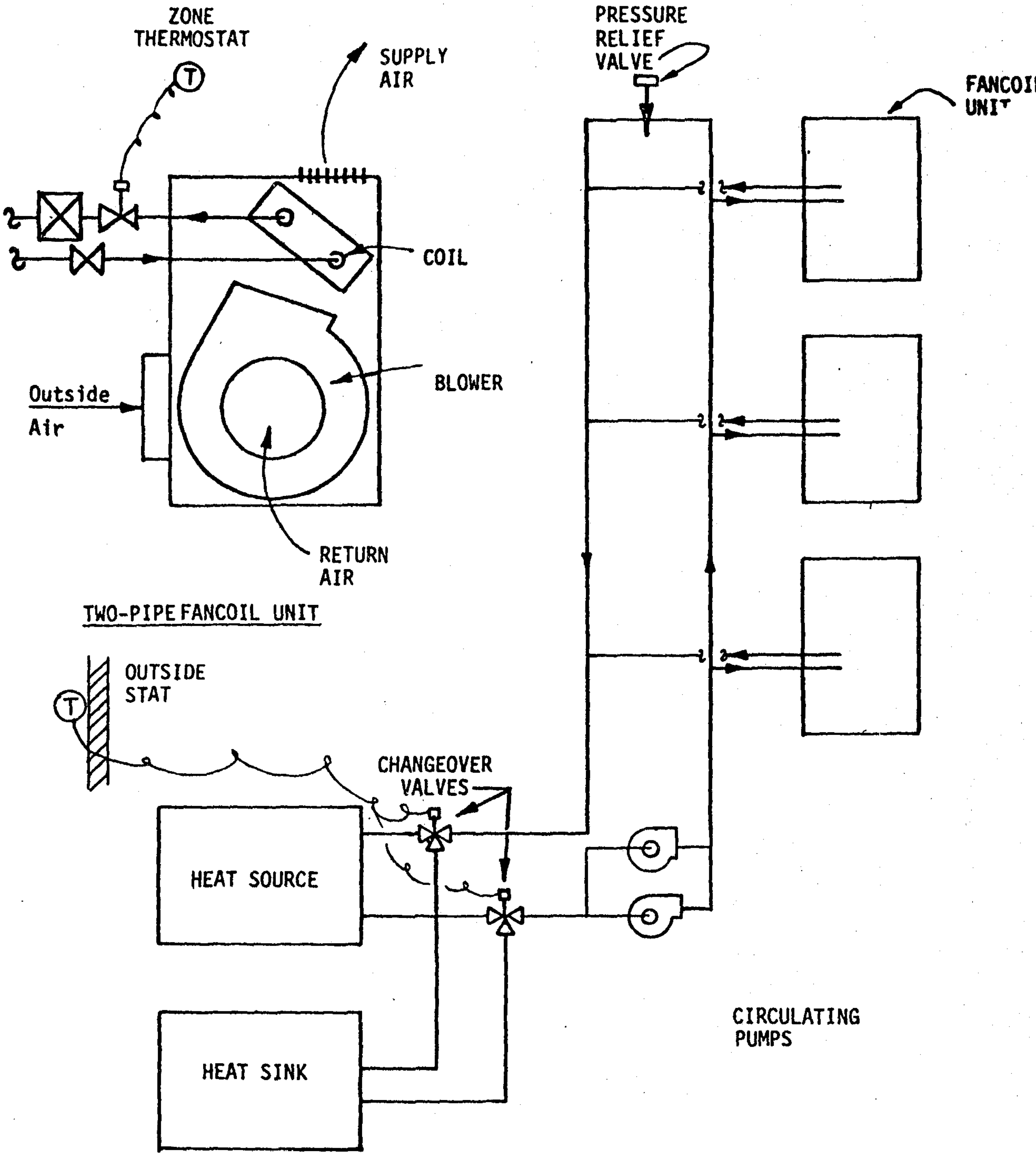


Figure 5.9 TWO-PIPE FANCOIL SYSTEM (DISTRIBUTION SYSTEM NO. 8)

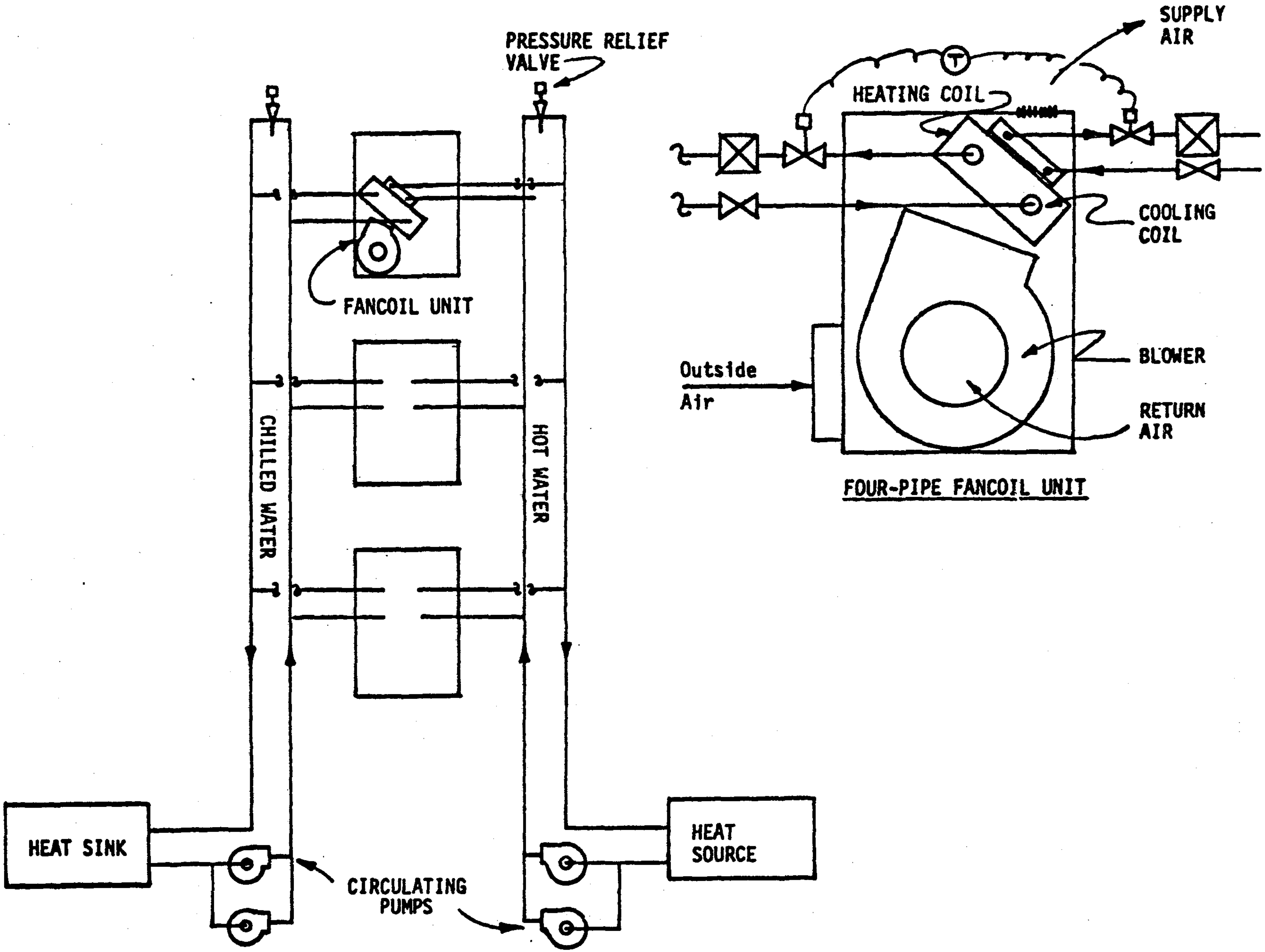


Figure 5.10 FOUR-PIPE FANCOIL SYSTEM (DISTRIBUTION SYSTEM NO. 9)

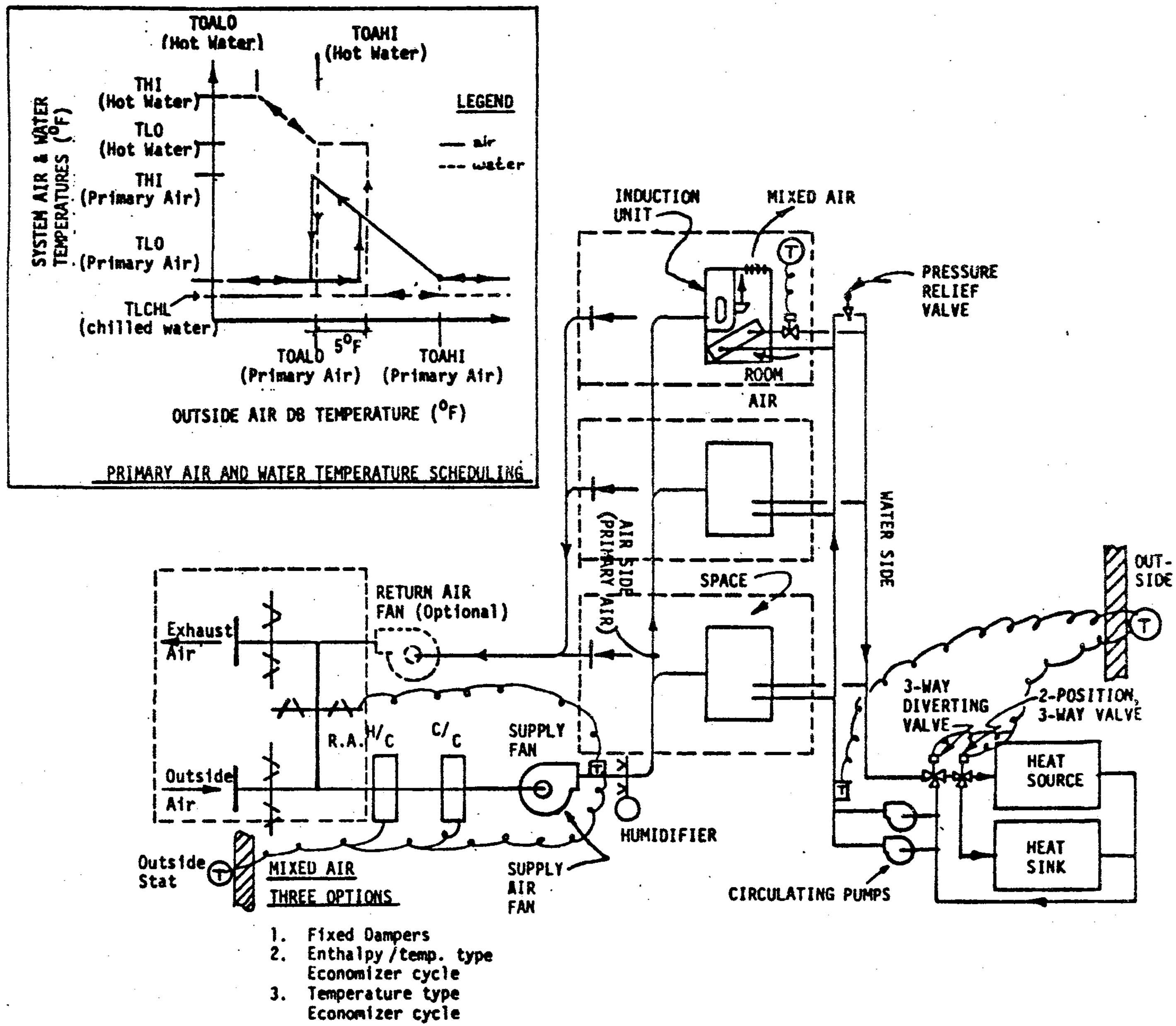


Figure 5.11 TWO-PIPE INDUCTION UNIT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 10)

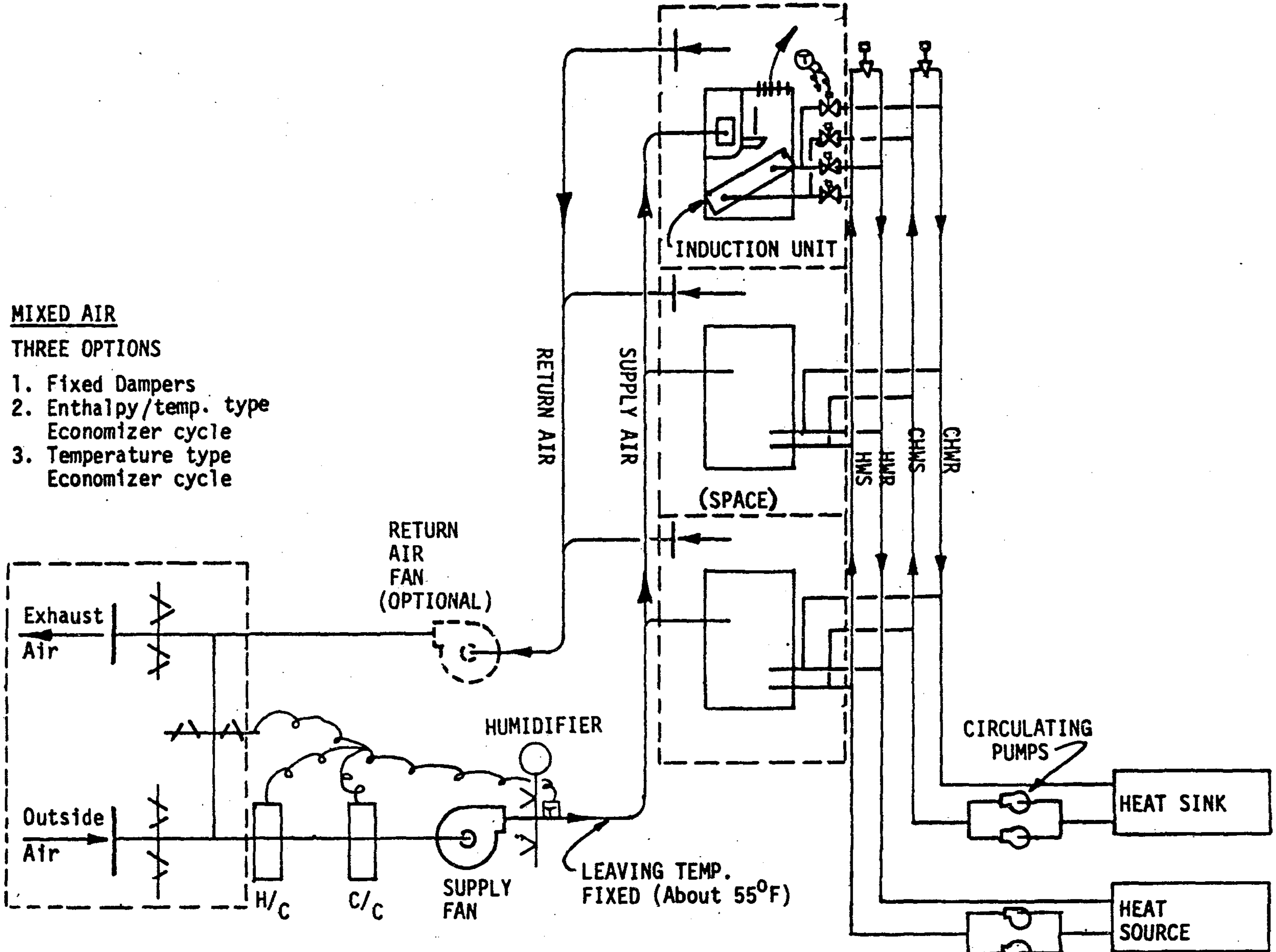
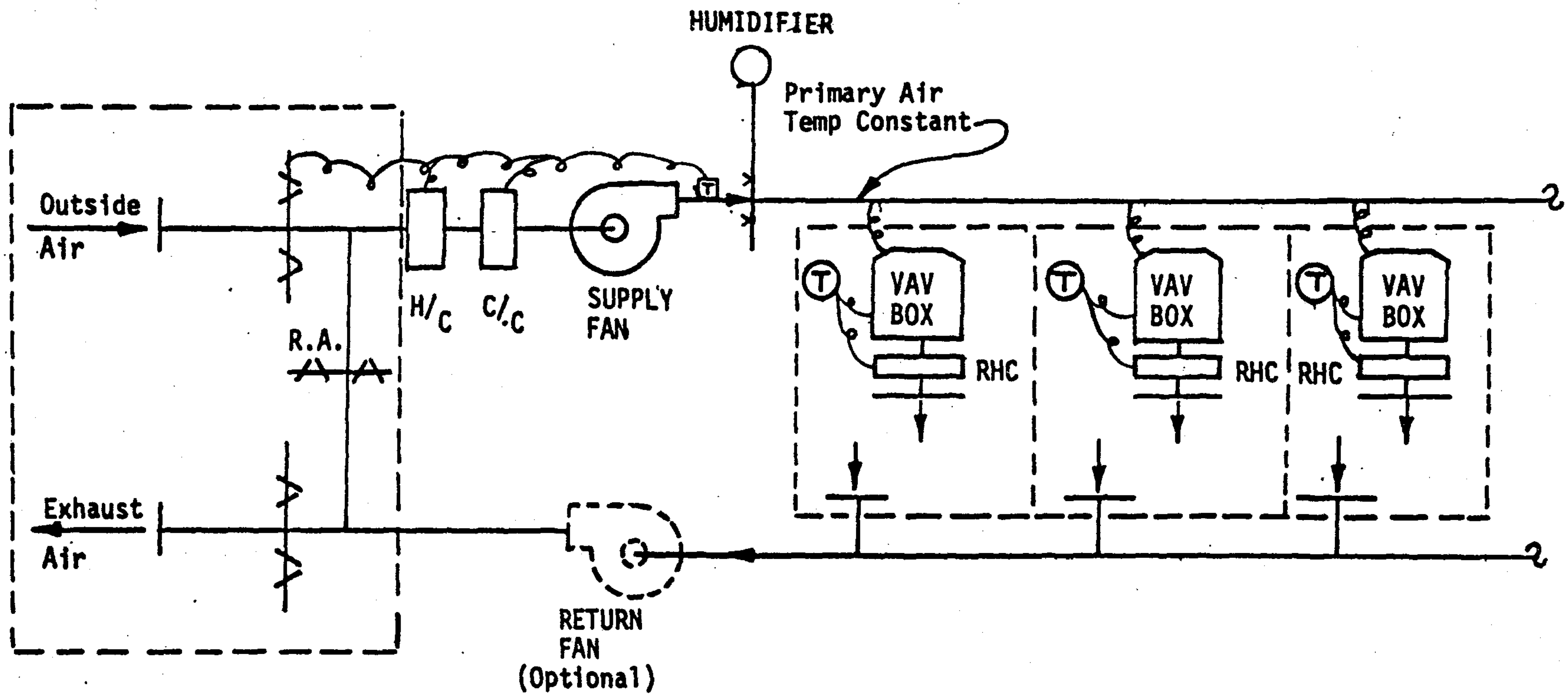


Figure 5.12 FOUR-PIPE INDUCTION UNIT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 11)

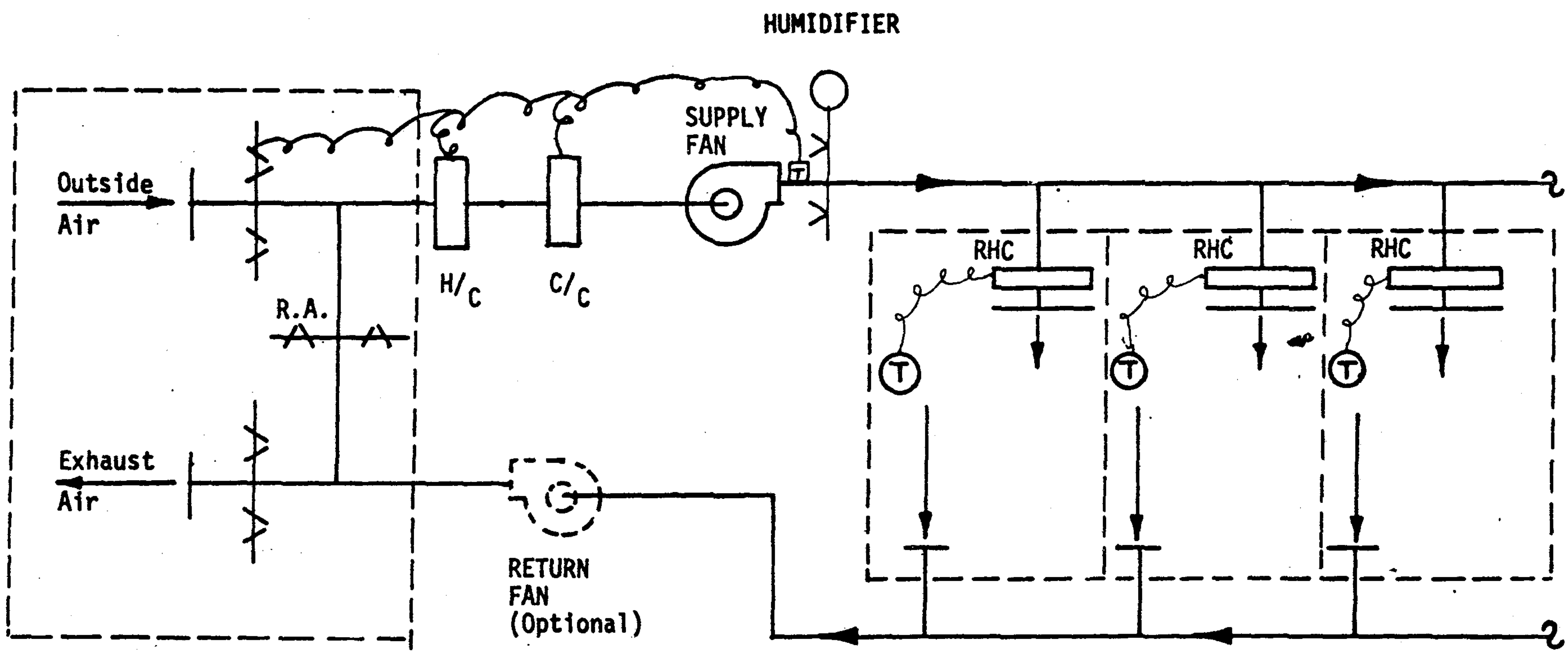


MIXED AIR

THREE OPTIONS

1. Fixed Dampers
2. Enthalpy/temp. type
   Economizer cycle
3. Temperature type
   Economizer cycle

Figure 5.13 VARIABLE VOLUME FAN SYSTEM WITH OPTIONAL REHEAT (DISTRIBUTION SYSTEM NO. 12)



MIXED AIR

THREE OPTIONS

1. Fixed Dampers
2. Enthalpy/temp. type Economizer cycle
3. Temperature type Economizer cycle

Figure 5.14 CONSTANT VOLUME REHEAT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 13)

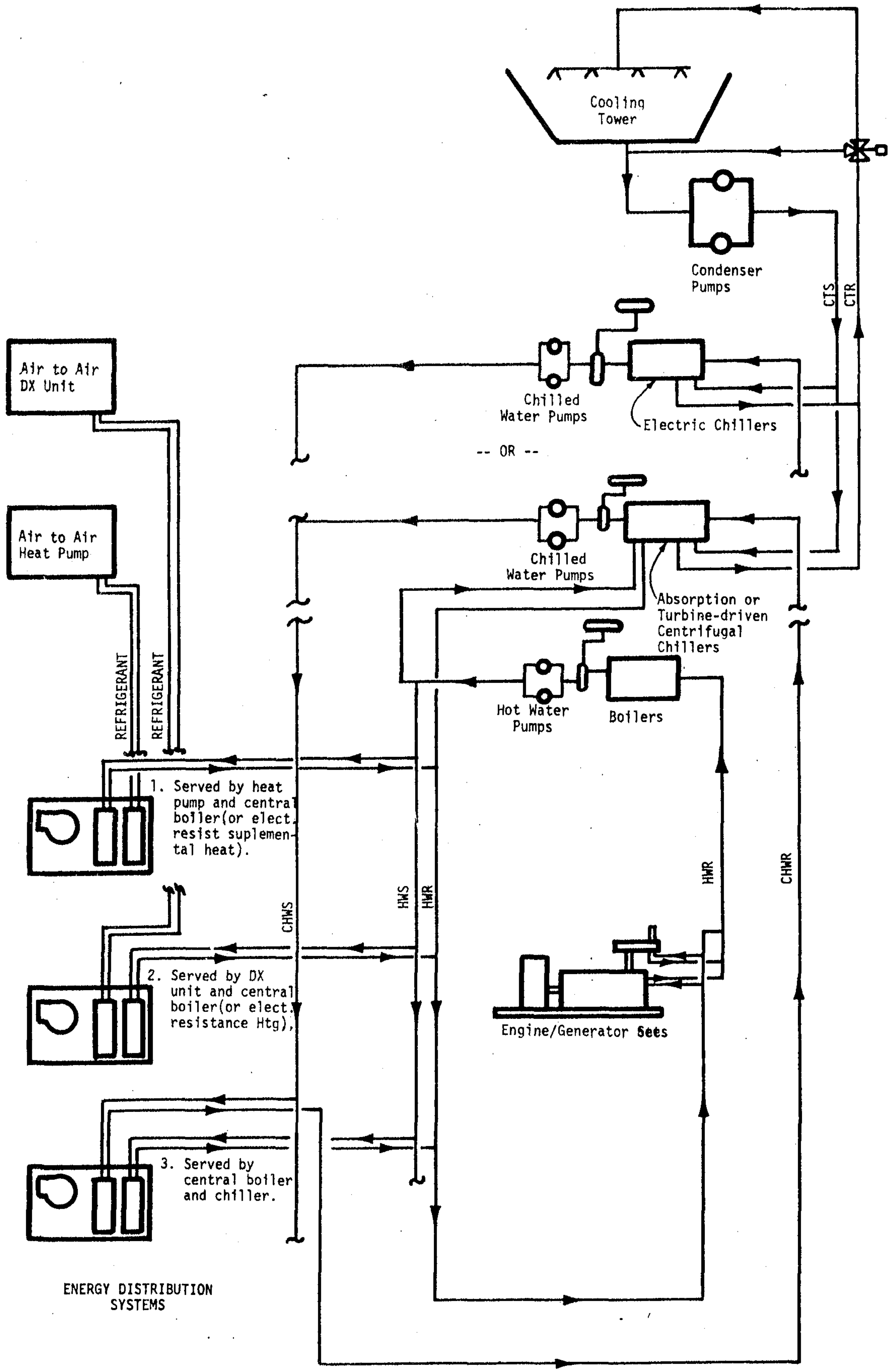


Figure 5.15 SYSTEMS ENERGY SIMULATION PROGRAM-EQUIPMENT SIMULATION SCHEMATIC DIAGRAM

Figure 5.16(a) - SCHEDULING

R = repitition numer of the schedule to be referenced
F = card's field number
L or S = Load or System card

<u>L5-R - Weekly Schedule Card</u>

F1 to 9 = # of a standard schedule. If # is greater than 10, a special schedule is used from L6's R.

<u>L6-R - Daily Profile Card</u>

R must be in order starting from 11.
F1 = Fractional part of load for HR#1.
F2 = Fractional part of load for HR#2.
F3 = Fractional part of load for HR#3 . . . etc.

<u>L17-R - Space Card</u>

F8 = People Schedule using L5's R.
F13 = Lighting Schedule using L5's R.
F18 = Equipment Schedule using L5's R.

<u>S4-R - Thermostat Schedule Card</u> (program will not sort)

F1 = Type of thermostat for HR#1.
F2 = High temperature setting for HR#1.
F3 = Low temperature setting for HR#1.
F4 = Type of thermostat for HR#2 . . . etc.

<u>S5-R - Daily Operating Schedule Card</u> (for venilation & process equipment)

F1 = Fractional part of load for HR#1.
F2 = Fractional part of load for HR#2.
F3 = Fractional part of load for HR#3 . . . etc.

<u>S6-R - Weekly Operating Schedule Card</u>

F1 = Operating or thermostat schedule.
F2 = S4's R or S5's R for Sunday.
F3 = S4's R or S5's R for Monday . . . etc.

Figure 5.16(b) - SCHEDULING

S7-R - Yearly Schedule Card

F1 & 2 = Month/day start of 1st period.
F3 = S6's R.
F4 & 5 = Month/day start of 2nd period . . . etc.

S11-R - Fan Description Card

F27 = Fan operation type: If value is 3, use F28 for schedule.
F28 = Schedules ventilation air using S7's R. This will keep fan on when ventilation required is > than 0, even though no heating or cooling is required.

S12 - Space Description Card

F8 = Thermostat schedule using S7's R.

F6 = If a plenum (a different format), fan schedule using S7's R.

S14 - Boiler Card

F3 & F4 = Month/day start boiler or heat pump.
F5 & F6 = Month/day stops.

S15 - Chiller Card

F4 & F5 = Month/day start chiller or DX unit.
F6 & F7 = Month/day stops.

S19 - Process Load Card

F3 = Schedule from S7's R.

Defaults are shown on the input information. If S4, 5, 6, 7 is not used, a special defaulted thermostat schedule is used. See the NECAP Input Manual pp. 3-10.

*****ECHO OF BUILDING DESCRIPTION DATA READ FROM INPUT TAPE*****

FAC= SYSTEMS ENGINEERING BUILDING,LARC
CITY= HAMPTON,VA.
ENGR=R.N. JENSEN
PROJ=SEB BASE-LONG
DATE=DEC 15,1981

NO. OF TYPES OF RESPONSE FACTOR SURFACES NRF= 3

RESPONSE FACTOR INDEX= 1 NRFT= 24 RATIO= .804645

5.176069	.000012	.443990
-3.267084	.001378	-.313892
-.755787	.006893	-.017697
-.384369	.011144	-.004341
-.211133	.011952	-.002968
-.126089	.010994	-.002324
-.081886	.009465	-.001849
-.057144	.007893	-.001479
-.042072	.006474	-.001186
-.032106	.005265	-.000953
-.025053	.004261	-.000766
-.019810	.003440	-.000616
-.015784	.002773	-.000495
-.012631	.002233	-.000399
-.010132	.001798	-.000321
-.008139	.001447	-.000258
-.006543	.001165	-.000208
-.005262	.000937	-.000167
-.004233	.000754	-.000134
-.003405	.000607	-.000108
-.002740	.000488	-.000087
-.002204	.000393	-.000070
-.001774	.000316	-.000056
-.001427	.000254	-.000045

RESPONSE FACTOR INDEX= 2 NRFT= 9 RATIO= .202652

2.003712	.011444	.602721
-1.849331	.064577	-.421263
-.031197	.031442	-.052672
-.005427	.007108	-.009895
-.001081	.001459	-.001986

Report S1 - ECHO OF BUILDING AND SYSTEMS INPUT DATA

Figure 5.17(a)

```
***************************************** ECHO OF CARD INPUT TO THE SESP PROGRAM *****************************************

    CARD S1: PROJECT NAME - SEB EXAMPLE

    CARD S2: GENERAL DATA

                   1  HOUR OF YEAR AT WHICH SIMULATION MAY BEGIN
                8760  HOUR OF YEAR AT WHICH SIMULATION MAY END

                   0  OUTPUT TAPE OPTION FLAG

    CARD S3: PRINTOUTS

                   1 - NUMBER OF PRINTOUTS DESIRED

         PRINT PERIOD NO.   1

                5089  PRINT START DATE
                5112  PRINT STOP DATE

                   1  OPTIONAL PRINT FLAG: LEVEL 1 HOURLY SUMMARIES
                   1  OPTIONAL PRINT FLAG: LEVEL 2 ZONE SUMMARIES
```

Report S1 - ECHO OF BUILDING AND SYSTEMS INPUT DATA

Figure 5.17(b)

```
*******************************************************************************
*                                                                             *
*                                                                             *
*                                                                             *
*                      ANALYSIS OF ENERGY UTILIZATION FOR                     *
*                                                                             *
*                                                                             *
*                       SYSTEMS ENGINEERING BUILDING,LARC                     *
*                                                                             *
*                                                                             *
*                                 HAMPTON,VA.                                 *
*                                                                             *
*                                                                             *
*  ENGINEER     - R.N. JENSEN                                                 *
*  PROJECT NO - SEB BASE-LONG                                                 *
*  DATE         - DEC 15,1981                                                 *
*                                                                             *
*                                                                             *
*******************************************************************************
```

Report S2 - TITLE PAGE

Figure 5.18

SYSTEMS ENGINEERING BUILDING,LARC HAMPTON,VA. DEC 15,1981 SEB BASE-LONG
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF ENERGY DISTRIBUTION SYSTEM CHARACTERISTICS.

SYSTEM NO.	TYPE	++++++ TOTAL FAN BHP +++++ SUPPLY	RETURN	EXHAUST	NO. OF ZONES	++TOTAL SYSTEM AIR FLOWS (CFM)++ SUPPLY	MIN.O.A.	EXH.SYSTEM	PER-CENT MIN.O.A.
1	VAVS	83.4	0.0	.1	5	54000.	1600.	550.	3.0
2	UVT	.7	0.0	0.0	1	2346.	100.	0.	4.3

Report S3 - SUMMARY OF ENERGY DISTRIBUTION SYSTEM CHARACTERISTICS

Figure 5.19

SUMMARY OF ZONE AIR FLOWS

FAN SYSTEM	ZONE NUMBER	LOAD SPACE NUMBER	MULT FACTOR	SUPPLY CFM	EXHAUST CFM	LOAD SET POINT TEMP.	COOLING CAPACITY BTU/HR	HEATING CAPACITY BTU/HR	YEARLY THERMOSTAT SCHEDULE
1	1	1	1	4000.	0.	72.	80000.	0.	1
1	2	2	1	4000.	0.	72.	80000.	0.	1
1	3	3	1	4000.	0.	72.	80000.	0.	1
1	4	4	1	4000.	0.	72.	80000.	0.	1
1	5	5	1	38000.	550.	72.	760000.	-200000.	3
2	1	12	1	2346.	0.	72.	48000.	-15000.	2

Report S4 - SUMMARY OF ZONE AIR FLOWS

Figure 5.20

HOURLY BUILDING PERFORMANCE FOR: WEDNESDAY, AUG 1 FROM 3:00 TO 4:00

ENVIRONMENTAL CONDITIONS

DRY BULB= 68 WET BULB= 68 ENTHALPY= 32.51 ATM PRESS= 29.94 WIND SPD= 0 CLD FAC= .833 SOLAR (DIR NOR)= 0.0 SKY BRT= 0.0

PLANT CAPACITIES:

MAIN PLANT - COOLING= 108.7 TONS HEATING= 2200.0 MBH

DX UNIT (1) - COOLING = 52.9 KBTU/HR

NUMBER OF ITERATIONS = 1

SPACES:

SPACE NO.	SPACE TEMP.	HIGH TEMP.	LOW TEMP.	TEMP. CORR.	HEATING CAPACITY	COOLING CAPACITY	SYSTEM LOAD	CONST. TEMP. SYSTEM LOAD	RHOH	RHOC	TSTAT TYPE	SCHED TYPE
1	77.3	23.0	-17.0	5.33	0.	80000.	0.	10329.	0.0000	0.0000	2	1
2	77.3	23.0	-17.0	5.30	0.	80000.	0.	7704.	0.0000	0.0000	2	1
3	77.4	23.0	-17.0	5.36	0.	80000.	0.	13112.	0.0000	0.0000	2	1
4	77.3	23.0	-17.0	5.34	0.	80000.	0.	10992.	0.0000	0.0000	2	1
5	77.2	23.0	-17.0	5.16	200000.	760000.	0.	48420.	0.0000	0.0000	2	5
6	77.9			5.91	0.	0.	0.	323.	0.0000	0.0000	0	0
7	77.2			5.19	0.	0.	0.	-549.	0.0000	0.0000	0	0
8	78.6			6.62	0.	0.	0.	1634.	0.0000	0.0000	0	0
9	78.4			6.42	0.	0.	0.	877.	0.0000	0.0000	0	0
10	76.1			4.14	0.	0.	0.	-27325.	0.0000	0.0000	0	0
11	76.7			4.73	0.	0.	0.	4591.	0.0000	0.0000	0	0
12	75.9	3.9	1.0	3.90	15000.	48000.	9732.	19277.	0.0000	0.0000	2	4

-HOURLY FAN SYSTEM OUTPUT SUMMARY

FAN SYSTEM	TYPE	REQUIRED COOLING	REQUIRED PRIM HTG	REQUIRED REHEAT	REQUIRED PREHEAT	REQUIRED BSBD HTG	REQUIRED HUMIDIF.	BASE POWER	NET FAN BRK HSP
1	12	0.0	0.0	0.0	0.0	0.0	0.00000	4.8	.7
2	5	.0	0.0	0.0	0.0	0.0	0.00000	5.1	.7

--- FAN SYSTEM NO. - 1

VARIABLE VOLUME FAN SYSTEM

ENTERING AIR PROPERTIES MINIMUM FRACTION OF OUTSIDE AIR = .030

RETURN AIR	TEMPERATURE = 79.151		MIXED AIR	TEMPERATURE = 79.117
	MOISTURE = .009			MOISTURE = .009
	DENSITY = .073			DENSITY = .072

LEAVING AIR PROPERTIES

TEMPERATURE = 75.921	AFTER HUMIDIFIER:	
MOISTURE = .017		MOISTURE = .017
DENSITY = .072		WATER ADDED = 0.000

SPACE LOAD SUMMARY

Report S5 - SUMMARY OF HOURLY CALCULATIONS (Optional)

Figure 5.21(a)

```
 SPACE NO     LATENT     LIGHTING     SENSIBLE  SUPPLY AIR    ZONE HUMID
 LDS  SYS      LOAD        LOAD          LOAD   TEMPERATURE      RATIO
   1    1       113.          0.           0.      55.00          .009
   2    2       113.          0.           0.      55.00          .009
   3    3       113.          0.           0.      55.00          .009
   4    4       113.          0.           0.      55.00          .009
   5    5       905.          0.           0.      55.00          .009

--- FAN SYSTEM NO. -  2
   UNIT VENTILATOR(S)

 ENTERING AIR PROPERTIES      MINIMUM FRACTION OF OUTSIDE AIR =    .043
  RETURN AIR   TEMPERATURE =  75.900         MIXED AIR    TEMPERATURE =  75.557
               MOISTURE    =    .017                      MOISTURE    =    .017
               DENSITY     =    .072                      DENSITY     =    .072

 LEAVING AIR PROPERTIES
               TEMPERATURE =   0.000         AFTER HUMIDIFIER:
               MOISTURE    =   0.000                      MOISTURE    =   0.000
               DENSITY     =   0.000                      WATER ADDED =   0.000

 SPACE LOAD SUMMARY
  SPACE NO    LATENT     LIGHTING     SENSIBLE  SUPPLY AIR    ZONE HUMID
  LDS  SYS     LOAD        LOAD          LOAD   TEMPERATURE      RATIO
   12    6         0.         0.           0.      75.92          .017

 PLANT COMPARISION:
     MAIN PLANT     - COOLING - LOAD=          .00 BTU   CAPY=  1304160.00 BTU   LOAD RATIO=  .0000 NEW RHO= 1.0000
                    - HEATING - LOAD=         0.00 BTU   CAPY=  2200000.00 BTU   LOAD RATIO= 0.0000 NEW RHO= 1.0000
     DIR. EXP(1)    - COOLING - LOAD=         0.00 BTU   CAPY=    52896.00 BTU   LOAD RATIO= 0.0000 NEW RHO= 1.0000

 CENTRAL PLANT:
     GASC=     0.000  GASH=      0.000  GASG=      0.000  OILC=      0.000  OILH=      0.000
     STMC=     0.000  STMH=      0.000  ELEC=      0.000  ELEH=      0.000  FUEL=      0.000

*****************************************************************************************************************
```

Report S5 - SUMMARY OF HOURLY CALCULATIONS (Optional)

Figure 5.21(b)

SYSTEMS ENGINEERING BUILDING,LARC HAMPTON,VA. DEC 15,1981 SEB BASE-LONG
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF EQUIPMENT SIZES

TOTAL NUMBER OF CHILLERS = 1
TYPE OF CHILLER = STEAM ABSORPTION
NO. OF CHILLERS = 1
SIZE OF CHILLERS = 110.0 TONS

TOTAL NUMBER OF BOILERS = 1
TYPE OF BOILER = STEAM
NO. OF BOILERS = 1
SIZE OF BOILERS = 2200.0 KBTU

TOTAL HEATING CAPACITY = 2200.0 KBTU
TOTAL COOLING CAPACITY = 110.0 TONS

IF USED, TERMINAL REHEAT ENERGY SAME SOURCE AS BOILER.

COOLING TOWER FAN REQUIREMENT 38500. CFM 1.0 IN. S.P. 46.9 BHP

BOILER AUXILIARY HORSEPOWER REQUIREMENT (FAN,BLOWER,PUMP) 3.3 BHP

TOTAL FAN PLANT HORSEPOWER FOR BUILDING 84.2 BHP

SUMMARY OF PUMP SIZES

LOCATION	TOTAL GPM	TOTAL HEAD (FT)	TOTAL BHP
CHILLED WATER	264.	40.0	5.2
CONDENSER WATER	385.	30.0	5.7
HEATING WATER	220.	50.0	5.4

NO. OF DX/HEAT PUMP UNITS = 1

UNIT TYPE	DESIGN COOLING CAPACITY (KBH)	DESIGN COOLING POWER (KW)	DESIGN HEATING CAPACITY (KBH)	DESIGN HEATING POWER (KW)
DX	48.0	4.0	0.0	0.0

Report S6 - Summary of Equipment Capacities

Figure 5.22

SPACE TEMPERATURE FREQUENCY DISTRIBUTION SUMMARY

SPACE NO.	SPACE STATUS	* * * * * * * * * * * * * * * * TEMPERATURE OCCURANCE BANDS (F) * * * * * * * * * * * * * *															
		BELOW 50.0	50.0- <60.0	60.0- <65.0	65.0- <68.0	68.0- <70.0	70.0- <72.0	72.0- <74.0	74.0- <76.0	76.0- <78.0	78.0- <80.0	80.0- <85.0	85.0- <90.0	90.0- <100.0	100.0- <110.0	110.0- <120.0	120.0- & OVER
1	OCCUPIED	0	0	7	64	93	181	334	1498	78	4	0	0	0	0	0	0
	UNOCCUPIED	0	20	271	618	425	694	987	1687	1714	61	0	0	0	0	0	0
2	OCCUPIED	0	0	9	67	98	186	368	1456	72	3	0	0	0	0	0	0
	UNOCCUPIED	0	19	273	627	431	693	998	1711	1679	46	0	0	0	0	0	0
3	OCCUPIED	0	0	12	74	101	186	374	1437	71	4	0	0	0	0	0	0
	UNOCCUPIED	0	22	290	644	428	695	979	1660	1688	71	0	0	0	0	0	0
4	OCCUPIED	0	0	10	66	95	183	352	1465	84	4	0	0	0	0	0	0
	UNOCCUPIED	0	19	272	634	423	688	984	1681	1713	63	0	0	0	0	0	0
5	OCCUPIED	0	0	4	40	71	147	328	1551	111	7	0	0	0	0	0	0
	UNOCCUPIED	0	20	247	649	437	703	1034	1648	1698	41	0	0	0	0	0	0
6	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	54	783	951	738	576	671	818	1009	1300	958	840	38	0	0	0	0
7	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	83	942	999	761	592	691	862	1021	1326	782	653	24	0	0	0	0
8	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	73	866	986	746	592	683	800	980	1329	854	811	16	0	0	0	0
9	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	56	767	929	701	588	670	825	1024	1335	910	897	34	0	0	0	0
10	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	4	441	952	760	592	754	952	1305	1355	911	680	30	0	0	0	0
11	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	0	101	536	938	659	931	1144	1326	1038	675	1181	207	0	0	0	0
12	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	0	19	100	2130	5957	383	128	19	0	0	0	0	0

Report S7 - SPACE TEMPERATURE FREQUENCY DISTRIBUTION SUMMARY

Figure 5.23

***** MONTHLY AND ANNUAL ENERGY AND UTILITY USE SUMMARY *****

FACILITY - SYSTEMS ENGINEERING BUILDING,LARC DATE - DEC 15,1981
CITY - HAMPTON,VA. PROJECT - SEB BASE-LONG
USER - R.N. JENSEN

ENERGY CONSUMPTION	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
MONTHLY KBTU						
HEAT (KHB)						
MAX. DEMAND	-710.8	-537.6	-413.5	-391.6	-118.3	-2.8
CONSUMPTION	-56251.1	-41714.9	-34917.7	-14717.5	-592.3	-6.1
COOL (KCB)						
MAX. DEMAND	0.0	0.0	0.0	620.7	754.9	976.0
CONSUMPTION	0.0	0.0	0.0	28103.1	84817.7	115757.5
ELECTRICITY						
LIGHTS AND BUILDING EQUIPMENT						
INTERNAL						
DEMAND(KW)	163.7	163.7	163.7	163.7	163.7	163.7
CONS.(KWH)	42540.6	36990.6	42660.6	40770.6	42660.6	40770.6
EXTERNAL						
DEMAND(KW)	7.0	7.0	7.0	7.0	7.0	7.0
CONS.(KWH)	2968.0	2632.0	2639.0	2310.0	2226.0	1890.0
HEAT (INCL. CENT.PLT.HTG. LOAD, BLR.AUXIL., HOT WATER PUMPS, AND HEATPUMPS)						
DEMAND(KW)	6.5	6.5	6.5	6.5	6.5	6.5
CONS.(KWH)	4687.3	4374.8	4843.5	4687.3	4843.5	4687.3
COOL (INCL. CHILLERS, WATER PUMPS, COOLING TOWER FAN, DX, AND HEATPUMPS)						
DEMAND(KW)	0.0	0.0	0.0	43.2	43.4	43.5
CONS.(KWH)	0.0	0.0	0.0	7285.5	10763.5	11955.3
FANS						
DEMAND(KW)	62.8	62.8	62.8	62.8	62.8	62.8
CONS.(KWH)	5970.6	5126.1	5909.2	5598.5	5859.6	5598.5
PROCESS ELECTRICITY						
DEMAND(KW)	10.0	10.0	10.0	10.0	10.0	10.0
CONS.(KWH)	7200.0	6720.0	7440.0	7200.0	7440.0	7200.0
TOTAL						
DEMAND(KW)	202.6	195.6	195.6	238.7	238.9	239.1
CONS.(KWH)	63366.5	55843.4	63492.3	67852.0	73793.2	72101.7

Report S8 - MONTHLY AND ANNUAL ENERGY SUMMARY

Figure 5.24(a)

***** MONTHLY AND ANNUAL ENERGY AND UTILITY USE SUMMARY *****

FACILITY - SYSTEMS ENGINEERING BUILDING,LARC   DATE - DEC 15,1981
CITY - HAMPTON,VA.   PROJECT - SEB BASE-LONG
USER - R.N. JENSEN

	ENERGY CONSUMPTION						
	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
PURCHASED STEAM							
HEAT (12.0PSIG 245.0DEG.F. ENTERING)							
DEMAND (K-LBS/HR)	0.0	.0	.1	.5	.4	1.0	
CONS.(K-LBS)	0.0	.0	.4	9.0	33.1	72.4	302.4
COOL (125.0PSIG 353.0DEG.F. ENTERING)							
DEMAND (K-LBS/HR)	1.4	1.9	1.2	1.0	.4	0.0	
CONS.(K-LBS)	188.6	221.2	123.9	97.5	13.3	0.0	1031.6
OIL							
CITY WATER							
DEMAND (K-GALS/HR)	.3	.4	.3	.2	.1	.0	
CONS. (K-GALS)	18.7	22.1	11.3	8.4	.5	.4	98.3

Report S8 - MONTHLY AND ANNUAL ENERGY SUMMARY

Figure 5.24(b)

```
******************************************                ******************************************
                                          *  EXECUTIVE  SUMMARY  *
   SYSTEMS ENGINEERING BUILDING,LARC      *                      *         INPUT SPECIFICATIONS
          HAMPTON,VA.                     ************************
                                                                  LENGTH OF STUDY =  365 DAYS
  THIS NECAP RUN PREPARED BY: R.N. JENSEN                         TOTAL FLOOR AREA =        52800.00
                          ON: DEC 15,1981                         HEATING    2200.0 KBH,  .04167 /SQFT
                                                                  COOLING     114.0 TNS   .00216 /SQFT
  LOADS   CASE IDENTIFICATION : SEB BASE-LONG                     SUP AIR   56346.2 CFM  1.06716 /SQFT
  SYSTEMS CASE IDENTIFICATION : SEB EXAMPLE                       VNT AIR    1700.0 CFM   .03220 /SQFT
```

-----ENERGY SOURCE-----	-----BUILDING----- CONSUMPTION	--BUILDING LINE-- KBTU/SQ.FT.	---RAW SOURCE--- KBTU/SQ.FT.
ELECTRICITY (KWHR)			
LIGHTS & MISC. EQUIP.	518456.33	33.51	113.94
HEATING	56872.34	3.68	12.50
COOLING	80417.59	5.20	17.67
FANS	67407.83	4.36	14.81
PROCESS	87360.00	5.65	19.20
TOTAL	810514.09	52.39	178.13
GAS (THERM)	NONE USED FOR THIS MODEL		
PURCHASED STEAM (KLBS) (1000 BTU/LB)			
HEATING	302.41	5.73	7.96
COOLING	1031.61	19.54	27.16
PROCESS	0.00	0.00	0.00
TOTAL	1334.01	25.27	35.12
HEATING OIL (KGALS)	NONE USED FOR THIS MODEL		
DIESEL FUEL (KGALS)	NONE USED FOR THIS MODEL		
TOTAL ENERGY USAGE (EQUIV KBTU)	4100296.47	77.66	213.25

Report S9 – Executive Summary

Figure 5.25

ECONOMIC SUMMARY

SYSTEMS ENGINEERING BUILDING,LARC
HAMPTON,VA.

THIS NECAP RUN PREPARED BY: R.N. JENSEN
ON: DEC 15,1981

LOADS CASE IDENTIFICATION : SEB BASE-LONG
SYSTEMS CASE IDENTIFICATION : SEB EXAMPLE

ASSUMED ECONOMIC FACTORS:

BUILDING LIFE	40 YRS
ANNUAL INTREST RATE	10.0 %
ANNUAL LABOR WAGE INCR.	8.0 %
ANNUAL MATERIAL COST INCR.	10.0 %
ANNUAL FLOOR SPACE COST INCR.	8.0 %
ANNUAL ENERGY COST INCR.	10.0 %

ENERGY COSTS

ENERGY SOURCE / USE	ESTIMATED ENERGY COST/UNIT ($) CONS.	DEMAND	COMPUTED FR. SIMUL. CONSUMPTION	DEMAND	YRLY TOTAL ENERGY COST($)	ANNUITY ($)
ELECTRICITY						
ELEC LTS. HEAT COOL FANS PRC.	.035	20.00	808929.	239. KW	33095.	135372.
STEAM						
STM. HEAT COOL	5.00	-	1145.	- K LBS	5723.	23409.
WATER						
PRC. WATR	1.20	-	78.	- K GALS	94.	383.
TOTAL ENERGY COST					38912.	159165.

COSTS ARE BASED ON:
HEATING EQUIP - $40./KBTU
COOLING EQUIP -$3000./TON
20 YEARS ANTICIPATED LIFE
10 YEARS MAJOR OVERHAUL
NO RESALE VALUE ALLOWED

EQUIPMENT COSTS

MAINTENANCE & OVERHAUL COSTS BASED ON:
1% OF EQUIP COST FOR MAINT & OH LABOR
.5% OF EQUIP COST FOR MAINT MATERIALS
1% OF EQUIP COST FOR OVERHAUL MATERIALS
10% OF EQUIP COST FOR FLOOR SPACE

	INITIAL COST	OVERHAUL COST LABOR	MATERIAL	ANNUAL MAINTENACE LABOR	MATERIAL	FLOOR SP. COST	ANNUITY ($)
BOILERS	88000.	880.	880.	880.	440.	8800.	57184.
CHILLERS	330000.	3300.	3300.	3300.	1650.	33000.	214440.
D/X UNITS	12000.	120.	120.	120.	60.	1200.	7798.
TOTAL SYSTEMS & EQUIPMENT ANNUITY							279422.
TOTAL OWNING & OPERATING ANNUITY							438587.

NOTE -- ANNUITY IS CONSTRUED TO MEAN THE UNIFORM ANNUAL COST, CONSIDERING ALL THE LISTED COSTS
TO THE OWNER DURING THE LIFE TIME OF THE BUILDING.

Report S10 - ECONOMIC SUMMARY

Figure 5.26

TABLE 5.2

ENERGY CONVERSION SYSTEMS

TYPE	SOURCE OF ENERGY
CENTRAL COOLING PLANTS	
1. Hermetic Reciprocating	Electricity
2. Hermetic Centrifugal	Electricity
3. Open Centrifugal	Electricity
4. Steam Absorption	Gas-fired Steam Boiler Oil-fired Steam Boiler Purchased Steam
5. Open Centrifugal with Steam Turbine	Purchased Steam
CENTRAL HEATING PLANTS	
1. Hot Water or Steam	Gas Oil Electric Purchased Steam
2. Air to Air Heat Pump	Electricity
POWER GENERATION PLANTS	
1. Engine-Generator	Natural Gas Diesel Fuel
UNITARY EQUIPMENT*	
1. Air to Air Packaged DX Units	Electric
2. Air to Air Heat Pump	Electric

* One unit serves one fan system.

Table 5.3 ENERGY CONVERSION SYSTEM LOAD HANDLING

Load Source	Energy Distribution System Load Handling On Month Load Summary Table		Load Handling Equipment				
			Central Equipment			Unitary Equipment	
	Heating	Cooling	Reheat Coils	Boiler	Central Chiller	Heat Pump	DX Unit
Main Heating coil (or Hot Deck Coil)	√		- *√ √	√ - -		- √ -	
Preheat Coil	√			√ √ √			
Reheat Coil	√		√ √ √				
Humidification Energy	√			√ √ √			
Baseboard Heating	√			√ √ √			
Two-Pipe Changeover	√	√		- √ -	- √ -		
Central Cooling Coil		√			√	- √ -	- - √
Terminal Unit Cooling Coils		√			- √ -		

LEGEND

√ = Applies

\- = NA

* = Supplemental Heating Load

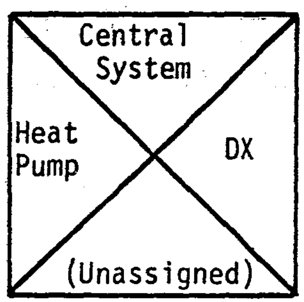


TABLE 5.4 HEATING & COOLING PRIMARY AIR DESIGN TEMPERATURE

SYSTEM TYPE	SYMBOL	PRIMARY AIR COOLING DESIGN (°F)	PRIMARY AIR HEATING DESIGN (°F)	INDUCED AIR HEATING (°F)	INDUCED AIR COOLING (°F)
1	SZFB	55.	120.	-	-
2	MZS	55.	120.	-	-
3	DDS	55.	120.	-	-
4	SZRH	52.	95.	-	-
5	UVT	55.	120.	-	-
6	UHT	55.	120.	-	-
7	FPH	0.	0.	-	-
8	2PFC	55.	110.	-	-
9	4PFC	55.	110.	-	-
10	2PIU	53.	53.	120.	62.
11	4PIU	53.	53.	120.	62.
12	VAVS	55.	120.	-	-
13	RHFS	55.	120.	-	-

These temperatures are the default values for the air handlers air discharge temperature. If the required space temperature is below the cooling design, or above the heating design, the calculations will produce negative air flows and are in error. The user is cautioned that if a space temperature design exceeds these temperatures, a system should be selected so an appropriate coil discharge temperature may be applied to the system.

NOTES AND COMMENTS

SECTION 6
OWNING AND OPERATING COST ANALYSIS PROGRAM

6.1 OBJECTIVE AND DESCRIPTION

The Economic Summary Provided by the Systems Energy Simulation Program (SESP) is produced using the Owning and Operating Cost Analysis Program (ECON). SESP uses internal values to compute annual cost. If annual cost is to be computed using different economic factors, then the ECON program should be used. Because of fluctuating costs for energy, fuel, material, labor, and interests, it may be difficult to accurately account for these factors.

ECON performs a life cycle cost analysis for each building heating and cooling system analyzed by SESP. Life cycle costs are those expenditures which occur singularly or periodically over the life of the building, and includes cost of energy, cost of equipment in terms of first costs and replacement costs, which occur if the expected life of the equipment is less than that of the building, cost of maintenance (material and labor), cost of periodic overhaul (material and labor), salvage value of equipment at end of building life, and opportunity costs for floor space occupied by equipment.

6.2 INPUT DATA

The punched card form of input data is required for ECON. Instructions for the preparation of this data are given in Table 6.1.

6.3 OUTPUT REPORT

An owning and operating cost report similar to that shown in Figure 6.1 is received for each set of input data given to the program. Most of the information appearing on this report is simply a recap of input data. The real results of the analysis are the annuities for each equipment category and for the total HVAC system. These annuities are calculated utilizing the uniform owning and operating cost technique.

6.4 EXAMPLE

To illustrate the use of ECON with the example facility, the input data shown in Figure 6.1 was used to exercise the program. The output follows the echo of input, shown in Figure 6.2.

```
SYSTEMS ENGINEERING BUILDING,LARC                                                        OC-1
HAMPTON, VA.                                                                             OC-2
R.N.JENSEN                                                                               OC-3
SEB BASE-LONG                                                                            OC-4
DEC. 15, 1981                                                                            OC-5
40.0                                                                                     OC-6
10.0       8.0        10.0       8.0        10.0                                         OC-7
.035       .50        1.20       5.00       1.20       1.40       20.00                  OC-8
1.0                                                                                      OC-9
VARIABLE VOLUME FAN SYSTEM WITH STEAM ABSORPTION CHILLER
3.0                                                                                      OC-11
1.         808929.    LTS FANS HTG COOL PROC EQUIP                                       OC-12-1
202.6      195.6      195.6      238.7      238.9      239.1      239.1                  OC-12-1A
239.1      238.9      223.5      202.6                            OC-12-1B
4.0        1145.      STEAM FOR HEATHING AND COOLING                                     OC-12-2
5.0        78.0       COOLING TOWER MAKE-UP WATER                                        OC-12-3
3.0                                                                                      OC-13
BOILERS                          88000.     20.        0.         10.                    OC-14-1
880.       440.       880.       880.       8800.                                        OC-15-1
CHILLERS                         330000.    20.0       0.         10.                    OC-14-2
3300.      1650.      3300.      3300.      33000.                                       OC-15-2
DX/UNITS                         12000.     20.        0.         10.                    OC-14-3
120.       60.        120.       120.       1200.                                        OC-15-3
```

SAMPLE INPUT TO OWNING AND OPERATING
COST ANALYSIS PROGRAM

FIGURE 6.1(a)

```
********************************************************************************
*                                                                              *
*                                                                              *
*                                                                              *
*                    OWNING AND OPERATING COST ANALYSIS FOR                    *
*                                                                              *
*                                                                              *
*                     SYSTEMS ENGINEERING BUILDING,LARC                        *
*                                                                              *
*                                                                              *
*                                  BUILDING                                    *
*                                                                              *
*                                                                              *
*                                HAMPTON, VA.                                  *
*                                                                              *
*                                                                              *
*  ENGINEER    - R.N.JENSEN                                                    *
*  PROJECT NO  - SEB BASE-LONG                                                 *
*  DATE        - DEC. 15, 1981                                                 *
*                                                                              *
*                                                                              *
********************************************************************************
```

OUTPUT OF OWNING AND OPERATING
COST ANALYSIS PROGRAM

FIGURE 6.2(a)

***************** INPUT ASSUMPTIONS *************	
BUILDING LIFE	40.00 YEARS
ANNUAL INTEREST RATE	10.00 PERCENT
ESTIMATED LABOR WAGE ANNUAL INCREASE	8.00 PERCENT
ESTIMATED MATERIAL COST ANNUAL INCREASE	10.00 PERCENT
ESTIMATED FLOOR SPACE COST ANNUAL INCREASE	8.00 PERCENT
ESTIMATED ENERGY COST ANNUAL INCREASE	10.00 PERCENT

OUTPUT OF OWNING AND OPERATING
COST ANALYSIS PROGRAM

FIGURE 6.2(b)

ANALYSIS FOR - VARIABLE VOLUME FAN SYSTEM WITH STEAM ABSORPTION CHILLER

ENERGY COST SUMMARY

	ENERGY UNIT COSTS CONS. ($)	ENERGY UNIT COSTS DEMAND ($)	CONSUMPTION	DEMAND	TOTAL COST ($)	ANNUITY ($)
ELECTRICITY						
LTS FANS HTG COOL PROC EQUIP	.04	20.00	808929. KW	239. KW	33095.	135369.
STEAM						
STEAM FOR HEATHING AND COOLING	5.00	0.00	1145. K LBS	0. K LBS	5725.	23417.
WATER						
COOLING TOWER MAKE-UP WATER	1.20	0.00	78. K GALS	0. K GALS	94.	383.
				GRAND TOTALS	38913.	159169.

SYSTEMS AND EQUIPMENT COST

	INITIAL COST	ANTICIPATED LIFE	SALVAGE CONSID.	MAJOR OVERHAUL PERIOD	MAJOR OVERHAUL LABOR	MAJOR OVERHAUL MATERIAL	ANNUAL MAINTENANCE LABOR	ANNUAL MAINTENANCE MATERIAL	FLOOR SPACE COST	ANNUITY
BOILERS	88000.	20	NO	10	880.	880.	880.	440.	8800.	57184.
CHILLERS	330000.	20	NO	10	3300.	3300.	3300.	1650.	33000.	214440.
DX/UNITS	12000.	20	NO	10	120.	120.	120.	60.	1200.	7796.
						TOTAL SYSTEMS AND EQUIPMENT ANNUITY				279422.

TOTAL OWNING AND OPERATING ANNUITY 438591. DOLLARS

NOTE -- ANNUITY IS CONSTRUED TO MEAN THE UNIFORM ANNUAL COST, CONSIDERING ALL THE LISTED COSTS, TO THE OWNER DURING THE LIFE TIME OF THE BUILDING.

OUTPUT OF OWNING AND OPERATING
COST ANALYSIS PROGRAM

FIGURE 6.2(c)

Table 6.1

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	COMMENTS
OC-1	1 to 35	Header 1, e.g. Facility Name	FAC	-	-	-	Any alpha-numeric character
OC-2	1 to 35	Header 2, e.g. Facility Location	CITY	-	-	-	-
OC-3	1 to 35	Header 3, e.g. Name of Engineer	ENGR	-	-	-	-
OC-4	1 to 15	Header 4, e.g. Project Number	PROJ	-	-	-	-
OC-5	1 to 15	Header 5, e.g. date	DATE	-	-	-	-
OC-6	1 to 10	Building Life	BLGLF	Years	-	-	-
OC-7	1 to 10	Annual Interest Rate	RINT	%	-	-	-
	11 to 20	Annual Increase of Labor Cost	RINL	%	-	-	-
	21 to 30	Annual Increase of Material Cost	RINM	%	-	-	-
	31 to 40	Annual Increase of Floor Space Cost	RINF	%	-	-	-
	41 to 50	Annual Increase of Energy & Fuel Cost	RINE	%	-	-	-
OC-8	1 to 10	Unit cost of Electricity	CELE	$/KW	-	-	-
	11 to 20	Unit Cost of Gas	CGAS	$/therm	-	-	-
	21 to 30	Unit cost of Oil	COIL	$/gal	-	-	-
	31 to 40	Unit cost of Purchased Steam	CSTM	$/1000 lbs	-	-	-
	41 to 50	Unit cost of City Water	CWAT	$/1000 gals	-	-	-
	51 to 60	Unit Cost of Diesel Fuel	CFUL	$/gal	-	-	-
	61 to 70	Unit Demand Cost of Electricty	DELEC	$/KW	-	-	-

Table 6.1 (Continued)

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	COMMENTS
OC-9	1 to 10	Number of cases to be analyzed	CASES	-	-	-	-
Reading Orders OC-10 Through OC-15 Should Be Repeated "CASES" Times.							
OC-10	1 to 30	System Description Label	DESC	-	-	-	-
OC-11	1 to 10	Number of Energy Categories ENCAT	-	1 to 15	-	-	-
Reading Order OC-12 Should Be Repeated "ENCAT" Times.							
OC-12	1 to 10	Energy Type	ETYPE	-	1 to 6	1 elect. 2 gas 3 oil 4 steam 5 water 6 diesel	-
	11 to 20	Annual Consumption	ECONS	KW. Therms. Gals.1000 1000 gals.	-	-	-
	21 to 50	Energy Category Label	ENLAB	-	-	-	-

Table 6.1 (Continued)

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	COMMENTS
Reading Orders OC-12A and B must follow any card OC-12 having an energy type (ETYPE) = 1.							
OC-12A	1 to 10	Electrical Demand for January	EDEMD	KW	-	-	-
	11 to 20	" " " February	"	"	-	-	-
	21 to 30	" " " March	"	"	-	-	-
	31 to 40	" " " April	"	"	-	-	-
	41 to 50	" " " May	"	"	-	-	-
	51 to 60	" " " June	"	"	-	-	-
	61 to 70	" " " July	"	"	-	-	-
OC-12B	1 to 10	Electrical Demand for August	EDEMD	KW	-	-	-
	11 to 20	" " " September	"	"	-	-	-
	21 to 30	" " " October	"	"	-	-	-
	31 to 40	" " " November	"	"	-	-	-
	41 to 50	" " " December	"	"	-	-	-

Table 6.1 (Continued)

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	COMMENTS
OC-13	1 to 10	Number of Equipment Categories	EQCAT	-	1 to 15	-	-
Reading Orders OC13 and OC14 Should Be Repeated "EQCAT" Times.							
OC-14	1 to 30	Equipment Category Label	EQLAB	-	-	-	-
	31 to 40	Installed Cost of Equipment	COST	$	-	-	-
	41 to 50	Expected Life of Equipment	LIFE	Years	-	-	-
	51 to 60	Is Resale Value to be Considered:	SV	-	-	0 No 1 Yes	Based on straight-line depreciation
	61 to 70	Major Overhaul Period	OHPD	Years	-	-	-
OC-15	1 to 10	Estimated Annual Maint. Labor Cost	AML	$	-	-	-
	11 to 20	Estimated Annual Maint. Material Cost	AMM	$	-	-	-
	21 to 30	Estimated Major Overhaul Labor Cost	OHL	$	-	-	-
	31 to 40	Estimated Major Overhaul Material Cost	OHM	$	-	-	-
	41 to 50	Estimated Cost of Floor Space Occupied by Equipment	FLR	$	-	-	-

NOTES AND COMMENTS

APPENDIX A

INSTRUCTIONS FOR DIMENSION STATEMENT ALTERATION

INSTRUCTIONS FOR DIMENSION STATEMENT ALTERATION

Certain variables in NECAP have only one value. For instance, FNS, the number of spaces, is described by one number. The direct normal radiation, RDN, also takes on one value, which varies with time, but may be described at any given time by one number. Such variables, called scalars, require only one location in the computer memory. This location is assigned automatically the first time scalar variable is used.

Other variables, however, possess a number of values. For example, AW, the area of a window, has as many values as there are windows in the building. The number of vertices of a shade polygon added to a window, FNVAW, has a different value, for each of the added shade polygons, for each window. Such multi-valued variables are called arrays or matrices. They each require more than one location in the computer's memory.

The computer does not assign such blocks of memory automatically. The number of values (the dimensions) of a matrix variable must be assigned by the use of special statements, called dimension statements.

The core requirements for running the program depend upon the numbers entered into the dimension statements. For the most efficient utilization of a computer system, the user of this program should arrange dimensions according to his applications.

NOTE: Since the computer does not accept "zero" for a dimension value, if a dimensioned variable is equal to zero, always use "ONE" for dimension value.

LOAD PROGRAM GLOSSARY

A	:	Number of spaces in buidling
B	:	Number of distinct delayed heat transfer surfaces in building
C	:	Number of distinct quick heat transfer surfaces in building
D	:	Number of distinct windows in building
E	:	Number of types of delayed heat transfer surfaces
F	:	Number of inside heat transfer surfaces in building
H	:	Number of underground floors in building
I	:	Maximum number of sides of any exterior heat transfer surface
K	:	Maximum number of shading surfaces deleted from any exterior heat transfer surface
L	:	Maximum number of shading surfaces deleted from a delayed heat transfer surface ($L < K$)
N	:	Maximum number of sides of a delayed heat transfer surface
P	:	Maximum number of shading surfaces deleted from a quick heat transfer surface ($P < K$)
R	:	Maximum number of sides of a quick heat transfer surface
T	:	Maximum number of shading surfaces deleted from a window ($T < K$)
V	:	Maximum number of sides of a window
X	:	Number of shading surfaces
Y	:	Maximum number of sides of a shading surface
AB	:	Maximum number of inside heat transfer surfaces in a space
AC	:	Maximum number of quick heat transfer surfaces in a space
AD	:	Maximum number of delayed heat transfer surfaces in a space
AF	:	Maximum number of underground spaces in a space
AG	:	Maximum number of windows in a space

AH	:	Number of pictures desired of shadows on delayed heat transfer surfaces
AI	:	Number of pictures desired of shadows on quick heat transfer surfaces
AJ	:	Number of pictures desired of shaded areas of windows
AK	:	Must exceed number of sides of any exterior heat transfer surface or any shading surface (for example: AK = J + 3)
AL	:	*Maximum value of number of shading surfaces - number of deletions + window setback shading surfaces (for any exterior heat transfer surface)
AM	:	Maximum number of sides of a shading surface + 3
AO,AN	:	Fineness of division of exterior heat transfer surface for shadow analysis (corresponds to X and Y divisions of a surface)

*NOTE: If a window is setback, the program generates three setback shading surfaces.

CURRENT VALUES FOR ARRAY SIZES

A = 35	B = 75	C = 25
D = 35	E = 26	F = 70
H = 30	I = 10	K = 10
L = 10	N = 10	P = 10
R = 10	T = 10	V = 10
X = 10	Y = 16	AB = 30
AC = 30	AD = 30	AF = 30
AG = 30	AH = 20	AI = 20
AJ = 20	AK = 19	AL = 8
AM = 19	AN = 50	AO = 50

TLAP DIMENSIONS WHICH REQUIRE CHANGE

MAIN ROUTINE

```
 COMMON /TLP1/
.   IHTS( AB, A ), ILITE( A ), NIHTS( A ),  WOF( A ),
.  BODER( D ),     SETBK( D ),
.    SXN( E ),       SXR( E ),   SYN( E ),   SYR( E ),
.  FIHTS( F ),     ISPC1( F ), ISPC2( F ),
. FFIHTS( AB),       FID( AD),  FIDD( L ), FIDQ( P ),
.   FIDW( T ),       FIQ( AC),  FIUF( AF),  FIW( AG)

 COMMON /TLP2/
.  HRLDL( A ),       H1( A ),        H2( A ),       H3( A ),
.    H2P(10,A ),   QUF( A ),    SSHMAX( A ),   STCMAX( A ),
.   SUMA(A A),     SUMB( A ),    SUMBP(10,A),    SUMC( A ),
.   CFMD( B ),   ICALD( B ),    QSTORD( B ),   SHADD(24, B),
.   CFMQ( C ),   ICALQ( C ),    QSTORQ( C ),   SHADQ(24, C),
.   CFMW( D ),   ICALW( D ),    QSTORC( D ),  QSTORR( D ),
.  SHADW(24, D )

 COMMON /TLP12A/
.   CFMEX( A ),CODINF( A ), FLORA( A ), HASSL( A ),  HTNZ( A ),
.   IPICK( A ), IPLEN( A ), ISKIP( A ),  IWOE( A ),  IWOL( A ),
.    IWOP( A ),  MULT( A ),    ND( A ), NFOLK( A ),    NQ( A ),
.     NUF( A ),    NW( A ), PLITE( A ), PWEKW( A ),   QEQ( A ),
.  QEQLAT( A ), QIHTS( A ), RATRG( A ),RATRIS( A ),RATRPS( A ),
.   RATRX( A ), RMRGC( A ), RMRG1( A ),RMRISC( A ),RMRIS1( A ),
.  RMRPSC( A ),RMRPS1( A ), RMRXC( A ), RMRX1( A ), TROOM( A ),
.   TSPAC( A ),   VOL( A ),
.  ID( AD, A ),IQ( AC, A ),IUF( AF, A ),IW( AG, A )

 COMMON /TLP12B/
.   ABD( B ),  AD( B ),CINFD( B ), IRF( B ),  ISD( B ),
.   NDD( B ), NVD( B ),  NXD( B ), NYD( B ), ROGD( B ),
.   WAD( B ), WTD( B ),
.   IDD( L, B ), QN(3, B ), QR(3, B ), SUMN( 3, B ), SUMR(3, B ),
.    TD(100, B, 3),XVD( N, B ), YVD( N , B ),ZVD( N, B)

 COMMON /TP12C/
.      ABQ( C ),     AQ( C ), CINFQ( C ),   ISQ( C ),   NDQ( C ),
.      NVQ( C ),    NXQ( C ),    NYQ( C ),QPERIM( C ),  ROGQ( C ),
.       UQ( C ),    WAQ( C ),    WTQ( C ),
.  IDQ( P , C ), XVQ( R , C ),YVQ( R , C ), ZVQ( R , C )

 COMMON /TLP12D/
.     AW( D ), CINFW( D ),  FFWG( D ),  FFWS( D ),IGLASW( D ),
.    NAW( D ),    NDW( D ),   NPW( D ),   NVW( D ),    NXW( D ),
.    NYW( D ),   ROGW( D ), SHACO( D ),   WAW( D 0,WPERIM( D ),
.    WTW( D ), NVAW(3, D ),
.    XAW(4,3, D ), YAW(4,3, D ), ZAW(4,3, D ),
.    TDW( T , D ), XVW( V , D ), YVW( V , D ), ZVW( V , D )
```

```
COMMON /TLP12E/
.       IR( E ), RATOS( E ),    RX(100, E ),    RY(100, E ),
.     NVSP( X ),    PSP( X ),
.      XSP( Y , X ), YSP( Y , X ), ZSP( Y , X ),
.   ILOOKD( AH),JLOOKD( AH),MLOOKD( AH),
.   ILOOKQ( AI),JLOOKQ( AI),MLOOKQ( AI),
.   ILOOKW( AJ),JLOOKW( AJ),MLOOKW( AJ)
```

MATCON SUBROUTINE

```
DIMENSION ISHADE( AO, AN)
```

SHADOW SUBROUTINE

```
DIMENSION
.XVERTF( I ),YVERTF( I ),ZVERTF( I ),IDLETE( K ),
.  ANGLE( AK),     X1( AK),     Y1( AK),      Z1( AK)
DIMENSION
.  NVERT( X ),  PERMS( AL),XVERTS( AM, AL),YVERTS( AM, AL),
.                          ZVERTS( AM, AL)
DIMENSION  ISHADE( AO, AN)
```

SYSTEMS PROGRAM GLOSSARY

A	:	Number of spaces in building
B	:	Number of distinct delayed heat transfer surfaces in building
C	:	Number of distinct quick heat transfer surfaces in building
D	:	Number of distinct windows in building
E	:	Number of types of delayed heat transfer surfaces
F	:	Number of inside heat transfer surfaces in building
H	:	Number of underground floors in building
AB	:	Maximum number of inside heat transfer surfaces in a space
AC	:	Maximum number of quick heat transfer surfaces in a space
AD	:	Maximum number of delayed heat transfer surfaces in a space
AF	:	Maximum number of underground spaces in a space
AG	:	Maximum number of windows in a space
BL	:	Number of boilers
CH	:	Number of chillers
DX	:	Number of DX and heat pump units
EG	:	Number of engine/generator units
FA	:	Number of fan systems
*FB	:	Total number of fan systems
PL	:	Process loads

CURRENT VALUES FOR ARRAY SIZES

A = 35	B = 75	C = 25
D = 35	E = 26	F = 70
H = 30	AB = 30	AC = 30
AD = 30	AF = 30	AG = 30
BL = 5	CH = 5	DX = 10
EG = 5	FA = 15	FB = 17
PL = 10		

* NOTE: Because the Systems Energy Simulation Program (SESP) loops by fan systems, a dummy fan system is used internally for plenums and uncontrolled zones. If more than 15 fan systems are to be simulated, changes to the program code are required.

SESP DIMENSIONS WHICH REQUIRE CHANGE

```
COMMON ZONE1
    COMMON /ZONE1/ QS( A)   ,QL( A)     ,QLITE( A) ,SLPOW( A) ,QSINF( A)
   .               ,QLINF( A),STEMP( A),UCFM( A)  ,TSP( A)    ,VOL( A)
   .               ,TOA      ,WOA       ,HOA       ,DOA       ,PATM
   .               ,TCO      ,KBLDG     ,KMAX      ,IZNMX     ,MSTRT
   .               ,NDAYS    ,MEND      ,IMAX(12)

COMMON FAN1
    COMMON /FAN1/ KFAN(FA) ,JMAX(FA)   ,CFMAX(FA) ,CFMEX(FA) ,ALFAM(FA)
   .             ,OACFM(FA) ,RHSP(FA)  ,WSP(FA)   ,DAVE(FA)  ,WRA(FA)
   .             ,DRA(FA)   ,PWGAL(FA) ,FMASS(FA) ,FMASR(FA) ,FMASX(FA)
   .             ,TFNPS(FA) ,TFNPR(FA) ,TFNPE(FA) ,FBHPS(FA) ,FBHPR(FA)
   .             ,FBHPE(FA) ,DTFNS(FA) ,DTFNR(FA) ,MXAO(FA)  ,IVVRH(FA)
   .             ,ICZN(FA)  ,ITMPC(FA,2),NVFC(FA) ,VVMIN(FA) ,TCOFC(FA)
   .             ,TOACO(FA) ,TFIX1(FA) ,TFIX2(FA) ,RIPA(FA)  ,JDXHP(FA)
   .             ,PLOC(FA)  ,PAREA(FA) ,PERIM(FA) ,ISET(FA,4)
   .             ,IFSO(FA)  ,IVENT(FA)

COMMON ZONE2
    COMMON /ZONE2/ CFM( A)  ,CFMS( A)  ,CFMR( A)  ,CFMX( A) ,ZMASS( A)
   .               ,ZMAS( A) ,ZMASR( A) ,ZMASX( A) ,QSI( A)  ,TS( A)
   .               ,WZ( A)   ,ALFBR( A) ,CBTU( A)  ,QCLNM( A)
   .               ,QCPNM( A),IHCNM( A) ,QHLNM( A) ,QHPNM( A),IHHNM( A)
   .               ,IPLEN( A),MULT( A)  ,SPACN(FB, A)        ,I
   .               ,IPL

COMMON ZONE3
    COMMON /ZONE3/ IPLS( A)    ,HCAPD( A)  ,CCAPD( A)   ,WOFN( A)
   .               ,IVS( A)     ,CFMP( A)   ,ISURF( A,3) ,IFD( A,3)
   .               ,AFLOR( A,3),IPSA( A),   QPLMS( A)    ,QPLMW( A)
   .               ,KSPA(50)    ,JSPA(50)   ,NSPA

COMMON ICTWR
    COMMON / ICTWR / MAX9D,     MAX9E,     MAX9F,     MAX9G,
   .                 TWB1(5),   CTWL(5),   CTPL1(5),  DCTWL(5),
   .                 CTWL2(5),  CTPPP(5),  CTPL2(5),  DCTPP(5)

COMMON IDXHP
    COMMON / IDXHP / NDXHP,       IDXHP(DX),  DCCAP(DX),  DCPOW(DX),
   .                 DHCAP(DX),   DHPOW(DX),  NCP(DX),    NHP(DX),
   .                 PVCCA(DX,5),PVCPO(DX,5),TREFC(DX,5),PVHCA(DX,5),
   .                 PVHPO(DX,5),TREFH(DX,5)

COMMON ICHLUS
    COMMON / ICHLUS / MAX9A(CH),   MAX9B(CH),  MAX9C(CH),   TCON1(CH,5),
   .                  TCON2(CH,5), CCAP(CH,5), CPPWR(CH,5), CPPL(CH,5),
   .                  CPPP(CH,5)
```

SESP DIMENSIONS WHICH REQUIRE CHANGE

```
COMMON IBLRUS
   COMMON / IBLRUS / MAXBA, BPL(6,BL), BPCT(6)

COMMON IBOIL
   COMMON / IBOIL / NBOIL,    IBOPT(BL), NUMB(BL), SZB(BL), M3(BL),
   .                KREHT   , HVHO,     HDBLP,   BLRAUX

COMMON ICHIL
   COMMON / ICHIL / NCHIL,     ICOPT(CH),  NUMC(CH),  SZC(CH),
   .                M1(CH),     M2(CH),     M6(CH),    M7(CH),
   .                FFLMN,      TLCHL,      HDCLP,     HDCNP

COMMON IEG
   COMMON / IEG / NENG,     IEGOP(EG), M4(EG),    M5(EG),      EGCAP(EG),
   .              HVDF,     EFUEL(EG), EQBAK(EG), EFPCT(EG,5), EQPCT(EG,5)
   .             ,MAX7A,    MAX7B,    EGPCT(EG), EGPLD(EG)

COMMON IPROC
   COMMON /IPROC / NPROC , PRPK(PL), IPREN(PL), IPRSC(PL),
   .               PRSTMP, PRSTMT

COMMON SCHDI
   COMMON /SCHDI/ NDTS,        IVTSD(20,24),VTSD1(20,24),VTSD2(20,24)
   .             ,NRSCH,      STDS(10,24), SCHD(10,8,24)
   .             ,NWSC,       ISTT(10,8)
   .   ,IHOUR,NYTS,IYZT( A),IVNO( A),IYTSN(10,5),IYTSD(10,5)

COMMON RSET
   COMMON / RSET / NRSET,       TOALO(FB),   TOAHI(FB),   TLO(FB),
   .               THI(FB)

COMMON RESF
   COMMON / RESF / NRES,        IRFL(20),    CRFL(20),     FLRY(20,50),
   .FLRZ(20,50),FLRX(20,50),TFURN( A,5,3),QFURN( A,3),BCKT( A,5),
   .DFURNX( A,5),DFURNY( A,5),DFURNZ( A,5),DCR( A),QSPC( A,3),
   .RMF(20),DMF( A),DVF( A),FTHK(20)

COMMON MISC
   COMMON / MISC / EFF    , PWOL   ,KFLCV  ,CINSL  ,DINSL
   .              ,DDF    , DHO    ,CFMBN  ,CFMBX  ,CFMBE
   .              ,PWBIL  , TFBHP  ,IISRT  ,IHSTP ,FAN(13)
   .              ,QRCNM  , QRPNM  ,IHRNM  ,QBCNM  ,QBPNM
   .        ,IHBNM , CFMIN( A)
```

SESP DIMENSIONS WHICH REQUIRE CHANGE

COMMON VTDATA

```
    COMMON / VTDATA /  AD( B),      AQ( C),      ALF( H),      ALW( H)
   .                  ,AW( D),      FIHTS( F),   FLORB( A),    FLF( H)
   .                  ,FLW( H),     ID( A,AD),   IHTS( A,AB),  IMLT( A)
   .                  ,IQ( A,AC),   IR(26),      IRF( B),      ISPC1( F)
   .                  ,ISPC2( F),   ISQ( C),     ILF( A, H),   ILW( A, H)
   .                  ,IW(A, D),   NC( A),     ND( A),       NDB
   .                  ,NFN(13),     NF( A),      NRF,          NIHT
   .                  ,NIHTS( A),   NQ( A),      NQB,          NS
   .                  ,NLFB,        NLF( H),     NLWB,         NLW( H)
   .                  ,NW( A),      NWB,         RATOS(26),    RX(26,100)
   .                  ,RY(26,100), RZ(26,100),  TSPAC( A),    UGW( A)
   .                  ,UQ(25),      WOF( A),   IWOP( A), FOLK(15,9,24)
```

COMMON VTTEMP

```
    COMMON / VTTEMP /  SMH( A),      SMC( A),      SLT( A)
   .                  ,SHT( A),      SIHTC( A)
   .                 ,ITMAT(2, A,16)      ,       RANGE(15)
```

COMMON VTSRF

```
    COMMON / VTSRF /  NSRF( A),  ETEMP( A,100),  SRF( A,100)
```

COMMON VTHRLY

```
    COMMON / VTHRLY /  SUM4( A), SUM5( A), JDAY,   IDT
   .                  ,IITIME,   IPOSE,    KEASON, IWS
   .                  ,ITIME,    ISTRT,    IEND
```

COMMON MAINCOM

```
    COMMON / MAINCOM / IHSRT    ,IPSUM   ,ISHBN   ,ISHRN
   .         ,SQBCN   ,SQRCN    ,DCNM    ,DUMMY1  ,DUMMY2
   .         ,DUMMY   ,ZERO
   .         ,NMDAY(7),NCODE(11),MONTH(12)
   .         ,SQCNM( A), ISHCN( A), SQHNM( A), ISHHN( A)
   .         ,QKC(FB),    QKH(FB),    QKKW(FB),  PWLK(FB)
   .         ,H2OK(FB),   TKHL(FB),   TKCD(FB)
   .         ,DXCAPC(DX),DXCAPH(DX)
   .         ,RHOC(6),    RHOH(6),    RHOCHP(6,DX),RHOHHP(6,DX)
   .         ,TEMP3(5)   ,TEMP4(5)
   .         ,HPCLG(DX), HPHTG(DX), DXRHOC(DX), DXRHOH(DX)
   .         ,LABDX(2),   SUBLAB(22)
   .         ,HRLDS( A), HRLDL( A), QINFS( A)
   .         ,TPKGAS(12),TPKOIL(12)
```

NOTES AND COMMENTS

APPENDIX B

NECAP INPUT FILE

FORMATS
FOR
CODED FILES

This appendix shows program input instructions with only a minimum of data. It's use should be considered after the user has a good understanding of the program and input requirements as described in the NECAP Input Manual.

The NECAP input file is a free formatted file. Each card consists of two parts. The first part is the label which is terminated with an equal sign. The second part is the variable list, where the variables are separated with commas or blanks. The entire card is terminated with a semi-colon.

Also included in this appendix are the coded files produced by the NECAP Input Processing Program (NIPP). These files are used by NIPP for data checking, and by the Thermal Loads Analysis Program (TLAP), and the Systems Energy Simulation Program (SESP). The building data and systems data are on coded files so that they can be viewed from printout, or can be viewed or modified from an interactive terminal.

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
L1	1	Program Header	-	See Form	See Form
L2	1	Building Azimuth Angle	degrees(from north)	0. to 360	0.0
	2	Job Processing Code	-	1 to 3	
	3	Estimated Total Fan Pressure	inches of water	0. to 15.	2.0
	4	Zone Cold Air Supply Temperature	^{o}F	40. to 70.	52.0
	5	Zone Hot Air Supply Temperature	^{o}F	80. to 200.	120.0
	6	Ventilation Air Rate	CFM/FT^2	0.0 to 10.0	0.1
	7	Latitude	degrees	-90. to 90.	wt
	8	Longitude	degrees	0. to 360.	wt
	9	Time Zone Number	-	4 to 8	wt
	10	Clearness Number for Summer	-	0.90 to 1.15	wt
	11	Clearness Number for Winter	-	0.84 to 1.05	wt
L3	1	Starting Month	Months	1 to 12	1
	2	Starting Day	Days	1 to 31	1
	3	Ending Month	Month	1 to 12	12
	4	Ending Day	Day	1 to 31	31
	5	Special	Days	0 to 365	0
	6	Altitude Above Sea Level	Ft.	0. to 10,000.	wt
	7	Summer Maximum Dry-Bulb Temperature	^{o}F	50. to 150.	wt
	8	Summer Daily Dry-Bulb Temperature Range	^{o}F	0. to 30	wt
	9	Summer Dew Point Temperature	^{o}F	30. to 90.	wt
	10	Summer Windspeed	MPH	0. to 25	wt
	11	Winter Minimum Dry-Bulb Temperature	^{o}F	-50. to 75	wt
	12	Winter Daily Dry-Bulb Temperature Range	^{o}F	0. to 30	wt
	13	Winter Dew Point Temperature	^{o}F	-50. to 75.	wt
	14	Winter Windspeed	MPH	0. to 25.	wt

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
L4	1	Starting Month and Day of Printout No. 1	-	1 to 12	0
	2		-	1 to 31	0
	3	Ending Month and Day of Printout No. 1	-	1 to 12	0
	4		-	1 to 31	0
	5	Starting Month and Day of Printout No. 2	-	1 to 12	0
	6		-	1 to 31	0
	7	Ending Month and Day of Printout No. 2	-	1 to 12	0
	8		-	1 to 31	0
	9	Starting Month and Day of Printout No. 3	-	1 to 12	0
	10		-	1 to 31	0
	11	Ending Month and Day of Printout No. 3	-	1 to 12	0
	12		-	1 to 31	0
L5	1	Sunday Schedule Code	-	1 to 20	1
	:	: : :	-	: : :	:
	7	Saturday Schedule Code	-	1 to 20	1
	8	Holiday Schedule Code	-	1 to 20	1
	9	Special Holiday Schedule Code	-	1 to 20	1
L6	1	Fraction of load for 12 midnight to 1 AM	decimal	0.0 to 1.0	0.0
	2	Fraction of load for 1 AM to 2 AM	"	"	"
	3	Fraction of load for 2 AM to 3 AM	"	"	"
	4	Fraction of load for 3 AM to 4 AM	"	"	"
	:	: : :	:	:	:
	23	Fraction of load for 10 PM to 11 PM	"	"	"
	24	Fraction of load for 11 PM to 12 Midnight	"	"	"

NECAP INPUT FILE

CARD		VARIABLE NUMBER AND DESCRIPTION	UNITS	LIMITS	DEFAULTS
L7	1	Form Description Code	-	0 or 1	0
	2	Surface Transmittance	-	0.0 to 1.0	0.0
	3	Lower lefthand vertex X-coordinate value	FT.	-	0.0
	4	Lower lefthand vertex Y-coordinate value	FT.	-	0.0
	5	Lower lefthand vertex Z-coordinate value	FT.	-	0.0
	6	Height (vertical dimension) of surface	FT.	-	1.0
	7	Width (horizontal dimension) of surface	FT.	-	1.0
	8	Azimuth angle of surface	degrees	0. to 360.	180.0
	9	Surface tilt angle	degrees	0. to 180.	90.0
L7'	1	Form Description Code	-	0 or 1	0
	2	Surface Transmittance	-	0.0 to 1.0	0.0
	3	x,y,and z - coordinate values for vertex no. 1	FT.	-	0.0
	4		FT.	-	0.0
	5		FT.	-	0.0
	6	x,y,and z - coordinate values for vertex no. 2	FT.	-	0.0
	7		FT.	-	0.0
	8		FT.	-	0.0
	:	: : :	:	:	:
	48	x,y, and z - coordinate values for vertex no. 16	FT.	-	0.0
	49	(if necessary)	FT.	-	0.0
	50		FT.	-	0.0
L8	1	Standard Surface Code no. 1	-	1 to 16	1
	2	Standard Surface code no. 2	-	1 to 16	2
	:	: :	:	:	:
	16	Standard Surface code no. 16 (if necessary)	-	1 to 16	16
L9	1	Material Thickness	FT.	-	0.0
	2	Material Thermal Conductivity	$Btu/hr\text{-}ft^2\text{-}^oF$	-	0.0
	3	Material Density	Lb/ft^3	-	0.0
	4	Material Specific Heat Capacity	$Btu/lb\text{-}^oF$	-	0.0
	5	Material Thermal Resistivity	$Hr\text{-}ft^2\text{-}^oF/Btu$	-	0.0
	6	Material Name	-	30 characters	(Blank)

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
L10	1	Material Index 1	-	1 to 30	0
	2	Material Index 2	-	1 to 30	0
	⋮	⋮ ⋮	⋮	⋮	⋮
	10	Material Index 10 (if necessary)	-	1 to 30	0
L11	1	Similar Surface Index	-	-	0
	2	Response Factor Surface Code	-	-	0
	3	Surface Exterior Absorptivity	-	0.0 to 1.0	0.75
	4	Reflectivity of Ground Facing Surface	-	0.0 to 1.0	0.20
	5	Surface Roughness Index	-	1 to 6	2
	6	Infiltration Flow Coefficient	-	-	0.0
	7	Number of X-Divisions in Surface	-	1 to 50	1
	8	Number of Y-Divisions in Surface	-	1 to 50	1
	9	Number of Vertices	-	0 to 10	1
	10	Surface Azimuth Angle	degrees	0. to 360.	180.0
	11	Surface Tilt Angle	degrees	0. to 180.	90.0
	12	Surface Height (Vertical Dimension)	ft.	-	1.0
	13	Surface Width (Horizontal Dimension)	ft.	-	1.0
	14	Lower lefthand Vertex X-Coordinate Value	ft.	-	0.0
	15	Lower lefthand Vertex Y-Coordinate Value	ft.	-	0.0
	16	Lower lefthand Vertex Z-Coordinate Value	ft.	-	0.0
	17	Index of Added Shading Surface 1	-	-	0
	⋮	⋮ ⋮ ⋮			
L11'	1	Similar Surface Index	-	-	0
	2	Response Factor Surface Code	-	-	0
	3	Surface Exterior Absorptivity	-	0.0 to 1.0	0.75
	4	Reflectivity of Ground Facing Surface	-	0.0 to 1.0	0.20
	5	Surface Roughness Index	-	1 to 6	2
	6	Infiltration Flow Coefficient	-	-	0.0
	7	Number of X-Divisions in Surface	-	1 to 50	1
	8	Number of Y-Divisions in Surface	-	1 to 50	1
	9	Number of Vertices	-	0 to 10	1
	10	X, Y, and Z-Coordinates of Vertex No. 1	ft.	-	0.0
	11		ft.	-	0.0
	12		ft.	-	0.0
	13	X, Y, and Z-Coordinates of Vertex No. 2	ft.	-	0.0
	14		ft.	-	0.0
	15		ft.	-	0.0
	⋮	Index of Added Shading Surface 1	-	-	0
		⋮ ⋮ ⋮ ⋮			

NECAP INPUT FILE

CARD	VARIABLE NUMBER	AND DESCRIPTION	UNITS	LIMITS	DEFAULTS
L12	1	Similar Surface Index	-	-	0
	2	Heat Transfer Coefficient	Btu/hr-ft^2-^{o}F	-	0.0
	3	Surface Exterior Absorptivity	-	0.0 to 1.0	0.75
	4	Reflectivity of Ground Facing Surface	-	0.0 to 1.0	0.20
	5	Surface Roughness Index	-	1 to 6	2
	6	Infiltration Flow Coefficient	-	-	0.0
	7	Number of X-Divisions in Surface	-	1 to 50	1
	8	Numver of Y-Divisions in Surface	-	1 to 50	1
	9	Number of Vertices	-	0 to 10	1
	10	Surface Azimuth Angle	degrees	0. to 360.	180.0
	11	Surface Tilt Angle	degrees	0. to 180.	90.
	12	Surface Height (Vertical Dimension)	ft.	-	1.0
	13	Surface Width (Horizontal Dimension)	ft.	-	1.0
	14	Lower lefthand Vertex X-Coordinate value	ft.	-	0.0
	15	Lower lefthand Vertex Y-Coordinate value	ft.	-	0.0
	16	Lower lefthand Vertex Z-Coordinate value	ft.	-	0.0
	17	Index of Added Shading Surface 1	-	-	0
	:	: : :			
L12'	1	Similar Surface Index	-	-	0
	2	Heat Transfer Coefficient	Btu/hr-ft^2-^{o}F	-	0.0
	3	Surface Exterior Absorptivity	-	0.0 to 1.0	0.75
	4	Reflectivity of Ground Facing Surface	-	0.0 to 1.0	0.20
	5	Surface Roughness Index	-	1 to 6	2
	6	Infiltration Flow Coefficient	-	-	0.0
	7	Number of X-Divisions in Surface	-	1 to 50	1
	8	Number of Y-Divisions in Surface	-	1 to 50	1
	9	Number of Vertices	-	0 to 10	1
	10	X, Y, and Z-Coordinates of Vertex No. 1	ft.	-	0.0
	11		ft.	-	0.0
	12		ft.	-	0.0
	13	X, Y, and Z-Coordinates of Vertex No. 2	ft.	-	0.0
	14		ft.	-	0.0
	15		ft.	-	0.0
	:	X, Y, and Z-Coordinates of the last vertex	ft.	-	0.0
	:	Index of Added Shading Surface 1	-	-	0
	:	: : :			

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
L13	1	Similar Surface Index	-	-	0
	2	ASHRAE Shading Coefficient	-	1. to 1.	1.0
	3	Form Factor between Window and Sky	-	0. to 1.	0.5
	4	Form Factor between Window and Ground	-	0. to 1.	0.5
	5	Reflectivity of Ground Facing Surface	-	0.0 to 1.0	0.20
	6	Window Setback	ft.	-	0.0
	7	Window Border	ft.	-	0.0
	8	Infiltration Flow Coefficient	-	-	0.0
	9	Number of X-Divisions in Surface	-	1 to 60	1
	10	Number of Y-Divisions in Surface	-	1 to 60	1
	11	Number of Panes of Glass	-	1 or 2	1
	12	Glass Code	-	1 to 8	1
	13	Number of Vertices	-	0 to 10	1
	14	Surface Azimuth Angle	degrees	0. to 360.	180.0
	15	Surface Tilt Angle	degrees	0. to 180	90.
	16	Surface Height (Vertical Dimension)	ft.	-	1.0
	17	Surface Width (Horizontal Dimension)	ft.	-	1.0
	18	Lower lefthand vertex X-Coordinate value	ft.	-	0.0
	19	Lower lefthand vertex Y-Coordinate value	ft.	-	0.0
	20	Lower lefthand vertex Z-Coordinate value	ft.	-	0.0
	21	Index of Added Shading Surface 1	-	-	0
	:	: : :			

CARD	VARIABLE NUMBER	AND DESCRIPTION	UNITS	LIMITS	DEFAULTS
L13′	1	Similar Surface Index	-	-	0
	2	ASHRAE Shading Coefficient	-	1 to 8	1
	3	Form Factor between Window and Sky	-	0. to 1.	0.5
	4	Form Factor between Window and Ground	-	0. to 1.	0.5
	5	Reflectivity of Ground Facing Surface	-	0.0 to 1.0	0.20
	6	Window Setback	ft.	-	0.0
	7	Window Border	ft.	-	0.0
	8	Infiltration Flow Coefficient	-	-	0.0
	9	Number of X-Divisions in Surface	-	1 to 50	1
	10	Number of Y-Divisions in Surface	-	1 to 50	1
	11	Number of Panes of Glass	-	1 to 2	1
	12	Glass Code	-	1 to 8	1
	13	Number of Vertices	-	0 to 10	1
	14	X, Y, and Z-Coordinates of Vertex No. 1	ft.	-	0.0
	15		ft.	-	0.0
	16		ft.	-	0.0
	17	X, Y, and Z-Coordinates of Vertex No. 2	ft.	-	0.0
	18		ft.	-	0.0
	19		ft.	-	0.0
	⋮	X, Y, and Z-Coordinates of the last vertex	ft.	-	0.0
	⋮	Index of Added Shading Surface 1	-	-	0
L14	1	Surface Number	-	-	0
	2	Picture Month	-	1 to 12	1
	3	First Picture Hour	-	1 to 24	1
	4	Last Picture Hour	-	1 to 23	see manual
L15	1	Surface Area	ft^2	-	0.0
	2	Heat Transfer Coefficient	$BTU/hr\text{-}ft^2\text{-}{}^oF$	-	0.0
	3	Zone Index 1	-	-	1
	4	Zone Index 2	-	-	2
L16	1	Ground Temperature for first month of analysis	^oF	-	wt
	2	Ground Temperature for second month of analysis	^oF	-	wt
	⋮	: : :			
		Ground Temperature for last month of analysis	^oF	-	wt

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
L17	1	Similar Space Number	-	-	0
	2	Space Floor Area	ft^2	-	0.0
	3	Space Volume	ft^3	-	Area * 10
	4	Weight of Floor in Space	lb/ft^2	-	60.0
	5	Space Temperature	^oF	-	72.0
	6	Maximum Number of People	-	-	0.0
	7	People Activity Level	Btu/hr	-	450.0
	8	People Schedule Index	-	-	1
	9	Type of Light Fixture	-	-	1
	10	Percent of Light Heat to Space	decimal	0.0 to 1.0	1.0
	11	Lighting Load Catagory No. 1	$watts/ft^2$	-	0.0
	12	Lighting Load Catagory No. 2	KW	-	0.0
	13	Lighting Schedule Index	-	-	1
	14	Equipment Load Catagory No. 1	$watts/ft^2$	-	0.0
	15	Equipment Load Catagory No. 2	KW	-	0.0
	16	Equipment Load Catagory No. 3 (Sensible Loads)	Btu/hr	-	0.0
	17	Equipment Load Catagory No. 4 (Latent Loads)	Btu/hr	-	0.0
	18	Equipment Schedule Index	-	-	1
	19	Type of Infiltration Analysis	-	0 to 2	0
	20	Infiltration Rate	no. of air changes per hour	0. to 10.	0.0
	21	Height Above or Below Neutral Zone	ft.	-	0.0
	22	Space Exhaust Air Quantity	CFM	-	0.0
	23	Number of Additional Identical Spaces	-	-	0
	24	Plenum Indicator	-	0 or 1	0
	25	Load Summation Index	-	0 or 1	0
L18	1	Surface Index No. 1	-	-	0
	2	Surface Index No. 2	-	-	0
	:	: :			
	30	Surface Index No. 30 (if necessary)	-	-	0

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
S1	1	Program Header	-	see manual	see manual
S2	1	Simulation Period Beginning Month	-	1 to 12	1
	2	Simulation Period Beginning Day	-	1 to 31	1
	3	Simulation Period Ending Month	-	1 to 12	12
	4	Simulation Period Ending Day	-	1 to 31	31
	5	Output Data File Option Flag	-	0 or 1	0
S3	1	Beginning Month and Day of print Period No. 1	-	1 to 12	0
	2		-	1 to 31	1
	3	Ending Month and Day of print Period No. 1	-	1 to 12	0
	4		-	1 to 31	1
	5	Print Flag 1 for print Period No. 1	-	0 or 1	0
	6	Print Flag 2 for print Period No. 1	-	0 or 1	0
	7	Beginning Month and Day of print Period No. 2	-	1 to 12	0
	8	⋮ ⋮ ⋮	-	1 to 31	0
	⋮				
S4	1	Type of Thermostat for Hour 1	-	0, 1, or 2	0
	2	High Limit of Throttling Range for Hour 1	^{o}F	-	0.0
	3	Low Limit of Throttling Range for Hour 1	^{o}F	-	0.0
	4	Type of Thermostat for Hour 2	-	0, 1, or 2	0
	5	High and Low Limits of Throttling Range for Hour 2	^{o}F	-	0.0
	6	⋮ ⋮ ⋮	^{o}F	-	0.0
	⋮				
	70	Type of Thermostat for Hour 24	-	0, 1, or 2	0
	71	High and Low Limits of Throttling Range for Hour 24	^{o}F	-	0.0
	72		^{o}F	-	0.0
S5	1	Fraction of Total at Hour 1	decimal	0.0 to 1.0	0.0
	2	Fraction of Total at Hour 2	decimal	0.0 to 1.0	0.0
	⋮	⋮ ⋮ ⋮			
	24	Fraction of Total at Hour 24	decimal	0.0 to 1.0	0.0

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
S6	1	Weekly Schedule Type Index	-	0 or 1	see manual
	2	Schedule Code for Sunday	-	-	1
	3	Schedule Code for Monday	-	-	1
	⋮	⋮ ⋮			
	8	Schedule Code for Saturday	-	-	1
	9	Schedule Code for Holiday	-	-	1
S7	1	Yearly Period 1, Starting Month and Day	-	1 to 12	1
	2		-	1 to 31	1
	3	Yearly Period 1, Weekly Schedule Code	-	1 to 10	1
	4	Yearly Period 2, Starting Month and Day	-	1 to 12	12
	5		-	1 to 31	31
	6	Yearly Period 2, Weekly Schedule Code	-	1 to 10	0
	⋮	⋮ ⋮ ⋮			
	13	Yearly Period 5, Starting Month and Day	-	1 to 12	12
	14		-	1 to 31	31
	15	Yearly Period 5, Weekly Schedule Code	-	1 to 10	0
S8	1	Low Outside Air Temperature	^{o}F	-	0.0
	2	High Outside Air Temperature	^{o}F	-	0.0
	3	Low System Fluid Temperature	^{o}F	-	0.0
	4	High System Fluid Temperature	^{o}F	-	0.0
	5	Reset Schedule Label	-	30 characters	(Blank)
S9	1	Material Thickness	ft	-	0.0
	2	Material Thermal Conductivity	Btu/hr-ft^{2}-^{o}F	-	0.0
	3	Material Density	lb/ft^{3}	-	0.0
	4	Material Specific Heat Capacity	Btu/lb-^{o}F	-	0.0
	5	Material Thermal Resistivity	Hr-ft^{2}-^{o}F/Btu	-	0.0
	6	Material Name	-	30 characters	(Blank)
S10	1	Material Index 1	-	1 to 30	0
	2	Material Index 2	-	1 to 30	0
	⋮	⋮ ⋮			
	10	Material Index 10 (if necessary)	-	1 to 30	0

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRITPION		UNITS	LIMITS	DEFAULTS
S11	1	Type of Fan Distribution System	-	1 to 13	1
	2	Number of Zones on System	-	-	1
	3	System Relative Humidity Setpoint	% RH	-	10.
	4	Fixed or Minimum Outside Air	SCFM	-	0.
	5	Mixed Air Option	-	1 to 3	1
	6	Variable Volume Fan Control Option	-	1 to 3	2
	7	Hot Deck/AHU Discharge Temperature Control	-	1 to 3, 6	1
	8	Cold Deck Temperature Control	-	1 to 3, 6	1
	9	Supply Fan Total Pressure	inches of H_2O	-	*
	10	Return Fan Total Pressure	inches of H_2O	-	*
	11	Exhaust Fan Total Pressure	inches of H_2O	-	*
	12	VAV Reheat Coil Option	-	0 or 1	0
	13	Minimum Air Flow Through VAV Box	percent	0. to 100.	10.
	14	Fixed Hot Deck/AHU Discharge Temperature	^oF	-	*
	15	Fixed Cold Deck Temperature	^oF	-	55.
	16	Reset Schedule Index 1	-	0 to 10	0
	17	Reset Schedule Index 2	-	0 to 10	0
	18	Reset Schedule Index 3	-	0 to 10	0
	19	Reset Schedule Index 4	-	0 to 10	0
	20	Ratio of Induced to Primary Air	-	-	1.0
	21	Two-Pipe System Changeover Temperature	^oF	-	50.
	22	Floor Panel Heating System Hot Water Shutoff Temperature	^oF	-	50.
	23	Two-Pipe System Water Volume	gals	-	0.0
	24	Location of Floor Heating Panel	-	1 or 2	1
	25	Floor Heating Panel Area	ft^2	-	0.0
	26	Exposed Perimeter of Floor	ft	-	0.0
	27	Fan System Shut-Off Flag	-	0 to 2	0
	28	Ventilation Schedule Index	-	0 to 10	0
	29	Humidistat Location	-	-	1
	30	DX/Heat Pump Index	-	0 to 6	0

* See Next Page

VARIABLE NUMBER:	Pan System Code	Number of Zones	R. H. Set Point	Minimum O. A.	Mixed Air Opt.	Var. Vol Fan	Hot Deck/AHU Lvng. Temp. Control	Cold Deck Temp. Control	Sup. Fan Press.	Ret. Fan Press.	Ex. Fan Press.	Reheat Coils	Minimum Air Flow	Hot Deck/AHU Temp.	Cold Deck Temp.	Hot Deck/Prim. Air AHU Reset Sched.	Cold Deck Reset Schedule	Baseboard Reset	Two Pipe Reset Schedule	Frac. Induced Air	Two Pipe Changeover Temp.	Hotwater Shutoff	Vol. Water	Heating Panels	Floor Area	Perimeter	Shutoff Flag	Vent. Schedule	Humidity Control	DX/Heat Pump Index
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
* SINGLE ZONE W/DAMPERS	1	1	10	0	1		1	1	3	0	.5				55			0									2	0	1	0
MULTI-ZONE	2	1	10	0	1		1	1	3	0	.5			110	55	0	0	0									2	0	1	0
DUAL DUCT	3	1	10	0	1				5	0	.5			110	55	0	0	0									2	0	1	0
SINGLE ZONE W/REHEAT	4	1	10	0	1	2			3	0	.5			55													2	0	1	0
UNIT VENTILATOR	5	1		0					1		.5																2	0		0
UNIT HEATER	6	1							1		.5																2	0		0
FLOOR PANEL HEATING	7	1																X				X		X	X	X				
TWO PIPE FANCOIL	8	1		0					1		.5							0	0		50		100				2	0		
FOUR PIPE FANCOIL	9	1		0					1		.5							0									2	0		
TWO PIPE INDUCTION	10	1	10	0	1				5	0	.5					0		0	0	2	50		100				2	0	1	0
FOUR PIPE INDUCTION	11	1	10	0	1				5	0	.5			55				0		2							2	0	1	0
VARIABLE VOLUME	12	1	10	0	1	2			5	0	.5	1	40	55				0									2	0	1	0
CONSTANT VOLUME REHEAT	13	1	10	0	1		1		3	0	.5			55		0		0									2	0	1	0

NOTES: *) S11 Card defaults to this fan system
1) Numbers in chart are default values except field 1
2) Blank spaces do not require a value
3) Spaces that have a zero are optional input
4) Spaces that have an 'X' are required input

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
S12	1	Fan System Number	-	1 to 15	1
	2	Load Program Space Number	-	1 to 35	1
	3	Plenum Indicator	-	0 or 1	0
	4	Supply Air Quantity	CFM	-	*
	5	Exhaust Air Quantity	CFM	-	0.0
	6	Baseboard Output	Btu/hr/linear ft.	-	0.0
	7	Baseboard Radiation Active Length	ft	-	0.0
	8	Yearly Thermostat Schedule	-	0 to 10	0
	9	Design Heating Capacity	Btu/hr	-	*
	10	Design Cooling Capacity	Btu/hr	-	*
	11	Weight of Furnishings	lb/ft^2	-	10.0
	12	Zone Multiplier	-	-	1
	13	Load Program Plenum Space Number	-	-	0
	14	Internal Component Type 1	-	1 to 3	0
	15	Response Factor Index of Component 1	-	1 to 10	0
	16	Area of Component 1	ft^2	-	0.0
	17	Internal Component Type 2	-	1 to 3	0
	18	Response Factor Index of Component 2	-	1 to 10	0
	19	Area of Component 2	ft^2	-	0.0
	20	Internal Component 3	-	1 to 3	0
	21	Response Factor Index of Component 3	-	1 to 10	0
	22	Area of Component 3	ft^2	-	0.0
	23	Zone Name	-	30 characters	(Blank)
S12'	1	Fan System Number	-	1 to 15	1
	2	Load Program Space Number	-	1 to 35	1
	3	Plenum Indicator	-	0 or 1	0
	4	Space Number Below Plenum	-	-	1
	5	Plenum Airflow	CFM	-	0.0
	6	Weekday Fan Schedule - Hour On	-	0 to 24	1
	7	Weekday Fan Schedule - Hour Off	-	0 to 24	24
	8	Weekend Fan Schedule - Hour On	-	0 to 24	1
	9	Weekend Fan Schedule - Hour Off	-	0 to 24	24
	10	Plenum Name	-	30 characters	(Blank)

* Program will size at execution

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULT
S13	1	Quantity of This Type of E/G Sets	-	-	2
	2	Type of E/G Set	-	0 to 2	0
	3	Capacity of E/G Set	-	-	500
	4	Heating Value of Diesel Fuel	Btu/gal	-	140,000
	5	Full Load Fuel Consumption	gal/hr or ft^3/hr	-	0.0
	6	Percent Fuel Consumption at Idle	percent	-	0.0
	7	Percent Fuel Consumption at 25% Load	percent	-	0.0
	8	" " " " 50% Load	percent	-	0.0
	9	" " " " 75% Load	percent	-	0.0
	10	" " " " 100% Load	percent	-	0.0
	11	Heat Recoverable at 100% Load	1000 Btu/hr	-	0.0
	12	Percent Heat Recovery at Idle	percent	-	0.0
	13	Percent Heat Recovery at 25% Load	percent	-	0.0
	14	" " " " 50% Load	percent	-	0.0
	15	" " " " 75% Load	percent	-	0.0
	16	" " " " 100% Load	percent	-	0.0
S14	1	Quantity of This Type of Boiler	-	-	1
	2	Capacity of Boiler	100 Btu/hr	-	*
	3	Month and Day of Start-up	-	1 to 12	1
	4		-	1 to 31	1
	5	Month and Day of Shut-Down	-	1 to 12	12
	6		-	1 to 31	31
	7	Source of Heating Energy	-	1 to 4	3
	8	Source of Reheat Coil Energy	-	0 or 4	0
	9	Heating Value of Heating Oil	Btu/gal	-	150,000
	10	Boiler Part Load Performance @ 0% Load	percent	-	80.0
	11	" " " " @ 20% Load	percent	-	80.0
	12	" " " " @ 40% Load	percent	-	80.0
	13	" " " " @ 60% Load	percent	-	80.0
	14	" " " " @ 80% Load	percent	-	80.0
	15	" " " " @ 100% Load	percent	-	80.0

* Program will size at execution

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMTIS	DEFAULT
S15	1	Type of Chiller	-	0 to 5	1
	2	Quantity of This Type of Chiller	-	-	1
	3	Capacity of Chiller	tons	-	*
	4	Month and Day of Chiller Start-Up	-	1 to 12	1
	5		-	1 to 31	1
	6	Month and Day of Chiller Shut-Down	-	1 to 12	12
	7		-	1 to 31	31
	8	Source of Chiller Energy	-	1 to 4	1*
	9	Minimum Part Load Cut-Off	percent	10. to 100.	10.
	10	Chilled Water Setpoint Temperature	^{o}F	32. to 50.	45.
	11	Chiller Rating	KW/TON or Lb	>0	*
	12	Number of Chiller Capacity vs. Condenser Water	-	0 to 5	0
	13	Chiller Capacity Point 1	tons	-	**
	14	Leaving Condenser Water Temperature for Capacity Point 1	^{o}F	-	**
	15	Chiller Capacity Point 2	tons	-	**
	16	Leaving Condenser Water Temperature for Capacity Point 2	^{o}F	-	**
	⋮	⋮ ⋮ ⋮			**
	⋮	Chiller Capacity Point 5	tons	-	**
	⋮	Leaving Condenser Water Temperature for Capacity Point 5	^{o}F	-	**
	⋮	Number of Chiller Power vs. Condenser Water Temperature	-	0 to 5	**
		Data Points			**
		Chiller Power Point 1	KW or lb or steam	-	**
		Leaving Condenser Water Temperature for Power Point 1	^{o}F	-	**
		⋮ ⋮ ⋮			**
		Chiller Power Point 5	KW or lb of steam	-	**
		Leaving Condenser Water Temperature Power Point 5	^{o}F	-	**
		Number of % Chiller Power vs % Peak Load Data Points	-	0 to 5	0
		% Chiller Peak Power Point 1	-	-	**
		% Chiller Peak Load Point 1	-	-	**
		⋮ ⋮			**
		% Chiller Peak Power Point 5	-	-	**
		% Chiller Peak Load Point 5	-	-	**

* Program will determine at execution

** See chart

CHILLER DEFAULTED OPERATING CURVES

CHILLER TYPE	# POINTS	% CAPACITY VERSUS LEAVING CONDENSER WATER TEMPERATURE					# POINTS	% PEAK POWER VERSUS LEAVING CONDENSER WATER TEMPERATURE					# POINTS	% PEAK POWER VERSUS % PEAK LOAD				
		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
RECIPROCATING	5	100 65	100 95	100 97	100 100	20 130	5	90 65	100 95	104 97	109 100	120 105	5	35 10	45 40	90 90	100 100	120 110
HERMETIC CENTRIFUGAL	5	100 65	100 95	100 97	100 100	10 120	5	93 65	100 95	104 97	109 100	120 105	5	25 10	40 40	89 90	100 100	110 105
OPEN CENTRIFUGAL	5	100 65	100 90	100 95	100 100	10 110	5	25 65	42 90	72 95	100 100	100 110	5	25 10	42 40	72 70	100 100	120 110
STEAM ABSORPTION	5	102 65	98 90	82 98	69 101	35 103	5	100 65	97 90	86 98	80 101	62 103	5	14 10	39 40	65 70	100 100	110 125
STEAM TURBINE	5	100 65	100 90	100 95	100 100	10 110	5	60 65	88 90	94 95	100 100	100 110	5	50 10	62 40	87 70	100 100	110 110

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
S16	1	Cooling Tower Water Low Limit Temperature	^oF	75. to 90.	75.
	2	Condenser Water Temperature Rise	^oF	5. to 20.	10.
	3	Cooling Tower Peak Power	KW	-	*
	4	Number of Leaving Tower Water Temperature vs. Ambient Wet-bulb Temperature at 100% Load Data Points	-	0 to 5	0.
	5	Leaving Tower Water Temperature Point 1	^oF	-	0.0
	6	Ambient Wet-bulb Point 1	^oF	-	0.0
	⋮	⋮ ⋮			
	⋮	Leaving Tower Water Temperature Point 5	^oF	-	0.0
	⋮	Ambient Wet-bulb Point 5	^oF	-	0.0
	⋮	Number of Δ Leaving Tower Water Temperature vs. % Peak Load Data Points	-	0 to 5	0
		Change in Leaving Tower Water Temperature for Part Load 1A	^oF	-	0.0
		Part Load 1A	percent	-	0.0
		⋮ ⋮			
		Change in Leaving Tower Water Temperature for Part load 5A	^oF	-	0.0
		Part Load 5A	percent	-	0.0
		Number of Cooling Tower % Peak Power vs. Leaving Tower Water Temperature at 100% Load Data Points	-	0 to 5	0
		Cooling Tower % Peak Power Point 1	percent	-	0.0
		Leaving Tower Water Temperature Point 1	^oF	-	0.0
		⋮ ⋮ ⋮			
		Cooling Tower % Peak Power Point 5	percent	-	0.0
		Leaving Tower Water Temperature Point 5	^oF	-	0.0
		Number of Δ Tower % Peak Power vs. % Peak Load Data Points	-	0 to 5	0
		Change in Tower % Peak Power for Part Load 1B	percent	-	0.0
		Part Load 1B	percent	-	0.0
		⋮ ⋮			
		Change in Tower % Peak Power for Part Load 5B	percent	-	0.0
		Part Load 5B	percent	-	0.0

* Program will size

NECAP INPUT FILE

CARD	VARIABLE NUMBER AND DESCRIPTION		UNITS	LIMITS	DEFAULTS
S17	1	Design Cooling Capacity	100 Btu/hr	-	*
	2	Design Cooling Power	KW	-	*
	3	Number of Cooling Performance Data Points	-	0 to 5	0
	4	Ambient Dry-bulb Temperature at Point 1A	^oF	-	**
	5	% of Design Cooling Capacity at Ambient Temperature 1A	percent	-	**
	6	% of Design Cooling Power at Ambient Temperature 1A	percent	-	**
	⋮	⋮ ⋮ ⋮			**
	⋮	Ambient Dry-bulb Temperature at Point 5A	^oF	-	**
	⋮	% of Design Cooling Capacity at Ambient Temperature 5A	percent	-	**
	⋮	% of Design Cooling Power at Ambient Temperature 5A	percent	-	**
		Design Heating Capacity	1000 Btu/hr	-	**
		Design Heating Power	KW	-	**
		Number of Heating Performance Data Points	-	0 to 5	0
		Ambient Dry-bulb Temperature at Point 1B	^oF	-	**
		% of Design Heating Capacity at Ambient Temperature 1B	percent	-	**
		% of Design Heating Power at Ambient Temperature 1B	percent	-	**
		⋮ ⋮ ⋮			**
		Ambient Dry-bulb Temperature at Point 5B	^oF	-	**
		% of Design Heating Capacity at Ambient Temperature 5B	percent	-	**
		% of Design Heating Power at Ambient Temperature 5B	percent	-	**
S18	1	Boiler Pump Head	ft	-	50.0
	2	Chiller Water Pump Head	ft	-	40.0
	3	Condenser Water Pump Head	ft	-	30.0
	4	Fan and Pump Motor Efficiency	percent	1. to 100	85.
S19	1	Peak Process Load	see manual	-	0.0
	2	Energy Source Code	-	0 to 4	0
	3	Operating Schedule Index	-	1 to 10	0
S20	1	General Steam Pressure	psig	2. to 12.	12.0
	2	General Steam Temperature	^oF	-	245.0
	3	Turbine Steam Pressure	psig	-	125.
	4	Turbine Steam Temperature	^oF	-	353.
	5	Turbine Speed	rpm	-	3600.
	6	External Lighting Power	KW	-	0.
	7	Type of Floor Covering	-	1 to 3	1
	8	Floor Insulation Conductance	Btu/hr-^oF-ft^2	-	0.0
	9	Floor Insulation Thickness	ft	-	0.0

* Program will size ** See chart

DX/HEAT PUMP DEFAULTED HEATING & COOLING DATA POINTS

If default is used then all values must default

COOLING

5 NUMBER OF COOLING PERFORMANCE DATA POINTS					
DATA POINT	1	2	3	4	5
AMBIENT DRY-BULB TEMP.	85.0	95.0	100.0	105.0	110.0
% DESIGN COOLING CAPACITY	100.0	94.0	90.0	86.0	79.0
% DESIGN COOLING POWER	100.0	105.0	107.0	110.0	115.0

HEATING

5 NUMBER OF HEATING PERFORMANCE DATA POINTS					
DATA POINT	1	2	3	4	5
AMBIENT DRY-BULB TEMP.	-10.0	0.0	20.0	40.0	60.0
% DESIGN HEATING CAPACITY	16.0	24.0	40.0	61.0	100.0
% DESIGN HEATING POWER	66.0	69.0	83.0	99.0	100.0

The loads data input via the L cards is written to a coded file (TAPE7) which is read by TLAP. This is a rigidly formatted file. The Data may be entered directly into TLAP without using NIPP by constructing a TAPE7 file, however, no defaults are allowed, and the method is tedious. The TAPE7 file may be altered with a text editor if desired. The TAPE7 file may be input into NIPP for data error checking.

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L1-A	1-35	Header 1 - e.g., Facility name	IDEN1				Engineering building	Not more than 35 characters
L1-B	1-35	Header 2 - e.g., Facility location	IDEN2				Hampton, VA	Not more than 35 characters
L1-C	1-35	Header 3 - e.g., Engineer's name	IDEN3				R. Jensen	Not more than 35 characters
L1-D	1-15	Header 4 - e.g., Project number	IDEN4				NASI-16078	Not more than 15 characters
L1-E	1-15	Header 5 - e.g., Date	IDEN5				15 July 1974	Not more than 15 characters
L2-B	1-10	Latitude	STALAT	Degrees	-90.0-90.0		42.0	See 1972 ASHRAE Handbook, Chapter 33
	11-20	Longitude	STALON	Degrees	0.0-360.0		88.0	See 1972 ASHRAE Handbook, Chapter 33
	21-30	Time zone number	TZN		4.0-8.0		6.0	
	31-40	Clearness number for summer	CNS		0.84-1.05		0.98	
	41-50	Clearness number for winter	CNW		0.84-1.05		0.98	
	51-60	Building azimuth	BAZ	Degrees	0.0-360.0		270.0	
L2-A	1-10	Job processing code	CODE		1.0 2.0 3.0	1.0 Design load analysis only 2.0 Design load & hourly energy analysis 3.0 Hourly Energy analysis only	2.0	If code equal 3.0,skip L3-B, C and D; go to L4-A

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L2-A	11-20	Ventilation air rate	CFMSF	CFM/FT^2	0.-10.		0.1	
	21-30	Estimated total fan pressure	FPRES	Inches water	0.-15.		4.0	Used to estimate fan heat
	31-40	Zone cold air supply temperature - 1	DTC	^oF	40.-40.		52.0	Used to determine zone cold air supply rate
	41-50	Blank						
	51-60	Zone hot air supply temperature - 1	DTH	^oF	80.-200.		120.0	Used to determine zone hot air supply rate
L3-B	1-10	Building altitude above sea level	ALTUD	FT	0.-10,000		500.0	See 1972 ASHRAE Hand book, Chapter 33
L3-C	1-10	Summer-Maximum dry-bulb temperature	TDBS	^oF	50.-150.		94.0	
	11-20	Summer-Daily range of dry-bulb temperature	RANGS	^oF	0.-30.		16.0	Summer Design Day Condition
	21-30	Summer-Dew point temperature	TDPS	^oF	30.-90.		75.0	
	31-40	Summer-Wind speed	WINDS	MPH	0.-25.		5.0	
L3-D	1-10	Winter-Minimum dry-bulb temperature	TDBW	^oF	-50.-75		-10.0	
	11-20	Winter-Daily range of dry-bulb temperature	RANGW	^oF	0.-30.		3.0	
	21-30	Winter-Dew point temperature	TDPW	^oF	-50.-60.		-10.0	Winter design day condition
	31-40	Winter-Wind speed	WINDW	MPH	0.-25.		7.0	

IF PERFORMING DESIGN LOAD ANALYSIS ONLY (i.e., CODE=1), SKIP L3-A AND GO TO L4-A

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L3-A	1-10	Starting day	YEAR		1.-31		1	
	11-20	Starting month	ONTH		1.-12.		1	
	21-30	Length of study	ENGTH	Days	1.-365.		12.0	
	31-40	Length of special schedule at end of year	XMAS		1.-365.		365	
L-4	1-6	Starting hour for printing	CPRINT	Hours	0.-8784.		5089.	For printout of hourly data and calculated space load.
	7-12	Stopping hour for printing	CPRINT				5136.	
	13-18	Starting hour for printing	CPRINT					
	19-24	Stopping hour for printing	CPRINT					
	25-30	Starting hour for printing	CPRINT					
	31-36	Stopping hour for printing	CPRINT					
	37-42	Starting hour for printing	CPRINT					
	43-48	Stopping hour for printing	CPRINT					
L5-Z	1-10	Number of different types of space schedules desired	TYPS		1.0-3.0		2.0	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
READING ORDER L5-A SHOULD BE REPEATED "TYPS" TIMES								
L5-A	4-6	Is schedule required?	CFKSCH		0.0-1.0	0.0 No 1.0 Yes	1.0	
	7-9	Schedule code-Sunday	FISCH		1.0-20.0	1 thru 10 indicates standard schedules built into program. See Table for description. 11 thru 20 indicates schedules to be defined by user via Card L6-A.	1.0	
	10-12	Monday	FISCH				4.0	
	13-15	Tuesday	FISCH				1.0	
	16-18	Wednesday	FISCH				1.0	
	19-21	Thursday	FISCH				1.0	
	25-27	Friday	FISCH				1.0	
	28-30	Saturday	FISCH				1.0	
	31-33	Holiday	FISCH				7.0	
	34-36	Special	FISCH				1.0	
READING ORDER L6-A SHOULD BE USED TO DEFINE NON-STANDARD SCHEDULES NOT IN PROGRAM.								
L6-A	1-3	Fraction of load - 1 AM	STDSCH	Decimal	0.-1.0		0.2	New schedules must be defined in increasing sequence once defined, it need not be entered again.
	4-6	" "	"	"	"			
	"	" "	"	"	"			
	"	" "	"	"	"			
	"	" "	"	"	"			

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L6-A	67-69	Fraction of load - 11 PM	STDSC	Decimal	0.-1.0			
	70-42	Fraction of load - 12 PM	STDSCH	Decimal	0.-1.0		.75	
L7-Z	1-10	Number of common shading surfaces	FNSP		0.0-5.0		0.0	If equal to 0.0, skip reading orders L7-A, B, B' and L8-Z.
READING ORDERS L7-A AND L7-B (OR B') INCLUSIVE SHOULD BE REPEATED "FNSP" TIMES.								
L7-A	1-10	Number of vertices in surface	FNVSP		1.0 or 3.0 to 4.0	1.0 Short form for a rectangle	3.0	If equal to 1.0, use reading order L7-B; otherwise use L7-B'.
	11-20	Transmittance of surface	PSP		0.0-1.0	0.0 Opaque 1.0 Clear	0.5	
L7-B	1-10	Coordinates of lower left hand corner of rectangle surface when viewed from outside.	XCORN	FT			50.0	
	11-20		YCORN	FT			10.0	
	21-30		ZCORN	FT			5.0	
	31-40	Height of surface	H	FT			15.0	
	41-50	Width of surface	W	FT			50.0	
	51-60	Azimuth angle of surface	A	Degree	0.0-360.0		45.0	
	61-70	Tilt angle of surface	B	Degree	0.0-180.0		90.0	
READING ORDER L7-B' SHOULD BE REPEATED "FNVSP" TIMES								

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L7-B'	1-10	Cordinates of surface vertex	XSP	FT			15.0	
	11-20		YSP	FT			20.0	
	21-30		ZSP	FT			0.0	
L8-Z	1-10	Number of different types of delayed surfaces	FNRF		0.0-26.0		2.0	If equals to 0.0, skip reading orders L8-A - L14B, L12-Z
	11-20	Number of standard surfaces	FNSTD		0.0-FNRF		2.0	If equal to 0.0, skip L8-A and go to L10-A.
READING ORDER L8-A IS REQUIRED IF FNSTD GREATER THAN 0.0								
L8-A	1-10	Standard surface code	ISTD		1-16		5.0	
	"	" " "	"		"		"	
	"	" " "	"		"		"	
	"	" " "	"		"		"	
	61-70	Standard surface code	ISTD		1-16		0.0	
READING ORDER L9-A SHOULD BE REPEATED (FNRF-FNSTD) TIMES								
L10-A	1-10	Number of layers	FNOL		1.0-10.0		3.0	Exclude outside air film

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L9-A (Card number not given on output)	1-10	Thickness of the layer	XL				0.333	If layer has no thermal mass, set equal to 0.0
	11-20	Thermal conductivity of the layer	XK	Btu/hr, ft^2, ^oF			0.770	
	21-30	Density of the layer	D	lb/ft^3			125.0	
	31-40	Specific heat capacity of the layer	SH	Btu/lb, ^oF			0.22	
	41-50	Thermal resistivity of the layer	RES	Hr,ft^2, ^oF/Btu			0.00	If layer has thermal mass, set equal to 0.0.
	51-80	Alphanumeric description of layer	DESC				2-inch brick	
L11-Z	1-10	Number of delayed heat transfer surfaces in the building	FNDB		0.0-75.0		28.0	If equal to 0.0, skip reading orders L11-A-L14-B; go to L12-Z
THE READING ORDERS L11-A, L11-B, L11-C, L11-C' INCLUSIVE SHOULD BE REPEATED "FNDB" TIMES.								
L11-A	1-10	Absorptivity of outside of surface	ABD		0.0-1.0		0.35	See Table 6.9
	11-20	Reflectivity of ground facing surface	ROGD		0.0-10.		0.30	See Table 6.10
	21-30	Infiltration flow coefficient	CINFD				0.50	See Table 6.13. Use for crack method; otherwise leave blank.

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L11-B	1-10	Number of vertices in surface	FNVD		1.0 or 3.0 to 20	1.0 Short form for a rectangle	1.0	If equal to 10, use reading order L11-C; otherwise use L11-C'
	11-20	Number of X divisions in surface	FNXD		1.0-50		15.0	Determines number of segments to break surface into for shadow analysis.
	21-30	Number of Y divisions in surface	FNYD		1.0-50		10.0	
	31-40	Number of common shading surfaces deleted from surface	FNDD		0.0 or less than or equal to FNSP		2.0	If equal to 0.0 or FNSP, skip reading order L11-D.
	41-50	N O T U S E D						
	51-60	Surface roughness index	FISD		1.0-6.0		2.0	See Table 6.8.
	61-70	Index for type of surface	FIRF		1.0-FNRF		1.0	
L11-C	1-10	Coordinates of lower left-hand corner of rectanglar surface when viewed from outside	XCORN	FT			18.5	
	11-20		YCORN	FT			23.7	
	21-30		ZCORN	FT			1.3	
	31-40	Height of surface	H	FT			10.0	
	41-50	Width of surface	W	FT			15.0	
	51-60	Azimuth angle of surface	A	Degree	0.0-360.0		0.0	
	61-70	Tilt angle of surface	B	Degree	0.0-180.0		25.5	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVD" TIMES.								
L11-C'	1-10	Coordinates of surface vertex	XVD	FT			25.5	
	11-20		YVD	FT			18.5	
	21-30		ZVD	FT			0.0	
L11-D	1-10 : 61-70	Index of common shading surface deleted	FIDD		1.0-FNSP		2.0,5.0,...	If number of deletions is greater than seven, use more than one computer card.
L14-A	1-10	Total number of pictorial outputs desired	FLOOKD		0.0-20.0		5.0	If equal to 0.0, skip reading order L14-B; go to L12-Z.
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FLOOKD" TIMES.								
L14-B	1-10	Month	FMLOKD		1.0-12.0		7.0	
	11-20	Hour of the day	FILOKD		1.0-24.0		11.0	
	21-30	Surface index	FJLOKD		1.0-FNDB		3.0	
L12-Z	1-10	Number of quick heat transfer in the building	FNQB		0.0-25.0		1.0	If equal to 0.0, skip reading orders L12-A - L14-B; go to L13-Z.
THE READING ORDERS L12-A, L12-B, L12-C (L12-C') INCLUSIVE SHOULD BE REPEATED "FNQB" TIMES.								
L12-A	1-10	Absorptivity of outside of surface	ABQ		0.0-1.0		0.3	
	11-20	Reflectivity of ground facing surface	ROGQ		0.0-1.0		0.4	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L12-A	21-30	Heat transfer coefficient	UQI	Btu/hr-ft^2-^{o}F			1.65	
	31-40	Infiltration flow coefficient	CINFQ		0.0-		5.3	See Table 6.13 use for crack method; otherwise, leave blank.
L12-B	1-10	Number of vertices in surface	FNVQ		1.0 or 3.0-10.0		4.0	If equal to 1.0, use reading order L12-C; otherwise use L12-C'.
	11-20	Number of X divisions in surface	FNXQ		1.0-50.0		10.0	Determines number of segments to break surface into for shadow analysis.
	21-30	Number of Y divisions in surface	FNYQ		1.0-50.0		5.0	
	31-40	Number of common shading surfaces deleted from surface	FNDQ		0.0 or less than or equal to FNSP		0.0	If equal to 0.0 or FNSP, skip reading order L12-D.
	41-50	N O T U S E D						
	51-60	Surface roughness index	FIZQ		1.0-6.0		4.0	
L12-C	1-10	Coordinates of lower left-hand corner of rectangular surface when viewed from outside.	XCORN	FT			25.0	
	11-20		YCORN	FT			15.0	
	21-30		ZCORN	FT			20.0	
	31-40	Height of surface	H	FT			10.0	
	41-50	Wdith of surface	W	FT			5.0	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L12-C	51-60	Azimuth angle of surface	A	Degree	0.0-360.0		360.0	
	61-70	Tilt angle of surface	B	Degree	0.0-180.0		90.0	
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVQ" TIMES.								
L12-C'	1-10	Coordinates of surface vertex	XVQ	FT			25.0	
	11-20		YVQ	FT			20.0	
	21-30		ZVQ	FT			10.0	
L12-D	1-10 : 61-70	Index of common shading surface deleted	FIDQ		1.0-FNSP		3.0, 4.0,	If number of deletions is greater than seven, use more than one computer card.
L14-A	1-10	Total number of pictorial outputs desired	FLOOKQ		0.0-20.0		2.0	If equal to 0.0, skip reading order L14-B; go to L13-Z.
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FLOOKQ" TIMES.								
L14-B	1-10	Month	FMLOKQ		1.0-12.0		11.0	
	11-20	Hour of the day	FILOKQ		1.0-24.0		9.0	
	21-30	Surface index	FJLOKQ		1.0-FNQS		5.0	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L13-Z	1-10	Number of windows in the building	FNWB		0.0-35.0		6.0	If equal to 0.0, skip reading orders L13-A - L14-B; go to L15-C.
THE READING ORDERS L13-A, L13-B, L13-C(C') INCLUSIVE SHOULD BE REPEATED "FNWB" TIMES.								
L13-A	1-10	ASHRAE shading coefficient	SHACO		0.0-1.0		0.5	See 1972 ASHRAE Guide Chapter 22 1.0 = no shading
	11-20	Form factor between window and sky	FFWS		0.0-1.0		0.4	
	21-30	Form factor between window and ground	FFWG		0.0-1.0		0.4	
	31-40	Reflectivity of ground facing window	FOGW		0.0-1.0		0.30	
	41-50	Window setback	SETBK	Inches			4.0	Window must be short-form rectangle to use.
	51-60	Window border	BODR	Inches			3.0	
	61-70	Infiltration flow coefficient	CINEW				5.3	See Table 6.13. Use for crack method; otherwise leave blank.

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L13-B	1-10	Number of vertices in window	FNVW		1.0 or 3.0 - 4.0	1.0 Short form for rectangle	8.0	If equal to 1.0, use reading order L13-C; otherwise, use L13-C'
	11-20	Number of X divisions in window	FNXW		1.0-50.0		15.0	Determines number of segments to break window into for shadow analysis.
	21-30	Number of Y divisions in window	FNYW		1.0-50.0		10.0	
	31-40	Number of common shading surfa surfaces deleted from window	FNDW		0.0 or less than or equal to FNSP		0.0	If equal to 0.0 or FNSP, skip reading order L13-C.
	41-50	Number of shading surfaces added to window	FNAW		0.0 OR 3.0		0.0 3.0	Means setbk = 0.0 Means setbk = >0.0
	51-60	Number of panes of window glass	FNPW		1.0 or 2.0	1.0 Single pane 2.0 Double pane	1.0	
	61-70	Index for type of window glass	FGLASW		1.0-8.0		1.0	
L13-C	1-10	Coordinates of lower left-hand corner of rectangular window when viewed from out-side.	XCORN	FT			8.5	
	11-20		YCORN	FT			22.7	
	21-30		ZCORN	FT			2.0	
	31-40	Height of window	H	FT			10.0	
	41-50	Width of window	W	FT			15.0	
	51-60	Azimuth angle of window	A	Degree	0.0-360.0		90.0	
	61-70	Tilt angle of window	B	Degree	0.0-180.0		25.5	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUE	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVW" TIMES.								
L13-C'	1-10	Coordinates of window vertex	XVW	FT			25.0	
	11-20		YVW	FT			5.0	
	21-30		ZVW	FT			10.0	
L13-D	1-10 : 61-70	Index of common shading surface deleted	FIDW		1.0-FNSP		3.0, 6.0,	If number of deletions is greater than seven, use more than one computer card.
THE READING ORDERS L13-V1 AND L13-V2 INCLUSIVE SHOULD BE REPEATED "FNAW" TIMES.								
L13-V1	1-10	Number of vertices of added shading surface	FNVAW				4.0	
	11-20	Transmittance of added shading surface	PAW				0.0	
L13-V2	1-10	Coordinates of lower left-hand corner of added rectangular shading surface when viewed from outside	XCORN	FT			22.0	
	11-20		YCORN	FT			10.0	
	21-30		ZCORN	FT			10.0	
	31-40	Height of surface added to window	H	FT			15.0	
	41-50	Width of surface added to window	W	FT			26.0	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L13-VZ	51-60	Azimuth angle of surface added to window	A	Degree	0.0-360.0		85.0	
	61-70	Tilt angle of surface added to window	B	Degree	0.0-180.0		90.0	
L14-A	1-10	Total number of pictorial outputs desired.	FLOOKW		0.0-20.0		0.0	If equal to 0.0, skip reading order L14-B; go to L15-Z.
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FLOOKW" TIMES.								
L14-B	1-10	Month	FMLOKW		1.0-12.0		1.0	
	11-20	Hour of the day	FILOKW		1.0-24.0		12.0	
	21-30	Window index	FJLOKW		1.0-FNWB		5.0	
L15-Z	1-10	Number of internal heat transfer surface in the building	FNIHTS		0.0-35.0		8.0	If equal to 0.0, skip reading order L15-A; go to L15-Z.

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATE "FNIHTS" TIMES.								
L15-A	1-10	Area of surface	AIHTS	FT^2			100.0	
	11-20	Heat transfer coefficient of surface	FIHTS	Btu/hr-ft^2 FT^2, ^oF			0.9	
	21-30	Indices of spaces connected to surface	SPC1				11.0	
	31-40		SPC2				9.0	
L15-Z	1-10	Number of underground walls in the building	FNUWB		0.0-30.0		1.0	If equal to 0.0, skip reading order L15-B; go to L15-Z.
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNUWB" TIMES.								
L15-B	1-10	Area of wall	AUW	FT^2			50.0	
	11-20	Heat transfer coefficient of wall	FUW	Btu/hr FT^2, ^oF			1.5	
L15-Z	1-10	Number of underground floors in the building	FNUFB		0.0-30.0		0.0	If equal to 0.0, skip reading order L15-C; go to L16-A.

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNUFB" TIMES.								
L15-C	1-10	Area of floor	AUF	FT^2			25.0	
	11-20	Heat transfer coefficient of floor	FUF	Btu/hr FT^2,^{o}F			2.5	
L16-A	1-6 ⋮ 67-72	Ground temperature-Jan ⋮ Ground temperature-Dec	TGRND	^{o}F			30.0,35.0, ...	First data is for 1st month of study. If study length is greater than seven months, use 2nd computer card. If NUWB+FNUWB=0.0, skip this reading order. For CODE=1 or 2, all 12 months are required.
L17-Z	1-10	Number of spaces in the building	FNS		1.0-35.0		11.0	
THE READING ORDERS L17-A THROUGH L17-E AND L18-A THROUGH L18-F INCLUSIVE SHOULD BE REPEATED "FNS" TIMES.								
L18-Z	1-10	Number of delayed surfaces in the space	FND		0.0-30.0		3.0	If equal to 0.0, skip reading order L18-A.
	11-20	Number of quick surfaces in the space	FNQ		0.0-30.0		2.0	If equal to 0.0, skip reading order L18-B.
	21-30	Number of windows in the space	FNW		0.0-30.0		3.0	If equal to 0.0, skip reading order L18-C.

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	CODE	LIMIT VALUES	EXAMPLE	COMMENTS
L18-Z	31-40	Number of internal surfaces in the space	FINT			0.0-30.0	0.0	If equal to 0.0, skip reading order L18-D.
	41-50	Not Used						
	51-60	Number of underground surfaces in the space	FNUF			0.0-30.0	1.0	If equal to 0.0, skip reading order L18-E.
	61-70	Number of additional identical spaces in the building.	FMULT				0.0	
L17- A	1-10	Floor area of space	FLORA	FT^2			100.0	
	11-20	Volume of space	VOL	FT^3			1000.0	
	21-30	Weight of floor of space	WOF	lb/ft^2			80.0	
	31-40	Temperature of space	TSPAC	^oF			75.0	
	41-50	Number of people in space	FOLK				5.0	
	51-60	Activity level in the space	HASSL	Btu/ft		400.0-1350.0	550.0	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMN	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
L17-C	1-10	Type of light fixture	VENT		1.0-4.0		1.0	See Table 6.12.
	11-20	Percent of light heat to space	PERCT	Decimal	0.0-1.0		0.85	Refer to manufacturer data.
	21-30	People schedule index	UINDEX		1.0-15.0		2.0	
	31-40	Type of infiltration analysis	P12K		0.0,1.0 or 2.0	0.0 No air change 1.0 Air change method 2.0 Crack method	1.0	
	41-50	Infiltration rate	CODINF	No. air changes per hour	0.0-10.0		1.0	Est. changes at 10 mph
	51-60	Height above or below neutral zone		FT				- is above neutral zone
	61-70	Space exhaust air cfm		CFM	0.0-			
L17-D	1-10	Lighting load (watts/FT^2)	WPFSL	Watts/FT^2			4.0	These are summed to get total space lighting load.
	11-20	Lighting load (KW)	PWRLT	KW			1.5	
	21-30	Lighting schedule index	EIHDEX		1.0-15.0		3.0	
L17-E	1-10	Equipment load (watts/ft^2)	WPFSE	Watts/FT^2			0.0	These are summed to get total space sensible equipment load.
	11-20	Equipment load (KW)	PWREQ	KW			10.0	
	21-30	Equipment load (BTU sensible)	EQSEN	Btu/hr			0.0	
	31-40	Equipment load (BTU latent)	EQLAT	Btu/hr			1500.0	
	41-50	Equipment schedule index	PINDEX		1.0-15.0		1.0	

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	CODE	LIMIT VALUES	EXAMPLE	COMMENTS
L18-A	1-10 : 61-70	Indices of delayed surfaces of space	FID			1.0-FND	3.0,4.0,...	If number of indices is greater than seven, use more than one computer card.
L18-B	1-10 : 61-70	Indices of quick surfaces of space	FIQ			1.0-FNQ	1.0,2.0,...	
L18-C	1-10 : 61-70	Indices of windows of space	FIW			1.0-FNW	15.0,22.0,...	
L18-D	1-10 : 61-70	Indices of internal surfaces in space	FFIHTS			1.0-FNIHTS	11.0,22.0,...	To handle repetitive surfaces, repeat indices as many times as required.
L18-E	1-10 : 61-70	Indices of underground surfaces in space	FIUW			1.0-FNUWB	6.0,7.0,...	

The systems data input via the S cards is written to a coded file (TAPE8) which is read by SESP. The data may be entered directly into SESP without using NIPP by constructing a TAPE8 file, however, no defaults are allowed, and the method is tedious. The TAPE8 file may be altered with a text editor if desired. The TAPE8 file may be input into NIPP for data error checking.

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S0A	1-4	Echo of building description data	IBUG(1)		0 or 1	0=Do Not Print 1=Print	0	
	5-8	Echo of equipment scheduling & floor, ceiling & furnishing data	IBUG(2)		0 or 1	0=Do Not Print 1=Print	1	
	9-12	Echo of space input data	IBUG(3)		0 or 1	0=Do not print 1=print	0	
	13-16	Echo of thermostat schedules	IBUG(4)		0 or 1	0=Do Not Print 1=Print	1	
S1A	1-35	Program title	SNAME					Not more than 35 characters
S2A	1-5	Beginning hour of study	IHSRT	Hour of year	0 to 8784		0	Default value - begin first hour on load tape
	6-10	Ending hour of study	IHSTP		0 to 8784 IHSRT.LE.IHSTD		0	Default value - end with last hour on load tape
	11-15	Output tape option tape	IOTWF		0, 1, or 2	0:No tape (output) 1:Formatted tape 2:Unformatted file	1	Default = 0
S3	1-3	Number of printouts desired	IPO		0 - 12		2	If equal to 0.0, skip S3A
REPEAT S3A IPO TIMES								
S3A	1-5	Printout start hour	IPOS	Hour of Year	0 to 8784		1	Use whole numbers with no decimal point and right-justified in each field
	6-10	Printout stop hour	IPOE	Hour of Year	0 to 8784 IPOS.LE.IPOE		61	

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S3A	11-15	Optional print flag: Level 1: Hourly Summaries	IPRNT1		0 or 1	0 = Do Not Print	1	Default = 0
	16-20	Optional print flag: Level 2: Zone Summaries	IPRNT2		0 or 1	1 = Print	0	Default = 0
S4Z	1-3	Number of thermostat schedules	NDTS		1 to 5		2	This card is required
A SET OF 24 MUST BE REPEATED NDTS TIMES								
S4A	1-3	Thermostat type	IVSTD		0,1 or 2	0 = float 1 = linear 2 = hi-low limit	1	Default = 0
	4-16	High temperature limit	VTSD1	Deg/F			85	Default = 0.0
	12-19	Low temperature limit	VTSD2	Deg/F			65	Default = 0.0
S5Z	1-3	Number of regular schedules	NRSCH		0-10			Default = 0
READ S5A NRSCH TIMES								
S5AA	1-3 70-72	Fraction of total at hour 1 . . Fraction of total at Hour 24	STDS STDS	Decimal	0-1		.25	Default = 0.0
S6Z	1-3	Number of weekly schedules	NWSC		0-10		2	Default = 0

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
READ S6A AND S6B NWSC TIMES								
S6A	1-3	Application of schedule	ITYPE		0 or 1	0=operating schedule 1=thermostat schedule		
S6B		Thermostat Schedule						
	1-4	Sunday	ISTT		0-10 if ITYPE=0 0-20 if ITYPE=1			
	5-8	Monday	ISTT					
	9-12	Tuesday	ISTT					
	13-16	Wednesday	ISTT					
	17-20	Thursday	ISTT					
	21-24	Friday	ISTT					
	25-28	Saturday	ISTT					
	29-32	Holiday	ISTT					
S7B	1-3	Number of yearly thermostat schedules	NYTS		0-10			Default = 0
READ S7A NYTS TIMES								
S7A	1-3	Weekly thermostat index for period I	IYTSN		0-10			
	4-8	Beginning hour of thermostat schedule	IYTSD	Hour of Year	0-8784			
	. . .							
	33-35	Yearly period 5, Weekly thermostat index						
	36-40	Yearly period 5, Beginning hour of thermostat schedule						
S8Z	1-3	Number of reset schedules	NPSET		0-16			Default = 0

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
READ S8A NRSET TIMES								
S8A	1-7	Low outside air temperature at which system temp is THI	TOALO	Deg/F			-15	Default = 0.0
	8-14	High outside air temperature at which system temp is TLO	TOAHI	Deg/F			55	Default = 0.0
	15-21	Low system fluid temperature	TLO	Deg/F			140	Default = 0.0
	22-28	High system fluid temperature	THI	Deg/F			210	Default = 0.0
	30-60	Reset schedule label (alpha-numeric)	ZNAME				Hot water	Not more than 30 characters
S107	1-3	Number of user-defined surfaces	NRES		0-20			
REPEAT S10A AND S9A NRES TIMES								
S10A	1-3	Number of layers	NOL		1.0 to 10.0		3.0	Exclude outside air film
REPEAT S9A NOL TIMES								

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S9A	1-10	Thickness of the layer	XL	Ft			0.333	If layer has no thermal mass, set equal to 0.0
	11-20	Thermal conductivity of the layer	XK	BTU/Hr, Sq Ft, Deg/F			0.770	
	21-30	Density of the layer	D	1b/Cu Ft			125.0	
	31-40	Specific heat capacity of the layer	SH	BTU/1b, Deg/F			0.22	
	41-50	Thermal resistivity of the layer	RES	Hr,Sq Ft, Deg/F,BTU			0.00	If layer has thermal mass, set equal to 0.0 Default = 0.0
	51-80	Alphanumeric description of the layer	DEFC				brick	Limit to 30 characters
S11Z	1-3	Number of fan systems	KMAX		0-15		7	
READ S11A THROUGH S11E KMAX TIMES								
S11A	1-10	Type of distribution fan system	TYPE		1-13	See Input Manual	10	Default = 1
	11-20	Number of zones on system	JMAX				6	Default = 1
	21-30	Relatve humidity set point	RHSP	%R.H.			50	Default = 10
	31-40	Minimum outside air volume	OAFCM	CFM			3000	If exhaust air exceeds OAFCM, OSFCM will be set equal to exhaust air
	41-50	Mixed air option	MXAO		1,2 or 3		2	Default = 1
	51-60	Variable volume fan control type	NVFC		1,2 or 3		1	Default = 2

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S11B	1-10	Hot deck temp KFANK = 2 or 3	ITMPC(K,1)	Deg/F	1,3 or 6		1	Default = 1
	1-10	AHU leaving temp KFANK = 13	ITMPC(K,1)	Deg/F	1,2 or 3		1	Default = 1
	11-20	Cold deck discharge temp	ITMPC(K,2)	Deg/F	1 or 2		2	
	21-30	Supply fan pressure	TFNPS	Inches of water	Non-negative		3.8	
	31-40	Return fan pressure	TFNPR	Inches of water	Non-negative		2.1	
	41-50	Exhaust fan pressure	TFNPE	Inches of water	Non-negative		1.6	
	51-60	Are reheat coils located after variable volume boxes?	IVVRH		0 or 1	0 = no 1 = yes	0	
S11C	1-10	Minimum air flow through variable volume boxes	VVMIN	%	0 to 100		25	
	11-20	Fixed hot deck temp KFANK=2,3 Fixed AHU discharge temp KFANK=4,11,12,13	TFIX1	Deg/F			95	For system types 2, 3 & 13 this variable is functional only if ITMPC(K,1)=1
	21-30	Fixed cold deck temperature	TFIX2	Deg/F			55	For system types 2, 3, & 13 this variable is functional only if ITMPC(K,2)=1
	31-40	Hot deck air temp reset index 2,3 Primary air temp reset index 10 AHU discharge air temp reset index 13	ISET(K,1)		1 to 10		1	ISET(K,N) keys a specific outside air reset schedule to control the temperature of a specified portion of system.
	41-50	Cold deck air temp reset schedule index	ISET(K,2)		1 to 10		2	
	51-60	Baseboard radiation water temperature reset schedule index	ISET(K,3)		1 to 10		3	

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S11D	1-10	Two pipe fancoil system & two-pipe induction unit system hot water temp reset index	ISET(K,4)		1 to 10		7	
	11-20	Ratio of induced to primary air	RIPA(K)				2.7	Induced air equals RIPA primary air
	21-30	Two-pipe system changeover temp	TCOFC	Deg/F			53	At 2.5 Deg/F lag inhibits repeated changeover in temperature weather
	31-40	Floor panel shutoff temp	TOACB	Deg/F			53	
	41-50	Water volume in changeover system	PWGAL	Gals	Non-negative		1000	Changeover load is calculated by the program
	51-60	Floor panel location	PLOC		1 or 2	1=slab on grade 2=intermediate floor slab	1	More than one zone may be included on the floor panel heating system only if they all have the same set point temperature Default = 0.
S11E	1-10	Heating panel floor area	PAREA	Sq Ft				
	11-20	Exposed perimeter of floor area	PERIM	Ft				
	21-30	Fan system shutoff flag	IFSO		0-3	0=fan on, baseboard on 1=fan may be off, baseboard on 2=fan & baseboard may be off 3=fan uses schedule (S7A)		Default = 2
	31-40	Ventilation schedule code	IVENT		0-10			Default = 0 must be used if
	41-50	Humidistat location	ICZN					Default = 1
	51-60	DX/Heat pump index	IDXHP		0-6			Default = 0

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S12Z	1-3	Number of spaces	NSPA1		0-35			Default = 0
REPEAT S12A THROUGH S12E NSPA1 TIMES								
S12A	1-3	Type of zone	IPLS		0-1	0=occupied 1=plenum		Default = 0
	4-6	Fan system index	KFANP		1-KMAX			Default = 1
IF PLENUM SPACE, SEE S12B' THROUGH S12C'								
S12B	1-10	Loads space number	SPACN		0-35		17	Default = 1
	11-20	Supply air CFM	CFM	CFM			0.0	Default=0, if 0 is entered then CFM is computed. This value is constant unless fan system is off.
	21-30	Exhaust air CFM	CFMX	CFM			500	
	31-40	Heat output of baseboard radiation per linear ft. at design conditions	CBTU	BTU/HR Lin Ft			700	Design Conditions: 65 Deg/F incoming air; 215 Deg/F heating medium temp
	41-50	Active length of baseboard	ALFBR	FT			10	
	51-60	Yearly thermostat schedule index	IYNO		1-NYTS			Default = 1

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S12C	1-10	Space design heating capacity	HCAPD	BTU/Hr	Negative			Default = 0
	11-20	Space design cooling capacity	CCAPD	BTU/Hr	Non-negative			Default = 0
	21-30	Weight of furnishings	WOFN	LB/Sq Ft			5	Must be defined if no furnishings
	31-40	Multiplication factor	MULT		Non-negative whole numbers		2	
	41-50	Plenum number above space	IPLEN				84	
S12D	1-10	Surface type 1	FSURF1		0-3	0:none 1:floor 2:ceilings 3:furnishings		Default = 0
	11-20	Response factor index of surface 1	FD1		1-NRES			
	21-30	Area of surface 1	AFLOR(J,1)	Sq Ft				
	31-40	Surface type 2	FSURF2					
	41-50	Response factor index of surface 2	FD2					
	51-60	Area of surface 2	AFLOR(J,2)	Sq Ft				
S12E	1-10	Surface type 3	FSURF3					
	11-20	Response factor index of surface 3	FD3					
	21-30	Area of surface 3	AFLOR(J,3)	Sq Ft				
	31-60	Alphanumeric description of space	ZNAME					30 characters

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S12B*	1-10	Loads space number	SPACN(16, KNO16)		NSPA1			
	11-20	Space below Plenum	IV5		NSPA1			
	21-30	Plenum air flow	CFMP	CFM				Default = 0
	31-40	fan schedule	IVON					Default = 0
S12C*	1-10	Surface type 1	FSURF1		0-3	0:none 1:floor 2:ceilings 3:furnishings		Default = 0
	11-20	Response factor index of surface 1	FD1		1-NRES			
	21-30	Area of surface 1	AFLOR(J,1)	Sq Ft				
	31-40	Surface type 2	FSURF2					
	41-50	Response factor index of surface 2	FD2					
	51-60	Area of surface 2	AFLOR(J,2)	Sq Ft				
S12D*	1-10	Surface type 3	FSURF3					
	11-20	Response factor index of surface 3	FD3					
	21-30	Area of surface 3	AFLOR(d,3)	Sq Ft				
	31-60	Alphanumeric	ZNAME					≤30 characters
S13Z	1-3	Number of ENG/GEN sets	NENG		0-5			Default = 0 If equal to 0 Skip S13A - S13B

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
REPEAT S13A THROUGH S13C NENG TIMES								
S13A	1-3	ENG/GEN simulation option code	IEGOP		0 to 1	0=internal curves used 1=user-defined curves used	0	Default=0
	4-13	Number of this type of ENG/GEN sets	M4		1-5			Default = 2
	14-23	Type of ENG/GEN set	M5		1 or 2	1=diesel 2=gas	1	Default = 1
	24-33	ENG/GEN set capacity	EGCAP	KW				Default=500.0 KW
	34-43	Heating value diesel fuel	HVDFP	BTU/GAL				Default=14,000 BTU/GAL
	44-53	Peak load fuel input	EFUEL	GAL/Hr or Cubic Ft/Hr				Default = 0
S13B	1-10	Percentage fuel consumption at idle	EFPCT	%				Default = 0
	11-20	Percent fuel consumption at 25% load	EFPCT	%				
	21-30	Percent fuel consumption at 50% load	EFPCT	%				
	31-40	Percent fuel consumption at 75% load	EFPCT	%				
	41-50	Percent fuel consumption at 100% load	EFPCT	%				

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S13C	1-10	Full load heat recovery rate	EQBAK	KBTU/Hr				Default = 0
	11-20	Percentage heat recovery at idle	EQPCT	%				Default = 0
	21-30	Percent heat recovery at 25% load	EQPCT	%				
	31-40	Percent heat recovery at 50% load	EQPCT	%				
	41-50	Percent heat recovery at 75% load	EQPCT	%				
	51-60	Percent heat recovery at 100% load	EQPCT	%				
S14	1-3	Number of boilers	NBOIL				2	Default = 1 If equal to 0 Skip S14A-S14B
REPEAT S14A AND S14B NBOIL TIMES								
S14A	1-3	Boiler component simulation option code	OBOPT		0 or 1	0=internal curves 1=user-defined curves		Default = 0
	7-16	Number of this type of boiler	NUMB		1-5			Default = 1
	17-26	Size of boiler	SZB	MBH			350	
	27-31	Hour of seasonal boiler start-up	BON	Hour of year	0-8784		0	If left 0,0, boiler is avail-able for entire year
	32-36	Hour of seasonal boiler sutdown	BOFF		0-8784 .LE.BON		0	
	37-46	Source of heating energy	M3		1-4	1=gas 2=oil 3=steam 4=electric	1	Includes heating & pre-heating coils, baseboard radia-tion and floor panel heating

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
	47-56	Source of reheat coil energy	AREHT		0-4	0=same as boiler 4=electric resistance	1	
	57-66	Heating value heating oil	HVHO	BTU/GAL	Non-negative		147,000	Default value = 150,000 BTU/GAL
S14B	1-10	Boiler Part Load performance at 0% load	BPL	%				
	11-20	Boiler Part Load performance at 20% load	BPL	%				
	21-30	Boiler Part Load performance at 40% load	BPL	%				
	31-40	Boiler Part Load performance at 60% load	BPL	%				
	41-50	Boiler Part Load performance at 80% load	BPL	%				
	51-60	Boiler Part Load performance at 100% load	BPL	%				
S15Z	1-3	Number of chillers	NCHIL		0-5			Default = 1 If equal to 0 Skip S15A-S15G
REPEAT S15A THROUGH S15G NCHIL TIMES								
S15A	1-3	Chiller component simulation code	ICOPT		0 or 1			Default = 0
	7-16	Type of chiller	M1		0-5	0=none 1=reciprocating 2=hermetic centrifugal 3=open centrifugal 4=steam absorption 5=centrifugal/ steam turbine		Default = 1

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S15A	17-26	Number of this type of chiller	NUMC		1-5			Default = 1
	27-36	Size of chiller	SZC	TONS			100.0	
	37-41	Hour of seasonal chiller start-up	ICON	Hour of year	0-8784		2161	
	42-46	Hour of seasonal chiller shut-down	ICOFF	Hour of year	0-8784		5833	Default = 8785 which causes chiller availability from CON thru end of year
S15B	1-10	Source of chiller energy	M2		1-4		2	
	11-20	Minimum part load chiller cut-off	FFLMN	%	0-100		20	Default = 10%
	21-30	Chilled water set point temperature	TLCHL	Deg/F	40-50		44	Default = 45 Deg/F
S15C	1-3	Number of capacity/ cond. temp points	MAX9A		0-5		2	Default = 0
REPEAT S15D MAX9D TIMES								

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S15D	1-10	Chiller capacity point	CCAP	TONS			150.0	Default = 0
	11-20	Leaving condenser water temp for capacity point	TCON1	Deg/F				Default = 0
S15E	1-3	Number of power/cond temp points	MAX9B		0-5		3	Default = 0
REPEAT S15F MAX9B TIMES								
S15F	1-10	Chiller power point	CCPWR	KW or LB of steam				Default = 0
	11-20	Leaving condenser water temperature for power point	TCON2	Deg/F				Default = 0
S15G	1-3	Number PCT peak POW/ PCT load	MAX9C		0-5		1	Default = 0
REPEAT S15H MAX9C TIMES								
S15H	1-10	Percentage chiller peak power point	CPPP					Default = 0
	11-20	Percentage of chiller peak load point	CPPL					Default = 0
S16Z	1-3	Number of cooling towers	NCTWR		1			If equal to 0 Skip S16A-S16J

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S16A	1-3	Cooling tower simlation code	ICTOPT		0 or 1	0=internal curves used 1=user defined curves used		
	7-16	Cooling tower water low limit temp	TECMN	Deg/F	75-90		80	Default=75 Deg/F
	17-26	Condenser water temp rise	TCRIS	Deg/F	5-20			Default = 10
	27-36	Cooling tower peak power	CTPKW	KW				Default = 0
S16B	1-3	Number cond WTR/AMB WBT points	MAX9D		0-5			Default = 0
REPEAT S16C MAX9D TIMES								
S16C	1-10	Leaving tower water temperature point	CTWL	Deg/F				Default = 0.0
	11-20	Ambient wet-bulb point	TWB1	Deg/F				Default = 0.0
S16D	1-3	Number PCT load/cond WTR temp points	MAX9E		0-5			Default = 0
REPEAT S16E MAX9E TIMES								
S16E	1-10	Change in leaving tower water temp for part load A	DCTWL	Deg/F				Default = 0.0
	11-20	Part load A	CTPL1	%				Default = 0.0

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S16F	1-3	Number PCT peak POW/ cond WTR temp points	MAX9F		0-5			Default = 0
REPEAT S16G MAX9F TIMES								
S16G	1-10	Cooling tower PCT peak power point	CTPPD	%				Default = 0.0
	11-20	Leaving tower water temperature point	CTWL2	Deg/F				Default = 0.0
S16H	1-3	Number of peak POW/PCT load points	MAX9G		0-5			Default = 0
REPEAT S16J MAX9G TIMES								
S16J	1-10	Change in tower PCT peak power for part load B	DCTPP	%				Default = 0.0
	11-20	Part load B	CTPL2	%				Default = 0.0
S17Z	1-3	Number DX/heat pumps	NDXHP		0-6			Default = 0
READ S17A THROUGH S17F NDXHP TIMES								
S17A	1-3	Unit type index	IDXHP		1 or 2	1=DX 2=Heat		
	7-16	Design cooling capacity	DCCAP	KBTU/Hr				Default = 0.0
	17-26	Design cooling power	DCPOW	KW				Default = 0.0

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S17B	1-3	Number cooling data points	NCHP		0-5		1	Default = 0
READ S17C NCHP TIMES								
S17C	1-10	Ambient dry-bulb temperature at point A	TREFC	Deg/F				Default = 0.0
	11-20	PCT of design cooling capacity of ambient temp A	PVCCA	%	0-1		.25	Default = 0.0
	21-30	PCT of design cooling power at ambient temp A	PVCPD	%	0-1		.25	Default = 0.0
S17D	1-10	Design heating capacity	DHCAP	KBTU/Hr				Default = 0.0
	11-20	Design heating power	DHPGW	KW				Default = 0.0
S17E	1-3	Number heating data points	NHHP		0-5		1	Default = 0
READ S17F NHHP TIMES								
S17F	1-10	Ambient dry-bulb temp at point B	TREFH					
	11-20	PCT of design heating capacity at ambient temp B	PVHCA	%	0-1		.25	Default = 0.0
	21-30	PCT of design heating power at ambient temp B	PVHPD	%	0-1		.25	Default = 0.0

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S18A	1-10	Total water boiler pump head	HDBLP	Ft	Non-negative		50	Default = 50
	11-20	Total chilled water pump head	HDCLP	Ft	Non-negative		40	Default = 40
	21-30	Total condenser water pump head	HDCNP	Ft	Non-negative		30	Default = 30
	31-40	Fan and pump motor efficiency	EFF	%	1-100			Default = 85%
S19Z	1-3	Number process loads	NPROC		1-10			IF EQUAL TO 0 Skip S19A
READ S19A NPROC TIMES								
S19A	1-10	Peak load	PRPK	MBH or KW				Default = 0.0
	11-20	Energy source code	IPREN		0-4	0=indirect process 1=gas 2=heating oil 3=purchased steam 4=electricity		Default = 0
	21-30	Operating schedule	IPRSC		1-10			Default = 0
S20A	1-10	Boiler supply/absorption chiller entering STM pressure	PESTM	PSIG	2-12		12	
	11-20	Boiler supply/absorption chiller entering STM temperature	TESTM	Deg/F			245	
	21-30	Steam turbine entering STM pressure	PPS	PSIG			125	Default value
	31-40	Steam turbine entering STM temperature	TPS	Deg/F			353	PPS=125 PSIG TPS=353 Deg/F
	41-50	Steam turbine speed	RPM	RPM			3500	Default=3600 RPM

SYSTEM ENERGY SIMULATION PROGRAM INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	UNIT VALUES	CODE	EXAMPLE	COMMENTS
S208	1-10	External lighting POW	PWOL	KW				Default = 0
	11-20	Type of floor covering	FLVC		1-3	1=concrete 2=tile 3=carpeting	2	Default = 1
	21-30	Floor insulation conductance	CINSL	BTU/Hr Sq Ft - Deg/F	-			Default = 0.0
	31-40	Floor insulation thickness	DINSL	Ft				Default = 0.0

APPENDIX C

NECAP DATA FILES

UNFORMATTED

The hourly loads are written to an unformatted file called ANADT. ANADT is written by the Thermal Loads Analysis Program (TLAP) and read by the Systems Energy Simulation Program (SESP). The building data used by TLAP is also written to an unformatted file called INIDT. INIDT is read by SESP to initialize the building data and, if desired, size the equipment.

These two files are stored on mass storage when running TLAP. They may be saved on tape or disk. Using these files, the user may simulate many types of control strategies without having to run TLAP for each SESP run.

The systems loads computed by SESP are written to a file called TAPE3. The data may be formatted or unformatted. The formatted version will vary depending upon the user's needs, therefore it is not documented. The unformatted version is documented so that a processing program could be modified to use the hourly data generated by SESP.

FILE INIDT

VARIABLE	DESCRIPTION
	Job Description Variables
IDEN1	Facility name
IDEN2	Facility location
IDEN3	Engineer's name
IDEN4	Project number
IDEN5	Date
	Building Surface Description Data
NRF	Number of types of response factor surfaces
(for each surface type)	
NRFT	Number of response factor terms
R1	Common ratio
RX, RY, RZ	Surface response factors
NDB	Number of delayed surfaces
(for each delayed surface)	
IRF	Response Factor type index
AD	Surface area, sq. ft.
NQB	Number of quick surfaces
(for each quick surface)	
ISQ	Surface roughness index
UQ	Surface U-factor less outside film coefficient, Btu/hr-sq ft- ^{o}F
AQ	Surface area, sq. ft.

FILE INIDT

VARIABLE	DESCRIPTION
NWB	Number of windows
(for each window)	
NPW	Number of panes of glass
AW	Window area, sq. ft.
(for single pane windows)	
REI	0.5 inside film resistance
REA	0.0 interpane resistance
R	REI + REA total resistance
UGW	1.0/R U-factor
(for multi-pane windows)	
REI	0.5 inside film resistance
REA	1.6 interpane resistance
R	REI + REA total resistance
UGW	1.0/R U-factor
NIHT	Number of internal heat transfer surfaces
(for each internal heat transfer surface)	
ISPC1 ISPC2	Spaces connected to surface
FIHTS	Surface U*A, Btu/hr. °F
NUFB	Number of underground surfaces
(for each underground surface)	
AUF	Underground surface area, sq. ft.
FUF	U-factor, Btu/hr-sq ft- °F

FILE INIDT

VARIABLE	DESCRIPTION
	Zone Description Data
FOLK	Fraction of people for space
NS	Number of spaces in building
(for each space)	
ND	Number of delayed surfaces in space
NQ	Number of quick surfaces in space
NW	Number of windows in space
NIHTS	Number of internal H.T. surfaces in space
NUF	Number of underground floors in space
IMULT	Space repetition factor
FLORB	Floor area, sq. ft.
VOL	Space volume, cu. ft.
TSPAC	Set point temperature, ^{o}F
WOF	Weight of floor, lbs/sq. ft.
IWOP	Loads schedule index for people
ID	Index associated with each of ND delayed surfaces
IQ	Index associated with each of NQ quick surfaces
IW	Index associated with each of NW windows
IHTS	Index associated with each of NIGHTS internal H.T. surfaces
IUF	Index associated with each of NUF underground surfaces
	Run Description Data
MSTRT	Starting month, 1 to 12
NDAYS	Number of days
IMAX	Number of hours in each month
ISTRT	Starting hour of analysis, 1 to 8760
IEND	End hour of analysis, 1 to 8760

FILE INIDT

VARIABLE	DESCRIPTION
	Peak Loads Description Data
PWBIL	Peak base power for the building
(for each space)	
CCPY	Peak cooling capacity
HCPY	Peak heating cpapcity
QPLMS	Plenum return air load summer
QPLMW	Plenum return air load winter

FILE ANADT

VARIABLE	DESCRIPTION
For each hour the following data is available:	
IHOUR	Hour number, hour of year
IMOY	Month of year
IDOM	Day of month
NDOW	Day of the week
IHOD	Hour of the day
ISUN	Sun index which indicates whether or not the sun is up (0 = sun up; 1 = sun not up)
TOA	Outside air dry-bulb temperature (^{o}F)
TWB	Outside air wet-bulb temperature (^{o}F)
VEL	Wind velocity (knots)
WOA	Outside air humidity ration (lb water/lb dry air)
PATM	Barometric pressure (inches of mercury)
DOA	Outside air density (lbm/ft^3)
HOA	Enthalpy of outside air (Btu/lb dry air)
JSC	Day type (i.e., weekday, Saturday, Sunday, Holiday, Xmas)
CCM	Cloud cover modifier
RON	Solar Radiation (horiz Btu/hr)
For each zone, for each hour, the following data is available:	
IS	Sapce number
QS	Zone sensible load (Btu/hr)
QL	Zone latent load (Btu/hr)
QLITE	Zone lighting load picked up by return air (Btu/hr)
SLPOW	Zone internal lighting and machinery power consumption (KW)
QSINF	Zone sensible infiltration load (Btu/hr)
QLINF	Zone latent infiltration load (Btu/hr)

DEFINITION OF TAPE3 OUTPUT TAPE VARIABLES

FILE TAPE3

VARIABLE	DESCRIPTION
FAC	Facility
CITY	Location
ENGR	User name
PROJ	Project ID.
DATE	Date
ISYS	System Combination No.
KMAX	No. Distribution Systems
IHSRT	Start Hour (hour of year)
IHSTP	Stop Hour (hour of year)
For each hour	
IHOUR	Current Hour (hour of year)
IMOY	Month of Year (1 - 12)
IDOM	Day of Month (1 - 31)
IHOD	Hour of Day
ITOA	Ambient Dry-Bulb Temperature (^oF)
ITWB	Ambient Wet-Bulb Temperature (^oF)
WOA	Ambient Humidity Ratio (lbs-H_2O/lb-dry air)
PATM	Barometric Pressure (in Hg)
DOA	Ambient Air Density (lbm/ft^3)
TNFBP	Total Net Fan Brake horsepower (bhp)
TABCD	Total Power of Building (KW)
BGAS	Building Natural Gas Requirement (therms)
OILH	Building Heating Oil Requirement (gals)

FILE TAPE3

VARIABLE	DESCRIPTION
For each Fan System	
$KFAN_k$	Energy Distribution System Type No. (1 - 13)
QKC_k	System Cooling Requirement (Btu)
QKH_k	System Heating Requirement (less elect.resist. re-htg.) (Btu)
$QKKW_k$	Electric Resistance Reheat Requirement (Btu)
$PWLK_k$	Base Power Requirement of Zones served by this system (KW)
$H2OK_k$	Base Power Requirement of Zones served by this system (KW)
ZERO	Reserved (=0.0)
$TKHL_k$	Hot Deck Temperature or AHU Leaving Temperature (°F)
$TKCD_k$	Cold Deck Temperature (°F)

APPENDIX D

NECAP WEATHER

The weather data provided by NECAP 4.1 contains 63 weather stations. Each provides design conditions and hourly data for one year. These stations and their local data are listed alphabetically by state and then by city in table D-1.

NECAP uses environmental conditions to compute heating and cooling loads. The data may be design day conditions or recorded hourly data. This appendix describes:

1. Default design weather conditions used by L2 and L3 cards (see Table D-1).
2. The format for the weather station file (see Table D-2).
3. How to generate the file from NOAA-1440 tape or TRY tape.

Originally NECAP read either a NOAA-1440 10 year weather tape or a modified tape having only the data used by NECAP. In NECAP 4.1, the weather file was constructed with design day values placed at the beginning of the weather data file. The appropriate design day data can now be taken from the file for the selected station and used as default values for the L2 and L3 cards. The data can also be dumped to a line printer if desired. The weather data base is stored on magnetic tape, but stations used frequently are stored on disk.

TABLE D-1 NECAP WEATHER STATIONS

ALABAMA

BIRMINGHAM AL — STATION NO 13876 — FOR THE YEAR 1965 (365 DAYS)
DEGREE DAY 2551

LATITUDE = 33 CLEARNESS NO (SUM) = .91 TIME ZONE = 6
LONGITUDE = 86 CLEARNESS NO (WIN) = .91 ALTITUDE = 610

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	94.0	21.0	72.1	5.0
WINTER:	22.0	3.0	18.0	8.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	54	54	56	59	66	71	76	74	72	70	65	59

ALABAMA

HUNTSVILLE AL — STATION NO 3856 — FOR THE YEAR 1959 (365 DAYS)
DEGREE DAY 1983

LATITUDE = 34 CLEARNESS NO (SUM) = .90 TIME ZONE = 6
LONGITUDE = 86 CLEARNESS NO (WIN) = .90 ALTITUDE = 697

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	94.0	19.0	67.1	7.0
WINTER:	20.0	3.0	9.2	12.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	48	48	50	54	60	65	70	70	68	64	58	52

ARIZONA

PHOENIX AZ — STATION NO 23183 — FOR THE YEAR 1951 (365 DAYS)
DEGREE DAY 1765

LATITUDE = 33 CLEARNESS NO (SUM) = 1.10 TIME ZONE = 7
LONGITUDE = 112 CLEARNESS NO (WIN) = 1.10 ALTITUDE = 1117

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	107.0	27.0	63.1	5.0
WINTER:	34.0	3.0	31.0	5.4

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	58	58	60	61	68	72	77	76	75	74	69	63

CALIFORNIA

FRESNO CA — STATION NO 93193 — FOR THE YEAR 1951 (365 DAYS)
DEGREE DAY 2611

LATITUDE = 36 CLEARNESS NO (SUM) = 1.07 TIME ZONE = 8
LONGITUDE = 119 CLEARNESS NO (WIN) = 1.07 ALTITUDE = 326

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	100.0	34.0	58.8	8.0
WINTER:	30.0	3.0	27.0	5.4

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	57	57	58	59	65	71	76	75	74	73	68	62

TABLE D-1 NECAP WEATHER STATIONS

CALIFORNIA

```
LOS ANGELES  CA     STATION NO 23174    FOR THE YEAR 1973    (365 DAYS)
                    DEGREE DAY  2061

          LATITUDE  =  34  CLEARNESS NO (SUM) = 1.05  TIME ZONE  =  8
          LONGITUDE = 118  CLEARNESS NO (WIN) = 1.05  ALTITUDE =   99

   DESIGN DAY        DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:       80.0     15.0     60.3     6.0
          WINTER:       43.0      3.0     40.0     6.4

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         66  66  68  71  78  82  87  86  86  85  79  72
```

CALIFORNIA

```
SACRAMENTO   CA     STATION NO 23232    FOR THE YEAR 1962    (365 DAYS)
                    DEGREE DAY  2502

          LATITUDE  =  38  CLEARNESS NO (SUM) = 1.06  TIME ZONE  =  8
          LONGITUDE = 121  CLEARNESS NO (WIN) = 1.06  ALTITUDE =   17

   DESIGN DAY        DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:       98.0     36.0     55.8     7.0
          WINTER:       32.0      3.0     29.0     7.2

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         66  66  68  71  78  82  87  86  86  85  79  72
```

CALIFORNIA

```
SAN DIEGO    CA     STATION NO 23188    FOR THE YEAR 1974    (365 DAYS)
                    DEGREE DAY  1458

          LATITUDE  =  32  CLEARNESS NO (SUM) = 1.05  TIME ZONE  =  8
          LONGITUDE = 117  CLEARNESS NO (WIN) = 1.05  ALTITUDE =   19

   DESIGN DAY        DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:       80.0     12.0     63.9     7.0
          WINTER:       44.0      3.0     41.0     6.4

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         66  66  68  71  78  82  87  86  86  85  79  72
```

CALIFORNIA

```
SANFRANCISCO CA     STATION NO 23234    FOR THE YEAR 1974    (365 DAYS)
                    DEGREE DAY  3015

          LATITUDE  =  37  CLEARNESS NO (SUM) = 1.05  TIME ZONE  =  8
          LONGITUDE = 122  CLEARNESS NO (WIN) = 1.05  ALTITUDE =    8

   DESIGN DAY        DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:       77.0     20.0     53.1    12.0
          WINTER:       38.0      3.0     35.0     7.5

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         57  57  58  59  65  71  76  75  74  73  68  62
```

TABLE D-1 NECAP WEATHER STATIONS

DISTRICT OF COLUMBIA

WASHINGTON DC STATION NO 13743 FOR THE YEAR 1957 (365 DAYS)
DEGREE DAY 4224

LATITUDE = 38 CLEARNESS NO (SUM) = .97 TIME ZONE = 5
LONGITUDE = 77 CLEARNESS NO (WIN) = .97 ALTITUDE = 14

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	18.0	71.3	5.0
WINTER:	17.0	3.0	14.0	7.8

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	41	41	44	46	56	62	69	67	66	64	56	49

FLORIDA

JACKSONVILLE FL STATION NO 13889 FOR THE YEAR 1965 (365 DAYS)
DEGREE DAY 1239

LATITUDE = 30 CLEARNESS NO (SUM) = .91 TIME ZONE = 5
LONGITUDE = 81 CLEARNESS NO (WIN) = .91 ALTITUDE = 24

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	94.0	19.0	73.7	8.0
WINTER:	32.0	3.0	29.0	9.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	58	58	63	67	75	78	81	80	80	79	72	65

FLORIDA

MIAMI FL STATION NO 12839 FOR THE YEAR 1964 (366 DAYS)
DEGREE DAY 214

LATITUDE = 25 CLEARNESS NO (SUM) = .90 TIME ZONE = 5
LONGITUDE = 80 CLEARNESS NO (WIN) = .90 ALTITUDE = 7

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	90.0	15.0	75.2	7.0
WINTER:	47.0	3.0	44.0	10.1

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	64	68	74	76	79	79	78	78	72	67

FLORIDA

TAMPA FL STATION NO 12842 FOR THE YEAR 1953 (365 DAYS)
DEGREE DAY 683

LATITUDE = 28 CLEARNESS NO (SUM) = .90 TIME ZONE = 5
LONGITUDE = 82 CLEARNESS NO (WIN) = .90 ALTITUDE = 19

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	17.0	76.3	6.0
WINTER:	40.0	3.0	37.0	8.6

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	64	68	74	76	79	79	78	78	72	67

TABLE D-1 NECAP WEATHER STATIONS

KANSAS

DODGE CITY KS STATION NO 13985 FOR THE YEAR 1971 (365 DAYS)
DEGREE DAY 4986

LATITUDE = 37 CLEARNESS NO (SUM) = 1.00 TIME ZONE = 6
LONGITUDE = 100 CLEARNESS NO (WIN) = 1.00 ALTITUDE = 2594

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	97.0	25.0	62.0	0.0
WINTER:	5.0	3.0	2.6	10.6

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	44	44	46	47	55	62	68	67	66	65	58	51

KENTUCKY

LOUISVILLE KY STATION NO 93821 FOR THE YEAR 1972 (366 DAYS)
DEGREE DAY 4660

LATITUDE = 38 CLEARNESS NO (SUM) = .96 TIME ZONE = 5
LONGITUDE = 85 CLEARNESS NO (WIN) = .96 ALTITUDE = 474

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	93.0	23.0	72.5	7.0
WINTER:	10.0	3.0	7.0	9.8

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	47	47	48	50	57	63	69	68	66	65	59	53

LOUISIANA

LAKE CHARLES LA STATION NO 3937 FOR THE YEAR 1966 (365 DAYS)
DEGREE DAY 1459

LATITUDE = 30 CLEARNESS NO (SUM) = .90 TIME ZONE = 6
LONGITUDE = 93 CLEARNESS NO (WIN) = .90 ALTITUDE = 14

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	93.0	17.0	74.1	5.0
WINTER:	31.0	3.0	28.0	9.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	56	56	58	60	67	71	76	75	75	74	68	62

LOUISIANA

NEW ORLEANS LA STATION NO 12916 FOR THE YEAR 1958 (365 DAYS)
DEGREE DAY 1385

LATITUDE = 30 CLEARNESS NO (SUM) = .90 TIME ZONE = 6
LONGITUDE = 90 CLEARNESS NO (WIN) = .90 ALTITUDE = 3

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	92.0	16.0	76.3	6.0
WINTER:	33.0	3.0	30.0	8.6

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	64	68	74	76	79	79	78	78	72	67

TABLE D-1 NECAP WEATHER STATIONS

GEORGIA

```
ATLANTA       GA     STATION NO 13874    FOR THE YEAR 1975    (365 DAYS)
                     DEGREE DAY  2981

          LATITUDE  =  33  CLEARNESS NO (SUM) =  .94  TIME ZONE  =  5
          LONGITUDE =  84  CLEARNESS NO (WIN) =  .94  ALTITUDE = 1005

   DESIGN DAY       DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:      92.0     19.0     71.3      7.0
          WINTER:      22.0      3.0     19.0     11.7

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         52  52  55  58  67  72  78  76  75  73  66  59
```

IDAHO

```
BOISE         ID     STATION NO 24131    FOR THE YEAR 1966    (365 DAYS)
                     DEGREE DAY  5809

          LATITUDE  =  43  CLEARNESS NO (SUM) = 1.15  TIME ZONE  =  7
          LONGITUDE = 116  CLEARNESS NO (WIN) = 1.15  ALTITUDE = 2842

   DESIGN DAY       DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:      94.0     31.0     49.3      5.0
          WINTER:      10.0      3.0      7.0      9.1

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         40  40  41  41  46  51  55  54  54  53  49  44
```

ILLINOIS

```
CHICAGO       IL     STATION NO 14819    FOR THE YEAR 1974    (365 DAYS)
                     DEGREE DAY  6155

          LATITUDE  =  41  CLEARNESS NO (SUM) =  .99  TIME ZONE  =  6
          LONGITUDE =  87  CLEARNESS NO (WIN) =  .99  ALTITUDE =  658

   DESIGN DAY       DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:      89.0     20.0     68.9     10.0
          WINTER:       0.0      3.0     -3.0     12.0

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         42  42  44  45  53  59  65  64  62  61  55  48
```

INDIANA

```
INDIANAPOLIS IN      STATION NO 93819    FOR THE YEAR 1972    (366 DAYS)
                     DEGREE DAY  5699

          LATITUDE  =  39  CLEARNESS NO (SUM) =  .97  TIME ZONE  =  5
          LONGITUDE =  86  CLEARNESS NO (WIN) =  .97  ALTITUDE =  793

   DESIGN DAY       DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:      90.0     22.0     71.7      9.0
          WINTER:       2.0      3.0     -1.0     11.3

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         43  43  44  46  53  60  66  65  63  62  56  49
```

TABLE D-1 NECAP WEATHER STATIONS

MASSACHUSETS

BOSTON MA STATION NO 14739 FOR THE YEAR 1969 (365 DAYS)
DEGREE DAY 5634

LATITUDE = 42 CLEARNESS NO (SUM) = 1.00 TIME ZONE = 5
LONGITUDE = 71 CLEARNESS NO (WIN) = 1.00 ALTITUDE = 15

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	88.0	16.0	68.2	9.0
WINTER:	9.0	3.0	6.2	12.4

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	43	43	43	44	50	56	62	61	60	59	54	48

MARYLAND

PATUXENT MD STATION NO 13721 FOR THE YEAR 1962 (365 DAYS)
DEGREE DAY 3538

LATITUDE = 37 CLEARNESS NO (SUM) = .98 TIME ZONE = 5
LONGITUDE = 75 CLEARNESS NO (WIN) = .98 ALTITUDE = 10

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	20.0	71.7	11.0
WINTER:	21.0	3.0	10.6	12.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	47	41	44	47	50	56	62	69	65	62	59	53

MAINE

PORTLAND ME STATION NO 14764 FOR THE YEAR 1965 (365 DAYS)
DEGREE DAY 7511

LATITUDE = 43 CLEARNESS NO (SUM) = 1.03 TIME ZONE = 5
LONGITUDE = 70 CLEARNESS NO (WIN) = 1.03 ALTITUDE = 61

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	84.0	22.0	67.9	7.0
WINTER:	-1.0	3.0	-4.0	10.4

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	39	39	39	38	45	52	59	57	56	54	49	44

MICHIGAN

DETROIT MI STATION NO 94847 FOR THE YEAR 1968 (366 DAYS)
DEGREE DAY 6232

LATITUDE = 42 CLEARNESS NO (SUM) = 1.00 TIME ZONE = 5
LONGITUDE = 83 CLEARNESS NO (WIN) = 1.00 ALTITUDE = 633

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	88.0	20.0	69.8	10.0
WINTER:	6.0	3.0	3.0	12.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	41	41	41	41	48	54	61	60	59	58	52	47

TABLE D-1 NECAP WEATHER STATIONS

MINNESOTA

```
MINNEAPOLIS  MN     STATION NO 14922    FOR THE YEAR 1970    (365 DAYS)
                    DEGREE DAY  8382

          LATITUDE  =  44  CLEARNESS NO (SUM) = 1.02  TIME ZONE  =  6
          LONGITUDE =  93  CLEARNESS NO (WIN) = 1.02  ALTITUDE =  822

    DESIGN DAY          DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:          89.0     22.0     69.4     10.0
          WINTER:         -12.0      3.0    -13.0     11.3

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         38  38  38  38  46  54  62  60  59  57  51  44
```

MISSOURI

```
COLUMBIA      MO    STATION NO 13983    FOR THE YEAR 1968    (  3 DAYS)
                    DEGREE DAY  5046

          LATITUDE  =  39  CLEARNESS NO (SUM) =  .95  TIME ZONE  =  6
          LONGITUDE =  92  CLEARNESS NO (WIN) =  .95  ALTITUDE =  778

    DESIGN DAY          DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:          94.0     22.0     71.7      0.0
          WINTER:           4.0      3.0      1.1      9.0

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         44  44  45  47  54  59  65  64  63  62  56  50
```

MISSOURI

```
KANSAS CITY  MO     STATION NO 13988    FOR THE YEAR 1968    (366 DAYS)
                    DEGREE DAY  4711

          LATITUDE  =  39  CLEARNESS NO (SUM) =  .95  TIME ZONE  =  6
          LONGITUDE =  94  CLEARNESS NO (WIN) =  .95  ALTITUDE =  742

    DESIGN DAY          DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:          96.0     20.0     69.2      9.0
          WINTER:           6.0      3.0      3.3     10.0

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         44  44  45  47  54  59  65  64  63  62  56  50
```

MISSOURI

```
ST. LOUIS     MO    STATION NO 13944    FOR THE YEAR 1972    (366 DAYS)
                    DEGREE DAY  4900

          LATITUDE  =  38  CLEARNESS NO (SUM) =  .95  TIME ZONE  =  6
          LONGITUDE =  90  CLEARNESS NO (WIN) =  .95  ALTITUDE =  535

    DESIGN DAY          DRY BULB  TMP RNG  DEW PNT  WND SPD
          SUMMER:          94.0     21.0     71.7      9.0
          WINTER:           6.0      3.0      3.3     11.8

          GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                         43  43  44  44  52  58  65  64  62  61  55  49
```

TABLE D-1 NECAP WEATHER STATIONS

MISSISSIPPI

JACKSON MS STATION NO 3940 FOR THE YEAR 1964 (365 DAYS)
DEGREE DAY 2239

LATITUDE = 32 CLEARNESS NO (SUM) = .91 TIME ZONE = 6
LONGITUDE = 90 CLEARNESS NO (WIN) = .91 ALTITUDE = 330

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	95.0	21.0	71.3	5.0
WINTER:	25.0	3.0	22.0	7.7

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	56	56	58	60	67	71	76	75	75	74	68	62

MONTANA

GREAT FALLS MT STATION NO 24143 FOR THE YEAR 1956 (3 DAYS)
DEGREE DAY 7750

LATITUDE = 47 CLEARNESS NO (SUM) = 1.09 TIME ZONE = 7
LONGITUDE = 111 CLEARNESS NO (WIN) = 1.09 ALTITUDE = 3664

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	88.0	28.0	45.9	7.0
WINTER:	-15.0	3.0	-18.0	9.4

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	36	36	36	36	42	47	53	52	50	49	45	40

NORTH CAROLINA

RALEIGH NC STATION NO 13722 FOR THE YEAR 1965 (365 DAYS)
DEGREE DAY 3393

LATITUDE = 35 CLEARNESS NO (SUM) = .95 TIME ZONE = 5
LONGITUDE = 78 CLEARNESS NO (WIN) = .95 ALTITUDE = 433

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	92.0	20.0	72.9	6.0
WINTER:	20.0	3.0	17.0	7.9

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	49	49	52	55	64	70	76	74	71	69	62	56

NORTH DAKOTA

BISMARCK ND STATION NO 24011 FOR THE YEAR 1970 (365 DAYS)
DEGREE DAY 8851

LATITUDE = 46 CLEARNESS NO (SUM) = 1.05 TIME ZONE = 6
LONGITUDE = 100 CLEARNESS NO (WIN) = 1.05 ALTITUDE = 1647

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	27.0	63.3	9.0
WINTER:	-19.0	3.0	-16.0	9.1

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	36	36	37	37	45	52	59	58	56	55	49	42

TABLE D-1 NECAP WEATHER STATIONS

NEBRASKA

```
OMAHA          NE      STATION NO 14942    FOR THE YEAR 1966    (365 DAYS)
                       DEGREE DAY  6612

            LATITUDE  =  41  CLEARNESS NO (SUM) = 1.00  TIME ZONE  =  6
            LONGITUDE =  95  CLEARNESS NO (WIN) = 1.00  ALTITUDE =  978

    DESIGN DAY         DRY BULB  TMP RNG  DEW PNT  WND SPD
            SUMMER:       91.0     22.0     72.1      8.0
            WINTER:       -3.0      3.0     -6.0      9.7

            GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                           40  40  41  43  51  58  65  64  62  61  54  47
```

NEW MEXICO

```
ALBUQUERQUE   NM      STATION NO 23050    FOR THE YEAR 1959    (365 DAYS)
                      DEGREE DAY  4348

            LATITUDE  =  35  CLEARNESS NO (SUM) = 1.10  TIME ZONE  =  7
            LONGITUDE = 106  CLEARNESS NO (WIN) = 1.10  ALTITUDE = 5310

    DESIGN DAY         DRY BULB  TMP RNG  DEW PNT  WND SPD
            SUMMER:       94.0     27.0     45.9      8.0
            WINTER:       16.0      3.0     13.0      7.3

            GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                           58  58  60  61  68  72  77  76  75  74  69  63
```

NEW YORK

```
ALBANY         NY      STATION NO 14735    FOR THE YEAR 1969    (365 DAYS)
                       DEGREE DAY  6875

            LATITUDE  =  42  CLEARNESS NO (SUM) = 1.00  TIME ZONE  =  5
            LONGITUDE =  73  CLEARNESS NO (WIN) = 1.00  ALTITUDE =  277

    DESIGN DAY         DRY BULB  TMP RNG  DEW PNT  WND SPD
            SUMMER:       88.0     23.0     68.2      7.0
            WINTER:       -1.0     23.0     -4.3     10.0

            GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                           41  41  41  41  47  52  58  57  55  54  50  45
```

NEW YORK

```
BUFFALO        NY      STATION NO 14733    FOR THE YEAR 1974    (365 DAYS)
                       DEGREE DAY  7062

            LATITUDE  =  43  CLEARNESS NO (SUM) = 1.00  TIME ZONE  =  5
            LONGITUDE =  78  CLEARNESS NO (WIN) = 1.00  ALTITUDE =  705

    DESIGN DAY         DRY BULB  TMP RNG  DEW PNT  WND SPD
            SUMMER:       56.0     21.0     67.4     12.0
            WINTER:        6.0      3.0      3.0     17.0

            GROUND TEMPS: JAN FEB MAR APR MAY JUN JUL AUG SEB OCT NOV DEC
                           41  41  41  41  47  52  58  57  55  54  50  45
```

TABLE D-1 NECAP WEATHER STATIONS

NEW YORK

NEW YORK NY STATION NO 14732 FOR THE YEAR 1951 (365 DAYS)
DEGREE DAY 4871

LATITUDE = 40 CLEARNESS NO (SUM) = .99 TIME ZONE = 5
LONGITUDE = 73 CLEARNESS NO (WIN) = .99 ALTITUDE = 16

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	89.0	16.0	71.8	13.0
WINTER:	15.0	3.0	12.0	17.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	44	44	45	46	52	58	63	62	62	61	55	50

OHIO

CINCINNATI OH STATION NO 93814 FOR THE YEAR 1957 (365 DAYS)
DEGREE DAY 5265

LATITUDE = 39 CLEARNESS NO (SUM) = .97 TIME ZONE = 5
LONGITUDE = 84 CLEARNESS NO (WIN) = .97 ALTITUDE = 761

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	90.0	21.0	71.3	7.0
WINTER:	6.0	3.0	3.0	8.5

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	42	42	43	44	50	56	61	60	60	59	53	48

OHIO

CLEVELAND OH STATION NO 14820 FOR THE YEAR 1969 (365 DAYS)
DEGREE DAY 6351

LATITUDE = 41 CLEARNESS NO (SUM) = .99 TIME ZONE = 5
LONGITUDE = 81 CLEARNESS NO (WIN) = .99 ALTITUDE = 777

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	88.0	22.0	69.4	11.0
WINTER:	5.0	3.0	2.6	14.7

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	42	44	45	46	51	56	62	61	60	59	53	48

OKLAHOMA

OKLAHOMACITY OK STATION NO 13967 FOR THE YEAR 1951 (365 DAYS)
DEGREE DAY 3725

LATITUDE = 35 CLEARNESS NO (SUM) = .95 TIME ZONE = 6
LONGITUDE = 97 CLEARNESS NO (WIN) = .95 ALTITUDE = 1280

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	97.0	23.0	69.2	10.0
WINTER:	13.0	3.0	10.0	11.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	49	49	52	54	64	70	77	76	74	73	65	57

TABLE D-1 NECAP WEATHER STATIONS

OKLAHOMA

TULSA OK STATION NO 13968 FOR THE YEAR 1973 (365 DAYS)
DEGREE DAY 3860

LATITUDE = 36 CLEARNESS NO (SUM) = .95 TIME ZONE = 6
LONGITUDE = 95 CLEARNESS NO (WIN) = .95 ALTITUDE = 650

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	98.0	22.0	70.0	10.0
WINTER:	13.0	3.0	13.0	10.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	50	50	51	53	60	66	72	71	69	68	62	56

OREGON

MEDFORD OR STATION NO 24225 FOR THE YEAR 1966 (365 DAYS)
DEGREE DAY 5008

LATITUDE = 42 CLEARNESS NO (SUM) = 1.05 TIME ZONE = 8
LONGITUDE = 122 CLEARNESS NO (WIN) = 1.05 ALTITUDE = 1298

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	94.0	35.0	53.3	4.0
WINTER:	23.0	3.0	20.0	7.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	48	48	49	51	56	60	64	63	62	61	57	52

OREGON

PORTLAND OR STATION NO 24229 FOR THE YEAR 1960 (366 DAYS)
DEGREE DAY 4635

LATITUDE = 45 CLEARNESS NO (SUM) = 1.05 TIME ZONE = 8
LONGITUDE = 122 CLEARNESS NO (WIN) = 1.05 ALTITUDE = 21

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	85.0	23.0	57.2	6.0
WINTER:	23.0	3.0	20.0	7.3

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	47	47	48	49	55	59	64	63	61	60	56	51

PENNSYLVANIA

PHILADELPHIA PA STATION NO 13739 FOR THE YEAR 1969 (365 DAYS)
DEGREE DAY 5144

LATITUDE = 39 CLEARNESS NO (SUM) = .98 TIME ZONE = 5
LONGITUDE = 75 CLEARNESS NO (WIN) = .98 ALTITUDE = 7

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	90.0	21.0	72.1	10.0
WINTER:	14.0	3.0	11.0	11.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	40	40	41	43	51	59	66	64	61	59	53	46

TABLE D-1 NECAP WEATHER STATIONS

PENNSYLVANIA

PITTSBURGH PA STATION NO 94823 FOR THE YEAR 1957 (365 DAYS)
DEGREE DAY 5987

LATITUDE = 40 CLEARNESS NO (SUM) = .98 TIME ZONE = 5
LONGITUDE = 80 CLEARNESS NO (WIN) = .98 ALTITUDE = 1137

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	86.0	22.0	68.6	9.0
WINTER:	5.0	3.0	2.0	11.6

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	42	42	43	43	50	57	63	62	60	59	53	48

SOUTH CAROLINA

CHARLESTON SC STATION NO 13880 FOR THE YEAR 1955 (365 DAYS)
DEGREE DAY 2033

LATITUDE = 32 CLEARNESS NO (SUM) = .94 TIME ZONE = 5
LONGITUDE = 80 CLEARNESS NO (WIN) = .94 ALTITUDE = 41

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	18.0	75.9	10.0
WINTER:	27.0	3.0	24.5	10.5

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	49	49	52	55	64	70	76	74	71	69	62	56

TENNESSEE

MEMPHIS TN STATION NO 13893 FOR THE YEAR 1964 (366 DAYS)
DEGREE DAY 3232

LATITUDE = 35 CLEARNESS NO (SUM) = .95 TIME ZONE = 6
LONGITUDE = 90 CLEARNESS NO (WIN) = .95 ALTITUDE = 263

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	95.0	21.0	72.9	7.0
WINTER:	18.0	3.0	15.0	9.3

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	50	50	52	53	60	64	69	67	66	64	59	55

TENNESSEE

NASHVILLE TN STATION NO 13897 FOR THE YEAR 1972 (366 DAYS)
DEGREE DAY 3578

LATITUDE = 36 CLEARNESS NO (SUM) = .95 TIME ZONE = 6
LONGITUDE = 86 CLEARNESS NO (WIN) = .95 ALTITUDE = 577

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	94.0	21.0	71.7	8.0
WINTER:	14.0	3.0	11.0	9.8

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	48	48	50	53	61	66	72	69	67	64	59	53

TABLE D-1 NECAP WEATHER STATIONS

TEXAS

AMARILLO TX STATION NO 23047 FOR THE YEAR 1968 (366 DAYS)
DEGREE DAY 3985

LATITUDE = 35 CLEARNESS NO (SUM) = 1.00 TIME ZONE = 6
LONGITUDE = 101 CLEARNESS NO (WIN) = 1.00 ALTITUDE = 3607

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	95.0	26.0	58.5	11.0
WINTER:	11.0	3.0	8.0	12.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	62	64	70	76	81	80	78	77	72	66

TEXAS

BROWNSVILLE TX STATION NO 12919 FOR THE YEAR 1955 (365 DAYS)
DEGREE DAY 600

LATITUDE = 25 CLEARNESS NO (SUM) = .90 TIME ZONE = 6
LONGITUDE = 97 CLEARNESS NO (WIN) = .90 ALTITUDE = 16

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	93.0	18.0	75.9	9.0
WINTER:	39.0	3.0	36.0	10.4

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	58	58	60	63	71	78	84	82	79	77	71	64

TEXAS

EL PASO TX STATION NO 23044 FOR THE YEAR 1967 (365 DAYS)
DEGREE DAY 2700

LATITUDE = 31 CLEARNESS NO (SUM) = .99 TIME ZONE = 7
LONGITUDE = 106 CLEARNESS NO (WIN) = .99 ALTITUDE = 3918

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	98.0	27.0	52.8	9.0
WINTER:	24.0	3.0	21.0	9.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	62	64	70	76	81	80	78	77	72	66

TEXAS

FORT WORTH TX STATION NO 3927 FOR THE YEAR 1975 (365 DAYS)
DEGREE DAY 2405

LATITUDE = 32 CLEARNESS NO (SUM) = .95 TIME ZONE = 6
LONGITUDE = 97 CLEARNESS NO (WIN) = .95 ALTITUDE = 544

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	98.0	27.0	69.6	10.0
WINTER:	24.0	3.0	21.0	10.5

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	62	64	70	76	81	80	78	77	72	66

TABLE D-1 NECAP WEATHER STATIONS

TEXAS

HOUSTON TX STATION NO 12918 FOR THE YEAR 1966 (365 DAYS)
DEGREE DAY 1396

LATITUDE = 29 CLEARNESS NO (SUM) = .91 TIME ZONE = 6
LONGITUDE = 95 CLEARNESS NO (WIN) = .91 ALTITUDE = 50

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	94.0	18.0	75.2	8.0
WINTER:	32.0	3.0	29.0	10.5

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	62	64	70	76	81	80	78	77	72	66

TEXAS

LUBBOCK TX STATION NO 23042 FOR THE YEAR 1955 (365 DAYS)
DEGREE DAY 3578

LATITUDE = 33 CLEARNESS NO (SUM) = .95 TIME ZONE = 6
LONGITUDE = 101 CLEARNESS NO (WIN) = .95 ALTITUDE = 3243

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	96.0	26.0	60.0	11.0
WINTER:	15.0	3.0	12.0	12.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	61	61	62	64	70	76	81	80	78	77	72	66

TEXAS

SAN ANTONIO TX STATION NO 12921 FOR THE YEAR 1960 (366 DAYS)
DEGREE DAY 1546

LATITUDE = 29 CLEARNESS NO (SUM) = .91 TIME ZONE = 6
LONGITUDE = 98 CLEARNESS NO (WIN) = .91 ALTITUDE = 792

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	97.0	19.0	69.2	7.0
WINTER:	30.0	3.0	27.0	8.3

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	58	58	60	63	71	78	84	82	79	77	71	64

UTAH

SALTLAKECITY UT STATION NO 24127 FOR THE YEAR 1948 (366 DAYS)
DEGREE DAY 6052

LATITUDE = 40 CLEARNESS NO (SUM) = 1.15 TIME ZONE = 7
LONGITUDE = 112 CLEARNESS NO (WIN) = 1.15 ALTITUDE = 4220

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	95.0	32.0	48.5	7.0
WINTER:	8.0	3.0	5.0	7.8

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	40	40	42	43	50	55	60	59	57	56	51	45

TABLE D-1 NECAP WEATHER STATIONS

VIRGINIA

HAMPTON VA STATION NO 13702 FOR THE YEAR 1962 (365 DAYS)
DEGREE DAY 3421

LATITUDE = 37 CLEARNESS NO (SUM) = .96 TIME ZONE = 5
LONGITUDE = 76 CLEARNESS NO (WIN) = .96 ALTITUDE = 17

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	18.0	74.0	11.0
WINTER:	23.0	3.0	29.0	12.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	45	45	50	55	60	70	75	80	75	65	60	50

VIRGINIA

NORFOLK VA STATION NO 13737 FOR THE YEAR 1951 (365 DAYS)
DEGREE DAY 3421

LATITUDE = 36 CLEARNESS NO (SUM) = .96 TIME ZONE = 5
LONGITUDE = 76 CLEARNESS NO (WIN) = .96 ALTITUDE = 26

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	91.0	18.0	74.0	11.0
WINTER:	22.0	3.0	19.0	12.1

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	41	41	44	46	56	62	69	67	66	64	56	49

VIRGINIA

RICHMOND VA STATION NO 13740 FOR THE YEAR 1969 (365 DAYS)
DEGREE DAY 3865

LATITUDE = 37 CLEARNESS NO (SUM) = .96 TIME ZONE = 5
LONGITUDE = 77 CLEARNESS NO (WIN) = .96 ALTITUDE = 162

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	92.0	21.0	72.5	6.0
WINTER:	17.0	3.0	14.0	8.1

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	41	41	44	46	56	62	69	67	66	64	56	49

VERMONT

BURLINGTON VT STATION NO 14742 FOR THE YEAR 1966 (365 DAYS)
DEGREE DAY 8269

LATITUDE = 44 CLEARNESS NO (SUM) = 1.05 TIME ZONE = 5
LONGITUDE = 73 CLEARNESS NO (WIN) = 1.05 ALTITUDE = 331

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	85.0	23.0	67.9	8.0
WINTER:	-7.0	3.0	-10.0	11.6

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	39	39	39	38	45	52	59	57	56	54	49	44

TABLE D-1 NECAP WEATHER STATIONS

WASHINGTON

SEATTLE WA STATION NO 24233 FOR THE YEAR 1960 (366 DAYS)
DEGREE DAY 5145

LATITUDE = 47 CLEARNESS NO (SUM) = 1.05 TIME ZONE = 8
LONGITUDE = 122 CLEARNESS NO (WIN) = 1.05 ALTITUDE = 386

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	81.0	22.0	53.8	7.0
WINTER:	26.0	3.0	23.0	9.8

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	46	46	47	49	53	56	58	57	56	56	53	49

WISCONSIN

MADISON WI STATION NO 14837 FOR THE YEAR 1974 (365 DAYS)
DEGREE DAY 7863

LATITUDE = 43 CLEARNESS NO (SUM) = 1.00 TIME ZONE = 6
LONGITUDE = 89 CLEARNESS NO (WIN) = 1.00 ALTITUDE = 858

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	88.0	22.0	69.8	8.0
WINTER:	-7.0	3.0	-10.0	10.1

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	36	36	37	37	45	52	59	57	56	54	48	42

WYOMING

CHEYENE WY STATION NO 24018 FOR THE YEAR 1974 (365 DAYS)
DEGREE DAY 7381

LATITUDE = 41 CLEARNESS NO (SUM) = 1.05 TIME ZONE = 7
LONGITUDE = 104 CLEARNESS NO (WIN) = 1.05 ALTITUDE = 6126

DESIGN DAY	DRY BULB	TMP RNG	DEW PNT	WND SPD
SUMMER:	86.0	30.0	45.1	9.0
WINTER:	-1.0	3.0	-4.0	13.0

GROUND TEMPS:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEB	OCT	NOV	DEC
	41	41	41	42	47	51	56	55	54	53	49	45

NECAP WEATHER INPUT FORMAT

The weather data base used by NECAP is coded. There are 6 records containing the local data, followed by a record for each hour of the year. Each record is 120 characters long and blank filled.

Table D-2 shows the variable input format used by NECAP 4.1. Eleven items for each hour are required. Those items with astericks are provided on the tape, but are again computed by TLAP for the program. Double asterick data is not provided. The data used in the NECAP weather data base was obtained from the sources listed in the last page of table D-2. The solar data was calculated from cloud cover data.

TABLE D-2 NECAP WEATHER FORMAT

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	FORTRAN FORMAT	UNITS	SOURCE OF INFORMATION
WT-1	1-10	Latitude	F10.2	Degrees	1
	11-20	Longitude	F10.2	Degrees	2
	21-30	Clearness no. Summer	F10.2		2
	31-40	Clearness no. Winter	F10.2		2
	41-50	Time Zone	F10.2		2
WT-2	1-10	Altitude above sea level	F10.0	Feet	1
WT-3	1-10	Summer - max dry-bulb	F10.2	Deg F	1
	11-20	Summer - temp. range	F10.2	Deg F	1
	21-30	Summer - dew point	F10.2	Deg F	3
	31-40	Summer - wind speed	F10.2	MPH	4
WT-4	1-10	Winter main dry-bulb	F10.2	Deg F	1
	11-20	Winter - temp. range	F10.2	Deg F	5
	21-30	Winter - dew point	F10.2	Deg F	3
	31-40	Winter - wind speed	F10.2	MPH	4
WT-5	1-10	Station number	F10.0		6
	11-20	Weather year	F10.0		6
	21-30	Degree day	F10.2		1
	31-40	Number of days	F10.2	no of days in year	6
	41-55	Station name	15A1		6

TABLE D-2
NECAP WEATHER INPUT

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	FORTRAN FORMAT	UNITS	SOURCE OF INFORMATION
WT-6	1-6 7-12 . . . 67-72	Ground temperatures for each month	12 F6.1	Deg F	7
WT - Hourly	1-2	Month	I2		6
	3-4	Day	I2		6
	5	Day of week *	I1		8
	6	Daylight Savings flag *	I1		8
	7	Holiday flag *	I1		8
	8-10	Hour of day	I3	1-24	6
	11-13	Dry bulb	I3	Deg F	6
	14-16	Wet bulb	I3	Deg f	6
	17-19	Dew point	I3	Deg F	6
	20-23	Atmospheric pressure	I4	inch*100	6
	24-26	Wind speed	I3	Knots	6
	27-29	Wind direction	I3	Degrees	6
	30-31	Cloud Amount	I2		6
	32-33	Cloud type	I2		6

TABLE D-2
NECAP WEATHER INPUT

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION		FORTRAN FORMAT	UNITS	SOURCE OF INFORMATION
WT-Hourly (continued)	34-39	Humidity ratio *		F6.4	lbs. water/ lbs. air	8
	40-45	Amount of saturated air *		F6.2	btu/lb	8
	46-50	Density *		F5.3	lb/ ft^3	8
	51-56	Tangent of the declination angle *		F6.3	radians	8
	57-64	Hourly angle of the sum *		F8.4	radians	8
	65-71	Position	X COS of α from West *	F7.3	radians	8
	72-78	of the	Y COS of α from South *	F7.3	radians	8
	79-85	sun	Z SIN of α upward *	F7.3	radians	8
	86-90	Cloud cover factor *		F5.3		8
	91-96	Direct normal radiation thru clds *		F6.1	btu/hr/sqft	8
	97-102	Sky brightness through clouds *		F6.1	btu/hr/sqft	8
	103-108	Total horizontal radiation *		F6.1	btu/hr/sqft	8
	109-114	Measured beam radiation **		F6.1	btu/hr/sqft	9
	115-120	Diffuse radiation **		F6.1	btu/hr/sqft	9

TABLE D-2

NECAP WEATHER INPUT

NOTE:

* Data is provided but not currently used by NECAP 4.1. Data is computed during each run for design-only and/or hourly analysis.

** Data is not provided or used by NECAP 4.1. Input provisions are provided for future use of the NECAP Weather Data Base.

Information sources:

1. ASHRAE 1981 Handbook of Fundamentals, Chapter 24.
2. ASHRAE 1982 Handbook of Applications, Chapter 57.
3. Computed from design wet-bulb and dry-bulb taken from ASHRAE 1981 Handbook of Fundamentals, Chapter 24 and using NECAP 4.1 subroutines.
4. Carrier System Design Manual, Section 1, Chapter 2.
5. NECAP default value.
6. NOAA Weather Tape and Documentation.
7. National Bureau of Standards, NBS BSS 69, Table TG-3.
8. Computed using NECAP 4.1 subroutines.
9. Supplied by User.

NECAP WEATHER DATA PREPARATION

The NECAP weather data base was prepared using a FORTRAN routine which is now part of the NECAP Input Processor Program. The routine is called program WETHER and is described, as such, in the NECAP Engineering Manual. In the program listing, the NECAP Flowcharts Manual and the NECAP Operations Manual it is referred to as program WEATHER.

The WETHER was preferred in order to distinguish between the WETHER input processor used in NECAP 4.1, and the subroutine WEATHER that was used in earlier versions of NECAP, which only reads the NOAA 1440 data. Program WETHER is the combination of subroutine WEATHER and program RWTTRY which converts Test Reference Year tapes to NECAP format.

WETHER uses as input, NOAA tape and local data, such as design day, latitude, etc. The local data is read in using the format given in table D-3. The NOAA data is described in the documentation provided with the NOAA tape. The output format of program WEATHER is the same format shown in Table D-2.

Program WETHER performs all the necessary solar and psychrometric calculations required to prepare the data. All of the algorithms used are documented in the NECAP Engineering Manual.

INPUT TO PROGRAM WETHER

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUE	CODE	EXAMPLE	COMMENTS
W-1	1-10	Station Latitude	STALAT	Degrees	-90.0-90.0		37.	See 1981 ASHRAE handbook, Ch.24
	11-20	Station Longitude	STALON	Degrees	0.0--360.0		75.	
	21-30	Time Zone	TZN		0.0-24.		4	
	31-40	Clearness No. for Summer	CNS		.84-1.05		0.98	
	41-50	Clearness No. for Winter	CNW		.84-1.05		0.98	
W-2	1-10	Station Altitude above sea level	ALTUD	Feet			100.0	See 1981 ASHRAE Handbook
	11-20	Print flag	PRFLG		0-1	0-No Print 1-Daily Print	1.	
W-3	1-10	Summer Design Day Dry Bulb	TDBS	^{o}F			90.	See 1981 ASHRAE Handbook Ch. 24
	11-20	Dry-Bulb Temperature Range	RANGS	^{o}F			20.0	
	21-30	Summer Design Day Wet-Bulb	TWBS	^{o}F			72.0	
	31-40	Summer Design Day Wind Speed	WINDS	Knots			12.0	
W-4	1-10	Winter Design Day Dry-Bulb Temperature	TDBW	^{o}F			10.0	See 1981 ASHRAE Handbook, Ch. 24
	11-20	Dry Bulb Temperature Range	RANGW	^{o}F			3.0	
	21-30	Winter Design Day Wet-Bulb Temperature	TWBW	^{o}F			9.0	
	31-40	Winter Design Day Wind Speed	WINDW	Knots			10.0	
W-5	1-10	Year of Weather	YEAR				1962	
	11-20	Station Number	STATNO				13721	
	21-30	Type of Tape	TAPENO		1-3	1=1440 4-6 2=1440 1-24 3=TRY	3.0	
	31-45	Station Name	STANAM	ALPHA			Hampton VA	
W-6	1-10	Winter Wet Soil Temperature	SGRND(1)	^{o}F			45.0	
	11-20	Spring Wet Soil Temperature	SGRND(2)	^{o}F			50.0	
	21-30	Summer Wet Soil Temperature	SGRND(3)	^{o}F			70.0	
	31-40	Autumn Wet Soil Temperature	SGRND(4)	^{o}F			50.0	

Appendix E

7 Zone Model of the

Systems Engineering Building 1209
Langley Research Center
Hampton, VA

The 12 zone example in section two is a detailed model where most building components were input. The energy calculated is very similar to the real building energy use. The 7 zone model presented in this appendix demonstrates the use of default values, and the ramifications of the same building using a few different building characteristics.

To illustrate how default values can be used, the input to the 7 zone model is listed on the left hand pages, the 12 zone on the right. The lines are specially numbered sequentially for easier comparison. The occupied zones numbered 1-5 are the same as the 12 zone model. Zone 6 is the plenum over the center zones, but internal surfaces are input to show heat transfer to all 5 zones. The uncontrolled equipment room and computer room are combined into zone number 7.

Following the input data comparison of the two models in this appendix, are the summary reports for the 7 zone model only. When using different modeling techniques on the same building, NECAP may compute a different energy use for each model, although default values may be overridden to bring the two models and results closer together. In this case, the 7 zone model uses 90% of the energy simulated in the 12 zone model, which can be attributed to the use of default thermostat and fan system controls, elimination of the baseboard heat, and the supply cfms used are computed at 80% of the specified air flow for the 12 zone model.

A third model of the same building has also been provided with one zone. It is shown in the NECAP Fast Input Manual. Here the energy is considerably higher than the more detailed model because the simulated building characteristics and infiltration produces higher loads causing the VAV conditioning system to require higher air flows. This results in the use of considerable reheat since the default limits the reduced air flow of the VAV to only 40% of the design values. The total energy use is 154% greater than the 12 zone model, although the models could be "tuned" by using appropriate values in critical items instead of defaulted values.

INPUT FOR 7 ZONE MODEL

```
C
L1=SEB/HAMPTON/D.L. MINER/BASE;
C
C
C
C
L2=300;
C
C                                              DESIGN LOADS NOT REQUESTED
C
C
L5=;                                           DEFAULTED PEOPLE WEEKLY SCHEDULE
L5=,5*5;                                       WEEKLY LIGHTING LOADS
C
C
C
C
C                                              NO EXTERNAL SHADE USED
C
C                                              ALL 16 STANDARD SURFACES
C                                              REQUESTED BY DEFAULT
C
C
C
C
C
L11=,8,@9,7.27,243;                            DS #1 USING #8 STD SURFACE
C
L11=1,@8,0,@6/1,@8,270,,,213/1,@8,90,,,213;  DS #2,3,4
C
C
C
C
C
C
L11=,4,@9,5,243/5,@8,0,@3/5,@8,270,@2,213/5,@8,90,@2,213;  PLENUM WALLS
C
C
C
L11-9=,12,@8,0,1400;                           ROOF SECTIONS
C
C
C
C
L13=,.8,@9,5,@3,7,3;
C
L13=1,@12,90,@3/1,@12,0,@3/1,@12,90,@3;
C
C
```

INPUT FOR 12 ZONE MODEL

```
C                                                   LOAD CARDS
L1=SYSTEMS ENGINEERING BUILDING,LARC;                 FAC.NAME
L1=HAMPTON,VA.;                                       FAC.LOCATION
L1=R.N. JENSEN;                                       ENGR.NAME
L1=SEB BASE-LONG;                                     PROJ.NO.
L1=DEC 15,1981;                                       DATE
L2=300,2,0.1,2.0,55,120,37,76.0,5,0.96,
   0.96;                                              LOCATION CARD
L3=1,1,12,31,0,10,95,16,76,8,18,5,13,12;              STUDY LENGTH & WEATHER
L4=8,1,6,1;                                           DATA  PRINT OUT
C                                                     SCHEDULE CARDS
L5-1=1,4,4,4,4,4,1,1,1;                                 SCH #1 (USED FOR PEOPLE) & EQUIP
L5-2=1,5,5,5,5,5,1,1,1;                                 SCH #2 (USED FOR LIGHTS)
L5=1,4,4,4,4,4,11,1,1;                                  SCH #3 (USED FOR SPECIAL PEOPLE)
L5=9*2;                                                 SCH #4 (USED FOR EQUIP)
L6=8*0,5*0.15,11*0;                                     SPEC. SCH#11 (SPECIAL PEOPLE ON SAT)
C                                                     SHADE CARD
L7=0,.1,-30,200,0,40,100,270,90;                        EXTERNAL SHADE -TREES @ 90% TRANS.
C                                                     RESPONSE FACTOR CARD
L8=5,12;                                                STANDARD DELAYED SURF. USED
L9-1=0.33,0.742,125,0.220,BRICK 4 IN;                       1ST MATERIAL CARD
L9-2=@4,0.91,AIR SPACE;                                   2ND MATERIAL CARD
L9-3=0.667,0.33,38,.2,BLOCK,BIN;                          3RD, LETTER B FORCES 6TH FIELD DA
L9-4=@4,0.658,INSIDE AIR FILM;                            4TH MATERIAL CARD
L10=1,2,3,4;                                            DELAYED SURFACE #3 MAKE-UP
C                                                     DELAYED SURFACES CARDS
L11-1=0,1,.75,.2,2,0,1,1,1,180,90,7.27,
      243,0,0,0;                                        FRONT WALL-ALL DATA INPUT
L11-2=1,@@,0,@6;                                        REAR WALL -SIMULAR SURFACE @ 0 AZ
L11-3=0,1,.75,.2,2,0,20,3,,270,90,7.9,
      213,0,213,,1;                                     D3- LARGER X&Y WILL ALLOW SHADOW
L11-4=0,1,.75,.2,2,0,4,4,10,243,0,0,243,
      10,0,243,6.5,3,243,3.5,3,243,3.5,
      9.9,243,6.5,9.9,243,6.5,3,243,10,0,
      243,10,10,243,0,10;                               D4-LONG FORM W/WINDOW -NORTH
L11-5=,3,@9,5,243,0,0,10;                               D5-DEFAULTS USED.
L11-6=5,@8,0,@3;
L11-7=5,@8,270,@2,213;
L11-8=7,@8,90,@3;                                       DOUBLE SIM. SURFACE
L11-9=0,2,.75,,1,@5,0,1400;                             ROOF SECTION
L11-10=0,3,@9,1100;                                     F/R WALL
C                                                     QUICK SURFACE CARDS
L12=,.2,@7,270,90,8,16;                                 DAMPERS IN E/R
C                                                     WINDOW & DOOR(GLASS) CARDS
L13-1=,.8,.5,.5,.2,5,2,1.2,6,14,1,5,1,
      180,90,7,3,3.5,0,3.5;                             ASSUMED SOUTH(FRONT) (22)
L13-2=1,@12,90,@3;                                      ASSUMED EAST(RT SIDE) (21)
L13-3=1,@12,0,@3;                                       ASSUMED NORTH(REAR) (22)
L13-4=,.8,.5,.5,.2,1.2,2,20,,4,20,1,5,1,
```

INPUT FOR 7 ZONE MODEL

```
C
L13-5=,@4,72,@4,2,5,@3,10,20;
C
L13=5,@12,0,@3;
C
C
C
L15-I=3200,.25,1,6/2800,.25,2,6/3200,.25,3,6;
L15-I=2800,.25,4,6/39000,.25,5,6;        ZONES TO PLENUM(6)
C
C
L15-I=2000,50,1,5/2000,50,2,5/2000,50,3,5;
L15-I=2000,50,4,5;                       IMAGINARY WALLS
L15-I=2800,.3,6,7;                       PLENUM TO E/R
C
L15-U=3000,0.1/39000,0.02;
C
C
C
L17=,3200,,,,25,,1,2,.7,3,,2,0.4,,,,1,1,1;
L17=1,2800,28000/1/1,3200,32000;
C
C
C
C
C
C
C
L17-5=,39000,@3,200,,,2,.7,2.6,,2,0.4,,,,1,1,.2,,500;
C
C
L17=,51000,388000,3,@19,1,;
C
C
C
C
C
C
L17=0,2800,,40,,,,,4,,2,,,,5,20000,,,1,1,@4,1;
C
L18-1-0=1/G=22*1,5/I=1,6/U=1;
L18-2-0=4/G=21*2/I=2,7/U=1;
L18-3-0=2/G=22*3,6/I=3,8/U=1;
L18-4-0=3/G=21*4/I=4,9/U=1;
L18-5-I=5,6,7,8,9/U=2;
L18-6-0=5,6,7,8,36*9/I=1,2,3,4,5,10;     PLENUM
L18-7-0=4*9/I=10;
C
C
```

INPUT FOR 12 ZONE MODEL

```
               270,90,2.1,213,0,213,3.5,1;          ASSUMED WEST(LFT SIDE) (1)
L13-5=,1.0,.5,.5,.2,72,0,160.8,50,30,2,5,1,
      180,90,10,20;                                 FRONT DOOR
L13-6=5,212,0,23;                                   REAR DOOR
C                                                  SHADOW PICTURES
L14-G=5,2,10;
C                                                  INTERNAL SURFACES
L15-I=3200,.32,1,6/2800,.32,2,7;                    CEILING # 1 & 2
L15-I=3200,.32,3,8/2800,.32,4,9;                    CEILING #3 & 4
L15-I=39000,.32,5,10;                               CENTER CEILING #5
L15-I=2000,50,1,5/2000,50,2,5;                      IMAGINARY INT. SURF. (NOTE HIGH U)
L15-I=2000,50,3,5/2000,50,4,5;                      IMAGINARY INT. SURF.
L15-I=2000,.3,10,11/2000,.3,10,12;                  INTERNAL WALL #10 & 11
L15-I=700,.2,11,12;                                 #12
C                                                  UNDERGROUND SURFACE
L15-U=3000,0.1/39000,0.02;
C                                                  UNDERGROUND TEMP.
L16=45,45,50,55,60,70,75,80,75,65,60,50;
C                                                  SPACE CARDS
L17-1=0,3200,32000,60,72,25,450,1,2,.7,
      3.0,0,2,0.4,,,,1,2,,,,,,;                     ASSUMED SOUTH(FRONT)
L18-1-D=1/G=22*1,5/I=1,6/U=1;
L17-2=1,2800,28000;                                 ASSUMED EAST(RT SIDE)
L18-2-D=21*4/G=21*2/I=2,7/U=1;
L17-3=1;                                            ASSUMED NORTH(REAR)
L18-3-D=2/G=22*3,6/I=3,8/U=1;
L17-4=1,86,3;                                       ASSUMED WEST(LFT SIDE)
L18-4-D=3/G=4/I=4,9/U=1;
L17-5=,39000,390000,60,72,200,450,1,2,
     .7,2.6,,2,0.4,,,,1,1,.2,,500;                  CENTER ZONE(AIRCHANGE METH)
L18-5-I=5,6,7,8,9/U=2;
L17-6=0,3200,15000,3,72,218,1;                      ASSUMED SOUTH (FRONT) PLEN
L17-7=6,2800,14000;                                 ASSUMED EAST (RT SIDE) PLEN
L17-8=6;                                            ASSUMED NORTH (REAR) PLEN
L17-9=7;                                            ASSUMED WEST (LFT SIDE) PLEN
L17-10=6,39000,195000;                              CENTER PLEN
L17-11=0,1400,14000,40,72,0,,2,4,,1.,,1,,
       5,20000,,2,1,2,,,,,1;                        EQUIP. ROOM
L17-11=0,1400,14000,40,72,,,4,1,,2,,
       2,,5,,,4,1,.4;                               COMPUTER ROOM
L18-6-D=5,2*9/I=1;
L18-7-D=8,2*9/I=2;
L18-8-D=6,2*9/I=3;
L18-9-D=7,2*9/I=4;
L18-10-D=26*9/I=5,10,11;
L18-11-D=9,10/I=10,12/Q=1;                          EQUIP ROOM
L18-12-D=9,10/I=11,12;                              COMPUTER ROOM
C
C                                               SYSTEM CARDS
```

INPUT FOR 7 ZONE MODEL

```
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
C
S11=12,5,010,20;
C
C
S12=1,1;
C
S12=1,2;
C
S12=1,3;
C
S12=1,4;
C
S12=1,5;
C
S12=1,6,1,5,50000,1;
```

INPUT FOR 12 ZONE MODEL

```
S1=SEB EXAMPLE ;                                   HEADER
S2=1,1,12,31,0;                                    RUN ANALYSIS
S3=8,1,8,1,1,1;                                    PRINT DATA
C                                                  SCHEDULES
S4-1=6(2,95,55),1(2,80,66),
  10(1,77,73.83),7(2,95,55);                       WEEKDAY THERMOSTAT OUTSIDE ZONES
S4-2=24(2,95,55);                                  WEEKEND THERMOSTAT
S4-3=24(2,75,72.1)/24(2,75.9,73);                  SEASONAL DX THRMO.
S4-5=6(2,95,55),1(2,80,66),
  10(1,77,73.0),7(2,95,55);                        WEEKDAY THERMOSTAT CENTER ZONE
C                                                  SCHEDULES
S5-1=7(0),10(1.0),7(0);                              VENT SCH/ EQUIP SCH
S5-2= 24(0);                                         WEEKEND VENT
S5-3=24(1.0);                                        PROCESS SCH.
S6-1=1,2,1,1,1,1,1,2,2;                              #1 THRMO SCH (WEEKLY OUTSIDE ZONES)
S6-2=1,3,3,3,3.3,3,3,3;                              #2, WINTER C/R SCH
S6-3=1,4,4,4,4,4,4,4,4;                              #3, SUMMER C/R SCH
S6-4=0,2,1,1,1,1,1,2,2;                              #4, VENTILATION & PROCESS SCH.
S6-5=0,8*3;
S6-6=1,2,5,5,5,5,5,2,2;                              #1 THRMO SCH (WEEKLY CENTER ZONE)
C                                                  TIME OF YEAR (SEASONAL) SCHEDULES
S7-1=1,1,1;                                          YR SCH FOR OUTSIDE ZONES
S7-2=1,1,2,6,1,3,10,1,2;                             YEAR SCH  FOR C/R DX
S7-3=1,1,6;                                           YEAR SCH FOR CENTER ZONE
S7-4=1,1,4;                                           YEAR SCH FOR VENT AND PROC
S7-5=1,1,5;                                           YEAR SCH FOR VENT AND PROC
S8-1=10,55,90,170,HOT WATER;                         RESET SCH.
C                                                  INTERNAL DELAYED SURFACE
S9-1=24,0.67,CEILING AIR SURFACE/
     0.0625,0.035,30.,0.2,,ACOUSTICAL TILE/
     24,0.67,INSIDE AIR SURFACE ;
S10-1=1,2,3;                                       CEILING OVER SPACE
S10-2=1;                                           CEILING OVER PLENUM
S10-3=3,2,1;                                       FLOOR OF PLENUM
C                                                  FAN SYSTEM/SPACE CARDS
S11-1=12,5,5,1600,2,2,,,5.,0,0.5,0,20,
      55,,,,1,28,3,4,1;                               VAV SYSTEM
S11-2=5,1,  ,100,,,,,1,,,215,0,0,1,-1;                COMP.ROOM DX UNIT
S12-1=1,1,0,4000,0,1000,220,1,0,
      80000,10,,6,22,1,3200,FRONT ZONE(ASSUMED SOUTH);
S12-2=1,2,0,4000,0,1000,200,1,0,
      80000,10,,7,22,1,2800,RT SIDE ZONE(ASSUMED EAST);
S12-3=1,3,0,4000,0,1000,220,1,0,
      80000,10,,8,22,1,3200,REAR ZONE(ASSUMED NORTH);
S12-4=1,4,0,4000,0,1000,200,1,0,
      80000,10,,9,22,1,2800,LEFTSIDE ZONE(ASSUMED WEST);
S12-5=1,5,0,38000,550,500,100,3,200000,
      760000,10,,10,22,1,38000,CENTER Z;
S12-6=1,6,1,1,4000,4,3,3200,2,3200,PLENUM OVER FRONT ZONE;
```

INPUT FOR 7 ZONE MODEL

```
C
C
C
C
C
C
S15=4,1;
C
C
C
C
C
C
C
C
C
C
C
S19=10,4,1;
S20=25,7;
```

INPUT FOR 12 ZONE MODEL

```
S12-7=1,7,1,2,4000,4,3,2800,2,2800,PLENUM OVER RT SIDE ZONE;
S12-8=1,8,1,3,4000,4,3,3200,2,3200,PLENUM OVER REAR ZONE;
S12-9=1,9,1,4,4000,4,3,2800,2,2800,PLENUM OVER LFT SIDE ZONE;
S12-10=1,10,1,5,38000,4,3,39000,2,39000,PLENUM OVER CENTER ZONE;
S12-11=2,12,0,0,0,,,2,15000,48000,,COMPUTER ROOM;
S14=1,2200,1,1,12,31,3,0,,6*80;            BOILER
S15=4,1,110,4,1,12,1,3,10,45,20.,
 5 102,65 98,90 82,98 69,101 35,103,
 5 100,65 97,90 86,98 80,101 52,103,
 5 14,10 39,40 65,70 100,100 110,125;      CHILLER
S16=75,10,35;                              COOLING TOWER
S17=48,4,5,
 85,100,100
 95, 94,105
 100,90,107
 105,86,110
 110,79,115;                               DX UNIT FOR COMP. ROOM
S18=50,40,30,85;                           PUMP CARD
S19=10,4,5;                                HW CIR PUMP FOR SOLAR COLL.
S20=12,245,,,,7;                           MISC.
```

THERMAL LOADS SUMMARY

BUILDING LOAD SUMMARY FOR
SEB
HAMPTON

SPACE NOS. 1 THRU 7

TOTAL FLOOR AREA (SQ.FT.) 51400.

TOTAL VOLUME (CU.FT.) 514000.

SUMMER COOLING PEAK: AUG. 20 AT HOUR 18
DBT= 89 WBT= 79 WND SP= 12

WINTER HEATING PEAK: DEC. 31 AT HOUR 7
DBT= 15 WBT= 12 WND SP= 14

	***** SUMMER LOAD *****		WINTER
	SENSIBLE (BTUH)	LATENT (BTUH)	LOAD (BTUH)
WALLS	54446.	0.	-122528.
CEILINGS	122861.	0.	-231720.
WINDOW CONDUCTANCE	41600.	0.	-152023.
WINDOW SOLAR	49555.	0.	0.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND SURFACES	15840.	0.	-43560.
OCCUPANTS	78530.	44360.	5.
LIGHT TO SPACE	287304.	0.	27.
EQUIPMENT TO SPACE	61726.	0.	4.
INFILTRATION	60255.	160330.	-282436.
SUBTOTAL	772117.	204690.	-832232.
RETURN AIR	123130.	0.	8.
FAN HEAT	37352.	0.	37352.
VENTILATION AIR	88391.	227573.	-355128.
TOTAL	1020990.	432263.	-1150000.

TOTAL BUILDING COOLING 1453253. BTUH 121.1 TONS
TOTAL BUILDING HEATING -1150000. BTUH -1150.0 MBH

	******* VARIABLE VOLUME SYSTEM *******		******* CONSTANT VOLUME SYSTEM *******	
SUPPLY AIR AT 52 F AT DIFFUSER	38164. CFM	.74 CFM/SQ.FT. MAX.	46527. CFM	.91 CFM/SQ.FT. CONST.
SUPPLY AIR AT 120 F AT DIFFUSER	14304. CFM	.28 CFM/SQ.FT. MAX.	15318. CFM	.30 CFM/SQ.FT. CONST.

FAN SUMMARY

SEB HAMPTON JUL 2, 1982 BASE

SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF ENERGY DISTRIBUTION SYSTEM CHARACTERISTICS.

SYSTEM NO.	TYPE	++++++ TOTAL FAN BHP +++++ SUPPLY	RETURN	EXHAUST	NO. OF ZONES	++TOTAL SYSTEM AIR FLOWS (CFM)++ SUPPLY	MIN.O.A.	EXH.SYSTEM	PER-CENT MIN.O.A.
1	VAVS	66.8	0.0	0.0	5	43255.	0.	0.	0.0

E-11

SUMMARY OF ZONE AIR FLOWS

FAN SYSTEM	ZONE NUMBER	LOAD SPACE NUMBER	MULT FACTOR	SUPPLY CFM	EXHAUST CFM	LOAD SET POINT TEMP.	COOLING CAPACITY BTU/HR	HEATING CAPACITY BTU/HR	YEARLY THERMOSTAT SCHEDULE
1	1	1	1	5414.	0.	72.	101480.	-98269.	1
1	2	2	1	4330.	0.	72.	81159.	-87095.	1
1	3	3	1	5787.	0.	72.	108472.	-99982.	1
1	4	4	1	4761.	0.	72.	89228.	-92478.	1
1	5	5	1	22962.	0.	72.	430370.	-154910.	1

PLANT SUMMARY

SEB HAMPTON JUL 2, 1982 BASE
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF EQUIPMENT SIZES

TOTAL NUMBER OF CHILLERS = 1
TYPE OF CHILLER = STEAM ABSORPTION
NO. OF CHILLERS = 1
SIZE OF CHILLERS = 102.6 TONS

TOTAL NUMBER OF BOILERS = 1
TYPE OF BOILER = STEAM
NO. OF BOILERS = 1
SIZE OF BOILERS = 978.0 KBTU

TOTAL HEATING CAPACITY = 978.0 KBTU
TOTAL COOLING CAPACITY = 102.6 TONS

IF USED, TERMINAL REHEAT ENERGY SAME SOURCE AS BOILER.

COOLING TOWER FAN REQUIREMENT 35895. CFM 1.0 IN. S.P. 6.7 BHP

BOILER AUXILIARY HORSEPOWER REQUIREMENT (FAN,BLOWER,PUMP) 1.5 BHP

TOTAL FAN PLANT HORSEPOWER FOR BUILDING 66.8 BHP

SUMMARY OF PUMP SIZES

LOCATION	TOTAL GPM	TOTAL HEAD (FT)	TOTAL BHP
CHILLED WATER	246.	40.0	4.9
CONDENSER WATER	359.	30.0	5.3
HEATING WATER	98.	50.0	2.4

TEMPERATURE DISTRIBUTION

SPACE TEMPERATURE FREQUENCY DISTRIBUTION SUMMARY

* * * * * * * * * * * * * * T E M P E R A T U R E   O C C U R A N C E   B A N D S   (F)   * * * * * * * * * * * *

SPACE NO.	SPACE STATUS	BELOW 50.0	50.0- <60.0	60.0- <65.0	65.0- <68.0	68.0- <70.0	70.0- <72.0	72.0- <74.0	74.0- <76.0	76.0- <78.0	78.0- <80.0	80.0- <85.0	85.0- <90.0	90.0- <100.0	100.0- <110.0	110.0- <120.0	120.0- & OVER
1	OCCUPIED	0	0	0	0	17	341	1012	878	11	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	30	269	1835	2852	1417	74	0	0	0	0	0	0	0
2	OCCUPIED	0	0	0	0	24	394	1039	800	2	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	29	308	1880	2825	1381	54	0	0	0	0	0	0	0
3	OCCUPIED	0	0	0	0	26	396	1021	798	18	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	31	323	1852	2817	1361	93	0	0	0	0	0	0	0
4	OCCUPIED	0	0	0	0	23	388	1041	804	3	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	30	301	1875	2832	1382	57	0	0	0	0	0	0	0
5	OCCUPIED	0	0	0	0	5	288	1080	885	1	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	4	200	1892	3032	1315	34	0	0	0	0	0	0	0
6	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	0	0	169	4166	3852	549	0	0	0	0	0	0	0	0
7	OCCUPIED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNOCCUPIED	0	0	82	633	1279	1646	2102	1356	755	544	339	0	0	0	0	0

MONTHLY AND ANNUAL ENERGY REPORT

***** MONTHLY AND ANNUAL ENERGY AND UTILITY USE SUMMARY *****

FACILITY - SEB
CITY - HAMPTON
USER - D.L. MINER

DATE - JUL 2, 1982
PROJECT - BASE

ENERGY CONSUMPTION

	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
MONTHLY KBTU						
HEAT (KHB)						
MAX. DEMAND	-385.6	-182.7	-187.7	-194.5	-196.5	-200.4
CONSUMPTION	-35433.8	-31437.4	-36871.1	-36726.2	-39887.9	-39005.8
COOL (KCB)						
MAX. DEMAND	590.0	610.6	619.3	655.8	497.5	473.5
CONSUMPTION	56339.0	46649.0	55144.5	55318.0	64605.8	71379.1
ELECTRICITY						
LIGHTS AND BUILDING EQUIPMENT						
INTERNAL						
DEMAND(KW)	156.0	156.0	156.0	156.0	156.0	156.0
CONS.(KWH)	38252.6	33036.3	38252.6	36513.8	38252.6	36513.8
EXTERNAL						
DEMAND(KW)	7.0	7.0	7.0	7.0	7.0	7.0
CONS.(KWH)	2968.0	2632.0	2639.0	2310.0	2226.0	1890.0
HEAT (INCL. CENT.PLT.HTG. LOAD, BLR.AUXIL., HOT WATER PUMPS, AND HEATPUMPS)						
DEMAND(KW)	2.9	2.9	2.9	2.9	2.9	2.9
CONS.(KWH)	2083.7	1944.8	2153.2	2083.7	2153.2	2083.7
COOL (INCL. CHILLERS, WATER PUMPS, COOLING TOWER FAN, DX, AND HEATPUMPS)						
DEMAND(KW)	9.6	10.0	9.7	12.6	12.6	12.6
CONS.(KWH)	5626.3	5268.5	5867.9	5804.4	6317.1	6287.7
FANS						
DEMAND(KW)	49.8	49.8	49.8	49.8	49.8	49.8
CONS.(KWH)	4360.3	3765.7	4360.3	4162.1	4360.3	4162.1
PROCESS ELECTRICITY						
DEMAND(KW)	10.0	10.0	10.0	10.0	10.0	10.0
CONS.(KWH)	2200.0	1900.0	2200.0	2100.0	2200.0	2100.0
TOTAL						
DEMAND(KW)	194.8	188.7	188.4	191.3	191.3	191.3
CONS.(KWH)	55490.9	48547.3	55473.0	52974.1	55509.2	53037.4

MONTHLY AND ANNUAL ENERGY REPORT

***** MONTHLY AND ANNUAL ENERGY AND UTILITY USE SUMMARY *****

FACILITY -	SEB	DATE	- JUL 2, 1982
CITY -	HAMPTON	PROJECT	- BASE
USER - D.L. MINER			

	ENERGY CONSUMPTION						
	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
MONTHLY KBTU							
HEAT (KHB)							
MAX. DEMAND	-200.2	-202.4	-198.6	-193.5	-185.0	-303.6	
CONSUMPTION	-39167.4	-43386.2	-34742.0	-38890.9	-33554.7	-30538.9	-439642.3
COOL (KCB)							
MAX. DEMAND	475.4	489.2	498.3	638.4	642.6	316.0	
CONSUMPTION	67458.0	77346.5	55774.4	59927.7	55399.3	45290.2	710631.5
ELECTRICITY							
LIGHTS AND BUILDING EQUIPMENT							
INTERNAL							
DEMAND(KW)	156.0	156.0	156.0	156.0	156.0	156.0	
CONS.(KWH)	36513.8	39991.3	33036.3	38252.6	34775.1	33036.3	436427.1
EXTERNAL							
DEMAND(KW)	7.0	7.0	7.0	7.0	7.0	7.0	
CONS.(KWH)	2107.0	2345.0	2408.0	2821.0	2905.0	3248.0	30499.0
HEAT (INCL. CENT.PLT.HTG. LOAD, BLR.AUXIL., HOT WATER PUMPS, AND HEATPUMPS)							
DEMAND(KW)	2.9	2.9	2.9	2.9	2.9	2.9	
CONS.(KWH)	2153.2	2153.2	2083.7	2153.2	2083.7	2153.2	25282.8
COOL (INCL. CHILLERS, WATER PUMPS, COOLING TOWER FAN, DX, AND HEATPUMPS)							
DEMAND(KW)	12.6	12.6	12.6	12.6	9.6	9.0	
CONS.(KWH)	6481.2	6638.7	6018.0	6117.4	5700.1	5762.9	71890.2
FANS							
DEMAND(KW)	49.8	49.8	49.8	49.8	49.8	49.8	
CONS.(KWH)	4162.1	4558.5	3765.7	4360.3	3963.9	3765.7	49747.1
PROCESS ELECTRICITY							
DEMAND(KW)	10.0	10.0	10.0	10.0	10.0	10.0	
CONS.(KWH)	2100.0	2300.0	1900.0	2200.0	2000.0	1900.0	25100.0
TOTAL							
DEMAND(KW)	191.3	191.3	191.3	191.3	195.3	194.7	
CONS.(KWH)	53517.3	57986.8	49211.8	55904.4	51427.8	49866.1	638946.2

MONTHLY AND ANNUAL SUMMARY REPORT

***** MONTHLY AND ANNUAL ENERGY AND UTILITY USE SUMMARY *****

FACILITY - SEB   DATE - JUL 2, 1982
CITY - HAMPTON   PROJECT - BASE
USER - D.L. MINER

ENERGY CONSUMPTION

	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
PURCHASED STEAM						
HEAT (12.0PSIG 245.0DEG.F. ENTERING)						
DEMAND (K-LBS/HR)	.4	.2	.2	.2	.2	.2
CONS.(K-LBS)	35.8	31.8	37.3	37.2	40.4	39.5
COOL (125.0PSIG 353.0DEG.F. ENTERING)						
DEMAND (K-LBS/HR)	.8	.9	.9	.9	.7	.7
CONS.(K-LBS)	79.8	66.0	78.1	78.3	91.0	100.6
OIL						
CITY WATER						
DEMAND (K-GALS/HR)	.2	.2	.2	.2	.2	.2
CONS. (K-GALS)	8.8	7.3	8.6	8.7	10.1	11.2

E-16

***** MONTHLY AND ANNUAL ENERGY AND UTILITY USE SUMMARY *****

FACILITY - SEB   DATE - JUL 2, 1982
CITY - HAMPTON   PROJECT - BASE
USER - D.L. MINER

ENERGY CONSUMPTION

	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
PURCHASED STEAM							
HEAT (12.0PSIG 245.0DEG.F. ENTERING)							
DEMAND (K-LBS/HR)	.2	.2	.2	.2	.2	.3	
CONS.(K-LBS)	39.6	43.9	35.1	39.3	33.9	30.9	444.8
COOL (125.0PSIG 353.0DEG.F. ENTERING)							
DEMAND (K-LBS/HR)	.7	.7	.7	.9	.9	.4	
CONS.(K-LBS)	95.2	109.4	78.6	84.6	78.4	64.1	1004.0
OIL							
CITY WATER							
DEMAND (K-GALS/HR)	.2	.2	.2	.2	.2	.1	
CONS. (K-GALS)	10.6	12.1	8.7	9.4	8.7	7.1	111.3

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

SEB
HAMPTON

THIS NECAP RUN PREPARED BY: D.L. MINER
ON: JUL 2, 1982

LOADS CASE IDENTIFICATION : BASE
SYSTEMS CASE IDENTIFICATION : SEB

INPUT SPECIFICATIONS

LENGTH OF STUDY =	365 DAYS		
TOTAL FLOOR AREA =	51400.00		
HEATING	978.0 KBH,	.01903	/SQFT
COOLING	102.6 TNS	.00200	/SQFT
SUP AIR	43255.1 CFM	.84154	/SQFT
VNT AIR	0.0 CFM	0.00000	/SQFT

ENERGY SOURCE	BUILDING CONSUMPTION	BUILDING LINE KBTU/SQ.FT.	RAW SOURCE KBTU/SQ.FT.
ELECTRICITY (KWHR)			
LIGHTS & MISC. EQUIP.	466926.05	31.00	105.41
HEATING	25282.81	1.68	5.71
COOLING	71890.22	4.77	16.23
FANS	49747.10	3.30	11.23
PROCESS	25100.00	1.67	5.67
TOTAL	638946.19	42.43	144.25
GAS (THERM)	NONE USED FOR THIS MODEL		
PURCHASED STEAM (KLBS) (1000 BTU/LB)			
HEATING	444.79	8.65	12.03
COOLING	1004.03	19.53	27.15
PROCESS	0.00	0.00	0.00
TOTAL	1448.83	28.19	39.18
HEATING OIL (KGALS)	NONE USED FOR THIS MODEL		
DIESEL FUEL (KGALS)	NONE USED FOR THIS MODEL		
TOTAL ENERGY USAGE (EQUIV KBTU)	3629550.21	70.61	183.43

NOTES AND COMMENTS

NOTES AND COMMENTS

NOTES AND COMMENTS

NOTES AND COMMENTS

NOTES AND COMMENTS

REFERENCES

1. "Handbook of Air Conditioning System Design," Carrier Air Conditioning Company 1965, Chapter 1.

2. R.H. Henninger, NECAP - NASA's Energy Cost Analysis Program CR-2590 National Aeronautics and Space Administration, Hampton, Va. 1975 Parts I & II

3. "Procedures for Determining Heating and Cooling Loads for Computerized Energy Calculations," ASHRAE, 1975

1. Report No. NASA TM-83238	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle NECAP 4.1 - NASA's Energy-Cost Analysis Program Users Manual		5. Report Date July 1983
		6. Performing Organization Code
7. Author(s) *Ronald N. Jensen and **David L. Miner and ***Robert H. Henninger		8. Performing Organization Report No.
9. Performing Organization Name and Address NASA Langley Reseach Center Hampton, VA 23665		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546		13. Type of Report and Period Covered Technical Memorandum
		14. Sponsoring Agency Code

15. Supplementary Notes
*NASA Langley Research Center, Hampton, Virginia
**Computer Sciences Corporation, Hampton, Virginia
***GARD, Inc., Niles, IL

16. Abstract

NASA's Energy-Cost Analysis Program (NECAP) is a powerful computerized method to determine and to minimize building energy consumption. The program calculates hourly heat gain or losses taking into account the building thermal resistance and mass, using hourly weather and a "response factor" method. Internal temperatures are allowed to vary in accordance with thermostat settings and equipment capacity.

NECAP 4.1 is a updated version of NECAP published in 1975 (see CR2590, Parts I and II). It has a simplified input procedure and numerous other technical improvements. Documentation consists of a Users Manual, Engineering Manual, Input Manual, Fast Input Manual and Example, Engineering Flow Chart Manual and an Operations Manual (specifically for LaRC's Computer System).

This Users Manual describes the program and provides examples. It should be used in conjunction with the Input Manual, TM 832339.

17. Key Words (Suggested by Author(s)) Energy, Energy Conservation, Energy Analysis, Air Conditioning and Heating	18. Distribution Statement Unclassified-Unlimited Subject Category 44

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	268	A12

N-305 For sale by the National Technical Information Service, Springfield, Virginia 22161