NASA CONTRACTOR REPORT

NASA CR-2590 PART I

NASA CR-2590

NECAP - NASA'S ENERGY-COST ANALYSIS PROGRAM

FINAL REPORT

Part I - User's Manual

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The Technical Monitor for this project was Ronald N. Jensen. The members of the GHRD's Technical Staff were Messrs. R. H. Henninger, J. T. McNally and R. W. Wallace.

Final report.

16. Abstract

The NASA's Energy-Cost Analysis Program (NECAP) is an extremely powerful and sophisticated computerized system to determine and minimize building energy consumption.

The program complies with ASHRAE's "Procedures for Determining Heating and Cooling Loads for Computerized Energy Calculations" manual. It calculates the thermodynamic heat gains and losses of a structure, taking accound of the building's thermal storage and hourly weather data. It uses new weighting factors for building lights, and environmental equipment schedules. Infiltration is allowed to vary in accordance to wind velocity. Internal temperature are allowed to vary when equipment capacity is scheduled or does not meet loads. Standard walls and schedules can be used to simplify program input. System simulation models systems now in general use.

Users of NECAP can obtain data for selection of the most economical system, system size, fuels, window area, thermal barries, etc., during the design phase. After installation, users can optimize operating schedules, most economical temperature settings for components, and other valuable data.

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This version of NASA's Energy-Cost Analysis Program (NECAP) is for internal NASA use.

This program has been run on NASA Langley's CDC 6600 computers. Field length of 230K and CPU time of 1300 seconds are typical with the load program - other parts of the program are substantially smaller. The program is punched in 026 format. Engineers using NECAP could find that specific needs for a project may not match program capabilities, dimensions, computer size, or computer procedures. Judgment should be exercised before investing time to implement and to assure that needs are compatible with the detailed results. Judgment is also necessary when interpreting output data. For example: doors don't stay open, filters don't get dirty, and ducts don't leak in a computer program.

Since the NECAP program is so large and detailed, we expect to find additions and/or modifications that will improve its use. NASA is continuing to work to upgrade certain areas of the program, plus conducting some verification studies. Beyond the funded scope of the present project, we have listed 40 to 60 ideas that could be incorporated into the program. We are sure others who work with the program could suggest many other ideas, modifications, suggestions, or might find errors.

There is presently no established procedure to handle and evaluate these comments or to disseminate updated procedures. For the interim, I will accept readers' comments if sent to my office. No obligation, of course, will be accepted by the Government, even if ideas are used. If funds and time permit, a committee review will be conducted and updating of the manuals and program will be made.

Operational guidance or assistance to non-government agencies in running the program can not be provided. I would speculate that within a short period of time enough commercial firms will be running NECAP or a modified version, to handle the problem.

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WEATHER DATA NOTE

The weather data now used is derived from a standard weather tape produced by the National Climatic Center, Asheville, North Carolina.

Due to reading problems, our computers need modifications to the sub-program (WEATH). We have, however, detailed these changes in the program tape and have also included a subroutine IVAR.

A second load program has been included which reads data cell weather. The data cell has been produced from standard weather tapes, but this still requires special routines in its production. The use of this simplified weather data will cut, by up to one-third, the CPU time required to run a typical load program.

It is our understanding that the National Climatic Center will produce a multi-station, typical year, weather tape in a simplified format, in the near future. At that time we expect to modify the program so that a weather data cell can be produced which will have only computed radiation, type of day (i.e. Sunday, Saturday, Holiday, etc., using new logic), sun location, etc.; much of the load program subroutine would then be eliminated.

FOREWORD

Several years ago, the Energy Utilization Program developed by the U. S. Postal Service was presented to the public. The program was enthusiastically received as a tool to investigate building energy consumption. Shortly thereafter, the USPS construction program was reorganized and the computerized energy program was shelved.

NASA representatives had attended some of the USPS conferences in 1970-71, and were impressed with the program as a policy-generating tool - impressed enough to implement the program to determine energy requirements for a proposed NASA office building. This output data became more important when it was decided to use a solar heated and cooled environmental system. The usefulness of the program for evaluating the design and operation of facilities was obvious, but it was equally obvious that program complexities and limited flexibility were major road blocks to its use. LaRC, therefore, initiated a program to upgrade and improve the program.

It would be fair to say that this new energy analysis program (NECAP) is the concept of many people. We therefore wish to acknowledge the contributions made by personnel from General American Transportation Company, U. S. Postal Service, ASHRAE Task Group on Energy Requirements, National Bureau of Standards, the Canadian Research Council, and others who have documented data used in the modified program. The program was renamed, not to indicate a completely new program, but rather to eliminate confusion and history of program problems.

Program modifications were directed specifically at program deficiencies and not at a complete rework of the program structure. This goal has been met and will be met in the future with more planned modifications. It will be obvious to the users that other concepts could be added to the program. We hope that those who find an opportunity to make these program improvements can share their accomplishments with the public.

Specific modifications and additions made to NECAP to date included the following:

1. DESIGN LOAD ANALYSIS:ability to perform design heating and cooling load calculations via user inputted design weather data.

2. VARIABLE TEMPERATURE ANALYSIS: accounts for temperature swing due to thermostat action, equipment capacity, and equipment scheduling. Unconditioned space temperatures are computed.

3. DATA SIMPLIFICATION: input data methods to simplify the handling of repetitive surfaces, spaces and floors.

4. DATA VERIFICATION: method to check the input data for correctness of order, range, and format.

5. TYPICAL SCHEDULES AND SURFACES: coding of typical hourly schedules to be used for scheduling people, lights, and equipment; also typical wall and roof constructions.

6. MODIFICATION OF WEIGHTING FACTORS: new load weighting factors relating room heat gain to solar load, wall and roof load, and lighting load, to account for the effect of type of construction and types of lighting fixtures. Zone infiltration rate is a function of wind velocity.

7. EXPANDED SYSTEM SIMULATION: additions to allow simulation of the following types of distributions:

   a) Single zone
   b) Multi-zone
   c) Dual duct
   d) Single zone with sub-zone reheat
   e) Unit ventilator
   f) Unit heater
   g) Floor panel heat
   h) 2-pipe and 4-pipe fan coil systems
   i) 2-pipe and 4-pipe induction systems
   j) Variable air volume system
   k) Fixed volume reheat system
   l) Finned tube radiation system

Also the incorporation of the ability to handle:

a) Three (3) types of outside air control systems
b) Three (3) types of air temperature control systems
c) Humidification system.

8. ECONOMICS: new format for economics analysis is provided.

9. REVISE DOCUMENTATION

   Complete documentation to reflect status of the revised program.

This User's Manual outlines the intended use of each segment of NECAP, presents instructions for input data preparation, and gives examples of all reports generated by each segment of the program.

Two major manuals accompany this program. Part I, entitled USER'S MANUAL, explains the intended use of each segment of NECAP and presents the instructions for preparing the input data and interpreting the resulting reports. Part II, entitled ENGINEERING MANUAL, presents the algorithms that were programmed and provides the means by which a user can familiarize himself with the internal workings of the program and make any modifications that further needs will dictate.

Further validation of computerized procedures and specifically NECAP are being planned. Of general interest are the validation tests that have been done on ASHRAE algorithms conducted by Ohio State. To date, data indicates satisfactory correlation and program flexibility to absorb most conditions encountered. However, pecularities were encountered; eg. the discrepancy between measured solar data and that calculated from cloud cover readings.

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SECTION 1
INTRODUCTION

NECAP is a sophisticated building design and energy analysis tool which has embodied within it all of the latest ASHRAE state-of-the-art techniques for performing thermal load calculation and energy useage predictions. NECAP is actually a set of six (6) individual computer programs whose descriptions are given briefly below:

1. RESPONSE FACTOR PROGRAM

   For wall or roof structures different from the typical ones built into NECAP, the Response Factor Program, using a layer-by-layer description of the surface, will calculate and output the set of response factors required to perform transient heat transfer analysis.

2. DATA VERIFICATION PROGRAM

   The Data Verification Program interrogates the building description input data to check for proper order, range and format of the card input data.

3. THERMAL LOAD ANALYSIS PROGRAM

   Performs hourly transient heat transfer calculations for each building space utilizing actual hourly recorded weather, geometry and construction of the building, scheduled internal loads and astronomy of the sun.

4. VARIABLE TEMPERATURE PROGRAM

   Corrects the thermal loads calculated above to account for temperature swings occurring within each space due to thermostat action, equipment capacity and equipment scheduling.

5. SYSTEM AND EQUIPMENT SIMULATION PROGRAM

   For a specified type of distribution system allocation and type of energy conversion equipment, the Simulation Program determines the total load on each distribution system, transfers it to the energy conversion equipment, and based upon part load efficiencies determines the building's monthly demand and consumption of all forms of fuels and energy.

6. OWNING AND OPERATING COST PROGRAM

   For the expected life of the building, the Owning and Operating Cost Program calculates the expected annual expenditure to own and operate the building utility systems.

Each building design and analysis problem might not require use of all of the 6 programs enumerated above. To illustrate the suggested sequential use, refer to Figure 1.1.

The remaining sections of this manual deal with each segment of NECAP and sets forth the instructions for preparing the required input data and for interpreting the resulting reports.

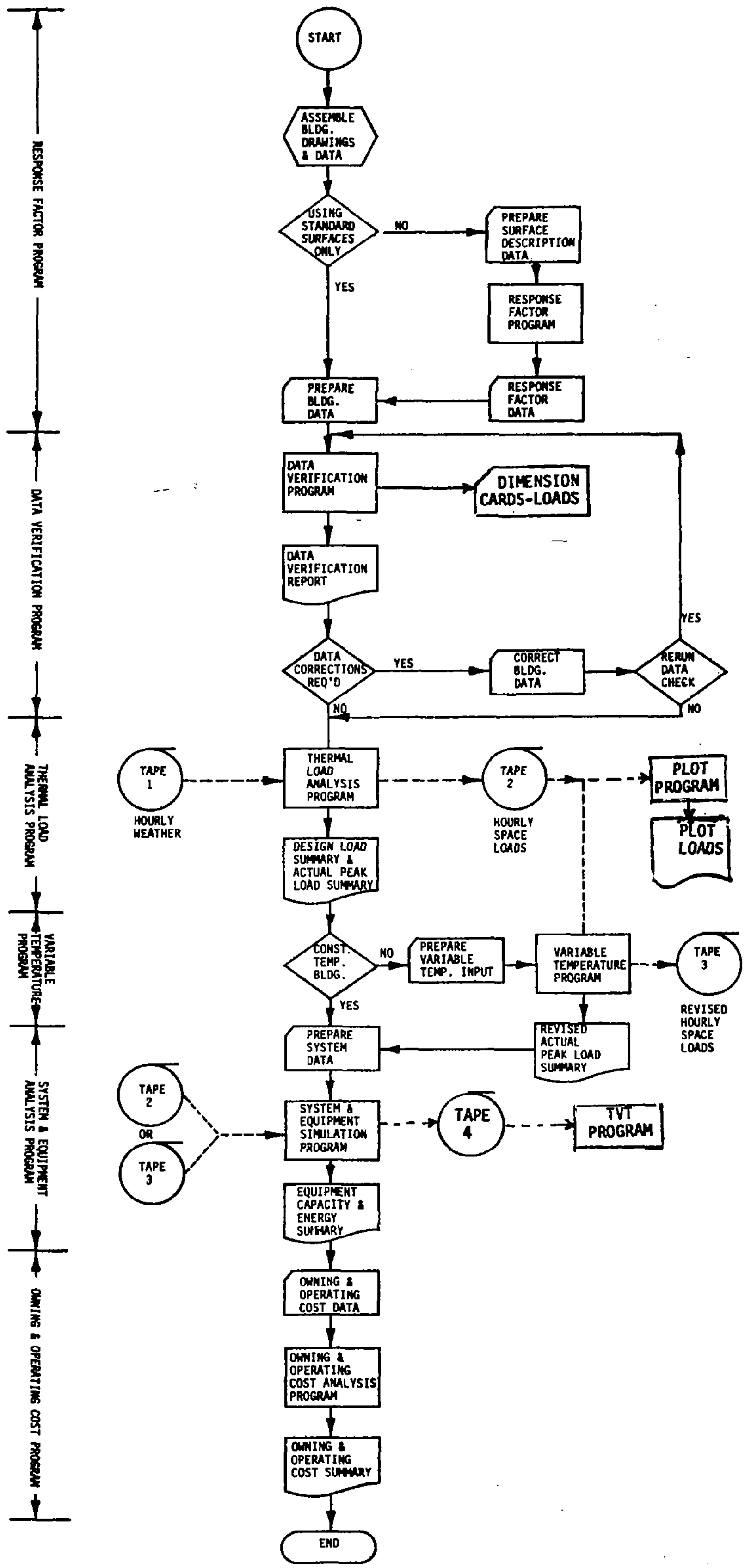


Figure 1.1 NECAP FLOWCHART

SECTION 2
RESPONSE FACTOR PROGRAM

2.1 OBJECTIVE AND DESCRIPTION

The Response Factor Progam generates the set of heat transfer factors called response factors required to accurately determine the transient flow of heat into, through and out of building exterior walls and roofs as they react to temperatures differences across them. These response factors are a function of the type of materials used and their order of placement and therefore require that the following be known for each layer:

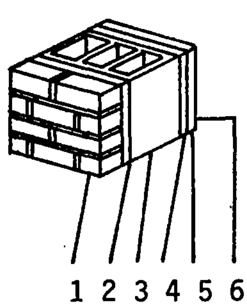
1. XL, thickness, ft.
2. XK, thermal conductivity, BTU per (hr.)(ft.)(^oF)
3. D, density, lb. per cu. ft.
4. SH, specific heat, BTU per (lb.)(^oF)
5. RES, Resistivity, (hr.)(sq.ft.)(^oF) per BTU.

Using this data, the Response Factor Program calculates the set of response factors peculiar to the wall or roof construction in question and then outputs this data onto punched computer cards for direct insertion into the Thermal Load Analysis Program input data deck. The Response Factor Program need not be used if all wall and roof types desired are among the standard walls and roofs built into the Thermal Load Analysis Program and available for use simply by the calling out of an input code (see Table 4.6 for a list of these standard walls and roofs).

2.2 INPUT DATA

Before the actual input data preparation task is undertaken, the properties (XL, XK, D, SH, RES) of each type wall or roof used in the building being studied should be assembled and a sketch similar to that shown below prepared.

Example



Layer Description

1. Face Brick (4 in.)
2. Air Space (2 in.)
3. Concrete Block (6 in.)
4. Fiberglas Insulation (2 in.)
5. Gypsum Board (½ in.)
6. Inside Air

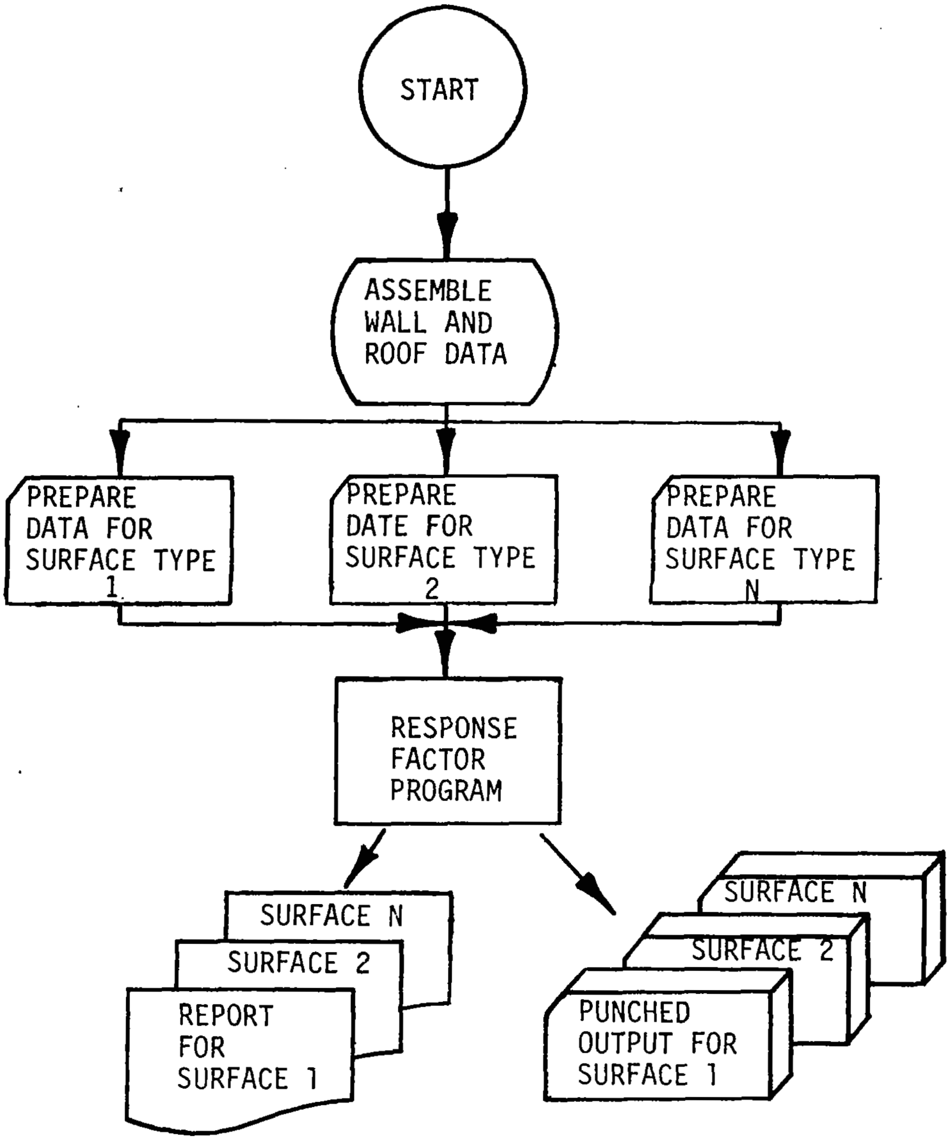


Figure 2.1 RESPONSE FACTOR PROGRAM FLOWCHART

Note: Order of layers should always be from outside to inside. Do not include outside air film as a layer, since the Thermal Load Analysis Program will adjust for this effect each hour as a function of wind speed.

With this task complete, now proceed to prepare the input data for keypunching in accordance with instructions outlined in Table 2.1. Figure 2.1 visually summarizes all of the steps required to use the Response Factor Program.

2.3 OUTPUT REPORTS

An output report similar to that shown in Figure 2.2 is printed by the Response Factor Program for each type of surface analyzed. The first part of the report echoes the input data. The next line then indicates the thermal conductance for the surface - i.e., the summation of the X, Y or Z response factor terms. The last part of the report displays the sets of response factors calculated by the program as well as the common ratio and number of hours required to reach the common ratio. The three columns of response factors, X, Y, and Z are used respectively to determine

1. the heat flux at the outside layer due to a change in temperature at outside layer.

2. the heat flux at the outside layer due to a change in temperature at the inside layer or the heat flux at the inside layer due to a change in temperature at the outside layer

3. the heat flux at the inside layer due to a change in temperature at the inside layer.

The number of terms in each set of response factors indicates the number of time increments it takes the wall or roof to respond to a temperature impulse of one time increment duration and reach the point of common ratio where the ratio of successive terms is a constant.

2.4 EXAMPLE

To illustrate the use of the Response Factor Program, the wall described earlier will be used. The six layers making up the wall have the following properties:

LAYER NO.	XL	XK	D	SH	RES
1	0.333	0.770	125.0	0.22	-
2	-	-	-	-	0.090
3	0.500	0.320	37.4	0.16	-
4	0.167	0.025	0.5	0.16	-
5	0.042	0.093	50.0	0.20	-
6	-	-	-	-	0.68

The data entered onto the cards would then appear as shown in Figure 2.3. The output from such an analysis would be identical to that shown in Figure 2.2.

Table 2.1

RESPONSE FACTOR PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
RF-1	1 to 10	Number of delayed surfaces to be analyzed	FNOC	-	1.0 to	-	2.0	-
READING ORDERS RF-2 & RF-3 INCLUSIVE SHOULD BE REPEATED "FNOC" TIMES.								
RF-2	1 to 10	Number of layers	FNOL	-	1.0 to 10.0	-	3.0	Exclude outside air film
READING ORDER RF-3 SHOULD BE REPEATED "FNOL" TIMES.								
RF-3	1 to 10	Thickness of the layer	XL	Ft	-	-	0.333	If layer has no thermal mass, set equal to 0.0.
	11 to 20	Thermal conductivity of the layer	XK	Btu/hr, ft^2, °F	-	-	0.770	"
	21 to 30	Density of the layer	D	lb/ft^3	-	-	125.0	"
	31 to 40	Specific heat capacity of the layer	SH	Btu/lb, °F	-	-	0.22	"
	41 to 50	Thermal resistivity of the layer	RES	Hr, ft^2, °F/Btu	-	-	0.00	If layer has thermal mass, set equal to 0.0.
	51 to 80	Alphanumeric description of layer	DESC	-	-	-	2 inch brick	-

NOTES: 1) Card Format for RF-1 and RF-2 is (F10.0).
2) Card Format for RF-3 is (5D10.5, 30A1).
3) Refer to Table 2.2 for examples of thermal properties of building materials.

Table 2.2

THERMAL PROPERTIES OF TYPICAL BUILDING MATERIALS

Description	Thickness and Thermal Properties				
	XL	XK	D	SH	RES
1" stucco (asbestos cement or wood siding plaster, etc.)	0.0833	0.4	116	0.20	
4" face brick (dense concrete)	0.333	0.77	125	0.22	
Steel siding (aluminum or other lt-wt cladding)	0.005	26.0	480	0.10	
Air space resistance					0.91
1" insulation light weight	0.083	0.025	2.0	0.2	
2" insulation light weight	0.167	0.025	2.0	0.2	
3" insulation light weight	0.25	0.025	2.0	0.2	
1" insulation	0.0833	0.025	5.7	0.2	
2" insulation	0.167	0.025	5.7	0.2	
1" wood	0.0833	0.07	37.0	0.6	
2.5" wood	0.2083	0.07	37.0	0.6	
4" wood	0.333	0.07	37.0	0.6	
2" wood	0.167	0.07	37.0	0.6	
3" wood	0.25	0.07	37.0	0.6	
3" insulation	0.25	0.025	5.7	0.2	
4" clay tile	0.333	0.33	70.0	0.2	
4" l.w. concrete block	0.333	0.22	38.0	0.2	
4" h.w. concrete block	0.333	0.47	61.0	0.2	
4" common brick	0.333	0.42	120.0	0.2	
4" h.w. concrete	0.333	1.0	140.0	0.2	
8" clay tile	0.667	0.33	70.0	0.2	
8" l.w. concrete block	0.667	0.33	38.0	0.2	
8" h.w. concrete block	0.667	0.6	61.0	0.2	
8" common brick	0.667	0.42	120.0	0.2	
8" h.w. concrete	0.667	1.0	140.0	0.2	
12" h.w. concrete	1.0	1.0	140.0	0.2	
2" h.w. concrete	0.167	1.0	140.0	0.2	
6" h.w. concrete	0.5	1.0	140.0	0.2	
4" l.w. concrete	0.333	0.1	40.0	0.2	
6" l.w. concrete	0.5	0.1	40.0	0.2	
8" l.w. concrete	0.667	0.1	40.0	0.2	
Inside surface resistance					0.685
3/4" plaster; 3/4" gypsum or similar finishing layer	0.0625	0.42	100.0	0.2	
1/2" slag or stone	0.0417	0.83	55.0	0.40	
3/8" felt & membrane	0.0313	0.11	70.0	0.40	
Ceiling air space					1.0
Acoustic tile	0.0625	0.035	30.0	0.20	

UNITS: XL=feet, XK=Btu per (hr)(ft)(^{o}F), D=lbs per cu ft, SH=Btu per (lb)(^{o}F), RES=(hr)(sq ft)(^{o}F) per Btu.

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	0.3330	0.770	125.0	0.22	0.0	4 IN. FACE BRICK
2	0.0	0.0	0.0	0.0	0.90	2 IN. AIR SPACE
3	0.5000	0.320	37.4	0.16	0.0	6 IN. CONCRETE BLOCK
4	0.1670	0.025	0.5	0.16	0.0	2 IN. FIBERGLAS
5	0.0420	0.093	50.0	0.20	0.0	GYPSUM BOARD (1/2 IN. DRYWALL
6	0.0	0.0	0.0	0.0	0.68	INSIDE AIR

THERMAL CONDUCTANCE = 0.093 BTU PER (HR)(SQ FT)(F)

RESPONSE FACTORS

HOUR	X	Y	Z
0	5.1760690615	0.0000115877	0.4439902914
1	-3.2670838588	0.0013777480	-0.3138918862
2	-0.7557869855	0.0068934014	-0.0176965466
3	-0.3843689468	0.0111441629	-0.0043407542
4	-0.2111334742	0.0119522028	-0.0029676851
5	-0.1260887556	0.0109942480	-0.0023240584
6	-0.0818863673	0.0094649507	-0.0018494570
7	-0.0571435615	0.0078925361	-0.0014793520
8	-0.0420716914	0.0064743214	-0.0011864391
9	-0.0321059989	0.0052647825	-0.0009529141
10	-0.0250532825	0.0042609730	-0.0007659763
11	-0.0198101191	0.0034396053	-0.0006159898
12	-0.0157841950	0.0027725923	-0.0004954969
13	-0.0126309912	0.0022331561	-0.0003986293
14	-0.0101323213	0.0017978824	-0.0003207239
15	-0.0081390029	0.0014470969	-0.0002580549
16	-0.0065427869	0.0011645958	-0.0002076363
17	-0.0052618399	0.0009371738	-0.0001670707
18	-0.0042326699	0.0007541313	-0.0001344313
19	-0.0034052407	0.0006068254	-0.0001081689
20	-0.0027397611	0.0004882868	-0.0000870373
21	-0.0022044236	0.0003929009	-0.0000700340
22	-0.0017737284	0.0003161472	-0.0000563524
23	-0.0014271992	0.0002543869	-0.0000453437

NUMBER OF HOURS REQUIRED TO REACH COMMON RATIO = 23
NUMBER OF RESPONSE FACTORS PER SET = 24
COMMON RATIO = 0.8046447957

Figure 2.2 TYPICAL OUTPUT FROM RESPONSE FACTOR PROGRAM

1.0					
6.000					
0.333	0.7700	125.	0.220	0.00	4 IN. FACE BRICK
0.000	0.0000	0.00	0.000	0.90	2 IN. AIR SPACE
0.500	0.3200	37.4	0.156	0.00	6 IN. CONCRETE BLOCK
0.167	0.0250	0.50	0.157	0.00	2 IN FIBERGLAS
0.042	0.0926	50.0	0.200	0.00	GYPSUMBOARD(1/2" DRYWALL)
0.000	0.0000	0.00	0.000	0.68	INSIDE AIR

Figure 2.3 RESPONSE FACTOR PROGRAM CARD INPUT DATA FOR EXAMPLE PROGRAM

SECTION 3
DATA VERIFICATION PROGRAM

3.1 OBJECTIVE AND DESCRIPTION

The Data Verification Program checks the complete input data deck required for the Thermal Load Analysis Program. 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 card image listing of the data card.

3.2 INPUT DATA

The input data required for the Data Verification Program is the data deck that the user must prepare for the Thermal Load Analysis Program described in Section 4. The instructions explaining how this data should be prepared is enumerated in Table 4.3 of that section. No additional input data of any kind is required by the Data Verification Program. NECAP will punch new dimensions statements to be used in the Load Program if a master deck is placed behind the data input.

3.3 OUTPUT REPORTS

Three types of errors are signaled by the Data Verification Program. 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 indices 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 ERRORS will stop the Thermal Load Analysis Program instantly. These may be 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.

The Data Verification Program 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.

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 Data Verification Program was able to fully scan the entire input deck, there is provided a summary listing of the three types 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. Examples of the type of output reports recieved from the Data Verification Program are illustrated in Figures 3.1 to 3.5.

3.4 EXAMPLE

To illustrate the makeup of a complete report as received from the Data Verification Program, the user is referred to the program listing where such a report is shown in its entirety for the example building described in Section 4.4

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


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

          LRC SYSTEMS ENGINEERING
          HAMPTON, VIRGINIA
          R.JENSEN
          SZ, 4W, 3IN
          NOV 26, 1973


THE FOLLOWING LINES ARE SITE CHARACTERISTIC AND STUDY PARAMETER DATA.

          LATITUDE  LONGITUDE            CLEARNESS CLEARNESS BUILDING
          DEGREE    DEGREE    TIME ZONE  NO. - SUM NO. - WIN AZIMUTH
          37.0      76.0      5.         0.96      0.96      299.

          OPTION    VENT.     FAN        COLD AIR  COLD AIR  HOT AIR   HOT AIR
          CODE      AIR       PRESS.     TEMP. 1   TEMP. 2   TEMP. 3   TEMP. 4
          2.0       .12       4.         50.       55.       120.      140.

          BUILDING ALTITUDE
          25.

          SUMMER DESIGN DAY DATA
          MAX.      DBT       AVG. DEW   WIND
          DBT       RANGE     PT. TEMP.  SPEED
          94.       18.       72.        5.

          WINTER DESIGN DAY DATA
          MIN.      DBT       AVG. DEW   WIND
          DBT       RANGE     PT. TEMP.  SPEED
          20.       3.        5.         7.

          WEATHER   STARTING  STUDY      CHRISTMAS INITIAL TEMP
          YEAR      MONTH     LENGTH     LENGTH    WALL + ROOF
          1963.     1.0       365.       0.        20.

THE FOLLOWING LINE CONTAINS PRINT OPTION CODE.

          0.0

THE FOLLOWING LINE CONTAINS NO. OF TYPES OF SPACES

          1.
```

Figure 3.1 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

THE FOLLOWING LINE CONTAINS THE NUMBER OF COMMON SHADING SURFACES.

5.

TABLE OF COMMON SHADING SURFACE ATTRIBUTES

SHADING SURFACE	NO. OF VERTICES	TRANSMIT COEF	------VERTEX COORDINATES------ X	Y	Z	HEIGHT	WIDTH	AZIMUTH ANGLE	TILT ANGLE	*** DERIVED DATA *** ORIENTATION	AREA
1	1.	0.	130.	70.	18.	7.	40.	180.	90.	ESE	280.0
2	1.	0.	170.	70.	18.	7.	70.	90.	90.	NNE	490.0
3	1.	0.	170.	140.	18.	7.	40.	0.	90.	WNW	280.0
4	1.	0.	130.	140.	18.	7.	70.	270.	90.	SSW	490.0
5	1.	0.	130.	70.	25.	70.	40.	180.	0.	ESE	2800.0

Figure 3.2 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

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

SURFACE ABSORBT'N	GROUND REFLECTIVITY
.7	.2

NO. OF VERTICES	NO. OF X DIVISIONS	NO. OF Y DIVISIONS	COM'N SUR DELETED	SHADE SUR ADDED	SURFACE ROUGHNESS	SURFACE INDEX
1.	1.	1.	5.	0.	0.	1.

***** SEVERE ERRORS *****
FIELD 6 DATA OUT OF BOUNDS.

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.	0.	11.	7.	240.	180.	90.	ESE	1680.0

ALL COMMON SHADING SURFACES ARE DELETED.

Figure 3.3 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

THE FOLLOWING TWO LINES CONTAIN DATA ON WINDOW 2

ASHRAE SHAD COEF	SKY FORM FACTOR	GROUND FACTOR	GROUND REFLECTIVITY
.35	.5	.5	.2

NO. OF VERTICES	NO. OF X DIVISIONS	NO. OF Y DIVISIONS	COM'N SUR DELETED	SHADE SUR ADDED	NO. OF PANES	GLASS INDEX
1.	26.	11.	5.	3.	1.	5.

THE FOLLOWING DATA DESCRIBES WINDOW 2

------VERTEX COORDINATES------ X	Y	Z	HEIGHT	WIDTH	AZIMUTH ANGLF	TILT ANGLE	*** DERIVED DATA *** ORIENTATION	AREA
137.	8.	0.	11.	26.	180.	90.	ESE	286.0

ALL COMMON SHADING SURFACES ARE DELETED.

TABLE OF ATTRIBUTES OF SHADING SURFACES ADDED TO WINDOW 2

SHADING SURFACE	NO. OF VERTICES	TRANSMIT COEF	------VERTEX COORDINATES------ X	Y	Z	HEIGHT	WIDTH	AZIMUTH ANGLE	TILT ANGLE	*** DERIVED DATA *** ORIENTATION	AREA
1	1.	0.	137.	0.	0.	11.	8.	90.	90.	NNE	88.0
2	1.	0.	137.	0.	11.	8.	26.	180.	0.	ESE	208.0
3	1.	0.	163.	8.	0.	11.	8.	270.	90.	SSW	88.0

Figure 3.4 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

THE FOLLOWING LINES CONTAIN DATA ON SPACE 2

NO. OF DELAYEDS	NO. OF QUICKS	NO. OF WINDOWS	NO. OF INTERNALS	NO. OF WALLS	UNDERGROUND FLOORS	NO. OF ADDITIONAL IDENTICAL SPACES
25.	0.	22.	0.	0.	1.	0.

FLOOR AREA	VOLUME	FLOOR WEIGHT	TEMPER- ATURE	NO. OF PEOPLE	ACTIVITY LEVEL
500.	4700.	60.	75.	1.	500.

VENT. INDEX	USE INDEX	INFILTRATION CODE	
1.	100.	1.	0.

The 0. is an error

NOTE: Since this output was obtained a new format has been used.

***** WARNING *****
ILLEGAL DATA STARTING IN COLUMN 31.

***** SEVERE ERRORS *****
FIELD 2 DATA OUT OF BOUNDS. - - - -only use index of 1., 2., or 3 can be used - see LC#11

LIGHTING LOAD

WATTS/ SQ.FT.	KILO- WATTS
4.0	0.0

EQUIPMENT LOAD

WATTS/ SQ.FT.	KILO- WATTS	SENSIBLE BTU/HR	LATENT BTU/HR
0.25	0.0	0.0	0.0

THE FOLLOWING LINE CONTAINS THE INDECES OF THE DELAYED SURFACES OF SPACE 2

1.	2.	2.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	18.	13.		

***** WARNING *****
THE NUMBER OF INDECES LISTED HERE DIFFERS FROM THE STATED NUMBER GIVEN EARLIER

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 thermal loads, both heating and cooling, resulting in each building space each hour due to:

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.

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

1. Design load analysis - Utilizing user-defined design weather data, a 24-hour design day analysis is done for each month to determine peak heating and cooling requirements for each space and the entire building.

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

The input to the Thermal Load Analysis Program reflects building architecture, building construction, building surroundings, local weather, and pertinent astronomy 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 entitled "Procedures for Determining Heating and Cooling Loads for Computerized Energy Calculations"(Reference 1). Figure 4.1 briefly depicts the overall methodology built into the Thermal Load Analysis Program.

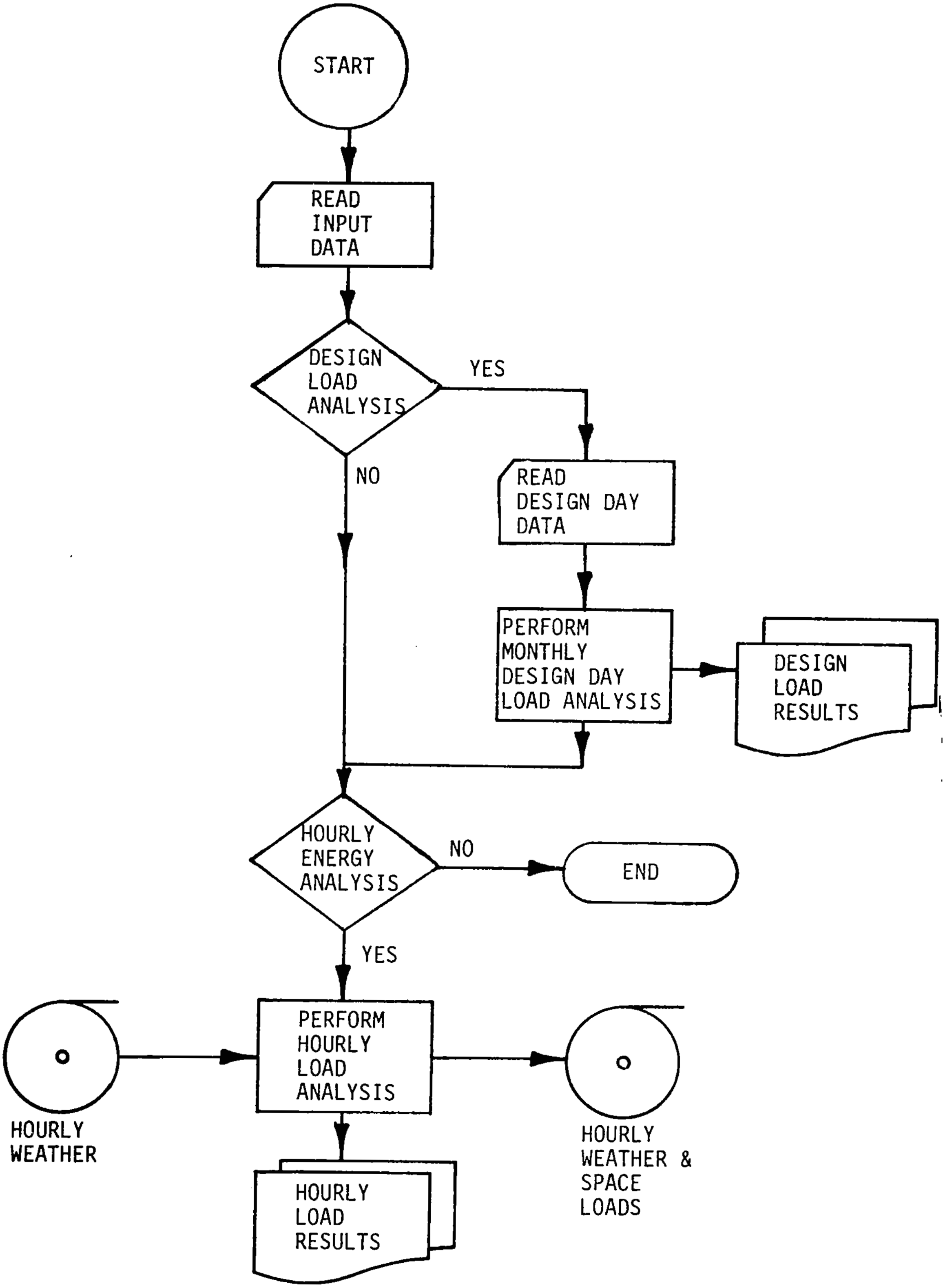


Figure 4.1 THERMAL LOAD ANALYSIS PROGRAM FLOWCHART

4.2 INPUT DATA

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

4.2.1 DEFINITIONS

4.2.1.1 Building Coordinate System

To communicate numerically to the computer the position of the aboveground exterior surfaces of the building, a coordinate system is needed to establish the location of a point. Figure 4.2 shows the recommended coordinate system for a rectangular building. In this coordinate system, called a right-handed Cartesian 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. The vertices of the plane polygons which represent the building surfaces should follow, as shown in Figure 4.3 on a right-handed order about the outward normal.

4.2.1.2 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 north to the Y-axis, as shown in Figure 4.4. In the case where the building does not align with the cardinal points of the compass, interpolation yields the building azimuth. For example, a NW frontal exposure yields a building azimuth of 135°. A SSE frontal exposure yields a building azimuth of 337.5°.

4.2.1.3 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 and the second is a simplified method which can be used for rectangular surfaces only. Method 1 requires that the x, y, z coordinates for all surface vertices be defined. From this data, the computer then 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 therefore may desire to use Method 2 if the surfaces are rectangular in shape. Method 2 requires that the following data be entered for rectangular surfaces:

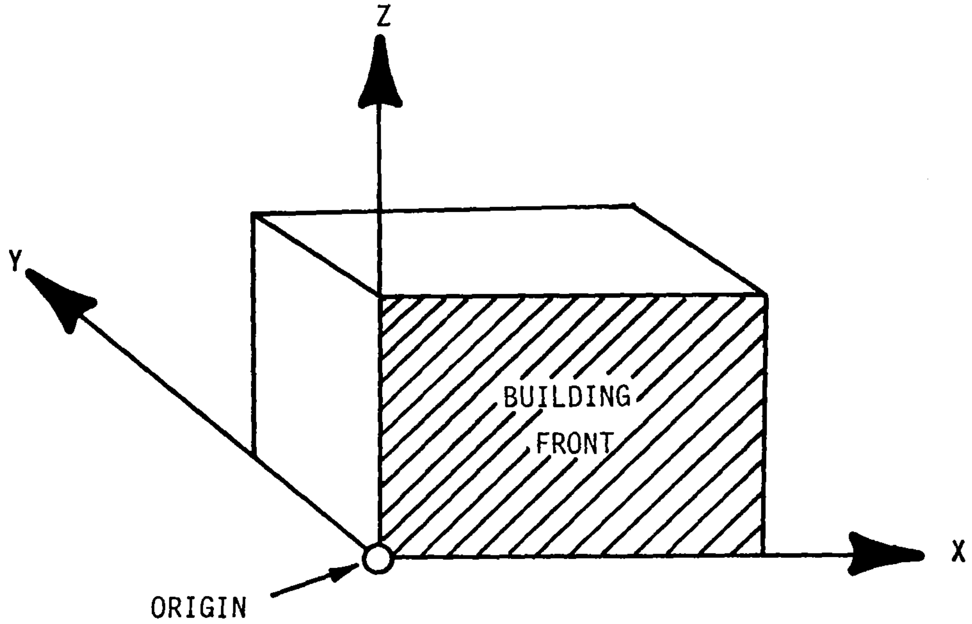


Figure 4.2 COORDINATE SYSTEM

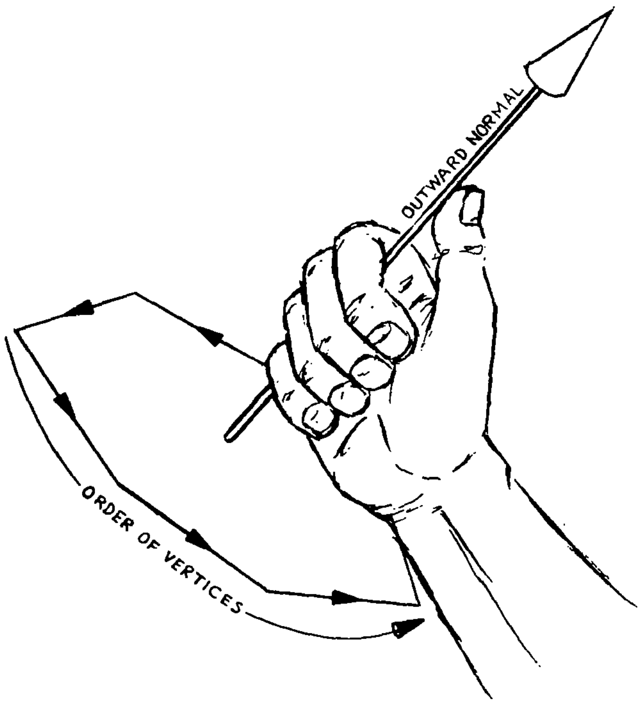
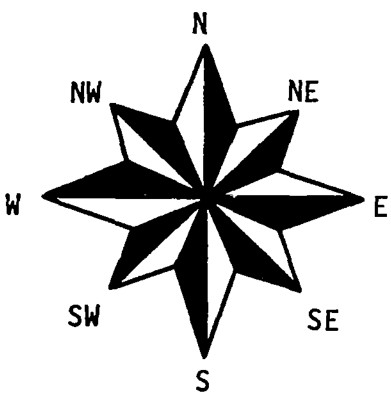


Figure 4.3 DEFINITION OF RIGHT-HANDED ORDER OF POLYGON VERTICES



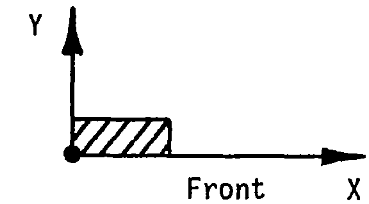
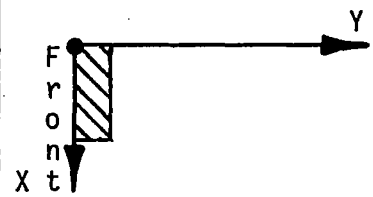
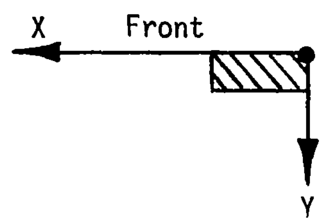
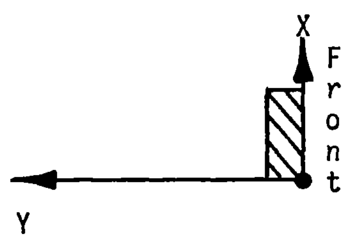
Orientation of Coordinate System relative to compass points	Value of Building Azimuth Angle (o)	Exposure of Building Front
	0	S
	90	W
	180	N
	270	E

Figure 4.4 BUILDING AZIMUTH ANGLE

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

(x,y,z coordinates may be left blank if common shade is not used)

Using this data, the computer can generate the remaining 3 sets of x, y, z coordinates and the surface area.

Since most buildings are made up of rectangular surfaces, it is envisioned that the user would make most use of Method 2. Method 1 would be reserved for surfaces of three or more than four vertices.

4.2.1.4 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, as shown in Figure 4.5.

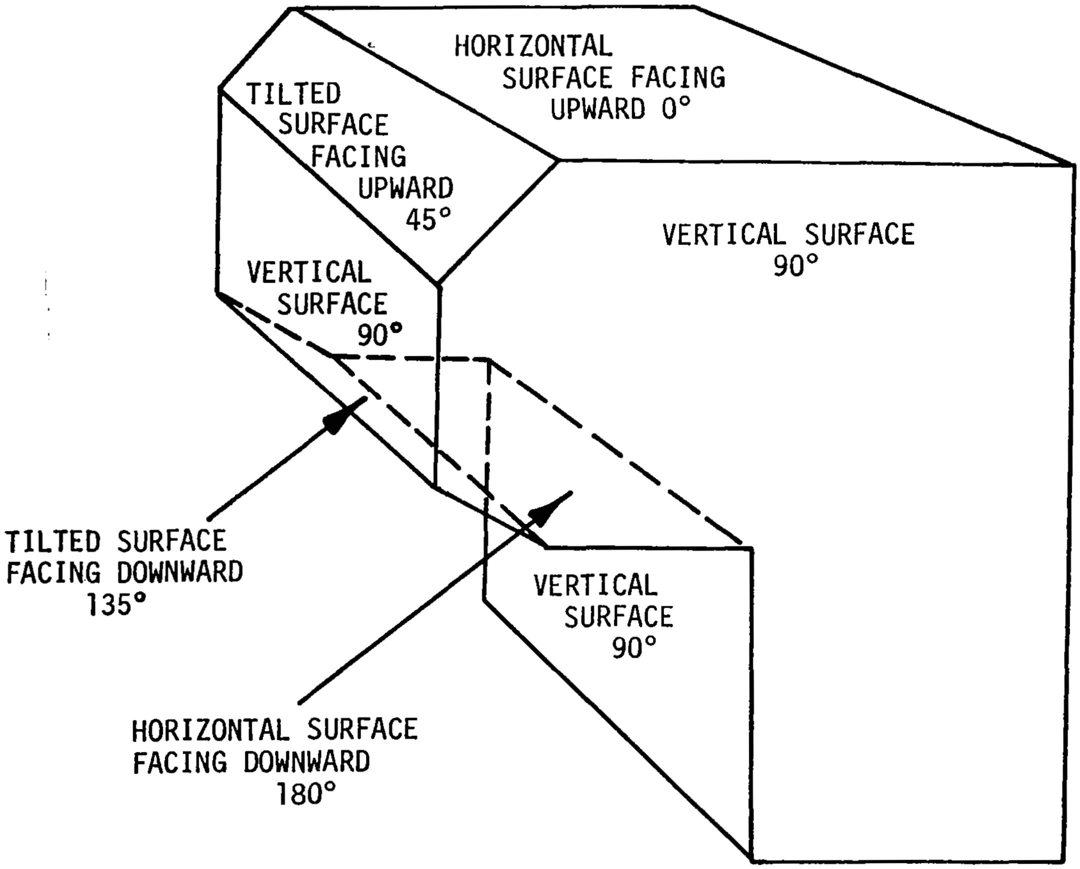


Figure 4.5 SURFACE TILT ANGLE

4.2.1.5 Surface Azimuth Angle

Surface azimuth angle is defined as the clockwise angle from the Y-axis to the horizontal projection of the surface outward normal as shown, for vertical surfaces, in Figure 4.6 and Table 4.1. 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.

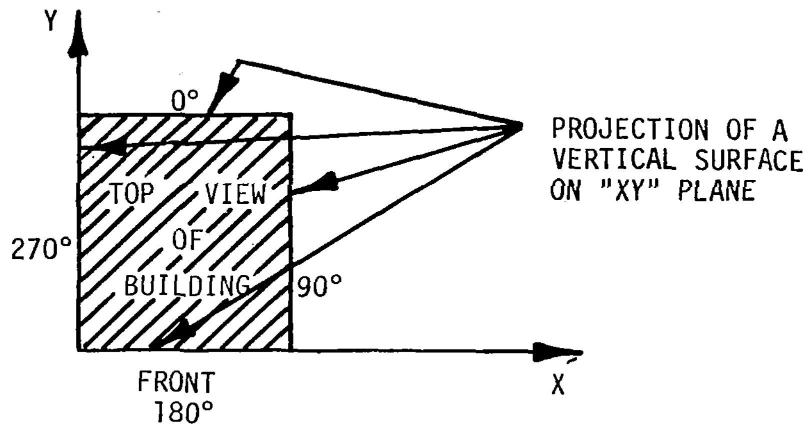


Figure 4.6 VERTICAL SURFACE AZIMUTH ANGLE

Table 4.1

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

4.2.1.6 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."

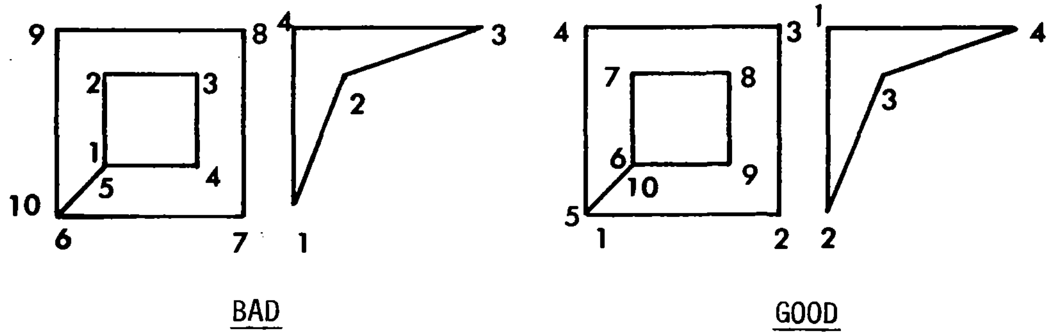


Figure 4.7 CHOICE OF FIRST VERTEX OF A HEAT TRANSFER SURFACE

4.2.1.7 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.

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).

3. Windows

4. Internal Heat Transfer Surfaces

   Interior walls or floors across which there is a temperature difference but that experience slow or little change in temperature and which therefore can be treated as a steady state heat transfer surface (e.g. partitioning walls).

5. Underground Walls

   Below-grade walls with exterior exposed to soil and across which there is a temperature difference but experiences slow or little change in temperature and therefore can be treated as a steady state heat transfer surface.

6. Underground Floors

   Same conditions as for Underground Walls (e.g. building foundation slab).

All of these surfaces have this in common: Each can transfer sensible energy in or out of the space. Stored energy appears in the space sometime after it enters the outside of the surface layer.

4.2.1.8. Surfaces with Windows

Often a hole or cutout lies in the middle of a surface. If the perimeter of the surface is input as the perimeter of a polygon, the region over the hole will be counted twice, once as a hole and once as a part of a heat transfer surface (Figure 4.8). 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 eight vertices, which surrounds but does not enclose the hole (Figure 4.9).

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

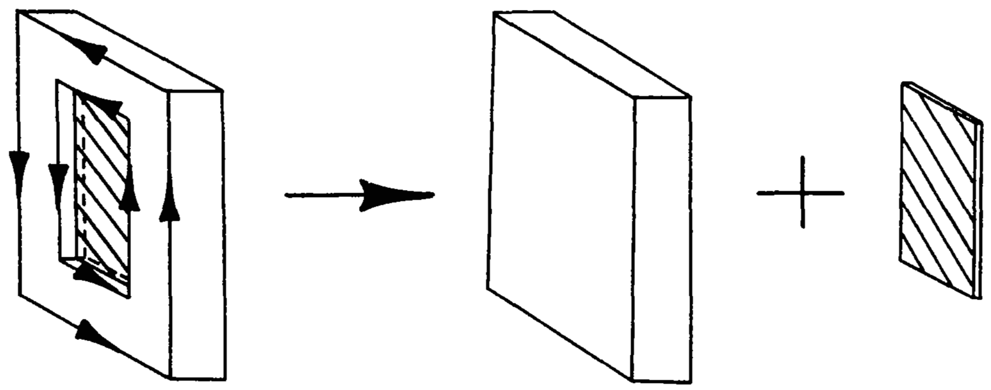


Figure 4.8 INCORRECT REPRESENTATION OF SURFACE WITH HOLE

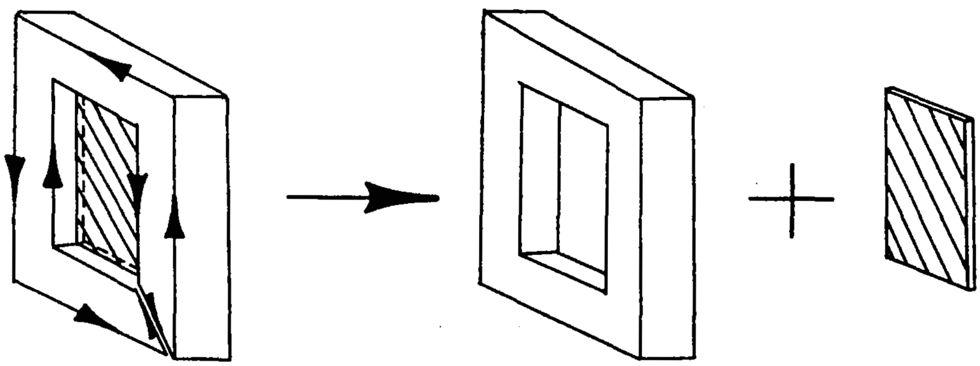


Figure 4.9 CORRECT USE OF A CUT TO REPRESENT SURFACE WITH A HOLE

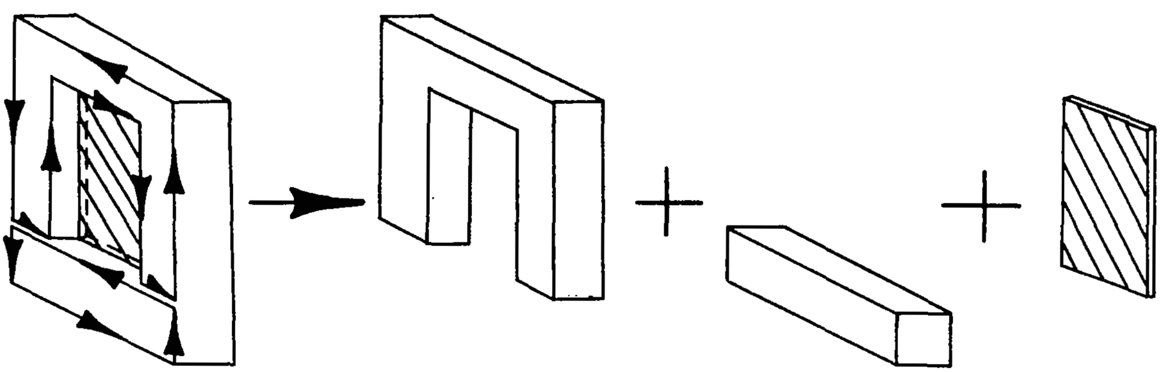


Figure 4.10 CORRECT USE OF MULTIPLE POLYGONS TO REPRESENT A SURFACE WITH A HOLE

4.2.1.9 SHADING SURFACES

Shading surfaces are divided into two classes: common and added. This division has been found to increase the usefulness of the program.

Common shade surfaces represent surfaces which shade more than one heat transfer surface and prevent the extra labor required to input any shading surface twice. Were "commons" not used, each shading surface would have to be repeated for each heat transfer surface that it shades. To save computer time, the input forms for heat transfer surfaces provide space for the indices of common shade surfaces which shall be deleted from the shadow calculation of a particular heat transfer surface. For example, suppose that at the end of the input form for delayed surface 1, there appears the list 1;2;10;13. The computer program would then assume, without calculation, that neither the 1st, 2nd, 10th, or 13th common shading surfaces shade the 1st delayed surface. The user may use this feature when he knows that certain commons do not cast significant shadows on a heat transfer surface.

Added shade surfaces represent surfaces which shade only one heat transfer surface and prevents the task of deleting a common for all but one heat transfer surface.

The usual classification of some shading surfaces appears in Table 4.2. There is no hard rule for classification, so the user must use judgement. In case of doubt as to whether a shading surface casts significant shadows upon more than one heat transfer surface, that shading surface should, to be safe, be treated as common.

TABLE 4.2

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

*The shading surfaces around a window can be represented in NECAP by specifying the set back and the border. The program develops the shading surfaces - three additional shade surfaces are counted in the dimension cards in the load program.

4.2.2 CARD FORM INPUT DATA

Since the Thermal Load Analysis Program requires a great deal of input data, the formatting of the data on cards has been kept as uniform as possible to minimize user preparation errors and also facilitate ease of keypunching. Three card formats are utilized and are as follows:

1. FORMAT (35A1)

   This format allows alphanumeric data to be read, and is used for identifying five sets of Header data, e.g. name of facility, location, name of engineer, project number, date.

2. FORMAT (24F3.2)

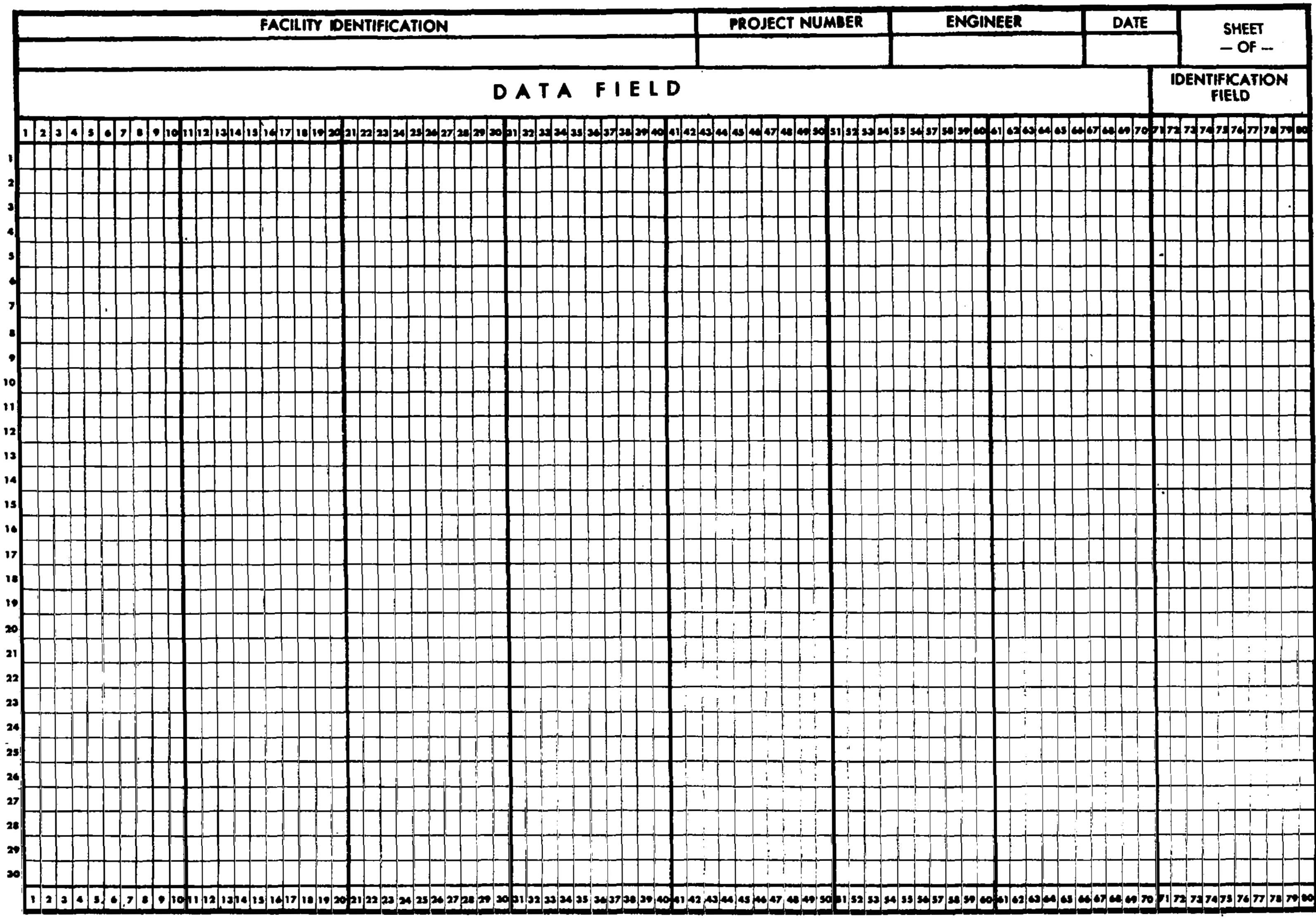
   This format is used to define operating schedules for lights, people and building equipment and allows 24 real numbers to be read from one card. All data must contain a decimal point and appear completely within the specified 3-column fields.

3. FORMAT (7F10.0)

   This format is used for the greater majority of the data and allows 7 real numbers to be read from one card. Again, all data must contain a decimal point and appear completely within the 10-column field.

A standard coding form, like that shown in Figure 4.11, can be utilized for preparing the input data for key punching. Each line represents the information to be punched on one card. Columns 71 through 80 (except for scheduling cards which use columns 73 - 80), have been reserved for comments or identification. The computer ignores anything punched within these columns. The use of the simplified forms, as provided in Appendix C, is beneficial to speed up input and to provide better future reference.

Prior to preparing the actual input data, the user should obtain a floor plan of the building to be analyzed and divide the floor area into temperature control or load control zones. The boundaries of these zones do not have to be actual walls, but rather should represent the area that could be controlled by a single thermostat. Once this zoning has been accomplished, the following information should be developed for each zone.



FACILITY IDENTIFICATION | PROJECT NUMBER | ENGINEER | DATE | SHEET — OF —

DATA FIELD | IDENTIFICATION FIELD

Figure 4.11 TYPICAL INPUT CODING FORM

1. For each aboveground exterior wall, roof, window or shading surface, the x, y, z coordinates of its vertices and the type of construction. For all other surfaces, (internal or underground), the area and heat transfer coefficient.

2. Lighting level (KW or watts/sq.ft.) and hours of operation.

3. Occupancy level (number of people) and hours of occupancy.

4. Other internal loads (KW, watts/sq.ft. or BTU/Hr.) and hours of operation.

To ensure proper coding of the data, Table 4.3 has been prepared for the user and contains the following columns of information:

1. READING ORDER - the order in which the input card occurs in the data check.

2. COLUMNS - the columns in which the input data are to be punched.

3. INPUT VARIABLE DESCRIPTION - the definition of the input data contained on the card.

4. PROGRAM SYMBOL - the name given to the input variable within the computer program.

5. UNITS - the engineering units of the input data.

6. LIMIT VALUES - the maximum and minimum values of the input variables.

7. CODE - the designation code used to simplify the input of certain information.

8. EXAMPLE - typical input values.

9. COMMENT - any supporting remark which further clarifies the use of the input data.

The user should pay particular attention to any comments or further instructions that are embodied within Table 4.3. The total number of cards in an input data deck will not be the same for every problem, but will vary with the number of spaces and number of surfaces identified in the building.

4.2.3 COMPUTER TAPE FORM INPUT DATA

Hourly thermal load calculation procedures require the hourly values of the following weather data:

1. Dry-bulb temperature
2. Dew point temperature or wet-bulb temperature
3. Total cloud amount
4. Cloud type
5. Wind velocity
6. Atmospheric pressure.

This hourly data can be obtained, as Form 1440, either in punch card or magnetic tape form, from the National Climatic Center, Asheville, N. C. Detailed information on these data may be found in:

1. Reference Manual WBAN Hourly Surface Observations 144, April 1966.

2. Reference Manual WBAN Solar Radiation - Hourly 280, April 1967.

3. Tape Reference Manual, Airways Surface Observations, TDF 14.

The Thermal Load Analysis Program uses the magnetic tape form of the data. When an order is given for a selected tape, that is, a selected weather station in proximity to the city in which the building is located, the user should obtain 10 years of weather data. This will ensure all possible types of weather years will be available for analysis, since weather tends to repeat itself in 7 year cycles. See Appendix B for more information on weather tapes.

4.2.4 BUILDING SIZE LIMITATIONS

The Thermal Load Analysis Program is limited in the size of building that it can analyze. This limitation is not due to the inability of the program to handle a larger building, but rather is due to values that have been assigned to the dimension statements (not the measure of distance) that are embodied within the program. The maximum values set in the program are called out in the "Limit Values" column of Table 4.3. and are underlined,.....

If any one of these limits are exceeded for the building under study, the program cannot be used as supplied, and the engineer must consult Appendix A and prepare the required new dimension statements to be inserted into the program. NECAP, Data Verification Program will automatically produce the cards if desires. The use of these new dimension cards can considerably reduce the core requirement of a small project.

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

GENERAL

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-1	1 to 35	Header 1 - e.g. Facility Name	IDEN1	-	-	-	Engineering Building	Not more than 35 characters
LC-2	1 to 35	Header 2 - e.g. Facility Location	IDEN2	-	-	-	Hampton, Va.	Not more than 35 characters
LC-3	1 to 35	Header 3 - e.g. Engineer's Name	IDEN3	-	-	-	R. Jensen	Not more than 35 characters
LC-4	1 to 15	Header 4 - e.g. Project Number	IDEN4	-	-	-	NASI-12843	Not more than 15 characters
LC-5	1 to 15	Header 5 - e.g. Date	IDEN5	-	-	-	15 July 1974	Not more than 15 characters
LC-6	1 to 10	Latitude	STALAT	Degrees	-90.0 to 90.0	-	42.0	See 1972 ASHRAE Handbook, Chapter 33
	11 to 20	Longitude	STALON	Degrees	0.0 to 360.0	-	88.0	See 1972 ASHRAE Handbook, Chapter 33
	21 to 30	Time Zone Number	TZN	-	4.0 to 8.0	-	6.0	See Figure 4.12 and Table 4.3
	31 to 40	Clearness Number for Summer	CNS	-	0.84 to 1.05	-	0.98	See Figure 4.13
	41 to 50	Clearness Number for Winter	CNW	-	0.84 to 1.05	-	0.98	See Figure 4.13
	51 to 60	Building Azimuth	BAZ	Degrees	0.0 to 360.0	-	270.0	See Figure 4.4
LC-7	1 to 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 Energly Analysis Only	2.0	If Code equals 3.0, skip LC-8A, 8B & 8C; go to LC-9
	11 to 20	Ventilation Air Rate	CFMSF	CFM/FT^2	0. to 10.	-	0.1	
	21 to 30	Estimated Total Fan Pressure	FPRES	Inches Water	0. to 15.	-	4.0	Used to estimate fan heat
	31 to 40	Zone Cold Air Supply Temperature - 1	DTC	°F	40. to 70.	-	52.0	Used to determine zone cold air supply rate
	41 to 50	Zone Cold Air Supply Temperature - 2	DTC	°F	40. to 70.	-	55.0	
	51 to 60	Zone Hot Air Supply Temperature - 1	DTH	°F	80. to 200.	-	120.0	Used to determine zone hot air supply rate
	61 to 70	Zone Hot Air Supply Temperature - 2	DTH	°F	80. to 200.	-	140.0	

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

	READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
DESIGN LOAD DATA	LC-8A	1 to 10	Building Altitude Above Sea Level	ALTUD	FT.	0. to 10,000	-	500.0	See 1972 ASHRAE Handbook, Chapter 33
	LC-8B	1 to 10	Summer - Maximum Dry-Bulb Temperature	TDBS	°F	50. to 150.	-	94.0	Summer Design Day Condition
		11 to 20	Summer - Daily Range of Dry-Bulb Temperature	RANGS	°F	0. to 30.	-	16.0	
		21 to 30	Summer - Dew Point Temperature	TDPS	°F	30. to 90.	-	75.0	
		31 to 40	Summer - Wind Speed	WINDS	MPH	0. to 25.	-	5.0	
	LC-8C	1 to 10	Winter - Minimum Dry-Bulb Temperature	TDBW	°F	-50. to 75.	-	-10.0	Winter Design Day Condition
		11 to 20	Winter - Daily Range of Dry-Bulb Temperature	RANGW	°F	0. to 30.	-	3.0	
		21 to 30	Winter - Dew Point Temperature	TDPW	°F	-50. to 60.	-	-10.0	
		31 to 40	Winter - Wind Speed	WINDW	MPH	0. to 25.	-	7.0	
GENERAL	IF PERFORMING DESIGN LOAD ANALYSIS ONLY (i.e. CODE = 1), SKIP LC-9 AND GO TO LC-10								
	LC-9	1 to 10	Weather Year	YEAR	-	-	-	1957.0	-
		11 to 20	Month at which study to be started	ONTH	-	1 to 12	-	11.0	-
		21 to 30	Length of study	ENGTH	Days	1 to 365	-	7.0	See Table 4.7
		31 to 40	Length of special schedule at end of year	XMAS	Days	0 to 365	-	0.0	-
		41 to 50	Estimated initial wall and roof outside surface temperature	TDB	°F	-50.0 to 150.0	-	80.0	Used to initialize wall temp if weather tape has no temp on first hour.
	LC-10	1 to 10	Code for printing hourly space thermal and infiltration loads	CPRINT	-	0.0 to 1.0	0.0 Printing is not wanted 0.1 Printing is wanted	1.0	-
	LC-11	1 to 10	Number of different types of space schedules desired	TYPS	-	1.0 to 3.0	-	2.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION (CONTINUED)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
	READING ORDER LC-12 SHOULD BE REPEATED "TYPS" TIMES, WITH LC-13 INTERSPERSED WHERE REQUIRED.							
SCHEDULING LC-12	4 to 6	Is people schedule required?	CFKSCH	-	0.0 or 1.0	0.0 No 1.0 Yes	1.0	
	7 to 9	People schedule code - Sunday	FISCH	-	1.0 to 20.0	1 through 10 indicates standard schedules built into program. See Table 4.5 for description. 11 through 20 indicates schedules to be defined by user via card LC-13.	1.0	If Code is 11 through 20, Card LC-13 must follow immediately and describe the newly defined schedule. Once the new schedule has been defined it need not be described again
	10 to 12	" " " - Weekday	FISCH	-	"		4.0	
	13 to 15	" " " - Saturday	FISCH	-	"		1.0	
	16 to 18	" " " - Holiday	FISCH	-	"		1.0	
	19 to 21	" " " - Special	FISCH	-	"		1.0	
	25 to 27	Is Lighting schedule required?	CLTSCH	-	0.0 to 1.0	0.0 No 0.1 Yes	1.0	
	28 to 30	Lighting schedule code - Sunday	FISCH	-	1.0 to 20.0	1 through 10 indicates standard schedules built into program. See Table 4.5 for description. 11 through 20 indicates schedules to be defined by user via Card LC-13	1.0	Same as above
	31 to 33	" " " - Weekday	FISCH	-	"		7.0	
	34 to 36	" " " - Saturday	FISCH	-	"		1.0	
	37 to 39	" " " - Holiday	FISCH	-	"		1.0	
	40 to 42	" " " - Special	FISCH	-	"		1.0	
	46 to 48	Is equipment schedule required?	CEQSCH	-	0.0 to 1.0	0.0 No 1.0 Yes	0.0	
	49 to 51	Equipment schedule code - Sunday	FISCH	-	1.0 to 20.0	1 through 10 indicates standard schedules built into program. See Table 4.5 for description 11 through 20 indicates schedules to be defined by user via Card LC-13	0.0	Same as above.
	52 to 54	" " " - Weekday	FISCH	-	"		0.0	
	55 to 57	" " " - Saturday	FISCH	-	"		0.0	
	58 to 60	" " " - Holiday	FISCH	-	"		0.0	
	61 to 63	" " " - Special	FISCH	-	"		0.0	

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

	READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
SCHEDULING	READING ORDER LC-13 SHOULD BE USED TO DEFINE NON-STANDARD SCHEDULES NOT IN PROGRAM.								
	LC-13	1 to 3	Fraction of load - 1 AM	STDSCH	Decimal	0. to 1.0	-	0.2	New schedules must be defined in increasing sequence; once define it need not be entered again.
		4 to 6	" "	"	"	"	-	-	
		"	" "	"	"	"	-	-	
		"	" "	"	"	"	-	-	
		"	" "	"	"	"	-	-	
		67 to 69	" "	"	"	"	-	-	
		70 to 72	Fraction of load - 12 PM	STDSCH	Decimal	0. to 1.0	-	.75	
COMMON SHADING SURFACES	LC-14	1 to 10	Number of common shading surfaces	FNSP	-	0.0 to 5.0	-	0.0	If equal to 0.0, skip reading orders 15,16, and 16';go to 17.
	THE READING ORDERS 15 AND 16 (OR 16') INCLUSIVE SHOULD BE REPEATED "FNSP" TIMES.								
	LC-15	1 to 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 16; otherwise use 16'.
		11 to 20	Transmittance of surface	PSP	-	0.0 to 1.0	0.0 Opaque 1.0 Clear	0.5	-
	LC-16	1 to 10	Coordinates of lower left hand corner of rectangular surface when viewed from outside	XCORN	Ft.	-	-	50.0	-
		11 to 20		YCORN	Ft.	-	-	10.0	-
		21 to 30		ZCORN	Ft.	-	-	5.0	-
		31 to 40	Height of surface	H	Ft.	-	-	15.0	-
		41 to 50	Width of surface	W	Ft.	-	-	50.0	-
		51 to 60	Azimuth angle of surface	A	Degree	0.0 to 360.0	-	45.0	-
		61 to 70	Tilt angle of surface	B	Degree	0.0 to 180.0	-	90.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
READING ORDER LC-16' SHOULD BE REPEATED "FNVSP" TIMES								
LC-16'	1 to 10	Coordinates of Surface Vertex	XSP	FT	-	-	15.0	-
	11 to 20		YSP	FT	-	-	20.0	-
	21 to 30		ZSP	FT	-	-	0.0	-
LC-17	1 to 10	Number of different types of delayed surfaces	FNRF	-	0.0 to 5.0	-	2.0	If equal to 0.0, skip reading orders 18-29, go to 30
	11 to 20	Number of standard surfaces	FNSTD	-	0.0 to FNRF	See Table 4.6	2.0	If equal to 0.0, skip LC-18 and go to LC-19
READING ORDER LC-18 IS REQUIRED IF FNSTD GREATER THAN 0.0								
LC-18	1 to 10	Standard surface code	ISTD	-	1 to 16	See table 4.6	5.0	-
	"	" " "	"	-	"	"	"	-
	"	" " "	"	-	"	"	"	-
	"	" " "	"	-	"	"	"	-
	61 to 70	Standard surface code	ISTD	-	1 to 16	"	0.0	-
READING LC-19 AND LC-20 SHOULD BE REPEATED (FNRF-FNSTD) TIMES								
LC-19	1 to 3	Number of response	NRFT	-	1 to 100	-	18	Use response factor program described in section 2 to generate these cards.
	4 to 23	Common ratio	R1	-	-	-	0.7970107	
READING ORDER LC-20 SHOULD BE REPEATED "NRFT" TIMES								
LC-20	1 to 20	X Response Factor	RFX	BTU/HR-FT^2-°F	-	-	5.1996040	
	21 to 40	Y Response Factor	RFY	"	-	-	0.0000227	
	41 to 60	Z Reponse Factor	RFZ	"	-	-	2.6492141	

COMMON SHADING

TYPES OF DELAYED SURFACES

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

DELAYED SURFACES

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-21	1 to 10	Number of delayed heat transfer surfaces in the building	FNDB	-	0.0 to 28	-	28.0	If equal to 0.0 skip reading orders 22 through 29;go to 30.
THE READING ORDERS 22,23,24 (OR 24') 25,26,27 (OR 27') INCLUSIVE SHOULD BE REPEATED "FNDB" TIMES.								
LC-22	1 to 10	Absorptivity of outside of surface	ABD	-	0.0 to 1.0	-	0.35	See Table 4.9
	11 to 20	Reflectivity of ground facing surface	ROGD	-	0.0 to 1.0	-	0.30	See Table 4.10
	21 to 30	Infiltration flow coefficient	CINFD	—	0.0 to –	—	0.50	See Table 4.13 -Use for crack method -otherwise leave blank.
LC-23	1 to 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 1.0, use reading order 24; otherwise use 24'
	11 to 20	Number of X divisions in surface	FNXD	-	1.0 to 120	-	15.0	Determines number of segments to break surface into for shadow analysis
	21 to 30	Number of Y divisions in surface	FNYD	-	1.0 to 90	-	10.0	
	31 to 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 25.
	41 to 50	Number of shading surfaces added to surface	FNAD	-	0.0 to 3	-	3.0	-
	51 to 60	Surface roughness index	FISD	-	1.0 to 6.0	-	2.0	See Table 4.8
	61 to 70	Index for type of surface	FIRF	-	1.0 to FNRF	-	1.0	-
LC-24	1 to 10	Coordinates of lower left-hand corner of rectangular surface when viewed from outside	XCORN	Ft.	-	-	18.5	-
	11 to 20		YCORN	Ft.	-	-	23.7	-
	21 to 30		ZCORN	Ft.	-	-	1.3	-
	31 to 40	Height of surface	H	Ft.	-	-	10.0	-
	41 to 50	Width of surface	W	Ft.	-	-	15.0	-
	51 to 60	Azimuth angle of surface	A	Degree	0.0 to 360.0	-	0.0	-
	61 to 70	Tilt angle of surface	B	Degree	0.0 to 180.0	-	25.5	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

DELAYED SURFACES

READING ORDER	COLUMN	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVD" TIMES.								
LC-24'	1 to 10	Coordinates of surface vertex	XVD	Ft	-	-	25.5	-
	11 to 20		YVD	Ft	-	-	18.5	-
	21 to 30		ZVD	Ft	-	-	0.0	-
LC-25	1 to 10 : 61 to 70	Index of common shading surface deleted.	FIDD	-	1.0 to FNSP	-	2.0, 5.0, ...	If number of deletions is greater than seven, use more than one computer card.
THE READING ORDERS 26 AND 27 (OR 27') SHOULD BE REPEATED "FNAD" TIMES.								
LC-26	1 to 10	Number of vertices of added shading surface	FNVAD	-	1.0 or 3.0 to 7.0	1.0 Short form for rectangle	8.0	If equal to 1.0, use reading order 27; otherwise use 27'.
	11 to 20	Transmittance of added shading surface	PAD	-	0.0 to 1.0	0.0 Opaque 1.0 Clear	0.8	-
LC-27	1 to 10	Coordinates of lower left-hand corner of added rectangular shading surface when viewed from outside	XCORN	Ft	-	-	12.0	-
	11 to 20		YCORN	Ft	-	-	11.0	-
	21 to 30		ZCORN	Ft	-	-	10.0	-
	31 to 40	Height of added shading surface	H	Ft	-	-	5.0	-
	41 to 50	Width of added shading surface	W	Ft	-	-	6.0	-
	51 to 60	Azimuth angle of added shading surface	A	Degree	0.0 to 360.0	-	35.0	-
	61 to 70	Tilt angle of added shading surface	B	Degree	0.0 to 180.0	-	90.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION (CONTINUED)

READING ORDER	COLUMN	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVAD" TIMES.								
LC-27'	1 to 10	Coordinates of vertex of added shading surface	XAD	Ft	-	-	15.0	-
	11 to 20		YAD	Ft	-	-	23.0	-
	21 to 30		ZAD	Ft	-	-	12.0	-
LC-28	1 to 10	Total number of pictorial outputs desired	FLOOKD	-	0.0 to 20.0	-	5.0	If equal to 0.0, skip reading order 29; go to 30.
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FLOOKD" TIMES.								
LC-29	1 to 10	Month	FMLOKD	-	1.0 to 12.0	-	7.0	-
	11 to 20	Hour of the day	FILOKD	-	1.0 to 24.0	-	11.0	-
	21 to 30	Surface index	FJLOKD	-	1.0 to FNDB	-	3.0	-
LC-30	1 to 10	Number of quick heat transfer surfaces in the building	FNQB	-	0.0 to 10.0	-	1.0	If equal to 0.0, skip reading orders 31 through 38; go to 39.
THE READING ORDERS 31, 32, 33 (OR 33') 34, 35, 36, (OR 36') INCLUSIVE SHOULD BE REPEATED "FNQB" TIMES.								
LC-31	1 to 10	Absorptivity of outside of surface	ABQ	-	0.0 to 1.0	-	0.3	See Table 4.9.
	11 to 20	Reflectivity of ground facing surface	ROGQ	-	0.0 to 1.0	-	0.4	See Table 4.10.
	21 to 30	Heat transfer coefficient	UQI	Btu/hr-ft^2-°F	-	-	1.65	-
	31 to 40	Infiltration flow coefficient	CINFQ	-	0.0 to —	-	5.3	See Table 4.13 -use for crack method - otherwise leave blank.
LC-32	1 to 10	Number of vertices in surface	FNVQ	-	1.0 or 3.0 to 10.0	-	4.0	If equal to 1.0, use reading order 33; otherwise use 33'.
	11 to 20	Number of X divisions in surface	FNXQ	-	1.0 to 120.0	-	10.0	Determines number of segments to break surface into for shadow analysis.
	21 to 30	Number of Y divisions in surface	FNYQ	-	1.0 to 90.0	-	5.0	
	31 to 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 34.
	41 to 50	Number of shading surfaces added to surface	FNAQ	-	0.0 to 3.0	-	3.0	-
	51 to 60	Surface roughness index	FISQ	-	1.0 to 6.0	-	4.0	See Table 4.8.

DELAYED SURFACES

QUICK SURFACES

Table 4.4
THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION
(CONTINUED)

QUICK SURFACES

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-33	1 to 10	Coordinates of lower left-hand corner of rectangular surface when viewed from outside	XCORN	Ft	-	-	25.0	-
	11 to 20		YCORN	Ft	-	-	15.0	-
	21 to 30		ZCORN	Ft	-	-	20.0	-
	31 to 40	Height of surface	H	Ft	-	-	10.0	-
	41 to 50	Width of surface	W	Ft	-	-	5.0	-
	51 to 60	Azimuth angle of surface	A	Degree	0.0 to 360.0	-	360.0	-
	61 to 70	Tilt angle of surface	B	Degree	0.0 to 180.0	-	90.0	-
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVQ" TIMES.								
LC-33	1 to 10	Coordinates of surface vertex	XVQ	Ft	-	-	25.0	-
	11 to 20		YVQ	Ft	-	-	20.0	-
	21 to 30		ZVQ	Ft	-	-	10.0	-
LC-34	1 to 10 : 61 to 70	Index of common shading surface deleted	FIDQ	-	1.0 to FNSP	-	3.0, 4.0, ...	If number of deletion is greater than seven, use more than one computer card.
THE READING ORDERS 35 AND 36 (OR 36') INCLUSIVE SHOULD BE REPEATED "FNAQ" TIMES.								
LC-35	1 to 10	Number of vertices of added shading surface	FNVAQ	-	1.0 or 3.0 to 7.0	1.0 Short form for a rectangle	8.0	If equal to 1.0, use reading order 36; otherwise use 36'.
	11 to 20	Transmittance of added shading surface	PAQ	-	0.0 to 1.0	0.0 Opaque 1.0 Clear	0.8	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

QUICK SURFACES

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-36	1 to 10	Coordinates of lower left-hand corner of added rectangular shading surface when viewed from outside	XCORN	Ft	-	-	12.0	
	11 to 20		YCORN	Ft	-	-	11.0	-
	21 to 30		ZCORN	Ft	-	-	10.0	-
	31 to 40	Height of added shading surface	H	Ft	-	-	5.0	-
	41 to 50	Width of added shading surface	W	Ft	-	-	6.0	-
	51 to 60	Azimuth angle added shading surface	A	Degree	0.0 to 360.0	-	35.0	-
	61 to 70	Tilt angle of added shading surface	B	Degree	0.0 to 180.0	-	90.0	-
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVAQ" TIMES.								
LC-36	1 to 10	Coordinates of vertex of added shading surface	XAQ	Ft	-	-	12.0	-
	11 to 20		YAQ	Ft	-	-	0.0	-
	21 to 30		ZAQ	Ft	-	-	1.0	-
LC-37	1 to 10	Total number of pictorial outputs desired	FLOOKQ	-	0.0 to 20.0	-	2.0	If equal to 0.0, skip reading order 38; go to 39.
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FLOOKQ" TIMES.								
LC-38	1 to 10	Month	FMLOKQ	-	1.0 to 12.0	-	11.0	-
	11 to 20	Hour of the day	FILOKQ	-	1.0 to 24.0	-	9.0	-
	21 to 30	Surface index	FJLOKQ	-	1.0 to FNQS	-	5.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

WINDOWS

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-39	1 to 10	Number of windows in the building	FNWB	-	0.0 to 9.0	-	6.0	If equal to 0.0, skip reading orders 40 through 47; go to 48.
THE READING ORDERS 40, 41, 42 (OR 42'), 43, 44, 45 (OR 45') INCLUSIVE SHOULD BE REPEATED "FNWB" TIMES.								
LC-40	1 to 10	ASHRAE shading coefficient	SHACO	-	0.0 to 1.0	-	0.5	See 1972 ASHRAE Guide, Chapter 22 1.0 = no shading
	11 to 20	Form factor between window and sky	FFWS	-	0.0 to 1.0	-	0.4	-
	21 to 30	Form factor between window and ground	FFWG	-	0.0 to 1.0	-	0.4	-
	31 to 40	Reflectivity of ground facing window	ROGW	-	0.0 to 1.0	-	0.30	See Table 4.10.
	41 to 50	Window Setback	SETBK	inches	0.0 to –	–	4.0	window must be short-form-rectangle to use.
	51 to 60	Window border	BODR	inches	0.0 to –	–	3.0	
	61 to 70	Infiltration flow coefficient	CINEW		0.0 to –	–	5.3	See Table 4.13 -use for crack method - otherwise leave blank
LC-41	1 to 10	Number of vertices in window	FNVW	-	1.0 or 3.0 to 4.0	1.0 Short form for rectangle	8.0	If equal to 1.0, use reading order 42; otherwise use 42'.
	11 to 20	Number of X divisions in window	FNXW	-	1.0 to 120.0	-	15.0	Determines number of segments to break window into for shadow analysis.
	21 to 30	Number of Y divisions in window	FNYW	-	1.0 to 90.0	-	10.0	
	31 to 40	Number of common shading surfaces deleted from window	FNDW	-	0.0 or less than or equal FNSP	-	0.0	If equal to 0.0 or FNSP, skip reading order 43.
	41 to 50	Number of shading surfaces added to window	FNAW	-	0.0 to 3.0	-	5.0	-
	51 to 60	Number of panes of window glass	FNPW	-	1.0 or 2.0	1.0 Single pane 2.0 Double pane	1.0	-
	61 to 70	Index for type of window glass	FGLASW	-	1.0 to 8.0	-	1.0	See Table 4.11 and Figure 4.14.
LC-42	1 to 10	Coordinates of lower left-hand corner of rectangular window when viewed from outside	XCORN	Ft	-	-	8.5	-
	11 to 20		YCORN	Ft	-	-	22.7	-
	21 to 30		ZCORN	Ft	-	-	2.0	-
	31 to 40	Height of window	H	Ft	-	-	10.0	-
	41 to 50	Width of window	W	Ft	-	-	15.0	-
	51 to 60	Azimuth angle of window	A	Degree	0.0 to 360.0	-	90.0	-
	61 to 70	Tilt angle of window	B	Degree	0.0 to 180.0	-	25.5	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION (CONTINUED)

WINDOWS

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVW" TIMES.								
LC-42'	1 to 10	Coordinates of window vertex	XVW	Ft	-	-	25.0	-
	11 to 20		YVW	Ft	-	-	5.0	-
	21 to 30		ZVW	Ft	-	-	10.0	-
LC-43	1 to 10 : 61 to 70	Index of common shading surface deleted	FIDW	-	1.0 to FNSP	-	3.0, 6.0, ...	If number of deletions is greater than 7.0, use more than one computer card.
THE READING ORDERS 44 and 45 (OR 45') INCLUSIVE SHOULD BE REPEATED "FNAW" TIMES.								
LC-44	1 to 10	Number of vertices of added shading surface	FNVAW	-	1.0 or 3.0 to 4.0	1.0 Short form for rectangle	1.0	If equal to 1.0, use reading order 45; otherwise use 45'.
	11 to 20	Transmittance of added shading surface	PAW	-	0.0 to 1.0	0.0 Opaque 1.0 Clear	0.0	-
LC-45	1 to 10	Coordinates of lower left-hand corner of added rectangular shading surface when viewed from outside	XCORN	Ft	-	-	22.0	-
	11 to 20		YCORN	Ft	-	-	10.0	-
	21 to 30		ZCORN	Ft	-	-	10.0	-
	31 to 40	Height of surface added to window	H	Ft	-	-	15.0	-
	41 to 50	Width of surface added to window	W	Ft	-	-	26.0	-
	51 to 60	Azimuth angle of surface added to window	A	Degree	0.0 to 360.0	-	85.0	-
	61 to 70	Tilt angle of surface added to window	B	Degree	0.0 to 180.0	-	90.0	-
THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNVAW" TIMES.								
LC-45'	1 to 10	Coordinates of vertex of surface added to window	XAW	Ft	-	-	25.0	-
	11 to 20		YAW	Ft	-	-	18.0	-
	21 to 30		ZAW	Ft	-	-	12.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION

(CONTINUED)

	READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
WINDOWS	LC-46	1 to 10	Total number of pictorial outputs desired	FLOOKW	-	0.0 to 20.0	-	0.0	If equal to 0.0, skip reading order 47; go to 48.
	THE FOLLOWING READING ORDER SHOULD BE REPEATED "FLOOKW" TIMES.								
	LC-47	1 to 10	Month	FMLOKW	-	1.0 to 12.0	-	1.0	-
		11 to 20	Hour of the day	FILOKW	-	1.0 to 24.0	-	12.0	-
		21 to 30	Window index	FJLOKW	-	1.0 to FNWB	-	5.0	-
INTERNALS	LC-48	1 to 10	Number of internal heat transfer surface in the building	FNIHTS	-	0.0 to 20.0	-	0.0	If equal to 0.0, skip reading order 49; go to 50.
	THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNIHTS" TIMES.								
	LC-49	1 to 10	Area of surface	AIHTS	Ft^2	-	-	100.0	-
		11 to 20	Heat transfer coefficient of surface	FIHTS	Btu/hr-ft^2-°F	-	-	0.9	-
		21 to 30	Indices of spaces connected to surface	SPC1	-	-	-	11.0	-
		31 to 40		SPC2	-	-	-	9.0	-
U. G. WALLS	LC-50	1 to 10	Number of underground walls in the building	FNUWB	-	0.0 to 20.0	-	1.0	If equal to 0.0, skip reading order 51; go to 52.
	THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNUWB" TIMES.								
	LC-51	1 to 10	Area of wall	AUW	Ft^2	-	-	50.0	-
		11 to 20	Heat transfer coefficient of wall	FUW	Btu/hr-ft^2-°F	-	-	1.5	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION
(CONTINUED)

	READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
U. G. FLOORS	LC-52	1 to 10	Number of underground floors in the building.	FNUFB	-	0.0 to 10.0	-	0.0	If equal to 0.0, skip reading order 53; go to 54.
U. G. FLOORS	THE FOLLOWING READING ORDER SHOULD BE REPEATED "FNUFB" TIMES.								
U. G. FLOORS	LC-53	1 to 10	Area of floor	AUF	Ft^2	-	-	25.0	-
U. G. FLOORS		11 to 20	Heat transfer coefficient of floor	FUF	Btu/hr-ft^2-°F	-	-	2.0	-
SOIL TEMP.	LC-54	1 to 10 ⋮ 61 to 70	Ground temperature	TGRND	°F	-	-	30.0,35.0, ...	First data is for 1st mo.of study. If study length > 7 mos., use 2nd computer card. If FNUWB+FNUWB = 0.0, skip this reading order. For CODE = 1 or 2, all 12 mos. are required.
SPACES	LC-55	1 to 10	Number of spaces in the building	FNS	-	1.0 to 25.0	-	11.0	-
SPACES	THE READING ORDERS 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, AND 66 INCLUSIVE SHOULD BE REPEATED "FNS" TIMES.								
SPACES	LC-56	1 to 10	Number of delayed surfaces in the space	FND	-	0.0 to 25.0	-	3.0	If equal to 0.0, skip reading order 61.
SPACES		11 to 20	Number of quick surfaces in the space	FNQ	-	0.0 to 10.0	-	2.0	If equal to 0.0, skip reading order 62.
SPACES		21 to 30	Number of windows in the space	FNW	-	0.0 to 45.0	-	3.0	If equal to 0.0, skip reading order 63.
SPACES		31 to 40	Number of internal surfaces in the space	FINT	-	0.0 to 10.0	-	0.0	If equal to 0.0, skip reading order 64.
SPACES		41 to 50	Number of underground walls in the space	FNUW	-	0.0 to 5.0	-	2.0	If equal to 0.0, skip reading order 65.
SPACES		51 to 60	Number of underground floors in the space	FNUF	-	0.0 to 5.0	-	1.0	If equal to 0.0, skip reading order 66.
SPACES		61 to 70	Number of additional identical spaces in the building	FMULT	-	-	-	0.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION (CONTINUED)

SPACES

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-57	1 to 10	Floor area of space	FLORA	Ft^2	-	-	100.0	-
	11 to 20	Volume of space	VOL	Ft^3	-	-	1000.0	-
	21 to 30	Weight of floor of space	WOF	lb/ft^2	-	-	80.0	-
	31 to 40	Temperature of space	TSPAC	°F	-	-	75.0	-
	41 to 50	Number of people in space	FOLK	-	-	-	5.0	-
	51 to 60	Activity level in the space	HASSL	Btu/hr	400.0 to 1350.0	-	550.0	-
LC-58	1 to 10	Type of light fixture	VENT	-	1.0 to 4.0	-	1.0	See Table 4.12.
	11 to 20	Percent of light heat to space	PERCT	Decimal	0.0 to 1.0	-	0.85	Refer to manufacturer data.
	21 to 30	Schedule index	UINDEX	-	1.0, 2.0, 3.0	-	2.0	-
	31 to 40	Type of infiltration analysis	-	-	0.0, 1.0, or 2.0	0.0 No air change 1.0 Air change method 2.0 Crack method	1.0	
	41 to 50	Infiltration rate	CODINF	No. air changes/hr	0.0 to 10.0	-	1.0	Est. changes at 10 mph
	51 to 60	Height above or below neutral zone	-	Ft.	—	-		— is above neutral zone
	61 to 70	Space exhaust air cfm	-	CFM	0.0 to —	-		
LC-59	1 to 10	Lighting load ($watts/ft^2$)	WPFSL	$Watts/ft^2$	-	-	4.0	These are summed to get total space lighting load.
	11 to 20	Lighting load (KW)	PWRLT	KW	-	-	1.5	
LC-60	1 to 10	Equipment load ($watts/ft^2$)	WPFSE	$Watts/ft^2$	-	-	0.0	These are summed to get total space sensible equipment load.
	11 to 20	Equipment Load (KW)	PWREQ	KW	-	-	10.0	
	21 to 30	Equipment load (BTU sensible)	EQSEN	BTU/hr	-	-	0.0	
	31 to 40	Equipment load (BTU latent)	EQLAT	BTU/hr	-	-	1500.0	-

Table 4.4

THERMAL LOAD ANALYSIS PROGRAM CARD INPUT INFORMATION (CONTINUED)

SPACES

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
LC-61	1 to 10 : 61 to 70	Indices of delayed surfaces of space	FID	-	1.0 to FND	-	3.0, 4.0, ...	If number of indices is greater than seven, use more than one computer card.
LC-62	1 to 10 : 61 to 70	Indices of quick surfaces of space	FIQ	-	1.0 to FNQ	-	1.0, 2.0, ...	
LC-63	1 to 10 : 61 to 70	Indices of windows of space	FIW	-	1.0 to FNW	-	15.0, 22.0, ...	
LC-64	1 to 10 : 61 to 70	Indices of internal surfaces in space	FFIHTS	-	1.0 to FNIHTS	-	11.0, 22.0, ...	To handle repetitive surfaces, repeat indices as many times as required.
LC-65	1 to 10 : 61 to 70	Indices of underground walls in space	FIUW	-	1.0 to FNUWB	-	6.0, 7.0, ...	
LC-66	1 to 10 : 61 to 70	Indices of underground floors in space	FIUF	-	1.0 to FNUFB	-	9.0, 12.0, ...	

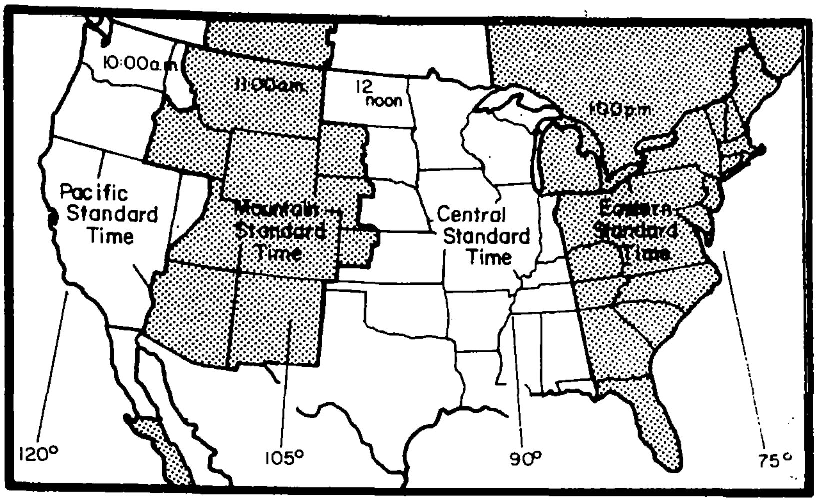


Figure 4.12 TIME ZONES IN THE UNITED STATES

TABLE 4.3
TIME ZONE NUMBERS IN U.S. FOR STANDARD TIME

TIME ZONE	TZN
Atlantic	4
Eastern	5
Central	6
Mountain	7
Pacific	8

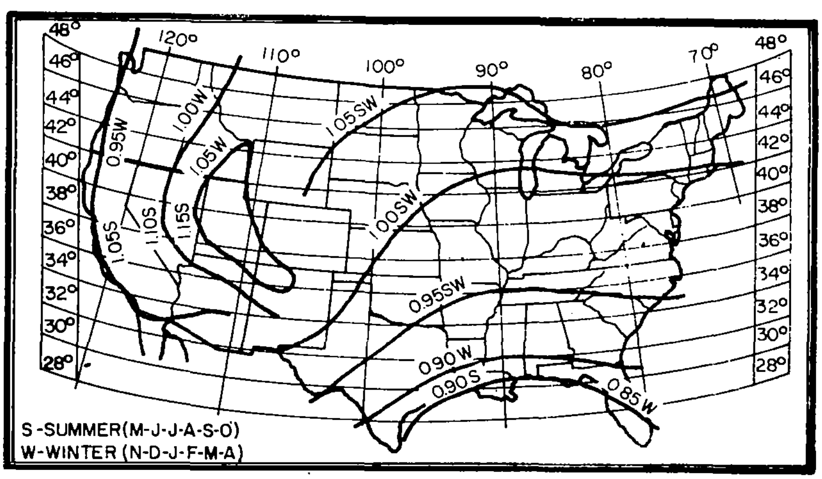


Figure 4.13 CLEARNESS NUMBERS OF NON-INDUSTRIAL ATMOSPHERE IN UNITED STATES

Table 4.5
STANDARD CODED SCHEDULES

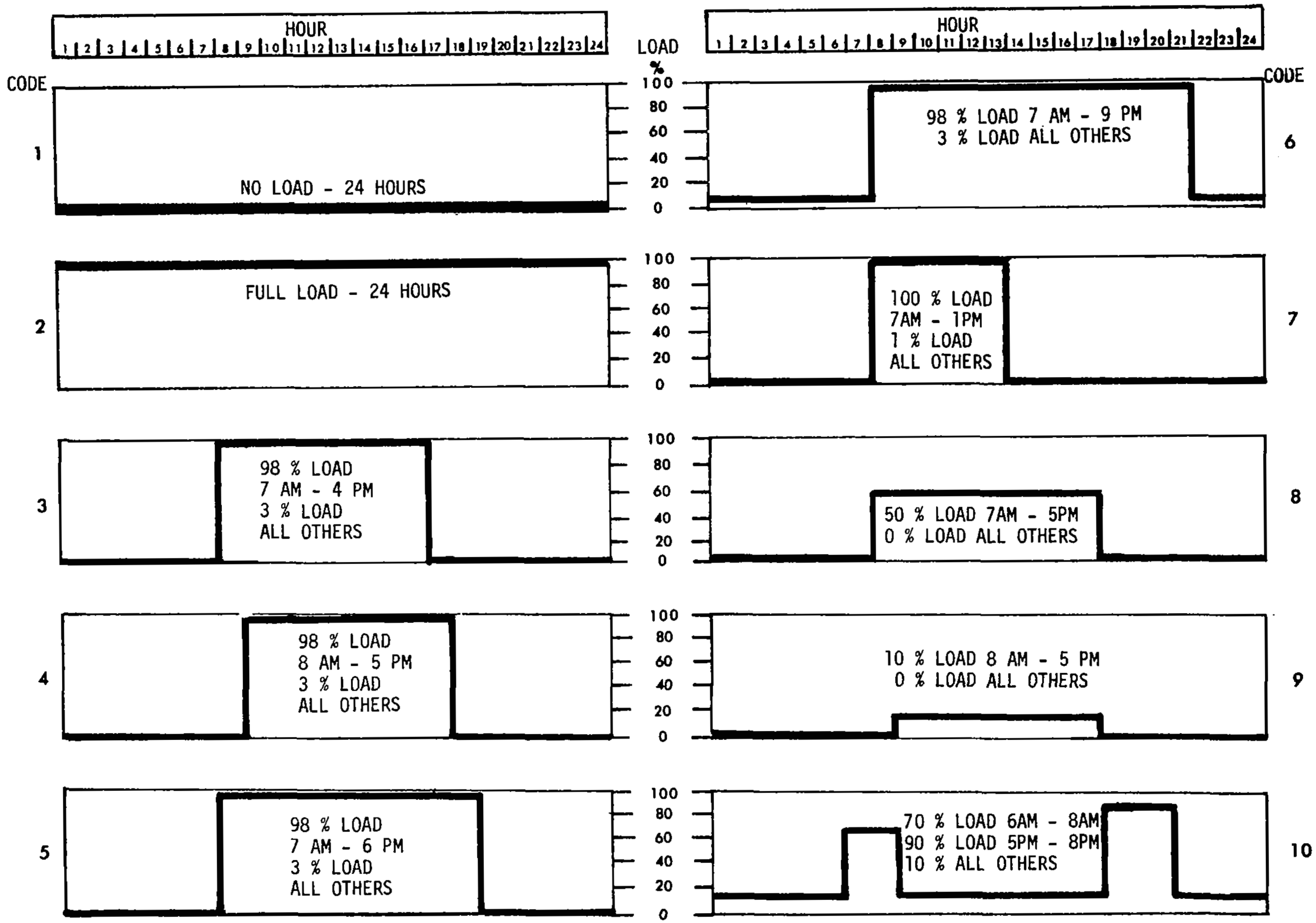


TABLE 4.6

STANDARD CODED SURFACES

CODE	TYPE	LAYER DESCRIPTION
1	Wall	Wood Drop Siding 3/4" Sheathing Board 4" Air Space 1/2" Gypsum Board Inside Air
2	Wall	Wood Drop Siding 3/4" Sheathing Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
3	Wall	4" Face Brick 1/2" Air Space 3/4" Sheathing Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
4	Wall	8" Concrete Block Inside Air
5	Wall	12" Solid Concrete Inside Film
6	Wall	12" Concrete Block 2" Air Space 1/2" Gypsum Board Inside Air
7	Wall	4" Face Brick 2" Air Space 6" Concrete Block Inside Air
8	Wall	4" Face Brick 2" Air Space 6" Concrete Block 2" Fiberglass Insulation 1/2" Gypsum Board Inside Air
9	Wall	Sheet Metal 2" Dense Insulation Sheet Metal Inside Air

TABLE 4.6 CONT'D

CODE	TYPE	LAYER DESCRIPTION
10	Wall	Metal Siding 1" Dense Insulation 8" Concrete Block Air Space 1/2" Gypsum Board Inside Air
11	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 2" Fiberglass Insulation Metal Pan Inside Air
12	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 3" Cellular Glass Metal Pan Inside Air
13	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 3" Cellular Glass Metal Pan Ceiling Air Space Acoustical Tile Inside Air
14	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 2" Cellular Glass 4" L.W. Concrete Metal Pan Ceiling Air Space Acoustical Tile Inside Air
15	Roof	Sheet Metal 6" Fiberglass Gypsum Board Inside Air
16	Roof	Asphalt Shingle (Pitched Roof) 1/2" Plywood Sheathing Attic Air Space 6" Insulation Gypsum Board Inside Air

TABLE 4.7 UPPER LIMIT FOR LENGTH OF STUDY AS FUNCTION OF STARTING MONTH

STARTING MONTH	UPPER LIMIT FOR LENGTH
January	365
February	334
March	306
April	275
May	245
June	214
July	184
August	153
September	122
October	92
November	61
December	31

TABLE 4.8 CODE FOR EXTERIOR SURFACE FINISH

CODE	SURFACE FINISH	EXAMPLE	
		WALL	ROOF
1	Rough	•Stucco	•Wood Shingles •Built-up Roof with Stones
2	↓ INCREASING SMOOTHNESS	•Brick •Plaster	
3		•Concrete	•Asphalt Shingles
4		•Clear Pine	
5		•Smooth Plaster •Metal	•Metal
6	Smooth	•Glass •Paint on Pine	

TABLE 4.9

SOLAR ABSORPTIVITY OF TYPICAL BUILDING MATERIALS

MATERIAL	SOLAR ABSORPTIVITY
Tinned Surface	0.05
White Glazed Brick	0.25
White on Galvanized Iron	0.26
Gravel	0.29
Bituminous Felt-Aluminized	0.40
Aluminum Paint	0.40
Built-up Roof-White	0.50
Light Buff Brick	0.55
White Marble	0.58
Asbestos Cement, White	0.61
Uncolored Concrete	0.65
Uncolored Abestos Cement	0.75
Wood, Smooth	0.78
Asphalt Pavement, Weathered	0.82
Roofing, Green	0.86
Blue Gray Slate	0.87
Red Brick	0.88
Bituminous Felt	0.88

TABLE 4.10
REFLECTANCE OF GROUND SURFACES
FOR VISIBLE RADIATION

SURFACE	REFLECTANCE
Ocean	0.05
Bituminous Concrete	0.07
Wheat Field	0.07
Dark Soil	0.08
Green Field	0.12-0.25
Grass, Dry	0.20
Crushed Rock Surface	0.20
Concrete, Old	0.24
Concrete, Light Colored	0.30

Table 4.11

CODE FOR THICKNESS TIMES
EXTINCTION COEFFICIENT

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

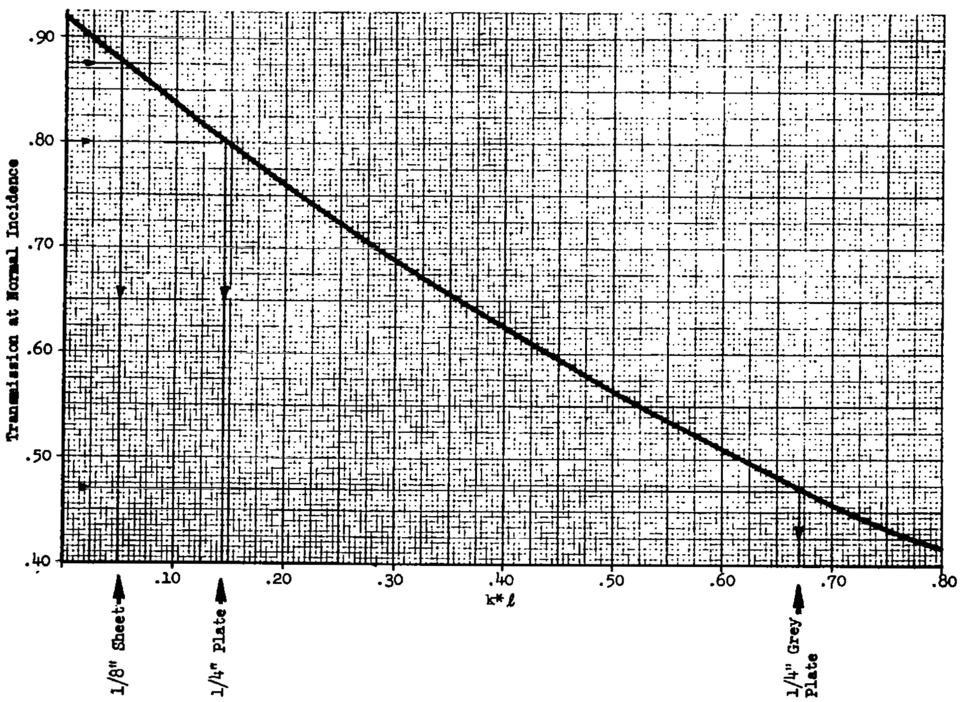


Figure 4.14 $k^*\ell$ VS TRANSMISSION AT NORMAL INCIDENCE FOR SINGLE SHEET GLASS

Table 4.12

TYPES OF LIGHT FIXTURES

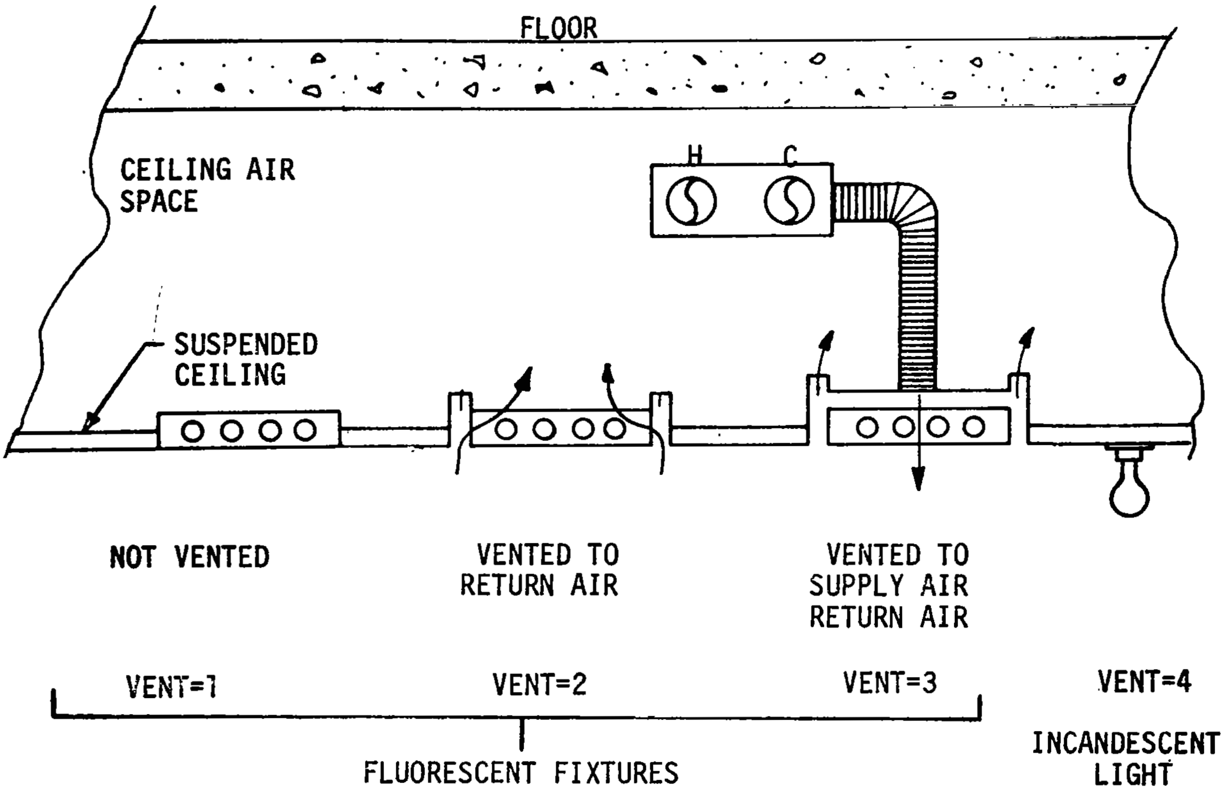


TABLE 4.13

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	(.04 cfh/sq.ft.)	.0005
2.	13" brick, furring, lath & plaster	(0.35)	.004
3.	Frame wall, lath, & plaster	(0.18)	.002
4.	4" brick-6" concrete block-painted	(0.25)	.003
5.	8" cement block-painted both sides	(0.8)	.001
6.	8" brick - plain-poor workmanship	(8.0)	.10
7.	16" shingles on shiplap w/building paper	(2.0)	.023
8.	16" shingles on shiplap	(20.0)	.23
9.	16" shingles on 1x4 boards on 5" CT.	(90.0)	1.1

Quick Surfaces

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

			CINF
1.	1/8" crack	(.3cfm/ft)	.77
	1/4" crack	(.5)	1.3
	1/2" crack	(1.1)	2.8
2.	Door - Residential (3x7) type		
	closed w/WS	(20cfm/unit)	2.4
	average use without WS	(100)	12.0
	average use with WS	(80)	9.8
3.	Door - Office (3.5x7) type		
	closed	(25)	3.1
	open 10% of time	(110)	13.5
	open 25% of time	(450)	55.0
	open 50% of time	(1250)	153.0
	open 10% of time and vestibule	(75)	9.3
4.	Door - Revolving type		
	average use	(100)	12.0
5.	Garage or Shipping Room Door		
	No use	(120)	6.0
	Average use	(480)	60.0

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)	.23
Architectural Projected 1/32" crack	(.45)	.94
Residential casement 1/64" crack	(.20)	.41
2. Double-Hung (crack length equals 125% of perimeter)		
Wood		
Average with WS	(.14 cfm/ft crack)	.6
Average without WS	(.24)	1.1
Poor fitted without WS	(.75)	3.2
Metal		
Average with WS	(.22)	1.0
Average without WS	(.55)	2.2
3. Glass Door (3.5x7) Average Use	(110)	18.0

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

4.3 OUTPUT REPORTS

The Thermal Load Analysis Program prints out, at various stages of analysis, 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, if desired, a summary of calculations performed at various stages leading up to the final results.

Eleven types of reports, in all, can be created by the Thermal Load Analysis Program. They include:

1. Report L1 - Echo of Card Input Data
2. Report L2 - Title Page - Design Load Analysis
3. Report L3 - Summary of Design Day Weather
4. Report L4 - Space Load Summary
5. Report L5 - Building Load Summary
6. Report L6 - Title Page - Hourly Energy Analysis
7. Report L7 - Summary of Weather Tape Parameters
8. Report L8 - Summary of Output Tape Data Labels
9. Report L9 - Summary of Output Tape 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 mandatory outputs; 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 read each time the program is used, the first report coming out will always be a summary of input data read. An example of this report is shown in Figure 4.15. This report will occupy several pages depending upon the size of the input data deck.

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.

4.3.3 REPORT L3 - SUMMARY OF DESIGN DAY WEATHER

As indicated by Figure 4.17, Report L3 summarizes the monthly design day weather that was generated by the program via the user-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 results where the WBT is equal to or greater than the corresponding DBT. A fix, therefore, has been placed in the program to limit the approach of the WBT to within no less than 3^{o}F of the DBT.

4.3.4 REPORT L4 - SPACE LOAD SUMMARY

At the end of the design load analysis, a summary (see Figure 4.18) 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 by input LC-56.

3. Area - defined by input LC-57.

4. Volume - defined by input LC-57.

5. Summer Cooling Peak - time of occurance of peak cooling load (sensible and latent) and corresponding ambient DBT and WBT. Peak will always occur during the 5th day of the month since the design day weather 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 sensible load only.

7. Walls - summation of transmission loads through delayed surfaces with tilt angles equal to or greater than 45^o.

8. Ceilings - summation of transmission loads through delayed and quick surfaces with tilt angles less than 45^o.

9. Window Conductance - summation of transmission loads through windows due to temperature difference.

10. Window Solar - summation of transmission loads through windows due to solar radiation.

11. Quick Surfaces - summation of transmission loads through quick surfaces with tilt angles equal to or greater than 45^o.

12. Internal Surfaces - summation of transmission loads through internal surfaces.

13. Underground Walls - summation of transmission loads through underground walls.

14. Underground Floors - summation of transmission loads through underground floors.

15. Occupants - summation of loads produced by people.

16. Light to Space - Summation of light heat that goes directly into space.

17. Equipment to Space - summation of equipment heat that goes directly into space.

18. Infiltration - summation of loads produced by infiltration of outside air into building.

19. Total - algebraic summation of items 7 through 18.

20. Total Space Cooling - summation of item 19 for summer sensible and latent load.

21. Total Space Heating - summation of item 19 for winter load.

22. Supply air - amount of supply air required to handle peak loads for various supply air temperatures.

4.3.5 REPORT L5 - BUILDING LOAD SUMMARY

Report L5 (see Figure 4.19) is similar to Report L4 except results are for time when the building load peaked. Additional items include:

1. Return Air - summation of space return air lighting loads.

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

3. Supply Air - total building air delivery rates required for both constant volume and variable volume distribution systems.

4.3.6 REPORT L6 - TITLE PAGE - HOURLY ENERGY ANALYSIS

Report L6 (see Figure 4.20) is similar to Report L2 except that it is produced only at the time an hourly energy analysis is begun.

4.3.7 REPORT L7 - SUMMARY OF WEATHER TAPE PARAMETERS

To give the user a record of the source of weather data used for the hourly energy analysis, Report L7 is produced each time an hourly energy analysis is undertaken. See Figure 4.21 for an example report.

4.3.8 REPORT L8 - SUMMARY OF OUTPUT TAPE DATA LABELS

Reports L8 and L9 are companion reports. Report L8 (see Figure 4.22) 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 tape. This report also is an aid in interpreting the data that is printed as part of Report L9.

4.3.9 REPORT L9 - SUMMARY OF OUTPUT TAPE DATA

Report L9 (See Figure 4.23) is an optional output and summarizes weather data and calculated space loads for each hour of the analysis. The user is cautioned that this report could require several hundred pages of output depending upon length of study and number of spaces in building.

4.3.10 REPORT L10 - SURFACE SHADOW PICTURES AND SHADOW CALCULATIONS

At the user's option, shadow pictures similar to that shown in Figure 4.24 can be printed by the computer. The starred area indicates that portion of the surface which is shaded. The shadow picture will always be for the first day of month desired since the program computes the sun's location only during the first day of each month. All other days in the month would therefore give 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 Variable Temperature Program (Section 5) require as input to it, the maximum heating and cooling capacities provided to each space. Report L10 (Figure 4.25) lists the recommended capacities based upon hourly energy analysis results. These quantities are taken directly from item 19 of Report L4 for each space.

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

BASIC DATA	37.00	76.00	5.00	0.96	0.96	299.00	
PROCESSING DATA	1.00	0.12	4.00	50.00	55.00	120.00	140.00
DESIGN LOAD DATA							
ALTITUDE	25.00						
SUMMER DAY	94.00	18.00	72.00	5.00			
WINTER DAY	20.00	3.00	5.00	7.00			
PRINT CODE	1.00						
NO. OF SCHEDULE TYPES	1.						

Figure 4.15 REPORT L1 (TYPICAL)

```
****************************************************************************
*                                                                          *
*                      DESIGN LOAD ANALYSIS FOR                            *
*                                                                          *
*                     LRC SYSTEMS ENGINEERING                              *
*                                                                          *
*                             BUILDING                                     *
*                                                                          *
*                         HAMPTON, VIRGINIA                                *
*                                                                          *
*  ENGINEER     - R.JENSEN                                                 *
*  PROJECT NO   - SZ, 4W, 3IN                                              *
*  DATE         - NOV 26, 1973                                             *
*                                                                          *
****************************************************************************
```

Figure 4.16 REPORT L2 (TYPICAL)

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 TEMPFRATURE = 94.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 18.
4. AVERAGE DEW-POINT TEMPERATURE = 72.
5. AVERAGE WIND SPEED = 5.

WINTER DAY INPUT PARAMETERS

1. MONTH ASSUMED TO BE DECEMBER
2. MINIMUM DRY-BULB TEMPERATURE = 20.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 3.
4. AVERAGE DEW-POINT TEMPERATURE = 5.
5. AVERAGE WIND SPEED = 7.

		* * * * * * * * * *					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	62.	61.	60.	60.	60.	62.	64.	66.	68.	70.	72.	75.	77.	79.	80.	79.	78.	77.	75.	73.	71.	69.	66.	64.
	WBT	59.	58.	57.	57.	57.	59.	61.	63.	65.	67.	68.	69.	70.	70.	70.	70.	70.	70.	69.	68.	68.	66.	63.	61.
APRIL																									
	DBT	67.	66.	65.	65.	65.	67.	69.	71.	73.	75.	77.	80.	82.	84.	85.	84.	83.	82.	80.	78.	76.	74.	71.	69.
	WBT	64.	63.	62.	62.	62.	64.	66.	68.	69.	70.	70.	71.	72.	72.	72.	72.	72.	72.	71.	70.	70.	69.	68.	66.
MAY																									
	DBT	72.	71.	70.	70.	70.	72.	74.	76.	78.	80.	82.	85.	87.	89.	90.	89.	88.	87.	85.	83.	81.	79.	76.	74.
	WBT	69.	68.	67.	67.	67.	69.	71.	72.	72.	73.	73.	74.	75.	75.	75.	75.	75.	75.	74.	74.	73.	73.	72.	71.
JUNE																									
	DBT	75.	74.	73.	73.	73.	75.	77.	79.	81.	83.	85.	88.	90.	92.	93.	92.	91.	90.	88.	86.	84.	82.	79.	77.
	WBT	72.	71.	70.	70.	70.	72.	73.	74.	74.	75.	75.	76.	77.	77.	77.	77.	77.	77.	76.	76.	75.	75.	74.	73.
JULY																									
	DBT	76.	75.	74.	74.	74.	76.	78.	80.	82.	84.	86.	89.	91.	93.	94.	93.	92.	91.	89.	87.	85.	83.	80.	78.
	WBT	73.	72.	71.	71.	71.	73.	73.	74.	74.	75.	75.	76.	77.	77.	77.	77.	77.	77.	76.	76.	75.	75.	74.	73.
AUGUST																									
	DBT	76.	75.	74.	74.	74.	76.	78.	80.	82.	84.	86.	89.	91.	93.	94.	93.	92.	91.	89.	87.	85.	83.	80.	78.
	WBT	73.	72.	71.	71.	71.	73.	73.	74.	74.	75.	75.	76.	77.	77.	77.	77.	77.	77.	76.	76.	75.	75.	74.	73.
SEPTEMBER																									
	DBT	73.	72.	71.	71.	71.	73.	75.	77.	79.	81.	83.	86.	88.	90.	91.	90.	89.	88.	86.	84.	82.	80.	77.	75.
	WBT	70.	69.	68.	68.	68.	70.	71.	72.	72.	73.	73.	74.	75.	75.	75.	75.	75.	75.	74.	74.	73.	72.	72.	71.
OCTOBER																									
	DBT	69.	68.	67.	67.	67.	69.	71.	73.	75.	77.	79.	82.	84.	86.	87.	86.	85.	84.	82.	80.	78.	76.	73.	71.
	WBT	66.	65.	64.	64.	64.	66.	68.	70.	70.	71.	71.	72.	73.	73.	73.	73.	73.	73.	72.	72.	71.	70.	70.	68.
NOVEMBER																									
	DBT	61.	60.	59.	59.	59.	61.	63.	65.	67.	69.	71.	74.	76.	78.	79.	78.	77.	76.	74.	72.	70.	68.	65.	63.
	WBT	58.	57.	56.	56.	56.	58.	60.	62.	64.	66.	67.	68.	69.	69.	69.	69.	69.	69.	68.	67.	67.	65.	62.	60.
DECEMBER																									
	DBT	21.	20.	20.	20.	20.	20.	20.	21.	21.	22.	22.	22.	23.	23.	23.	23.	23.	23.	22.	22.	22.	22.	21.	21.
	WBT	17.	17.	17.	16.	16.	16.	17.	17.	17.	17.	18.	18.	18.	18.	19.	18.	18.	18.	18.	18.	18.	17.	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.

Figure 4.17 REPORT L3 (TYPICAL)

PAGE 4

DESIGN LOAD CALCULATION RESULTS FOR
LRC SYSTEMS ENGINEERING
HAMPTON, VIRGINIA

SPACE NO.	4
SPACE REPETITION FACTOR	1
AREA (SQ.FT.)	500.
VOLUME (CU.FT.)	4700.
SUMMER COOLING PEAK DBT/WBT/HR OF DAY/DATE	98 / 75 / 18 / JULY 1
WINTER HEATING PEAK DBT/WBT/HR OF DAY/DATE	-14 / -14 / 21 / JAN. 23

	***** SUMMER LOAD *****		WINTER
	SENSIBLE (BTUH)	LATENT (BTUH)	LOAD (BTUH)
WALLS	5800.	0.	-35586.
CEILINGS	1709.	0.	-3570.
WINDOW CONDUCTANCE	20660.	0.	-96917.
WINDOW SOLAR	20270.	0.	0.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND WALLS	0.	0.	0.
UNDERGROUND FLOORS	185.	0.	-1690.
OCCUPANTS	111.	0.	17.
LIGHT TO SPACE	5529.	0.	1474.
EQUIPMENT TO SPACE	0.	0.	0.
INFILTRATION	0.	0.	0.
	---------	---------	---------
TOTAL	54264.	0.	-136271.

TOTAL SPACE COOLING 54264. BTUH
TOTAL SPACE HEATING -136271. BTUH

SUPPLY AIR AT 50 F AT DIFFUSER	2223. CFM	4.45 CFM/SQ.FT.
SUPPLY AIR AT 55 F AT DIFFUSER	2779. CFM	5.56 CFM/SQ.FT.
SUPPLY AIR AT 120 F AT DIFFUSER	2376. CFM	4.75 CFM/SQ.FT.
SUPPLY AIR AT 140 F AT DIFFUSER	1645. CFM	3.29 CFM/SQ.FT.

Figure 4.18 REPORT L4 (TYPICAL)

BUILDING LOAD SUMMARY FOR
LRC SYSTEMS ENGINEERING
HAMPTON, VIRGINIA

SPACE NOS.	1 THRU 6
TOTAL FLOOR AREA (SQ.FT.)	53000.
TOTAL VOLUME (CU.FT.)	488800.
SUMMER COOLING PEAK	
DBT/WBT/HR OF DAY/DATE	93 / 81 / 17 / AUG. 2
WINTER HEATING PEAK	
DBT/WBT/HR OF DAY/DATE	-15 / -15 / 6 / JAN. 23

	***** SUMMER LOAD *****		WINTER
	SENSIBLE (BTUH)	LATENT (BTUH)	LOAD (BTUH)
WALLS	4536.	0.	-109526.
CEILINGS	108050.	0.	-337488.
WINDOW CONDUCTANCE	54813.	0.	-344317.
WINDOW SOLAR	38064.	0.	0.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	7280.	0.	7280.
UNDERGROUND WALLS	0.	0.	0.
UNDERGROUND FLOORS	13738.	0.	-178599.
OCCUPANTS	85080.	67716.	75.
LIGHT TO SPACE	579218.	0.	16470.
EQUIPMENT TO SPACE	0.	0.	0.
INFILTRATION	0.	0.	0.
SUBTOTAL	890779.	67716.	-946104.
RETURN AIR	103640.	0.	2251.
FAN HEAT	68029.	0.	68029.
VENTILATION AIR	111764.	316788.	-729386.
TOTAL	1174211.	384504.	-1605210.

TOTAL BUILDING COOLING	1558714. BTUH	129.9 TONS
TOTAL BUILDING HEATING	-1605210. BTUH	-1605.2 MBH

	******* VARIABLE VOLUME SYSTEM *******		******* CONSTANT VOLUME SYSTEM *******	
SUPPLY AIR AT 50 F AT DIFFUSER	36497. CFM	0.69 CFM/SQ.FT. MAX.	42370. CFM	0.80 CFM/SQ.FT. CONST.
SUPPLY AIR AT 55 F AT DIFFUSER	45621. CFM	0.86 CFM/SQ.FT. MAX.	52962. CFM	1.00 CFM/SQ.FT. CONST.
SUPPLY AIR AT 120 F AT DIFFUSER	16500. CFM	0.31 CFM/SQ.FT. MAX.	17608. CFM	0.33 CFM/SQ.FT. CONST.
SUPPLY AIR AT 140 F AT DIFFUSER	11423. CFM	0.22 CFM/SQ.FT. MAX.	12190. CFM	0.23 CFM/SQ.FT. CONST.

Figure 4.19 REPORT L5 (TYPICAL)

```
ANALYSIS OF ENERGY UTILIZATION FOR

LRC SYSTEMS ENGINEERING

HAMPTON, VIRGINIA

ENGINEER    - R.JENSEN
PROJECT NO  - SZ, 4W, 3IN
DATE        - NOV 26, 1973
```

Figure 4.20 REPORT L6 (TYPICAL)

```
******************************************************************************
*                                                                            *
*                                                                            *
*                                IN THIS RUN                                 *
*                                                                            *
*                                                                            *
* - U. S. WEATHER BUREAU 1440 WEATHER TAPE OF STATION 14819 IS USED.         *
*                                                                            *
*                                                                            *
* - THE FIRST DATA OBTAINED FROM WEATHER TAPE IS FOR 0TH HOUR OF 01/01/1963. *
*                                                                            *
*                                                                            *
* - THE LENGTH OF THIS STUDY IS 365 DAYS.                                    *
*                                                                            *
*                                                                            *
* - THE INITIAL OUTSIDE SURFACE TEMPERATURE IS 17 DEGREES FAHRENHEIT.        *
*                                                                            *
*                                                                            *
******************************************************************************
```

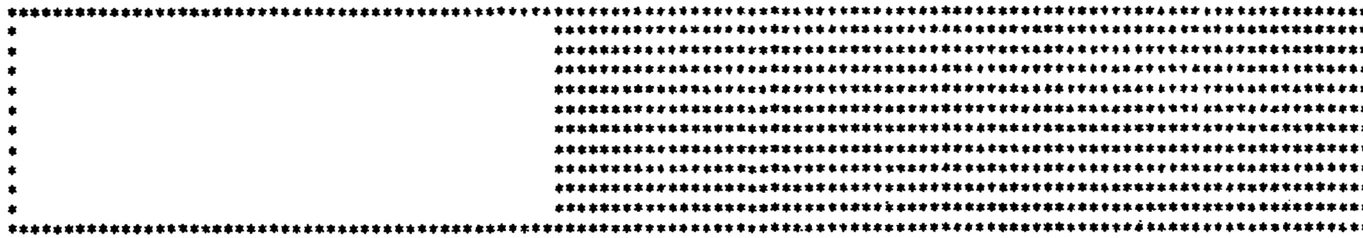
Figure 4.21 REPORT L7 (TYPICAL)

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                            IN THE FOLLOWING PAGES                         *
*                                                                           *
*                                                                           *
*                  THE FIRST LINE OF EACH PRINTED BLOCKS GIVES              *
*                                                                           *
*   TIME            - HOURS, STANDARD TIME FROM FIRST HOUR OF JANUARY       *
*   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                                     *
*   ENTHALPY        - BTU PER LB DRY-AIR                                    *
*   DENSITY         - LBS DRY-AIR PER CUBIC FOOT                            *
*   CLOUD COVER MODIFIER - FRACTION OF TOTAL SOLAR RADIATION INCIDENT       *
*                          UPON A HORIZONTAL SURFACE                        *
*                                                                           *
*               THE FOLLOWING LINES OF EACH PRINTED BLOCKS GIVES            *
*                                                                           *
*   SPACE NUMBER                                                            *
*   NUMBER OF IDENTICAL SPACES IN BUILDING                                  *
*   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                          *
*                                                                           *
*                                                                           *
*****************************************************************************
*          NOTE - THE LOADS EXCLUDES OUTSIDE VENTILATION AIR LOADS          *
*****************************************************************************
```

Figure 4.22 REPORT L8 (TYPICAL)

5185	1	76. 73.	4.	0.016790	29.89	36.62	0.072027	0.000
1	1	91805.06		0.0	7560.14		0.0	
2	1	12934.36		0.0	74.12		0.0	
3	1	9486.27		0.0	74.12		0.0	
4	1	14351.00		0.0	74.12		0.0	
5	1	11911.75		0.0	74.12		0.0	
6	1	0.0		0.0	0.0		0.0	
5186	1	75. 72.	4.	0.016389	29.89	35.95	0.072207	0.000
1	1	69205.25		0.0	5887.84		0.0	
2	1	11022.34		0.0	57.72		0.0	
3	1	8088.65		0.0	57.72		0.0	
4	1	12393.02		0.0	57.72		0.0	
5	1	10353.26		0.0	57.72		0.0	
6	1	0.0		0.0	0.0		0.0	
5187	1	74. 71.	4.	0.015805	29.89	35.05	0.072408	0.000
1	1	51414.73		0.0	4585.45		0.0	
2	1	9278.81		0.0	44.96		0.0	
3	1	6809.26		0.0	44.96		0.0	
4	1	10613.82		0.0	44.96		0.0	
5	1	8910.63		0.0	44.96		0.0	
6	1	0.0		0.0	0.0		0.0	
5188	1	74. 71.	4.	0.015805	29.89	35.05	0.072408	0.000
1	1	37518.85		0.0	3571.15		0.0	
2	1	8162.98		0.0	35.01		0.0	
3	1	6000.18		0.0	35.01		0.0	
4	1	9424.14		0.0	35.01		0.0	
5	1	7941.05		0.0	35.01		0.0	
6	1	0.0		0.0	0.0		0.0	
5189	1	74. 71.	4.	0.015805	29.89	35.05	0.072408	0.000
1	1	27324.63		0.0	2781.22		0.0	
2	1	7248.71		0.0	27.27		0.0	
3	1	5336.04		0.0	27.27		0.0	
4	1	8430.42		0.0	27.27		0.0	
5	1	7122.46		0.0	27.27		0.0	
6	1	0.0		0.0	0.0		0.0	
5190	0	76. 73.	4.	0.016790	29.89	36.62	0.072027	0.000
1	1	21008.82		0.0	2166.01		0.0	
2	1	12639.13		0.0	21.24		0.0	
3	1	8985.18		0.0	21.24		0.0	
4	1	9167.80		0.0	21.24		0.0	
5	1	7748.35		0.0	21.24		0.0	
6	1	0.0		0.0	0.0		0.0	
5191	0	78. 73.	4.	0.016776	29.89	37.10	0.071761	0.000
1	1	276690.13		0.0	59763.02		204.00	
2	1	25719.92		0.0	585.91		2.00	
3	1	15143.36		0.0	585.91		2.00	
4	1	13579.34		0.0	585.91		2.00	
5	1	11853.03		0.0	585.91		2.00	
6	1	0.0		0.0	0.0		0.0	
5192	0	80. 74.	4.	0.016763	29.89	37.58	0.071496	0.000
1	1	420518.63		66824.88	69645.00		204.00	
2	1	35612.92		222.75	682.79		2.00	
3	1	18235.54		222.75	682.79		2.00	
4	1	16870.24		222.75	682.79		2.00	
5	1	14766.43		222.75	682.79		2.00	
6	1	0.0		0.0	0.0		0.0	
5193	0	82. 74.	4.	0.016748	29.89	38.06	0.071234	0.000
1	1	520986.81		66824.88	77341.13		204.00	
2	1	42092.56		222.75	758.25		2.00	
3	1	20074.19		222.75	758.25		2.00	
4	1	20072.11		222.75	758.25		2.00	
5	1	17561.06		222.75	758.25		2.00	

Figure 4.23 REPORT L9 (TYPICAL)

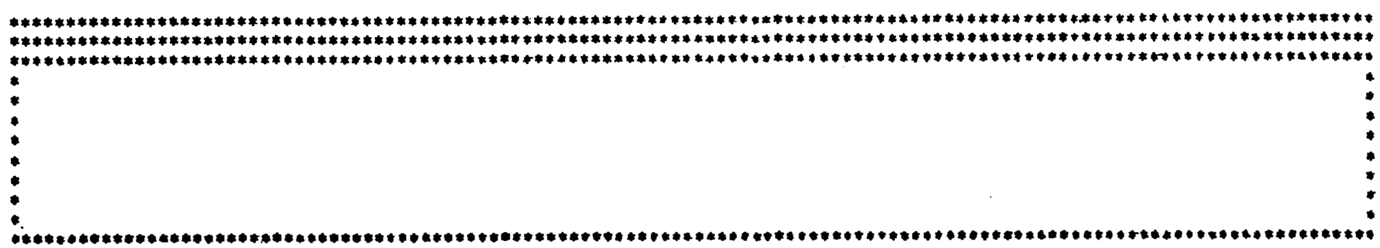


THE PRECEDING SHADOW PICTURE IS FOR
WINDOW NUMBER 1 OF SPACE NUMBER 1
AT 600 HOUR OF THE FIRST DAY OF SEP.

AREA OF THE WINDOW = 450.87 FT**2
SHADED AREA OF THE WINDOW = 270.60 FT**2

THE PRECEDING SHADOW PICTURE IS FOR
WINDOW NUMBER 1 OF SPACE NUMBER 1
AT 800 HOUR OF THE FIRST DAY OF SEP.

AREA OF THE WINDOW = 450.87 FT**2
SHADED AREA OF THE WINDOW = 80.80 FT**2



THE PRECEDING SHADOW PICTURE IS FOR
WINDOW NUMBER 1 OF SPACE NUMBER 1
AT 1200 HOUR OF THE FIRST DAY OF SEP.

AREA OF THE WINDOW = 450.87 FT**2
SHADED AREA OF THE WINDOW = 115.57 FT**2

Figure 4.24 REPORT L10 (TYPICAL)

SUMMARY OF RECOMMENDED HEATING AND COOLING EXTRACTION RATES TO BE USED AS INPUT TO VARIABLE TEMPERATURE PROGRAM

SPACE NO.	HEATING EXTRACTION RATE (BTU/HR)	COOLING EXTRACTION RATE (BTU/HR)
1	-500389.	861499.
2	-143732.	45320.
3	-115744.	35014.
4	-136271.	54264.
5	-113510.	38009.
6	0.	0.

Figure 4.25 REPORT L11 (TYPICAL)

4.4 EXAMPLE

To illustrate the use of the Thermal Load Analysis Program, a complete study was performed on the 1244C Engineering offices (Figure 4.26) located at the NASA Langley Research Center. This structure is actually a wing of the much larger Building 1244 (Figure 4.26). Building 1244C is a two-story office-type facility having a total of 4300 square feet of occupied area. Details for this building are summarized in Table 4.13. For the purposes of this study, the building was broken into 5 spaces (Figure 4.27) with spaces 1 through 4 being office areas and space 5 being the mechanical room, entryway and stairwell. Figure 4.28 illustrates how the building was broken into:

1. 18 delayed heat transfer surfaces
2. 5 windows
3. 6 internal heat transfer surfaces
4. 1 underground floor.

Due to the orientation of the building and its location relative to Building 1244, two common shading surfaces were required and are indicated in Figure 4.26. For the sake of illustration, it was also assumed that window W1 had a setback of 6" and therefore necessitated that 3 added shading surfaces be defined for that window. Were it not for the shading problem, advantage could have been taken of repetitive surfaces thereby reducing the amount of input data. Neglecting of this effect would have meant that

1. surface D2 = surface D3
2. surface D8 = surface D9
3. surface D1 = surface D4
4. surface D7 = surface D10
5. window W1 = window W2
6. window W3 = window W4.

Having assimilated all of the above information, the input data deck was prepared, a listing of which is shown in Figures 4.29 to 4.33. Several handwritten comments have been added to this listing to indicate the structure of the data deck. The comments indicated at the far right of each card represent one engineer's method of sequencing the cards. The complete set of output reports received after processing of the deck is shown in Appendix C.

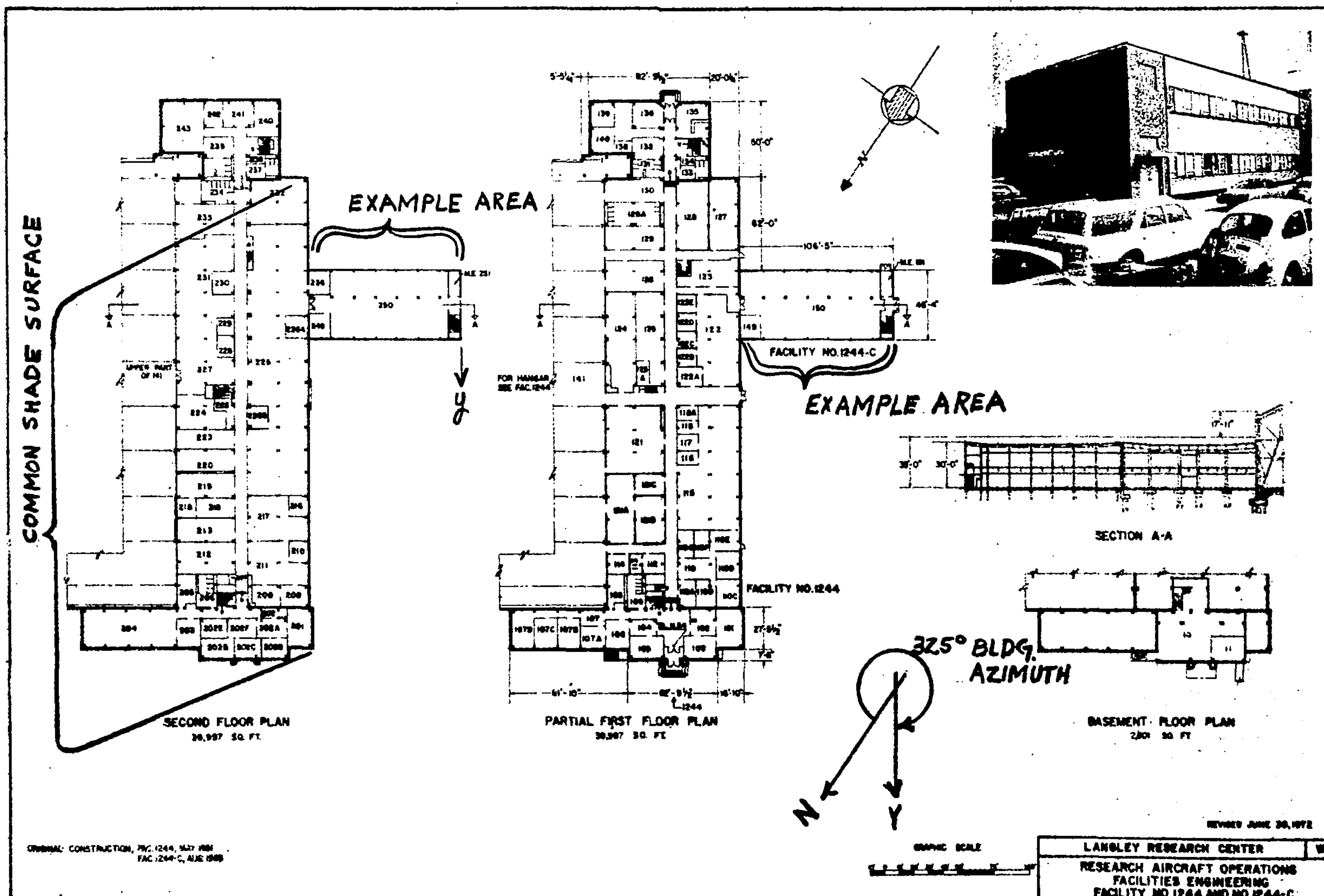
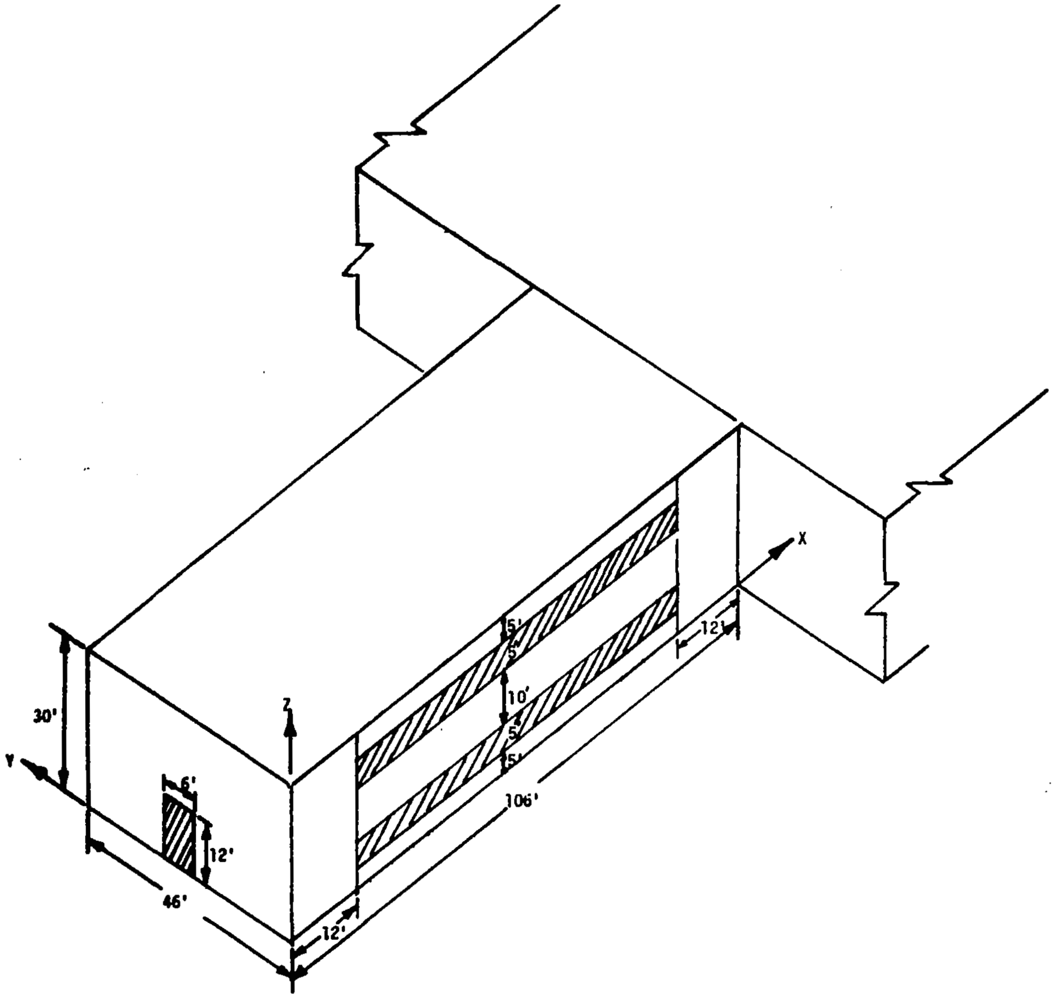


Figure 4.26 PLAN AND ELEVATION OF EXAMPLE BUILDING

TABLE 4.13

EXAMPLE BUILDING DESCRIPTION

NAME:	1244C Engineering Offices
TYPE:	2-Story, Slab-on-Grade, Office Building
LOCATION:	Hampton, Virginia
FLOOR AREA:	4300 sq. ft. Occupied
CEILING HT.:	10 ft.
LIGHTING:	Recessed Florescent Fixtures Office Area-3 Watts/sq. ft., 7am.-8pm. Weekdays, Otherwise 10% Mechanical Room-0.5 Watt/sq. ft., 7am.-8pm. Weekdays, Otherwise 10%
OCCUPANCY:	60 People, 8am.-5pm. Weekdays Only
EQUIPMENT:	Office Area-0.2 Watts/sq. ft., 7am.-8pm. Weekdays, Otherwise 10% Mechanical Room-0.5 Watts/sq. ft., 7am.-8pm. Weekdays, Otherwise 10% Mechanical Room-42,000 Btu/Hr., 7am.-8pm., Weekdays, Otherwise 10%
WINDOWS:	Single Pane, Clear Glass with Venitian Blinds
WALL TYPE 1:	Metal 2" Insulation 7½" Air Space 3/4" Gypsum Board and Plaster
WALL TYPE 2:	4" Face Brick 2" Air Space 6" Concrete Block 3/4" Plaster
ROOF:	Built-up Coating (Stone and Felt) Sheathing Board 1½" Insulation Metal Pan 5' Ceiling Air Space Acoustical Tile



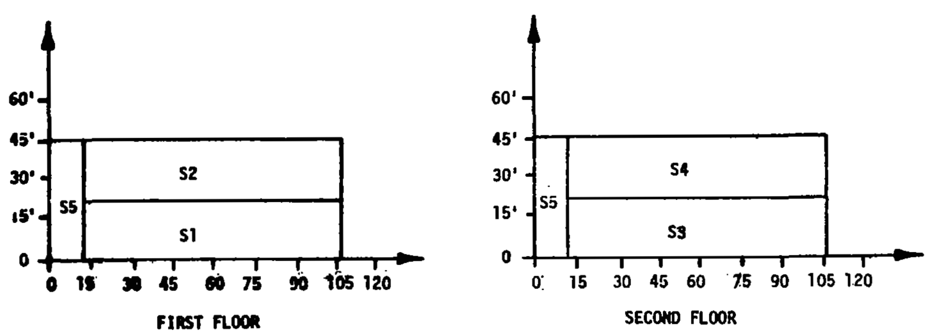
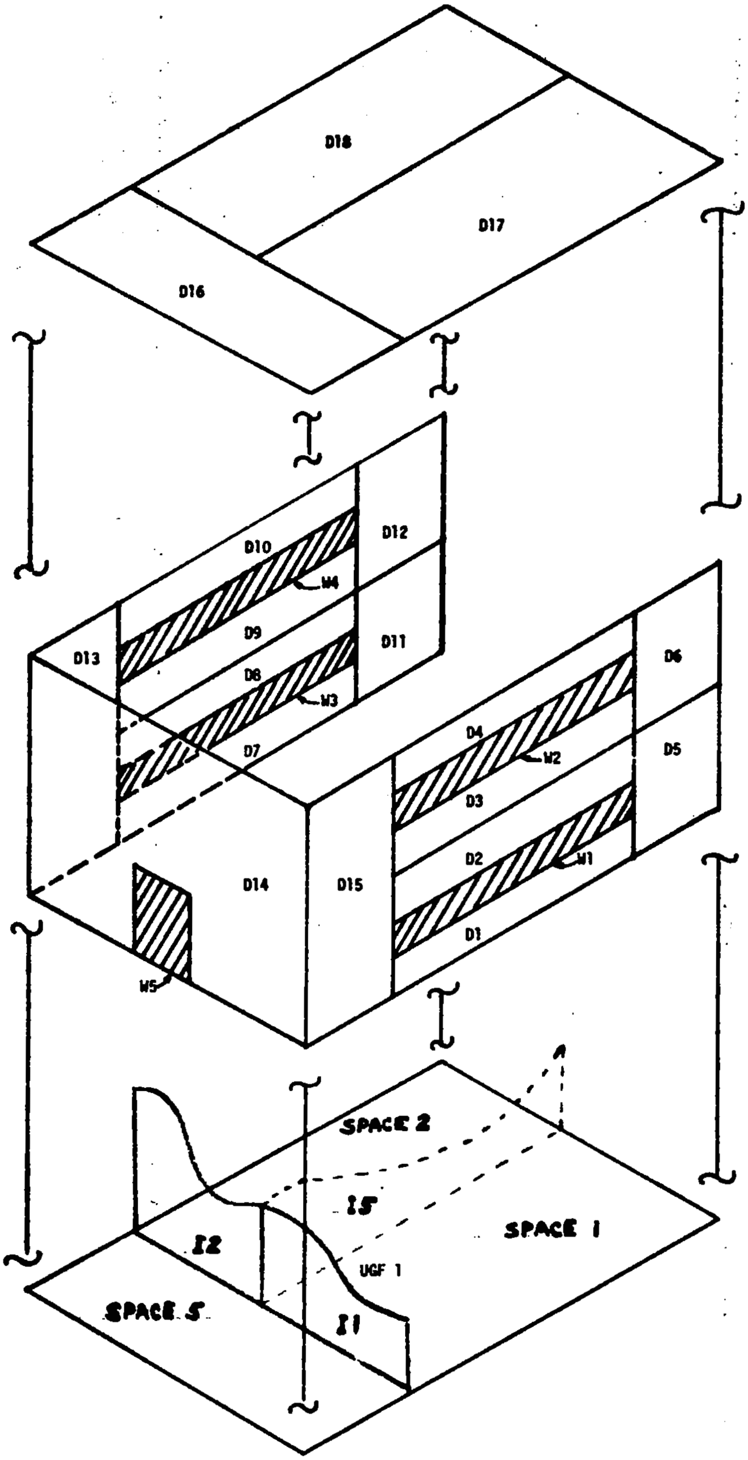


Figure 4.27 SCHEMATIC OF EXAMPLE BUILDING SHOWING COORDINATE SYSTEM, DIMENSIONS & SPACE NUMBERS



INTERNAL SURFACES

I1 - BETWEEN S1 & S5
I2 - " S2 & S5
I3 - " S3 & S5
I4 - " S4 & S5
I5 - " S1 & S2
I6 - " S3 & S4

Figure 4.28 IDENTIFICATION OF SURFACES INTO WHICH EXAMPLE BUILDING WAS BROKEN FOR ANALYSIS

```
1244C  ENGINEERING OFFICES                                                      L1
LANGLEY RESEARCH CENTER, HAMPTON,VA                                             L2
R.JENSEN                                                                        L3
RRUN-5Z                                                                         L4
MARCH 15,1975                                                                   L5
37.0      76.3      5.0       0.98      0.98      325.0                         L6
2.0       0.125     2.0       52.0      55.0      100.0     120.0               L6B
15.0                                                                            L6C ELEV   DESIGN
91.0      16.0      73.0      8.0                                               L6D SUMM   DATA
20.0      3.0       17.0      10.0                                              L6E WINT
 1959.0   1.0       365.0     0.0       45.0                                    L7
0.0                                                                             L8 PRINT
1.0                                                                             L9 SP.    # SPACE TYPES
   1.01.04.01.01.01.0   1.01.06.01.01.01.0   1.09.06.09.09.011.                 L12       SCHEDULES
0.00.00.00.00.00.00.20.20.20.00.00.30.00.00.00.00.21.00.20.20.00.00.00.0L13-SH11  NON-STAND. SCH.
1.0                                                                             L14.COMM
1.0       0.0                                                                   L15-1     COMMON
106.0     -60.0     0.0       30.0      320.0     90.0      90.0                L16-1     SHADE
3.0        2.0                                                                 LC17
9.0       8.0                                                                   L18  STAND. WALLS
  7          .4847955490                                                        L19
        1.9370661361          .0079575473          .3933973230                           RESPONCE
       -1.7518237458          .0482065012         -.1820271785                           FACTOR FOR
        -.0315995577          .0356126102         -.0443277658                           NON-STAND.
        -.0143854076          .0174901532         -.0212866134                           WALL
        -.0069705013          .0084808031         -.0103184648
        -.0033792506          .0041114661         -.0050023387
        -.0016382455          .0019932205         -.0024251115
18.0                                                                            L21 D.S.  # DELAYEDS
0.3       0.1                                                                   L22-1
1.0       8.0       2.0       0.0       0.0       6.0       1.0                 L23-1     D1
12.0      0.0       0.0       3.5       82.       180.0     90.0                L24-1
0.3       0.1                                                                   L22-2
1.0       8.0       2.0       0.0       0.0       6.0       1.0                 L23-2     D2
12.0      0.0       9.0       5.0       82.0      180.0     90.0                L24-2
0.3       0.1                                                                   L22-3
1.0       8.0       2.0       0.0       0.0       6.0       1.0                 L23-3     D3
12.0      0.0       14.0      3.5       82.       180.0     90.0                L24-3
```

FIGURE 4.29 - LOCAL PROGRAM CARD INPUT (EXAMPLE PAGE 1)

0.3	0.1						L22-4	D4 (FORM #1 INPUT)
1.0	8.0	2.0	0.0	0.0	6.0	1.0	L23-4	
12.0	0.0	23.0	5.0	82.0	180.0	90.0	L24-4	
0.7	0.1						L22-5	D5
1.0	2.0	2.0	0.0	0.0	2.0	2.0	L23-5	
94.	0.0	0.0	14.0	12.0	180.0	90.0	L24-5	
0.7	0.1						L22-6	D6
1.0	2.0	2.0	0.0	0.0	2.0	2.0	L23-6	
94.0	0.0	14.0	14.0	12.0	180.0	90.0	L24-6	
0.3	0.1						L22-7	D7
1.0	8.0	2.0	0.0	0.0	6.0	1.0	L23-7	
94.0	46.0	0.0	3.5	82.0	0.0	90.0	L24-7	
0.3	0.1						L22-8	D8
1.0	8.0	2.0	0.0	0.0	6.0	1.0	L23-8	
94.0	46.0	9.0	5.0	82.0	0.0	90.0	L24-8	
0.3	0.1	0.04					L22-9	D9
1.0	8.0	2.0	0.0	0.0	6.0	1.0	L23-9	
94.0	46.0	14.0	3.5	82.0	0.0	90.0	L24-9	EXAMPLE OF WALL INFILTRATION
0.3	0.1	0.04 ←					L22-10	D10
1.0	8.0	2.0	0.0	0.0	6.0	1.0	L23-10	
94.0	46.0	23.0	5.0	82.0	0.0	90.0	L24-10	
0.7	0.1						L22-11	D11
1.0	2.0	2.0	0.0	0.0	2.0	2.0	L23-11	
106.0	46.0	0.0	14.0	12.0	0.0	90.0	L24-11	
0.7	0.1						L22-12	D12
1.0	2.0	2.0	0.0	0.0	2.0	2.0	L23-12	
106.0	46.0	14.0	14.0	12.0	0.0	90.0	L24-12	
0.7	0.1						L22-13	D13
1.0	2.0	2.0	0.0	0.0	2.0	2.0	L23-13	
12.0	46.0	0.0	28.0	12.0	0.0	90.0	L24-13	
0.7	0.1						L22-14	D14
8.0	10.0	10.0	1.0	0.0	2.0	2.0	L23-14	EXAMPLE OF VERTICE INPUT
0.0	46.0	0.0					L24-14	
0.0	26.0	0.0					L24-14	
0.0	26.0	12.0					L24-14	
0.0	20.0	12.0	VERTICES				L24-14	
0.0	20.0	0.0					L24-14	
0.0	0.0	0.0					L24-14	
0.0	0.0	28.0					L24-14	
0.0	46.0	28.0					L24-14	

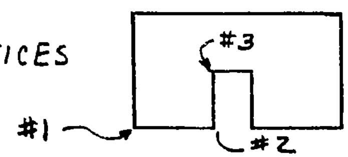


FIGURE 4.30 - LOCAL PROGRAM CARD INPUT (EXAMPLE PAGE 2)

0.7	0.1						L22-15	D15	
1.0	2.0	2.0	0.0	0.0	2.0	2.0	L23-15		
0.0	0.0	0.0	28.0	12.0	180.0	90.0	L24-15		
0.5	0.1						L22-16	D16	
1.0	1.0	1.0	1.0	0.0	1.0	3.0	L23-16		
0.0	46.0	28.0	12.0	46.0	270.0	0.0	L24-16		
0.5	0.1						L22-17	D17	← NOTE: LLH VERTICE IS BLANK OR 0.0 SINCE COMMON SHADE DOES NOT AFFECT.
1.0	1.0	1.0	1.0	0.0	1.0	3.0	L23-17		
			23.0	94.0	180.0	0.0	L24-17		
0.5	0.1						L22-18	D18	
1.0	1.0	1.0	1.0	0.0	1.0	3.0	L23-18		
106.0	46.0	28.0	23.0	94.0	0.0	0.0	L24-18		
0.0							L28 P.O.		
0.0							L30QUICK	# OF QUICK SURF.	
5.0							L39WINDO	# OF WINDOWS	
0.6	0.4	0.4	0.1				L40-1	W1	
1.0	82.0	5.0	0.0	3.0	1.0	1.0	L41-1		
12.0	0.5	3.5	5.5	82.0	180.0	90.0	L42-1		
1.0	0.0						L44-1A		
12.0	0.0	3.5	5.5	0.5	90.0	90.0	L45-1A		
1.0	0.0						L44-1B		
94.0	0.0	9.0	82.0	0.5	90.0	0.0	L45-1B	3 SHADE SURFACES	
1.0	0.0						L44-1C		
94.0	0.0	3.5	5.5	0.5	90.0	90.0	L45-1C		
0.6	0.4	0.4	0.1	6.0 ← SETBK	3.0 ← BOARDER		L40-2	W2	← 6" SETBACK DOES SAME AS ABOVE
1.0	10.0	4.0	0.0	0.0	1.0	1.0	L41-2		
12.0	0.5	17.5	5.5	82.0	180.0	90.0	L42-2		
0.6	0.4	0.4	0.1			1.2 ← INF.	L40-3	W3	
1.0	10.0	4.0	0.0	0.0	1.0	1.0	L41-3		
94.0	45.5	3.5	5.5	82.0	0.0	90.0	L42-3		
0.6	0.4	0.4	0.1				L40-4	W4	
1.0	10.0	4.0	0.0	0.0	1.0	1.0	L41-4		
94.0	45.5	17.5	5.5	82.0	0.0	90.0	L42-4		
0.6	0.4	0.4	0.1				L40-5	W5	
1.0	1.0	1.0	1.0	0.0	1.0	1.0	L41-5		
0.0	26.0	0.0	12.0	6.0	270.0	90.0	L42-5		

FIGURE 4.31 - LOCAL PROGRAM CARD INPUT (EXAMPLE PAGE 3)

3.0							L46 W.P.	# PICTURE OUTPUTS
8.0	8.0	1.0					L47-1	
8.0	10.0	1.0					L47-2	TIME
8.0	6.0	2.0					L47-3	
6.0							L48 INTR	
322.0	0.2	1.0	5.0				L49-1	
322.0	0.2	2.0	5.0				L49-2	
322.0	0.2	3.0	5.0				L49-3	
322.0	0.2	4.0	5.0				L49-4	
1300.0	0.8	1.0	2.0				L49-5	
1300.0	0.8	3.0	4.0	"U" FACTOR FOR IMAGINARY WALL ???			L49-6	
0.0							L50 U.F.	# OF U.G. WALLS
1.0							L52FLOOR	# OF U.G. FLOORS
2160.	0.1						L53	
41.	44.	48.	62.	72.	77.	79.		GROUND TEMP.
80.	74.	66.	54.	43.				

5.0							L55SPACE	# OF SPACES
3.0	0.0	1.0	2.0	0.0	1.0	0.0	L56-1	
2160.0	21600.	80.0	75.0	15.0	550.0		L57-1	
1.0	1.0	1.0	1.0	0.05			L58-1	
3.0			TYPE INFILTRATION				L59-1	LIGHTS
0.2							L60-1	EQUIP.
1.0	2.0	5.0					L61-1	DELAYS
1.0							L63-1	WINDOWS
1.0	5.0						L64-1	INT. SURF.
1.0							L66-1	FLOOR

FIGURE 4-32 - LOCAL PROGRAM CARD INPUT (EXAMPLE PAGE 4)

3.0	0.0	1.0	2.0	0.0	1.0	0.0	L56-2	
2160.	21600.	80.0	75.0	15.0	550.0		L57-2	
1.0	1.0	1.0	1.0	0.05			L58-2	
3.0							L59-2	SPACE 2
0.2							L60-2	
7.0	8.0	11.0					L61-2	
3.0							L63-2	
2.0	5.0						L64-2	
1.0							L66-2	
4.0	0.0	1.0	2.0	0.0	0.0		L56-3	
2160.0	21600.	80.0	75.0	15.0	550.0		L57-3	
1.0	1.0	1.0	1.0	0.05			L58-3	
3.0							L59-3	SPACE 3
0.2							L60-3	
3.0	4.0	6.0	17.0				L61-3	
2.0							L63-3	
3.0	6.0						L64-3	
4.0	0.0	1.0	2.0	0.0	0.0		L56-4	
2160.0	21600.0	80.0	75.0	15.0	550.0		L57-4	
1.0	1.0	1.0	2.0		-4.0	20.0	L58-4	
3.0				CRACK METHOD INFILTRATION			L59-4	SPACE 4
0.2							L60-4	
9.0	10.0	12.0	18.0				L61-4	
4.0							L63-4	
4.0	6.0						L64-4	
4.0	0.0	1.0	4.0	0.0	0.0		L56-5	
552.0	14000.0	80.0	75.0	0.0	0.0		L57-5	
1.0	1.0	1.0	1.0	0.9			L58-5	
0.5							L59-5	
0.5	0.0	12000.0	0.0				L60-5	SPACE 5 E/R & ENT.
15.0	13.0	14.0	16.0				L61-5	
5.0							L63-5	
1.0	2.0	3.0	4.0				L64-5	

FIGURE 4.33 - LOCAL PROGRAM CARD INPUT (EXAMPLE PAGE 5)

SECTION 5
VARIABLE TEMPERATURE PROGRAM

5.1 OBJECTIVE AND DESCRIPTION

The space loads calculated by the Thermal Load Analysis Program described in Section 4 are determined on the basis of the following two assumptions:

1. space heating and/or cooling is available any time it is required.

2. space temperature is always maintained at its specified setpoint.

In reality, however, the space temperature is not maintained at a constant, but rather varies from its setpoint from time to time due to:

1. throttling range and deadband of thermostat

2. undersized space heating and/or cooling capacity

3. shutdown of equipment during specified periods.

If the user wishes to investigate the effects of the above items on building performance and energy usage, he can do so with the use of the Variable Temperature Program.

Utilizing such information as the type of thermostat, operating characteristics of thermostat, heating and cooling capacity available to each space, and seasonal start-up/shutdown dates for the heating and cooling plant, the Variable Temperature Program corrects the basic loads calculated by the Thermal Load Analysis Program for these effects and generates a new output tape containing corrected hourly space loads.

5.2 INPUT DATA

The Variable Temperature Program requires two forms of input:

1. the output tape generated by the Thermal Load Analysis Program and containing hourly weather and basic space loads

2. the card input data described in Table 5.1.

In attempting to simulate the effect of varying space temperature, all surfaces and objects having mass, and therefore thermal inertia, have their influence on the room's response to that effect. For this reason, the Variable Temperature Program requires the user to define some additional information that may not have been required by the

Table 5.1

VARIABLE TEMPERATURE PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
VT-1	1 to 10	Print Option 1 - Echo of Building Description Data	BUG1	-	0 or 1	0 - Do not print 1 - Print	1.	Source of data is input tape.
	11 to 20	Print Option 2 - Echo of Equipment Scheduling & Floor, Ceiling & Furnishing Data	BUG2	-	0 or 1	0 - Do not print 1 - Print	0.	Summary of Inputs VT-3 through VT-15.
	21 to 30	Print Option 3 - Echo of Space Input Data	BUG3	-	0 or 1	0 - Do not print 1 - Print	0.	Summary of Inputs VT-16 through VT-19.
	31 to 40	Print Option 4 - Echo of Thermostat Schedules	BUG5	-	0 or 1	0 - Do not print 1 - Print	1.	Summary of Input VT-20 through VT-22.
	41 to 50	Print Option 5 - Summary of Internal H.T.S. Calculations	BUG6	-	0 or 1	0 - Do not print 1 - Print	0.	
	51 to 60	Print Option 6 - Summary of Space Response Factors	BUG8	-	0 or 1	0 - Do not print 1 - Print	1.	Calculated internally by program.
VT-2	1 to 70	Output Page Label	NAME	-	-	-	Bldg.1202	Printed at top of output pages.
VT-3	1 to 10	Number of Hourly Printout Periods Desired	PO	-	0 to 12	-	2.	If equal to 0.0, skip input VT-4.
	11 to 20	Do you Desire to Schedule Operation of Chiller & Boiler	BC	-	0 or 1	0 No 1 Yes	1.	If equal to 0.0, equipment operates year-round; skip inputs VT-5 and VT-6.
	READING ORDER VT-4 SHOULD BE REPEATED "PO" TIMES.							
VT-4	1 to 2	Printout Start Date - Month	MONS	-	01 to 12	-	08	Use whole numbers with no decimal point and right-justified in each field. A "/" can be used in columns 3, 6, 12 and 15. If start and end dates are same, one day of printout will be received.
	4 to 5	" - Day	IDAYS	-	01 to 31	-	01	
	7 to 8	" - Year	IYRS	-	00 to 99	-	73	
	10 to 11	Printout End Date - Month	MONE	-	01 to 12	-	08	
	13 to 14	" - Day	IDAYE	-	01 to 31	-	15	
	16 to 17	" - Year	IYRE	-	00 to 99	-	73	

Table 5.1

VARIABLE TEMPERATURE PROGRAM CARD INPUT INFORMATION

(CONTINUED)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
	READING ORDER VT-5 AND VT-6 ARE REQUIRED ONLY IF "BC" EQUALS 1.							
VT-5	1 to 2	Boiler Turnoff Date - Month	MONS	-	01 to 12	-	04	Use whole numbers with no decimal point and right-justified in each field. A "/" can be used in columns 3, 6, 12 and 15.
	4 to 5	" - Day	IDAYS	-	01 to 31	-	01	
	7 to 8	" - Year	IYRS	-	00 to 99	-	73	
	10 to 11	Boiler Turnon Date - Month	MONE	-	01 to 12	-	10	Turnon date should fall after turnoff date.
	13 to 14	" - Day	IDAYE	-	01 to 31	-	01	
	16 to 17	" - Year	IYRE	-	00 to 99	-	73	
VT-6	1 to 2	Chiller Turnon Date - Month	MONS	-	01 to 12	-	04	Use whole numbers with no decimal point and right-justified in each field. A "/" can be used in columns 3, 6, 12 and 15.
	4 to 5	" - Day	IDAYS	-	01 to 31	-	01	
	7 to 8	" - Year	IYRS	-	00 to 99	-	73	
	10 to 11	Chiller Turnoff Date - Month	MONE	-	01 to 12	-	10	Turnoff date should fall after turnon date.
	13 to 14	" - Day	IDAYE	-	01 to 31	-	01	
	16 to 17	" - Year	IYRE	-	00 to 99	-	73	
VT-7	1 to 10	Number of types of delayed floors in building	DF	-	1 to 10	-	1.	If equal to 0, program uses default values; skip VT-8 & 9, go to VT-10.
VT-8	1 to 3	Number of response factor terms	IRFL	-	-	-	18	To generate these data, use the Response Factor Program. See Section 2 for instructions.
	4 to 23	Common ratio	CRFL	-	-	-	0.79701	
VT-9	1 to 20	X-Response Factor	FLRX	Btu/Hr-ft^2-°F	-	-	5.19960	
	21 to 40	Y-Response Factor	FLRY	"	-	-	0.00022	
	41 to 60	Z-Response Factor	FLRZ	"	-	-	0.29215	

Table 5.1

VARIABLE TEMPERATURE PROGRAM CARD INPUT INFORMATION (CONTINUED)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
VT-10	1 to 10	Number of types of delayed ceilings in building	DC	-	-	-	1.	If equal to 0, program uses default values; skip VT-11 & 12; go to VT-13.
VT-11	1 to 3	Number of response factor terms	IRC	-	-	-	18	To generate these data, use the Response Factor Program. See Section 2 for instructions.
	4 to 23	Common ratio	CRC	-	-	-	0.79701	
VT-12	1 to 20	X-Response Factor	CRX	Btu/Hr-ft^2-^{o}F	-	-	5.19960	
	21 to 40	Y-Response Factor	CRY	"	-	-	0.00022	
	41 to 60	Z-Response Factor	CRZ	"	-	-	0.29215	
VT-13	1 to 10	Number of types of delayed furnishings in building	DFU	-	-	-	1.	If equal to 0, program uses value, enter in VT-16; skip VT-14 & 15; go to VT-16.
VT-14	1 to 3	Number of response factor terms	IRFU	-	-	-	18	To generate these data, use the Response Factor Program. See Section 2 for instructions.
	4 to 23	Common ratio	CRFU	-	-	-	0.79701	
VT-15	1 to 20	X-Response Factor	FURX	Btu/Hr-ft^2-^{o}F	-	-	5.19960	
	21 to 40	Y-Response Factor	FURY	"	-	-	0.00022	
	41 to 60	Z-Response Factor	FURZ	"	-		0.29215	
	READING ORDER VT-16 THROUGH VT-19 SHOULD BE REPEATED ONCE FOR EACH SPACE IN BUILDING.							
VT-16	1 to 10	Number of delayed floors in space	F	-	0 to 10	-	0.	
	11 to 20	Number of delayed ceilings in space	C	-	0 to 10	-	0.	
	21 to 30	Number of delayed furnishings in space	FUR	-	0 or 1	0 Let program generate 1 User input	1.	
	31 to 40	Weight of furnishings	WOFN	lb/ft^2	0 to -	—	5.	Must be defined if DFU equals 0.

Table 5.1

VARIABLE TEMPERATURE PROGRAM CARD INPUT INFORMATION

(CONTINUED)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
READING ORDER VT-17 SHOULD BE REPEATED "F" TIMES. IF "F" EQUALS 0, SKIP VT-17 AND GO TO VT-18.								
VT-17	1 to 10	Index of delayed floor	FD	-	0 to DF	-	1.	
	11 to 20	Area of delayed floor	AFLOR	ft^2	-	-	500.	
READING ORDER VT-18 SHOULD BE REPEATED "C" TIMES. IF "C" EQUALS 0, SKIP VT-18 AND GO TO VT-19.								
VT-18	1 to 10	Index of delayed ceiling	CD	-	0 to DC	-	1.	
	11 to 20	Area of delayed ceiling	ACEIL	ft^2	-	-	500.	
READING ORDER VT-19 SHOULD BE REPEATED "FUR" TIMES. IF "FUR" EQUALS 0, SKIP VT-19 AND GO TO VT-20.								
VT-19	1 to 10	Index of furnishings	FND	-	0 to DFU	-	1.	
	11 to 20	Area of furnishings	AFN	ft^2	-	-	100.	
VT-20	1 to 10	Number of different types of thermostat schedules	DTS	-	1 to 5	-	1.	
A SET (24 IN ALL) OF READING ORDER VT-21 MUST BE REPEATED "DTS" TIMES.								
VT-21	1 to 10	Thermostat type	VTSD	-	0, 1 or 2	0 Float 1 Linear 2 HI-LOW limit	1.	Card VT-21 should be repeated 24 times. First 12 describe thermostat action for 24 hours of a weekday (2 hours to each card). Second 12 describe thermostat action for 24 hours of weekend or holiday (2 hours to each card). See Table 5.1 for description of thermostats.
	11 to 20	High limit of throttling range	VTSD1	^oF	-	-	77.	
	21 to 30	Low limit of throttling range	VTSD2	^oF	-	-	73.	
	31 to 40	Thermostat type	VTSD	^oF	0, 1 or 2	0 Float 1 Linear 2 HI-LOW limit	2.	
	41 to 50	High limit of throttling range	VTSD1	^oF	-	-	85.	
	51 to 60	Low limit of throttling range	VTSD2	^oF	-	-	65.	

Table 5.1

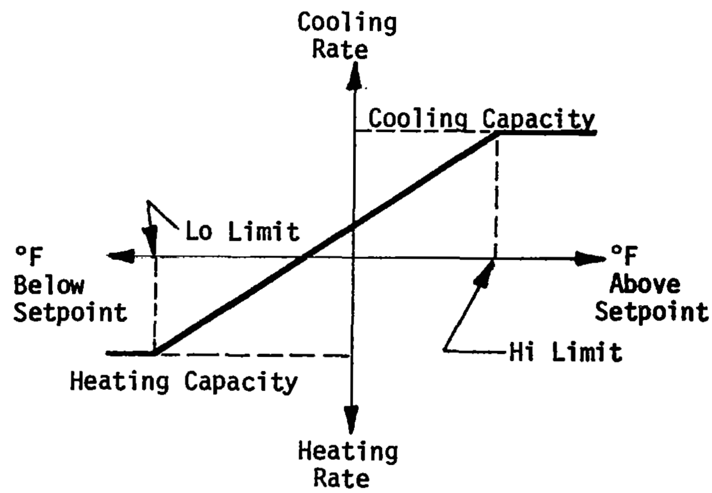
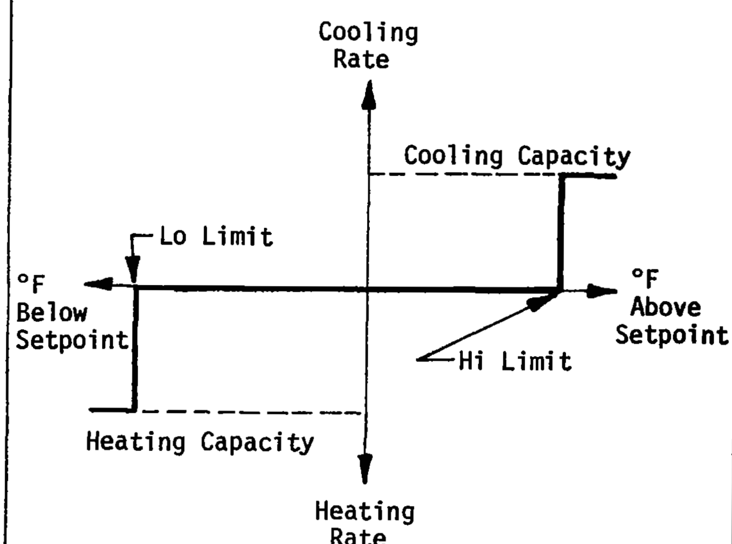
VARIABLE TEMPERATURE PROGRAM CARD INPUT INFORMATION

(CONTINUED)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
	READING ORDER VT-22 SHOULD BE REPEATED ONCE FOR EACH SPACE IN BUILDING.							
VT-22	1 to 10	Thermostat schedule type	STT	-	0 to DTS	-	1.	If describing a conditioned space, fill in columns 1 through 30 only.
	11 to 20	Maximum heat addition rate- heating capacity	HCAP	Btu/Hr	-	Must be negative	-60000.	
	21 to 30	Maximum heat extraction rate-cooling capacity	CCAP	Btu/Hr	-	Must be positive	100000.	
	31 to 35	Is space a return air plenum?	PLS	-	0, 1	0 No 1 Yes	0.	If describing a plenum space, fill in columns 31 through 65 only.
	36 to 40	Space number below plenum	VS	-	1 to NS	-	0.	
	41 to 45	Amount of air returned through plenum	CFM	CFM	-	-	0.	
	46 to 50	Hour of weekday fan is turned on	VON	-	0 to 24	-	0.	
	51 to 55	Hour of weekday fan is turned off	VOFF	-	0 to 24	-	0.	
	56 to 60	Hour of weekend day fan is turned on	VON	-	0 to 24	-	0.	
	61 to 65	Hour of weekend day fan is turned off	VOFF	-	0 to 24	-	0.	

Table 5.2

TYPES OF THERMOSTATS

TYPE	DESCRIPTION	ACTION
1	LINEAR OR PROPORTIONAL CONTROL	
2	HI-LOW OR ON-OFF CONTROL	

Thermal Load Analysis Program, i.e., the types of floors, ceilings and furnishings that are part of each space. If, however, the user desires not to go into this kind of detail, an alternative approach can be used, i.e., make use of typical default values built into the program. The default values set by the program are determined as follows:

1. For floors, the default parameters are a function of the weight of floor (lbs per sq. ft.) which are specified in Table 4.3, Reading Order LC-57, and passed along to the Variable Temperature Program via the input tape.

2. For ceilings, the default parameters are a function of the weight of ceiling (lbs per sq. ft.), which is assumed to be one-half of the weight of floor.

3. For furnishings, the default parameters are a function of the weight of furnishings (lbs per sq. ft.), called for in Table 5.1, Reading Order VT-16.

The more detailed solution requires that the make-up of the floors, ceilings and furnishings be known and use be made of the Response Factor Program (Section 2) to generate the response factors corresponding to each.

5.3 OUTPUT REPORTS

Results of the variable temperature analysis are summarized in a one-page report (Report V1) entitled "Summary of Variable Temperature Load Calculations". At the user's option, additional reports can be called for which echo input data and detail results for various phases of the analysis. The optional reports include:

1. Report V2 - Hourly Summary of Results

2. Report V3 - Echo of Building Description Data Read From Tape

3. Report V4 - Echo of Floor, Ceiling and Furnishing Input Data

4. Report V5 - Echo of Space Description Input Data

5. Report V6 - Echo of Thermostat Scheduling Input Data

6. Report V7 - Summary of Internal Surface Data and Calculation

7. Report V8 - Summary of Calculated Space Response Factors

5.3.1 Report V1 - Summary of Variable Temperature Load Calculations

Report V1 (Figure 5.1) enumerates for each building space the extreme loads and temperatures that occurred for the period of analysis. In particular, the data listed thereon includes:

1. Space number.

2. Maximum Heat Addition - will be either equal to or less than the quantity specified in Reading Order VT-22.

3. Hour/Day/Month - time that maximum heat addition occurred.

4. Maximum Heat Extracted - will be either equal to or less than the quantity specified in Reading Order VT-22.

5. Hour/Day/Month - time that maximum heat extraction occurred.

6. Lowest Space Temperature - lowest temperature that occurred in space during period of analysis.

7. Hour/Day/Month - time that lowest space temperature occurred.

8. Highest Space Temperature - highest temperature that occurred in space during period of analysis.

9. Hour/Day/Month - time that highest space temperature occurred.

To give the user an indication of the building's annual requirement for heating and cooling, two additional items are listed at the bottom of the report:

10. Total Building Heating - a summation over the year of the hourly space heat addition requirements.

11. Total Building Cooling - a summation over the year of the hourly heat extraction requirements.

NOTE: The total building heating and cooling requirements mentioned above exclude ventilation air loads.

5.3.2 Report V2 - Hourly Summary of Results

For each day called for by input VT-4, a report similar to that shown in Figure 5.2 will be printed summarizing hourly weather parameters and end-of-hour space conditions. Specific items listed are:

1. Weather

   a) Hour of day

b) DBT - ambient dry-bulb temperature, ^{o}F
c) WBT - ambient wet-bulb temperature, ^{o}F
d) SUN - 1 indicates sundown;
   0 - 2 indicates sunup
e) HOA - enthalpy of ambient air, Btu/lb
f) PATM - barometric pressure, inches of mercury
g) VEL - wind speed, mph
h) CC - cloud cover, ranges from 0.0 to 1.0

2. Space Parameters

a) Space Number
b) Space Temperature - resulting end-of-hour condition, ^{o}F
c) High Temperature - number of degrees above setpoint temperature to upper limit of thermostat throttling range, ^{o}F
d) Low Temperature - number of degrees below setpoint temperature to lower limit of thermostat throttling range, ^{o}F
e) Temperature Correction - space temperature minus setpoint temperature, ^{o}F
f) Heating Capacity - defined in Reading Order VT-22, Btu/hr
g) Cooling Capacity - defined in Reading Order VT-22, Btu/hr
h) System Load - heating (-) or cooling (+) supplied by HVAC system, Btu/hr
i) Constant Temperature System Load - heating (-) or cooling (+) requirement established by Thermal Load Analysis Program, Btu/hr
j) Thermostat Type - defined in Reading Order VT-21
k) Schedule Type - defined in Reading Order VT-22.

The user can request Report L2 for as many as 12 time periods, with each time period being one day or many days in length.

5.3.3 Report V3 - Echo of Building Description Data

Certain building description data is passed to the Variable Temperature Program via the input tape. If the user desires, a hard copy listing of that data can be obtained from the program by indicating such in Reading Order VT-1. The report produced may run several pages in length and is similar to that shown in Figure 5.3.

5.3.4 Report V4 - Echo of Printout and Equipment Scheduling and Floor, Ceiling and Furnishing Input Data

Report V4 (Figure 5.4) can be asked for via Reading Order VT-1 also; it summarizes the dates for which Report V2 is desired, the seasonal startup and shutdown dates for chiller and boiler (by date and hour of year, and input data supplied in Reading Order VT-7 through VT-15 for floors, ceilings and furnishings.

SUMMARY OF VARIBLE TEMPERATURE LOAD CALULATIONS

LRC SYSTEMS ENGINEERING BUILDING

SPACE NO.	*******HEATING******** MAX. HEAT ADDITION (BTU/HR)	HOUR/DAY/MO	********COOLING******** MAX. HEAT EXTRACTED (BTU/HR)	HOUR/DAT/MO	***LOWEST SPACE TEMP.*** TEMP. (F)	HOUR/DAY/MO	***HIGHEST SPACE TEMP.*** TEMP. (F)	HOUR/DAY/MO
1	-422349.	7/ 4/ 1	781727.	16/ 2/ 7	65.0	22/ 7/ 1	79.8	20/ 2/ 7
2	-84546.	7/ 4/ 1	37410.	7/ 2/ 6	52.9	7/ 5/ 1	82.5	17/ 7/ 7
3	-68535.	7/ 4/ 1	28594.	7/ 2/ 6	53.6	7/ 5/ 1	80.9	18/ 7/ 7
4	-80411.	7/ 4/ 1	35203.	7/ 2/ 6	52.9	7/ 5/ 1	83.1	18/ 1/ 6
5	-67267.	7/ 4/ 1	30003.	7/ 2/ 6	55.4	7/ 5/ 1	81.4	18/ 7/ 7
6	0.	1/ 3/ 1	0.	1/ 3/ 1	85.0	1/ 3/ 1	85.0	1/ 3/ 1

TOTAL BUILDING HEAT EXTRACTIONS AND ADDITIONS
HEATING= -808810723.
COOLING= 1041576949.

Figure 5.1 REPORT VI (Typical)

DATE= 1/15	SPACE NO.	SPACE TEMP.	HIGH TEMP.	LOW TEMP.	TEMP. CORR.	HEATING CAPACITY	COOLING CAPACITY	SYSTEM LOAD	CONSTANT TEMP. SYSTEM LOAD	THERMOSTAT TYPE	SCHEDULE TYPE
HOUR OF DAY= 1	DBT= -9		WBT= -9		SUN= 1	HOA= -1.9	PATM= 29.72		VEL= 11.0	CC= 0.724	
	1	69.1	10.0	-10.0	-5.91	422349.	895829.	0.	-421184.	2	1
	2	63.5	10.0	-10.0	-11.52	84546.	37410.	-84546.	-118811.	2	1
	3	63.0	10.0	-10.0	-11.97	68535.	28594.	-68535.	-95900.	2	1
	4	62.7	10.0	-10.0	-12.27	80411.	35203.	-80411.	-112715.	2	1
	5	64.2	10.0	-10.0	-10.83	67267.	30003.	-67267.	-93706.	2	1
	6	85.0	0.0	-20.0	0.0	0.	0.	0.	0.	2	1
HOUR OF DAY= 2	DBT= -8		WBT= -9		SUN= 1	HOA= -1.7	PATM= 29.73		VEL= 10.0	CC= 0.724	
	1	68.4	10.0	-10.0	-6.59	422349.	895829.	0.	-439885.	2	1
	2	63.2	10.0	-10.0	-11.77	84546.	37410.	-84546.	-118321.	2	1
	3	62.8	10.0	-10.0	-12.17	68535.	28594.	-68535.	-95516.	2	1
	4	62.5	10.0	-10.0	-12.47	80411.	35203.	-80411.	-112242.	2	1
	5	64.0	10.0	-10.0	-11.05	67267.	30003.	-67267.	-93588.	2	1
	6	85.0	0.0	-20.0	0.0	0.	0.	0.	0.	2	1
HOUR OF DAY= 3	DBT= -9		WBT=-10		SUN= 1	HOA= -1.9	PATM= 29.76		VEL= 10.0	CC= 0.724	
	1	67.8	10.0	-10.0	-7.23	422349.	895829.	0.	-453325.	2	1
	2	63.0	10.0	-10.0	-12.04	84546.	37410.	-84546.	-119437.	2	1
	3	62.6	10.0	-10.0	-12.38	68535.	28594.	-68535.	-96369.	2	1
	4	62.3	10.0	-10.0	-12.69	80411.	35203.	-80411.	-113246.	2	1
	5	63.7	10.0	-10.0	-11.29	67267.	30003.	-67267.	-94665.	2	1
	6	85.0	0.0	-20.0	0.0	0.	0.	0.	0.	2	1
HOUR OF DAY= 4	DBT=-10		WBT=-10		SUN= 1	HOA= -2.1	PATM= 29.78		VEL= 9.0	CC= 0.724	
	1	67.2	10.0	-10.0	-7.82	422349.	895829.	0.	-464116.	2	1
	2	62.7	10.0	-10.0	-12.28	84546.	37410.	-84546.	-119629.	2	1
	3	62.4	10.0	-10.0	-12.57	68535.	28594.	-68535.	-96522.	2	1
	4	62.1	10.0	-10.0	-12.88	80411.	35203.	-80411.	-113416.	2	1
	5	63.5	10.0	-10.0	-11.51	67267.	30003.	-67267.	-95010.	2	1
	6	85.0	0.0	-20.0	0.0	0.	0.	0.	0.	2	1
HOUR OF DAY= 5	DBT=-11		WBT=-11		SUN= 1	HOA= -2.4	PATM= 29.78		VEL= 7.0	CC= 0.724	
	1	66.6	10.0	-10.0	-8.38	422349.	895829.	0.	-473562.	2	1
	2	62.6	10.0	-10.0	-12.40	84546.	37410.	-84546.	-118135.	2	1
	3	62.3	10.0	-10.0	-12.65	68535.	28594.	-68535.	-95387.	2	1
	4	62.0	10.0	-10.0	-12.97	80411.	35203.	-80411.	-112052.	2	1
	5	63.4	10.0	-10.0	-11.63	67267.	30003.	-67267.	-94041.	2	1
	6	85.0	0.0	-20.0	0.0	0.	0.	0.	0.	2	1
HOUR OF DAY= 6	DBT=-11		WBT=-11		SUN= 1	HOA= -2.4	PATM= 29.78		VEL= 6.0	CC= 0.724	
	1	66.1	10.0	-10.0	-8.90	422349.	895829.	0.	-481983.	2	1
	2	62.6	10.0	-10.0	-12.44	84546.	37410.	-84546.	-116604.	2	1
	3	62.3	10.0	-10.0	-12.68	68535.	28594.	-68535.	-94229.	2	1
	4	62.0	10.0	-10.0	-12.98	80411.	35203.	-80411.	-110661.	2	1
	5	63.3	10.0	-10.0	-11.70	67267.	30003.	-67267.	-93028.	2	1
	6	85.0	0.0	-20.0	0.0	0.	0.	0.	0.	2	1
HOUR OF DAY= 7	DBT=-11		WBT=-11		SUN= 1	HOA= -2.4	PATM= 29.79		VEL= 5.0	CC= 0.724	
	1	69.1	2.0	-2.0	-5.91	422349.	895829.	-422349.	-236032.	1	1
	2	62.7	2.0	-2.0	-12.27	84546.	37410.	-84546.	-112185.	1	1
	3	62.5	2.0	-2.0	-12.49	68535.	28594.	-68535.	-90280.	1	1
	4	62.2	2.0	-2.0	-12.81	80411.	35203.	-80411.	-106420.	1	1
	5	63.4	2.0	-2.0	-11.56	67267.	30003.	-67267.	-89206.	1	1
	6	85.0	-8.0	-12.0	0.0	0.	0.	0.	0.	1	1

Figure 5.2 REPORT V2 (Typical)

```
***IBU61=1***

     IDEN1=      LRC SYSTEMS ENGINEERING
     IDEN2=         HAMPTON, VIRGINIA
     IDEN3=R.JENSEN
     IDEN4=SZ, 4W, 3IN
     IDEN5=NOV 26, 1973


NRF=  2


RESPONCE FACTOR INDEX=  1   NRFT= 30     RATIO=0.870676
             5.223269       0.000000      5.223269
            -3.110390       0.000074     -3.110390
            -0.582690       0.001356     -0.582690
            -0.326882       0.004783     -0.326882
            -0.216421       0.008151     -0.216421
            -0.154776       0.010043     -0.154776
            -0.116290       0.010613     -0.116290
            -0.090706       0.010364     -0.090706
            -0.072871       0.009685     -0.072871
            -0.059897       0.008819     -0.059897
            -0.050082       0.007905     -0.050082
            -0.042399       0.007014     -0.042399
            -0.036213       0.006184     -0.036213
            -0.031119       0.005429     -0.031119
            -0.026856       0.004753     -0.026856
            -0.023243       0.004154     -0.023243
            -0.020156       0.003625     -0.020156
            -0.017502       0.003162     -0.017502
            -0.015211       0.002756     -0.015211
            -0.013228       0.002401     -0.013228
            -0.011508       0.002092     -0.011508
            -0.010014       0.001822     -0.010014
            -0.008716       0.001587     -0.008716
            -0.007587       0.001382     -0.007587
            -0.006604       0.001203     -0.006604
            -0.005750       0.001048     -0.005750
            -0.005006       0.000912     -0.005006
            -0.004358       0.000794     -0.004358
            -0.003794       0.000691     -0.003794
            -0.003304       0.000602     -0.003304

RESPONCE FACTOR INDEX=  2   NRFT=  8     RATIO=0.393645
             0.292150       0.006481      0.292150
            -0.161527       0.037336     -0.161527
            -0.028397       0.024278     -0.028397
            -0.010872       0.009824     -0.010872
            -0.004274       0.003872     -0.004274
            -0.001682       0.001524     -0.001682
            -0.000662       0.000600     -0.000662
            -0.000261       0.000236     -0.000261


NDB= 17
     SURFACE INDEX=  1    RESPONCE FACTOR TYPE=  1    AREA AD=  1680.00
     SURFACE INDEX=  2    RESPONCE FACTOR TYPE=  1    AREA AD=    22.00
     SURFACE INDEX=  3    RESPONCE FACTOR TYPE=  1    AREA AD=    88.00
     SURFACE INDEX=  4    RESPONCE FACTOR TYPE=  1    AREA AD=  1470.00
     SURFACE INDEX=  5    RESPONCE FACTOR TYPE=  1    AREA AD=    22.00
     SURFACE INDEX=  6    RESPONCE FACTOR TYPE=  1    AREA AD=    88.00
```

Figure 5.3 REPORT V3 (Typical)

```
***IBUG2=1***

PRINTOUT OPTION= 2     BOILER-CHILLER START-STOP OPTION=1

     PRINT START DATE= 1/15/66     PRINT STOP DATE= 1/15/66
     PRINT START DATE= 8/15/66     PRINT STOP DATE= 8/15/66
     BOILER SPRING OFF DATE= 4/ 1/66      BOILER FALL ON DATE  = 9/ 1/66
     CHILLER SPRING ON DATE= 4/ 1/66      CHILLER FALL OFF DATE= 9/ 1/66


     ******************************************************************************
     SYSTEM SIMULATION INPUT DATA.
           5833  BON    - HOUR OF SEASONAL BOILER START-UP.
           2161  BOFF   - HOUR OF SEASONAL BOILER SHUT-DOWN.
           2161  CON    - HOUR OF SEASONAL CHILLER START-UP.
           5833  COFF   - HOUR OF SEASONAL CHILLER SHUT-DOWN.
     ******************************************************************************


     NO. OF DELAYED FLOOR TYPES NDF=  0


     NO. OF DELAYED CEILING TYPES NDC=  0


     NO. OF DELAYED FURNISHING TYPES NDFU=  0
```

Figure 5.4 REPORT V4 (Typical)

```
***IBUG3=1***     NO. OF SPACES NS=  6

    SPACE INDEX=  1     NO. OF DELAYED FLOORS NF=  0     NO. DELAYED CEILINGS NC=  0     NO. OF FURNISHINGS NFUR=  0
                                                                                         WEIGHT OF FURNISHINGS=  1.0

    SPACE INDEX=  2     NO. OF DELAYED FLOORS NF=  0     NO. DELAYED CEILINGS NC=  0     NO. OF FURNISHINGS NFUR=  0
                                                                                         WEIGHT OF FURNISHINGS=  1.0

    SPACE INDEX=  3     NO. OF DELAYED FLOORS NF=  0     NO. DELAYED CEILINGS NC=  0     NO. OF FURNISHINGS NFUR=  0
                                                                                         WEIGHT OF FURNISHINGS=  1.0

    SPACE INDEX=  4     NO. OF DELAYED FLOORS NF=  0     NO. DELAYED CEILINGS NC=  0     NO. OF FURNISHINGS NFUR=  0
                                                                                         WEIGHT OF FURNISHINGS=  1.0

    SPACE INDEX=  5     NO. OF DELAYED FLOORS NF=  0     NO. DELAYED CEILINGS NC=  0     NO. OF FURNISHINGS NFUR=  0
                                                                                         WEIGHT OF FURNISHINGS=  1.0

    SPACE INDEX=  6     NO. OF DELAYED FLOORS NF=  0     NO. DELAYED CEILINGS NC=  0     NO. OF FURNISHINGS NFUR=  0
                                                                                         WEIGHT OF FURNISHINGS=  0.0
```

Figure 5.5 REPORT V5 (Typical)

IBUG5=1 NO. OF DIFFERENT SCHEDULES= 1

SCHU. TYPE	DAY TYPE	HOUR OF DAY	THERM TYPE	HI LIMIT	LOW LIMIT	SET POINT
1	WEEKDAY					
		1	2	85.0	65.0	75.0
		2	2	85.0	65.0	75.0
		3	2	85.0	65.0	75.0
		4	2	85.0	65.0	75.0
		5	2	85.0	65.0	75.0
		6	2	85.0	65.0	75.0
		7	1	77.0	73.0	75.0
		8	1	77.0	73.0	75.0
		9	1	77.0	73.0	75.0
		10	1	77.0	73.0	75.0
		11	1	77.0	73.0	75.0
		12	1	77.0	73.0	75.0
		13	1	77.0	73.0	75.0
		14	1	77.0	73.0	75.0
		15	1	77.0	73.0	75.0
		16	1	77.0	73.0	75.0
		17	1	77.0	73.0	75.0
		18	2	85.0	65.0	75.0
		19	2	85.0	65.0	75.0
		20	2	85.0	65.0	75.0
		21	2	85.0	65.0	75.0
		22	2	85.0	65.0	75.0
		23	2	85.0	65.0	75.0
		24	2	85.0	65.0	75.0
1	SAT./SUN./HOL.					
		1	2	85.0	65.0	75.0
		2	2	85.0	65.0	75.0
		3	2	85.0	65.0	75.0
		4	2	85.0	65.0	75.0
		5	2	85.0	65.0	75.0
		6	2	85.0	65.0	75.0
		7	2	85.0	65.0	75.0
		8	2	85.0	65.0	75.0
		9	2	85.0	65.0	75.0
		10	2	85.0	65.0	75.0
		11	2	85.0	65.0	75.0
		12	2	85.0	65.0	75.0
		13	2	85.0	65.0	75.0
		14	2	85.0	65.0	75.0
		15	2	85.0	65.0	75.0
		16	2	85.0	65.0	75.0
		17	2	85.0	65.0	75.0
		18	2	85.0	65.0	75.0
		19	2	85.0	65.0	75.0
		20	2	85.0	65.0	75.0
		21	2	85.0	65.0	75.0
		22	2	85.0	65.0	75.0
		23	2	85.0	65.0	75.0
		24	2	85.0	65.0	75.0

SPACE INDEX	THERMOSTAT TYPE	HEATING CAPACITY	COOLING CAPACITY	PLENUM	OVER SPACE	CFM	SCHEDULES			
1	1	-422349.	895829.	0	0	0.	0	0	0	0
2	1	-84546.	37410.	0	0	0.	0	0	0	0
3	1	-68535.	28594.	0	0	0.	0	0	0	0
4	1	-80411.	35205.	0	0	0.	0	0	0	0
5	1	-67267.	30005.	0	0	0.	0	0	0	0
6	1	0.	0.	0	0	0.	0	0	0	0

Figure 5.6 REPORT V6 (Typical)

```
***IDUG6=1***

     SPACE=  1      NO. OF INTERNAL HEAT TRANSFER SURFACES=  1          SIHTC(I)=      728.

     SPACE=  2      NO. OF INTERNAL HEAT TRANSFER SURFACES=  0

     SPACE=  3      NO. OF INTERNAL HEAT TRANSFER SURFACES=  0

     SPACE=  4      NO. OF INTERNAL HEAT TRANSFER SURFACES=  0

     SPACE=  5      NO. OF INTERNAL HEAT TRANSFER SURFACES=  0

     SPACE=  6      NO. OF INTERNAL HEAT TRANSFER SURFACES=  0
```

Figure 5.7 REPORT V7 (Typical)

IBUG8=1

FINAL SPACE RESPONSE FACTORS FOR SPACE= 1

-193348.2500
230321.2500
-47098.8398
-1295.9922
-291.2617
-89.9453
-45.1621
-19.4460
-6.1973
0.0002

FINAL SPACE RESPONSE FACTORS FOR SPACE= 2

-20560.8438
30025.5469
-8276.4219
-701.3948
-271.9626
-136.7441
-76.1282
-43.8718
-25.5769
-14.9590
-8.7492
-5.0947
-2.9479
-1.6875
-0.9495
-0.5185
-0.2689
-0.1251
-0.0443
0.0000

FINAL SPACE RESPONSE FACTORS FOR SPACE= 3

-18623.4492
27197.7734
-7496.5586
-634.9932
-246.9197
-124.4336
-69.4050
-40.0513
-23.3769
-13.6886
-8.0146
-4.6724
-2.7069
-1.5514
-0.8740
-0.4779
-0.2481

Figure 5.8 REPORT V8 (Typical)

5.3.5 Report V5 - Echo of Space Description Input Data

Report V5 (Figure 5.5) enumerates the input data supplied with Reading Order VT-16 through VT-19.

5.3.6 Report V6 - Echo of Thermostat Scheduling Input Data

Data entered using Reading Orders VT-20, 21 and 22 is echoed back in Report V6 if asked for in Reading Order VT-1. See Figure 5.6 for example of Report V6.

5.3.7 Report V7 - Summary of Internal Surface Data and Calculations

Report V7 summarizes the number of internal heat transfer surfaces in each space as well as the product of the surface area and U-factor. See Figure 5.7 for example of Report V7.

5.3.8 Report V8 - Summary of Calculated Space Response Factors

Internally within the Variable Temperature Program, all surface response characteristics are combined and a set of response factors for the space calculated. Report V8 (Figure 5.8) summarizes these calculated space response factors. For a more in-depth explanation of how this is accomplished, refer to Volume II, Engineering Manual, Section 5.

5.4 EXAMPLE

To demonstrate the use of the Variable Temperature Program on the example building defined in Section 4, the following characteristics will be assumed:

1. No additional delayed floors or ceilings will be used; instead, use will be made of default parameters built into program.

2. Weight of furnishing is 5 lbs per sq. ft. for office areas and 50 lbs per sq. ft. for equipment room.

3. During daylight hours (6 A.M. to 8 P.M.), a type 1 thermostat is used with $\pm$ 2°F throttling range. During other hours, thermostats switch to a type 2 action with a $\pm$ 10°F throttling range. In equipment room, a type 2 thermostat with $\pm$ 10°F throttling range is used.

4. Chiller will be scheduled for use from 4/15 through 9/15. Boiler will be scheduled for use from 9/1 through 5/1.

5. Printouts are desired for:

   a) 1/15 to 1/21
   b) 8/15 to 8/21

6. Space heating and cooling capacities are:

Space	Heating	Cooling
1	60,000 Btu/hr	50,000 Btu/hr
2	60,000 "	50,000 "
3	70,000 "	60,000 "
4	70,000 "	60,000 "
5	40,000 "	60,000 "

Using this information, the input data displayed in Fiqure 5.9 was prepared.

```
1.          0.          0.          1.          0.          0.                                VT-1
1244C ENGINEERING OFFICES                                                                     VT-2
2.          1.                                                                                VT-3
01/15/66 01/21/66                                                                             VT-4
08/15/66 08/21/66                                                                             VT-4
04/15/66 09/15/66                                                                             VT-5
05/01/66 09/01/66                                                                             VT-6
0.                                                                                            VY-7
0.                                                                                            VT-10
0.                                                                                            VT-13
0.          0.          0.          5.                                                        VT-16
0.          0.          0.          5.                                                        VT-16
0.          0.          0.          5.                                                        VT-16
0.          0.          0.          5.                                                        VT-16
0.          0.          0.          50.                                                       VT-16
2.                                                                                            VT-20
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
1.          77.         73.         1.          77.         73.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          65.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
2.          85.         65.         2.          85.         65.                               VT-21
```

Figure 5.9 VARIABLE TEMPERATURE PROGRAM CARD INPUT DATA FOR EXAMPLE BUILDING

2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
2.	85.	65.	2.	85.	65.	VT-21
1.	-60000.	50000.				VT-22
1.	-60000.	50000.				VT-22
1.	-70000.	60000.				VT-22
1.	-70000.	60000.				VT-22
2.	-40000.	60000.				VT-22

Figure 5.9 VAIABLE TEMPERATURE PROGRAM CARD INPUT DATA FOR EXAMPLE BUILDING (Continued)

SECTION 6
SYSTEMS AND EQUIPMENT SIMULATION PROGRAM

6.1 OBJECTIVE AND DESCRIPTION

The hourly space loads calculated by the Thermal Load Analysis and Variable Temperature Programs are not necessarily the loads that are seen by the heating and cooling plant. Due to ventilation air requirements, equipment operating schedules, 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. The purpose of the Systems and Equipment Simulation Program is therefore three-fold (see Figure 6.1).

1. Based upon peak heating and cooling requirements, size all energy-consuming equipment.

2. Simulate each distribution system as it responds to space thermal requirement and determine the requirement it is placing upon the central heating and cooling plant.

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

The thirteen (13) types of distribution systems that the program is capable of analyzing are listed in Table 6.1. Schematic diagrams along with brief explanations of operation are illustrated in Figures 6.2 through 6.14. The types of central heating and cooling plants available for use are shown in Table 6.2.

TABLE 6.1
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 Volume Reheat Fan System

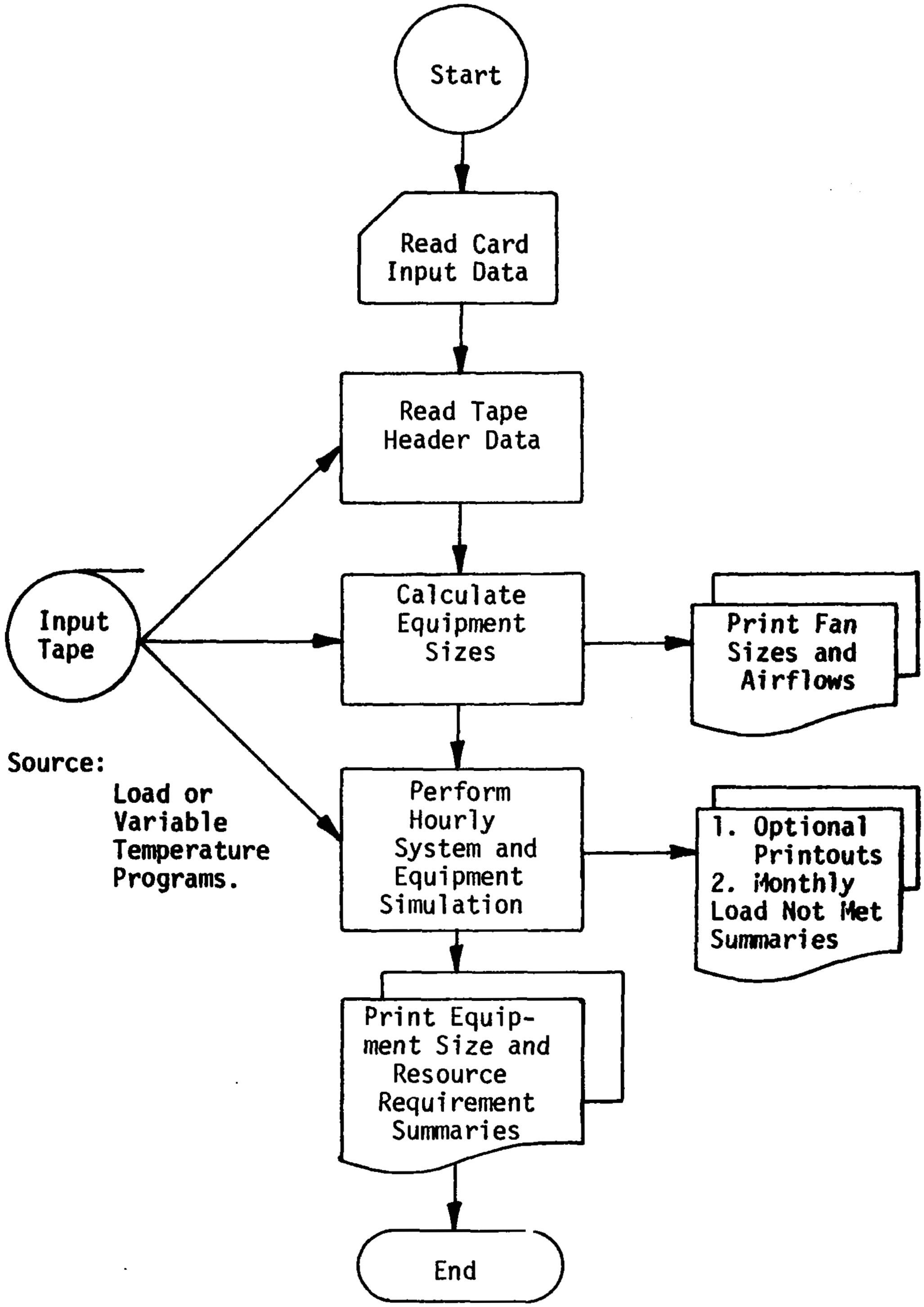


Figure 6.1 SYSTEM & EQUIPMENT SIMULATION PROGRAM MACRO FLOW DIAGRAM

TABLE 6.2

ENERGY CONVERSION SYSTEMS

TYPE	SOURCE OF ENERGY
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
HEATING PLANTS	
1. Hot Water or Steam	Gas Oil Electric Purchased Steam
GENERATING PLANTS	
1. Engine-Generator	Natural Gas Diesel Fuel

6.2 DESCRIPTION OF ENERGY DISTRIBUTION SYSTEMS

DISTRIBUTION SYSTEM NO. 1
SINGLE ZONE FAN SYSTEM WITH FACE AND BY-PASS DAMPERS

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

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 as follows:

- Optional return air fan simulation
- Humidifier
- Three outside air/return air options with the economizer attempting to equal the required cold deck temperature
- Baseboard heating as supplement heat to each zone
- Preheat coil. This will function to raise the mixed air dry-bulb temperature to a value defined by the user (default value = $40^{o}F$)
- Temperature control options:
    1) Fixed settings for both hot and cold decks
    2) Fixed cold deck temperature but allowing hot deck temperature to vary inversely with outside air temperature
    3) Reset temperature control as governed by spaces. Control for this mode consists of setting 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

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

This fan system is designed to serve a large centr requiring cooling the entire year and sub-zones whic reheating. Primary air temperature is controlled by of the central zone. During the winter and intermed the primary air is colder than that required for the Sub-zone all air induction boxes therefore open to m with primary air. The induction boxes are designed 50% inducted air can be mixed with primary air. If of primary air is required, the reheat coil is activ

Elements and operating characteristics of this fan

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

DISTRIBUTION SYSTEM NO. 5
UNIT VENTILATOR

This system consists of a draw-thru air handler wi coil. The coil is controlled by the first zone on t The air handler is capable of introducing a fixed am air. Although primarily designed to serve one zone, may be simulated.

DISTRIBUTION SYSTEM NO. 6
UNIT HEATER

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

DISTRIBUTION SYSTEM NO. 7
FLOOR PANEL HEATING SYSTEM

The floor panel heating system is designed to sim on-grade slabs or intermediate slabs as shown in th

Figure 6.8. The simulation calculates the water temperature required to meet zone loads and the resultant heat loss of the system assuming all zones 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

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:

- The blower runs continuously (unless turned off by V.T. program) while a room thermostat cycles a 2-position valve for temperature control.
- 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

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 reverse is taken. 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 V.T. program).

DISTRIBUTION SYSTEM NO. 10
TWO-PIPE INDUCTION UNIT FAN SYSTEM

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. The primary air jet which induces room air into it is the driving force in drawing room air through a coil. As this 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 stage 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 as follows:

- Three outside air/return air options
- Optional return air fan
- Humidifier
- Baseboard heating as supplemental heat 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

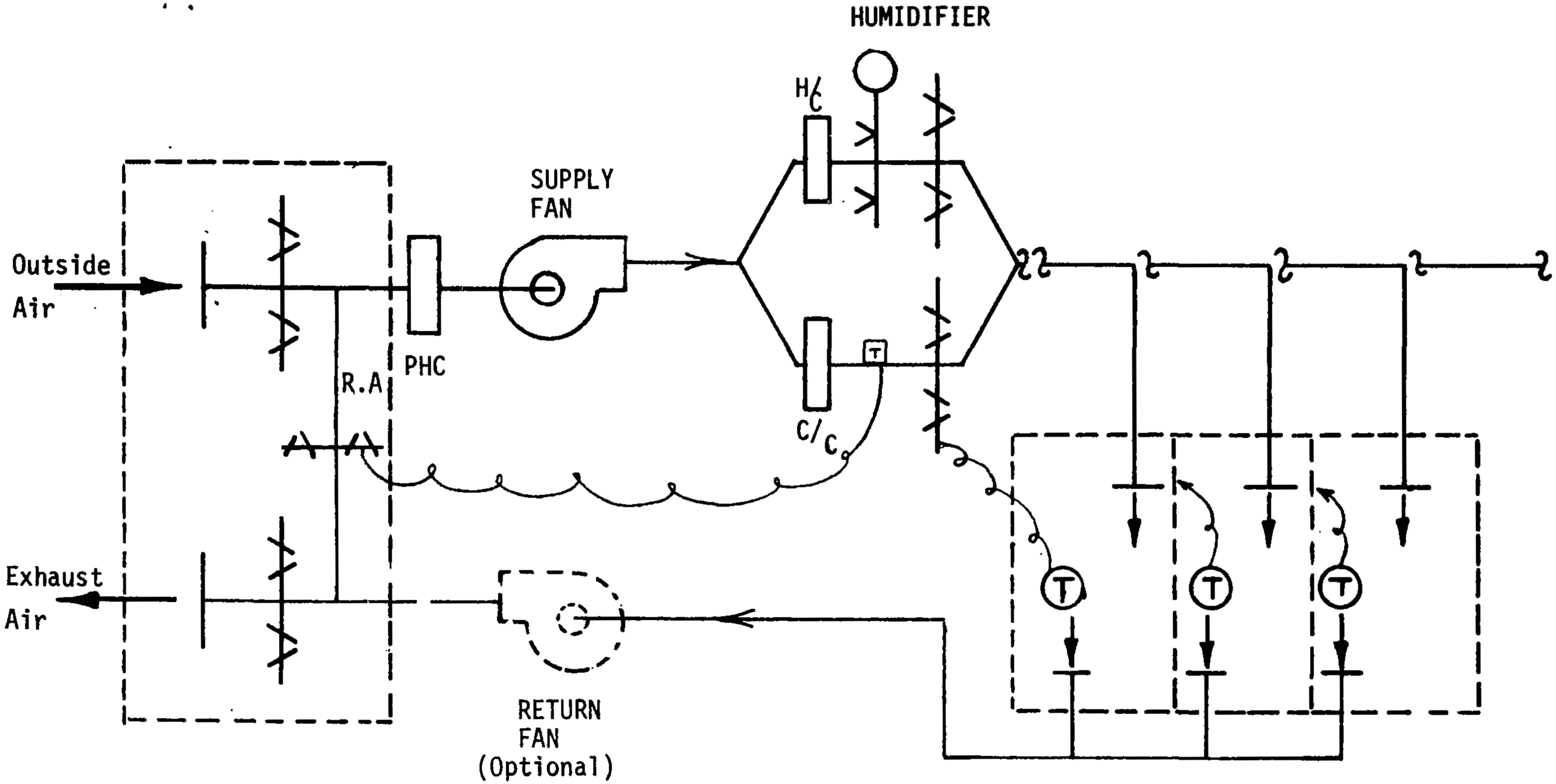
The four-pipe induction system is comprised of a primary supply air and hot and chilled water distribution networks feeding air-water induction-type terminal devices. The primary air which is held at a constant temperature (at about 55°F) serves to control humidity in the space as well as provide ventilation 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 satisfied thermal requirements. The coil is controlled by a thermostat which modulates 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 as follows:

- 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

The variable volume system simulated is comprised of 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 requirements diminish, the primary air flow is reduced proportionately to a minimum flow rate defined as user input (default minimum=10%). If less cooling is required than that given at minimum air flow, the reheat coil (if specified) is activated.

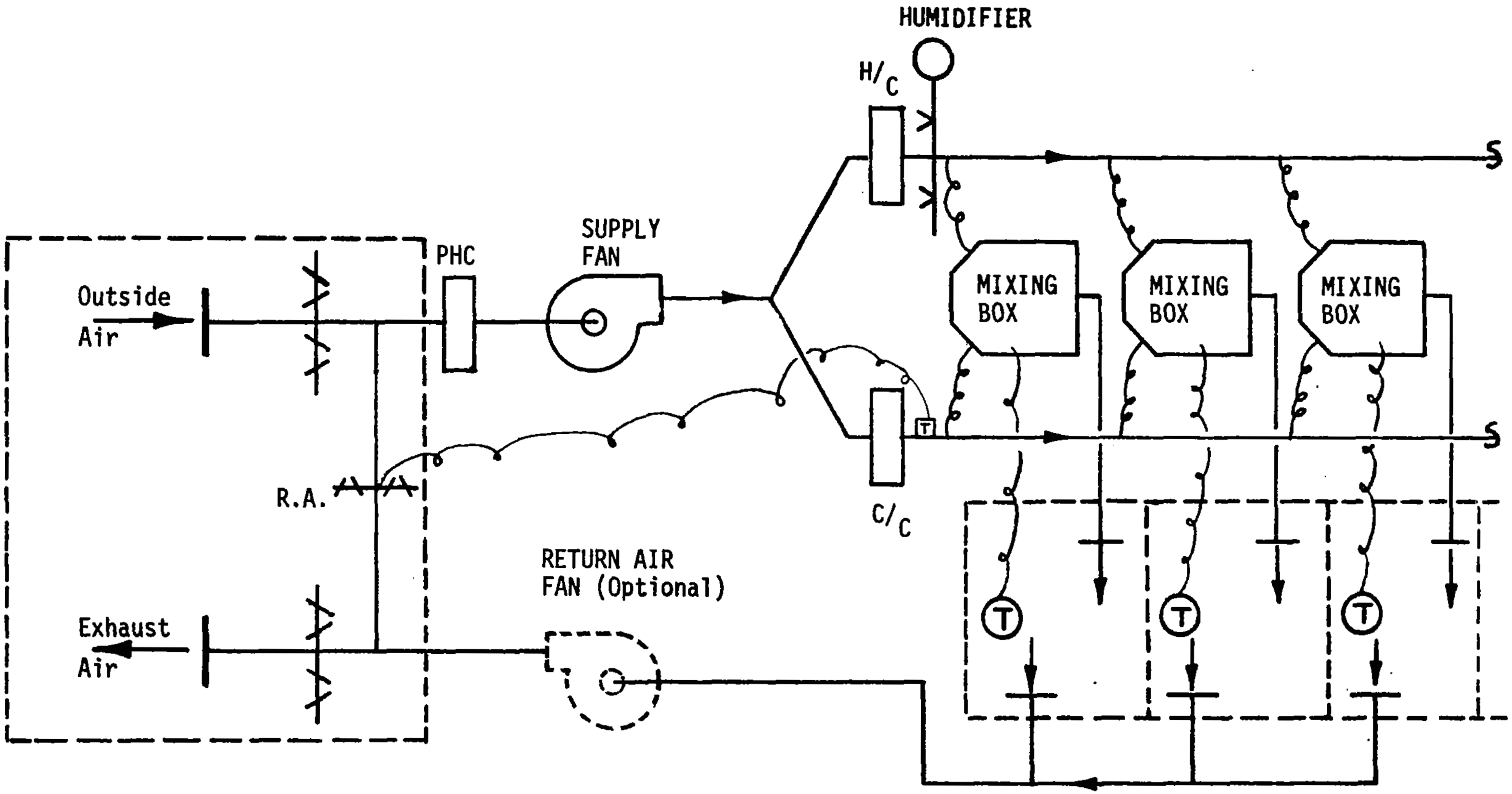


MIXED AIR

THREE OPTIONS

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

Figure 6.3 MULTI-ZONE FAN SYSTEM (DISTRIBUTION SYSTEM NO. 2)

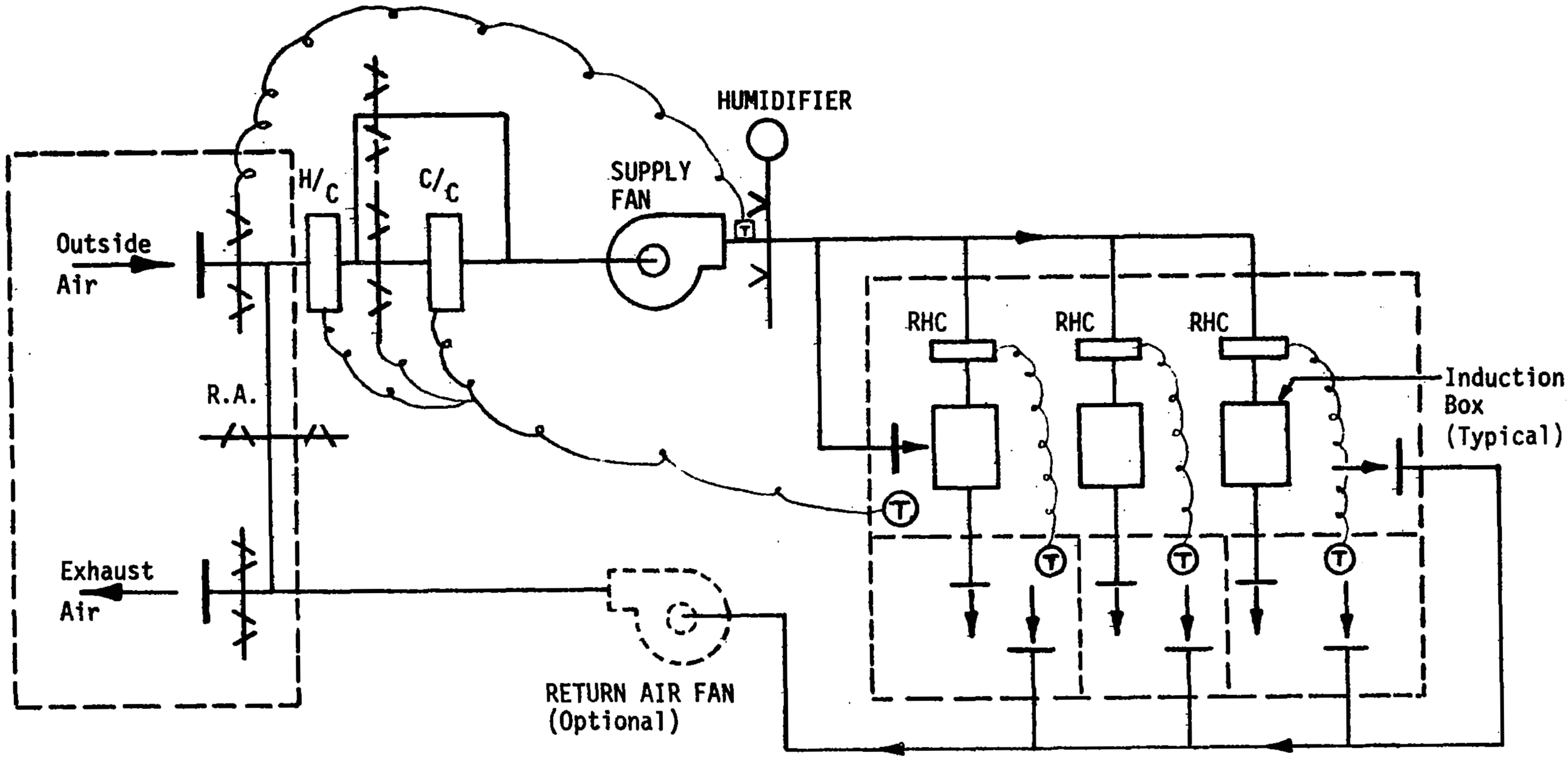


MIXED AIR

THREE OPTIONS

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

Figure 6.4 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 6.5 SINGLE ZONE FAN SYSTEM WITH SUB-ZONE REHEAT (DISTRIBUTION SYSTEM NO. 4)

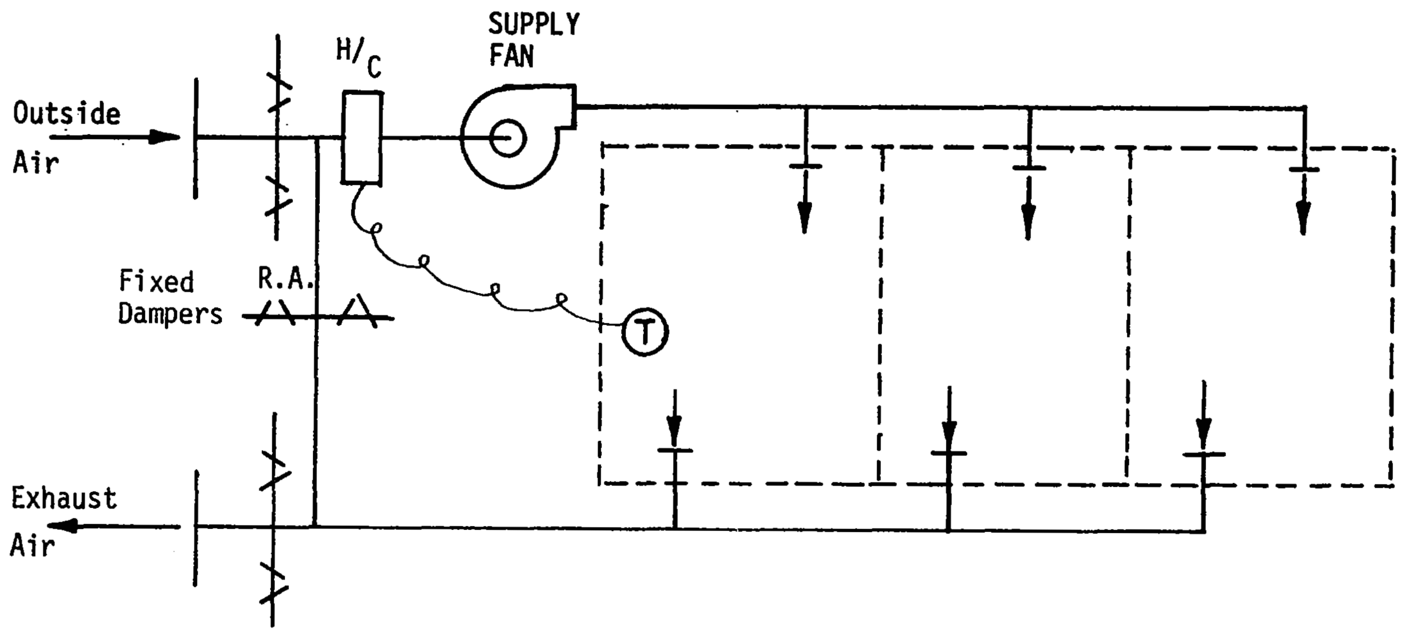
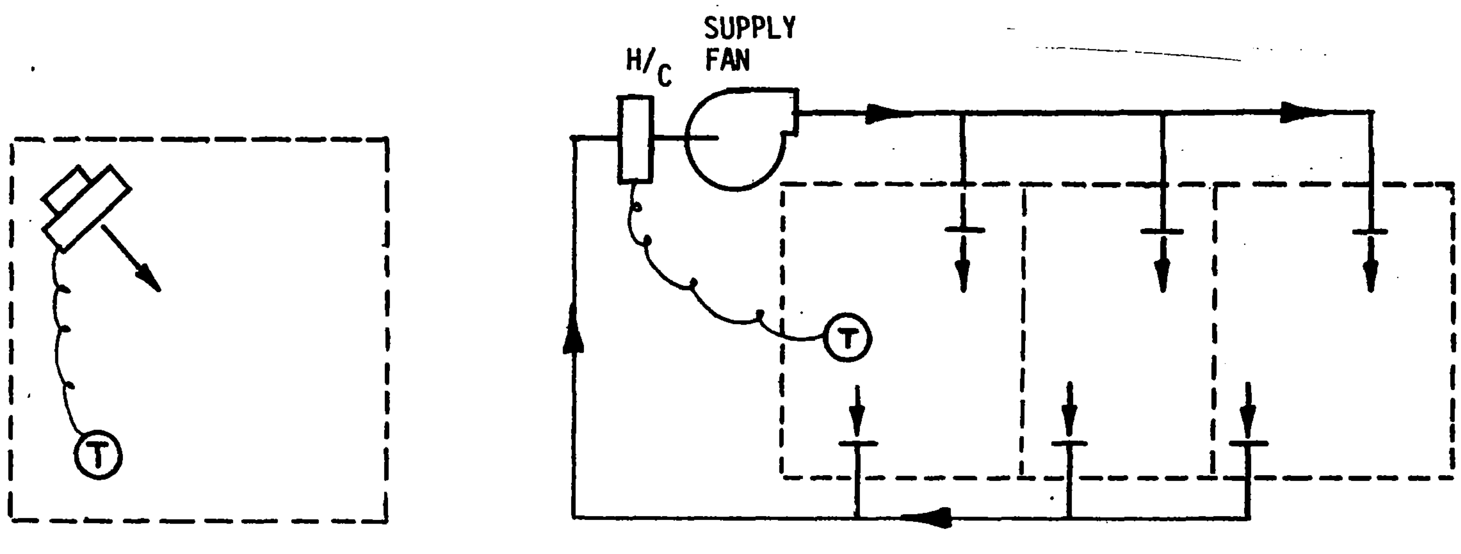


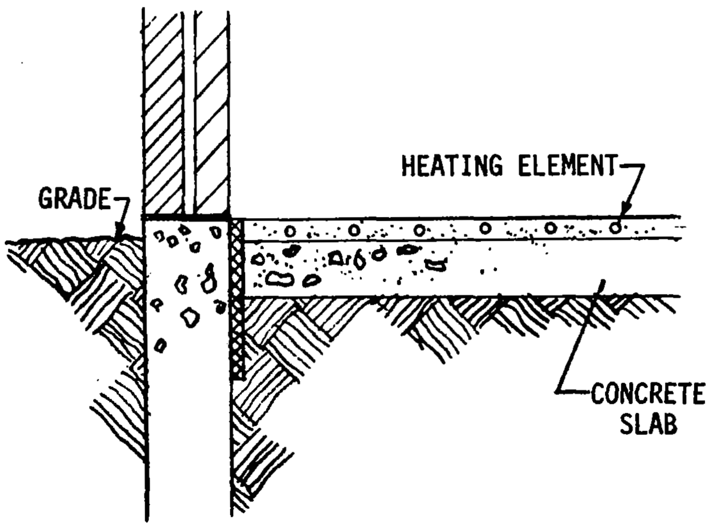
Figure 6.6 UNIT VENTILATOR (DISTRIBUTION SYSTEM NO. 5)



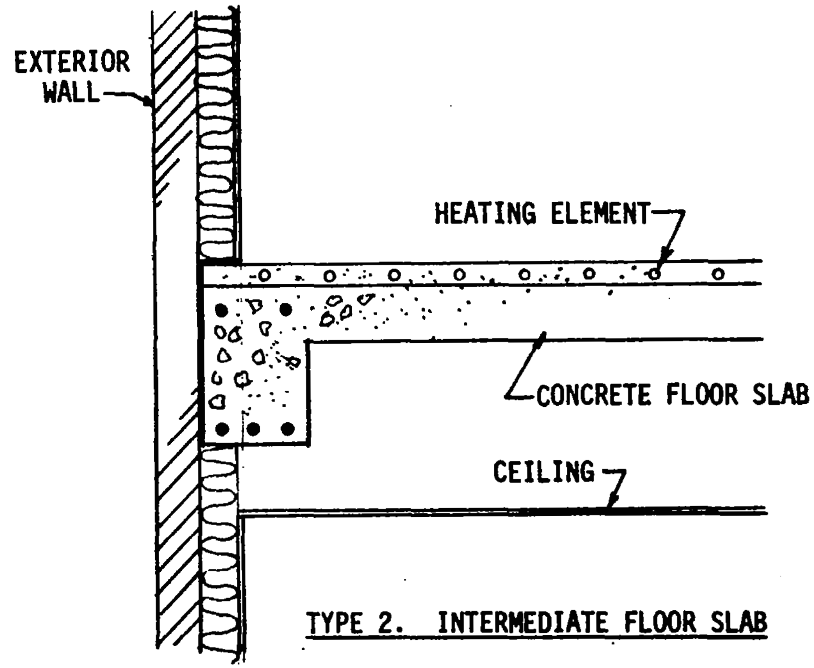
ONE-ZONE SCHEMATIC

MULTIPLE-ZONE SCHEMATIC

Figure 6.7 UNIT HEATER (DISTRIBUTION SYSTEM NO. 6)



TYPE 1. ON-GRADE FLOOR SLAB



TYPE 2. INTERMEDIATE FLOOR SLAB

Figure 6.8 FLOOR PANEL HEATING SYSTEM (DISTRIBUTION SYSTEM NO. 7)

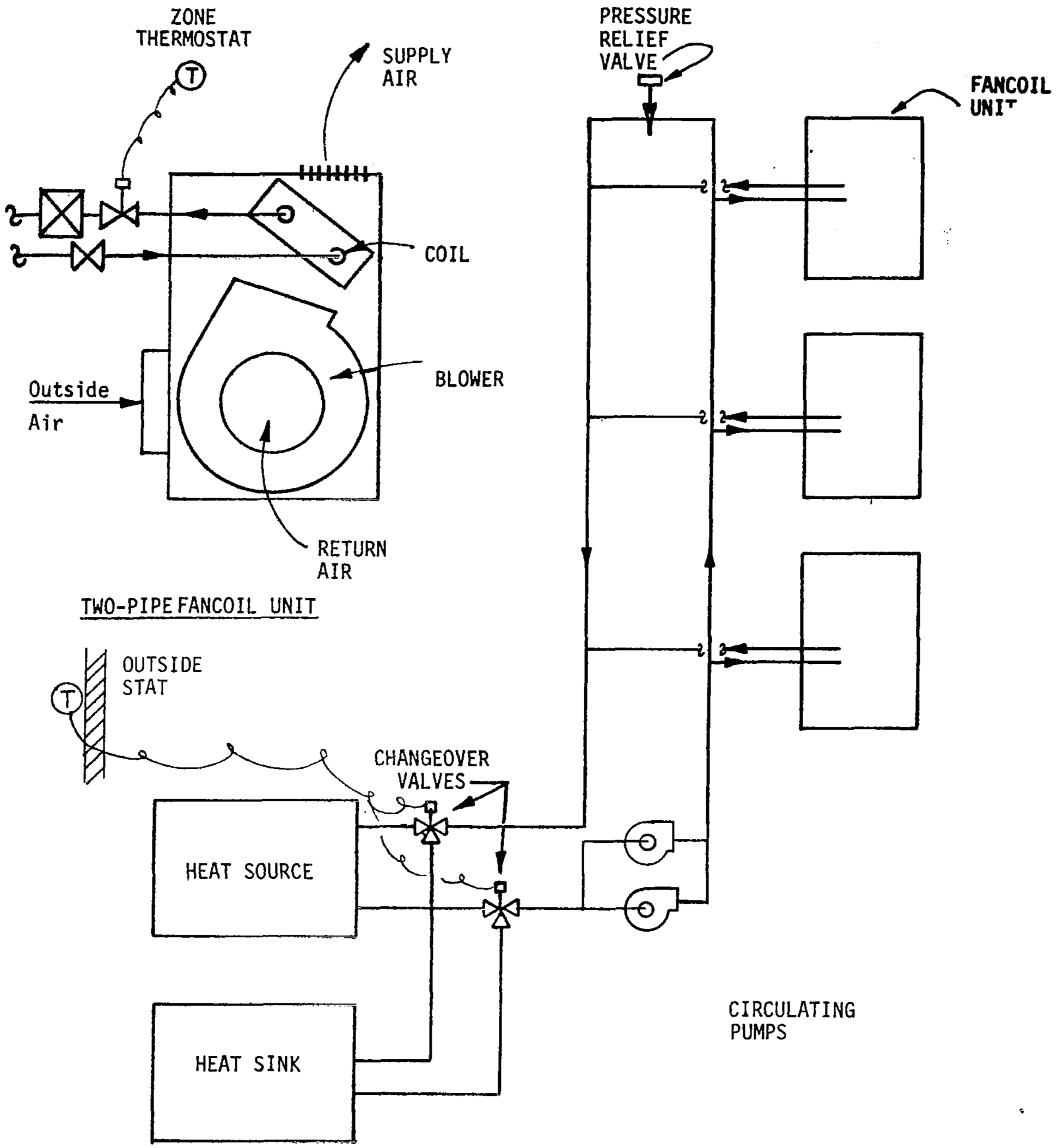


Figure 6.9 TWO-PIPE FANCOIL SYSTEM (DISTRIBUTION SYSTEM NO. 8)

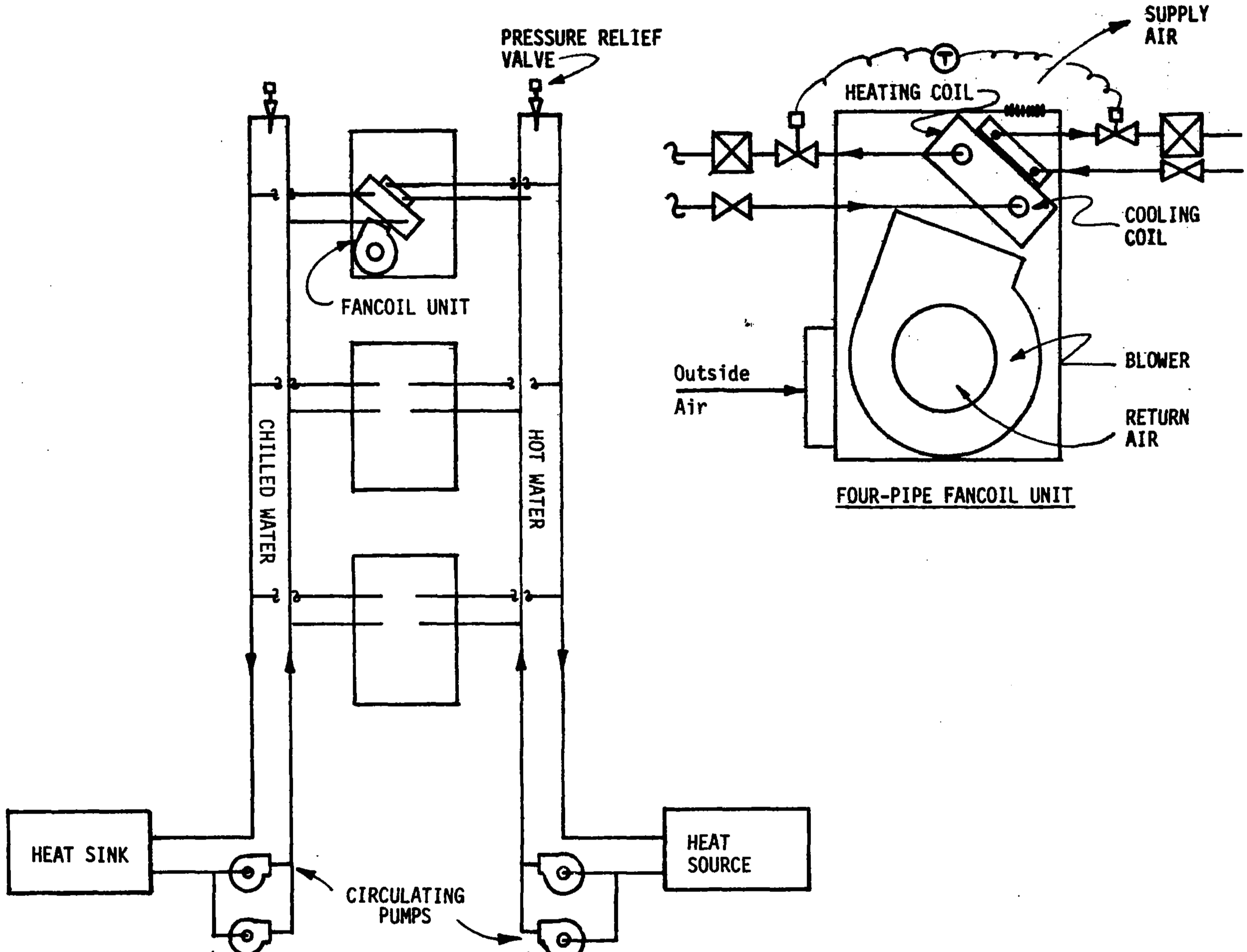
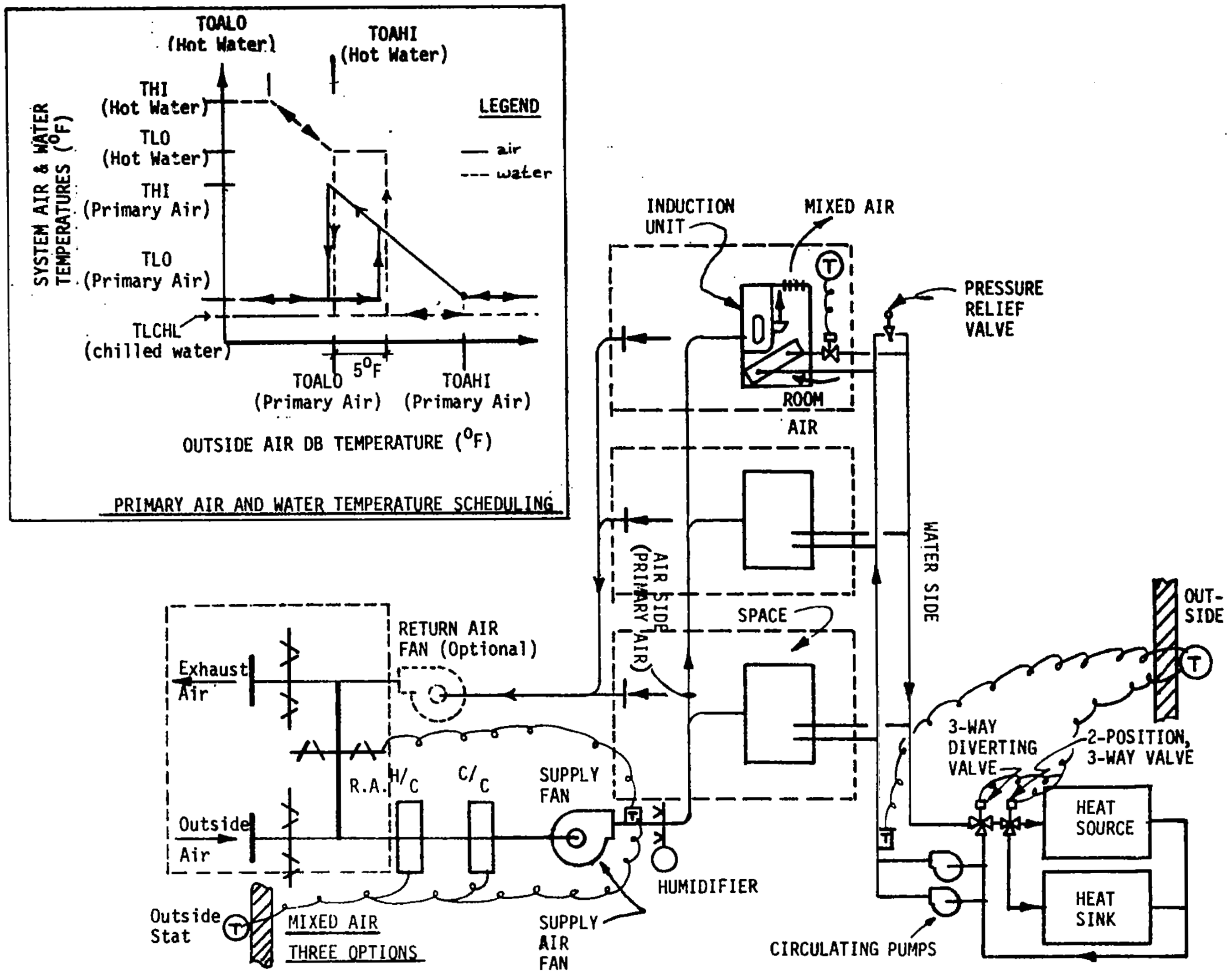


Figure 6.10 FOUR-PIPE FANCOIL SYSTEM (DISTRIBUTION SYSTEM NO. 9)



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

Figure 6.11 TWO-PIPE INDUCTION UNIT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 10)

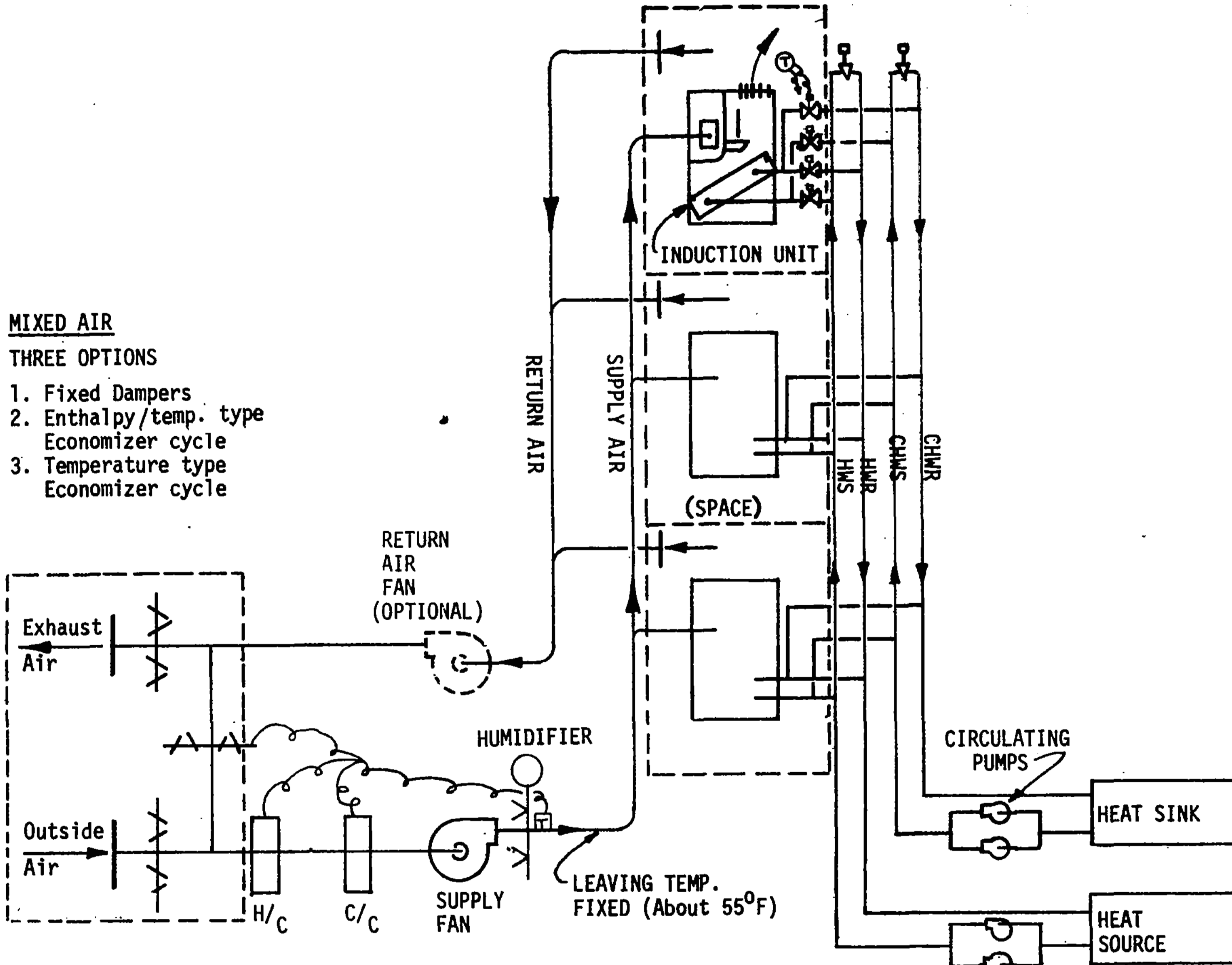
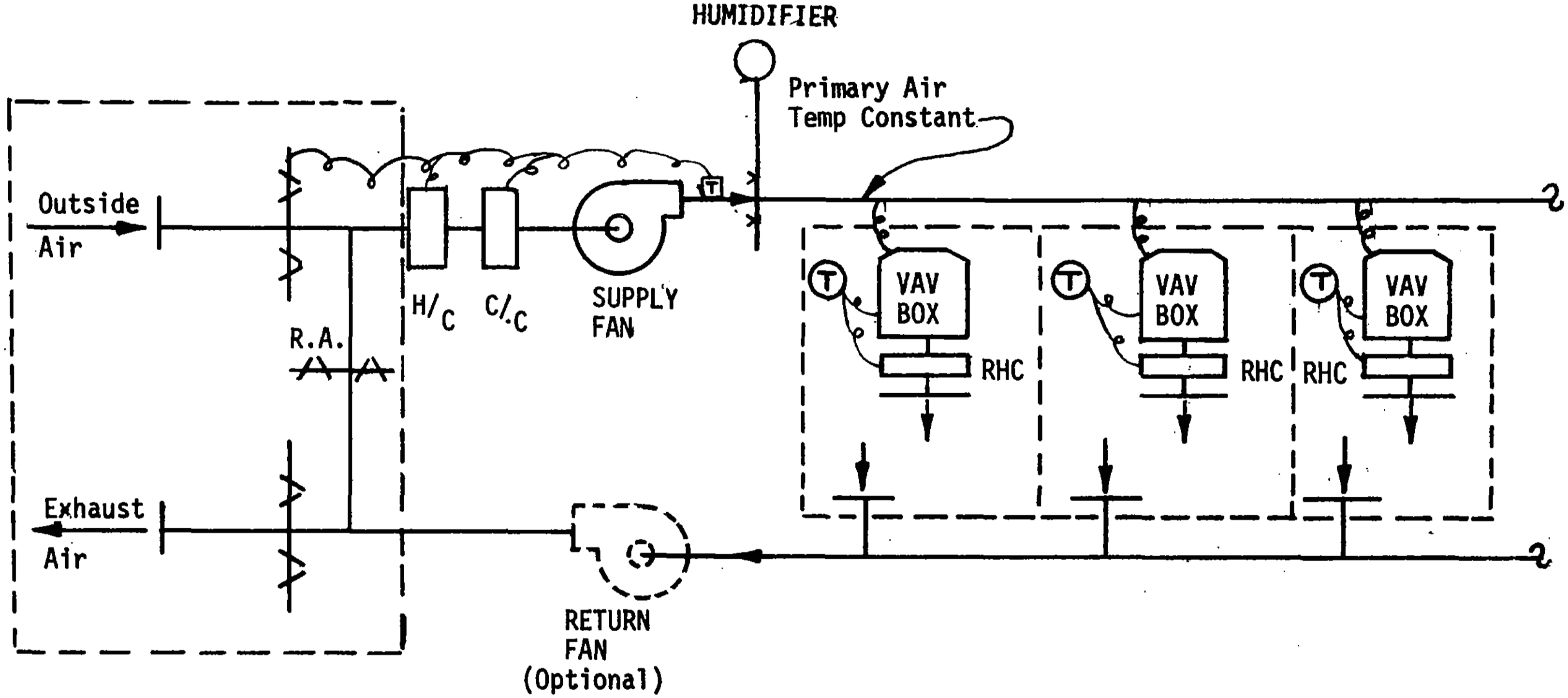


Figure 6.12 FOUR-PIPE INDUCTION UNIT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 11)



<u>MIXED AIR</u>

<u>THREE OPTIONS</u>

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

Figure 6.13 VARIABLE VOLUME FAN SYSTEM WITH OPTIONAL REHEAT (DISTRIBUTION SYSTEM NO. 12)

Error

An error occurred while processing this page. See the system log for more details.

6.3 INPUT DATA

The System and Equipment Simulation Program requires two forms of input, magnetic tape and punched cards. The magnetic tape required is that produced by the Thermal Load Analysis or Variable Temperature Programs and contains hourly weather and space load data (see Sections 4.3.8 and 4.3.9). The card input data must be prepared by the user in accordance with instructions contained in Table 6.3. Many of these card input variables apply only to certain types of distribution systems; therefore an extra column entitled "Required For the Following System Types" has been added to Table 6.3 to indicate when each variable must be defined. To aid the user in the preparation of card inputs SS-4A, 4B, 4C, 4D and SS-5, simplified input forms for each type of distribution system are presented in Appendix D. Other input aids can also be found there.

TABLE 6.3 SYSTEM AND EQUIPMENT SIMULATION PROGRAM CARD INPUT INFORMATION

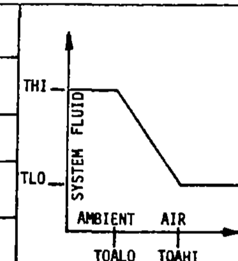
READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
SS-1	1 to 10	Hour of year at which simulation may begin	IHSRT	HOUR OF YEAR	0. to 8784.		0.	Default value-begin with first hour on load tape
	11 to 20	Hour of year at which simulation may end	IHSTP	HOUR OF YEAR	0. to 8784. IHSRT ≤ IHSTP		0.	Default value-end with last hour on load tape
	21 to 30	Number of primary equipment combinations to be run	NCASE		1. to 10.		1.	
	31 to 40	Number of reset schedules to be read (card type SS-3)	NRSET		0. to 10.		3.	
	41 to 50	Fan system shut-off flag	IFAN		0. or 1.	0 = Fans run continuously 1 = Fans may be shut off 2 = Fans & Basebd.htg. may be shut off	0.	If IFAN = 1 and $\Sigma\|Qs\|=0.$, then system(s) shut-off occurs
	51 to 60	Heat conservation system indicator. Does one case use heat conservation system?	KHCST		1. or 2.	1. = No 2. = Yes	1.	
	61 to 70	Number of energy distribution systems	KMAX				6.	Limited by value of dimension statements within program
SS-2	1 to 10	Optional print flag-1--hourly summaries	IPRT1		0. or 1.	0. = Do not print 1. = Print	1.	Recommended maximum run length w/IPRT1 ON = a few months
	11 to 20	Optional print flag-2--zone summaries	IPRT2		0. or 1.		0.	Recommended maximum run length w/IPRT2 ON = a few weeks
	21 to 30	Optional print flag-3--system component performance	IPRT3		0. or 1.		0.	Recommended maximum run length w/IPRT3 ON = a few days.
REPEAT CARD TYPE SS-3 "NRSET" TIMES.								
SS-3	1 to 10	Low outside air temperature at which system temp. is THI	TOALO(NR)	^{o}F.			-15.	All reset schedules are defined here and are referenced to the energy distribution systems via the variable ISET (see SS-4C). The schedules define hot and cold deck air temps., primary air temp. and boiler water temp. as a function of ambient air temp.
	11 to 20	High outside air temperature at which system temp. is TLO	TOAHI(NR)	^{o}F.			55.	
	21 to 30	Low system fluid temperature	TLO(NR)	^{o}F.			140.	
	31 to 40	High system fluid temperature	THI(NR)	^{o}F.			210.	
	41 to 50	Reset schedule label (alpha-numeric)	ZNAME				Hot Water	

TABLE 6.3 (CONT'D)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	REQUIRED FOR THE FOLLOWING SYSTEM TYPES	COMMENTS
READ CARD TYPES SS-4 AND SS-5 AS FOLLOWS: SS-4A,B,C,D, SS-5 (REPEATING SS-5 "JMAX(K)" TIMES). REPEAT ABOVE PROCEDURE "KMAX" TIMES. (SYSTEM-1 CARDS, ZONE-1 CARDS; SYSTEM-2 CARDS, ZONE-2 CARDS; ETC.)									
SS-4A	1 to 10	Type of energy distribution system	KFAN(K)		1. to 13.	1-Single Zone Fan System With Face And By-Pass Dampers. 2-Multi-Zone Fan System. 3-Dual Duct Fan System. 4-Single Zone Fan System With Sub-Zone Reheat. 5-Unit Ventilator. 6-Unit Heater 7-Floor Panel Heating 8-Two-pipe Fancoil System. 9-Four-pipe Fancoil System. 10-Two-pipe Induction Unit Fan System. 11-Four-pipe Induction Unit Fan System. 12-Variable Volume Fan System With Optional Reheat. 13-Constant Volume Reheat Fan System.	13.	ALL	
	11 to 20	Number of zones on system	JMAX(K)				10.	ALL	Limited by dimension statements
	21 to 30	System relative humidity set point	RHSP(K)	%R.H.			50.	1,2,3,4,10,11, 12,13	
	31 to 40	System zone in which humidistat controlling central humidifier is located	ICZN(K)				1.	1,2,3,4,10,11, 12,13	
	41 to 50	Minimum outside air volume	OACFM(K)	cfm			3000.	1,2,3,4,5,8,9, 10,11,12,13	If exh.air exceeds OACFM, OACFM will be set equal to exh. air.
	51 to 60	Mixed air option	MXAO(K)		1.,2., or 3.	1.Fixed percent outside air 2.Enth.temp.econo.control 3.Temp.econo.control	3.	1,2,3,4,10, 11,12,13	
	61 to 70	Variable volume fan control option	NVFC(K)		1.,2., or 3.	1.Variable speed motor 2.Inlet vane damper 3.Discharge damper	2.	4,12	Default value = 2.
SS-4B	1 to 10	Hot deck temp. control mode (KFAN(K)=2 or 3) AHU LVG temp. control mode (KFAN(K)=13)	ITMPC(K,1)		1.,3.,or 6. 1.,2.,or 3.	1.Predefined constant (TFIX1 or TFIX2) 2.Determined by zone with coldest supply air reqmt.	6.	2,3,13	
	11 to 20	Cold deck temp. control mode	ITMPC(K,2)		1. or 2.	3.Reset per reset schedule. 6.Determined by zone with warmest supply air requirement.	2.	2,3	
	21 to 30	Total supply fan pressure	TFNPS(K)	in.H_2O	Non-negative		3.8	1,2,3,4,5,6,8, 9,10,11,12,13	
	31 to 40	Total return fan pressure	TFNPR(K)	in.H_2O	Non-negative		2.1	1,2,3,4,10,11, 12,13	
	41 to 50	Total exhaust fan pressure	TFNPE(K)	in.H_2O	Non-negative		1.6	1,2,3,4,5,6,8, 9,10,11,12,13	
	51 to 60	Are reheat coils located after variable volume boxes?	IVVRH(K)		0. or 1.	0. - No 1. - Yes	1.	12.	
	61 to 70	Minimum air flow through variable volume boxes	VVMIN(K)	%	0. to 100.		25.	12	

TABLE 6.3 (CONT'D)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	REQUIRED FOR THE FOLLOWING SYSTEM TYPES*	COMMENTS
SS-4C	1 to 10	Fixed hot deck temp.(KFAN(K) = 2,3) Fixed AHU Discharge temp.(KFAN(K) = 4,11, 12,13	TFIX1(K)	^oF.			95.	2,3,4,11,12,13	For system types 2, 3 & 13, this variable is functional only if ITMPC(K,1)=1
	11 to 20	Fixed cold deck temperature	TFIX2(K)	^oF.			55.	1,2,3,	For system types 2 & 3, this variable is functional only if ITMPC(K,2) = 1.
	21 to 30	Hot deck air temp. reset schedule index (KFAN(K) = 2,3) Primary air temp. reset schedule index (KFAN(K) = 10) AHU discharge air temp. reset schedule index (KFAN(K) - 13)	ISET(K,1)		1. to 10.		1.	2,3,10,13	ISET (K,N) keys a specific outside air reset schedule to control the temperature of a specified portion of system. See Table 6.4 for ISET/system type matrix.
	31 to 40	Cold deck air temp. reset schedule index	ISET(K,2)		1. to 10.		2.	2,3,	
	41 to 50	Baseboard radiation water temperature reset schedule index	ISET(K,3)		1. to 10		3.	1,2,3,4,8,9, 10,11,12,13	
	51 to 60	Two-pipe fancoil system & two-pipe induction unit system hot water temperature reset schedule index	ISET(K,4)		1. to 10.		1.	8,10	
	61 to 70	Ratio of induced to primary air	RIPA(K)				2.7	10,11	Induced air = RIPA primary air
SS-4D	1 to 10	Two-pipe fancoil system changeover temp.	TCOFC(K)	^oF.			53.	8.	At +2.5^{o}F LAG inhibits repeated changeover in temperate weather
	11 to 20	Two-pipe induction unit fan system changeover temperature. Floor panel heating system hot water shutoff temperature	TOACO(K)	^oF.			53. 53.	10. 7	
	21 to 30	Volume of water in changeover type system (2-pipe fancoil or 2-pipe induction)	PWGAL	Gals.	Non-negative		1000.	8,10	The changeover load is calculated by the program
	31 to 40	Location of floor heating panels	PLOC(K)			1. - Slab on grade. 2. - Intermediate floor slab	1.	7	More than one zone may be included on the floor panel heating system only if they all have the same set point temperature
	41 to 50	Floor area covered by heating panels	PAREA(K)	Sq.Ft.				7	
	51 to 60	Exposed perimeter of floor	PERIM(K)	Ft.				7	

TABLE 6.3 (CONT'D)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	REQUIRED FOR THE FOLLOWING SYSTEM TYPES	COMMENTS
	REPEAT CARD TYPE SS-5 "JMAX(K)" TIMES.								
SS-5	1 to 10	Space number used in load and variable temperature programs	SPACN(K,J)				87	All	Spaces are renumbered internally by this program. Only those spaces specified will be included. Load space types may be used more than once or not at all.
	11 to 20	Zone multiplication factor	MULT(I)		Non-negative whole numbers		2.	All	
	21 to 30	Air exhausted from zone	CFMX(I)	CFM			500.	1,2,3,4,5,8,9, 10,11,12,13	This value is considered to be held constant unless the fan system is off (see SS-1,IFAN)
	31 to 40	Heat output of baseboard radiation per linear ft. at design conditions	CBTU(I)	BTU/Hr. Lin.Ft.			700.	1,2,3,4,8,9,10 11,12,13	Design conditions: 65°F incoming air; 215°F heating medium temperature.
	41 to 50	Active length of baseboard radiation	ALFBR(I)	Ft.			10.	1,2,3,4,8,9,10, 11,12,13	
	51 to 60	Load program space number of plenum above this space	IPLEN(I)				88.	1,2,3,4,5,10, 11,12,13	If a ceiling plenum(esp.return air ceiling plenum) was modeled in load program as a separate space above this zone, enter its load program space number here.
	61 to 70	Zone name	ZNAME				A236	All	Alpha-numeric characters may be used here
	REPEAT CARD TYPES SS-6 AND SS-7 "NCASE" TIMES USING THE FOLLOWING ORDER: SS-6(1), SS-7(1); SS-6(2), SS-7(2); ETC. NOTE: PLACE ALL HEAT CONSERVATION SYSTEMS LAST IN THE DECK.								
SS-6	1 to 10	System identification number	ISYS(NC)				160900101.		
	11 to 20	Is this a heat conservation building?	KBLDG(NC)		1. or 2.	1. - No 2. - Yes	1.		
	21 to 30	Type of chiller	M1 (NC)		1 thru 5. 1. thru 3. for heat cons. mach.	1.-Reciprocating 2.-Hermetic centrifugal 3.-open centrifugal 4.-Steam absorption 5.-Centrifugal/Steam turbine	2.		
	31 to 40	Source of chiller energy	M2(NC)			1.-Gas 2.-Oil 3.-Steam 4.-Electric	4.		
	41 to 50	Source of general heating energy	M3(NC)				1.	Includes heating and pre-heating coils, baseboard radiation and floor panel heating.	
	51 to 60	Source of reheat coil energy	KREHT(NC)			0. Same as Boiler 4. Electric Resistance	1.		

TABLE 6.3 (CONT'D)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUE	CODE	EXAMPLE	COMMENTS
SS-7	1 to 10	Type of auxiliary chiller	M6(NC)			0. - None 1. - Reciprocating 2. - Hermetic centrifugal 3. - Open centrifugal	0.	For heat conservation buildings only
	11 to 20	Source of supplemental heat	M7(NC)			0. - None 3. - Electric 1. - Gas 4. - Well water 2. - Oil 5. - City water	0.	
	21 to 30	Number of engine/generator sets	M4(NC)				0.	If left 0., the program will calculate this quantity
	31 to 40	Type of engine/generator sets	M5(NC)			0. - None 1. - Diesel 2. - Gas	1.	
SS-8	1 to 10	Number of boilers	NUMB				2.	Default value = 1.
	11 to 20	Size of each boiler	SZB	MBH			350.	
	21 to 30	Hour of seasonal boiler start-up	BON	Hour of year	0. to 8784.		0.	If left 0.0, boiler is available for entire year
	31 to 40	Hour of seasonal boiler shut-down	BOFF		0. to 8784. ≤ BON		0.	
	41 to 50	Heating value heating oil (for boiler)	HVHO	BTU/Gal	Non-negative		147,000.	Default value = 150,000. BTU/Gal
SS-9	1 to 10	Number of chillers	NUMC				2.	Default value = 1.
	11 to 20	Size of each chiller	SZC	Tons			100.0.	
	21 to 30	Hour of seasonal chiller start-up	CON	Hour of year			2161.	
	31 to 40	Hour of seasonal chiller shut-down	COFF	Hour of year			5833	Default value = 8785. which causes chiller availability from CON thru the end of the year
	41 to 50	Minimum part load chiller cut-off	FFLMN	%	0. to 100.		20.	Default value = 10.%
	51 to 60	Chilled water set point temperature	TLCHL	°F	40. to 50.		44.	Default value = 45. °F
	61 to 70	Cooling tower water low limit temperature	TECMN	°F	75. to 90.		80.	Default value = 75.°F

TABLE 6.3 (CONT'D)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUE	CODE	EXAMPLE	COMMENTS
SS-10	1 to 10	Total boiler water pump head	HDBLP	Ft.	Non-negative		50.	
	11 to 20	Total chilled water pump head	HDCLP	Ft.	Non-negative		40.	
	21 to 30	Total condenser water pump head	HDCNP	Ft.	Non-negative		30.	
SS-11	1 to 10	External lighting power	PWOL	KW	Non-negative		0.	
	11 to 20	Fan and pump motor efficiency	EFF	%	1. to 100.			Default value = 85.%
	21 to 30	*Building changeover temperature*	TCO	°F			56.	Default value = 55. °F
	31 to 40	Heating value diesel fuel (for engine/ generator)	HVDF	BTU/Gal.			139000.	Default value = 140,000 BTU/Gal.
SS-12	1 to 10	Boiler supply and absorption chiller entering steam pressure	PESTM	PSIG	2. to 12.		12.	Default value if PESTM out of range: PESTM = 12.0 Psia TESTM = 245. °F
	11 to 20	Boiler supply and absorption chiller *entering steam temperature*	TESTM	°F			245.	
	21 to 30	Steam turbine entering steam pressure	PPS	PSIG			125.	Default values if PPS not defined: PPS = 125. PSIG TPS = 353. °F
	31 to 40	Steam turbine entering steam temperature	TPS	°F			353.	
	41 to 50	Steam turbine speed	RPM	Rpm			3500.	Default value 3600. Rpm
SS-13	1 to 10	Type of floor covering	KFLCV			1. - Bare concrete 2. - Tile 3. - Carpeting	3.	These variables apply to floor panel heating systems only
	11 to 20	Floor insulation conductance	CINSL	BTU/Hr-SQ.FT.-°F			0.2	
	21 to 30	Floor insulation thickness	DINSL	Ft.			0.5	

TABLE 6.3 (CONT'D)

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
SS-14	1 to 10	maximum allowable condenser water temp.	TLCNM	^oF			115.	
	11 to 20	Well or city water design return water temperature	TLCMN	^oF			50.	
	21 to 30	City water supply temperature	TCWIN	^oF			60.	
	31 to 40	Well water supply temperature	TWWIN	^oF			60.	
	41 to 50	Total well water pump head	HDWWP	Ft.			50.	
SS-15	1 to 10	Type of snow melting system	KSNOW			0. - None 1. - Liquid 2. - Electric	0.	
	11 to 20	Snow melting system design load	QSNOW	BTU/Hr.			5000.	
	21 to 30	Snow melting slab area	SAREA	$Ft.^2$			800.	

SS-16		WBAN Summary Deck 345	SNOW(K)	This card deck can be obtained from the National Weather Record Center, Ashville, N.C. The deck would consist of 365 or 366 cards and is placed in the System Sub-program data deck after card SS-15. If no snow-melting system is to be used, the snow data need not be placed in deck.

TABLE 6.4

APPLICATION OF ISET VARIABLES

SYSTEM NUMBER	SYSTEM	RESET SCHEDULE INDEX TERM			
		ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)
1	SZFB	----	----	Baseboard Hot Water	----
2	MZS	Hot Deck	Cold Deck	Baseboard Hot Water	----
3	DDS	Hot Deck	Cold Deck	Baseboard Hot Water	----
4	SZRH	----	----	Baseboard Hot Water	----
5	UVT	----	----	----	----
6	UHT	----	----	----	----
7	FPH	----	----	----	----
8	2PFC	----	----	Baseboard Hot Water	Fancoil System Hot Water
9	4PFC	----	----	Baseboard Hot Water	----
10	2PIU	Primary Air	----	Baseboard Hot Water	Induction System Hot Water
11	4PIU	----	----	Baseboard Hot Water	----
12	VAVS	----	----	Baseboard Hot Water	----
13	RHFS	AHU Supply Air	----	Baseboard Hot Water	----

TABLE 6.5 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.	-	-

6.4 OUTPUT REPORTS

From the Systems and Equipment Simulation Program, the user will receive eight (8) types of reports summarizing the following:

1. Report S1 - Recap of Card 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 Loads Not Met
7. Report S7 - Summary of Equipment Capacities
8. Report S8 - Monthly and Annual Energy Summary.

6.4.1 Report S1 - Recap of Card Input Data

Report S1 (Figure 6.15) summarizes the card input data and default values used by the Systems and Equipment Simulation Program in performing each analysis. It provides the means by which the user can quickly ascertain if output errors or peculiar results are due to improperly defined input data.

6.4.2 Report S2 - Title Page

The Title Page (Figure 6.16) introduces the energy utilization analysis output and indicates the facility name, location, project number, engineer and date.

6.4.3 Report S3 - Summary of Energy Distribution System Characteristics

During the first part of the energy analysis phase, the Systems and Equipment Simulation Program calculates the rate of supply air required by each zone to meet peak heating and cooling loads. Report S3 (Figure 6.17) summarizes these results on a per-distribution system basis. Items printed on report include:

1. System Number - defined by order of input SS-4A.
2. Type - defined by input SS-4A.
3. Supply Fan BHP - determined using summation of calculated air flows for each distribution system and total supply fan pressure defined in SS-4B.

4. Return Fan BHP - determined using summation of calculated air flow minus summation of zone exhaust air flows (input SS-5) for each distribution system and total return fan pressure defined in SS-4B.

5. Exhaust Fan BHP - calculated using summation of zone exhaust air flows for each distribution system and total exhaust fan pressure defined in SS-4B.

6. Number of Zones - defined by input SS-4A.

7. Total Supply Air Flows - determined from zone peak heating and cooling loads retrieved off of input tape and design supply air temperatures summarized in Table 6.5.

8. Minimum Outside Air Flows - summation of zone requirements defined via input SS-4A.

9. Exhaust Air Flows - summation of zone exhaust air quantities defined in SS-5.

10. Percent of Minimum Outside Air - quantity determined in (8) divided by that determined in (7).

6.4.4 Report S4 - Summary of Zone Air Flows

Report S4 (Figure 6.18) 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 SS-4A.

2. Zone Number - increases sequentially from 1 to number of zones indicated in input SS-4A.

3. Load Space Number - defined by input SS-5.

4. Multiplication Factor - allows the user to handle repetitive zones; defined by input SS-5.

5. Supply CFM - determined from peak heating and cooling loads retrieved off of input tape and design supply air temperatures summarized in Table 6.5.

6. Exhaust CFM - defined by input SS-5.

7. Set Point Temperature - defined by input LC-57 and passed along on input tape.

6.4.5 Report S5 - Summary of Hourly Calculations

If the user desires to track the hourly calculations performed by the Systems and Equipment Simulation Program during the simulation phase, the optional report S5 (Figure 6.19) can be asked for via the use of input SS-2. The length of this report can be considerable depending upon the length of analysis and the number of optional print parameters turned on. Indicated on Figure 6.19 are the lines of output that will be printed with all three (3) print parameters turned on. For explanation of variable subscripts, see subroutine SYSIM in Vol. II, Engineering Manual.

6.4.6 Report S6 - Summary of Loads Not Met

At the end of each month, Report S6 (Figure 6.20) is printed to indicate zone-by-zone the heating and/or cooling loads that the distribution system was not able to meet. These "loads not met" are a result of one of the following:

1. Distribution system has a cooling requirement but cooling plant is off.

2. Distribution system has a heating requirement but heating plant is off.

3. Zone has a heating or cooling requirement but fan is off.

4. Undersized distribution system heating or cooling capacity.

An explanation of column headings follows:

1. Month - January through December

2. System - defined by order of input SS-4A

3. System Zone Number - increases sequentially from 1 to number of zones indicated in input SS-4A

4. Multiplication Factor - number of times zone is repeated on system

5. Cooling Load Not Met - summation of cooling loads for all hours during month when cooling was required but not available

6. Cooling Peak Not Met - the maximum cooling load not met during month

7. Cooling Hours Not Met - summation of the hours during month for which loads were not met

8. Heating Load Not Met - same as (5) but for heating

9. Heating Peak Not Met - same as (6) but for heating

10. Heating Hours Not Met - same as (7) but for heating.

11. Chiller and boiler loads not met due to undersized equipment - This line includes heating and cooling loads (consumption, demand, and hours of occurrence) not met by operating equipment. The energy distribution system simulation assumes energy conversion equipment to be of adequate capacity. If this is not the case, the excess loads are summarized on this line. Loads not met due to scheduled chiller and boiler shut-down are tallied as zone loads not met.

6.4.7 Report S7 - Summary of Equipment Capacities

Report S7 (Figure 6.21) summarizes the equipment capacities that were calculated 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 6 of Volume II, Engineering Manual.

6.4.8 Report S8 - Monthly and Annual Energy Summary

At the conclusion of the analysis period, a 4-part report (Figures 6.22 through 6.25) 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

   a) Monthly Heating - heat output of central heating plant

   b) Monthly Cooling - cooling output of central cooling plant

2. Electricity

   a) Internal Lights and Building Equipment - power used by items defined in inputs LC-59 and LC-60.

   b) External Lights and Building Equipment - power used by equipment defined in SS-11 and turned on whenever sun is down.

   c) Heat - power consumed by resistance boiler providing required heat, boiler controls, and hot water pumps.

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

3. Gas

a) Heat - fuel consumed by gas-fired boiler providing required heat and/or gas heat source 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

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

a) Heat - fuel consumed by oil-fired boiler providing required heat and oil source 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

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

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

6.5 EXAMPLE

To illustrate the use of the System and Equipment Simulation Program with the example facility described in Section 4.4, the input data shown in Figure 6.27 was prepared and used for the study.

```
******************************************** RECAP OF CARD INPUT DATA ********************************************
                                                              NOTE--ALTHOUGH SOME VARIABLES APPEAR
                                                                    AS INTEGERS IN THIS LISTING,
                                                                    ALL NUMERIC CARD INPUT DATA ARE
                                                                    READ AS REAL NUMBERS.
                                                                    DEFAULT VALUES FOR CERTAIN VARIABLES
                                                                    ARE SUBSTITUTED AS REQUIRED
                                                                    AND APPEAR IN THIS LISTING.
CARD TYPE-1.
         1  IHSRT - HOUR OF YEAR AT WHICH SIMULATION MAY BEGIN.
      8785  IHSTP - HOUR OF YEAR AT WHICH SIMULATION MAY END.
         1  NCASE  - NUMBER OF CASES TO BE RUN.
         5  NRSET - NUMBER OF RESET SCHEDULES TO BE READ.
         0  IFAN  - FAN SHUT-OFF FLAG.
         1  KHCST - HEAT CONSERVATION SYSTEM FLAG.
         1  KMAX  - NO. OF ENERGY DISTRIBUTION SYSTEMS.

CARD TYPE-2.
         0  IPRT1 - OPTIONAL PRINT FLAG, LEVEL 1...HOURLY SUMMARIES.
         0  IPRT2 - OPTIONAL PRINT FLAG, LEVEL 2...ZONE SUMMARIES.
         0  IPRT3 - OPTIONAL PRINT FLAG, LEVEL 3...SYSTEM COMPONENT PERFORMANCE.

CARD TYPE-3.
TEMPERATURE RESET SCHEDULES.
  SCHEDULE       TOALO       TOAHI        TLO        THI        ** LABEL **
   NUMBER
      1          -15.0        60.0       220.0      140.0        HOT WATER
      2           55.0        85.0        55.0       95.0        2PIU AIR-S
      3           55.0        95.0        55.0       70.0        PRIMARYAIR
      4          -15.0        55.0        90.0      115.0        HOT DECK
      5           55.0        85.0        55.0       65.0        COLD DECK
*****************************************************************************************************************
CARD TYPE-4.
SYSTEM NUMBER  1.
KFAN =      13.0 JMAX =       5.0 RHSP =      50.0 ICZN =       1.0 OACFM=    6000.0 MXAO =       3.0 NVFC =      0.0
ITMPC=       2.0 ITMPC=       0.0 TFNPS=      4.00 TFNPR=      2.00 TFNPE=      1.50 IVVRH=        0. VVMIN=     0.0
TFIX1=       0.0 TFIX2=       0.0 ISET =       1.0 ISET =       0.0 ISET =       1.0 ISET =       0.0 RIPA =      0.0
TCOFC=       0.0 TOACO=       0.0 PWGAL=       0.0 PLOC =       0.0 PAREA=       0.0 PERIM=       0.0

CARD TYPE-5.
ZONE DATA.
     J      SPACN(K,J)    MULT(I)    CFMX(I)    CBTU(I)   ALFBR(I)    IPLEN(I)     ZONE LABEL
  (CALC'D)
         1      1.0          1.0      1500.0       0.0        0.0             0     CENTR ZONE
         2      2.0          1.0         0.0       0.0        0.0             0     PERIM.OFF.
         3      3.0          1.0         0.0       0.0        0.0             0     PERIM.OFF.
         4      4.0          1.0         0.0       0.0        0.0             0     PERIM.OFF.
         5      5.0          1.0         0.0       0.0        0.0             0     PERIM.OFF.
*****************************************************************************************************************
PRIMARY EQUIPMENT DESCRIPTION.
CASE NUMBER  1.
CARD TYPE-6.
      102.  ISYS   - SYSTEM COMBINATION NUMBER.
        1.  KBLDG - BUILDING TYPE (1.=CONVENTIONAL OR ON-SITE, 2.=HEAT CONSERVATION).
        3.  M1     - TYPE OF CHILLER.
        4.  M2     - SOURCE OF CHILLER ENERGY.
        1.  M3     - SOURCE OF HEATING ENERGY.
        1.  KREHT - SOURCE OF REHEAT COIL ENERGY.

CARD TYPE-7.
        0.  M6     - TYPE OF AUXILIARY CHILLER.
        0.  M7     - SOURCE OF SUPPLEMENTAL HEAT.
        0.  M4     - NUMBER OF ON-SITE ENGINE GENERATOR SETS.
        0.  M5     - TYPE OF E/G SET.
*****************************************************************************************************************
```

Figure 6.15 REPORT S1 - RECAP OF CARD INPUT DATA

```
CARD TYPE-8.
        2   NUMB  - NUMBER OF BOILERS.
    100.0   SZB   - SIZE OF EACH BOILER (MBH).
      0.0   BON   - HOUR OF SEASONAL BOILER START-UP.
      0.0   BOFF  - HOUR OF SEASONAL BOILER SHUT-DOWN.
 150000.0   HVHO  - HEATING VALUE HEATING OIL

CARD TYPE-9.
        2   NUMC  - NUMBER OF CHILLERS.
    100.0   SZC   - SIZE OF EACH CHILLER (TONS).
      0.0   CON   - HOUR OF SEASONAL CHILLER START-UP.
   8785.0   COFF  - HOUR OF SEASONAL CHILLER SHUT-DOWN.
     10.0   FFLMN - MINIMUM PART LOAD CUT-OFF FOR CHILLERS (PER CENT).
     45.0   TLCHL - CHILLED WATER SET POINT TEMP.
     75.0   TECMN - COOLING TOWER WATER LOW LIMIT TEMPERATURE.

CARD TYPE-10.
     40.0   HDBLP - TOTAL BOILER WATER PUMP HEAD (FT.).
     50.0   HDCLP - TOTAL CHILLED WATER PUMP HEAD (FT.).
     30.0   HDCNP - TOTAL CONDENSER WATER PUMP HEAD (FT.).

CARD TYPE-11.
      0.0   PWOL  - EXTERNAL LIGHTING POWER.
     85.0   EFF   - FAN AND PUMP MOTOR EFFICIENCY (PER CENT).
     55.0   TCO   - BLDG CHANGEOVER TEMP.
 140000.0   HVDF  - HEATING VALUE DIESEL FUEL

CARD TYPE-12.
     12.0   PESTM - BOILER SUPPLY AND ABSORPTION CHILLER ENTERING STEAM PRESSURE (PSIG).
    245.0   TESTM - BOILER SUPPLY AND ABSORPTION CHILLER ENTERING STEAM TEMPERATURE (DEG.F.).
    125.0   PPS   - STEAM TURBINE ENTERING STEAM PRESSURE (PSIG.).
    353.0   TPS   - STEAM TURBINE ENTERING STEAM TEMPERATURE (DEG.F.).
   3600.0   RPM   - STEAM TURBINE SPEED (RPM).

CARD TYPE-13.
        0   KFLCV - TYPE OF FLOOR COVERING.
  0.0       CINSL - FLOOR INSULATION CONDUCTANCE.
  0.0       DINSL - FLOOR INSULATION THICKNESS.

CARD TYPE-14.
      0.0   TLCNM - MAXIMUM ALLOWABLE CONDENSER WATER TEMPERATURE (DEG.F.).
      0.0   TLCMN - WELL OR CITY WATER DESIGN RETURN WATER TEMPERATURE (DEG.F.).
      0.0   TCWIN - CITY WATER SUPPLY TEMPERATURE (DEG.F.).
      0.0   TWWIN - WELL WATER SUPPLY TEMPERATURE (DEG.F.).
      0.0   HDWWP - TOTAL WELL WATER PUMP HEAD (FT.).

CARD TYPE-15.
        0   KSNOW - TYPE OF SNOW MELTING SYSTEM.
      0.0   WSNOW - SNOW MELTING SYSTEM DESIGN LOAD.
      0.0   SAREA - SNOW MELTING SLAB AREA.
```

Figure 6.16 REPORT S1 (CONT'D) - RECAP OF CARD INPUT DATA

```
**********************************************************************************
*                                                                                *
*                                                                                *
*                                                                                *
*                       ANALYSIS OF ENERGY UTILIZATION FOR                       *
*                                                                                *
*                                                                                *
*                             LRC SYSTEMS ENGINEERING                            *
*                                                                                *
*                                                                                *
*                                HAMPTON, VIRGINIA                               *
*                                                                                *
*                                                                                *
*  ENGINEER    - R.JENSEN                                                        *
*  PROJECT NO  - SZ, 4W, 3IN                                                     *
*  DATE        - NOV 26, 1973                                                    *
*                                                                                *
*                                                                                *
**********************************************************************************
```

Figure 6.17 REPORT S2 - TITLE PAGE

LRC SYSTEMS ENGINEERING
SYSTEM SIMULATION AND ENERGY ANALYSIS

HAMPTON, VIRGINIA   NOV 26, 1973   SZ, 4W, 3IN

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	RHFS	36.5	17.7	0.4	5	49280.	6000.	1500.	12.2

Figure 6.18 REPORT S3 - SUMMARY OF ENERGY DISTRIBUTION SYSTEM CHARACTERISTICS

LRC SYSTEMS ENGINEERING
SYSTEM SIMULATION AND ENERGY ANALYSIS   HAMPTON, VIRGINIA   NOV 26, 1973   SZ, 4W, 3IN

SUMMARY OF ZONE AIR FLOWS

FAN SYSTEM	ZONE NUMBER	LOAD SPACE NUMBER	MULT FACTOR	SUPPLY CFM	EXHAUST CFM	SET POINT TEMP.
1	1	1	1	39070.	1500.	75.
1	2	2	1	2887.	0.	75.
1	3	3	1	2329.	0.	75.
1	4	4	1	2737.	0.	75.
1	5	5	1	2257.	0.	75.

Figure 6.19 REPORT S4 - SUMMARY OF ZONE AIR FLOWS

```
 153 1 7 2 9 0  26  25   9   0.00246  29.14998   0.07924   8.87628 2 0.491
SYSTEM NO.   1...REHEAT FAN SYSTEM.
ALFA= 0.12TMA=70.35WMA= 0.009DMA= 0.072DRA(K)= 0.071WRA(K)= 0.010TRA=77.23
WSUP= 0.01064WLVG= 0.00939TLVG= 72.73DLVG=0.0715
   J       QL(L)   QLITE(L)      QSI(I) ZMASS(I)     TS(I)  WZ(I)      QCLNM(I)    QCPNM(I) IHCNM(I)       QHLNM(I)    QHPNM(I) IHHNM(I)
   1      66825.     76318.      97588.  175816.      72.7 0.0102            0.          0.        0             0.          0.        0
   2        223.       748.     -56769.   12991.      92.8 0.0107            0.          0.        0             0.          0.        0
   3        223.       748.     -54249.   10479.      96.1 0.0107            0.          0.        0             0.          0.        0
   4        223.       748.     -64349.   12316.      96.3 0.0107            0.          0.        0             0.          0.        0
   5        223.       748.     -52765.   10157.      96.2 0.0107            0.          0.        0             0.          0.        0
 1            0.0        -50249.8      -253633.1           0.0          0.0          275.8          212.0         54.7
 154 1 7 210 0  27  26   9   0.00270  29.15999   0.07907   9.37992 2 0.491
SYSTEM NO.   1...REHEAT FAN SYSTEM.
ALFA= 0.13TMA=69.91WMA= 0.009DMA= 0.072DRA(K)= 0.071WRA(K)= 0.010TRA=77.36
WSUP= 0.01019WLVG= 0.00917TLVG= 71.37DLVG=0.0717
   J       QL(L)   QLITE(L)      QSI(I) ZMASS(I)     TS(I)  WZ(I)      QCLNM(I)    QCPNM(I) IHCNM(I)       QHLNM(I)    QHPNM(I) IHHNM(I)
   1      66825.     82538.     156498.  175816.      71.4 0.0110            0.          0.        0             0.          0.        0
   2        223.       809.     -52406.   12991.      91.5 0.0102            0.          0.        0             0.          0.        0
   3        223.       809.     -52995.   10479.      95.6 0.0102            0.          0.        0             0.          0.        0
   4        223.       809.     -62952.   12316.      95.9 0.0102            0.          0.        0             0.          0.        0
   5        223.       809.     -50195.   10157.      95.2 0.0102            0.          0.        0             0.          0.        0
 1            0.0            -0.8      -259443.1           0.0          0.0          227.1          212.0         54.7
 155 1 7 211 0  28  26   7   0.00258  29.14998   0.07890   9.48738 2 0.380
SYSTEM NO.   1...REHEAT FAN SYSTEM.
ALFA= 0.16TMA=68.79WMA= 0.009DMA= 0.072DRA(K)= 0.071WRA(K)= 0.011TRA=77.45
WSUP= 0.01100WLVG= 0.00939TLVG= 70.24DLVG=0.0718
   J       QL(L)   QLITE(L)      QSI(I) ZMASS(I)     TS(I)  WZ(I)      QCLNM(I)    QCPNM(I) IHCNM(I)       QHLNM(I)    QHPNM(I) IHHNM(I)
   1      66825.     87382.     204914.  175816.      70.2 0.0106            0.          0.        0             0.          0.        0
   2        223.       857.     -51018.   12991.      91.0 0.0110            0.          0.        0             0.          0.        0
   3        223.       857.     -50799.   10479.      94.8 0.0110            0.          0.        0             0.          0.        0
   4        223.       857.     -60414.   12316.      95.0 0.0110            0.          0.        0             0.          0.        0
   5        223.       857.     -45833.   10157.      93.4 0.0110            0.          0.        0             0.          0.        0
 1            0.0            -0.8      -261610.9           0.0          0.0          358.0          212.0         54.7
 156 1 7 212 0  29  27   7   0.00258  29.12999   0.07868   9.73043 2 0.491
SYSTEM NO.   1...REHEAT FAN SYSTEM.
ALFA= 0.18TMA=67.87WMA= 0.009DMA= 0.072DRA(K)= 0.071WRA(K)= 0.011TRA=77.53
WSUP= 0.00905WLVG= 0.00905TLVG= 69.33DLVG=0.0719
   J       QL(L)   QLITE(L)      QSI(I) ZMASS(I)     TS(I)  WZ(I)      QCLNM(I)    QCPNM(I) IHCNM(I)       QHLNM(I)    QHPNM(I) IHHNM(I)
   1      66825.     91155.     244315.  175816.      69.3 0.0114            0.          0.        0             0.          0.        0
   2        223.       894.     -51953.   12991.      91.3 0.009[illegible]            0.          0.        0             0.          0.        0
   3        223.       894.     -49244.   10479.      94.2 0.0091            0.          0.        0             0.          0.        0
   4        223.       894.     -58623.   12316.      94.4 0.0091            0.          0.        0             0.          0.        0
   5        223.       894.     -40722.   10157.      91.4 0.0091            0.          0.        0             0.          0.        0
 1            1.7             0.0      -264384.9           0.0          0.0            0.0          212.0         54.7
 157 1 7 213 0  30  28   7   0.00284  29.10999   0.07843  10.24951 2 0.491
SYSTEM NO.   1...REHEAT FAN SYSTEM.
ALFA= 0.20TMA=67.09WMA= 0.009DMA= 0.072DRA(K)= 0.071WRA(K)= 0.011TRA=77.58
WSUP= 0.01137WLVG= 0.00910TLVG= 68.55DLVG=0.0720
   J       QL(L)   QLITE(L)      QSI(I) ZMASS(I)     TS(I)  WZ(I)      QCLNM(I)    QCPNM(I) IHCNM(I)       QHLNM(I)    QHPNM(I) IHHNM(I)
   1      66825.     94093.     277778.  175816.      68.6 0.0094            0.          0.        0             0.          0.        0
   2        223.       922.     -53460.   12991.      91.8 0.0114            0.          0.        0             0.          0.        0
   3        223.       922.     -47947.   10479.      93.7 0.0114            0.          0.        0             0.          0.        0
   4        223.       922.     -57130.   12316.      93.9 0.0114            0.          0.        0             0.          0.        0
   5        223.       922.     -36332.   10157.      89.6 0.0114            0.          0.        0             0.          0.        0
 1            0.8             0.0      -267456.3           0.0          0.0          501.6          212.0         54.7
```

Figure 6.20 REPORT S5 - SUMMARY OF HOURLY CALCULATIONS (OPTIONAL)

********************************** L O A D   N O T   M E T   S U M M A R Y **********************************

MONTH	SYSTEM	SYSTEM ZONE NO.	MULTIPLICATION FACTOR	****** COOLING NOT MET ******* LOAD(MBTU)	PEAK(MBH)	HOURS	****** HEATING NOT MET ******* LOAD(MBTU)	PEAK(MBH)	HOURS
JAN	1	1	1	0.	0.	9	0.	0.	0
JAN	1	2	1	0.	0.	0	0.	0.	0
JAN	1	3	1	0.	0.	0	0.	0.	0
JAN	1	4	1	0.	0.	0	0.	0.	0
JAN	1	5	1	0.	0.	0	0.	0.	0
JAN	CHILLERS AND BOILERS			0.	0.	0	0.	0.	0
FEB	1	1	1	0.	0.	16	0.	0.	0
FEB	1	2	1	0.	0.	0	0.	0.	0
FEB	1	3	1	0.	0.	0	0.	0.	0
FEB	1	4	1	0.	0.	0	0.	0.	0
FEB	1	5	1	0.	0.	0	0.	0.	0
FEB	CHILLERS AND BOILERS			0.	0.	0	0.	0.	0
MAR	1	1	1	5652.	697.	46	0.	0.	0
MAR	1	2	1	90.	22.	7	0.	0.	0
MAR	1	3	1	49.	14.	6	0.	0.	0
MAR	1	4	1	65.	16.	6	0.	0.	0
MAR	1	5	1	108.	25.	10	0.	0.	0
MAR	CHILLERS AND BOILERS			0.	0.	0	0.	0.	0

Figure 6.21 REPORT S6 - SUMMARY OF LOADS NOT MET

LRC SYSTEMS ENGINEERING HAMPTON, VIRGINIA NOV 26, 1973 SZ, 4W, 3IN
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF EQUIPMENT SIZES

TYPE OF CHILLER = OPEN CENTRIFUGAL
NO. OF CHILLERS = 2
SIZE OF CHILLERS = 150.0 TONS

TYPE OF BOILER = GAS
NO. OF BOILERS = 2
SIZE OF BOILERS = 1000.0 MBTU

TOTAL HEATING CAPACITY = 2000.0 MBTU
TOTAL COOLING CAPACITY = 300.0 TONS

TYPE OF TERMINAL REHEAT - GAS

COOLING TOWER FAN REQUIREMENT 90000. CFM 1.0 IN. S.P. 16.7 BHP

BOILER AUXILIARY HORSEPOWER REQUIREMENT (FAN,BLOWER,PUMP) 3.0 BHP

TOTAL FAN PLANT HORSEPOWER FOR BUILDING 54.7 BHP

SUMMARY OF PUMP SIZES

LOCATION	TOTAL GPM	TOTAL HEAD (FT)	TOTAL BHP
CHILLED WATER	720.	50.0	17.8
CONDENSER WATER	900.	30.0	13.4
HEATING WATER	200.	40.0	4.0

Figure 6.22 REPORT S7 - SUMMARY OF EQUIPMENT CAPACITIES

EQUIPMENT AND ENERGY CONSUMPTION ANALYSIS	I FACILITY/ADDRESS LRC SYSTEMS ENGINEERING HAMPTON, VIRGINIA	I DATE/PROJECT NOV 26, 1973 SZ, 4W, 3IN	I USER AND SYSTEM IDENTIFICATION R.JENSEN SYSTEM NO. 102

ENERGY CONSUMPTION

	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
MONTHLY BTU/1000						
MAX. DEMAND	-489.7	-420.1	-295.1	-60.3	-0.0	-0.0
CONSUMPTION	-191045.1	-155726.3	-114348.4	-60.4	-0.1	-0.0
MAX. DEMAND	0.0	0.0	0.0	1351.6	1386.2	2104.3
CONSUMPTION	0.0	0.0	0.0	43153.9	86051.1	316318.8
ELECTRICITY						
LIGHTS AND BUILDING EQUIPMENT						
INTERNAL						
DEMAND(KW)	212.0	212.0	212.0	212.0	212.0	212.0
CONS.(KWH)	51304.0	44308.0	48972.0	51304.0	51304.0	46640.0
EXTERNAL						
DEMAND(KW)	0.0	0.0	0.0	0.0	0.0	0.0
CONS.(KWH)	0.0	0.0	0.0	0.0	0.0	0.0
HEAT (INCL. BOILER AND AUXILIARIES, AND HOT WATER PUMPS						
DEMAND(KW)	5.2	5.2	5.2	5.2	5.2	5.2
CONS.(KWH)	3729.7	3481.1	3185.8	2227.5	1434.9	150.2
COOL (INCL. CHILLERS, WATER PUMPS, AND COOLING TOWER FAN						
DEMAND(KW)	0.0	0.0	23.2	92.8	97.3	128.6
CONS.(KWH)	0.0	0.0	2999.2	9135.4	15766.8	33739.0
FANS						
DEMAND(KW)	40.8	40.8	40.8	40.8	40.8	40.8
CONS.(KWH)	29354.3	27397.4	30332.8	29354.3	30332.8	29354.3
TOTAL						
DEMAND(KW)	258.0	258.0	276.0	345.6	350.1	381.4
CONS.(KWH)	84387.9	75186.4	85489.7	92021.1	98838.4	109883.4
GAS						
HEAT						
DEMAND(THERMS)	6.1	5.3	3.7	0.8	0.0	0.0
CONS.(THERMS)	2388.2	1946.7	1429.4	0.8	0.0	0.0
COOL						
DEMAND(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0
CONS.(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0
GENERATION						
DEMAND(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0
CONS.(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL						
DEMAND(THERMS)	6.1	5.3	3.7	0.8	0.0	0.0
CONS.(THERMS)	2388.2	1946.7	1429.4	0.8	0.0	0.0

Figure 6.23 REPORT S8 - MONTHLY AND ANNUAL ENERGY SUMMARY

EQUIPMENT AND ENERGY CONSUMPTION ANALYSIS	FACILITY/ADDRESS	DATE/PROJECT	USER AND SYSTEM IDENTIFICATION
	LRC SYSTEMS ENGINEERING	NOV 26, 1973	R.JENSEN
	HAMPTON, VIRGINIA	SZ, 4W, 3IN	SYSTEM NO. 102

ENERGY CONSUMPTION

	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
MONTHLY BTU/1000							
MAX. DEMAND	-0.0	-0.0	-0.0	-0.0	-0.0	-366.5	
CONSUMPTION	-0.0	-0.0	-0.2	-0.3	-0.2	-52230.1	-513410.8
MAX. DEMAND	2041.2	3066.6	0.0	0.0	0.0	0.0	
CONSUMPTION	381186.0	355371.8	0.0	0.0	0.0	0.0	1182081.0
ELECTRICITY							
LIGHTS AND BUILDING EQUIPMENT							
INTERNAL							
DEMAND(KW)	212.0	212.0	212.0	212.0	212.0	212.0	
CONS.(KWH)	51304.0	51304.0	46640.0	53636.0	46640.0	46640.0	589996.0
EXTERNAL							
DEMAND(KW)	0.0	0.0	0.0	0.0	0.0	0.0	
CONS.(KWH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAT (INCL. BOILER AND AUXILIARIES, AND HOT WATER PUMPS							
DEMAND(KW)	0.0	5.2	5.2	5.2	5.2	5.2	
CONS.(KWH)	0.0	36.3	238.3	761.5	3035.6	3823.0	22103.8
COOL (INCL. CHILLERS, WATER PUMPS, AND COOLING TOWER FAN							
DEMAND(KW)	128.8	197.9	23.2	23.2	23.2	23.2	
CONS.(KWH)	38769.3	36836.7	15668.5	13878.6	3115.5	139.5	170048.3
FANS							
DEMAND(KW)	40.8	40.8	40.8	40.8	40.8	40.8	
CONS.(KWH)	30332.8	30332.8	29354.3	30332.8	29354.3	30332.8	489.3
TOTAL							
DEMAND(KW)	381.6	450.7	276.0	276.0	276.0	258.0	
CONS.(KWH)	120406.0	118509.7	91901.0	98608.8	82145.3	80935.1	1138312.0
GAS							
HEAT							
DEMAND(THERMS)	0.0	0.0	0.0	0.0	0.0	4.6	
CONS.(THERMS)	0.0	0.0	0.0	0.0	0.0	652.9	6417.9
COOL							
DEMAND(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0	
CONS.(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GENERATION							
DEMAND(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0	
CONS.(THERMS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL							
DEMAND(THERMS)	0.0	0.0	0.0	0.0	0.0	4.6	
CONS.(THERMS)	0.0	0.0	0.0	0.0	0.0	652.9	6417.9

Figure 6.24 REPORT S8 (CONT'D) - MONTHLY AND ANNUAL ENERGY SUMMARY

EQUIPMENT AND ENERGY CONSUMPTION ANALYSIS	FACILITY/ADDRESS LRC SYSTEMS ENGINEERING HAMPTON, VIRGINIA	DATE/PROJECT NOV 26, 1973 SZ, 4W, 3IN	USER AND SYSTEM IDENTIFICATION R.JENSEN SYSTEM NO. 102

	ENERGY CONSUMPTION					
	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
CITY WATER						
DEMAND (K GALS)	0.1	0.1	0.2	0.1	0.1	0.1
CONS. (K GALS)	30.4	28.2	28.4	15.5	19.6	50.9

Figure 6.25 REPORT S8 (CONT'D) - MONTHLY AND ANNUAL ENERGY SUMMARY

EQUIPMENT AND ENERGY CONSUMPTION ANALYSIS	FACILITY/ADDRESS LRC SYSTEMS ENGINEERING HAMPTON, VIRGINIA	DATE/PROJECT NOV 26, 1973 SZ, 4W, 3IN	USER AND SYSTEM IDENTIFICATION R.JENSEN SYSTEM NO. 102

ENERGY CONSUMPTION

	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
CITY WATER							
DEMAND (K GALS)	0.0	0.0	0.2	0.3	0.1	0.1	
CONS. (K GALS)	60.6	57.1	19.1	34.5	24.0	29.1	397.3

Figure 6.26 REPORT S8 (CONT'D) - MONTHLY AND ANNUAL ENERGY SUMMARY

1.	8785.	1.	5.	0.	1.	1.		SS-1
								SS-2
-15.	60.	220.	140.	HOT WATER				SS-3A
55.	85.	55.	95.	2PIU AIR-S				SS-3B
55.	95.	55.	70.	PRIMARYAIR				SS-3C
-15.	55.	90.	115.	HOT DECK				SS-3D
55.	85.	55.	65.	COLD DECK				SS-3E
13.	5.	50.	1.	6000.	3.			SS-4A
2.		4.0	2.0	1.5				SS-4B
		1.		1.				SS-4C
								SS-4D
1.		1500.					CENTR ZONE	SS-5A
2.							PERIM.OFF.	SS-5B
3.							PERIM.OFF,	SS-5C
4.							PERIM.OFF.	SS-5D
5.							PERIM.OFF.	SS-5E
102.	1.	3.	4.	1.	1.			SS-6
								SS-7
2.	1000.	8533.	2161.					SS-8
2.	150.	2161.	5833.	10.	45.	75.		SS-9
40.	50.	30.						SS-10
0.	85.	55.						SS-11
								SS-12
								SS-13
								SS-14
								SS-15

Figure 6.27 SYSTEM AND EQUIPMENT SIMULATION PROGRAM LISTING OF TYPICAL INPUT DATA

SECTION 7
OWNING AND OPERATING COST ANALYSIS PROGRAM

7.1 OBJECTIVE AND DESCRIPTION

The Owning and Operating Cost Analysis Program performs a life cycle cost analysis for each building heating and cooling system analyzed by the Systems and Equipment Simulation Program. 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.

Most of the burden of assembling the cost data required by the program is placed upon the user. During these times of escalating costs for energy, fuel, material and labor, it is impractical to expect the Owning and Operating Cost Analysis Program to accurately and automatically account for these factors.

7.2 INPUT DATA

Only the punched card form of input data is required for the Owning and Operating Cost Analysis Program. Instructions for the preparation of this data are given in Table 7.1.

7.3 OUTPUT REPORT

An owning and operating cost report similar to that shown in Figure 7.1 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 present worth techniques.

7.4 EXAMPLE

To illustrate the use of the Owning and Operating Cost Analysis Program with the example facility, the input data shown in Figure 7.2 was used to exercise the program. Output received back can be found in Appendix C.

Table 7.1

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING CARD	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
OC-1	1 to 35	Header 1, e.g. Facility Name	FAC	-	-	-	Engr.Bldg.	Any alphanumeric character can be used.
OC-2	1 to 35	Header 2, e.g. Facility Location	CITY	-	-	-	Hampton,Va.	"
OC-3	1 to 35	Header 3, e.g. Name of Engineer	ENGR	-	-	-	R. Jensen	"
OC-4	1 to 15	Header 4, e.g. Project Number	PROJ	-	-	-	NAS1-12843	"
OC-5	1 to 15	Header 5, e.g. date	DATE	-	-	-	July, '74	"
OC-6	1 to 10	Building Life	BLGLF	Years	-	-	40.	—
OC-7	1 to 10	Annual Interest Rate	RINT	%	-	-	10.	—
	11 to 20	Annual Increase of Labor Cost	RINL	%	-	-	8.	—
	21 to 30	Annual Increase of Material Cost	RINM	%	-	-	15.	—
	31 to 40	Annual Increase of Floor Space Cost	RINF	%	-	-	10.	—
	41 to 50	Annual Increase of Energy & Fuel Cost	RINE	%	-	-	5.	—
OC-8	1 to 10	Unit Cost of Electricity	CELE	$/KW	-	-	0.04	—
	11 to 20	Unit Cost of Gas	CGAS	$/therm	-	-	0.03	—
	21 to 30	Unit Cost of Oil	COIL	$/gal	-	-	0.35	—
	31 to 40	Unit Cost of Purchased Steam	CSTM	$/1000 lbs	-	-	1.25	—
	41 to 50	Unit Cost of City Water	CWAT	$/1000 gals	-	-	0.75	—
	51 to 60	Unit Cost of Diesel Fuel	CFUL	$/gal	-	-	0.35	—
	61 to 70	Unit Demand Cost of Electricity	DELEC	$/KW	-	-	2.20	—

Table 7.1 (Continued)

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	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 80**	**System Description Label**	DESC	-	-	-	Var.Vol./ Cent.Chllr/ Gas Boiler	
OC-11	1 to 10	Number of Energy Categories	ENCAT	-	1 to 15	-	10.	
	READING ORDER OC-12 SHOULD BE REPEATED "ENCAT" TIMES.							
OC-12	1 to 10	Energy Type	ETYPE	-	1 to 6	1 Electric 2 Gas 3 Oil 4 Steam 5 Water 6 Diesel Fuel	1.	
	11 to 20	Annual Consumption	ECONS	KW, Therms, Gals.1000 lbs 1000 gals	-	-	564923.	
	21 to 50	Energy Category Label	ENLAB	-	-	-	Cooling	
	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 7.1 (Continued)

OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT INFORMATION

READING ORDER	COLUMNS	INPUT VARIABLE DESCRIPTION	PROGRAM SYMBOL	UNITS	LIMIT VALUES	CODE	EXAMPLE	COMMENTS
OC-13	1 to 10	Number of Equipment Categories	EQCAT	-	1 to 15	-	8.	
READING ORDERS OC-13 AND OC-14 SHOULD BE REPEATED "EQCAT" TIMES.								
OC-14	1 to 30	Equipment Category Label	EQLAB	-	-	-	Chillers	
	31 to 40	Installed Cost of Equipment	COST	$	-	-	10000.	
	41 to 50	Expected Life of Equipment	LIFE	Years	-	-	20.	
	51 to 60	Is Resale Value to be considered?	SV	-	-	0 No 1 Yes	0.	Based on straight-line depreciation.
	61 to 70	Major Overhaul Period	OHPD	Years	-	-	10.	
OC-15	1 to 10	Estimated Annual Maintenance Labor Cost	AML	$	-	-	1000.	
	11 to 20	Estimated Annual Maint. Material Cost	AMM	$	-	-	500.	
	21 to 30	Estimated Major Overhaul Labor Cost	OHL	$	-	-	5000.	
	31 to 40	Estimated Major Overhaul Material Cost	OHM	$	-	-	4000.	
	41 to 50	Estimated Cost of Floor Space Occupied by Equipment	FLR	$	-	-	100.	

```
*******************************************************************************
*                                                                             *
*                                                                             *
*                                                                             *
*                 OWNING AND OPERATING COST ANALYSIS FOR                      *
*                                                                             *
*                                                                             *
*                        LRC SYSTEMS ENGINEERING                              *
*                                                                             *
*                                                                             *
*                               BUILDING                                      *
*                                                                             *
*                                                                             *
*                             HAMPTON, VA                                     *
*                                                                             *
*                                                                             *
*  ENGINEER    - R. JENSEN                                                    *
*  PROJECT NO  - NAS1-12843                                                   *
*  DATE        - JULY 10, 1974                                                *
*                                                                             *
*                                                                             *
*******************************************************************************
```

Figure 7.1 OWNING AND OPERATING COST ANALYSIS PROGRAM OUTPUT REPORT

**************** INPUT ASSUMPTIONS *************

BUILDING LIFE	40.00 YEARS
ANNUAL INTEREST RATE	12.00 PERCENT
ESTIMATED LABOR WAGE ANNUAL INCREASE	8.00 PERCENT
ESTIMATED MATERIAL COST ANNUAL INCREASE	15.00 PERCENT
ESTIMATED FLOOR SPACE COST ANNUAL INCREASE	10.00 PERCENT
ESTIMATED ENERGY COST ANNUAL INCREASE	10.00 PERCENT

Figure 7.1 (CONT'D) OWNING AND OPERATING COST ANALYSIS PROGRAM OUTPUT REPORT

ANALYSIS FOR - SYSTEM NO. 1 - MULTI ZONE W/BASEBOARD, CENTRIFUGAL CHILLERS, STEAM HEAT OC-10

ENERGY COST SUMMARY

	ENERGY UNIT COSTS CONS. ($)	ENERGY UNIT COSTS DEMAND ($)	CONSUMPTION	DEMAND	TOTAL COST ($)	ANNUITY ($)
ELECTRICITY						
LIGHTING						
HEATING-BOILER PUMPS, CONTROLS	0.03	1.50	520000. KW	2400. KW	19200.	
COOLING-CHILLER, PUMPS, TOWER	0.03	1.50	57658. KW	5600. KW	7129.	
FANS-SUPPLY, RETURN, EXHAUST	0.03	1.50	205446. KW	4500. KW	13363.	
	0.03	1.50	359160. KW	1200. KW	12574.	
			1142264. KW		52267.	179103.
STEAM						
HEATING						
WATER	1.50	0.00	1830. K LBS	0. K LBS	2745.	9406.
TOWER MAKE-UP						
	0.75	0.00	389. K GALS	0. K GALS	291.	999.
GRAND TOTALS					55304.	189509.

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
CHILLER, TOWER, PUMPS, PIPING	80000.	40	YES	10	800.	200.	16800.	8000.	8000.	147530.
BOILER, PUMPS, PIPING	20000.	40	YES	10	200.	50.	1000.	1000.	2000.	20617.
DISTRIBUTION SYSTEMS, CONTROLS	175000.	40	YES	10	1750.	400.	8750.	8750.	10000.	154702.
TOTAL SYSTEMS AND EQUIPMENT ANNUITY										322057.

TOTAL OWNING AND OPERATING ANNUITY 512365. 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.

Figure 7.1 (CONT'D) OWNING AND OPERATING COST ANALYSIS PROGRAM OUTPUT REPORT

```
LRC SYSTEMS ENGINEERING                                                                 OC-1
HAMPTON, VA                                                                             OC-2
R. JENSEN                                                                               OC-3
NAS1-12843                                                                              OC-4
JULY 10, 1974                                                                           OC-5
40.                                                                                     OC-6
12.        8.         15.        10.        10.                                         OC-7
.03        .04        .05        1.50       .75        .50        1.50                  OC-8
1.0                                                                                     OC-9
SYSTEM NO. 1 - MULTI ZONE W/BASEBOARD, CENTRIFUGAL CHILLERS, STEAM HEAT
6.                                                                                      OC-11
1.         520000.    LIGHTING                                                          OC-12
200.       200.       200.       200.       200.       200.       200.                  OC-12A
200.       200.       200.       200.       200.                                        OC-12B
1.         57658.     HEATING-BOILER PUMPS, CONTROLS                                    OC-12
300.       300.       300.       300.       300.       300.       300.                  OC-12A
300.       300.       300.       300.       300.                                        OC-12B
1.         265446.    COOLING-CHILLER, PUMPS, TOWER                                     OC-12
400.       400.       400.       400.       400.       400.       400.                  OC-12A
400.       400.       400.       400.       400.                                        OC-12B
1.         359160.    FANS-SUPPLY, RETURN, EXHAUST                                      OC-12
100.       100.       100.       100.       100.       100.       100.                  OC-12A
100.       100.       100.       100.       100.                                        OC-12B
4.         1830.      HEATING                                                           OC-12
5.         389.       TOWER MAKE-UP                                                     OC-12
3.                                                                                      OC-13
CHILLER, TOWER,PUMPS,PIPING      80000.     40.        1.         10.                   OC-14
16000.     8000.      800.       200.       8000.                                       OC-15
BOILER, PUMPS, PIPING            20000.     40.        1.         10.                   OC-14
1000.      1000.      200.       50.        2000.                                       OC-15
DISTRIBUTION SYSTEMS, CONTROLS175000.       40.        1.         10.                   OC-14
8750.      8750.      1750.      440.       10000.                                      OC-15
```

Figure 7.2 OWNING AND OPERATING COST ANALYSIS PROGRAM CARD INPUT FOR EXAMPLE BUILDING

SECTION 8
THERMAL LOAD PLOT PROGRAM

This program plots the hourly sensible loads for the building by space, or by building total for four days. The loads are printed in graph form on the line printer. The maximum and minimum loads are scaled to fit the page, and the scaling factors are printed out as the Y-axis of the plot. The X-axis is the hour of the year.

The input to the program is the start date, in the form of Month, Day, and the space for which the plot is desired. A space number of zero means that the building total sensible load is desired. The columns 21 to 80 contain the title for the plot. It is suggested that this title include the date. The program will make any number of plots, and will stop when it reads a card with -1 in columns 1 and 2.

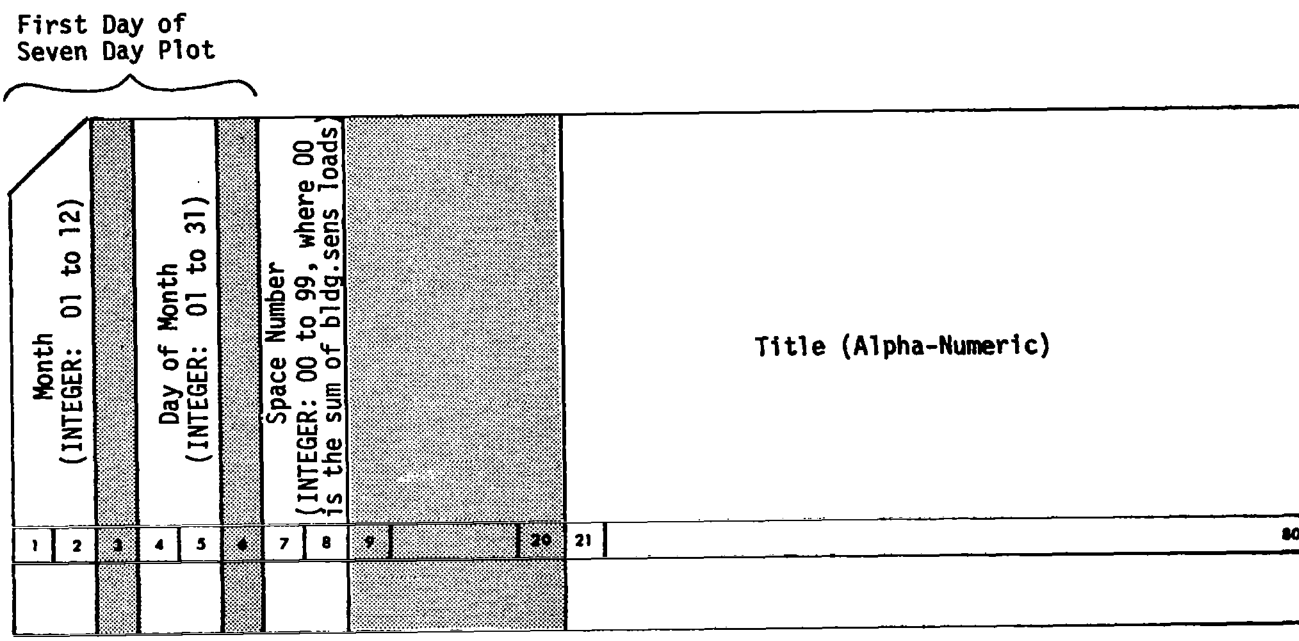


Figure 8.1 THERMAL LOAD PLOT PROGRAM FORM

SECTION 9
TVT--TEMPERATURE VERSUS TEMPERATURE PROGRAM

The function of this program is to plot coincident occurrences of ambient dry-bulb and distribution system primary temperatures. See Figure 9.2 for an example of the program's output.

The x-axis represents "hot" or "cold" deck temperature, while the y-axis is ambient dry-bulb temperature. The definition of hot and cold deck temperatures depends on the type of distribution system being plotted. They are defined as shown in Table 9.1.

The primary use of the program is in determining a fan system's optimum temperature as a function of ambient temperature. Deck temperature optimization applies to multi-zone, dual duct, and reheat fan systems. To use it as such, a solid state type temperature controller is simulated in the system simulation program. It selects the warmest cold deck and coolest hot deck which, for that time increment, will satisfy the requirements of the spaces. This data, when plotted by TVT, will show a characteristic relationship between system and ambient temperatures.

TVT card input requirements are defined in Figure 9.1 below. One card is required for each set of hot and cold deck plots. The data includes start time, stop time, distribution system number (a "K" number) and the title. There is no restriction to the number of plots which may be made by a TVT run. To terminate the program, the last card of the input deck should have -1 in the first two columns.

Start Month (01 to 12)		Start Day of Month (01 to 31)		Stop Month (01 to 12)		Stop Day of Month (01 to 31)		Distribution System Number		TITLE/COMMENTS (Alpha/Numeric)
1 2	3	4 5	6	7 8	9	10 11	12	13 14	15 20	21 80

Figure 9.1 TEMPERATURE VS TEMPERATURE PROGRAM INPUT FORM

The organization of data on the tape (generated by the system and equipment simulation program) read by TVT is outlined in Figure 9.3 These variables are defined in Table 9.2.

Table 9.1 DEFINITION OF HOT AND COLD DECK SYSTEM TEMPERATURES

System Number	Type[1]	"Hot Deck"	Cold Deck[2]
1	SZFB	AHU Leaving Air Temperature	-
2	MZS	Hot Deck Air Temperature	Cold Deck Air Temperature
3	DDS	Hot Deck Air Temperature	Cold Deck Air Temperature
4	SZRH	AHU Leaving Air Temperature	-
5	UVT	" " " "	-
6	UHT	" " " "	-
7	FPH	Floor Panel Temperature	-
8	2PFC	Discharge Temperature of	-
9	4PFC	Last Zone's Fancoil	-
10	2PIU	AHU Leaving Air Temperature	-
11	4PIU	" " " " (Constant)	-
12	VAVS	AHU Leaving Air Temperature (Constant)	-
13	RHFS	AHU Leaving Air Temperature	-

[1] See Table 6.1, User Manual, for definition of system types.

[2] Where cold deck does not apply, deck temperature is set equal to 0.0.

SYSTEM SIMULATION PLOT (PLOTSE) ...SPRING .. SYST*M.= 1.

SYSTEM TEMPERATURE (DEG. F.)

APB. TEMP	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	30
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	31
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	3	0	0	0	0	32
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	1	0	0	0	0	33
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	1	0	0	0	0	0	0	34
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	5	0	0	0	0	0	0	0	35
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	7	3	2	2	0	0	0	0	0	0	36
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	4	4	4	3	0	0	0	0	0	0	37
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	6	7	3	0	0	0	0	0	0	0	38
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	7	4	4	0	0	0	0	0	0	0	0	39
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6	8	3	1	0	0	0	0	0	0	0	0	40
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	8	7	5	0	0	0	0	0	0	0	0	0	41
42	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	13	13	6	0	0	0	0	0	0	0	0	0	42
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	10	15	1	0	0	0	0	0	0	0	0	0	43
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	18	3	0	0	0	0	0	0	0	0	0	0	44
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	16	1	0	0	0	0	0	0	0	0	0	0	45
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	4	0	0	0	0	0	0	0	0	0	0	0	46
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	23	0	0	0	0	0	0	0	0	0	0	0	47
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	48
49	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	49
50	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	50
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	51
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	52
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	53
54	0	0	0	0	0	0	0	1	1	2	2	0	0	0	0	54	0	0	0	0	0	0	0	0	0	0	0	54
55	0	0	0	0	0	0	0	3	7	9	1	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	55
56	0	0	0	0	0	1	3	0	9	5	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	56
57	0	0	0	0	1	0	3	10	10	8	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	57
58	0	0	0	1	0	3	6	14	14	2	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	58
59	0	0	0	0	2	4	15	20	10	1	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	59
60	0	0	0	2	2	4	21	13	1	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	60
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	2	0	1	2	0	0	1	0	0	0	61
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	1	1	2	3	0	0	0	0	0	62
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	1	1	2	2	2	0	0	0	0	63
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	43	1	0	0	1	0	1	0	0	0	0	64
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	52	0	1	2	0	0	0	1	0	0	65
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	37	0	0	1	0	0	0	0	0	0	66
67	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	5	35	0	0	0	0	0	0	0	0	0	67
68	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	12	52	0	0	0	0	0	0	0	0	0	68
69	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	5	13	31	0	0	0	0	0	0	0	0	0	69
70	0	0	0	0	0	0	0	0	0	0	1	0	2	1	4	9	25	42	0	0	0	0	0	0	0	0	0	70
71	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	6	18	14	0	0	0	0	0	0	0	0	0	71
72	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7	14	12	0	0	0	0	0	0	0	0	0	72
73	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	11	17	5	0	0	0	0	0	0	0	0	0	73
74	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	15	9	3	2	0	0	0	0	0	0	0	0	74
75	0	0	0	0	0	0	0	0	0	0	2	1	3	4	8	24	9	1	0	0	0	0	0	0	0	0	0	75
76	0	0	0	0	0	0	0	0	0	0	0	0	3	1	5	11	2	0	0	0	0	0	0	0	0	0	0	76
77	0	0	0	0	0	0	0	0	0	0	0	2	1	3	11	4	5	0	0	0	0	0	0	0	0	0	0	77
78	0	0	0	0	0	0	0	0	0	0	0	2	5	7	6	5	0	1	0	0	0	0	0	0	0	0	0	78
79	0	0	0	0	0	0	0	0	0	0	0	3	3	10	6	4	0	0	0	0	0	0	0	0	0	0	0	79
80	0	0	0	0	0	0	0	0	0	0	0	0	5	8	8	3	0	0	0	0	0	0	0	0	0	0	0	80
81	0	0	0	0	0	0	0	0	0	0	1	7	11	7	3	2	0	0	0	0	0	0	0	0	0	0	0	81
82	0	0	0	0	0	0	0	0	1	0	2	8	10	5	1	0	0	0	0	0	0	0	0	0	0	0	0	82
83	0	0	0	0	0	0	0	0	1	0	2	4	10	2	2	0	0	0	0	0	0	0	0	0	0	0	0	83
84	0	0	0	0	0	0	0	0	1	2	2	1	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	84
85	0	0	0	0	0	0	0	0	3	3	7	2	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	85
86	0	0	0	0	0	0	0	1	2	6	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86

Figure 9.2 SAMPLE TVT PROGRAM OUTPUT

VARIABLE	FORTRAN FORMAT
FAC	35A1
CITY	35A1
ENGR	35A1
PROJ	15A1
DATE	15A1
j=1,NCASE	
ISYS,KMAX,IHSRT,IHSTP	4I10
i=IHSRT,IHSTP	
IHOUR,IMOY,IDOM,IHOD, ITOA,ITWB,WOA,PATM, DOA,TNFBP,TABCD,BGAS,OILH	I4,3I2,2I4, 3F8.5,4F8.1
k=1,KMAX	
$KFAN_k$,QKC_k,QKH_k,$QKKW_k$,$PWLK_k$, $H2OK_k$,ZERO,$TKHL_k$,$TKCD_k$	I3,3F12.0, 3F10.1,2F5.1

Figure 9.3 ORGANIZATION OF SYSTEM AND EQUIPMENT SIMULATION PROGRAM OUTPUT TAPE

Table 9.2 DEFINITION OF SYSTEM AND EQUIPMENT SIMULATION PROGRAM OUTPUT TAPE VARIABLES

VARIABLE	DESCRIPTION	FIELD
FAC	Facility	35A1
CITY	Location	35A1
ENGR	User Name	35A1
PROJ	Project ID.	15A1
DATE	Date	15A1
ISYS	System Combination No.	I10
KMAX	No. Distribution Systems	I10
IHSRT	Start Hour (hour of year)	I10
IHSTP	Stop Hour (hour of year)	I10
IHOUR	Current Hour (hour of year)	I4
IMOY	Month of Year (1 - 12)	I2
IDOM	Day of Month (1 - 31)	I2
IHOD	Hour of Day	I2
ITOA	Ambient Dry-Bulb Temperature (^oF)	I4
ITWB	Ambient Wet-Bulb Temperature (^oF)	I4
WOA	Ambient Humidity Ratio (lbs-H_2O/lb-dry air)	F8.5
PATM	Barometric Pressure (in. Hg)	F8.5
DOA	Ambient Air Density (lbm/ft^3)	F8.5
TNFBP	Total Net Fan Brake horsepower (bhp)	F8.1
TABCD	Total Power of Building (KW)	F8.1
BGAS	Building Natural Gas Requirement (therms)	F8.1
OILH	Building Heating Oil Requirement (gals)	F8.1
$KFAN_k$	Energy Distribution System Type No. (1 - 13)	I3
QKC_k	System Cooling Requirement (Btu)	F12.0
QKH_k	System Heating Requirement (less elect.resist. re-htg.) (Btu)	F12.0
$QKKW_k$	Electric Resistance Reheat Requirement (Btu)	F12.0
$PWLK_k$	Base Power Requirement of Zones served by this system (KW)	F10.1
$H2OK_k$	Humidification Water Requirement (lbs H_2O)	F10.1
ZERO	Reserved (=0.0)	F10.1
$TKHL_k$	Hot Deck Temperature or AHU Leaving Temperature (^oF)	F5.1
$TKCD_k$	Cold Deck Temperature (^oF)	F5.1

APPENDIX A

INSTRUCTIONS FOR DIMENSION STATEMENT ALTERATION

INSTRUCTIONS FOR DIMENSION STATEMENT ALTERATION

Certain variables in the Thermal Load Analysis Program 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.

The dimension statements which require change in the variable temperature program are given in Table A2.

LOAD PROGRAM GLOSSARY

A	Building	: 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
G		: Number of underground walls in building
H		: Number of underground floors in building
I	Delayed, Quick Window	: Maximum number of sides of any exterior heat transfer surface
J		: Maximum number of sides of any exterior heat transfer or shading surfaces $(J \geq I)$
K		: Maximum number of shading surfaces deleted from any exterior heat transfer surface
L	Delayed	: Maximum number of shading surfaces deleted from a delayed heat transfer surface $(L \leq K)$
M		: Maximum number of shading surfaces added to a delayed heat transfer surface
N		: Maximum number of sides of a delayed heat transfer surface
O		: Maximum number of sides of a shading surface added to a delayed heat transfer surface
P	Quick	: Maximum number of shading surfaces deleted from a quick heat transfer surface $(P \leq K)$
Q		: Maximum number of shading surfaces added to a quick heat transfer surface
R		: Maximum number of sides of a quick heat transfer surface
S		: Maximum number of sides of a shading surface added to a quick heat transfer surface
T		: Maximum number of shading surfaces deleted from a window $(T \leq K)$

GLOSSARY (CONT'D)

U	Window	:	Maximum number of shading surfaces added to a window
V		:	Maximum number of sides of a window
W		:	Maximum number of sides of a shading surface added to a window
X	Common	:	Number of common shading surfaces
Y		:	Maximum number of sides of a common shading surface
Z	Added	:	Maximum number of shading surfaces added to any exterior heat transfer surface
AA		:	Maximum number of sides of a shading surface added to any exterior surface
AB	Spaces	:	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
AE		:	Maximum number of underground walls in a space
AF		:	Maximum number of underground floors in a space
AG		:	Maximum number of windows in a space
AH	Shading	:	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 commons - number of deletions + number of additions) for any exterior heat transfer surface
AM		:	Maximum number of sides of any shading surface, common or added +3
AN AO		:	Fineness of division of exterior heat transfer surface for shadow analysis (corresponds to x and y divisions of a surface)

TABLE A1

DIMENSION STATEMENTS WHICH REQUIRE CHANGE

MAIN ROUTINE

```
 DIMENSION                                                                LOAD0027
1      QU( A ),    SUMA( A ),    SUMB( A ),    SUMC( A ),   HRLDL( A ),   LOAD0028
1 RMRIS1( A ), RMRISC( A ), RATRIS( A ), RMRPS1( A ), RMRPSC( A ),        LOAD0029
1 RATRPS( A ),  RMRX1( A ),  RMRXC( A ),  RATRX( A ),  RMRG1( A ),        LOAD0030
1  RMRGC( A ),  RATRG( A ),     H1( A ),     H2( A ),     H3( A ),        LOAD0031
1    WOF( A ),  NIHTS( A ),     NQ( A ),     ND( A ),    NUW( A ),        LOAD0032
1    NUF( A ),     NW( A ),  PLITE( A ),  ILITE( A ),  NFOLK( A ),        LOAD0033
1  HASSL( A ),  TSPAC( A ),    QEQ( A ),   IWOO( A ),  QIHTS( A ),        LOAD0034
1    VOL( A ), SSHMAX( A ), STCMAX( A ), CODINF( A ), QEQLAT( A ),        LOAD0035
1  FLORA( A ),  TROOM( A ),    QUW( A ),    QUF( A ),   MULT( A ),        LOAD0036
1  IPICK( A ),   HTNZ( A ),  CFMEX( A )                                   LOAD036A
 DIMENSION                                                                LOAD0037
1      AD( B ),     WTD( B ),     WAD( B ),     NVD( B ),     NXD( B ),   LOAD0038
1     NYD( B ),     NDD( B ),     NAD( B ),   SHADD( B ,24),ROGD( B ),    LOAD0039
1     ISD( B ),     ABD( B ),     IRF( B ), QSTORD( B ),  ICALD( B ),     LOAD0040
1      QN( B ,3),    QR( B ,3),  SUMN( B ,3),  SUMR( B ,3),               LOAD0041
1   CINFD( B ),    CFMD( B )                                              LOAD041A
 DIMENSION                                                                LOAD0042
1      AQ( C ),     WTQ( C ),     WAQ( C ),     NVQ( C ),     NXQ( C ),   LOAD0043
1     NYQ( C ),     NDQ( C ),     NAQ( C ),   SHADQ( C ,24),ROGQ( C ),    LOAD0044
1     ISQ( C ),     ABQ( C ),      UQ( C ), QSTORQ( C ),  ICALQ( C ),     LOAD0045
1   CINFQ( C ),    CFMQ( C ), QPERIM( C )                                 LOAD045A
 DIMENSION                                                                LOAD0046
1      AW( D ),     WTW( D ),     WAW( D ),     NVW( D ),     NXW( D ),   LOAD0047
1     NYW( D ),     NDW( D ),     NAW( D ),   SHADW( D ,24),ROGW( D ),    LOAD0048
1     NPW( D ), IGLASW( D ),   FFWS( D ),   FFWG( D ),  SHACO( D ),       LOAD0049
1 QSTORC( D ), QSTORR( D ),  ICALW( D ),  SETBK( D ),  BODER( D ),        LOAD0050
1   CINFW( D ),    CFMW( D ), WPERIM( D )                                 LOAD050A
 DIMENSION                                                                LOAD0051
1  RATOS( E ),      IR( E ),     SXN( E ),     SXR( E ),     SYN( E ),    LOAD0052
1     SYR( E )                                                            LOAD0053
 DIMENSION                                                                LOAD0054
1  FIHTS( F ),  ISPC1( F ),  ISPC2( F ),    FUW( G ),     FUF( H )        LOAD0055
 DIMENSION                                                                LOAD0056
1      XV( I ),      YV( I ),      ZV( I ),      XX( J ),      YY( J ),   LOAD0057
1      ZZ( J ),  ILETE( K ),                                              LOAD0058
1     XXX( 3 ,4),   YYY( 3 ,4),   ZZZ( 3 ,4)                              LOAD0059
 DIMENSION                                                                LOAD0060
1 IDD( B , L ), NVAD( B , M ), XVD( B , N ), XAD( B , M , O ),            LOAD0061
1  TD( B ,100,3),PAD( B , M ), YVD( B , N ), YAD( B , M , O ),            LOAD0062
1FIDD(     L ),                ZVD( B , N ), ZAD( B , M , O )             LOAD0063
 DIMENSION                                                                LOAD0064
1 IDQ( C , P ), NVAQ( C , Q ), XVQ( C , R ), XAQ( C , Q , S ),            LOAD0065
1                PAQ( C , Q ), YVQ( C , R ), YAQ( C , Q , S ),            LOAD0066
1FIDQ(     P ),                ZVQ( C , R ), ZAQ( C , Q , S )             LOAD0067
 DIMENSION                                                                LOAD0068
1 IDW( D , T ), NVAW( D , U ), XVW( D , V ), XAW( D , U , W ),            LOAD0069
1                PAW( D , U ), YVW( D , V ), YAW( D , U , W ),            LOAD0070
1FIDW(     T ),                ZVW( D , V ), ZAW( D , U , W )             LOAD0071
```

TABLE A1 (CONT'D)

MAIN ROUTINE (CONT'D)

```
 DIMENSION                                                             LOAD0072
1  RX( E ,100),   RY( E ,100)                                          LOAD0073
 DIMENSION                                                             LOAD0074
1 NVSP( X ),  PSP(  X ),  XSP(  X , Y  ),  YSP(  X , Y  ),  ZSP( X  , Y )LOAD0075
 DIMENSION                                                             LOAD0076
1  NVA( Z ),   PA(  Z ),   XA(  Z , AA ),   YA(  Z , ZZ ),   ZA( Z  , AA )LOAD0077
 DIMENSION                                                             LOAD0078
1IHTS( A  , AB ),IQ(  A , AC ),ID( A  , AD),IUW( A  , AE ),IUF( A  , AF),  LOAD0079
1  IW( A , AG )                                                        LOAD0080
 DIMENSION                                                             LOAD0081
1 FFIHTS( AB),    FIQ( AC ),    FID( AD),    FIUW( AE ),    FIUF( AF ),  LOAD0082
1    FIW( AG)                                                          LOAD0083
 DIMENSION                                                             LOAD0084
1 MLOOKD( AH ), ILOOKD( AH ), JLOOKD(  AH)                             LOAD0085
 DIMENSION                                                             LOAD0086
1 MLOOKQ( AI ), ILOOKQ( AI ), JLOOKQ(  AI)                             LOAD0087
 DIMENSION                                                             LOAD0088
1 MLOOKW( AJ ), ILOOKW( AJ ), JLOOKW(  AJ)                             LOAD0089
```

MATCON SUBROUTINE

```
 DIMENSION                     ISHADE(  AN,  AO)                       MATC0006
```

SHADOW SUBROUTINE

```
 DIMENSION                                                             SHAD0007
1 XVERTF( I ), YVERTF(  I ), ZVERTF( I ), IDLETE(  K ),                 SHAD0008
1  ANGLE( AK),      X1(  AK),      Y1( AK ),      Z1(  AK)             SHAD0009
 DIMENSION                                                             SHAD0010
1  NVERT( X ),    PERM(  X ),   XVERT( X  , Y ), YVERT(  X , Y  ),     SHAD0011
1                               ZVERT( X  , Y )                        SHAD0012
 DIMENSION                                                             SHAD0013
1 NVERTA( Z ),   PERMA(  Z ), XVERTA( Z  , AA),YVERTA(  Z , AA ),      SHAD0014
1                              ZVERTA( Z  , AA)                        SHAD0015
 DIMENSION                                                             SHAD0016
1 NVERTS( AL),   PERMS(  AL), XVERTS( AL , AM),YVERTS(  AL, AM ),      SHAD0017
1                              ZVERTS( AL, AM)                         SHAD0018
 DIMENSION                     ISHADE( AN,  AO)                        SHAD0019
```

VARIABLE TEMPERATURE PROGRAM GLOSSARY

A : Number of spaces in building

B : Number of distinct exterior delayed heat transfer surfaces in building

C : Number of distinct exterior quick heat transfer surfaces in building

D : Number of distinct exterior windows in building

E : Number of distinct types of exterior heat transfer surfaces in building

F : Number of distinct inside heat transfer surfaces in building

G : Number of distinct delayed underground walls in building

H : Number of distinct delayed underground floors in building

I : Number of distinct delayed ceilings in building

J : Number of distinct delayed floors in building

K : Number of distinct delayed furnishings in building

L : Number of distinct types of thermostat schedules

M : Maximum number of exterior delayed heat transfer surfaces in a space

N : Maximum number of exterior quick heat transfer surfaces in a space

O : Maximum number of exterior windows in a space

P : Maximum number of inside heat transfer surfaces in a space

Q : Maximum number of quick underground walls in a space

R : Maximum number of quick underground floors in a space

S : Maximum number of response factor terms for exterior delayed heat transfer surfaces

T : Maximum number of response factor terms for delayed ceilings

U : Maximum number of response factor terms for delayed floors

V : Maximum number of response factor terms for delayed furnishings

TABLE A2

VARIABLE TEMPERATURE PROGRAM DIMENSION STATEMENTS

```
DIMENSION ACEIL (   A,   8)                                  VT   004
DIMENSION AD    (   B)                                       VT   005
DIMENSION AFLOR (   A,   8)                                  VT   006
DIMENSION AFN   (   A)                                       VT   007
DIMENSION AQ    (   C)                                       VT   008
DIMENSION AUF   (   A)                                       VT   009
DIMENSION AUW   (   A)                                       VT   010
DIMENSION AW    (   D)                                       VT   011
DIMENSION CCAP  (   A)                                       VT   012
DIMENSION CFM   (   A)                                       VT   013
DIMENSION CRC   (   I)                                       VT   014
DIMENSION CRFL  (   J)                                       VT   015
DIMENSION CRFU  (   K)                                       VT   016
DIMENSION CRX   (   I,   T)                                  VT   017
DIMENSION CRZ   (   I,   T)                                  VT   018
DIMENSION DFFRZ (   E)                                       VT   019
DIMENSION DFNRZ (   E)                                       VT   020
DIMENSION DFURZ (   E)                                       VT   021
DIMENSION ESHT  (   A)                                       VT   022
DIMENSION ETEMP (   A,   S)                                  VT   023
DIMENSION FIHTS (   F)                                       VT   024
DIMENSION FLORB (   A)                                       VT   025
DIMENSION FLRX  (   J,   U)                                  VT   026
DIMENSION FLRZ  (   J,   U)                                  VT   027
DIMENSION FUF   (   H)                                       VT   028
DIMENSION FURZ  (   K,   V)                                  VT   029
DIMENSION FUW   (   G)                                       VT   030
DIMENSION HCAP  (   A)                                       VT   031
DIMENSION HES   (   A)                                       VT   032
DIMENSION HRLDL (   A)                                       VT   033
DIMENSION ICD   (   A,   I)                                  VT   034
DIMENSION ID    (   A,   M)                                  VT   035
DIMENSION IDEN1 (  35)                                       VT   036
DIMENSION IDEN2 (  35)                                       VT   037
DIMENSION IDEN3 (  35)                                       VT   038
DIMENSION IDEN4 (  15)                                       VT   039
DIMENSION IDEN5 (  15)                                       VT   040
DIMENSION IFD   (   A,   J)                                  VT   041
DIMENSION IFND  (   A)                                       VT   042
DIMENSION IHTS  (   A,   P)                                  VT   043
DIMENSION IPLS  (   A)                                       VT   044
DIMENSION IPOE  (  12)                                       VT   045
DIMENSION IPOS  (  12)                                       VT   046
DIMENSION IQ    (   A,   C)                                  VT   047
DIMENSION IR    (   E)                                       VT   048
DIMENSION IRC   (   I)                                       VT   049
DIMENSION IRF   (   B)                                       VT   050
```

TABLE A2(CONT'D)

```
DIMENSION IRFL   ( J )                    VT 051
DIMENSION IRFJ   ( K )                    VT 052
DIMENSION ISPC1  ( F )                    VT 053
DIMENSION ISPC2  ( F )                    VT 054
DIMENSION ISQ    ( C )                    VT 055
DIMENSION ISTT   ( A )                    VT 056
DIMENSION ITSLT  ( A , 3 )                VT 057
DIMENSION ITSHT  ( A , 3 )                VT 058
DIMENSION ITSMC  ( A , 3 )                VT 059
DIMENSION ITSMH  ( A , 3 )                VT 060
DIMENSION IUF    ( A , R )                VT 061
DIMENSION IUW    ( A , Q )                VT 062
DIMENSION IVOFF  ( A , 2 )                VT 063
DIMENSION IVON   ( A , 2 )                VT 064
DIMENSION IVS    ( A )                    VT 065
DIMENSION IVTSD  ( L , 3 , 24 )           VT 066
DIMENSION IW     ( A , 0 )                VT 067
DIMENSION MULT   ( A )                    VT 068
DIMENSION NAME   ( 80 )                   VT 069
DIMENSION NC     ( A )                    VT 070
DIMENSION ND     ( A )                    VT 071
DIMENSION NF     ( A )                    VT 072
DIMENSION NIHTS  ( A )                    VT 073
DIMENSION NOHIE  ( 12 )                   VT 074
DIMENSION NQ     ( A )                    VT 075
DIMENSION NSRF   ( A )                    VT 076
DIMENSION NUF    ( A )                    VT 077
DIMENSION NUW    ( A )                    VT 078
DIMENSION NW     ( A )                    VT 079
DIMENSION RATOS  ( E )                    VT 080
DIMENSION RSRF   ( A )                    VT 081
DIMENSION RX     ( E , S )                VT 082
DIMENSION RY     ( E , S )                VT 083
DIMENSION RZ     ( E , S )                VT 084
DIMENSION SIHTC  ( A )                    VT 085
DIMENSION SHT    ( A )                    VT 086
DIMENSION SLT    ( A )                    VT 087
DIMENSION SMC    ( A )                    VT 088
DIMENSION SMH    ( A )                    VT 089
DIMENSION SRF    ( A , S )                VT 090
DIMENSION SRMRT  ( E )                    VT 091
DIMENSION TSPAC  ( A )                    VT 092
DIMENSION UQ     ( C )                    VT 093
DIMENSION UGW    ( D )                    VT 094
DIMENSION VOL    ( A )                    VT 095
DIMENSION VTSD1  ( L , 3 , 24 )           VT 096
DIMENSION VTSD2  ( L , 3 , 24 )           VT 097
DIMENSION VTSD3  ( L , 3 , 24 )           VT 098
DIMENSION WOF    ( A )                    VT 099
DIMENSION WOFN   ( A )                    VT 100
```

APPENDIX B

WEATHER TAPE INFORMATION

TAPE REFERENCE MANUAL

AIRWAYS SURFACE OBSERVATIONS

TDF 14

GENERAL TAPE INFORMATION

Observations (physical records) are placed on tape in groups (logical records) of six. Thus, the 24 observations for each day are contained in four logical record groups. Space is always retained on tape for 24 observations per day with missing observations being coded blank.

Beginning January 1, 1965 a new program was initiated for most Weather Bureau stations reducing the number of hourly observations being punched from 24 to 8 per day. These 3-hourly observations are punched in local standard time, the hours selected to coincide with the standard international synoptic times of 0000GMT, 0300GMT, 0600GMT, etc. Available taped LST observations will therefore vary depending upon the time zone at a given station. A few Weather Bureau stations that are specially processed and most Air Force and Navy stations continue to be available on a 24 observation/day basis.

The following relationship between tape field and observation time holds true for all tapes in this general format:

Observational Hours

Tape Field	Record No. 1	Record No. 2	Record No. 3	Record No. 4
101	00	06	12	18
201	01	07	13	19
301	02	08	14	20
401	03	09	15	21
501	04	10	16	22
601	05	11	17	23

Notation of a tape position within a field is made according to the following example:

105 (-0) = units position of wind speed
105 (-1) = tens position of wind speed
105 (-2) = hundreds position of wind speed

These notations hold true for all fields.

Each record within the record group consists of 80 character positions, including those for hour, and the position for record mark at the end of each record. Six such records, plus the record-group identification fields of 15 character positions, make up the record group, 495 characters in length. The fields within the first observation of the record group are referred to as fields 101 through 135, those of the second observation as 201 through 235, etc., up to the sixth and last observation, where the fields are numbered 601 through 635. Later in this manual, the coding of each meteorological element is described in detail. All references are made to fields 101 through 135, or to the fields of the first observation of each record group. These references apply by extension to fields 201-235, 301-335, etc., respectively, to the corresponding field or element of any observation within the record group. Following the record mark in the last observation of the record group is the inter-record gap.

The ideal standard tape form would be a coded observation wherein every element is reduced to a single method of representation, regardless of source or original coding scheme. In any actual data family (a group of relatively homogenious weather observations such as surface observations in all their various forms, that have been assimilated into a more-or-less common format); however, this can be accomplished only to a limited degree. Elements reported in numeric values, such as wind speed, temperature, and pressure, may be reduced to a common form, e.g., knots, fahrenheit, millibars. But, elements reported by discrete definitions within code tables, are not always so compatible; examples of these are sky condition and cloud types. By combining all such code tables for a single element into an expanded table containing all definitions, one may approach a uniform code, but in use of such tables one must remember how they were derived. If the combined code contains a value for "high obscuration"; for example, one may tabulate the observations for a station and find no occurrence of "high obscuration", not because it never occurred, but because at the time the observations were recorded, no provision was made in the observing instructions to define a "high obscuration".

This reference manual has been compiled mainly for the person whose primary need is to use the various meteorological parameters as they appear on tape, and who is not vitally concerned with the myriad coding and observing vagaries inherent in these data.

Sufficient tables have been included to enable the user to adequately define the codes found on these tapes. Those desiring more detailed coding and/or observing information may use this manual in conjunction with the appropriate Card Deck reference manual (Card Decks 141,142,144). Observations are on 7 channel tape, written in the BCD mode at 556 BPI.

Δ	This symbol represents a blank or no punch condition.
"-1"	X-punch (11 punch).
, Δ, ΔΔ*, ΔΔΔ* } Invalid	Whenever an invalid configuation appears it means that the punched card values did not conform to the standard reporting requirements and therefore were unacceptable for conversion to tape.

The following octal configurations are applicable to tapes in the TDF 14 series:

Octal	Card Punch	Octal	Card Punch
01	1	61	A (12,1)
02	2	62	B (12,2)
03	3	63	C (12,3)
04	4	64	D (12,4)
05	5	65	E (12,5)
06	6	66	F (12,6)
07	7	67	G (12,7)
10	8	70	H (12,8)
11	9	71	I (12,9)
12	0	72	ε (12,0)
20	Blank		
40	-(11)		
41	J (11,1)		
42	K (11,2)		
43	L (11,3)		
44	M (11,4)		
45	N (11,5)		
46	O (11,6)		
47	P (11,7)		
50	Q (11,8)		
51	R (11,9)		
52	(11,0)		
54	* (11,8,4)		

TAPE DECK	STATION NUMBER	DATE			HR	CEILING	VIS.	WIND		DRY BULB	WET BULB	DEW PT	REL. HUM.	SEA LEVEL PRESS.	STATION PRESS.	SKY COND.
		YR	MO	DAY				DIR	SPEED							
1 4 X X	X X X X X	X X	X X	X X	X X	i X X X	i X X X	X X	X X X	X X X	X X X	X X X	i X X X	X X X X X	X X X X	i X X X X
001	002	003	004	005	101	102	103	104	105	106	107	108	109	110	111	112

		CLOUDS															WEATHER				WIND DIR		R M	HR
		1st			2nd				3rd				4th											
a_t	a_o	a_1	t_1	h_1	a_2	t_2	h_2	Σ_2	a_3	t_3	h_3	Σ_3	a_4	t_4	h_4		LIQ RR	FRZN RRR	OBS TO VIS				
X	X	X	X	X X X	X	X	X X X	X	X	X	X X X	X	X	X	X X X	X	X X	X X X	X X	X X	X X X	±	X X
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	201

HR	CEILING	VIS.
X X	i X X X	i X X X
601	602	603

CLOUDS							WEATHER				WIND DIR		R M	IRG
3rd				4th										
a_3	t_3	h_3	Σ_3	a_4	t_4	h_4		LIQ RR	FRZN RRR	OBS TO VIS				
X	X	X X X	X	X	X	X X X	X	X X	X X X	X X	X X	X X X	±	
622	623	624	625	626	627	628	629	630	631	632	633	634	635	

Standard Tape Form - Airways Observations

IDENTIFICATION FIELDS

FIELD 001 - Tape Deck

14XX — 14 = Primary indicator for observations in this standard format.

XX = Arbitrary numbers assigned to each tape deck and usually are indicative of the punched cards from which the tapes were generated.

i.e.: 1440 = Tape deck 1440 generated from card deck 144.
1420 = Tape deck 1420 generated from card deck 142 etc.

FIELD 002 - Station Number

XXXXX — A five digit number used to identify each individual station. These station identifiers are referred to as WBAN numbers and are permanently assigned for each reporting station.

FIELD 003 - Year

XX — Last two digits of the year. The first two digits are an implied 19.

FIELD 004 - Month

XX — Recorded as the numbered month of the year. 01 = Jan., 02 = Feb., --- 12 = December.

FIELD 005 - Day

XX — Recorded as the numbered day of the month, from 01 through 31.

FIELD 101 - Hour

XX — Hour is based on the 24-hour clock and is recorded as 00 through 23. Times are Local Standard Time unless documentation to the contrary is provided.

OBSERVATIONAL FIELDS

FIELD 102 - Ceiling

iXXX   i = identifier:

"-" = clear, scattered conditions or ceiling above 20,000 feet.

Δ = clear, scattered conditions or partial obscuration.

XXX = ceiling in hundreds of feet, except:

888 = ceiling formed by cirroform clouds of unknown height.

999 = unlimited ceiling.

ΔΔΔ = unknown

ΔΔ* = invalid

FIELD 103 - Visibility

iXXX   i = identifier: always blank

XXX = visibility in coded statute miles or fractions thereof.

VISIBILITY TABLE

Tape Code	Visibility	Tape Code	Visibility
000	0 miles	017	1-1/2 miles
001	1/16	018	1-5/8
002	1/8	019	1-3/4
003	3/16	020	2
004	1/4	024	2-1/4
005	5/16	027	2-1/2
006	3/8	030 - 090	3-9 miles in increments of 1 mile.
007	1/2		
008	5/8	100 - 950	10-95 miles in increments of 5 miles.
009	3/4		
010	1	990	≥ 100
012	1-1/8	999	unlimited
014	1-1/4		
016	1-3/8		

FIELD 104 - Wind Direction

(See also FIELD 133)

XX Direction from which the wind is blowing, based on the 16 point compass.

WIND DIRECTION TABLE

Tape Code	Direction	Degrees
11	North	349-011
12	North-Northeast	012-033
22	Northeast	034-056
32	East-Northeast	057-078
33	East	079-101
34	East-Southeast	102-123
44	Southeast	124-146
54	South-Southeast	147-168
55	South	169-191
56	South-Southwest	192-213
66	Southwest	214-236
76	West-Southwest	237-258
77	West	259-281
78	West-Northwest	282-303
88	Northwest	304-326
18	North-Northwest	327-348
00	Calm	
ΔΔ	Unknown	
Δ*	Invalid	

FIELD 105 - Wind Speed

XXX Wind Speed in knots.

NOTE: In all cases where position 105 (-0) is a numeric code, it is signed plus, as a device for separating Field 105 from 106. This does not apply if the position is coded Δ or *.

XXX	=	000-199 = calm to 199 knots.
ΔΔΔ	=	Unknown
ΔΔ*	=	Invalid

FIELD 106 - Dry Bulb Temperature

XXX Dry bulb temperature in whole degrees fahrenheit.

NOTE: Position 106 (-0) is signed plus for all positive temperatures and minus for all negative temperatures.

ΔΔΔ	=	Unknown
ΔΔ*	=	Invalid

FIELD 107 - Wet Bulb Temperature

XXX Wet bulb temperature in whole degrees fahrenheit.

NOTE: Position 107 (-0) is signed plus for all positive temperatures and minus for all negative temperatures.

ΔΔΔ	=	Unknown
ΔΔ*	=	Invalid

FIELD 108 - Dew Point Temperature

XXX Dew point temperature with respect to water, in whole degrees fahrenheit.

NOTE: Position 108 (-0) is signed plus for all positive temperatures and minus for all negative temperatures.

ΔΔΔ	=	Unknown
ΔΔ*	=	Invalid

FIELD 109 - Relative Humidity

iXXX Relative humidity, with respect to water, expressed in whole percent.

i = Indicator of the method used to convert dewpoint temperatures and relative humidity percentages, with respect to water, when in certain cases these values were originally computed with respect to ice. With the possible exception of research involving detailed psychrometric investigation this indicator has little significance and therefore is not explained further in this manual.

FIELD 110 - Sea Level Pressure

XXXXX — Atmospheric pressure reduced to sea level and expressed in whole millibars and tenths.

FIELD 111 - Station Pressure

XXXX — Atmospheric pressure at the elevation of the station, expressed in inches to hundreths of mercury.

FIELD 112 - Sky Condition

iXXXX — A descriptive symbolic coding of the state of the sky, referring in general to the amount of the celestial dome covered by clouds or obscuring phenomena.

i = Indicator referring to method of coding. Usually this position contains an eleven punch ("-") prior to June 1951 and is blank from June 1951 onward.

XXXX = Sky condition symbols and/or heights of scattered clouds.

SKY CONDITION TABLE

Tape Code	Symbol	Sky Condition	
0	○	Clear or less than 1/10 sky cover	
1	−⦶	Thin scattered	1/10-5/10 sky cover
2	⦶	Scattered	1/10-5/10 sky cover
3	+⦶	Dark scattered	1/10-5/10 sky cover
4	−⦷	Thin broken	6/10-9/10 sky cover
5	⦷	Broken	6/10-9/10 sky cover
6	+⦷	Dark broken	6/10-9/10 sky cover
7	−⊕	Thin overcast	10/10 sky cover
8	⊕	Overcast	10/10 sky cover
9	+⊕	Dark overcast	10/10 sky cover
-	X	Obscuration	
Δ	−X	Partial obscuration	

In the combinations listed below, the four-digit field represents the complete sky condition report. The letter "d" represents a digit from 1 through 9, "hh" represents digits used for coding height of scattered layer reported in position 112 (-0), "0" indicates zero, "-" indicates zone -X, and "b" represents blank coding.

Sky Condition Before June 1951

CODE	PUNCH CODE POSSIBILITIES 112(-3)	112 (-2)	112 (-1)	112(-0)	CODE DEFINITION AND REMARKS
0---	0	X	X	X	Obscuration reported alone
0--0	0	X	X	0	Clear Sky (or less than 1/10 sky cover)
0--b	0	X	X	Blank	Thin obscuration reported alone
0--d	0	X	X	4-9	One symbol reported, not scattered, obscuration, or thin obscuration
0hhd	0	00 thru 95 and 99		1-3	One symbol reported, scattered
d---	4-9	X	X	X	Obscuration reported as the lower of two symbols, the higher one not obscured.
d--b	4-9	X	X	Blank	Thin obscuration reported as the lower of two symbols, the higher one not obscured
d--d	4-9	X	X	4-9	Two symbols reported, the lower not being scattered
dhhd	1-9	00 thru 95 and 99		1-3	Two symbols reported, the lower being scattered
----	X	X	X	X	Obscuration reported above obscuration
---b	X	X	X	Blank	Obscuration reported above thin obscuration
---d	X	X	X	4-6	Obscuration reported as the higher of two symbols, the lower one not scattered or obscured
-hhd	X	00 thru 95 and 99		1-3	Obscuration reported as the higher of two symbols, the lower one being scattered

Height of Scattered Clouds

CODE	CODE DEFINITION	REMARKS
00-95	0 to 95 hundred feet	Recorded in hundreds of feet to nearest 100 feet up to 5000 feet, to nearest 500 feet up to 9750 feet. Height in positions 112(-2 and -1) always applies to the scattered layer reported in position 112 (-0).
99	10,000 feet or higher	
--	No lower scattered clouds	
b,b,**	Invalid	
bb	Unknown	

Sky Condition Before June 1951

CODE	PUNCH CODE POSSIBILITIES				CODE DEFINITION AND REMARKS
	112(-3)	112(-2)	112(-1)	112(-0)	
b---	Blank	X	X	X	Thin obscuration reported above obscuration
b--b	Blank	X	X	Blank	Thin obscuration reported above thin obscuration
b--d	Blank	X	X	4-6	Thin obscuration reported as the higher of two symbols, the lower one being not scattered or obscured
bhhd	Blank	00 thru 95 and 99		1-3	Thin obscuration reported as the higher of two symbols, the lower one being scattered
****	*	*	*	*	If any position was punched invalid (*), the entire field was coded ****
bbbb	Blank	Blank	Blank	Blank	Unknown

Reporting and Coding Beginning in June 1951

Four positions were allowed for punching sky condition, which were reproduced to tape as punched. Beginning in June 1951, the concept of sky condition reporting changed. Instead of reporting two symbols, in descending order, with height of scattered cloud , the report now consisted of as many symbols as necessary to describe the sky, in ascending order. As many as four such symbols were punched, the remaining positions being punched zero if fewer than four symbols were reported. If more than four symbols were reported, the first three and the last symbols were punched, unless the symbol specifying the ceiling was thereby excluded; in that case, the first two symbols were punched in the two left positions, the ceiling symbol in the third position, and the highest symbol in the fourth (right) position.

Also at that time, the definition of the symbol "-X" was changed from thin obscuration to partial obscuration and by definition, all obscurations, both full and partial, are surface based. Obscurations above the ground were reported as scattered, broken, or overcast, depending upon their amounts.

The digits from 0 to 9 continued with the same definitions as before.

CODE	PUNCH CODE POSSIBILITIES 112(-3)	112(-2)	112(-1)	112(-0)	CODE DEFINITION AND REMARKS
0000	0	0	0	0	Clear sky (or less than 1/10 covered)
d000	1-9	0	0	0	One symbol reported, but not obscuration or partial obscuration
dd00	1-9	1-9	0	0	Two symbols reported, but not obscuration or partial obscuration
ddd0	1-9	1-9	1-9	0	Three symbols reported, but not obscuration or partial obscuration
dddd	1-9	1-9	1-9	1-9	Four symbols reported, but not obscuration or partial obscuration
-000	X	0	0	0	Obscuration (10/10 hidden by surface based phenomena)
b000	Blank	0	0	0	Partial obscuration and no other symbol
bd00	Blank	1-9	0	0	Partial obscuration and one other symbol
bdd0	Blank	1-9	1-9	0	Partial obscuration and two other symbols
bddd	Blank	1-9	1-9	1-9	Partial obscuration and three other symbols
b-00	Blank	X	0	0	Partial obscuration below obscuration
d-00	1-7	X	0	0	Obscuration above one layer
dd-0	1-7	1-7	X	0	Obscuration above two layers
ddd-	1-7	1-7	1-7	X	Obscuration above three layers
****	*	*	*	*	If any position was punched invalid (*), the entire field was coded ****
bbbb	Blank	Blank	Blank	Blank	Unknown

FIELDS 113-128 - Clouds

Provision is made in the standard tape form for coding amount, type, and height of as many as four cloud layers plus total amount and total opaque amount, as well as summation amounts at the second and third layers. Twenty-four character positions are set aside for the cloud fields in accordance with the following outline, comprising sixteen fields.

CLOUDS															
		1st			2nd				3rd				4th		
a_t	a_o	a_1	t_1	h_1	a_2	t_2	h_2	Σ_2	a_3	t_3	h_3	Σ_3	a_4	t_4	h_4
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128

Cloud Fields

Clouds are reported in four layers, plus fields for the total amount and the total opaque amount a_t and a_o respectively. Amounts, types and heights are indicated by symbols a, t, and h respectively; the layers are indicated by subscripts. Summation amounts at the second and third layers are indicated by Σ_2 and Σ_3 respectively.

CLOUD AMOUNT TABLE

The same coding system is used for cloud amount, whether applying to total amount, amount for individual layer, summation amount, or opaque amount.

Tape Code	Definition
0	Clear or less than 1/10
1-5	Scattered or 1/10 through 5/10
6-9	Broken or 6/10 through 9/10
"-"	Overcast or > 9/10

CLOUD TYPE TABLE

The same coding system is used for cloud type in all four positions reportable. Note that X-overpunching was used in the punch card codes, resulting in alphabetic codes for some types.

Tape Code	Definition
0	None
1	Fog
2	Stratus
3	Stratocumulus
4	Cumulus
5	Cumulonimbus
6	Altostratus
7	Altocumulus
8	Cirrus
9	Cirrostratus
K	Stratus Fractus/Fractostratus
M	Cumulus Fractus/Fractocumulus
N	Cumulonimbus mamma
O	Nimbostratus
P	Altocumulus castellanus
R	Obscuring phenomenon
"-"	Obscuring phenomenon other than fog

CLOUD HEIGHT TABLE

Tape Code	Definition
000-999	0 to 99,900 feet (in hundreds of feet)
---	None (no clouds for which a height could be reported).
---	Partial obscuration when appearing in field 117 and field 116 is coded "-".
888	Cirroform clouds of unknown height.
ΔΔΔ	Unknown
ΔΔ*	Invalid code

Heights are recorded in hundreds of feet above station level in the following manner:

Nearest 100 ft.	Surface to 5,000 ft.
Nearest 500 ft.	Between 5,000 and 10,000 ft.
Nearest 1,000 ft.	Above 10,000 ft.

FIELD 129 - 132 - Atmospheric Phenomena

Tape Code

Taken as a whole, the 8 positions may show the absence of all listed atmospheric phenomena, if coded as follows:

Position	Code	Code Definition
129 (-0)	0	No thunderstorm, tornado, or squall
130 (-1)	0	No rain, rain showers, or freezing rain
130 (-0)	0	No rain squalls, drizzle, or freezing drizzle
131 (-2)	0	No snow, snow pellets, or ice crystals
131 (-1)	0	No snow showers, snow squalls, or snow grains
131 (-0)	0	No sleet, hail, or small hail
132 (-1)	0	No fog, ice fog, ground fog, blowing dust, or blowing sand
132 (-0)	0	No smoke, haze, dust, blowing snow, or blowing spray

Wind Phenomena --Position 129 (-0)

Tape Code

Code	Symbol	Code Definition
0		No thunderstorm, tornado, squall, or other listed phenomena
1	T	Thunderstorm
2	T+	Heavy thunderstorm
3	TORNADO	Tornado (Report of tornado or waterspout never abbreviated)

Wind Phenomena - - Position 129 (-0) (Cont'd)

Code	Symbol	Code Definition
4	Q-	Light squall
5	Q	Moderate squall
6	Q+	Heavy squall
7		
8		
9		
b		Unknown
*		Invalid

Liquid Precipitation (No. 1) - - Position 130 (-1) Tape Code

Code	Symbol	Code Definition
0		No rain, rain showers, or freezing rain
1	R-	Light rain
2	R	Moderate rain
3	R+	Heavy rain
4	RW-	Light rain showers
5	RW	Moderate rain showers
6	RW+	Heavy rain showers
7	ZR-	Light freezing rain
8	ZR	Moderate freezing rain
9	ZR+	Heavy freezing rain
b		Unknown
*		Invalid

Code	Symbol	Code Definition
0		No drizzle , freezing drizzle , or rain squalls
1	RQ-	Light rain squalls
2	RQ	Moderate rain squalls
3	RQ+	Heavy rain squalls
4	L-	Light drizzle
5	L	Moderate drizzle
6	L+	Heavy drizzle
7	ZL-	Light freezing drizzle
8	ZL	Moderate freezing drizzle
9	ZL+	Heavy freezing drizzle
b		Unknown
*		Invalid

Frozen Precipitation (No. 1) - - Position 131 (-2) Tape Code

Code	Symbol	Code Definition
0		No snow, snow pellets, or ice crystals
1	S-	Light snow
2	S	Moderate snow
3	S+	Heavy snow
4	SP-	Light snow pellets
5	SP	Moderate snow pellets
6	SP+	Heavy snow pellets
7	IC-	Light ice crystals
8	IC	Moderate ice crystals
9	IC+	Heavy ice crystals
b		Unknown
*		Invalid

Frozen Precipitation (No. 2) - - Position 131 (-1) Tape Code

Code	Symbol	Code Definition
0		No snow showers, snow grains, or snow squalls
1	SW-	Light snow showers
2	SW	Moderate snow showers
3	SW+	Heavy snow showers
4	SQ-	Light snow squall
5	SQ	Moderate snow squall
6	SQ+	Heavy snow squall
7	SG-	Light snow grains
8	SG	Moderate snow grains
9	SG+	Heavy snow grains
b		Unknown
*		Invalid

Frozen Precipitation (No. 3) - - Position 131 (-0) Tape Code

Code	Symbol	Code Definition
0		No sleet, hail or small hail
1	E-,EW-	Light sleet or sleet showers
2	E, EW	Moderate sleet or sleet showers
3	E+,EW+	Heavy sleet or sleet showers
4	A-	Light hail
5	A	Moderate hail
6	A+	Heavy hail
7	AP-	Light small hail
8	AP	Moderate small hail
9	AP+	Heavy small hail
b		Unknown
*		Invalid

Obstructions to Vision (No. 1) - - Position 132 (-1) Tape Code

Code	Symbol	Code Definition
0		None listed below
1	F	Fog
2	IF	Ice Fog
3	GF	Ground Fog
4	BD	Blowing dust
5	BN	Blowing sand
6		
7		
8		
9		
b		Unknown
*		Invalid

Obstructions to Vision (No. 2) - - Position 132 (-0)

Code	Symbol	Code Definition
0		None listed below
1	K	Smoke
2	H	Haze
3	KH	Smoke and haze
4	D	Dust
5	BS	Blowing snow
6	BY	Blowing spray
7		
8		
9		
b		Unknown
*		Invalid

Conversion Procedures for Deck 144

Atmospheric phenomena as punched in Deck 144 are the model for the standard tape form. Therefore, the element was reproduced as punched, with but minor editing. Each card column was reproduced without consideration of the field as a whole, and edited for the valid codes in each, as are shown in the standard tape code. Columns punched with codes other than those described as a valid meteorological report were reproduced to tape as invalid, "*", and blanks were coded "Δ".

FIELD 133 — Special Positions

XX

Beginning January 01, 1964, wind directions were reported in tens of degrees, based on a 36 point compass. These values are entered in this field while directions converted to the 16-point scale are entered in field 104. Analogous coding is done for the remaining related fields of wind speed within each logical record.

The conversion procedure used was:

36 Pt.	to	16 Pt.
35-01		11
02-03		12
04-05		22
06-07		32
08-10		33
11-12		34
13-14		44
15-16		54
17-19		55
20-21		56
22-23		66
24-25		76
26-28		77
29-30		78
31-32		88
33-34		18

FIELD 134 — Special Positions

XXX

The three positions in this field are not required for data in Deck 144. These positions are blank and may be used for future data requirements.

FIELD 135 — Record Mark

X

The record mark follows the observation to indicate the end of the record.

APPENDIX C

SIMPLIFIED INPUT FORMS

Note

Input forms for Loads and System Simulation are available.

NECAP

NASA'S ENERGY-COST ANALYSIS PROGRAM

job name	
date	PAGE ___ OF ___

INPUT FORM LC1 GENERAL

THERMAL LOAD ANALYSIS

GENERAL NOTES : These input forms have been developed such that, with a few exceptions regarding building material properties, external references will not be required.

Unless otherwise noted, all input data are real numbers. The program is designed to by-pass unneeded portions of input only.

Twenty-two (22) input cards are required to execute the program. These are noted by an "R" at their extreme right.

(Alpha numeric data may be entered in input card types L1, LS.)

Columns 1–49	Columns 50–70	Card Index (71–80)	
FACILITY NAME		L 1	R
FACILITY LOCATION		L 2	R
USER NAME		L 3	R
PROJECT NUMBER		L 4	R
DATE		L 5	R

Latitude (DEG)	Longitude (DEG)	Time Zone Number	Clearness Number (summer)	Clearness Number (winter)	Bldg. Azimuth ANGLE(DEG)		Card Index	
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	
							L 6	R

Job Processing Code (CODE)	Ventilation Air Rate (cfm/sq.ft.)	Estimated Total Fan Pressure (in. H_2O)	Zone Cold Air Supply Temp.-1 ($^oF.$)	Zone Cold Air Sup'y Temp.-2 ($^oF.$)	Zone Hot Air Supply Temp.-1 ($^oF.$)	Zone Hot Air Supply Temp.-2 ($^oF.$)	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L 7

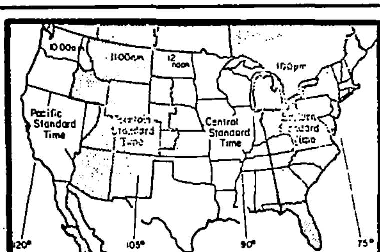


Figure TIME ZONES IN THE UNITED STATES

TIME ZONE NUMBERS IN U.S. FOR STANDARD TIME

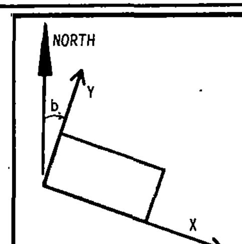
TIME ZONE	TZN
Atlantic	4.0
Eastern	5.0
Central	6.0
Mountain	7.0
Pacific	8.0

JOB PROCESSING CODE

1.0 - Design Load Analysis only

2.0 - Design Load & Hourly Energy Analysis

3.0 - Hourly Energy Analysis only



Building Azimuth Angle (b)

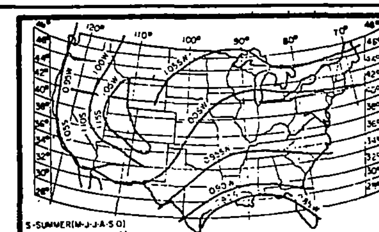


Figure 2 CLEARNESS NUMBERS OF NON-INDUSTRIAL ATMOSPHERE IN UNITED STATES

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THERMAL LOAD ANALYSIS

INPUT FORM L02 ANALYSIS PARAMETERS

DESIGN LOAD ANALYSIS PARAMETERS

(IF CODE = 3,do not include L8 type cards)

Altitude Above Sea Level (FT)		Card 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 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
		L 8 A

SUMMER DESIGN DAY CONDITIONS

Max. D.B Temperature (°F)	Daily D.B Temperature Range (°F)	Dew Point Temperature (°F)	Windspeed (MPH)		Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
					L 8 B

WINTER DESIGN DAY CONDITIONS

Minimum D.B Temperature (°F)	Daily D.B Temperature Range (°F)	Dew Point Temperature (°F)	Windspeed (MPH)		Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
					L 8 C

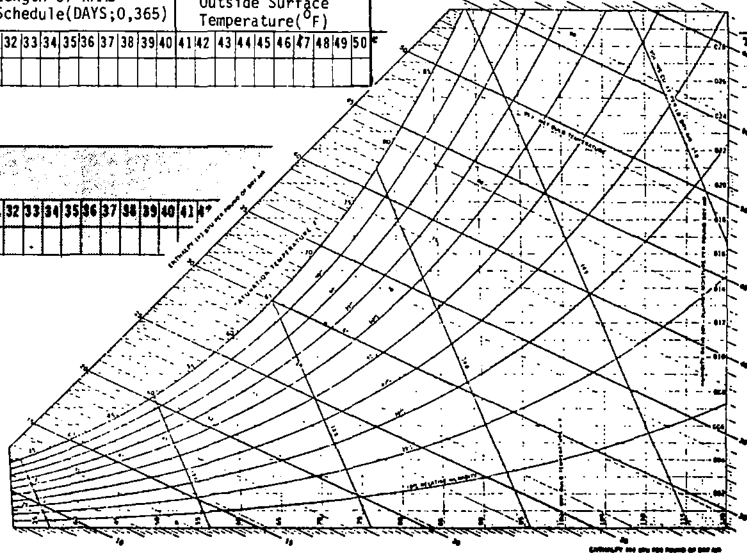
HOURLY ENERGY ANALYSIS PARAMETERS

(IF CODE = 1,do not include L9 type cards)

Weather Year	First Month Of Analysis(1,12)	Length of Study (DAYS;1,365)	Length of XMAS Schedule(DAYS;0,365)	Estimated Initial Outside Surface Temperature(°F)		Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	70	71 72 73 74 75 76 77 78 79 80
						L 9

Hourly Load Print Code		Card 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 31 32 33 34 35 36 37 38 39 40 41	71 72 73 74 75 76 77 78 79 80
		L 1 0

PRINT CODE
0.0 - No printing
1.0 - Printing



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THERMAL LOAD ANALYSIS

INPUT FORM L03 SCHEDULES

NO. Operating Schedule Types (1.0-3.0)		Card Index
1 2 3 4 5 6 7 8 9 10	11 – 70	71 72 73 74 75 76 77 78 79 80
		L 1 1 R

OPERATING SCHEDULE INDEXING

OPERATING SCHEDULE NO.		PEOPLE							LIGHTING							EQUIPMENT							Card Index
		REQ'D (0-1)	SUN	WEEK DAY	SAT	HOLI-DAY	XMAS		REQ'D (0-1)	SUN	WEEK DAY	SAT.	HOLI-DAY	XMAS		REQ'D (0-1)	SUN.	WEEK DAY	SAT.	HOLI-DAY	XMAS		
	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 31	32 33 34	35 36 37	38 39 40 41 42	43 44 45	46 47	48 49	50 51 52	53 54 55	56 57 58	59 60 61 62 63	64 – 70	71 72 73 74 75 76 77 78 79 80
1																							L 1 2 R
2																							
3																							

NON-STANDARD SCHEDULE WORK SPACE

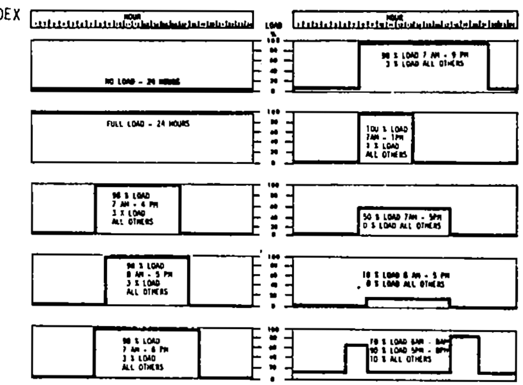
TIME (HOUR OF DAY)

% PEAK LOAD

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	LABEL.
100																									A-
80																									
60																									
40																									
20																									
0																									
100																									B-
80																									
60																									
40																									
20																									
0																									

UP TO 10 NON-STANDARD SCHEDULES MAY BE DEFINED

INDEX NO 1, 2, 3, 4, 5 — INDEX NO 6, 7, 8, 9, 10



NON-STANDARD SCHEDULES

INDEX NO	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 NOON	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	12MID-NIGHT	Card 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	31 32 33	34 35 36	37 38 39	40 41 42	43 44 45	46 47 48	49 50 51	52 53 54	55 56 57	58 59 60	61 62 63	64 65 66	67 68 69	70 71 72	73 74 75 76 77 78 79 80
11																									L 1 3
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

WHEN CARD L13 IS USED, IT MUST IMMEDIATELY FOLLOW THE FIRST CARD L12 REFERENCING IT.

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NASA'S ENERGY-COST ANALYSIS PROGRAM

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THERMAL LOAD ANALYSIS

INPUT FORM L04 COMMON SHADING

No. Common Shading Surfaces		Card Index
1–10	11–70	71–80
		L14

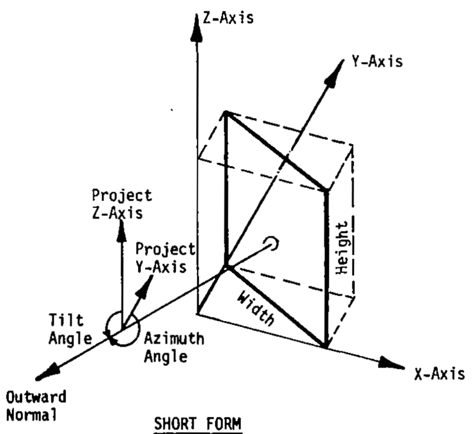
If there are no common shading surfaces do not include card type L15 & L16

DEFINITION OF COMMON SHADING SURFACES (May be long or short form)

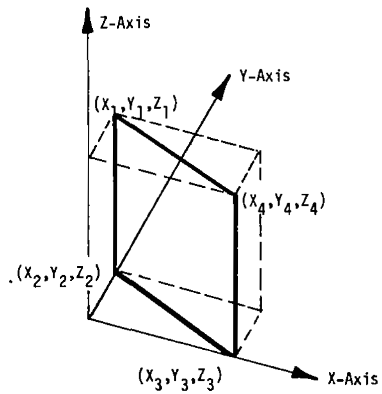
No. Vertices	Transmittance 0 (Opaque) to 1 (Clear)		Card Index
1–10	11–20	21–70	71–80
			L15

VERTICE COORDINATES (FEET) X	VERTICE COORDINATES (FEET) Y	VERTICE COORDINATES (FEET) Z	Height (FT)	Width (FT)	Surface Azimuth (DEG)	Tilt Angle (DEG)	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L16

(If more cards are required,use an Added Shading Continuation Form.)



SHORT FORM



LONG FORM

NOTES:

SHORT FORM - All columns apply.
No. Vertices equals 1.0 .
X,Y,Z coordinates refer to lower left hand corner of rectangular surface when viewed from outside.

LONG FORM - No. vertices, transmittance factor X,Y,Z coordinates, and card index apply.
No. vertices should be indicated only on first vertex card.

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NASA'S ENERGY-COST ANALYSIS PROGRAM

THERMAL LOAD ANALYSIS

INPUT FORM L05 RESPONSE FACTORS

Total No. Delayed Surface Types (cols 1–10)	No. Standard Surfaces (cols 11–20)	(cols 21–70)	Card Index (cols 71–80)
			L17

R

Response factor types are numbered by order of appearance. Hence, all standard surface types will be before non-standard surface types. SEE INPUT FORM L07 FOR DEFINITION OF STANDARD SURFACES.

STANDARD SURFACE RESPONSE FACTOR INDICES

INDEX NO 1 / INDEX NO 8 (cols 1–10)	INDEX NO 2 / INDEX NO 9 (cols 11–20)	INDEX NO 3 / INDEX NO 10 (cols 21–30)	INDEX NO 4 / INDEX NO 11 (cols 31–40)	INDEX NO 5 / INDEX NO 12 (cols 41–50)	INDEX NO 6 / INDEX NO 13 (cols 51–60)	INDEX NO 7 / INDEX NO 14 (cols 61–70)	Card Index (cols 71–80)
							L18

Repeat card types L19 & L20 for each non-standard response, factor type.

NON-STANDARD RESPONSE FACTORS

No time Response Grps (cols 1–3)	Common Ratio (cols 4–23)	(cols 24–70)	Card Index (cols 71–80)
			L19

TIME RESPONSE GROUPS

	X (cols 1–20)	Y (cols 21–40)	Z (cols 41–60)	(cols 61–70)	Card Index (cols 71–80)
1					L20
2					
3					
4					
5					
6					
7					
8					
9					
10					

100 Max.

Card types L19 & L20 may be generated by Response Factor Program.

DELAYED HEAT TRANSFER SURFACES

No. Delayed Surfaces (cols 1–10)	(cols 11–70)	Card Index (cols 71–80)
		L21

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THERMAL LOAD ANALYSIS

INPUT FORM L06 DELAYED SURFACES

DELAYED SURFACE No. ____ LABEL ____________

REPEAT THIS INPUT FORM FOR EACH DELAYED SURFACE

Surface Exterior Absorptivity	Ground Reflectivity Facing Surface	Infiltration Flow Coefficient					Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
							L 2 2

No. Vertices in Surfaces	No. X-divisions in Surface	No. Y-divisions in Surfaces	No. Common Shading Surfaces deleted	No. Shading Surfaces added to Surface	Surface Roughness Index *	Response Factor Index	Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
							L 2 3

DELAYED SURFACE GEOMETRY. (May be long form or short form).**

*See input form L07 for roughness index code.

VERTICE CO-ORDINATES (FEET) X	VERTICE CO-ORDINATES (FEET) Y	VERTICE CO-ORDINATES (FEET) Z	Height (FEET)	Width (FEET)	Azimuth Angle(DEG)	Tilt Angle(DEG)	Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
							L 2 4

DELETED COMMON SHADING SURFACE INDICES.
(Index is defined by order of appearence, Input form L04.) (If there are no deleted common, skip L25.)

							Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
							L 2 5

ADDED SHADING SURFACES (May be long or short form)

(If there are none, skip card type L26 and L27)

No. Vertices	Transmittance 0. (Opaque) to 1. (Clear)						Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
							L 2 6

VERTICE CO-ORDINATES (FEET) X	VERTICE CO-ORDINATES (FEET) Y	VERTICE CO-ORDINATES (FEET) Z	Height (FEET)	Width (FEET)	Azimuth Angle (DEG)	Tilt Angle (DEG)	Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
							L 2 7

** IF SURFACE SHADING IS NOT CONSIDERED, USE SHORT FORM AND LEAVE X,Y,Z COORDINATE BLANK. COMPUTER WILL THEN AUTOMATICALLY LOCATE SURFACE AT ORIGIN.

USE ADDITIONAL L26 AND L27 CARDS ARE REQUIRED. SEE ADDED SHADING CONTINUATION FORM.

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THERMAL LOAD ANALYSIS

INPUT FORM L07 DELAYED SURFACES

No. Delayed Surface Pictures		Card Index
1–10	11–70	71–80
		L28

CODE FOR EXTERIOR SURFACE FINISH

CODE	SURFACE FINISH	EXAMPLE WALL	EXAMPLE ROOF
1	Rough	•Stucco	•Wood Shingles •Built-up Roof with Stones
2	↑ INCREASING SMOOTHNESS	•Brick •Plaster	
3		•Concrete	•Asphalt Shingles
4		•Clear Pine	
5	↓	•Smooth Plaster •Metal	•Metal
6	Smooth	•Glass •Paint on Pine	

DELAYED SURFACE PICTURE DEFINITION

Month	Hour of day	Delayed Surface Index	Card Index
1–10	11–20	21–30	71–80
			L29

STANDARD CODED SURFACES

CODE	TYPE	LAYER DESCRIPTION
1	Wall	Wood Drop Siding 3/4" Sheathing Board 4" Air Space 1/2" Gypsum Board Inside Air
2	Wall	Wood Drop Siding 3/4" Sheathing Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
3	Wall	4" Face Brick 1/2" Air Space 3/4" Sheathing Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
4	Wall	8" Concrete Block Inside Air
5	Wall	12" Solid Concrete Inside Film
6	Wall	12" Concrete Block 2" Air Space 1/2" Gypsum Board Inside Air
7	Wall	4" Face Brick 2" Air Space 6" Concrete Block Inside Air
8	Wall	4" Face Brick 2" Air Space 6" Concrete Block 2" Fiberglass Insulation 1/2" Gypsum Board Inside Air
9	Wall	Sheet Metal 2" Dense Insulation Sheet Metal Inside Air
10	Wall	Metal Siding 1" Dense Insulation 8" Concrete Block Air Space 1/2" Gypsum Board Inside Air
11	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 2" Fiberglass Insulation Metal Pan Inside Air
12	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 3" Cellular Glass Metal Pan Inside Air
13	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 3" Cellular Glass Metal Pan Ceiling Air Space Acoustical Tile Inside Air
14	Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 2" Cellular Glass 4" L.W. Concrete Metal Pan Ceiling Air Space Acoustical Tile Inside Air
15	Roof	Sheet Metal 6" Fiberglass Gypsum Board Inside Air
16	Roof	Asphalt Shingle (Pitched Roof) 1/2" Plywood Sheathing Attic Air Space 6" Insulation Gypsum Board Inside Air

QUICK HEAT TRANSFER SURFACES

No. Quick Surfaces		Card Index
1–10	11–70	71–80
		L30

R

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THERMAL LOAD ANALYSIS

INPUT FORM L08 QUICK SURFACES

QUICK SURFACE No. ________ LABEL ______________________

Repeat this input form for each Quick Surface

*Does not include exterior air film

Surface Exterior Absorptivity	Ground Reflectivity Facing Surface	Heat Transfer Coefficient (BTU/HR. °F.FT²) *	Infiltration Flow Coefficient			Card Index
1–10	11–20	21–30	31–40	41–50	51–70	71–80
						L31

No. Vertices In Surfaces	No. X-Divisions In Surface	No. Y-Division In Surface	No. Common Shading Surfaces Deleted	No.Shading Surfaces Added to Surface	Surface Roughness Index		Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L32

QUICK SURFACE GEOMETRY.(May be long or short form) **

VERTICE CO-ORDINATES (FEET) X	Y	Z	Height (FEET)	Width (FEET)	Azimuth Angle(DEG)	Tilt Angle(DEG)	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L33

DELETED COMMON SHADING SURFACE INDICES.
(Index is defined by order of appearence,Input Form L04.)(If there are no deleted common, skip L34.)

							Card Index
1–10	11–21	22–30	31–40	41–50	51–60	61–70	71–80
							L34

ADDED SHADING SURFACES (May be long or short form) (If there are none, skip card type L35 and L36)

No. Vertices	Transmittance 0 (Opaque) to 1 (Clear)		Card Index
1–10	11–20	21–70	71–80
			L35

VERTICE CO-ORDINATES (FEET) X	Y	Z	Height (FEET)	Width (FEET)	Azimuth Angle (DEG)	Tilt Angle (DEG)	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L36

** IF SURFACE SHADING IS NOT CONSIDERED, USE SHORT FORM AND LEAVE X,Y,Z COORDINATE BLANK. COMPUTER WILL THEN AUTOMATICALLY LOCATE SURFACE AT ORIGIN.

USE ADDITIONAL L35 AND L36 CARDS AS REQUIRED. SEE ADDED SHADING CONTINUATION FORM.

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THERMAL LOAD ANALYSIS

INPUT FORM L09 QUICK SURFACES

No. Quick Surface Pictures		Card Index
1–10	11–70	71–80
		L 3 7 R

QUICK SURFACE PICTURE DEFINITION

Month	Hour of Day	Quick Surface Index		Card Index
1–10	11–20	21–30	31–70	71–80
				L 3 8

GLAZED HEAT TRANSFER SURFACES

No. Glazed Surfaces		Card Index
1–10	11–70	71–80
		L 3 9 R

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THERMAL LOAD ANALYSIS

INPUT FORM L10 GLAZED SURFACES

GLAZED SURFACE NO ______ LABEL ______________________

REPEAT THIS INPUT FORM FOR EACH GLAZED SURFACE

ASHRAE Shading Coefficient	Window/sky Form Factor	Window/Ground Form Factor	Ground Reflectivity	SETBACK (IN)	BORDER (IN)	Infiltration Flow Coefficient	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L 4 0

No. Vertices In Surface	No. X-Division In Surface	No. Y-Division In Surface	No. Common Shading Surfaces Deleted	No. Shading Surfaces Added to Surface	No. Panes of Glass (1.,2.)	Window type Index *	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L 4 1

GLAZED SURFACE GEOMETRY. (May be long form or short form) **

* See input form L11 for index code.

VERTICE CO-ORDINATES (FEET) X	Y	Z	Height (FEET)	Width (FEET)	Azimuth Angle (DEG)	Tilt Angle (DEG)	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L 4 2

DELETED COMMON SHADING SURFACE INDICES (Index is defined by order of appearence, Input Form L04.) (If there are no deleted common, skip L43.)	Card Index
1–70	71–80
	L 4 3

ADDED SHADING SURFACE

(If there are none, skip card type L44 and L45)

No. Vertices	Transmittance 0 (Opaque) to 1 (Clear)		Card Index
1–10	11–20	21–70	71–80
			L 4 4

VERTICE CO-ORDINATES (FEET) X	Y	Z	Height (FEET)	Width (FEET)	Azimuth Angle (DEG)	Tilt Angle (DEG)	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							L 4 5

** IF SURFACE SHADING IS NOT CONSIDERED, USE SHORT FORM AND LEAVE X,Y,Z COORDINATE BLANK. COMPUTER WILL THEN AUTOMATICALLY LOCATE SURFACE AT ORIGIN.

USE ADDITIONAL L44 AND L45 CARDS AS REQUIRED. SEE ADDED SHADING CONTINUATION FORM.

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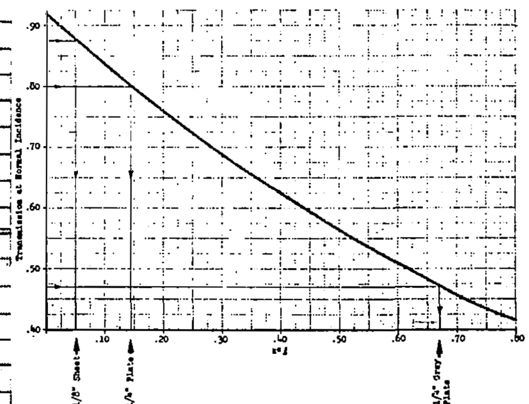
THERMAL LOAD ANALYSIS

INPUT FORM L11 GLAZED SURFACES

No. Glazed Surface Pictures (cols 1–10)	(cols 11–70)	Card Index (cols 71–80)
		L 4 6

GLAZED SURFACE PICTURE DEFINITION

Month (cols 1–10)	Hour of Day (cols 11–20)	Glazed Surface Index (cols 21–30)	(cols 31–70)	Card Index (cols 71–80)
				L 4 7



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

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

CODE	MEANING
5	k*ℓ = 0.40
6	k*ℓ = 0.60
7	50% transparent H.A. plate
8	k*ℓ = 1.00

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THERMAL LOAD ANALYSIS

INPUT FORM L12 INTERNAL SURFACES

No. Internal Heat Transfer Surfaces		Card Index
1–10	11–70	71–80
		L48

R

IF THERE ARE NO INTERNAL HEAT TRANSFER SURFACES, SKIP CARD TYPE L49.

*Includes air films on both sides.

INDEX NO.	Surface Area	Heat Transfer Coefficient (BTU/HR-^{o}F-FT^{2})*	ADJOINING SPACES: Space 1	ADJOINING SPACES: Space 2		Card Index
	1–10	11–20	21–30	31–40	41–70	71–80
1						L49
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

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THERMAL LOAD ANALYSIS

INPUT FORM L13 UNDERGROUND SURFACES

UNDERGROUND WALLS

* Heat transfer coefficient includes inside air film. Exterior surface temperature is set equal to ground temperature

No. Underground Walls (cols. 1–10)	Card Index (cols. 71–80)
	L 5 0

R

INDEX NO.	Wall Area (cols. 1–10)	Heat Transf. Coeff. (BTU/HR-°F-FT²) * (cols. 11–20)	Card Index (cols. 71–80)
1			L 5 1
2			
3			
4			
5			
6			
7			
8			
9			
10			

IF THERE ARE NO UNDERGROUND WALLS, SKIP CARD TYPE L51.

UNDERGROUND FLOORS

No. Underground Floors (cols. 1–10)	Card Index (cols. 71–80)
	L 5 2

R

INDEX NO.	Floor Area (cols. 1–10)	Heat Transf. Coeff. (BTU/HR-°F-FT²) * (cols. 11–20)	Card Index (cols. 71–80)
1			L 5 3
2			
3			
4			
5			
6			
7			
8			
9			
10			

IF THERE ARE NO UNDERGROUND FLOORS, SKIP CARD TYPE L53.

GROUND TEMPERATURE (°F)

If length of study is greater than 7 months, use 2nd L54 type card. For Design Day Analysis, all 12 months are required.

1st. Mon. of Study or Jan / August (cols. 1–10)	2nd Mon. of Study or Feb. / September (cols. 11–20)	March / October (cols. 21–30)	April / November (cols. 31–40)	May / December (cols. 41–50)	June (cols. 51–60)	July (cols. 61–70)	Card Index (cols. 71–80)
							L 5 4

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THERMAL LOAD ANALYSIS

INPUT FORM L14 SPACE IDENTIFICATION

Number of Spaces	This card type appears only once	Card Index
		L 5 5

R

SPACE NO.

REPEAT CARD TYPES L56, L65 FOR EACH SPACE

No. Delayed Surfaces	No. Quick Surfaces	No. Glazed Surfaces	No. Internal Surfaces	No. Underground Walls	No. Underground Floors	No. Additional Identical Spaces	Card Index
							L 5 6

R

Space Floor Area (FT^2)	Space Volume (FT^3)	Weight of Floor (LB/FT^2)	Space Temperature (^oF)	No. People at Peak	People Activity Level (BTU/HR) (S + L)		Card Index
							L 5 7

R

Type of Light Fixture (1.0,4.0)	Percent Light Heat to Space	Operating Schedule Index	Type of Infiltration Analysis *	Infiltration Rate (No. of Air Changes)	Height above (-) or below Neutral Zone (FT)	Space Exhaust Air(CFM)	Card Index
							L 5 8

R

Lighting Load ($WATTS/FT^2$)	Lighting Load (KW)						Card Index
							L 5 9

R

Equipment Load ($WATTS/FT^2$)	Equipment Load (KW)	Equipment Load (BTU/HR-Sensible)	Equipment Load (BTU/HR-Latent)	Card Index
				L 6 0

INDICES OF SPACE SURFACES:

- Begin new card for each surface type.
- If a surface type is not included, skip that card index type.

LIGHT FIXTURE CODE

1. Not vented
2. Vented to ret.air
3. Vented to sup. & ret.air
4. Incandescent

*INFILTRATION CODE

0. None
1. Air change method (only columns 41-50 req'd)
2. Crack method (only columns 51-70 req'd)

- Delayed — L61
- Quick — L62
- Glazed — L63
- Internal — L64
- Underground walls — L65
- Underground floors — L66

CARD INDEX

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THERMAL LOAD ANALYSIS

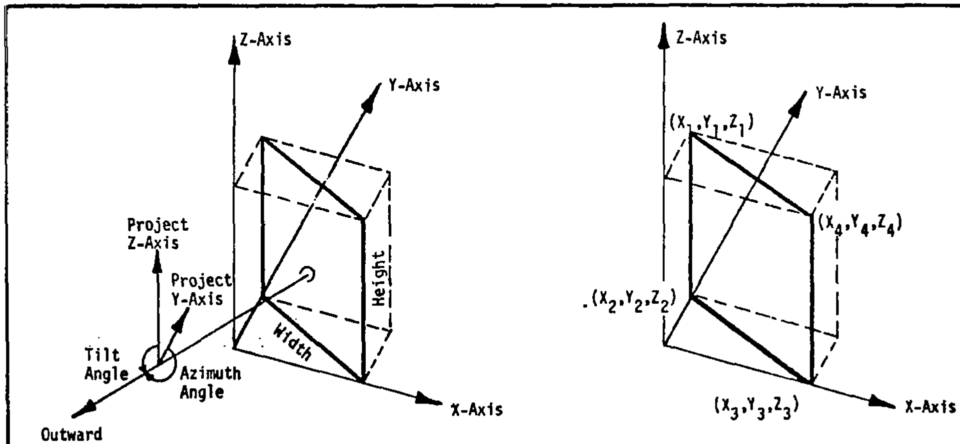
ADDED SHADING, CONTINUATION

DEFINITION OF ADDED SHADING SURFACES

No. Vertices	Transmittance 0 (Opaque) to 1 (Clear)		Card 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 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

VERTICE COORDINATES (FEET)			Height (FT)	Width (FT)	Surface Azimuth (DEG)	Tilt Angle (DEG)	Card Index
X	Y	Z					
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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

(If more cards are required, use an Added Shading Continuation Form.)



SHORT FORM   LONG FORM

NOTES:

SHORT FORM - All columns apply.
No. Vertices equals 1.0 .
X,Y,Z coordinates refer to lower left hand corner of rectangular surface when viewed from outside.

LONG FORM - No. vertices, transmittance factor X,Y,Z coordinates, and card index apply.
No. vertices should be indicated only on first vertex card.

FACILITY IDENTIFICATION	PROJECT NUMBER	ENGINEER	DATE	SHEET — OF —

DATA FIELD	IDENTIFICATION FIELD
1–70	71–80

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INPUT FORM S01

SYSTEM & EQUIPMENT SIMULATION

JOB CONTROL PARAMETERS

Begin Analysis (Hour of Year)	End Analysis (Hour of Year)	No. Primary Equipment Combinations	No. Reset Schedules	System Shut-off Flag	Heat Conservation Flag	No. Energy Distribution System	Card Index
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
							S 1

OPTIONAL HOURLY PRINT INDICATORS

Print-1 (0.-off;1.-on)	Print-2 (0.-off;1.-on)	Print-3 (0.-off;1.-on)		Card Index
1–10	11–20	21–30	31–70	71–80
				S 2

TEMPERATURE RESET SCHEDULES

INDEX NO	Low Outside Air Temp. (TOALO)	High Outside Air Temp. (TOAHI)	Low System Fluid Temp. (TLO)	High System Fluid Temp. (THI)	Schedule Label (Alpha-Numeric)		Card Index
	1–10	11–20	21–30	31–40	41–50	51–70	71–80
1							S 3
2							
3							
4							
5							
6							
7							
8							
9							
10							

HOURS OF YEAR FOR 365-DAY YEAR

Month	Days	Hours	First Hour of Month	Last Hour of Month
January	31	744	1	744
February	28	672	745	1416
March	31	744	1417	2160
April	30	720	2161	[illegible]
May	31	744	[illegible]	[illegible]
June	30	720	[illegible]	[illegible]
July	31	744	[illegible]	[illegible]
August	31	744	[illegible]	[illegible]
September	30	720	[illegible]	[illegible]
October	31	744	[illegible]	7296
November	30	720	7297	[illegible]
December	31	744	8017	[illegible]

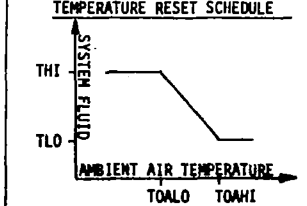
SYSTEM SHUT-OFF FLAG

0. = Fans run continuously
1. = Fans may be shut off
2. = Fans & Baseboard heating may be shut off

HEAT CONSERVATION FLAG

Does one case use heat conservation ?
1. = No
2. = Yes

TEMPERATURE RESET SCHEDULE



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INPUT FORM SO2a

SYSTEM & EQUIPMENT SIMULATION

ENERGY DISTRIBUTION SYSTEM DATA System No: System Type:

Type of Distribution System	No. Zones on System	Relative Humidity Set Point(%R.H)	Humidifier Control Zone(System Zone No.)	Min. Outside Air (CFM)	Mixed Air Option	Variable Volume Fan Control	Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80	
							S 4 A	R

TEMPERATURE CONTROL MODES		TOTAL FAN PRESSURES (IN.H_2O)			Variable Volume Reheat Coil Option	Variable Volume Box Min. Air (%)	Card Index	
Hot Deck or AHU Leaving	Cold Deck	Supply	Return	Exhaust				
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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80	
							S 4 B	R

Fixed Air Temperatures(^oF)		TEMPERATURE RESET SCHEDULE INDICES				Induction Unit, Induced/Primary Air Ratio	Card Index	
Hot Deck or AHU Leaving	Cold Deck	Hot Deck Schedule or AHU Leaving Schedule	Cold Deck Schedule	Baseboard Radiation Schedule	Two-pipe H.W Schedule			
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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80	
							S 4 C	R

Two-pipe Fan-Coil Changeover Temp.(^oF)	2-pipe ind.change over or flr.pan shutoff temp.(^oF)	Two-pipe System Water Volume (GALS)	Floor Heating Panel Location	Floor Heating Panel Area Covered (FT^2)	Exposed Perimeter (Lin.FT.)		Card 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	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80	
							S 4 D	R

Space data cards applicable to this system immediately follow.

DISTRIBUTION SYSTEM TYPES

1. Single Zone Fan System With Face And By-Pass Dampers
2. Multi-Zone Fan System.
3. Dual Duct Fan System.
4. Single Zone Fan System With Sub-Zone Reheat.
5. Unit Ventilator.
6. Unit Heater.
7. Floor Panel Heating.
8. Two-pipe Fancoil System.
9. Four-pipe Fancoil System.
10. Two-pipe Induction Unit Fan System.
11. Four-pipe Induction Unit Fan System.
12. Variable Volume Fan System WithOptional Reheat.
13. Constant Volume Reheat Fan System.

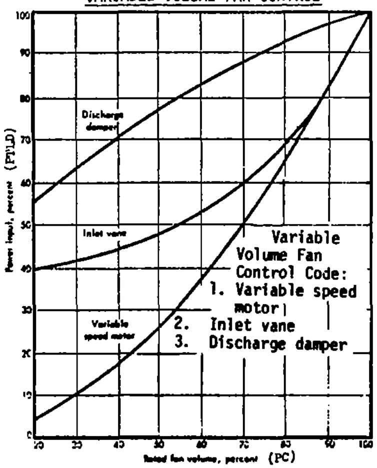
MIXED AIR OPTION

1. Fixed percent outside air.
2. Enth.Temp.Econo.Control.
3. Temp.Econo.Control

TEMPERATURE CONTROL MODES

1. Predefined constant temperature.
2. Determined by zone with coldest supply air reqmt.
3. Reset per hot deck. Reset schedule indexed in card S4C.
6. Determined by zone with warmest supply air reqmt.

VARIABLE VOLUME FAN CONTROL



VARIABLE VOLUME REHEAT COIL OPTION

Are reheat coils located after VAV Boxes ?
0. = No
1. = Yes

LOCATION OF FLOOR HEATING PANELS

1. = Slab on grade
2. = Intermediate floor slab.

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INPUT FORM SO2b

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SYSTEM & EQUIPMENT SIMULATION

SPACE DATA   For System No.

SYSTEM SPACE NO.	Load Program Space Number (1–10)	Space Multiplication Factor (11–20)	Constant Volume Exhaust air(CFM) (21–30)	Baseboard Radiation: Heat Output at std. Conditions(BTU/HR-FT) (31–40)	Baseboard Radiation: Active Length(LinFT) (41–50)	Load Program Plenum Space No. (51–60)	Space Name (Alpha-Numeric) (61–70)	Card Index (71–80)	
1								S 5	R
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

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INPUT FORM SO3

SYSTEM & EQUIPMENT SIMULATION

PRIMARY EQUIPMENT DESCRIPTION

RUN NO.	System Identification Number (1–10)	Heat Conservation Run Flag (11–20)	Chiller Type (21–30)	Source of Chiller Energy (31–40)	Source of General Heating Energy (41–50)	Source of Reheat Coil Energy (51–60)	(61–70)	Card Index (71–80)	
1								S 6	R

	Type of Auxiliary Chiller (1–10)	Source of Supplemental Heat (11–20)	Number of Energy / Generator Sets (21–30)	Type of Engine / Generator Set (31–40)	(41–70)	Card Index (71–80)	
						S 7	R

RUN NO.	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
2								
3								
4								
5								
6								
7								
8								
9								
10								

HEAT CONSERVATION RUN FLAG

Is this a heat conservation building
1. = No
2. = Yes

CHILLER TYPE

1. = Reciprocating
2. = Hermetic Centrifugal
3. = Opencentrifugal
4. = Steam Absorption
5. = Centrifugal/Steam Turbine

SOURCE OF CHILLER AND GENERAL HEATING ENERGY

1. = Gas
2. = Heating Oil
3. = Steam
4. = Electric

SOURCE OF REHEAT COIL ENERGY

0. = Same as boiler
4. = Electric

ENGINE/GENERATOR SET TYPES

0. = None
1. = Diesel
2. = Gas

TYPE OF AUXILLARY CHILLER

0. = None
1. = Reciprocating
2. = Hermetic Centrifugal
3. = Open Centrifugal

SUPLEMENTAL HEAT SOURCE

0. = None
1. = Gas
2. = Heating Oil
3. = Electricity
4. = Well Water
5. = City Water

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INPUT FORM SO5

SYSTEM & EQUIPMENT SIMULATION

FLOOR PANEL HEATING SYSTEMS

Type of Floor Covering	Floor Insulation Conductance (BTU/HR-^{o}F - FT^{2})	Floor Insulation Thickness (FT)		Card Index
1–10	11–20	21–30	31–70	71–80
				S 1 3

HEAT CONSERVATION

Max. Cond. H_2O Temp. (^{o}F)	Well or City H_2O Design return H_2O Temp. (^{o}F)	City H_2O Supply Temp. (^{o}F)	Well H_2O Supply Temp. (^{o}F)	Total Well H_2O Pump Head (FT)		Card Index
1–10	11–20	21–30	31–40	41–50	51–70	71–80
						S 1 4

SNOW MELTING SYSTEM

Type of Snow Melting System	Snow Melting System Design Load (BTU/HR)	Snow Melting Slab Area (FT^{2})		Card Index
1–10	11–20	21–30	31–70	71–80
				S 1 5

IF SNOW MELTING SYSTEM IS USED,PLACE WBAN SUMMARY DECK 345 HERE.OTHERWISE, IT MAY BE OMITTED.

TYPE OF FLOOR COVERING

1. = Bare Concrete
2. = Tile
3. = Carpeting

TYPE OF SNOW MELTING SYSTEM

0. = None
1. = Liquid
2. = Electric

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SYSTEM & EQUIPMENT SIMULATION

INPUT FORM S04

BOILERS

Number of Boilers	Size of each Boiler (MBH)	Hour of Seasonal Boiler Start-up	Hour of Seasonal Boiler Shut-down	Heating Value Heating Oil (BTU/GAL)		Card Index	
1–10	11–20	21–30	31–40	41–50	51–70	71–80	
						S 8	R

CHILLERS

Number of Chillers	Size of each Chiller (TONS)	Hour of Seasonal Chiller Start-up	Hour of Seasonal Chiller Shut-down	Min. Part Load Chiller Cut-off (%)	Chilled Water Set Point Temp. (°F)	Cooling Tower Water Low Limit Temp. (°F)	Card Index	
1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	
							S 9	R

PUMP HEADS

Total Boiler Water Pump Head (FT)	Total Chilled Water Pump Head (FT)	Total Condenser Water Pump Head (FT)		Card Index	
1–10	11–20	21–30	31–70	71–80	
				S 1 0	R

External Lighting Power (KW)	Fan & Pump Motor Efficiency (%)	Building Changeover Temperature (°F)	Heating Value Diesel Fuel (BTU/GAL)		Card Index	
1–10	11–20	21–30	31–40	41–70	71–80	
					S 1 1	R

STEAM & STEAM TURBINES

Boiler Supply & Absorption Chiller Entering		Steam Turbine				Card Index	
Steam Pressure (PSIG)	Temperature (°F)	Entering Stm Press (PSIG)	Entering Temp. (°F)	Speed (RPM)			
1–10	11–20	21–30	31–40	41–50	51–70	71–80	
						S 1 2	R

APPENDIX D

SYSTEMS AND EQUIPMENT SIMULATION PROGRAM INPUT AID SHEETS

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```
CARD TYPE-1.
            IHSRT - HOUR OF YEAR AT WHICH SIMULATION MAY BEGIN.
            IHSTP - HOUR OF YEAR AT WHICH SIMULATION MAY END.
            NCASE  - NUMBER OF CASES TO BE RUN.
            NRSET - NUMBER OF RESET SCHEDULES TO BE READ.
            IFAN  - FAN SHUT-OFF FLAG.
            KHCST - HEAT CONSERVATION SYSTEM FLAG.
            KMAX  - NO. OF ENERGY DISTRIBUTION SYSTEMS.

CARD TYPE-2.
            IPRT1 - OPTIONAL PRINT FLAG, LEVEL 1...HOURLY SUMMARIES.
            IPRT2 - OPTIONAL PRINT FLAG, LEVEL 2...ZONE SUMMARIES.
            IPRT3 - OPTIONAL PRINT FLAG, LEVEL 3...SYSTEM COMPONENT PERFORMANCE.

CARD TYPE-3.
TEMPERATURE RESET SCHEDULES.
  SCHEDULE     TOALO      TOAHI       TLO        THI        ** LABEL **
   NUMBER
      1
      2
      3
      4
      5
      6
      7
      8
      9
     10
************************************************************************************************************************
```

Figure D-1 SYSTEM & EQUIPMENT SIMULATION INPUT AND SHEET 1/4

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```
****************************************************************************************************
PRIMARY EQUIPMENT DESCRIPTION.
CASE NUMBER  1.
CARD TYPE-6.
            ISYS  - SYSTEM COMBINATION NUMBER.
            KBLDG - BUILDING TYPE (1.=CONVENTIONAL OR ON-SITE, 2.=HEAT CONSERVATION).
            M1    - TYPE OF CHILLER.
            M2    - SOURCE OF CHILLER ENERGY.
            M3    - SOURCE OF HEATING ENERGY.
            KREHT - SOURCE OF REHEAT COIL ENERGY.

CARD TYPE-7.
            M6    - TYPE OF AUXILIARY CHILLER.
            M7    - SOURCE OF SUPPLEMENTAL HEAT.
            M4    - NUMBER OF ON-SITE ENGINE GENERATOR SETS.
            M5    - TYPE OF E/G SET.
****************************************************************************************************

CARD TYPE-8.
            NUMB  - NUMBER OF BOILERS.
            SZB   - SIZE OF EACH BOILER (MBH).
            BON   - HOUR OF SEASONAL BOILER START-UP.
            BOFF  - HOUR OF SEASONAL BOILER SHUT-DOWN.
            HVHO  - HEATING VALUE HEATING OIL

CARD TYPE-9.
            NUMC  - NUMBER OF CHILLERS.
            SZC   - SIZE OF EACH CHILLER (TONS).
            CON   - HOUR OF SEASONAL CHILLER START-UP.
            COFF  - HOUR OF SEASONAL CHILLER SHUT-DOWN.
            FFLMN - MINIMUM PART LOAD CUT-OFF FOR CHILLERS (PER CENT).
            TLCHL - CHILLED WATER SET POINT TEMP.
            TECMN - COOLING TOWER WATER LOW LIMIT TEMPERATURE.

CARD TYPE-10.
            HDBLP - TOTAL BOILER WATER PUMP HEAD (FT.).
            HDCLP - TOTAL CHILLED WATER PUMP HEAD (FT.).
            HDCNP - TOTAL CONDENSER WATER PUMP HEAD (FT.).
```

Figure D-3 SYSTEM & EQUIPMENT SIMULATION INPUT AID SHEET 3/4

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```
***********************************************************************************************************
CARD TYPE-4.
SYSTEM NUMBER  1.
KFAN =          JMAX =          RHSP =          ICZN =          OACFM=          MXAO =          NVFC =
ITMPC=          ITMPC=          TFNPS=          TFNPR=          TFNPE=          IVVRH=          VVMIN=
TFIX1=          TFIX2=          ISET =          ISET =          ISET =          ISET =          RIPA =
TCOFC=          TOACO=          PWGAL=          PLOC =          PAREA=          PERIM=

CARD TYPE-5.
ZONE DATA.
       J    SPACN(K,J)   MULT(I)   CFMX(I)   CBTU(I)  ALFBR(I)   IPLEN(I)    ZONE LABEL
   (CALC'D)
       1
       2
       3
       4
       5
       6
       7
       8
       9
      10
      11
      12
      13
      14
      15
      16
      17
      18
      19
      20
***********************************************************************************************************
```

NOTE: SEE FIGURE D-5 TO D-17 FOR ELABORATION OF THESE CARD TYPES.

Figure D-2 SYSTEM & EQUIPMENT SIMULATION INPUT AID SHEET 2/4

```
CARD TYPE-11.
        PWOL  - EXTERNAL LIGHTING POWER.
        EFF   - FAN AND PUMP MOTOR EFFICIENCY (PER CENT).
        TCO   - BLDG CHANGEOVER TEMP.
        HVDF  - HEATING VALUE DIESEL FUEL

CARD TYPE-12.
        PESTM - BOILER SUPPLY AND ABSORPTION CHILLER ENTERING STEAM PRESSURE (PSIG).
        TESTM - BOILER SUPPLY AND ABSORPTION CHILLER ENTERING STEAM TEMPERATURE (DEG.F.).
        PPS   - STEAM TURBINE ENTERING STEAM PRESSURE (PSIG.).
        TPS   - STEAM TURBINE ENTERING STEAM TEMPERATURE (DEG.F.).
        RPM   - STEAM TURBINE SPEED (RPM).

CARD TYPE-13.
        KFLCV - TYPE OF FLOOR COVERING.
        CINSL - FLOOR INSULATION CONDUCTANCE.
        DINSL - FLOOR INSULATION THICKNESS.

CARD TYPE-14.
        TLCNM - MAXIMUM ALLOWABLE CONDENSER WATER TEMPERATURE (DEG.F.).
        TLCMN - WELL OR CITY WATER DESIGN RETURN WATER TEMPERATURE (DEG.F.).
        TCWIN - CITY WATER SUPPLY TEMPERATURE (DEG.F.).
        TWWIN - WELL WATER SUPPLY TEMPERATURE (DEG.F.).
        HDWWP - TOTAL WELL WATER PUMP HEAD (FT.).

CARD TYPE-15.
        KSNOW - TYPE OF SNOW MELTING SYSTEM.
        QSNOW - SNOW MELTING SYSTEM DESIGN LOAD.
        SAREA - SNOW MELTING SLAB AREA.
```

Figure D-4 SYSTEM & EQUIPMENT SIMULATION INPUT AID SHEET 4/4

FIG. D-5

SYSTEM NO. 1 SINGLE ZONE FAN SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option

ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)

TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (°F)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (°F)
ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air

TCOFC (K) - Two Pipe Fancoil Changeover Temp. (°F)
TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-6

SYSTEM NO. 2 MULTI-ZONE FAN SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - Hot Deck Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K) - Hot Deck Air Temperature (Fixed) (^oF)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^oF)
ISET (K,1) - Hot Deck Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^oF)
TOACO (K)
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-7

SYSTEM NO. 3 DUAL DUCT FAN SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option

ITMPC (K,1) - Hot Deck Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)

TFIX1 (K) - Hot Deck Air Temperature (Fixed) (°F)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (°F)
ISET (K,1) - Hot Deck Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air

TCOFC (K) - Two Pipe Fancoil Changeover Temp. (°F)
TOACO (K)
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-8

SYSTEM NO. 4 SINGLE-ZONE FAN SYSTEM W/SUB-ZONE REHEAT

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

- KFAN (K) - Type of Energy Distribution System
- JMAX (K) - Number of Zones on System
- RHSP (K) - System Relative Humidity Set Point (% R.H.)
- ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
- OACFM (K) - Minimum Outside Air Volume (CFM)
- MXAO (K) - Mixed Air Option
- NVFC (K) - Variable Volume Fan Control Option
- ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
- ITMPC (K,2) - Cold Deck Air Temperature Control Mode
- TFNPS (K) - Total Supply Fan Pressure (in H_2O)
- TFNPR (K) - Total Return Fan Pressure (in H_2O)
- TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
- IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
- VVMIN (K) - Min. Flow through Variable Volume Boxes. (%)
- TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (°F)
- TFIX2 (K) - Cold Deck Air Temperature (Fixed) (°F)
- ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
- ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
- ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
- ISET (K,4) - Process Water Temp. Reset Schedule Index
- RIPA (K) - Ratio of Induced to Primary Air
- TCOFC (K) - Two Pipe Fancoil Changeover Temp. (°F)
- TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
- PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
- PLOC (K) - Location of Floor Heating Panels
- PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
- PERIM (K) - Exposed Perimeter of Floor (Ft.)

- J - Zone Number
- SPACN (K,J) - Load Program Space Number
- MULT (I) - Zone Multiplication Factor
- CFMX (I) - Air Exhausted from Zone (CFM)
- CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
- ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
- IPLEN (I) - Load Program Space Number of Plenum Above this Space.
- ZNAME (I) - Zone Name. (alpha-numeric)

FIG. D-9

SYSTEM NO. 5 UNIT VENTILATOR

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

1	11	21	31	41	51	61–70
KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (^oF)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^oF)
ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^oF)
TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-10

SYSTEM NO. 6 UNIT HEATER

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K)	- Type of Energy Distribution System
JMAX (K)	- Number of Zones on System
RHSP (K)	- System Relative Humidity Set Point (% R.H.)
ICZN (K)	- Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K)	- Minimum Outside Air Volume (CFM)
MXAO (K)	- Mixed Air Option
NVFC (K)	- Variable Volume Fan Control Option
ITMPC (K,1)	- AHU Discharge Air Temperature Control Mode
ITMPC (K,2)	- Cold Deck Air Temperature Control Mode
TFNPS (K)	- Total Supply Fan Pressure (in H_2O)
TFNPR (K)	- Total Return Fan Pressure (in H_2O)
TFNPE (K)	- Total Exhaust Fan Pressure (in H_2O)
IVVRH (K)	- Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K)	- Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K)	- AHU Discharge Air Temperature (Fixed) (^{o}F)
TFIX2 (K)	- Cold Deck Air Temperature (Fixed) (^{o}F)
ISET (K,1)	- AHU Discharge Air Temperature Reset Schedule Index
ISET (K,2)	- Cold Deck Air Temp. Reset Schedule Index
ISET (K,3)	- Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4)	- Process Water Temp. Reset Schedule Index
RIPA (K)	- Ratio of Induced to Primary Air
TCOFC (K)	- Two Pipe Fancoil Changeover Temp. (^{o}F)
TOACO (K)	- Floor Panel Heating System Hot Water Shut-off Temp.
PWGAL (K)	- Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K)	- Location of Floor Heating Panels
PAREA (K)	- Floor Area Available for Heating Panels (Ft^2)
PERIM (K)	- Exposed Perimeter of Floor (Ft.)
J	- Zone Number
SPACN (K,J)	- Load Program Space Number
MULT (I)	- Zone Multiplication Factor
CFMX (I)	- Air Exhausted from Zone (CFM)
CBTU (I)	- Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I)	- Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I)	- Load Program Space Number of Plenum Above this Space.
ZNAME (I)	- Zone Name. (alpha-numeric)

FIG. D-11

SYSTEM NO. 7 FLOOR PANEL HEATING

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (^{o}F)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^{o}F)
ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^{o}F)
TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-12

SYSTEM NO. 8 TWO-PIPE FANCOIL SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (°F)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (°F)
ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (°F)
TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-13

SYSTEM NO. 9 FOUR-PIPE FANCOIL SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

- KFAN (K) - Type of Energy Distribution System
- JMAX (K) - Number of Zones on System
- RHSP (K) - System Relative Humidity Set Point (% R.H.)
- ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
- OACFM (K) - Minimum Outside Air Volume (CFM)
- MXAO (K) - Mixed Air Option
- NVFC (K) - Variable Volume Fan Control Option
- ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
- ITMPC (K,2) - Cold Deck Air Temperature Control Mode
- TFNPS (K) - Total Supply Fan Pressure (in H_2O)
- TFNPR (K) - Total Return Fan Pressure (in H_2O)
- TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
- IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
- VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
- TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (^oF)
- TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^oF)
- ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
- ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
- ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
- ISET (K,4) - Process Water Temp. Reset Schedule Index
- RIPA (K) - Ratio of Induced to Primary Air
- TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^oF)
- TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
- PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
- PLOC (K) - Location of Floor Heating Panels
- PAREA (K) - Floor Area Available for Heating Panels ($Ft.^2$)
- PERIM (K) - Exposed Perimeter of Floor (Ft.)
- J - Zone Number
- SPACN (K,J) - Load Program Space Number
- MULT (I) - Zone Multiplication Factor
- CFMX (I) - Air Exhausted from Zone (CFM)
- CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
- ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
- IPLEN (I) - Load Program Space Number of Plenum Above this Space.
- ZNAME (I) - Zone Name. (alpha-numeric)

FIG. D-14

SYSTEM NO. 10 TWO-PIPE INDUCTION UNIT FAN SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K) - Primary Air Temperature (Fixed) (°F)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (°F)
ISET (K,1) - Primary Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (°F)
TOACO (K) - Two Pipe Induction Fan System Changeover Temperature
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft.^{2})
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name.(alpha-numeric)

FIG. D-15

SYSTEM NO. 11 FOUR-PIPE INDUCTION UNIT FAN SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes. (%)
TFIX1 (K) - Primary Air Temperature (Fixed) (^oF)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^oF)
ISET (K,1) - Primary Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^oF)
TOACO (K) - Two Pipe Induction Fan System Changeover Temperature
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name. (alpha-numeric)

FIG. D-16

SYSTEM NO. 12 VARIABLE VOLUME FAN SYSTEM WITH OPTIONAL REHEAT

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	
1	11	21	31	41	51	61 70

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

KFAN (K) - Type of Energy Distribution System
JMAX (K) - Number of Zones on System
RHSP (K) - System Relative Humidity Set Point (% R.H.)
ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
OACFM (K) - Minimum Outside Air Volume (CFM)
MXAO (K) - Mixed Air Option
NVFC (K) - Variable Volume Fan Control Option
ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
ITMPC (K,2) - Cold Deck Air Temperature Control Mode
TFNPS (K) - Total Supply Fan Pressure (in H_2O)
TFNPR (K) - Total Return Fan Pressure (in H_2O)
TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
VVMIN (K) - Min. Flow through Variable Volume Boxes.(%)
TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (^oF)
TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^oF)
ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
ISET (K,4) - Process Water Temp. Reset Schedule Index
RIPA (K) - Ratio of Induced to Primary Air
TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^oF)
TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
PLOC (K) - Location of Floor Heating Panels
PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
PERIM (K) - Exposed Perimeter of Floor (Ft.)

J - Zone Number
SPACN (K,J) - Load Program Space Number
MULT (I) - Zone Multiplication Factor
CFMX (I) - Air Exhausted from Zone (CFM)
CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
IPLEN (I) - Load Program Space Number of Plenum Above this Space.
ZNAME (I) - Zone Name (alpha-numeric)

FIG. D-17

SYSTEM NO. 13 CONSTANT VOLUME REHEAT FAN SYSTEM

CARD TYPE - 4 ENERGY DISTRIBUTION SYSTEM DATA

1	11	21	31	41	51	61–70
KFAN(K)	JMAX(K)	RHSP(K)	ICZN(K)	OACFM(K)	MXAO(K)	NVFC(K)
ITMPC(K,1)	ITMPC(K,2)	TFNPS(K)	TFNPR(K)	TFNPE(K)	IVVRH(K)	VVMIN(K)
TFIX1(K)	TFIX2(K)	ISET(K,1)	ISET(K,2)	ISET(K,3)	ISET(K,4)	RIPA(K)
TCOFC(K)	TOACO(K)	PWGAL(K)	PLOC(K)	PAREA(K)	PERIM(K)	

CARD TYPE - 5 ZONE DATA

J	SPACN(K,J)	MULT(I)	CFMX(I)	CBTU(I)	ALFBR(I)	IPLEN(I)	ZNAME
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

DEFINITION OF VARIABLES

- KFAN (K) - Type of Energy Distribution System
- JMAX (K) - Number of Zones on System
- RHSP (K) - System Relative Humidity Set Point (% R.H.)
- ICZN (K) - Zone in which Humidistat Controlling and Central Humidifier is Located.
- OACFM (K) - Minimum Outside Air Volume (CFM)
- MXAO (K) - Mixed Air Option
- NVFC (K) - Variable Volume Fan Control Option
- ITMPC (K,1) - AHU Discharge Air Temperature Control Mode
- ITMPC (K,2) - Cold Deck Air Temperature Control Mode
- TFNPS (K) - Total Supply Fan Pressure (in H_2O)
- TFNPR (K) - Total Return Fan Pressure (in H_2O)
- TFNPE (K) - Total Exhaust Fan Pressure (in H_2O)
- IVVRH (K) - Are Reheat Coils Located After Variable Vol. Boxes? 0=No,1=Yes
- VVMIN (K) - Min. Flow through Variable Volume Boxes. (%)
- TFIX1 (K) - AHU Discharge Air Temperature (Fixed) (^oF)
- TFIX2 (K) - Cold Deck Air Temperature (Fixed) (^oF)
- ISET (K,1) - AHU Discharge Air Temperature Reset Schedule Index
- ISET (K,2) - Cold Deck Air Temp. Reset Schedule Index
- ISET (K,3) - Baseboard Radiation Temp. Reset Schedule Index
- ISET (K,4) - Process Water Temp. Reset Schedule Index
- RIPA (K) - Ratio of Induced to Primary Air
- TCOFC (K) - Two Pipe Fancoil Changeover Temp. (^oF)
- TOACO (K) - Floor Panel Heating System Hot Water Shut-off Temp.
- PWGAL (K) - Volume of Water in System (2 pipe fancoil or induction) (Gals.)
- PLOC (K) - Location of Floor Heating Panels
- PAREA (K) - Floor Area Available for Heating Panels (Ft^2)
- PERIM (K) - Exposed Perimeter of Floor (Ft.)
- J - Zone Number
- SPACN (K,J) - Load Program Space Number
- MULT (I) - Zone Multiplication Factor
- CFMX (I) - Air Exhausted from Zone (CFM)
- CBTU (I) - Heat Output of Baseboard Radiation at design conditions (BTU/HR.-Lin. Ft.)
- ALFBR (I) - Active Length of Baseboard Radiation (Lin. Ft.)
- IPLEN (I) - Load Program Space Number of Plenum Above this Space.
- ZNAME (I) - Zone Name. (alpha-numeric)

NOTES AND COMMENTS

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