scout

USER MANUAL

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GARD, INC.
A SUBSIDIARY OF
GATX CORPORATION

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Scout

THE COMPUTER PROGRAM FOR FACILITY/HVAC DESIGN AND ENERGY ANALYSIS

USER'S MANUAL

Published by

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FOREWORD

SCOUT is a series of computer programs used for facility/HVAC design and energy analysis of new and existing buildings and is the exclusive property of GARD, Inc.

This SCOUT User's Manual is provided to assist the user in preparation of input data for a particular problem and then interpreting the results. Two additional manuals are also available:

SCOUT Input Forms Manual

SCOUT Access and Control Guide

For further information on these manuals and the availability of SCOUT, contact your local Boeing Computer Service (BCS) Sales Office or the SCOUT Team at 312/647-9000.

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SECTION 1

INTRODUCTION

SCOUT is a versatile building and energy analysis tool which has embodied within it ASHRAE state-of-the-art techniques for performing thermal load calculations and energy usage predictions to compare design, rehabilitation and operational alternatives for new and existing buildings. Much of the thinking behind SCOUT is based on NECAP (NASA's Energy/Cost Analysis Program) that GARD developed for NASA. With SCOUT, GARD makes available to the user a more useable and versatile program series fully supported by GARD. Improvements now part of SCOUT include:

A. Increased Useability Features

1) Simplified, self instructional input forms for all programs.
2) Separate data check routines to validate input data.
3) Alternate method of entering building description data utilizing surface areas and orientations rather than coordinate geometry.
4) More logical organization of input data and greater use of repetative building features.
5) More cost effective.
6) Preprocessed, decoded hourly weather data.
7) Batch processing available at commercial computer service bureau, the Boeing Computer Service, Inc (BCS).

B. Increased Versatility Features

1) Simulation of packaged DX and heat pump systems.

2) Scheduling of ventilation air.

3) Seasonal scheduling of thermostats.

4) Supply/return air heat recovery devices.

5) Optional presized supply air flows.

6) Monthly utility cost calculation via utility rate structure.

7) Payback comparison of alternatives.

SCOUT is a series of individual programs placed entirely into the hands of the user to make an analysis as simple or as sophisticated and complete as he needs to make it. Briefly, the 10 programs making up the series include:

1. RESPONSE FACTOR PROGRAM (RESFAC)

   For wall or roof structures different from the typical ones built into SCOUT, 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 CHECK PROGRAMS

   Separate programs which validate and identify errors in card input data for

   - LOAD ANALYSIS PROGRAM(LAP)
   - LOAD ANALYSIS PROGRAM WITH SHADOWS(LAPS)
   - TEMPERATURE ANALYSIS PROGRAM(TAP)
   - SYSTEM ANALYSIS PROGRAM(SAP)

3. LOAD ANALYSIS PROGRAM(LAP)

   Performs hourly transient heat transfer calculations for each

building zone utilizing actual hourly recorded weather or design day data, geometry and construction of the building, scheduled internal loads and astronomy of the sun.

4. LOAD ANALYSIS PROGRAM WITH SHADOWS(LAPS)

   Performs hourly transient heat transfer calculations for buildings designed to utilize solar shading using actual hourly recorded weather or design day data, geometry and construction of the building, scheduled internal loads and astronomy of the sun.

5. TEMPERATURE ANALYSIS PROGRAM(TAP)

   Modifies the thermal loads calculated above by LAP or LAPS to account for temperature swings occuring within each zone due to thermostat action, equipment capacity and equipment scheduling.

6. SYSTEMS ANALYSIS PROGRAM(SAP)

   For a specified type of distribution system allocation and type of energy conversion equipment, this 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.

7. COST ANALYSIS PROGRAM(CAP)

   For the expected life of the building, it calculates the expected annual expenditures to own and operate the building utility systems. Calculates payback period to compare alternatives.

The user is free to use any program as many times as required or carry the analysis as far as he desires. The suggested sequence for using the

SCOUT series to analyze a problem depends upon whether a design load or energy analysis is being sought. Figures 1.1 and 1.2 illustrate the processing steps for each.

The remaining sections of this Manual describe input which should be formulated for each program and entered on the input forms. Also included are typical input examples, output reports and their explanation. Unless otherwise indicated all numbers entered on input forms require a decimal point. The only exceptions are titles or labels, dates, thermostat index, and design load index. Blank fields are always interpreted by the computer as zero.

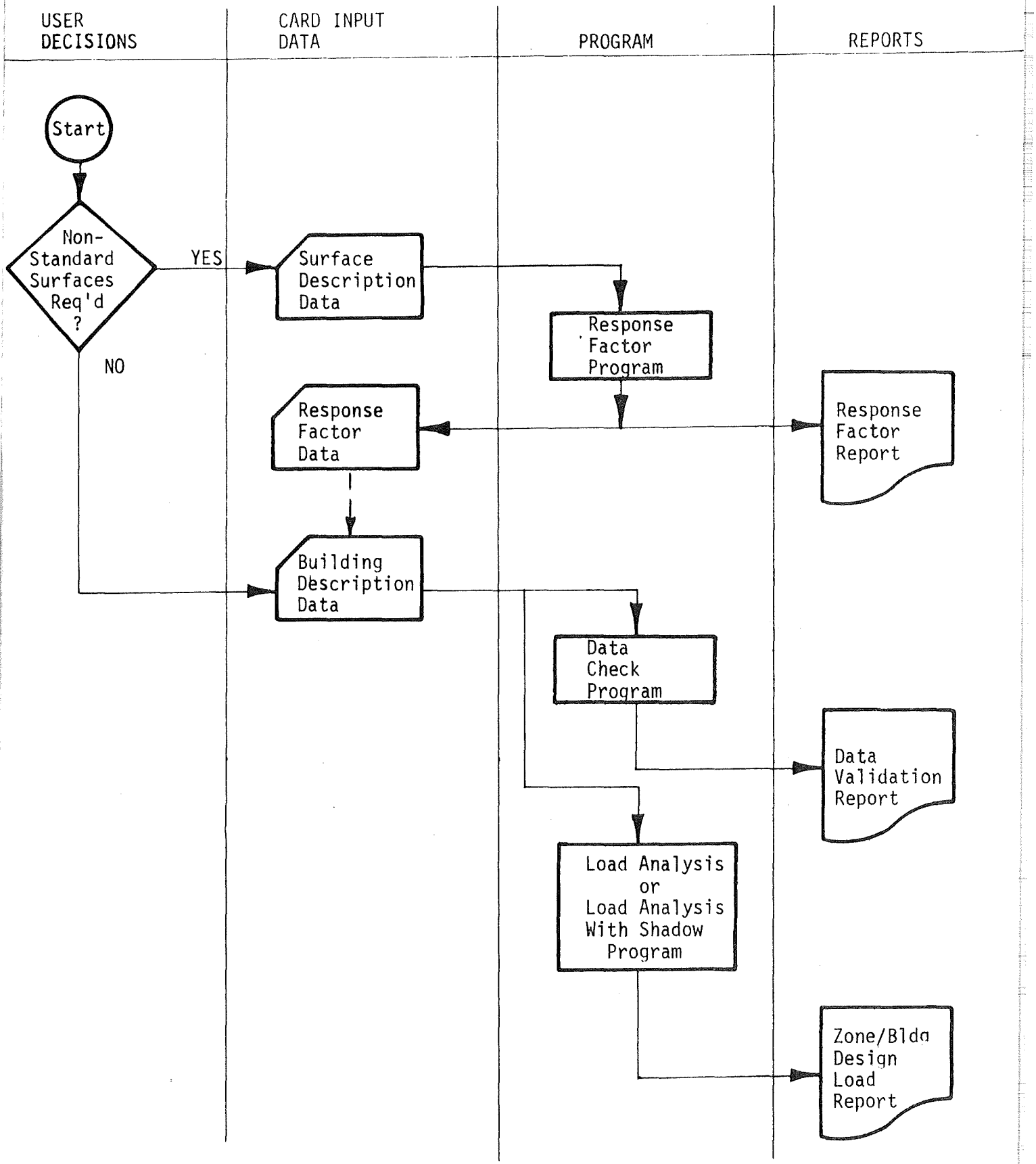


Figure 1.1 DESIGN LOAD ANALYSIS SEQUENCE

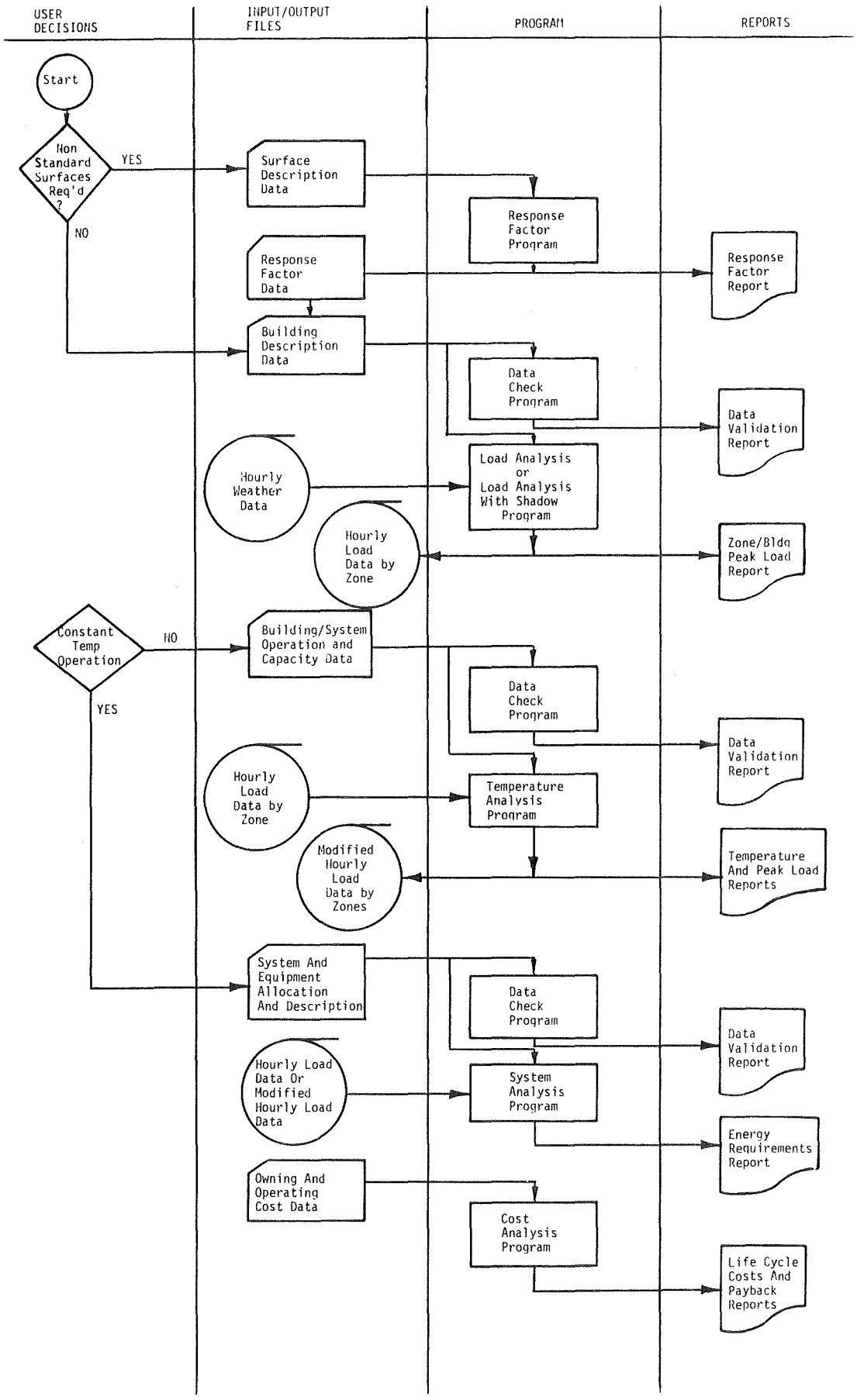


Figure 1.2 ENERGY ANALYSIS SEQUENCE

SECTION 2

RESPONSE FACTOR PROGRAM

2.1 OBJECTIVE AND DESCRIPTION

The Response Factor Program 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. T, thickness, ft.
2. C, thermal conductivity, BTU per (hr.)(ft.)(^{o}F)
3. D, density, lb. per cu. ft.
4. SH, specific heat, BTU per (lb.)(^{o}F)
5. RES, Resistivity, (hr.)(sq.ft.)(^{o}F) per BTU.

Using this data, the Response Factor Program calculates the set of response factors peculiar to the wall or roof constuction in question, prints a report summarizing results and punches the resultant response factor values onto punched computer cards for direct insertion by the user into the Load Analysis or Load Analysis With Shadows card input data. The Response Factor Program need not be used if all wall and roof types desired are among the standard constructions built into the Load Analysis and Load Analysis With Shadows Programs and available for use simply by calling out of an input code (see Table 2.1 for a list of these standard walls and roofs).

2.2 INPUT DATA DESCRIPTION

Before the actual input data preparation task is undertaken, the properties (T, C, D, SH, RES) of each type wall or roof used in the building being studied

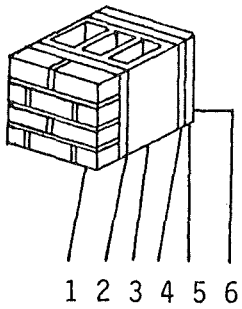
TABLE 2.1

STANDARD CODED CONSTRUCTIONS

TYPE	LAYER DESCRIPTION
Wall	Wood Drop Siding 3/4" Sheathing Board 4" Air Space 1/2" Gypsum Board Inside Air
Wall	Wood Drop Siding 3/4" Sheathing Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
Wall	4" Face Brick 1/2" Air Space 3/4" Sheathing Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
Wall	8" Concrete Block Inside Air
Wall	12" Solid Concrete Inside Film
Wall	12" Concrete Block 2" Air Space 1/2" Gypsum Board Inside Air
Wall	4" Face Brick 2" Air Space 6" Concrete Block Inside Air
Wall	4" Face Brick 2" Air Space 6" Concrete Block 2" Fiberglass Insulation 1/2" Gypsum Board Inside Air
Wall	Sheet Metal 2" Dense Insulation Sheet Metal Inside Air
Wall	Metal Siding 1" Dense Insulation 8" Concrete Block Air Space 1/2" Gypsum Board Inside Air
Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 2" Fiberglass Insulation Metal Pan Inside Air
Roof	Built-up Coating-1/2" Stone Built-up Coating-3/8" Felt 3" Cellular Glass Metal Pan Inside Air
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
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
Roof	Sheet Metal 6" Fiberglass Gypsum Board Inside Air
Roof	Asphalt Shingle (Pitched Roof) 1/2" Plywood Sheathing Attic Air Space 6" Insulation Gypsum Board

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

Note: Order of layers should always be from outside to inside. Do not include outside air film as a layer, since the Load Analysis Program and Load Analysis Program With Shadows 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 key-punching in accordance with instructions outlined on the following pages.

CARD TYPE R-1
NUMBER OF CONSTRUCTIONS TO BE ANALYZED

DEFINITION OF RESPONSE FACTOR SURFACES

No. of Response Factor Surfaces To be Analyzed		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	
		R 1	R

- <u>No. of Response Factor Surfaces to be Analyzed</u> (Cols.1-10) (No limit)

  Total number of surface construction types for which data will be entered.

  NOTE: A set of card types R-2 and R-3 are required for each surface.

DEFINITION OF RESPONSE FACTOR SURFACES

Number Of Layers (1. - 10.)	Do Not Include Outside Air Film As a Layer	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
		R 2 R

LAYER NO.	Thickness (FT.)	Thermal Conductivity (BTU/HR-SQ.FT.-F)	Density (LB/CU.FT)	Specific Heat (BTU/LB.-F)	Thermal Resistivity (HR.-SQ.FT.-F/BTU)	Label (Alphanumeric)	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
1							R 3 R
2							
3							
4							
5							
6							
7							
8							
9							
10							

CARD TYPE R-2

- NUMBER OF LAYERS (1-10) (Cols.1-10)

  Number of layers that surface is made up of including air spaces within and inside air film. Do not include outside air film as a layer. The resistance of this layer is accounted for each hour as a function of wind speed.

CARD TYPE R-3

NOTE: 1. One card is required for each layer. Order of layers should be from outside to inside.

2. See table 2.2 for typical values of layer properties.

- Thickness (Ft.) (Cols.1-10)

  If layer has no thermal mass (e.g. air space) leave this blank.

- Thermal Conductivity (BTU/HR.-SQ.FT.-F) (Cols.11-20)

  If layer has no thermal mass (e.g. air space) leave this blank.

- Density (LBS/CU.FT.) (Cols.21-30)

  If layer has no thermal mass (e.g. air space) leave this blank.

- Specific Heat (BTU/LB-F) (Cols.31-40)

  If layer has no thermal mass (e.g. air space) leave this blank.

- Thermal Resistivity (HR.-SQ.FT.-F/BTU) (Cols.41-50)

  Enter a value here only if layer has no thermal mass (e.g. air space).

- Label (Cols.51-70)

  Alphanumeric description of layer.

Table 2.2

THERMAL PROPERTIES OF TYPICAL BUILDING MATERIALS

Description	Thickness and Thermal Properties				
	T	C	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: T=feet, C=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.

2.3 OUTPUT REPORT DESCRIPTION

An output report similar to that shown in Figure 2.1 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 time increments (in this case 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 relatively constant. The Y-set of response factors indicates the rate of heat transfer through the wall during each time increment. The user will notice that the Y-set rises to a peak, gradually drops and then fades out in an exponential fashion. The time increment at which the peak occurs will vary depending upon a surface's make-up. Seldom, if ever, will two different surfaces have identical X, Y and Z sets.

Sometimes, with surfaces that have little thermal mass, the number of time increments is very small, i.e., the surface has little heat storage capacity, is reacting in a steady-state manner and can therefore be treated as a quick heat transfer in LAP and LAPS with little error in results.

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	GYPSUMBOARD(1/2" 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 2.1 TYPICAL OUTPUT FROM RESPONSE FACTOR PROGRAM

SECTION 3

DATA CHECK PROGRAMS

3.1 OBJECTIVE AND DESCRIPTION

Data Check Programs are available to check and verify card input data for

- Load Analysis Program (LAP)
- Load Analysis Program With Shadows (LAPS)
- Temperature Analysis Program (TAP)
- Systems Analysis Program (SAP)

These programs do a complete check of all card input data. As each card is read, each 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 card. These Data Check Programs do a limited amount of data cross-checking and do not key into the card index data entered in columns 71-80.

3.2 INPUT DATA DESCRIPTION

For an explanation of input data required for each Data Check Program, refer to Table 3.1 .

3.3 OUTPUT REPORT DESCRIPTION

Along with a card image listing of each read, the Data Check Programs will signal three types of errors. They are : WARNINGS, SEVERE ERRORS, and TERMINAL ERRORS.

TABLE 3.1

CARD INPUT REQUIREMENTS FOR

DATA CHECK PROGRAMS

DATA CHECK PROGRAM FOR	DATA CHECK PROGRAM ABREVIATED NAME	CARD INPUT DATA DESCRIPTION
Load Analysis Program	DVPLAP	See Section 4.2, Load Analysis Program Input Data Description
Load Analysis Program With Shadows	DVPLAPS	See Section 5.2, Load Analysis Program With Shadows Input Data Description
Temperature Analysis Program	DVPTAP	See Section 6.2, Temperature Analysis Program Input Data Description
Systems Analysis Program	DVPSAP	See Section 7.2, Systems Analysis Program Input Data Description

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 program to terminate. These errors tend to propagate through a program and may cause quite unrealistic results.

TERMINAL ERRORS will generally stop a program from executing further. These may be cause 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.

A Data Check 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 Check 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 received from the Data Check Programs are illustrated in Figures 3.1 to 3.5. The last page of each data check program run contains a list of parameters summarizing the size of the User's Program. For an explanation of what these parameters are, consult the appendix of the SCOUT AXCESS and CONTROL GUIDE.

```
**************************************************
**************************************************
******                                      ******
******    INPUT DATA VERIFICATION RESULTS   ******
******      FOR SCOUT 1.2/LOAD PROGRAM      ******
******                                      ******
**************************************************
**************************************************
```

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

```
EXAMPLE BUILDING                                                    L1
CHICAGO ILLINOIS                                                    L2
GARD INC                                                            L3
NOV 16 1975                                                         L4
87119-7000                                                          L5
```

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        0.96      0.96      300.0                 L6

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.        L7

BUILDING ALTITUDE
15.0                                                                    L8A

SUMMER DESIGN DAY DATA
MAX.      DBT       AVG. DEW   WIND
DBT       RANGE     PT. TEMP.  SPEED
92.0      16.0      74.0       11.0                                      L8B

WINTER DESIGN DAY DATA
MIN.      DBT       AVG. DEW   WIND
DBT       RANGE     PT. TEMP.  SPEED
20.0      0.0       19.0       13.0                                      L8C

WEATHER   STARTING  STUDY      INITIAL TEMP
YEAR      MONTH     LENGTH     WALL + ROOF
1963.     0.        0.         20.                                       L9

          ***** SEVERE ERRORS *****
          FIELD  2  DATA OUT OF BOUNDS.
          FIELD  3  DATA OUT OF BOUNDS.
```

(LOAD ANALYSIS PROGRAM)

FIGURE 3.1 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

THE FOLLOWING LINE CONTAINS THE NUMBER OF WINDOWS

9.

THE FOLLOWING LINES DESCRIBE THE WINDOW SURFACES

SURFACE NO.	SIMILAR SURFACE INDEX	GLASS TYPE	NUMBER OF PANES	SHADE COEFFICIENT	GROUND REFLECTIVITY	SURFACE AREA	AZIMUTH ANGLE	TILT ANGLE	WIN/SKY FACTOR	WIN/GRND FACTOR	INF. FLOW COEFF.	SURFACE PERIMETER	LABEL	** DERIVED DATA ** ORIENTATION
1		5.	1.	0.35	0.2	19.5	180.	90.	.5	.5			W1-FRONT	ESE
2		5.	1.	.35	.2	260.	180.	90.	.5	.5			W2-FRONT	ESE
3		5.	1.	0.35	.2	19.5	90.	90.	.5	.5			W3-RIGHT	NNE
4		5.	1.	.35	.2	70.	90.	90.	.5	.5			W4-RIGHT	NNE
5		5.	1.	.35	.2	19.5	0.	90.	.5	.5			W5-BACK	WNW
6		5.	1.	.35	.2	200.	0.	90.	.5	.5			W6-BACK	WNW
7		5.	1.	.35	.2	19.5	270.	90.	.5	.5			W7-LEFT	SSW
8		5.	1.	.35	.2	40.	270.	90.	.5	.5			W8-LEFT	SSW
9			1.	.35	.2	40.	270.	90.	.5	.5			W9-LEFT	SSW

***** SEVERE ERRORS *****
FIELD 2 DATA OUT OF BOUNDS.

(LOAD ANALYSIS PROGRAM)

FIGURE 3.2 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

```
THE FOLLOWING LINES CONTAIN DATA ON SPACE     4

                    GENERAL DATA
                         FLOOR                FLOOR     TEMPER-   SUM INTO
                         AREA      VOLUME     WEIGHT    ATURE     BLG. LOAD LABEL
                         3200.     320000.    100.      75.       1.        SPACE 4

                    OCCUPANCY LOAD DATA
                         NO. OF    ACTIVITY   SCHEDULE
                         PEOPLE    LEVEL      INDEX
                         25.       550.       1.        0.

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

                    LIGHTING LOAD DATA
                         LIGHT     FRACTION   WATTS/    KILO-     SCHEDULE
                         FIX. TYPE LITE HEAT  SQ.FT.    WATTS     INDEX
                         2.        0.5        4.8                 2.

                    EQUIPMENT LOAD DATA
                         WATTS/    KILO-      SENSIBLE  LATENT    SCHEDULE
                         SQ.FT.    WATTS      BTU/HR    BTU/HR    INDEX
                         0.25                                     5.

                    INFILTRATION LOAD DATA
                         INFILTR-N AIR        HEIGHT TO EXHAUST AIR
                         CODE      CHANGES    NEU. ZONE FLOW
                         1.        0.02

                    SPACE ENVELOPE DESCRIPTION DATA
                         NO. OF    NO. OF     NO. OF    NO. OF    NO. OF UNDERGROUND  NO. OF ADDITIONAL
                         DELAYEDS  QUICKS     WINDOWS   INTERNALS WALLS     FLOORS    IDENTICAL SPACES
                         24.0      0.0        23.0      1.0       0.0       1.0

THE FOLLOWING LINE CONTAINS THE INDICES OF THE DELAYED SURFACES OF SPACE     4

     8.0       8.0       9.0       9.0       9.0       9.0       9.0
     9.        9.        9.        9.        9.        9.        9.
     9.        9.        9.        9.        9.        9.        9.
     9.0       9.0       9.0       9.

          ***** WARNING *****
          THE NUMBER OF INDICES OR CODES LISTED HERE DIFFERS FROM THE STATED NUMBER GIVEN EARLIER


THE FOLLOWING LINE CONTAINS THE INDICES OF THE WINDOWS OF SPACE     4

     5.        5.        5.        5.        5.        5.        5.
     5.        5.        5.        5.        5.        5.        5.
     5.        5.        5.        5.        5.        5.        5.
     5.        6.

THE FOLLOWING LINE CONTAINS THE INDICES OF THE INTERNAL SURFACES OF SPACE     4

     6.                                        (LOAD ANALYSIS PROGRAM WITH SHADOWS)
```

FIGURE 3.3 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

THE FOLLOWING LINES DESCRIBE SPACE CHARACTERISTICS.

SPACE NO.	THERM. SCHED. INDEX	HEATING CAPACITY	COOLING CAPACITY	-PLENUM DATA- YES/ NO	SP. NO.	CFM	--FAN SCHEDULING-- WEEKDAY ON	WEEKDAY OFF	WEEKEND ON	WEEKEND OFF
1	01010101	-53000.	900000.							
2	01010101	-120000.	110000.							
3	01010101	-100000.	110000.							
4	01010101	-120000.	110000.							
5	01010101	100000.	110000.							
	***** SEVERE ERRORS ***** FIELD 5 DATA OUT OF BOUNDS.									
6				1.	1.	30000	7.	17.	0.	0.
7				1.	2.	3000.	7.	17.	0.	0.
8				1.	3.	3000.	7.	17.	0.	0.
9				1.	4.	3000.	7.	17.	0.	0.
10				1.	5.	3000.	7.	17.	0.	0.
11	01010101	0.	0.							

(TEMPERATURE VARIATION PROGRAM)

FIGURE 3.4 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

```
********************************************** RECAP OF CARD INPUT DATA **********************************************

                                        ************************************************
                                        ************************************************
                                         ******                                  ******
                                         ******   INPUT DATA VERIFICATION RESULTS ******
                                         ******              FOR                 ******
                                         ****** SCOUT 1.0/ SYSTEMS ANALYSIS PROGRAM ******
                                         ******                                  ******
                                        ************************************************
                                        ************************************************


CARD TYPE-1.
DESCRIPTION OF RUN.
        SAP TEST RUN ON BCS. ELEVEN SPACE BLDG.(5 OCCUPIED ZONES) BALT.MD.              S1 YEAR=54
CARD TYPE-2,3.
     01/01   - MONTH AND DAY AT WHICH SIMULATION MAY BEGIN.(F-1,3)
     12/31   - MONTH AND DAY AT WHICH SIMULATION MAY END.(F-5,7
13.          - NUMBER OF HOURLY PRINT PERIODS (CARD TYPE S-3).
2.           - NUMBER OF RESET SCHEDULES TO BE READ (CARD
2.           - NUMBER OF VENTILATION SCHEDULES TO BE READ (CARD
             - NUMBER OF ZONES
S2           - CARD
                                                    IN FIELD.
                    ***** WARNING *****     VARIABLE IN FIELD NO. 11 OUT OF RANGE.

CARD TYPE-5.
TEMPERATURE RESET SCHEDULES.
  SCHEDULE      TOALO      TOAHI       TLO        THI        ** LABEL **              CARD INDEX
   NUMBER
          1    -10.       55.        150.       200.       WATEP
          2    5.   5.    5.   11.   OFFICEAIR                <-- NOTE CARD OUT OF SEQUENCE

                ***** TERMINAL ERRORS *****
                FIELD 70  2ND PERIOD IN FIELD.
                ***** WARNING *****     VARIABLE IN FIELD NO.  1 OUT OF RANGE.

                ***** TERMINAL ERRORS *****
                FIELD 70  2ND PERIOD IN FIELD.
                ***** WARNING *****     VARIABLE IN FIELD NO.  2 OUT OF RANGE.

                ***** TERMINAL ERRORS *****
                FIELD 70  ALPHA IN FIELD.
                ***** WARNING *****     VARIABLE IN FIELD NO.  3 OUT OF RANGE.
          3    10.  10.   11.  12.

                ***** TERMINAL ERRORS *****
                FIELD 70  2ND PERIOD IN FIELD.
                ***** WARNING *****     VARIABLE IN FIELD NO.  1 OUT OF RANGE.

                ***** TERMINAL ERRORS *****
                FIELD 70  2ND PERIOD IN FIELD.
                ***** WARNING *****     VARIABLE IN FIELD NO.  2 OUT OF RANGE.
CARD TYPE 6A.
VENTILATION SCHEDULES.
SCHED. SUN. WEEK SAT. HOL.   LABEL                                          CARD INDEX
 NO.
```

FIGURE 3.5 DATA VERIFICATION PROGRAM EXAMPLE OUTPUT

SECTION 4

LOAD ANALYSIS PROGRAM

4.1 OBJECTIVE AND DESCRIPTION

The Load Analysis Program computes hourly sensible and latent loads for each zone as well as the block sensible and latent load for the building by accounting for:

1. Transmission gains and losses through walls, roofs, floors, and windows.
2. Solar gains through windows.
3. Internal gains from people, lights and building equipment.
4. Infiltration gains and losses due to wind and thermal pressure differences across openings.
5. Ventilation air gains and losses due to fresh air requirements.

The Load Analysis Program can be exercised in two modes:

1. Design load analysis - Utilizing user-defined design weather data, a 24-hour design day analysis is done for those months specified to determine peak heating and cooling requirements for each zone and the entire building. No provision is made for carrying this process on through to the Temperature Analysis and System Analysis Programs.
2. Hourly energy analysis - Utilizing actual hourly weather data, hourly heating and cooling loads for each zone are calculated for an entire year of building operation and results stored on magnetic tape for use by other programs.

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".

4.2 INPUT DATA DESCRIPTION

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

4.2.1 Definitions

- Building Azimuth Angle

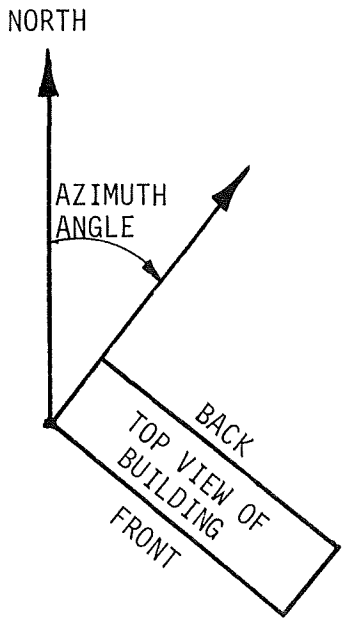
  Building azimuth angle expresses the orientation of the building relative to the points of the compass. It is defined as the clockwise angle from north to the direction in which the back of the building faces. Or, if the user were to stand outside the building facing the front wall, the building azimuth angle would be the compass direction (degrees clockwise from north) in which he faces. Refer to Figure 4.1 for further explanation. By changing the value of the building azimuth angle, the user can investigate the effects locating the building at different orientations.

- Surface Azimuth Angle

  Surface azimuth angle expresses the orientation of the surface relative to some reference surface on the building. It is defined as the clockwise angle between the direction in which the building back faces and the direction in which the surface in question faces. Refer to Figure 4.2 for further explanation.

- Surface Tilt Angle

  Surface tilt angle is defined as the angle between the vertical and the direction in which the surface in question faces. The value of the tilt angle changes between 0° and 180°, as shown in Figure 4.3.



Exposure of Building Front	Value of Building Azimuth Angle
S	0°
SW	45°
W	90°
NW	135°
N	180°
NE	225°
E	270°
SE	315°

Figure 4.1 BUILDING AZIMUTH ANGLE

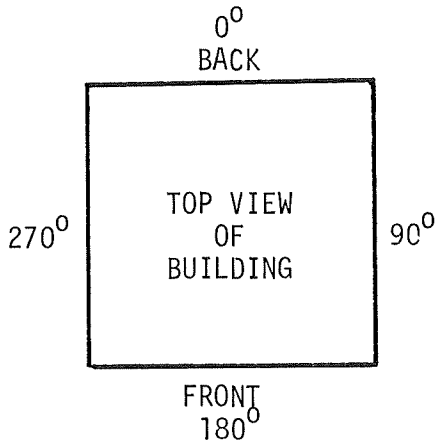


Figure 4.2 SURFACE AZIMUTH ANGLE

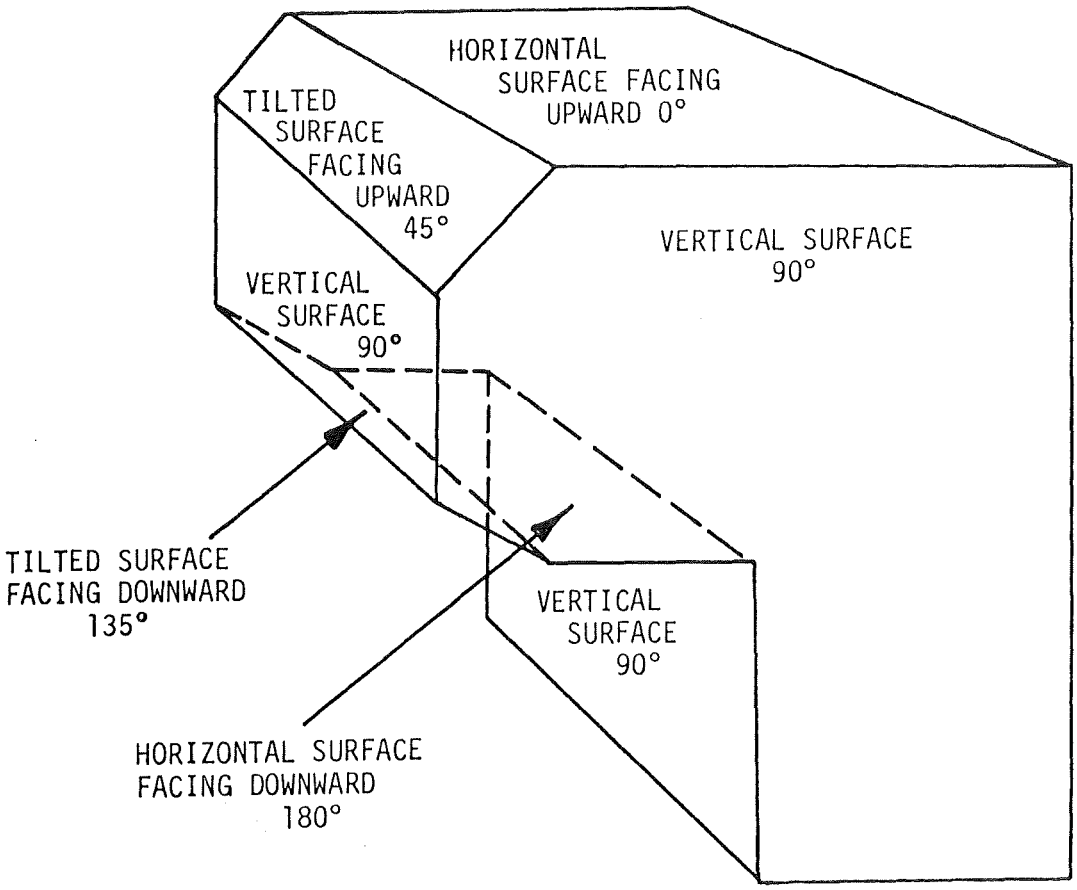


Figure 4.3 SURFACE TILT ANGLE

- Types of Building Surfaces

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

1. Delayed Heat Transfer Surfaces

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

2. Quick Heat Transfer Surfaces

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

3. Windows

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

4. Internal Heat Transfer Surfaces

   Interior walls or floors across which there is a temperature difference but 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 can transfer sensible energy in or out of the space.

4.2.2 Card Input

Prior to the filling in of the input forms for the Load Analysis Program, the user should perform the following:

Step 1

Obtain a floor plan of the building under study and divide the floor area into thermal zones sufficient for energy analysis. Generally, 5 zones would handle a one story building (one core zone and four exterior zones). If ceiling return air plenums are to be used, the plenum above each thermal zone should be identified as a zone also. For multistory buildings, floors between the first and top can usually be lumped together and broken into 5 zones or one typical floor identified and then use made of the repetition factor. Whenever possible, zones having identical load characteristics should be lumped into one giant zone or the basic zone described only once and use made of space repetition feature. Every effort should be made to minimize the total number of zones for which calculations are required without compromising accuracy of results.

Step 2

Using elevation drawings of building, brake out the surfaces that make up the exterior envelope of each zone identifying wherever possible surfaces that have identical characteristics (i.e., area, construction, orientation, tilt, etc.). Interior partitioning walls or floors between zones need only be identified if there will be a significant ΔT across it and an account of that heat transfer is desired.

Step 3

Attach a label to each surface using the a prefix and suffix to indicate the type of surface and numerical order respectively. For prefixes use

D = delayed heat transfer surface

Q = quick heat transfer surface

W = window surface

I = internal heat transfer surface

UW = underground wall heat transfer surface

UF = underground floor heat transfer surface

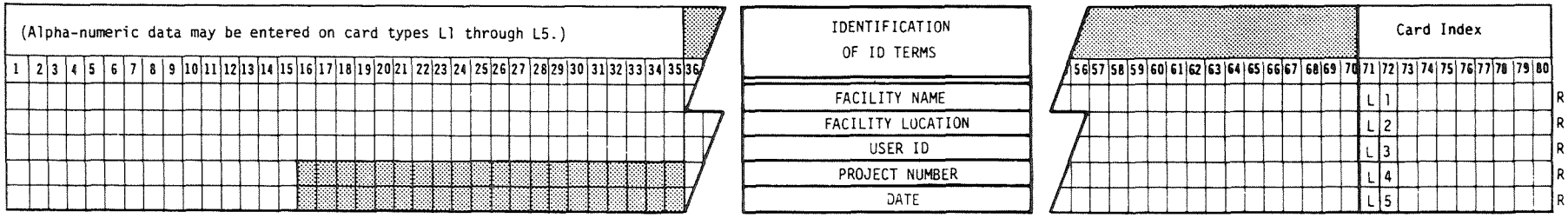
Make use of surface repetition where possible.

Step 4

Begin filling in Load Analysis Program input forms following instructions on the forms as well as those contained on the following pages.

CARD TYPE L-1 THROUGH L-5
JOB IDENTIFICATION

JOB IDENTIFICATION



CARD TYPE L-1

- Facility Name (Cols.1-35)

  Alphanumeric information identifying the building being studied. Also used for report labeling.

CARD TYPE L-2

- Facility Location (Cols.1-35)

  Alphanumeric information identifying the city in which the building is located. Also used for report labeling.

CARD TYPE L-3

- User Identification (Cols.1-35)

  Alphanumeric information identifying the name of the user. Also used for report labeling.

CARD TYPE L-4

- Project Number (Cols.1-15)

  Alphanumeric information identifying the project member associated with job. Also used for report labeling.

CARD TYPE L-5

- Date (Cols.1-15)

  Alphanumeric information identifying date of run. Also used for report labeling.

CARD TYPE L-6
GEOGRAPHIC PARAMETERS

GEOGRAPHIC PARAMETERS

Latitude (DEG)	Longitude (DEG)	Time Zone Number	Clearness Number (summer)	Clearness Number (winter)	Bldg. Azimuth 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 6 R

- Latitude (Degrees) (Cols. 1-10)

  Latitudinal location of the building under study. Used to calculate solar insolation data. For continental U.S., the latitude varies from 25° at southern Flordia to 48° at northern Washington state.

- Longitude (Degrees) (Cols. 11-20)

  Longitudinal location of the building under study. Used to calculate solar insolation data. For continental U.S., the longitude varies from 66° in Maine to 124° in California.

- Time Zone Number (4-8) (Cols. 21-30)

  A coded number ranging from 4 to 8 (see below) indicating which geographic time zone the building is operating in. Used to calculate hour angle of sun.

- Clearness Number (Summer) (Cols. 31-40)

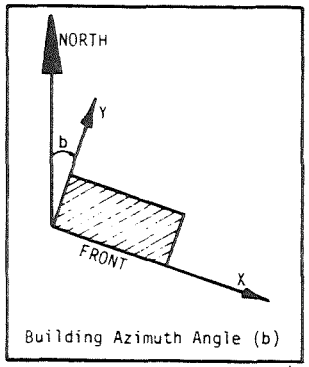
  Atmospheric clearness number or haze factor for geographic location in question. See map below for typical values for non-industrial atmosphere. Used to adjust solar insolation data. Ranges from 0.90 to 1.15.

- Clearness Number (Winter) (Cols. 41-50)

  Same as above except for winter. (November through April). Ranges from 0.85 to 1.05.

- Building Azimuth Angle (Degrees) (Cols. 51-60)

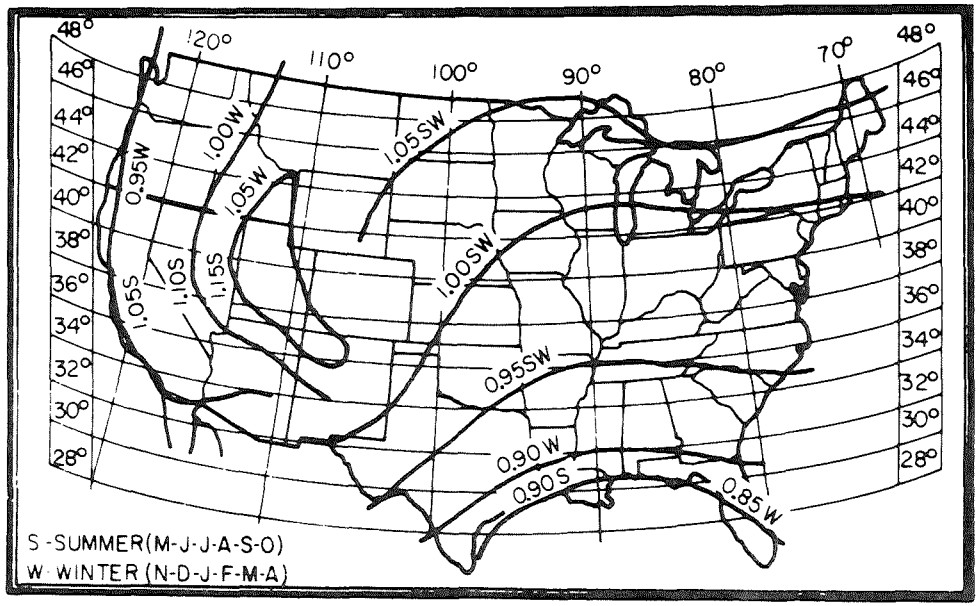
  Orientation of the back of building relative to the points of the compass. Angle can vary from 0° to 360°.



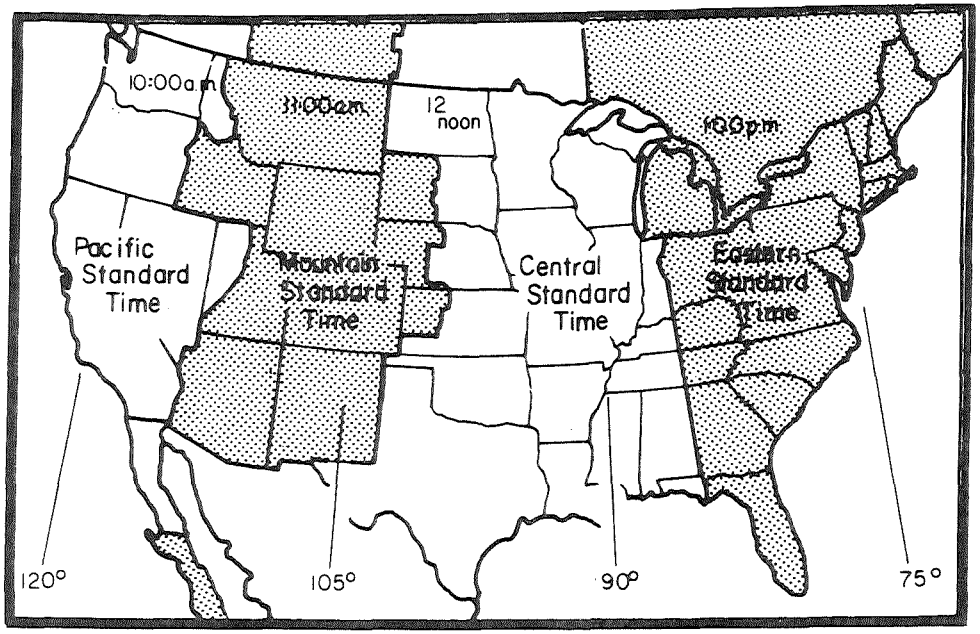
Building Azimuth Angle (b)

EXAMPLE:

Building Front Facing	Azimuth
South	0°
West	90°
North	180°
East	270°



CLEARNESS NUMBERS OF NON-INDUSTRIAL ATMOSPHERE IN UNITED STATES



TIME ZONES IN THE UNITED STATES

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

TIME ZONE NUMBER IN U.S. FOR STANDARD TIME

CARD TYPE L-7
JOB CONTROL PARAMETERS

JOB CONTROL PARAMETERS

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 Supply Temp.-2 (^oF.)	Zone Hot Air Supply Temp.-1 (^oF.)	Zone Hot Air Supply Temp.-2(^oF.)	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 7 R

- Job Processing Code (1-3) (Cols. 1-10)

  User is given the option of design load analysis and/or one year hourly analysis. This is indicated to the program in form of code as follows:

  1.0 = Design load analysis only
  2.0 = Design load analysis and one year hourly analysis desired
  3.0 = One year hourly analysis only

- Ventilation Air Rate (CFM/sq.ft.) (Cols. 11-20)

  Estimated rate at which outside air is introduced into building. Calculated on a zone-by-zone bases to account for each zone's ventilation air load. This ventilation air load is not passed along to other programs. It is used only to size chillers and boilers. It is also a parameter in crack infiltration analysis.

- Estimate Total Fan Pressure (Inches of water) (Cols. 21-30)

  Estimated building total fan pressure and used in conjunction with the calculated building total CFM to account for fan heat. This term does not affect space loads. It is only used to calculate total heating and cooling plant load for equipment sizing.

- Zone Cold Air Supply Temperature -1 (^oF) (Cols. 31-40)

  First choice for zone cold air supply temperature. Zone supply air quantities required to satisfy peak cooling loads will be calculated using this quantity. This term does not affect space loads passed on to other program. Range: 40-70°F.

- Zone Cold Air Supply Temperature -2 (^oF) (Cols. 41-50)

  Second choice for zone cold air supply temperature. Zone supply air quantities required to satisfy peak cooling loads will also be calculated using this quantity. This term does not affect space loads passed on to other programs. Range: 40-70°F.

- Zone Hot Air Supply Temperature -1 (^oF) (Cols. 51-60)

  First choice for zone hot air supply temperature. Zone supply air quantities required to satisfy peak heating loads will be calculated using this quantity. This term does not affect space loads passed on to other programs. Range: 80-200°F.

- Zone Hot Air Supply Temperature -2 (^oF) (Cols. 61-70)

  Second choice for zone hot air supply temperature. Zone supply air quantities required to satisfy peak heating loads will also be calculated using this quantity. This term does not affect space loads passed on to other programs. Range: 80-200°F.

CARD TYPES L-8A, L-8B and L-8C
DESIGN LOAD PARAMETERS

DESIGN LOAD ANALYSIS PARAMETERS (IF CODE = 3, do not include cards type L8A, L8B and L8C.)

Altitude Above Sea Level (FT)	DESIGN MONTHS M A M J J A S O N D	In Columns 11-20, enter 1 for each month to be included in Design Load Analysis. If all are left blank, all 10 months will be used.	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 (Enter July/August weather conditions - These are adjusted by program for other cooling months.

Max. D.B Temperature (^{o}F)	Daily D.B Temperature Range (^{o}F)	Dew Point Temperature (^{o}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 (Enter December weather conditions)

Minimum D.B Temperature (^{o}F)	Daily D.B Temperature Range (^{o}F)	Dew Point Temperature (^{o}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

Note: If not performing any design load analysis, skip card types L-8A, L-8B and L-8C.

CARD TYPE L-8A

- Altitude Above Sea Level (Ft) (Cols. 1-10)

  Height of building above sea level. Used to calculate psychrometric properties of outside air.

- Design Months (March-December) (Cols. 11-20)

  The user is given a choice as to which months he wishes to include in the design load analysis. Enter a 1 in column for those months desired. Other months will be ignored. If all columns are left blank, program will default to using all 10 months.

CARD TYPE L-8B

- Summer Maximum Dry-Bulb Temperature (Cols. 1-10)

  July/August Summer design day maximum dry-bulb temperature. Hourly dry-bulb temperatures for a design day in each other month March through November are calculated using this maximum DBT, range, and Carrier outdoor design-temperature correction factors.

- Summer Daily Dry-Bulb Temperature Range (^{o}F) (Cols. 11-20)

  Number of degrees of swing of dry-bulb temperature during the July/August summer design day.

- Summer Dew Point Temperature (^{o}F) (Cols. 1-10)

  July/August Summer design day average dew point temperature. This is assumed to remain constant throughtout the design day.

- Summer Windspeed (MPH) (Cols. 31-40)

  July/August Summer design day windspeed. Used to calculate outside surface film coefficient and infiltration air loads.

CARD TYPE L-8C

- Winter Minimum Dry-Bulb Temperature (Cols 1-10)

  December Winter design day minimum dry-bulb temperature. Hourly dry-bulb temperatures for this design day is calculated using typical diurnal cycle.

- Winter Daily Dry-Bulb Temperature Range (^{o}F) (Cols. 11-20)

  Number of degrees of swing of dry-bulb temperature during the December winter design day.

- Winter Dew Point Temperature (^{o}F) (Cols. 21-30)

  Average dew point temperature for the December winter design day. Assumed to remain constant throughout the design day.

- Winter Windspeed (MPH) (Cols. 31-40)

  Assumed windspeed for the December winter design day. Used to calculate outside surface film coefficient and infiltration air loads.

CARD TYPE L-9
HOURLY ANALYSIS PARAMETERS

HOURLY LOAD ANALYSIS PARAMETERS (IF CODE = 1., do not include card type L9.)

Weather Year	First Month Of Analysis (1-12)	Length of Study (Days; 1-365)	Estimated Initial Outside Surface Temperature (^{o}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 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 9

Note: If not performing an hourly analysis skip this card.

- Weather Year (1949-) (Cols. 1-10)

  Calender year for which analysis is to be performed. Must be a year that is available on weather tape. See SCOUT Axcess and Control Guide for available cities and years.

- First Month of Analysis (1-12) (Cols. 11-20)

  Month at which hourly analysis is to begin.

- Length of Study (Days) (Cols. 21-30)

  Number of days for which analysis is to proceed. May be from 1 to 365 days. Program will automatically correct for a leap year.

- Estimated Initial Outside Surface Temperature(^{o}F) (Cols. 31-40)

  Surface temperatures of all exterior surfaces must be initialized. If temperature recorded on weather tape for first hour of analysis is missing, this temperature will be used instead.

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

CARD TYPES L-10 AND L-10A
SCHEDULED PRINTOUTS

SCHEDULED PRINTOUTS (Hourly listing of weather and space load data)

Number of Printouts (0-12)		Card Index
1-10	11-70	71-80
		L 1 0

R

Repeat card L10A as many times as indicated on card L10. Fill in all columns indicated. Enter zeros if necessary.

PRINTOUT NO.	Start Date (Month/Day)	Stop Date (Month/Day)		Card Index
	1-10	11-20	21-70	71-80
1	/	/		L 1 0 A
2	/	/		
3	/	/		
4	/	/		
5	/	/		
6	/	/		
7	/	/		
8	/	/		
9	/	/		
10	/	/		
11	/	/		
12	/	/		

Note:
1. If number of printouts desired is equal to zero, skip card type L-10A.
2. Card type L-10A must be repeated number of times indicated on card type L-10.

CARD TYPE L-10

- Number of Printouts (0-12) (Cols. 1-10)

  Number of different periods for which an hourly listing of weather and calculated space loads are desired.

CARD TYPE L-10A

- Start Date (Month/Day) (Cols. 1-2, 4-5)

  Month and day at which printout is to start. Fill in all columns indicated, use zeros if necessary. No decimal point required. For design load analysis printouts, day must be set equal to "05".

- Stop Date (Month/Day) (Cols. 11-12, 14-15)

  Month and day at which printout is to stop. Fill in all columns indicated, use zeros if necessary. No decimal point required. If only one day's printout is desired, start date and stop date are the same. For design load analysis, day must be set equal to "05".

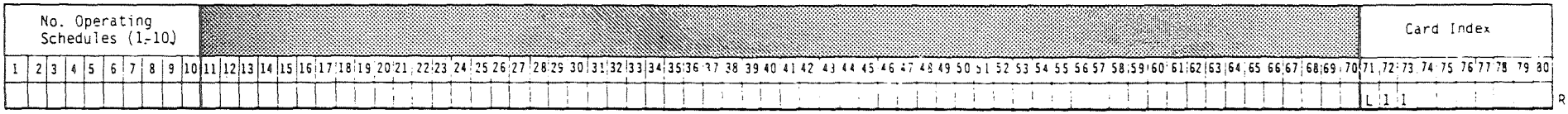
Note:
1. See page 4-65 and 4-66 for type of printout received back.
2. Printouts cost money (CPU time + paper). User is cautioned to estimate number of lines printed using following equation:
   #Lines = (1 + #Spaces)*24* #days printout
3. Example: 10 space bldg. with 1 day printout/month
   #Lines = (1 + 10)*24*12 = 3168

- No. Operating Schedules (1-10) (Cols. 1-10)

  Number of different 24-hour profile operating schedule combinations (Sunday, weekday, Saturday, holiday) to be used for scheduling use of people, lights and equipment.

CARD TYPE L-11
OPERATING SCHEDULES

SCHEDULES

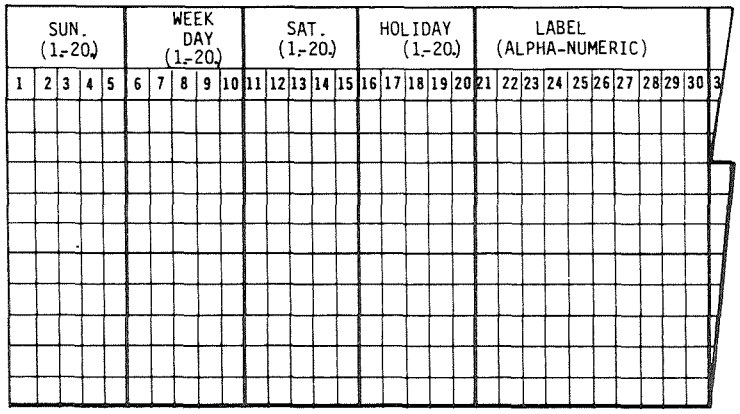


- No. Operating Schedules (1-10) (Cols. 1-10)

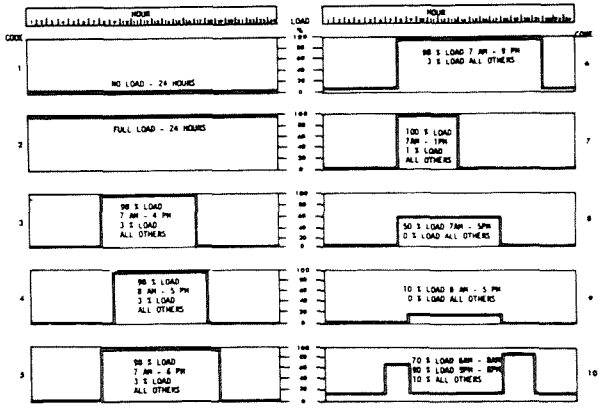
  Number of different 24-hour profile operating schedule combinations (Sunday, weekday, Saturday, holiday) to be used for scheduling use of people, lights and equipment.

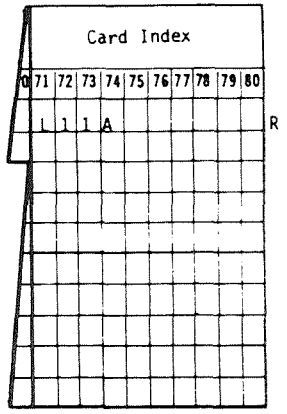
CARD TYPE L-11A
OPERATING SCHEDULE DEFINITION

OPERATING SCHEDULE DEFINITION



STANDARD TWENTY-FOUR HOUR PROFILES





Note: Repeat card type L-11A as many times as indicated in card type L-11.

- Sunday Schedule Code (1-20) (Cols. 1-5)

  Coded number from 1-20 that indicates which 24-hour profile is to be used for Sunday. A coded number from 1-10 indicates that a standard 24-hour profile already stored in program is to be used. See diagram above for definition of these standard profiles. A coded number from 11-20 indicates a non-standard profile to be defined by user will be used. These will be defined using card type L-11B.

- Weekday Schedule Code (1-20) (Cols. 6-10)

  Same remarks as above apply.

- Saturday Schedule Code (1-20) (Cols. 11-15)

  Same remarks as above apply.

- Holiday Schedule Code (1-20) (Cols. 16-20)

  Same remarks as above apply.

- Label (Cols. 21-30)

  Alphanumeric information describing how operating schedule is to be used.

CARD TYPE L-11B
NON-STANDARD TWENTY-FOUR HOUR PROFILES

NON-STANDARD TWENTY-FOUR HOUR PROFILES

CODE 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	12 MID-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 1 B
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

NOTE: CARD L12 NOT REQUIRED

Note: If no non-standard schedules are to be used, skip card type L-11B

1 AM	Cols. 1- 3	Fraction ranging from 0.0 to 1.0 indicating what portion of the 100% operating level exists each hour.
2 AM	4- 6	
3 AM	7- 9	
4 AM	10-12	
5 AM	13-15	
6 AM	16-18	
7 AM	19-21	
8 AM	22-24	
9 AM	25-27	
10 AM	28-30	
11 AM	31-33	
12 Noon	34-36	
1 PM	37-39	
2 PM	40-42	
3 PM	43-45	
4 PM	46-48	
5 PM	49-51	
6 PM	52-54	
7 PM	55-57	
8 PM	58-60	
9 PM	61-63	
10 PM	64-66	
11 PM	67-69	
12 Midnight	70-72	

CARD TYPE L-13
RESPONSE FACTOR SURFACES

RESPONSE FACTOR SURFACES

Total No. Of Response Factor Surface Types	No. Of Standard Surface Types To Be Used		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 1 3 R

- Total Number of Response Factor Surface Types (Cols. 1-10)

  Number of different types of response factor surfaces to be used to describe the construction of exterior wall and roof sections.

- Number of Standard Surface Types to be Used (Cols. 11-20)

  Coded into the program are 16 standard surfaces (10 wall types and 6 roof types) which the user can reference simply by using a code from 1 to 16. The quantity specified here indicates how many of these standard surfaces are to be used. Refer to next section which describes card type L-13A for description of standard surfaces.

CARD TYPE L-13A
STANDARD RESPONSE FACTOR SURFACES

STANDARD RESPONSE FACTOR SURFACES
NOTE: REPEAT CARD TYPE L13A NUMBER OF TIMES INDICATED ON CARD TYPE L13, COLUMNS 11-20.

Standard Surface Code (1. - 16.)										Label (Alphanumeric)																					
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		

CODE	TYPE	LAYER DESCRIPTION
1	Wall	Wood Drop Siding 3/4" Sheating Board 4" Air Space 1/2" Gypsum Board Inside Air
2	Wall	Wood Drop Siding 3/4" Sheating Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
3	Wall	4" Face Brick 1/2" Air Space 3/4" sheating Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
4	Wall	8" Concrete Block Inside Air
5	Wall	12" Solid Concrete Inside Air
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 Metal
10	Wall	Metal Sliding 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 4" Fiberglass Gypsum Board Inside Air
16	Roof	Asphalt Shingle(Fitched Roof) 1/2" Plywood Sheating Attic Air Space 6" Insulation Gypsum Board Inside Air

Card Index									
71	72	73	74	75	76	77	78	79	80
L	1	3	A						

Note: Card type L-13A must be repeated for each standard surface defined on card type L-13, columns 11-20 .

- Standard Surface Code (1-16) (Cols. 1-10)

  All standard response factor surfaces to be used must be specifically identified here so that the surface response factor data can be loaded into working storage for use by the program. Standard surfaces codes do not have to be called out in sequential order, should be specified only once and must be a number from 1 to 16 in accordance with the type of contruction desired.

- Label (Cols. 11-30)

  Alphanumeric information identifying the surface being described.

CARD TYPE L-13B
NON-STANDARD RESPONSE FACTOR SURFACES

NON-STANDARD RESPONSE FACTOR SURFACES

NOTE: 1. REPEAT CARD SETS L13B THROUGH L13D FOR EACH DIFFERENT NON-STANDARD CONSTRUCTION TYPE.
2. USE RESPONSE FACTOR PROGRAM TO GENERATE CARD TYPES L13C AND L13D.
3. SURFACE CODES 17-25 RESERVED FOR ADDITIONAL STANDARD SURFACES TO BE ADDED LATER.

Non-standard Surface Code (26. and up)	Label (Alphanumeric)		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 1 3 B

Note: Repeat this card along with sets of card types L-13C and L-13D, the number of times indicated on card type L-13 by subtracting (Total Number of Response Factor Surface Types-Number of Standard Response Factor Surface Types).

- Non-Standard Surface Code (26 and up) (Cols. 1-10)

  For each non-standard response factor surface entered, a numbered code 26 or higher must be specified. This code will be used later to identify delayed heat-transfer surface construction (see card type L-14B, Columns 61-70)

- Label (Cols. 11-30)

  Alphanumeric information identifying the surface being described.

CARD TYPE L-13C and L-13D
NON-STANDARD RESPONSE FACTOR SURFACE DESCRIPTION

No. time Response Grps (1–3)	Common Ratio (4–23)	(24–70)	Card Index (71–80)
			L 1 3 C

	TIME RESPONSE GROUPS X (1–20)	Y (21–40)	Z (41–60)	(61–70)	Card Index (71–80)
1					L 1 3 D
2					
3					
4					
5					
100 MAX					

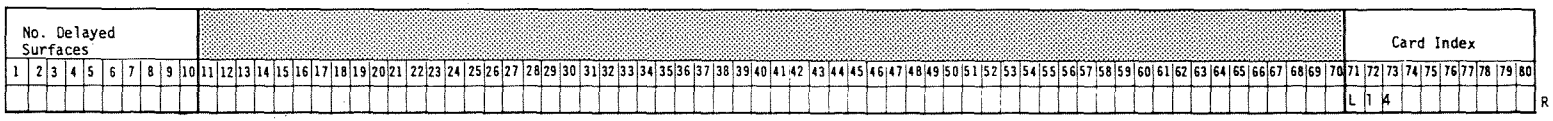
Use the Response Factor Program to generate these data cards and then insert the punched cards into the Load Analysis Program input deck at this point. See section 2 of this manual for further discussion.

EXAMPLE

```
3.0        1.0                                                          L13
3.0        WALL CONSTRUCTION-1                                          L13A
26.0       WALL CONSTRUCTION-2                                          L13B
  5         0.2764726221                                                L13C
          0.9413793355        0.0759544167        0.8566887090          L13D
         -0.7394342626        0.0865389870       -0.4784727683          L13D
         -0.0044131528        0.0241312100       -0.1319499516          L13D
         -0.0012201159        0.0066716189       -0.0364805491          L13D
         -0.0003373286        0.0018445200       -0.0100858731          L13D
27.0       ROOF-1                                                       L13B
  8         0.8508217837                                                L13C
          0.8514929357        0.0013354699        1.3403373103          L13D
         -0.7541613522        0.0100479075       -0.2256730001          L13D
         -0.0009524806        0.0117530147       -0.1537586384          L13D
         -0.0007922742        0.0101304076       -0.1297921446          L13D
         -0.0006735845        0.0086231001       -0.1103990864          L13D
         -0.0005730854        0.0073368394       -0.0939290199          L13D
         -0.0004875931        0.0062423463       -0.0799168284          L13D
         -0.0004148548        0.0053111243       -0.0679949776          L13D
```

CARD TYPE L-14
DELAYED HEAT TRANSFER SURFACES

DELAYED SURFACES



- No. Delayed Surfaces (Cols. 1-10)

  This is the total number of distinct delayed heat transfer surfaces that will be used to help describe the building shell. Since computer running time is proportional to this quantity, the user should attempt to minimize the number of delayed surfaces by

  1) making use of repetitive wall or roof features, i.e., identify delayed heat transfer segments that have identical characteristics (surface area, construction, orientation, tilt, interior space temperature, etc.), define it to the computer only once so that heat transfer calculations are done only once each hour, then reuse the results as many times as necessary to build up a space.

  2. defining the delayed surfaces areas small enough such that all other delayed surfaces of the same exposure can be represented as multiples of this reference surface.

NOTE: Repeat card type L-14A for each delayed heat transfer surface to be described.

CARD TYPE L-14A

DELAYED SURFACE DESCRIPTION

INDEX NO.	Similar Surface Index	SIMILAR SURFACE PROPERTIES: Surface Absorptivity	SIMILAR SURFACE PROPERTIES: Surface Roughness Index	SIMILAR SURFACE PROPERTIES: Response Factor Code	Ground Reflectivity	Surface Area (SQ.FT.)	Azimuth Angle(DEG)	Tilt Angle (DEG)	Infil.Flow Coeff.	Label (Alphanumeric)		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
1												L 1 4 A
2												
3												
4												
19												
20												
21												
22												
23												
24												
25												

- Similar Surface Index (Cols. 1-5)

  To decrease input time, user can use this feature if building envelope contains delayed heat transfer surfaces which have identical values for
  a) surface absorptivity
  b) surface roughness index
  c) response factor code

  but may have differing values for one or more of the following
  a) ground reflectivity
  b) surface area
  c) azimuth angle
  d) tilt angle

  Typically, this feature would find good use when building has a wall section that repeats itself on all building exposures. In this case, the surface would be described completely on one exposure and rotated into other exposures by using similar surface index and changing azimuth angle. When using similar surface feature, if any surface parameters (except for azimuth and tilt angles which must always be entered) are left blank, values entered for reference surface will be used automatically. Also, the similar surface feature can only be used when the reference surface has already been defined earlier in the input data.

- Surface Exterior Absorptivity (0.0 to 1.0) (Cols. 6-10)

  Indicates the surface's ability to absorb incident solar radiation. This property is mainly a function of the surface color and texture. See table below for typical values.

- Surface Roughness Index (1-6) (Cols. 11-15)

  User indicates the exterior roughness of the surface by using a code which varies from 1.0 (rough) to 6.0 (smooth). See table below for typical values. Program uses this information along with wind velocity data to calculate the outside film coefficient each hour.

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

CODE FOR EXTERIOR SURFACE FINISH

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

INCREASING SMOOTHNESS

- Response Factor Surface Code (Cols. 16-20)

  The code entered here should correspond to one of the response factor surfaces codes described previously on card types L-13A or L-13B.

- Ground Reflectivity Facing Surface (0.0 to 1.0) (Cols. 21-25)

  Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. See table below for typical values.

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

- Surface Area (sq. ft.) (Cols. 26-35)

  Total area of surface through which heat can be transmitted.

- Surface Azimuth Angle (Degrees) (Cols. 36-40)

  Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. May vary between 0°-360°.

- Surface Tilt Angle (Degrees) (Cols. 41-45)

  Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0° (facing sky) and 180° (facing ground).

- Infiltration Flow Coefficient (Cols. 46-50)

  A function of surface construction, this allows an estimate to be made of amount of infiltration that enters the building through a surface. This quantity should only be specified if crack infiltration analysis is to be specified on Card Type L-21E. See table below for typical values of infiltration flow coefficient for delayed surfaces.

- Label (Cols. 51-60)

  Alphanumeric description of surface.

DELAYED SURFACE
SUGGESTED INFILTRATION FLOW COEFFICIENTS (C)

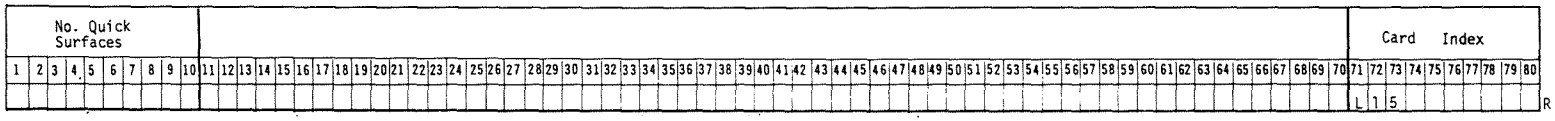
DESCRIPTION		C
1. 13" brick with plastered surface (.01 cfh/sq.ft.)		.004
2. 13" brick, furring, lath & plaster	(.09)	.025
3. Frame wall, lath, & plaster	(.05)	.016
4. 4" brick-6" concrete block-painted	(.11)	.034
5. 8" cement block-painted both sides	(.32)	.095
6. 8" brick - plain-poor workmanship	(3.2)	.949
7. 16" shingles on shiplap w/building paper	(.71)	.211
8. 16" shingles on shiplap	(5.3)	1.582
9. 16" shingles on 1x4 boards on 5" CT.	(23.0)	1.856

Values in ( ) are infiltration values at 7½ mph wind normal to the surface.
Data from 1972 ASHRAE Handbook of Fundamentals, pg. 339
SCOUT uses the basic equation $Q = C*A*\Delta P^{N}$.

Q is Air Flow Rate, CFM
C is Flow Coefficient, per unit area of wall surface
A is Flow Opening Area, sq. ft.
N is Pressure exponent; is set at 0.8 for delayed surfaces

CARD TYPE L-15
QUICK HEAT TRANSFER SURFACES

QUICK SURFACES

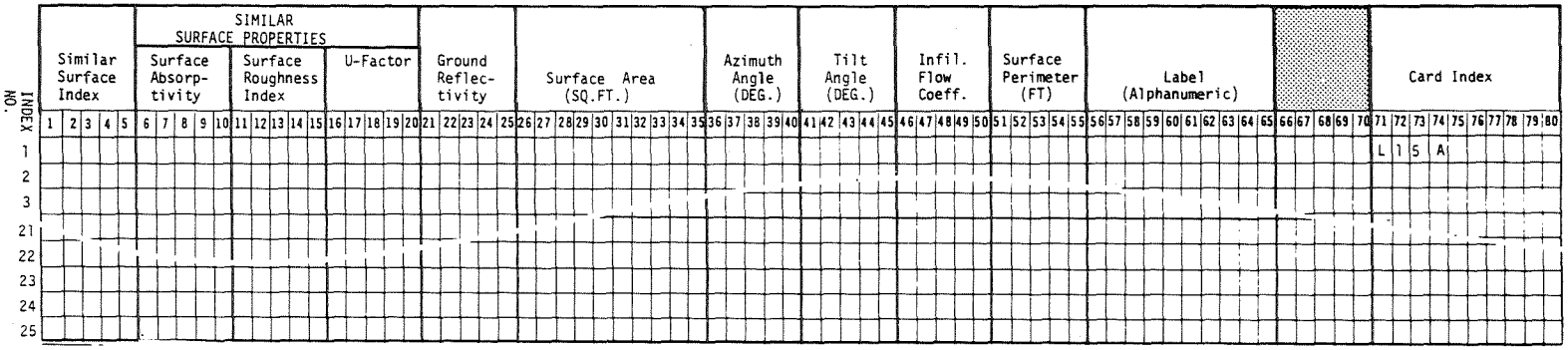


- No. Quick Surfaces (Cols. 1-10)

  This is the total number of distinct quick heat transfer surfaces that will be used to help describe the building shell. These are surfaces such as doors, metal sections, etc. that have small heat storage capacities and can be treated as steady state heat transfer surfaces. The same procedures that were explained for minimizing delayed surface input data also apply here, i.e., making use of repetitive features.

NOTE: Repeat card type L-15 for quick heat transfer surface to be described.

CARD TYPE L-15A
QUICK SURFACE DESCRIPTION



- Similar Surface Index (Cols. 1-5)

To decrease input time, user can use this feature if building envelope contains quick heat transfer surfaces which have identical values for

a) surface absorptivity
b) surface roughness index
c) U-factor

but may have differing values for one or more of the following

a) ground reflectivity
b) surface area
c) azimuth angle
d) tilt angle

Typically, this feature would find good use when building has a wall section that repeats itself on all building exposures. In this case, the surface would be described completely on one exposure and rotated into other exposures by using similar surface index and changing azimuth angle. When using similar surface feature, if any surface parameters (except for azimuth and tilt angles which must always be entered) are left blank, values entered for reference surface will be used automatically. Also, the similar surface feature can only be used when the reference surface has already been defined earlier in the input data.

- Surface Exterior Absorptivity (0.0 to 1.0) (Cols. 6-10)

Indicates the surface's ability to absorb incident solar radiation. This property is mainly a function of the surface color and texture. See table below for typical values.

- Surface Roughness Index (1-6) (Cols. 11-15)

User indicates the exterior roughness of the surface by using a code which varies from 1.0 (rough) to 6.0 (smooth). See table below for typical values. Program uses this information along with wind velocity data to calculate the outside film coefficient each hour.

- U-Factor (BTU/HR-Sq.Ft.-F) (Cols. 16-20)

Overall heat transfer coefficient for surface including inside air film but excluding exterior air film. Program will calculate exterior air film each hour as a function of wind speed.

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

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

CODE FOR EXTERIOR SURFACE FINISH

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

INCREASING SMOOTHNESS

- Ground Reflectivity Facing Surface (0.0 to 1.0) (Cols. 21-25)

  Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. See table below for typical values.

- Surface Area (Sq. Ft.) (Cols. 26-35)

  Total area of surface through which heat can be transmitted.

- Surface Azimuth Angle (Degrees) (Cols. 36-40)

  Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. May vary between 0° - 360°.

- Surface Tilt Angle (Degrees) (Cols. 41-45)

  Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0° (facing sky) and 180° (facing ground).

- Infiltration Flow Coefficient (Cols. 46-50)

  A function of surface construction, this allows an estimate to be made of amount of infiltration that enters the building through or around a surface. This quantity should only be specified if crack infiltration analysis is to be specified on card type L-21E. See table below for typical values of infiltration flow coefficient for quick surfaces.

- Surface Perimeter(FT.) (Cols. 51-55)

  Used to calculate amount of infiltration when specifying crack infiltration analysis, therefore only enter a value here if crack infiltration will be specified on card type L-21E.

- Label (Cols. 56-65)

  Alphanumeric description of surface.

QUICK SURFACE
SUGGESTED INFILTRATION FLOW COEFFICIENT (C)

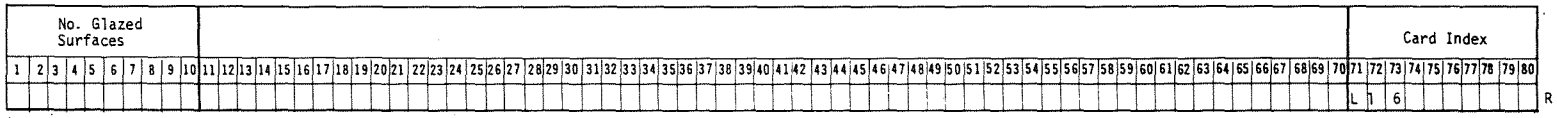
DESCRIPTION		C
1. 1/8" crack	(6.5 cfm/lf)	40.0
1/4" crack	(13.1)	80.0
1/2" crack	(26.2)	120.0
2. Door - Residential (3x7) type		
closed w/WS	(20 cfm/unit)	6.1
average use without WS	(100)	30.5
average use with WS	(80)	24.4
3. Door - Office (3.5x7) type		
closed	(25)	7.3
open 10% of time	(50)	14.6
open 25% of time	(310)	90.2
open 50% of time	(1250)	362.8
open 10% of time and vestibule	(35)	10.2
4. Door - Revolving type		
average use	(100)	30.5
5. Garage or Shipping Room Door		
No use	(120)	12.2
Average use	(450)	27.4

Values in ( ) are infiltration values at 7½ mph wind normal to the surface. Data from 1972 ASHRAE Handbook of Fundamentals, pg. 340 and Carrier Design Handbook, pg. 1-91. SCOUT uses the basic equation $Q = C * P * \Delta P^{N}$.

Q is Air Flow Rate
C is Flow Coefficient, per lineal foot of perimeter
P is Surface perimeter
N is Pressure Exponent, is set at 0.5 for Quick Surfaces
ΔP is pressure difference, in. water

CARD TYPE L-16
GLAZED HEAT TRANSFER SURFACES

GLAZED SURFACES



- No. Glazed Surfaces (Cols. 1-10)

  This is the total number of distinct glazed heat transfer surfaces that will be used to help describe the building shell. The same procedure that were explained for minimizing delayed surface input data also apply here, i.e., making use of repetitive features.

NOTE: Repeat card type L-16 for each glazed heat transfer to be described.

CARD TYPE L-16A
GLAZED SURFACE DESCRIPTION

INDEX NO.	Similar Surface Index	SIMILAR SURFACE PROPERTIES: Glass Code	No. Panes	Shade Coeff.	Ground Reflectivity	Surface Area (SQ.FT.)	Azimuth Angle (DEG.)	Tilt Angle (DEG)	Win/Sky Factor	Win/Gnd Factor	Infil. Flow Coeff.	Surface Perimeter (FT)	Label (Alphanumeric)	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
1														L 1 6 A
2														
21														
22														
23														
24														
25														

- Similar Surface Index (Cols. 1-5)

To decrease input time, user can use this feature if building envelope contains glazed heat transfer surfaces which have identical values for

a) glass code
b) no. panes
c) shade coefficient

but may have differing values for one or more of the following

a) ground reflectivity
b) surface area
c) azimuth angle
d) tilt angle

Typically, this feature would find good use when building has a window section that repeats itself on all building exposures. In this case, the surface would be described completely on one exposure and rotated into other exposures by using similar surface index and changing azimuth angle. When using similar surface feature, if any surface parameters (except for azimuth and tilt angles which must always be entered) are left blank, values entered for reference surface will be used automatically. Also, the similar surface feature can only be used when the reference surface has already been defined earlier in the input data.

- Glass Code (1-8) (Cols. 6-10)

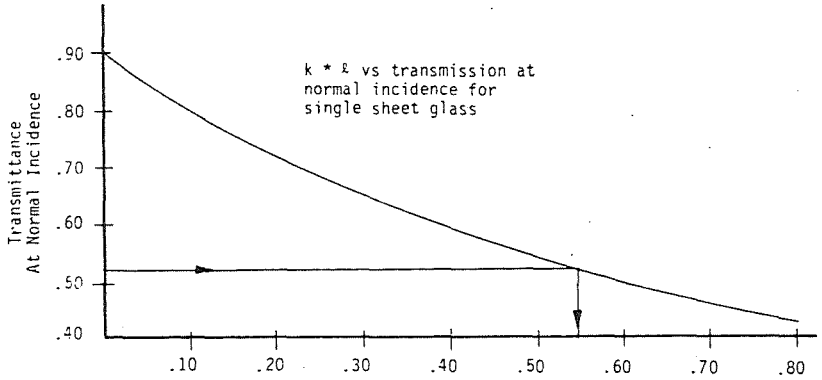
For the program to calculate proper transmission, absorption and reflection factors, the user must specify the type of glass. These three factors, as a function the angle of sun incident, have been determined for 8 types of glass, single and double glazed, and are set within the program. The 8 types are catagorized according to their ($\kappa * \ell$) value where κ is thickness and ℓ is extinction coefficient. The table below lists the allowable program codes and corresponding $\kappa * \ell$ value.

To determine glass code desired, obtain from glass manufacturer or 1972 ASHRAE Handbook of Fundamentals, pg. 400 the transmission at normal incidence. Enter ordinate of curve below with this value, move to right until curve is intersected, move downward to abscissa

GLASS CODES
FOR VALUES OF ($\kappa * \ell$)

CODE	MEANING
1	$\kappa * \ell = 0.05$ 1/8" sheet
2	$\kappa * \ell = 0.10$
3	$\kappa * \ell = 0.15$ 1/4" reg.plate
4	$\kappa * \ell = 0.20$
5	$\kappa * \ell = 0.40$
6	$\kappa * \ell = 0.60$
7	$\kappa * \ell = 0.80$ 50% transparent H.A. plate
8	$\kappa * \ell = 1.00$

and read $\kappa * \ell$ value. Choose a code from table above which has a $\kappa * \ell$ value closest to that desired.



- Number of Panes of Glass (1. or 2.) (Cols. 11-15)

How many panes of glass does the glazed surface have?

- Shading Coefficient

(0.0 to 1.0) (Cols. 16-20)

The shading coefficient, a rather simple term in concept, has been the subject of considerable misinterpretation. The ASHRAE 1972 Handbook of Fundamentals defines a shading coefficient (SC) as the ratio of the heat gain through a glazing system under a specific set of conditions to the solar heat gain through a single light of double-strength sheet glass under the same set of conditions, i.e.,

$$SC = \frac{\text{Solar heat gain of specific glazing system}}{\text{Solar heat gain of double-strength glass}}$$

Therefore, the heat gain of a specific glazing system (e.g. heat absorbing glass with venetian blinds) may be calculated as follows:

$$\begin{pmatrix}\text{Solar heat gain}\\ \text{for specific}\\ \text{glazing system}\end{pmatrix} = \begin{pmatrix}\text{Solar heat gain for}\\ \text{double strength}\\ \text{glass}\end{pmatrix} * SC$$

The calculation of window solar load in SCOUT is a 2-step process:

1) Transmission and absorption factor for direct and diffuse radiation are determined each hour as a function of angle of sun incidence and type of glass.

2) Transmission and absorption factors are modified by multiplying the factors determined in step 1 by the shade coefficient.

This procedure allows the user to describe glass data to the program in several ways as indicated below.

GLASS ONLY (NO SHADING DEVICE)

METHOD	DESCRIPTION	ALLOWABLE GLASS CODE	ALLOWABLE SHADE COEFFICIENT	REMARKS
1	Use cataloged glass properties	1-8	Blank or 1	Shading Coefficient By-passed
2	Use clear glass properties + shade coefficient	1	Greater than 0 but less than 1	Follows ASHRAE definition of S.C. See Table 12 of 1972 Handbook of fundamentals

GLASS + SHADING DEVICE

METHOD	DESCRIPTION	ALLOWABLE GLASS CODE	ALLOWABLE SHADE COEFFICIENT	REMARKS
3	Use cataloged properties plus shading coefficient for shade device	1-8	Greater than 0	Shading coefficient for shading device alone
4	Use clear glass plus shading coefficient for glass and shade device	1	Greater than 0	ASHRAE data in tables 15, 16, 17 & 19 of 1972 Handbook of fundamentals (ch.22) must be adjusted to exclude effect of transmission and absorption of standard glass before using. Numbers from those Tables may not be used directly

The shading coefficient of double-strength glass is, by definition, equal to unity (1.0). Shading coefficient (SC) for various glass types given in Table 12 (p 400) of the ASHRAE Handbook of Fundamentals are in accord with the above equation. "Shading Coefficients" given in Tables 15, 16, 17 and 19 for windows and coverings (venetian blinds, roller shades, sunscreens and draperies) are NOT in accord with the above equation. The term defined in these tables represent the fraction of incident radiation striking the glass and which makes its way through the glass and window covering and enters the room. In using these tables to derive shading coefficients for use by SCOUT, the effects of the shading device alone must be extracted by the user. The information in the GUIDE was based on calorimeter tests of shading devices on standard glass. Test data with other glass types is not generally available.

- Ground Reflectivity Facing Surface (0.0 to 1.0) (Cols. 21-25)

  Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. See table below for typical values.

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

- Surface Area (Sq. Ft.) (Cols. 26-35)

  Total area of surface through which heat can be transmitted.

(Degrees) (Cols. 36-40)

Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. May vary between 0° - 360°.

- Surface Tile Angle (Degrees) (Cols. 41-45)

Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0° (facing sky) and 180° (facing ground).

- Window/Sky Form Factor (0.0 to 1.0) (Cols. 46-50)

This area factor indicates what portion of the total diffuse radiation entering the glazed system is from the sky. Mainly a function of the surface tilt angle, typically the window/sky form factor takes on values as follows:

TILT ANGLE	POSITION	W/S FACTOR
0°	Parallel and Facing Sky	1.0
90°	At Right Angles to Sky and Ground	0.5
180°	Parallel and Facing Ground	0.0

- Window/Ground Form Factor (0.0 to 1.0 (Cols. 51-55)

This area factor indicates what portion of the total diffuse radiation entering Mainly a function of the surface tilt angle, typically the window/ground form factor takes on values as follows:

TILT ANGLE	POSITION	W/G FACTOR
0°	Paralled and Facing Sky	0.0
90°	At Right Angles to Sky and Ground	0.5
180°	Parallel and Facing Ground	1.0

- Infiltration Flow Coefficient (Col. 56-60)

A function of surface construction, this allows an estimate to be made of amount of infiltration that enters the building through or around a surface. This quantity should only be specified if crack infiltration analysis is to be specified on card type L-21E. See table below for typical values of infiltration flow coefficient for quick surfaces.

- Surface Perimeter (Ft.) (Cols. 61-65)

Used to calculate amount of infiltration when specifying crack infiltration analysis, therefore only enter a value here if crack infiltration will be specified on card type L-21E.

- Label (Cols. 66-75)

Alphanumeric description of surface.

GLAZED SURFACE
SUGGESTED INFILTRATION FLOW COEFFICIENTS (C)

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

Values in ( ) are infiltration values at 7-1/2 mph wind normal to the surface. Data from Carrier Design Handbook, pg. 1-95 and 1-96.
SCOUT uses the basic equation $Q=C*P*\Delta P^{N}$.

Q is Air Flow Rate, CFM
C is Flow Coefficient, per lineal foot of perimeter
ΔP is Surface Perimeter, ft.
N is Pressure Exponent; is set at 0.66 for Glazed Surfaces
P is Pressure Difference, in. water

CARD TYPE L-17

INTERNAL HEAT TRANSFER SURFACES

INTERNAL SURFACES

No. Internal Heat Transfer Surfaces																																																																						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	1	7							

R

(If there are no internal surfaces, skip card type L17A.)

- No. Internal Heat Transfer Surfaces (Cols. 1-10)

  The user will need to identify internal heat transfer surfaces only if there are interior walls across which there is a temperature difference, i.e., an interior wall that separates two spaces being maintained at different setpoint temperatures. If no internal surfaces are to be used, set this quantity at 0.0, otherwise,

NOTE: Repeat card type L-17A for each internal heat transfer surface to be described.

CARD TYPE L-17A

DESCRIPTION OF INTERNAL SURFACES

Index No.	Surface Area	Heat Transfer Coefficient (BTU/HR-^{o}F-FT^{2})	ADJOINING SPACES		Label (Alphanumeric)		Card Index
			Space 1	Space 2			
	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
1							L 1 7 A
2							
3							
4							
5							
6							
7							
8							
9							
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16							
17							
18							
19							
20							

(Heat transfer coefficient should include air film on both sides.)

- Surface Area (sq.ft.) (Cols. 1-10)

  Total area of surface through which heat is transferred.

- Heat Transfer Coefficient (BTU/HR-sq.ft.-F) (Cols. 11-20)

  Overall heat transfer coefficient (U-factor) for surface including air film on both sides.

- Adjoining Spaces- Space 1 (Cols. 21-30)

  Indicate the space index of space on one side of wall. Indices of spaces are defined by order of description on card types L-21A through L-21L.

- Adjoining Spaces - Space 2 (Cols. 31-40)

  Index of second space adjoining wall.

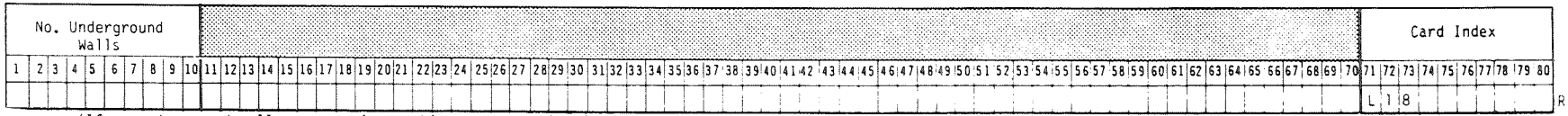
- Label (Cols. 41-60)

  Alphanumeric description of surface.

CARD TYPE L-18

UNDERGROUND WALLS

UNDERGROUND WALLS



(If no underground walls are required, skip card type L18A.)

- No. Underground Walls (Cols. 1-10)

  Buildings which have walls that are soil backed will require the use of underground walls. Indicate with this variable the total number of distinct underground wall sections to be described using card type L-18A.

NOTE: Repeat card type L-18A for each underground wall to be described.

CARD TYPE L-18A

DESCRIPTION OF UNDERGROUND WALLS

INDEX NO.	Wall Area	Heat Trans. Coeff. (BTU/HR-°F-FT²)	Label (Alphanumeric)		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
1					L 1 8 A
2					
3					
4					
5					
6					
7					
8					
9					
10					

- <u>Wall Area (sq. ft.)</u> (Cols. 1-10)

  Total area of surface through which heat is transferred.

- <u>Heat Transfer Coefficient (BTU/HR-SQ.FT.-F)</u> (Cols. 11-20)

  Overall heat transfer coefficient (U-factor) for surface including inside air film.

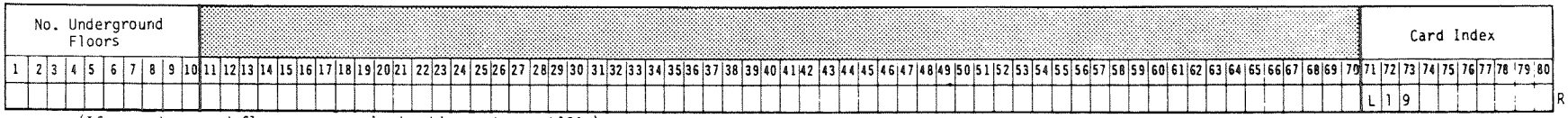
- <u>Label</u> (Cols. 21-40)

  Alphanumeric description of surface.

CARD TYPE L-19

UNDERGROUND FLOORS

UNDERGROUND FLOORS



(If no underground floors are required, skip card type L19A.)

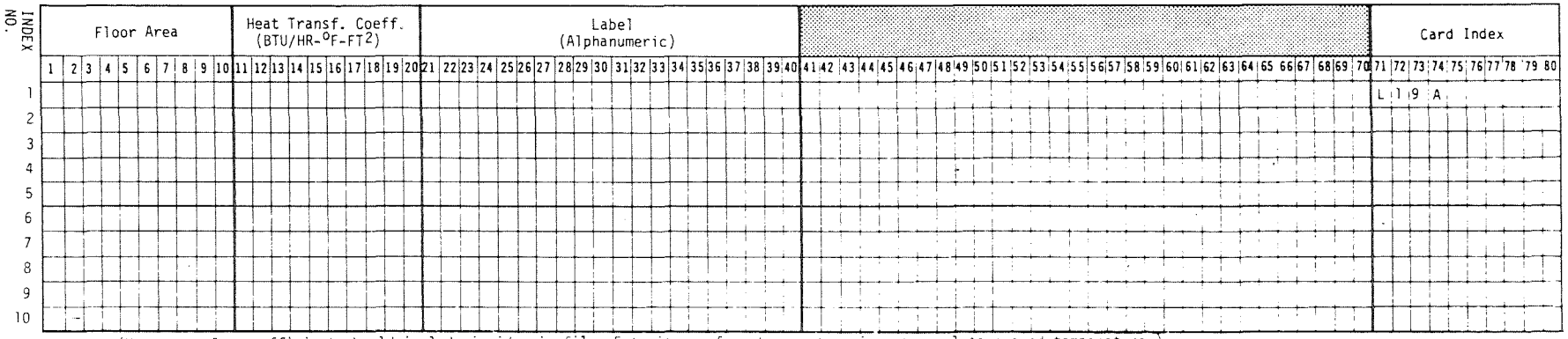
- No. Underground Floors (Cols. 1-10)

  Buildings which have soil backed floors (e.g., slab-on-grade) will require the use of underground floors. Indicate with this variable the total number of distinct underground floor sections to be described using card type L-19A.

NOTE: Repeat card type L-19A for each underground floor to be described.

CARD TYPE L-19A

DESCRIPTION OF UNDERGROUND FLOORS



(Heat transfer coefficient should include inside air film. Exterior surface temperature is set equal to ground temperature.)

- Floor Area (sq. ft.) (Cols. 1-10)

  Total area of surface through which heat is transferred.

- Heat Transfer Coefficient (BTU/HR-SQ.FT.-F) (Cols. 11-20)

  Overall heat transfer coefficient (U-factor) for the surface including inside air film.

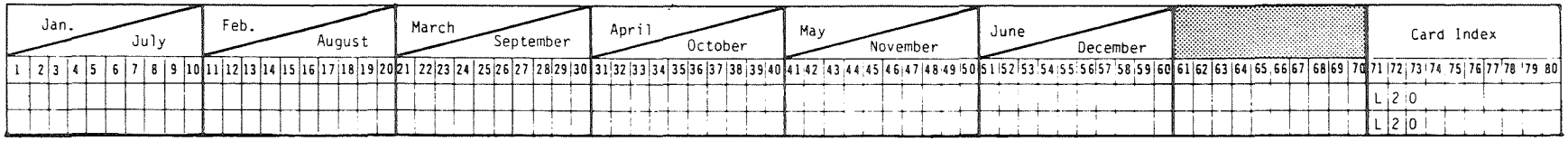
- Label (Cols. 21-40)

  Alphanumeric description of surface.

CARD TYPE L-20

GROUND TEMPERATURE

GROUND TEMPERATURE (^{o}F) (If no underground walls or floors are required, skip card type L20.)



NOTE: If no underground walls or floors are used, skip card type L-20.

- Ground Temperature (^{o}F)

  These temperatures are used to calculate heat flow through underground walls and floors.

FIRST CARD

COLUMNS	MONTH
1-10	January
11-20	February
21-30	March
31-40	April
41-50	May
51-60	June

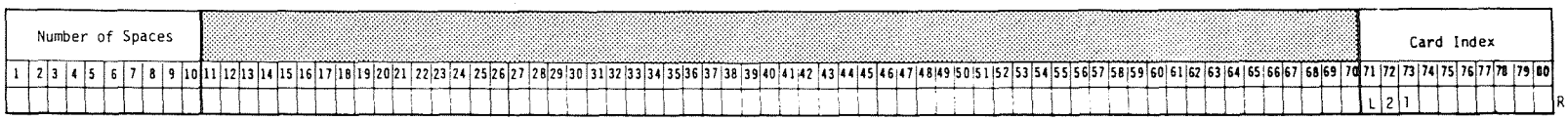
SECOND CARD

COLUMNS	MONTH
1-10	July
11-20	August
21-30	September
31-40	October
41-50	November
51-60	December

CARD TYPE L-21

SPACES

SPACES



NOTE: CARD TYPE L21 SHOULD APPEAR ONLY ONCE.

- Number of Spaces (Cols. 1-10)

  This quantity represents the total number of spaces in building for which load calculations are required. If the building contains spaces that have identical loads, e.g., spaces on intermediate floors of a multiple story building and having same exposure, describe it only once and use the space repetition feature on card type L-21F, columns 61-70. Generally, a space would be defined as a zone or zones controlled by one thermostat. Since computer computation time is a function of the number of spaces for which load calculations are required, every effort should be made to minimize this quantity.

CARD TYPE L-21A
GENERAL DATA

SPACE DESCRIPTION

Space Floor Area (FT^2)	Space Volume (FT^3)	Weight of Floor (LB/FT^2)	Space Temperature (^oF)	Include in bldg load? (0=NO, 1=YES)	Is space a plenum?	Label (Alphanumeric)	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 1 A R

- Space Floor Area (sq.ft.) (Cols. 1-10)

  Total square footage of zone floor area. This is used to calculate, when applicable, ventilation air load, lighting load, equipment load, etc.

- Space Volume (cu.ft.) (Cols. 11-20)

  When the air change method for calculating zone infiltration load is specified on card type L-21E, the space volume is used to calculate the total air change rate in CFM. If the air change method for determining infiltration load is not used, leave this quantity blank or enter 0.0.

- Weight of Floor (LB/SQ. FT.) (Cols. 21-30)

  Physical weight (LBS.) of a square foot of floor area. This is not density but actual floor weight, This quantity along with proper weighting factors is used to calculate the zone air load each hour.

- Space Temperature (°F) (Cols. 31-40)

  Temperature at which space is to be maintained the year around. This temperature is used as a reference temperature when calculating space heat gains and heat losses. If the user wishes to investigate the effects of thermostat deadbands or throttling ranges, equipment scheduling, night setback, etc., use should be made of the Temperature Variation Program. The Temperature Variation Program will adjust the basic hourly load data calculated by the Load Analysis Program for all of these effects and create a new set of corrected hourly load data.

- Include In Building Load? (0. or 1.) (Cols. 41-45)

  The user is given the option here of indicating whether or not this space's load should be included when determining building total heating and cooling capacity.

  0. = no, do not include
  1. = yes, do include

  Through this feature, the user is given the ability of not only investigating the basic building under study, but other spaces can be defined which are variations of the basic spaces, e.g., a different kind of glass, window shading, different lighting level, etc. However the loads of a space not included in the building load summary are still written to the load tape.

- Is Space A Plenum? (0. or 1.) (Cols. 46-50)

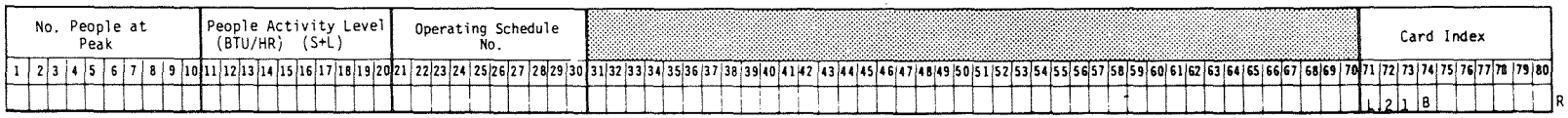
  If space is a return air plenum or a ceiling air space, enter 1.. If not, enter 0.. This will allow the program to determine the proper amount of total building conditioned floor area for calculation of ventilation air load and cfm per sq. ft..

- Label (Cols. 51-70)

  Alphanumeric Description of space.

CARD TYPE L-21B

OCCUPANCY LOADS



- No. People At Peak (Cols. 1-10)

  Maximum number of persons that will occupy the space.

- People Activity Level (BTU/HR) (Cols. 11-20)

  Metabolic heat (sensible and latent) given off by one person (BTU/HR).
  See table below for typical values for various working levels.

Kind of Work	Activity	Metabolic Rate Btu/hr
Light Work	Sleeping.....	250
	Sitting quietly.....	400
	Sitting, moderate arm and trunk movements.... (e.g., desk work, typing)	450-550
	Sitting, moderate arm and leg movements..... (e.g., playing organ, driving car in traffic)	550-650
	Standing, light work at machine or bench, mostly arms.....	550-650
Moderate Work	Sitting, heavy arm and leg movements.....	650-800
	Standing, light work at machine or bench, some walking about.....	650-750
	Standing, moderate work at machine or bench, some walking about.....	750-1000
	Walking about, with moderate lifting or pushing.....	1000-1400
Heavy Work	Intermittent heavy lifting, pushing or pulling..... (e.g., pick and shovel work)	1500-2000
	Hardest sustained work.....	2000-2400

- Operating Schedule No. (Cols. 21-30)

  Identify here the operating schedule number of schedule which is to be used to schedule occupancy of the space. Refer to card types L-11A and L-11B.

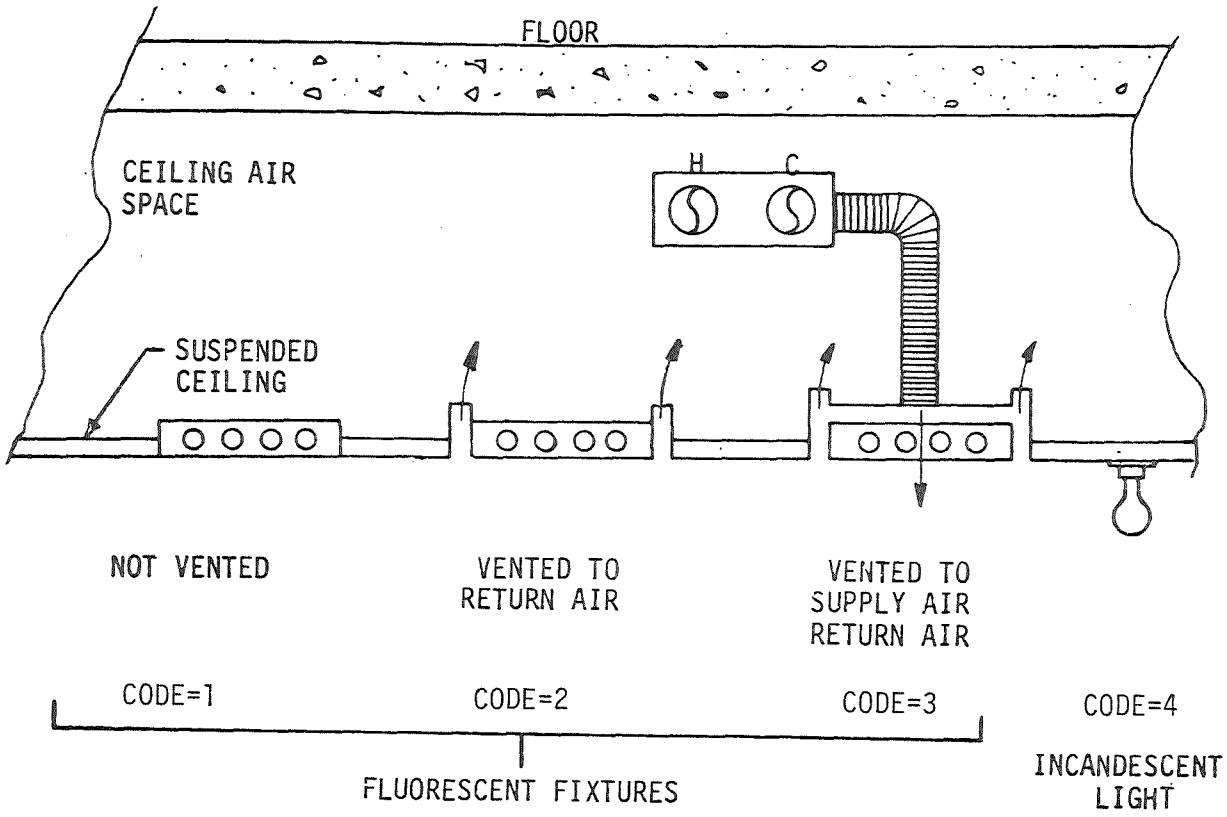
CARD TYPE L-21C

LIGHTING LOADS

Type of Light Fixture (1. - 4.)	Fraction of Light Heat to Space	Lighting Load (WATTS/FT^2)	Lighting Load (KW)	Operating Schedule No.	LIGHT FIXTURE 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 42 43 44 45 46 47 48 49 50	1. Not vented 2. Vented to ret. air 3. Vented to sup. & ret. air 4. Incandescent	71 72 73 74 75 76 77 78 79 80
						L 2 1 C R

- Type of Light Fixture (1.-4.) (Cols. 1-10)

  The user is given 4 types of lighting fixtures to choose from. Corresponding weighting factors are stored within program to transfer lighting load to space air and plenum air.



- Fraction of Light Heat To Space (0.0 - 1.0) (Cols. 11-20)

  If light fixture is mounted in a suspended ceiling, not all of the light heat is transferred into the space below, some is transferred into the ceiling air space above. Consult manufacturers data for proper value. Typically, this value ranges from 0.3 to 0.6 for suspended ceiling fixtures and 1.0 for fixtures mounted totally within space such as type 4 above. The remaining portion of the light heat not transfered into the space is assumed to be a return air load on the distribution system.

- Lighting Load (WATTS/SQ. FT.) (Cols. 21-30)

  The user is given the option of entering the lighting load for the space either in watts per square foot of floor area (columns 21-30) or in total kilowatts (columns 31-40) for the space. If values are enter in both catagories, program will sum the two together to get total space lighting load.

- Lighting Load (Kilowatts) (Cols. 31-40)

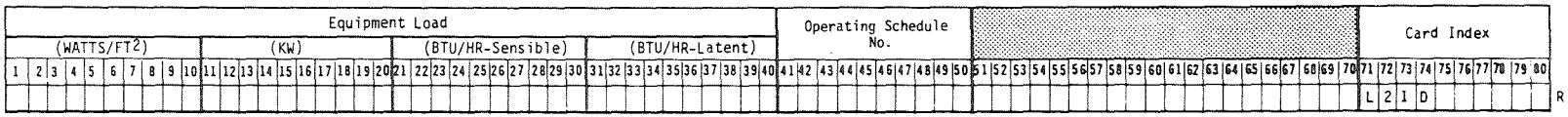
  See comments directly above.

- Operating Schedule No. (Cols. 41-50)

  Identity here the operating schedule number of schedule which is to be used to schedule the use of lighting for the space. Refer to card type L-11A and L-11B.

CARD TYPE L-21D

EQUIPMENT LOADS



- Miscellaneous Electrical and Thermal Loads

  Very often there is equipment (computers, office machines, reproduction equipment, etc.) or process loads that are adding to the total thermal load of the space. The user is given 4 catagories in which to enter these loads. They are:

  1. Watts/sq.ft. - Columns 1-10
  2. Kilowatts - Columns 11-20
  3. BTU/HR (sensible) - Columns 21-30
  4. BTU/HR (latent) - Columns 31-40

  The program will sum all 4 of these quantities together to arrive at the total space equipment load.

- Operating Schedule No. (Cols. 41-50)

  Identify here the operating schedule number of schedule which is to be used to schedule the use of equipment loads for the space. Refer to card type L-11A and L-11B.

CARD TYPE L-21E

INFILTRATION LOAD

Type of Infiltration Analysis (0.-2.)	Infiltration Rate (No. of Air Changes)	Height above (-) or below Neutral Zone (FT)	Space Exhaust Air (CFM)	INFILTRATION CODE 0. None 1. Air change method (columns 11-20 req'd) 2. Crack method (columns 21-40 req'd)	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		71 72 73 74 75 76 77 78 79 80
					L 2 1 E R

- Type of Infiltration Analysis (0. - 2.) (Cols. 1-10)

  Three choices are available for calculating space infiltration loads.

  0. None
  1. Air change method
  2. Crack method

- Infiltration Rate (No. of Air Changes) (Cols. 11-20)

  Enter a value here only if air change method has been specified in columns 1-10.

  The number of air changes per hour to be entered is that estimated for a 10 mph wind. Each hour program will adjust this air change rate as a function of the actual wind speed read from weather data.

- Height Above (-) Or Below Neutral Zone (Ft.) (Cols. 21-30)

  Enter a value here only if the crack method has been specified in columns 1-10.

  This value is used to calculate infiltration rate due to stack effect. If zone lies above the neutral zone, height should be entered with a (-) sign. If zone lies below neutral zone, height should be entered with a (+) sign.

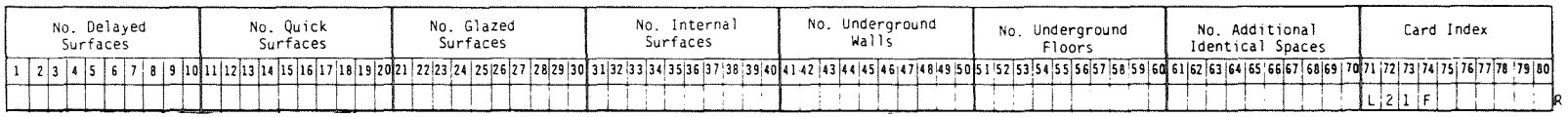
- Space Exhaust Air (CFM) (Cols. 31-40)

  Enter a value here only if the crack method has been specified in columns 1-10.

  Amount of exhaust air that is being taken out of space and directly dumped to outside by exhaust fans, etc. This quantity when subtracted from the ventilation air allotted for this space, represents the amount of interior pressurization that is taking place within the space to offset infiltration.

CARD TYPE L-21F

MAKEUP OF SPACE ENVELOPE



This card along with card types L-21G through L-21L are used to build up the space envelope. On card type L-21G the user indicates the quantities of each surface type that are to be used. On card types L-21G through L-21L the user indicates which specific surfaces are to be used.

- No. Delayed Surfaces (Cols. 1-10)

  Total number of delayed surface sections which will be used to describe space envelope. This number indicates how many indices are to be read from card type L-21G.

- No. Quick Surfaces (Cols. 11-20)

  Total number of quick surface sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21H.

- No. Glazed Surfaces (Cols. 21-30)

  Total number of window sections which will be used to describe space envelope. This number indicates how many window indices are to be read from card type L-21I

- No. Internal Surfaces (Cols. 31-40)

  Total number of internal surface sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21J .

- No. Underground Walls (Cols. 41-50)

  Total number of underground wall sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21K.

- No. Underground Floors (Cols. 51-60)

  Total number of underground floor sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21L.

- No. Additional Identical Spaces (Cols. 61-70)

  If building contains other spaces that are identical to the one described here on card types L-21A through L-21L, the user would enter here the number of additional identical spaces there are. This will save computer computation time and will be used in calculating the total building load each hour.

CARD TYPE L-21G Through L-21L
INDICES OF SPACE SURFACES

INDICES OF SPACE SURFACES

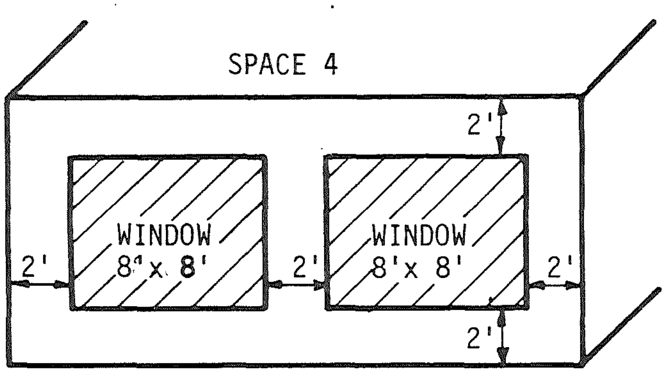
- Begin new card for each surface type.
- If a surface type is not included, skip that card index type.

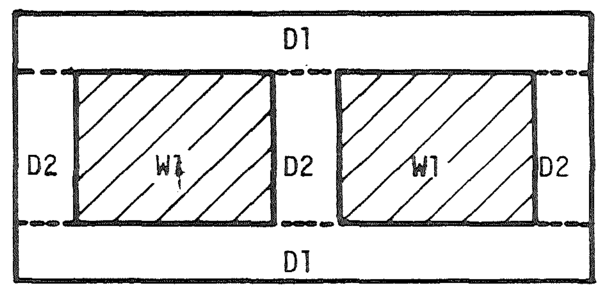
- Delayed ______________ L21G
- Quick ______________ L21H
- Glazed ______________ L21I
- Internal ______________ L21J
- Underground Walls ______________ L21K
- Underground Floors ______________ L21L

Card Index

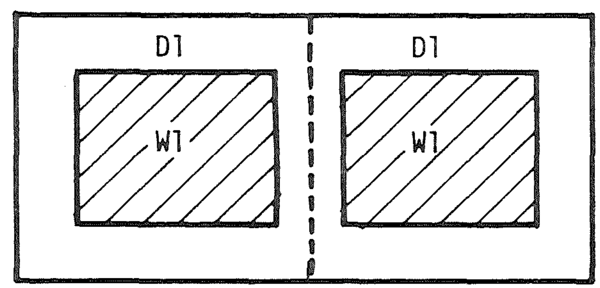
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

As the program read the data describing delayed, quick, glazed, internal, underground floor and and underground wall surfaces, an index was defined corresponding to the order to which the surfaces were entered. If 15 delayed surfaces were used, the program cataloged the data using indices 1-15. If 10 glazed surfaces were used the programs cataloged the data using indices 1-10. On card types L-21G through L-21L the user must call out the indices of those surfaces which are to be used to build up the space envelop. Indices can be used as many times as needed thereby taking advantage of the repetitiveness of certain surfaces. For example, pictured below is one wall of space 4 having two windows and 2' borders around windows.





Alternative 1



Alternative 2

Two alternate methods are illustrated for breaking the wall into delayed surfaces and glazed surfaces. If this was the only wall making up Space 4, card types L-21G and L-21I would contain data as follows:

Alternative 1

1.	1.	2.	2.	2.	L-21G
1.	1.				L-21I

Alternative 2

1.	1.				L-21G
1.	1.				L-21I

The space envelope surface indices must be entered in the order indicated in table below. If more than one card type is required, use as many as required. If use of a given card type is not required, skip that card.

SURFACE TYPE	USE CARD TYPE
DELAYED H.T.S.	L-21G
QUICK H.T.S.	L-21H
GLAZED H.T.S.	L-21I
INTERNAL H.T.S.	L-21J
UNDERGROUND WALLS	L-21K
UNDERGROUND FLOORS	L-21L

4.2.3 Hourly Weather Data

If an hourly load analysis for determining energy requirements is being sought, the Load Analysis Program requires hourly weather data to be supplied in the form of a magnetic tape. For the years and cities available, refer to the SCOUT Access and Control Guide.

4.3 OUTPUT REPORT DESCRIPTION

The 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.

Ten types of reports, in all, can be created by the 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 - Zone 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 Hourly Results Report Column Labels
9. Report L9 - Summary of Hourly Results
10. Report L10- Summary of Recommended Space Heat Extraction and Addition Rates

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

- REPORT L1 - ECHO OF CARD INPUT DATA

To give the user a hard copy record of the card input data read each time the program is used, the first report coming out will always be a summary of card input data read. An example of this report is shown in Figure 4.4. This report will occupy several pages depending upon the size of the input data deck.

- 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 data.

- REPORT L3 - SUMMARY OF DESIGN DAY WEATHER

As indicated by Figure 4.6, 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. 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.

- REPORT L4 - ZONE LOAD SUMMARY

At the end of the design load or hourly load analysis, a summary (see Figure 4.7) detailing the components of the peak heating and cooling load is printed for each building zone. An explanation of each item follows:

1. Zone No. - defined by order of input.
2. Zone Repetition Factor - defined by input L-21F.
3. Area - defined by input L-21A.
4. Volume - defined by input L-21A.
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°.
8. Ceilings - summation of transmission loads through delayed and quick surfaces with tilt angles less than 45°.
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 agnles equal to or greater then 45°.
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.

- REPORT L5 - BUILDING LOAD SUMMARY

Report L5 (see Figure 4.8) is similar to Report L4 except results are for time when the building load peaked. Additional items include:

1. Return Air - summation of zone 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.

- REPORT L6 - TITLE PAGE - HOURLY ENERGY ANALYSIS

Report L6 (see Figure 4.9) is similar to Report L2 except that it is produced only at the time an hourly energy analysis is begun.

- 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 4.10 for an example report.

- REPORT L8 - SUMMARY OF HOURLY RESULTS REPORT COLUMN LABELS

Reports L8 and L9 are companion reports. Report L8 (see Figure 4.11) indicates the hourly weather and zone load data that is calculated by the program and written each hour by the Load Analysis Program onto an output tape. This report also is an aid in interpreting the data that is printed as part of Report L9.

- REPORT L9 - SUMMARY OF HOURLY RESULTS

Report L9 (see Figure 4.12) is an optional output and summarizes weather data and calculated zone loads for each hour of the analysis.

- REPORT L10 - SUMMARY OF RECOMMENDED SPACE HEAT EXTRACTION AND ADDITION RATES

The Temperature Variation Program requires as input to it, the maximum heating and cooling capacities provided to each space. Report L10 (Figure 4.13) lists the recommended capacities based upon hourly energy analysis results. These quantities are taken directly from item 19 of Report L4 for each zone.

THERE ARE 22 DELAYED SURFACES

SURFACE NUMBER	SIM. SUR. INDEX	SURFACE ABSOR'N	SURFACE ROUGHNESS	SUR. TYPE INDEX	GROUND REFLEC'N	SURFACE AREA	AZIMUTH ANGLE	TILT ANGLE	INF. FLOW COEFF.	SURFACE LABEL
1	0.	0.70	2.	30.	0.20	1200.	180.	90.	0.0	D1-FRONT
2	0.	0.70	2.	30.	0.20	50.	180.	90.	0.0	D2-FRONT
3	0.	0.70	2.	30.	0.20	81.	180.	90.	0.0	D3-FRONT
4	0.	0.70	2.	30.	0.20	1050.	90.	90.	0.0	D4-RIGHT
5	0.	0.70	2.	30.	0.20	50.	90.	90.	0.0	D5-RIGHT
6	0.	0.70	2.	30.	0.20	81.	90.	90.	0.0	D6-RIGHT
7	0.	0.70	2.	30.	0.20	1200.	0.	90.	0.0	D7-BACK
8	0.	0.70	2.	30.	0.20	50.	0.	90.	0.0	D8-BACK
9	0.	0.70	2.	30.	0.20	81.	0.	90.	0.0	D9-BACK
10	0.	0.70	2.	30.	0.20	1050.	270.	90.	0.0	D10-LEFT
11	0.	0.70	2.	30.	0.20	50.	270.	90.	0.0	D11-LEFT
12	0.	0.70	2.	30.	0.20	581.	270.	90.	0.0	D12-LEFT
13	0.	0.80	1.	40.	0.0	3164.	180.	0.	0.0	D13-ROOF
14	0.	0.80	1.	40.	0.0	2744.	90.	0.	0.0	D14-ROOF
15	0.	0.80	1.	40.	0.0	3164.	0.	0.	0.0	D15-ROOF
16	0.	0.80	1.	40.	0.0	2744.	270.	0.	0.0	D16-ROOF
17	0.	0.80	1.	40.	0.0	35784.	180.	0.	0.0	D17-ROOF
18	0.	0.70	2.	50.	0.20	400.	180.	90.	0.0	D18-FRONT
19	0.	0.70	2.	50.	0.20	700.	90.	90.	0.0	D19-RIGHT
20	0.	0.70	2.	50.	0.20	400.	0.	90.	0.0	D20-BACK
21	0.	0.70	2.	50.	0.20	700.	270.	90.	0.0	D21-LEFT
22	0.	0.70	2.	40.	0.20	400.	180.	0.	0.0	D22-ROOF

FIGURE 4.4 REPORT L1 (TYPICAL)

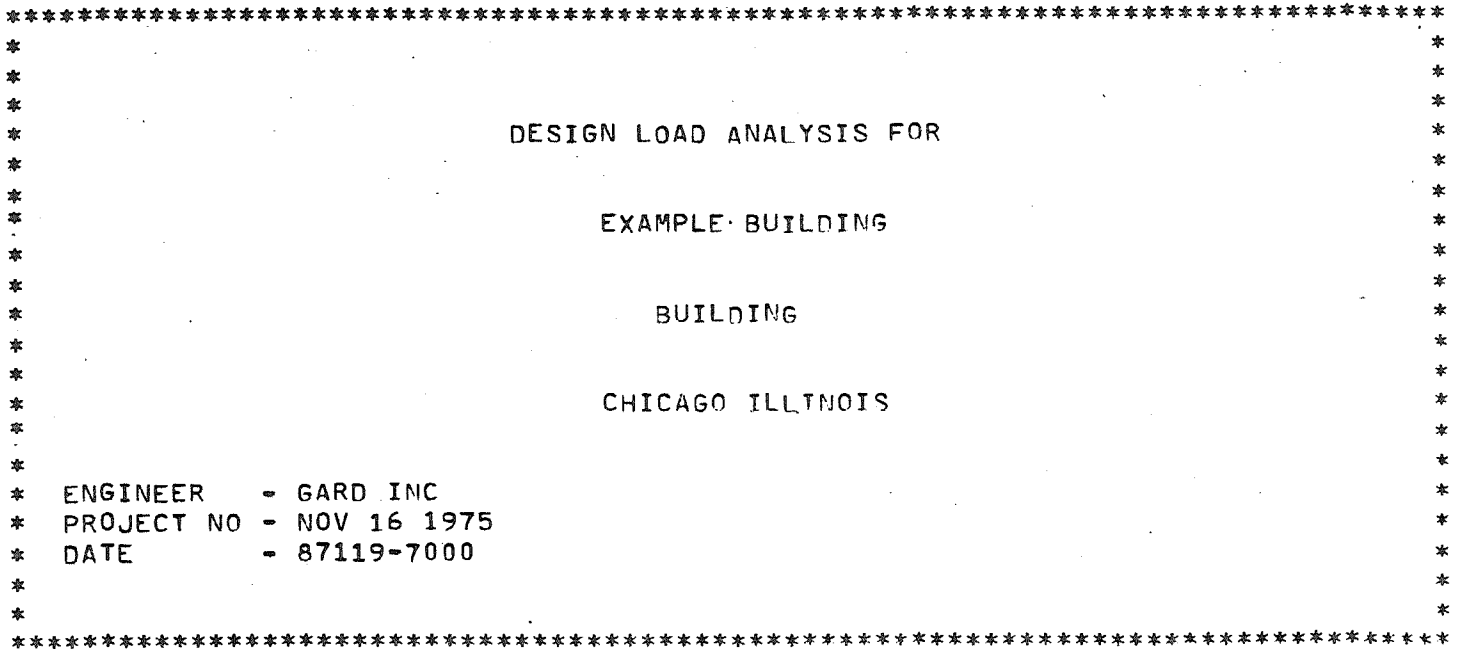


FIGURE 4.5 REPORT L2 (TYPICAL)

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 TEMPERATURE = 92.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 16.
4. AVERAGE DEW-POINT TEMPERATURE = 74.
5. AVERAGE WIND SPEED = 11.

WINTER DAY INPUT PARAMETERS

1. MONTH ASSUMED TO BE DECEMBER
2. MINIMUM DRY-BULB TEMPERATURE = 20.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 0.
4. AVERAGE DEW-POINT TEMPERATURE = 19.
5. AVERAGE WIND SPEED = 13.

	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	65.	65.	64.	64.	64.	65.	66.	67.	68.	70.	72.	74.	76.	78.	79.	78.	77.	77.	75.	73.	71.	69.	67.	65.
WBT	62.	62.	61.	61.	61.	62.	63.	64.	65.	67.	69.	71.	71.	72.	72.	72.	72.	72.	71.	70.	68.	66.	64.	62.
APRIL																								
DBT	69.	69.	68.	68.	68.	69.	70.	71.	72.	74.	76.	78.	80.	82.	83.	82.	81.	81.	79.	77.	75.	73.	71.	69.
WBT	66.	66.	65.	65.	65.	66.	67.	68.	69.	71.	72.	73.	73.	74.	74.	74.	74.	74.	73.	73.	72.	70.	68.	66.
MAY																								
DBT	74.	74.	73.	73.	73.	74.	75.	76.	77.	79.	81.	83.	85.	87.	88.	87.	86.	86.	84.	82.	80.	78.	76.	74.
WBT	71.	71.	70.	70.	70.	71.	72.	73.	73.	74.	74.	75.	75.	76.	76.	76.	76.	76.	75.	75.	74.	74.	73.	71.
JUNE																								
DBT	77.	77.	76.	76.	76.	77.	78.	79.	80.	82.	84.	86.	88.	90.	91.	90.	89.	89.	87.	85.	83.	81.	79.	77.
WBT	74.	74.	73.	73.	73.	74.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	74.
JULY																								
DBT	78.	78.	77.	77.	77.	78.	79.	80.	81.	83.	85.	87.	89.	91.	92.	91.	90.	90.	88.	86.	84.	82.	80.	78.
WBT	75.	75.	74.	74.	74.	75.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	75.
AUGUST																								
DBT	78.	78.	77.	77.	77.	78.	79.	80.	81.	83.	85.	87.	89.	91.	92.	91.	90.	90.	88.	86.	84.	82.	80.	78.
WBT	75.	75.	74.	74.	74.	75.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	75.
SEPTEMBER																								
DBT	76.	76.	75.	75.	75.	76.	77.	78.	79.	81.	83.	85.	87.	89.	90.	89.	88.	88.	86.	84.	82.	80.	78.	76.
WBT	73.	73.	72.	72.	72.	73.	74.	74.	74.	75.	76.	76.	77.	77.	77.	77.	77.	77.	76.	76.	75.	75.	74.	73.
OCTOBER																								
DBT	71.	71.	70.	70.	70.	71.	72.	73.	74.	76.	78.	80.	82.	84.	85.	84.	83.	83.	81.	79.	77.	75.	73.	71.
WBT	68.	68.	67.	67.	67.	68.	69.	70.	71.	72.	72.	73.	73.	74.	74.	74.	74.	74.	73.	73.	72.	72.	70.	68.
NOVEMBER																								
DBT	64.	64.	63.	63.	63.	64.	65.	66.	67.	69.	71.	73.	75.	77.	78.	77.	76.	76.	74.	72.	70.	68.	66.	64.
WBT	61.	61.	60.	60.	60.	61.	62.	63.	64.	66.	68.	70.	71.	72.	72.	72.	72.	72.	71.	69.	67.	65.	63.	61.
DECEMBER																								
DBT	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
WBT	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	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 4.6 REPORT L3 (TYPICAL)

HOURLY LOAD ANALYSIS RESULTS FOR
EXAMPLE BUILDING
CHICAGO ILLINOIS

SPACE NO. 3

SPACE REPETITION FACTOR 1

AREA (SQ.FT.) 2750.

VOLUME (CU.FT.) 27500.

SUMMER COOLING PEAK
DBT/WBT/HR OF DAY/DATE 97 / 75 / 13 / JULY 1

WINTER HEATING PEAK
DBT/WBT/HR OF DAY/DATE -14 / -14 / 21 / JAN. 23

	***** SUMMER LOAD ***** SENSIBLE (BTUH)	LATENT (BTUH)	WINTER LOAD (BTUH)
WALLS	1799.	0.	-13681.
CEILINGS	0.	0.	0.
WINDOW CONDUCTANCE	11534.	0.	-71224.
WINDOW SOLAR	6762.	0.	0.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND WALLS	0.	0.	0.
UNDERGROUND FLOORS	970.	0.	-9295.
OCCUPANTS	5591.	5337.	5943.
LIGHT TO SPACE	18402.	0.	2251.
EQUIPMENT TO SPACE	1966.	0.	417.
INFILTRATION	121.	117.	-2244.
TOTAL	47143.	5454.	-87832.

TOTAL SPACE COOLING 52597. BTUH
TOTAL SPACE HEATING -87832. BTUH

SUPPLY AIR AT 50 F AT DIFFUSER	1912. CFM	0.70 CFM/SQ.FT.
SUPPLY AIR AT 55 F AT DIFFUSER	2390. CFM	0.87 CFM/SQ.FT.
SUPPLY AIR AT 120 F AT DIFFUSER	1566. CFM	0.57 CFM/SQ.FT.
SUPPLY AIR AT 140 F AT DIFFUSER	1084. CFM	0.39 CFM/SQ.FT.

FIGURE 4.7 REPORT L4 (TYPICAL)

BUILDING LOAD SUMMARY FOR
EXAMPLE BUILDING
CHICAGO ILLINOIS

SPACE NOS. 1 THRU 11

TOTAL FLOOR AREA (SQ.FT.) 101700.

TOTAL VOLUME (CU.FT.) 1363000.

SUMMER COOLING PEAK
DBT/WBT/HR OF DAY/DATE 96 / 75 / 14 / JULY 1

WINTER HEATING PEAK
DBT/WBT/HR OF DAY/DATE -6 / -6 / 4 / FEB. 22

	***** SUMMER LOAD ***** SENSIBLE (BTUH)	LATENT (BTUH)	WINTER LOAD (BTUH)
WALLS	31289.	0.	-190078.
CEILINGS	241258.	0.	-410653.
WINDOW CONDUCTANCE	46735.	0.	-257332.
WINDOW SOLAR	35388.	0.	6166.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND WALLS	0.	0.	0.
UNDERGROUND FLOORS	11072.	0.	-103896.
OCCUPANTS	95822.	90724.	23618.
LIGHT TO SPACE	292390.	0.	12735.
EQUIPMENT TO SPACE	191046.	0.	13845.
INFILTRATION	4928.	5313.	-72065.
SUBTOTAL	949927.	96038.	-977660.
RETURN AIR	292390.	0.	12735.
FAN HEAT	65351.	0.	65351.
VENTILATION AIR	252712.	267728.	-1231832.
TOTAL	1560378.	363766.	-2131405.

TOTAL BUILDING COOLING 1924144. BTUH 160.3 TONS
TOTAL BUILDING HEATING -2131405. BTUH -2131.4 MBH

	******* VARIABLE VOLUME SYSTEM *******		******* CONSTANT VOLUME SYSTEM *******	
SUPPLY AIR AT 50 F AT DIFFUSER	38534. CFM	0.38 CFM/SQ.FT. MAX.	40702. CFM	0.40 CFM/SQ.FT. CONST.
SUPPLY AIR AT 55 F AT DIFFUSER	48168. CFM	0.47 CFM/SQ.FT. MAX.	50877. CFM	0.50 CFM/SQ.FT. CONST.
SUPPLY AIR AT 120 F AT DIFFUSER	17435. CFM	0.17 CFM/SQ.FT. MAX.	20753. CFM	0.20 CFM/SQ.FT. CONST.
SUPPLY AIR AT 140 F AT DIFFUSER	12070. CFM	0.12 CFM/SQ.FT. MAX.	14367. CFM	0.14 CFM/SQ.FT. CONST.

FIGURE 4.8 REPORT L5 (TYPICAL)

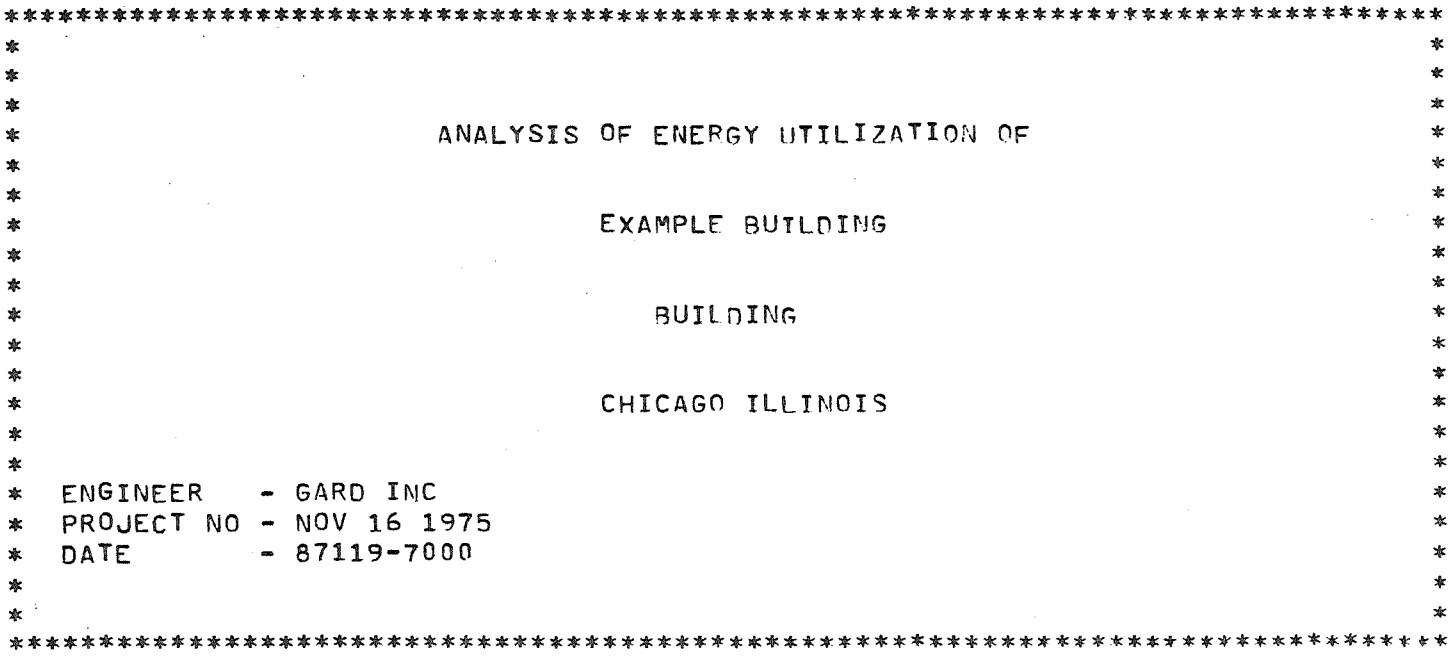


FIGURE 4.9 REPORT L6 (TYPICAL)

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                              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  1/ 1/1963. *
*                                                                           *
*                                                                           *
* - THE LENGTH OF THIS STUDY IS 365 DAYS.                                   *
*                                                                           *
*                                                                           *
* - THE INITIAL OUTSIDE SURFACE TEMPERATURE IS 17 DEGREES FAHRENHEIT.       *
*                                                                           *
*                                                                           *
*****************************************************************************
```

FIGURE 4.10 REPORT L7 (TYPICAL)

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                          IN THE FOLLOWING PAGES                           *
*                                                                           *
*                                                                           *
*                 THE FIRST LINE OF EACH PRINTED BLOCKS GIVES.              *
*                                                                           *
*   TIME            - HOURS, STANDARD TIME FROM FIRST HOUR OF JANUARY       *
*   MONTH           - MONTH OF YEAR                                         *
*   DAY INDEX 1     - DAY OF MONTH                                          *
*   DAY INDEX 2     - DAY OF  WEEK(1-7)                                     *
*   HOUR            - HOUR OF DAY (1-24)                                    *
*   SUN INDEX       - IF EQUAL TO ONE SUN IS DOWN, IF EQUAL TO ZERO SUN IS UP *
*   DRY-BULB TEMP.  - DEGREES FAHRENHEIT                                    *
*   WET-BULB TEMP.  - DEGREES FAHRENHEIT                                    *
*   WIND VELOCITY   - KNOTS                                                 *
*   HUMIDITY RATIO  - LBS WATER PER LB DRY-AIR                              *
*   PRESSURE        - INCHES OF MERCURY                                     *
*   DENSITY         - LBS DRY-AIR PER CUBIC FOOT                            *
*   ENTHALPY        - BTU PER LB DRY-AIR                                    *
*   DAY INDEX 3     - TYPE OF DAY(1-9),                                     *
*   CLOUD COVER MODIFIER - FRACTION OF TOTAL SOLAR RADIATION INCIDENT       *
*                          UPON A HORIZONTAL SURFACE                        *
*                                                                           *
*               THE FOLLOWING LINES OF EACH PRINTED BLOCKS GIVES            *
*                                                                           *
*   SPACE NUMBER                                                            *
*   SPACE SENSIBLE LOAD - BTU PER HOUR                                      *
*   SPACE LATENT LOAD   - BTU PER HOUR                                      *
*   PLENUM RETURN AIR LIGHTING LOAD    - BTU PER HOUR                       *
*   SPACE LIGHTING AND EQUIPMENT POWER - KILOWATTS                          *
*   INF. SENSIBLE LOAD  - BTU PER HOUR                                      *
*   INF. LATENT LOAD    - BTU PER HOUR                                      *
*                                                                           *
*                                                                           *
*****************************************************************************
*            NOTE - THE LOADS EXCLUDES OUTSIDE VENTILATION AIR LOADS        *
*****************************************************************************
```

FIGURE 4.11 REPORT L8 (TYPICAL)

97	1	5	7	1	1	30.	28.	6.	0.002666	29.56	0.079668	10,06	7	0.380
1	-22323.25		2001.28		13918.37				0.29	-1728.28	0.0			
2	-50057.44		200.13		1457.50				0.02	-2865.54	0.0			
3	-40296.37		160.10		1252.53				0.02	-246.26	0.0			
4	-48035.85		200.13		1457.50				0.02	-2865.54	0.0			
5	-69133.13		160.10		1252.53				0.02	-246.26	0.0			
6	-163791.63		0.0		0.0				0.0	-805.93	0.0			
7	-19041.74		0.0		0.0				0.0	-71.64	0.0			
8	-16764.81		0.0		0.0				0.0	-62.68	0.0			
9	-19238.69		0.0		0.0				0.0	-71.64	0.0			
10	-16343.81		0.0		0.0				0.0	-62.68	0.0			
11	-5309.40		0.0		0.0				0.0	-9402.57	0.0			
98	1	5	7	2	1	29.	27.	5.	0.002543	29.55	0.079819	9.69	7	0.272
1	-27483.43		2001.28		12108.98				0.29	-1475.04	0.0			
2	-50476.74		200.13		1268.03				0.02	-2445.67	0.0			
3	-40515.27		160.10		1089.70				0.02	-210.17	0.0			
4	-48324.94		200.13		1268.03				0.02	-2445.67	0.0			
5	-70068.13		160.10		1089.70				0.02	-210.17	0.0			
6	-165397.75		0.0		0.0				0.0	-687.84	0.0			
7	-19220.24		0.0		0.0				0.0	-61.14	0.0			
8	-16894.68		0.0		0.0				0.0	-53.50	0.0			
9	-19392.74		0.0		0.0				0.0	-61.14	0.0			
10	-16517.02		0.0		0.0				0.0	-53.50	0.0			
11	-7543.82		0.0		0.0				0.0	-8024.85	0.0			
99	1	5	7	3	1	29.	27.	5.	0.002542	29.56	0.079846	9.69	7	0.272
1	-31972.79		2001.28		10534.81				0.29	-1475.54	0.0			
2	-51158.36		200.13		1103.18				0.02	-2446.50	0.0			
3	-40940.60		160.10		948.04				0.02	-210.25	0.0			
4	-48865.73		200.13		1103.18				0.02	-2446.50	0.0			
5	-71160.19		160.10		948.04				0.02	-210.25	0.0			
6	-167296.13		0.0		0.0				0.0	-688.08	0.0			
7	-19426.53		0.0		0.0				0.0	-61.16	0.0			
8	-17051.13		0.0		0.0				0.0	-53.52	0.0			
9	-19577.39		0.0		0.0				0.0	-61.16	0.0			
10	-16714.34		0.0		0.0				0.0	-53.52	0.0			
11	-9520.68		0.0		0.0				0.0	-8027.57	0.0			
100	1	5	7	4	1	29.	27.	0.	0.002666	29.56	0.079831	9.82	7	0.272
1	-35878.56		2001.28		9165.28				0.29	0.0	0.0			
2	-44289.98		200.13		959.77				0.02	0.0	0.0			
3	-35782.82		160.10		824.80				0.02	0.0	0.0			
4	-42524.79		200.13		959.77				0.02	0.0	0.0			
5	-67298.81		160.10		824.80				0.02	0.0	0.0			
6	-168568.13		0.0		0.0				0.0	0.0	0.0			
7	-19579.26		0.0		0.0				0.0	0.0	0.0			
8	-17163.51		0.0		0.0				0.0	0.0	0.0			
9	-19711.02		0.0		0.0				0.0	0.0	0.0			
10	-16864.52		0.0		0.0				0.0	0.0	0.0			
11	-11265.02		0.0		0.0				0.0	0.0	0.0			
101	1	5	7	5	1	28.	27.	0.	0.002667	29.55	0.079967	9.58	7	0.272
1	-39276.55		2001.28		7973.79				0.29	0.0	0.0			
2	-44763.05		200.13		835.00				0.02	0.0	0.0			
3	-36074.07		160.10		717.57				0.02	0.0	0.0			
4	-42895.41		200.13		835.00				0.02	0.0	0.0			
5	-68214.31		160.10		717.57				0.02	0.0	0.0			
6	-168475.31		0.0		0.0				0.0	0.0	0.0			
7	-19612.25		0.0		0.0				0.0	0.0	0.0			
8	-17174.31		0.0		0.0				0.0	0.0	0.0			
9	-19727.22		0.0		0.0				0.0	0.0	0.0			
10	-16909.75		0.0		0.0				0.0	0.0	0.0			
11	-12762.48		0.0		0.0				0.0	0.0	0.0			

FIGURE 4.12 REPORT L9 (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	-59016.	314746.
2	-132668.	63036.
3	-87832.	47143.
4	-129278.	55195.
5	-148883.	54111.
6	-347137.	202998.
7	-40240.	19682.
8	-35245.	16570.
9	-40474.	18535.
10	-34687.	16114.
11	-108259.	195235.

FIGURE 4.13 REPORT L10 (TYPICAL)

SECTION 5

LOAD ANALYSIS PROGRAM WITH SHADOWS

5.1 OBJECTIVE AND DESCRIPTION

The Load Analysis Program With Shadows computes hourly sensible and latent loads for each zone as well as the block sensible and latent load for the building by accounting for:

1. Transmission gains and losses through walls, roofs, floors and windows.
2. Solar gains through windows.
3. Internal gains from people, lights and building equipment.
4. Infiltration gains and losses due to wind and thermal pressure differences across openings.
5. Ventilation air gains and losses due to fresh air requirements.
6. Shading effects created by the structure itself (fins, overhangs, setbacks, etc.) as well as those from adjacent buildings or structures.

The Load Analysis Program With Shadows can be exercised in two modes:

1. Design load analysis - Utilizing user-defined design weather data, a 24-hour design day analysis is done for those months specified to determine peak heating and cooling requirements for each zone and the entire building. No provision is made for carrying this process on through to the Temperature Analysis and System Analysis Programs.

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

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".

5.2 INPUT DATA DESCRIPTION

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

5.2.1 Definitions

- Building Coordinate System

In order to properly communicate to the computer the spacial relationship between shading surfaces and surfaces which are being shaded, a coordinate system must be attached to the building and used to describe the location of surfaces. Figure 5.1 shows the recommended coordinate system. In this coordinate system, the front of the building lies in the xz plane. The origin, as viewed by a person outside the building, lies at the lower left hand corner of the building front. The z-axis points straight upward. For non-rectangular surfaces, i.e., surfaces having more than 4 corners, the order in which the corners are described should follow, as shown in Figure 5.2, a righthanded order about the outward normal.

- Building Azimuth Angle

Building azimuth angle expresses the orientation of the building relative to the points of the compass. It is defined as the clockwise angle from north to the direction in which the y-axis faces. Refer to Figure 5.3 for further explanation. By changing the value of the building azimuth angle the user can investigate the effects of locating the building in a different orientation.

- Surface Azimuth Angle

Surface azimuth angle expresses the orientation of the surface relative to the y-axis. It is defined as the clockwise angle between the y-axis and the direction in which the surface in question faces. Refer to Figure 5.4 for further explanation.

- Surface Tilt Angle

Surface tilt angle is defined as the angle between the vertical and the direction in which the surface in question faces. The value of the tilt angle changes between 0° and 180°, as shown in Figure 5.5.

- Surface Description

The user is given two methods for 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:

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

Using this data, the computer can generate the remaining 3 sets of x, y, z coordinates and the surface area. If the surface being described with Method 2 never experiences any shading, the user can leave item 1 above blank

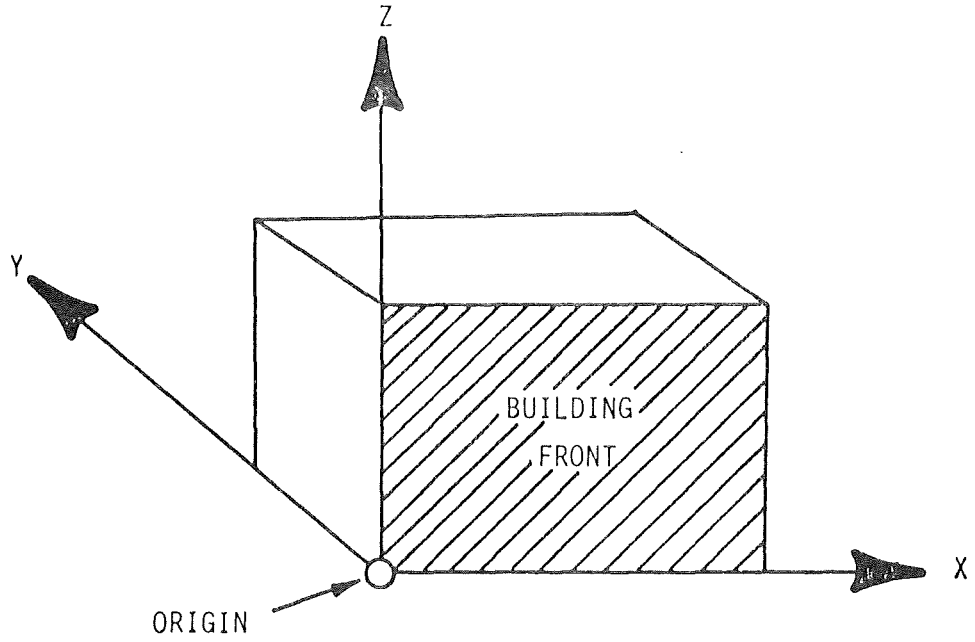


Figure 5.1 COORDINATE SYSTEM

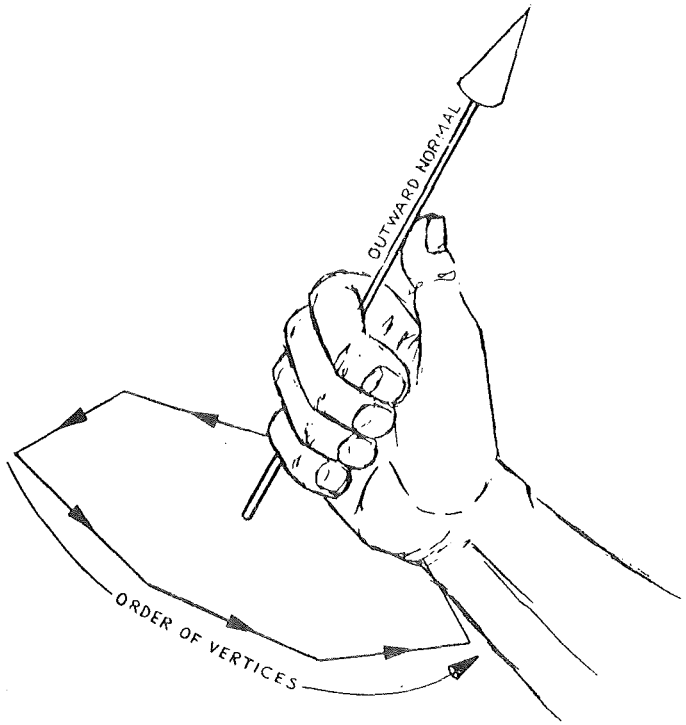
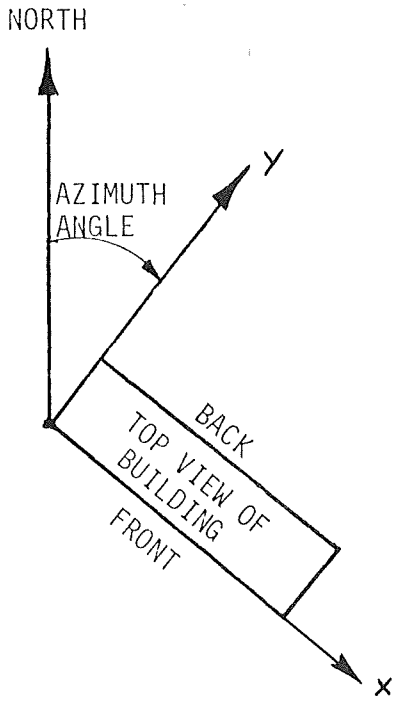


Figure 5.2 DEFINITION OF RIGHT-HANDED ORDER OF SURFACE VERTICES



Exposure of Building Front	Value of Building Azimuth Angle
S	0°
SW	45°
W	90°
NW	135°
N	180°
NE	225°
E	270°
SE	315°

Figure 5.3 BUILDING AZIMUTH ANGLE

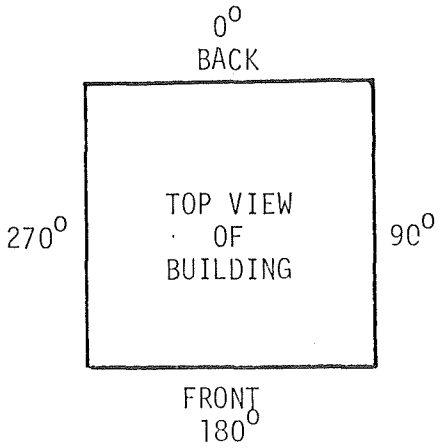


Figure 5.4 SURFACE AZIMUTH ANGLE

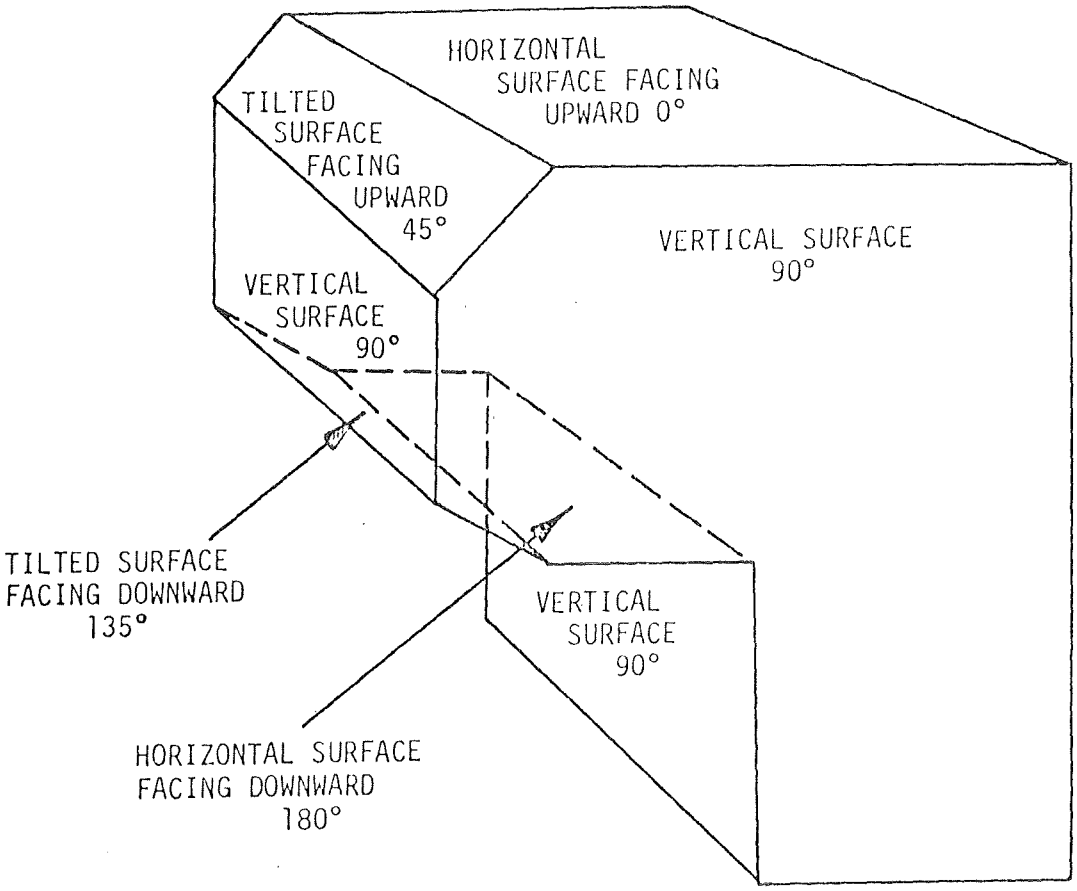


Figure 5.5 SURFACE TILT ANGLE

on the input form and enter data for only items 2 through 5. The program will automatically locate the surface at the origin with the specified azimuth and tilt angles.

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

- Types of Building Heat Transfer Surfaces

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

1. Delayed Heat Transfer Surfaces

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

2. Quick Heat Transfer Surfaces

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

3. Windows

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

4. Internal Heat Transfer Surfaces

   Internal 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 can transfer sensible energy in or out of the space.

- Types of 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 excluded from the shadow calculation of a particular heat transfer surface. For example, suppose that at the end of the Input Form LA/S-06 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 5.1. 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 5.1

USUAL CLASSIFICATION OF SHADING SURFACES

Type of Surface	Classification
Roof Overhang	Common
Adjacent Building	Common
Window Setback	Added
Window Overhang	Added

One of the more prevalent uses of solar shading by architects, is to setback windows into a wall or put shade fins around the window. Generally this would require the user to define 3 added shading surfaces. SCOUT will automatically generate these 3 added shading surfaces for the user, simply by specifying the setback and border distances for each window (see Input Form LA/S-10, card index L16A).

5.2.2 Card Input

Prior to the filling in of the input forms for the Load Analysis Program With Shadows, the user should perform the following:

Step 1

Obtain a floor plan of the building under study and divide the floor area into thermal zones sufficient for energy analysis. Generally,

5 zones will handle a one story building (one core zone and four exterior zones). If ceiling return air plenums are to be used, the plenum above each thermal zone should be identified as a zone also. For multistory buildings, floors between the first and top stories can usually be lumped together and broken into 5 zones or one typical floor identified and then use made of the repetition factor. Whenever possible, zones having identical load characteristics should be lumped into one giant zone or the basic zone described only once and use made of space repetition feature. Every effort should be made to minimize the total number of zones for which calculations are required without compromising accuracy of results.

Step 2

Using elevation drawings of building, brake out the surfaces that make up the exterior envelope of each zone identifying wherever possible surfaces that have identical characteristics (i.e., area construction, orientation, tilt, etc.). Interior partitioning walls or floors between zones need only be identified if there will be a significant ΔT across it and an account of that heat transfer is desired.

Step 3

Attach a label to each surface using a prefix and suffix to indicate the type of surface and numberical order respectively. For prefixes use

D = delayed heat transfer surface

Q = quick heat transfer surface

W = window surface

I = internal heat transfer surface

UW = underground wall heat transfer surface

UF = underground floor heat transfer surface

C = common shading surface

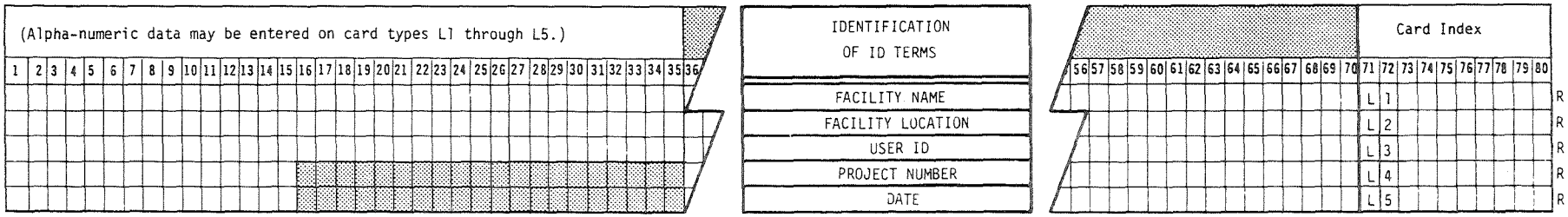
Make use of surface repetition where possible.

Step 4

Begin filling in Load Analysis Program With Shadows input forms following instructions on the forms as well as those contained on the following pages.

CARD TYPE L-1 THROUGH L-5
JOB IDENTIFICATION

JOB IDENTIFICATION



CARD TYPE L-1
- **Facility Name** (Cols.1-35)

  Alphanumeric information identifying the building being studied. Also used for report labeling.

CARD TYPE L-2
- **Facility Location** (Cols.1-35)

  Alphanumeric information identifying the city in which the building is located. Also used for report labeling.

CARD TYPE L-3
- **User Identification** (Cols.1-35)

  Alphanumeric information identifying the name of the user. Also used for report labeling.

CARD TYPE L-4
- **Project Number** (Cols.1-15)

  Alphanumeric information identifying the project member associated with job. Also used for report labeling.

CARD TYPE L-5
- **Date** (Cols.1-15)

  Alphanumeric information identifying date of run. Also used for report labeling.

CARD TYPE L-6
GEOGRAPHIC PARAMETERS

GEOGRAPHIC PARAMETERS

Latitude (DEG)	Longitude (DEG)	Time Zone Number	Clearness Number (summer)	Clearness Number (winter)	Bldg. Azimuth 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 6 R

- Latitude (Degrees) (Cols. 1-10)

  Latitudinal location of the building under study. Used to calculate solar insolation data. For continental U.S., the latitude varies from 25° at southern Flordia to 48° at northern Washington state.

- Longitude (Degrees) (Cols. 11-20)

  Longitudinal location of the building under study. Used to calculate solar insolation data. For continental U.S., the longitude varies from 66° in Maine to 124° in California.

- Time Zone Number (4-8) (Cols. 21-30)

  A coded number ranging from 4 to 8 (see below) indicating which geographic time zone the building is operating in. Used to calculate hour angle of sun.

- Clearness Number (Summer) (Cols. 31-40)

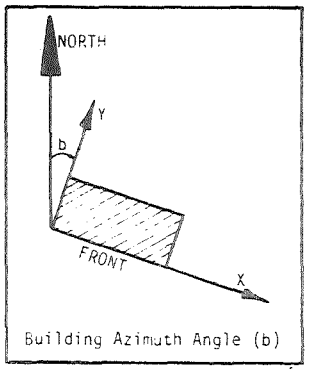
  Atmospheric clearness number or haze factor for geographic location in question. See map below for typical values for non-industrial atmosphere. Used to adjust solar insolation data. Ranges from 0.90 to 1.15.

- Clearness Number (Winter) (Cols. 41-50)

  Same as above except for winter. (November through April). Ranges from 0.85 to 1.05.

- Building Azimuth Angle (Degrees) (Cols. 51-60)

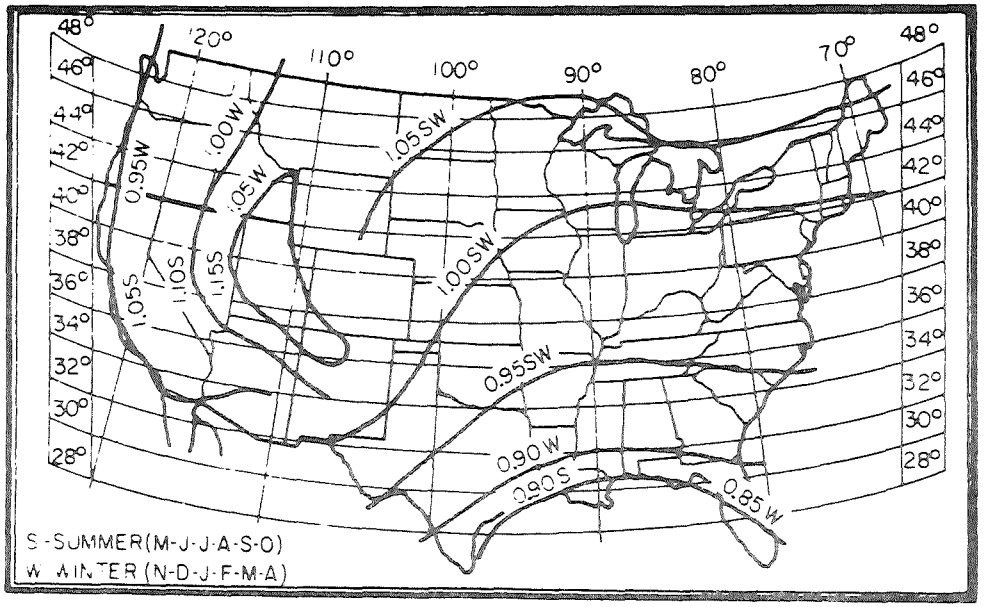
  Orientation of the back of building relative to the points of the compass. Angle can vary from 0° to 360°.



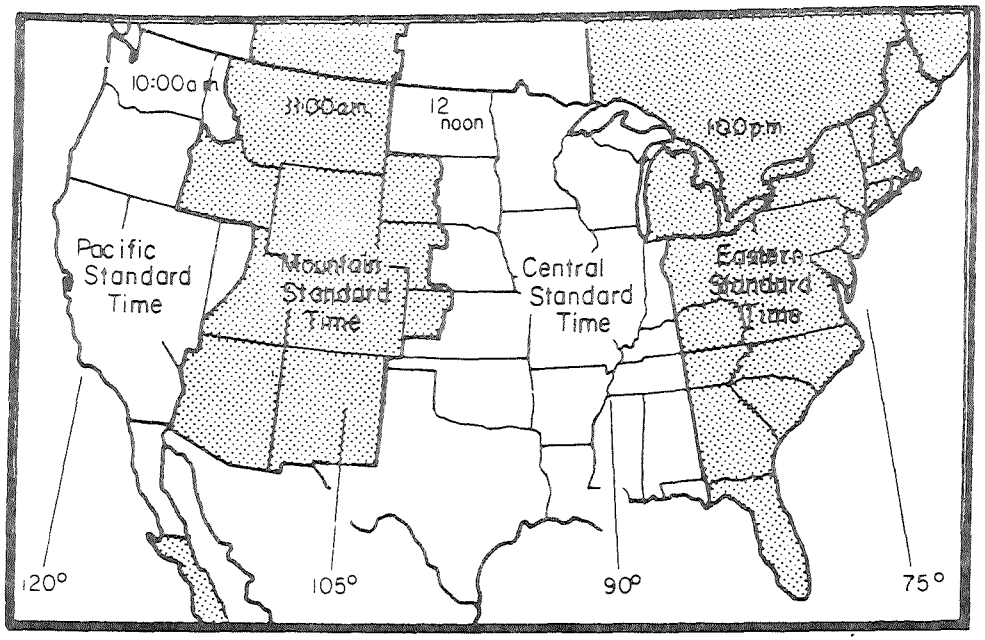
Building Azimuth Angle (b)

EXAMPLE:

Building Front Facing	Azimuth
South	0°
West	90°
North	180°
East	270°



CLEARNESS NUMBERS OF NON-INDUSTRIAL ATMOSPHERE IN UNITED STATES



TIME ZONES IN THE UNITED STATES

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

TIME ZONE NUMBER IN U.S. FOR STANDARD TIME

CARD TYPE L-7
JOB CONTROL PARAMETERS

JOB CONTROL PARAMETERS

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 Supply Temp.-2 (^oF.)	Zone Hot Air Supply Temp.-1 (^oF.)	Zone Hot Air Supply Temp.-2(^oF.)	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 7 R

- Job Processing Code (1-3) (Cols. 1-10)

  User is given the option of design load analysis and/or one year hourly analysis. This is indicated to the program in form of code as follows:

  1.0 = Design load analysis only
  2.0 = Design load analysis and one year hourly analysis desired
  3.0 = One year hourly analysis only

- Ventilation Air Rate (CFM/sq. ft.) (Cols. 11-20)

  Estimated rate at which outside air is introduced into building. Calculated on a zone-by-zone bases to account for each zone's ventilation air load. This ventilation air load is not passed along to other programs. It is used only to size chillers and boilers. It is also a parameter in crack infiltration analysis.

- Estimate Total Fan Pressure (Inches of water) (Cols. 21-30)

  Estimated building total fan pressure and used in conjunction with the calculated building total CFM to account for fan heat. This term does not affect space loads. It is only used to calculate total heating and cooling plant load for equipment sizing.

- Zone Cold Air Supply Temperature -1 (^oF) (Cols. 31-40)

  First choice for zone cold air supply temperature. Zone supply air quantities required to satisfy peak cooling loads will be calculated using this quantity. This term does not affect space loads passed on to other program. Range: 40-70°F.

- Zone Cold Air Supply Temperature -2 (^oF) (Cols. 41-50)

  Second choice for zone cold air supply temperature. Zone supply air quantities required to satisfy peak cooling loads will also be calculated using this quantity. This term does not affect space loads passed on to other programs. Range: 40-70°F.

- Zone Hot Air Supply Temperature -1 (^oF) (Cols. 51-60)

  First choice for zone hot air supply temperature. Zone supply air quantities required to satisfy peak heating loads will be calculated using this quantity. This term does not affect space loads passed on to other programs. Range: 80-200°F.

- Zone Hot Air Supply Temperature -2 (^oF) (Cols. 61-70)

  Second choice for zone hot air supply temperature. Zone supply air quantities required to satisfy peak heating loads will also be calculated using this quantity. This term does not affect space loads passed on to other programs. Range: 80-200°F.

CARD TYPES L-8A, L-8B and L-8C
DESIGN LOAD PARAMETERS

DESIGN LOAD ANALYSIS PARAMETERS (IF CODE = 3, do not include cards type L8A, L8B and L8C.)

Altitude Above Sea Level (FT)	DESIGN MONTHS	In Columns 11-20, enter 1 for each month to be included in Design Load Analysis. If all are left blank, all 10 months will be used.	Card Index
1 2 3 4 5 6 7 8 9 10	M A M J J A S O N D 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 (Enter July/August weather conditions - These are adjusted by program for other cooling months.

Max. D.B Temperature (^{o}F)	Daily D.B Temperature Range (^{o}F)	Dew Point Temperature (^{o}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 (Enter December weather conditions)

Minimum D.B Temperature (^{o}F)	Daily D.B Temperature Range (^{o}F)	Dew Point Temperature (^{o}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

Note: If not performing any design load analysis, skip card types L-8A, L-8B and L-8C.

CARD TYPE L-8A

- Altitude Above Sea Level (Ft) (Cols. 1-10)

  Height of building above sea level. Used to calculate psychrometric properties of outside air.

- Design Months (March-December) (Cols. 11-20,

  The user is given a choice as to which months he wishes to include in the design load analysis. Enter a 1 in column for those months desired. Other months will be ignored. If all columns are left blank, program will default to using all 10 months.

CARD TYPE L-8B

- Summer Maximum Dry-Bulb Temperature (Cols. 1-10)

  July/August Summer design day maximum dry-bulb temperature. Hourly dry-bulb temperatures for a design day in each other month March through November are calculated using this maximum DBT, range, and Carrier outdoor design-temperature correction factors.

- Summer Daily Dry-Bulb Temperature Range (^{o}F) (Cols. 11-20)

  Number of degrees of swing of dry-bulb temperature during the July/August summer design day.

- Summer Dew Point Temperature (^{o}F) (Cols. 1-10)

  July/August Summer design day average dew point temperature. This is assumed to remain constant throughtout the design day.

- Summer Windspeed (MPH) (Cols. 31-40)

  July/August Summer design day windspeed. Used to calculate outside surface film coefficient and infiltration air loads.

CARD TYPE L-8C

- Winter Minimum Dry-Bulb Temperature (Cols 1-10)

  December Winter design day minimum dry-bulb temperature. Hourly dry-bulb temperatures for this design day is calculated using typical diurnal cycle.

- Winter Daily Dry-Bulb Temperature Range (^{o}F) (Cols. 11-20)

  Number of degrees of swing of dry-bulb temperature during the December winter design day.

- Winter Dew Point Temperature (^{o}F) (Cols. 21-30)

  Average dew point temperature for the December winter design day. Assumed to remain constant throughout the design day.

- Winter Windspeed (MPH) (Cols. 31-40)

  Assumed windspeed for the December winter design day. Used to calculate outside surface film coefficient and infiltration air loads.

CARD TYPE L-9
HOURLY ANALYSIS PARAMETERS

HOURLY LOAD ANALYSIS PARAMETERS (IF CODE = 1., do not include card type L9.)

Weather Year	First Month Of Analysis (1-12)	Length of Study (Days; 1-365)	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 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
					1 9

Note: If not performing an hourly analysis skip this card.

- Weather Year (1949-) (Cols. 1-10)

  Calender year for which analysis is to be performed. Must be a year that is available on weather tape. See SCOUT Axcess and Control Guide for available cities and years.

- First Month of Analysis (1-12) (Cols. 11-20)

  Month at which hourly analysis is to begin.

- Length of Study (Days) (Cols. 21-30)

  Number of days for which analysis is to proceed. May be from 1 to 365 days. Program will automatically correct for a leap year.

- Estimated Initial Outside Surface Temperature(°F) (Cols. 31-40)

  Surface temperatures of all exterior surfaces must be initialized. If temperature recorded on weather tape for first hour of analysis is missing, this temperature will be used instead.

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

CARD TYPES L-10 AND L-10A
SCHEDULED PRINTOUTS

SCHEDULED PRINTOUTS (Hourly listing of weather and space load data)

Number of Printouts (0-12) (Cols. 1-10)	(Cols. 11-70)	Card Index (Cols. 71-80)
		L 1 0

R

PRINTOUT NO.	Start Date (Month/Day) (Cols. 1-10)	Stop Date (Month/Day) (Cols. 11-20)	Repeat card L10A as many times as indicated on card L10. Fill in all columns indicated. Enter zeros if necessary. (Cols. 21-70)	Card Index (Cols. 71-80)
1	/	/		L 1 0 A
2	/	/		
3	/	/		
4	/	/		
5	/	/		
6	/	/		
7	/	/		
8	/	/		
9	/	/		
10	/	/		
11	/	/		
12	/	/		

Note:
1. If number of printouts desired is equal to zero, skip card type L-10A.
2. Card type L-10A must be repeated number of times indicated on card type L-10.

CARD TYPE L-10

- Number of Printouts (0-12) (Cols. 1-10)

  Number of different periods for which an hourly listing of weather and calculated space loads are desired.

CARD TYPE L-10A

- Start Date (Month/Day) (Cols. 1-2, 4-5)

  Month and day at which printout is to start. Fill in all columns indicated, use zeros if necessary. No decimal point required. For design load analysis printouts, day must be set equal to "05".

- Stop Date (Month/Day) (Cols. 11-12, 14-15)

  Month and day at which printout is to stop. Fill in all columns indicated, use zeros if necessary. No decimal point required. If only one day's printout is desired, start date and stop date are the same. For design load analysis, day must be set equal to "05".

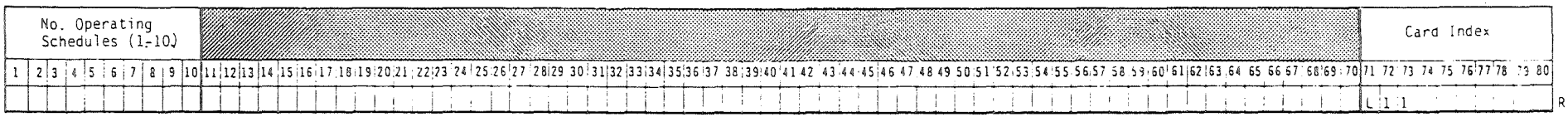
Note:
1. See page 4-65 and 4-66 for type of printout received back.
2. Printouts cost money (CPU time + paper). User is cautioned to estimate number of lines printed using following equation:
   #Lines = (1 + #Spaces)*24* #days printout
3. Example: 10 space bldg. with 1 day printout/month
   #Lines = (1 + 10)*24*12 = 3168

- No. Operating Schedules (1-10) (Cols. 1-10)

  Number of different 24-hour profile operating schedule combinations (Sunday, weekday, Saturday, holiday) to be used for scheduling use of people, lights and equipment.

CARD TYPE L-11
OPERATING SCHEDULES

SCHEDULES

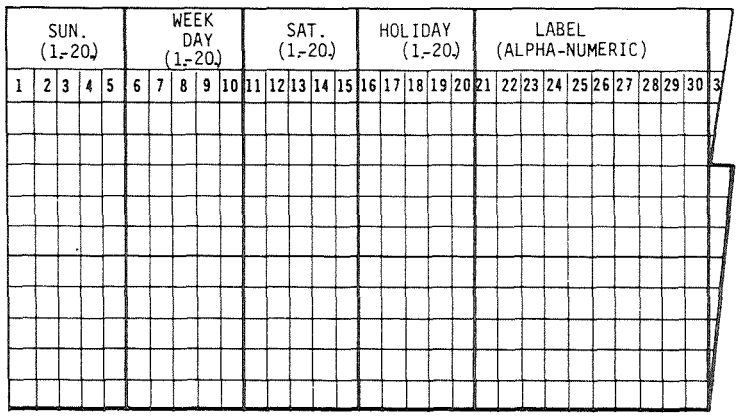


- No. Operating Schedules (1-10) (Cols. 1-10)

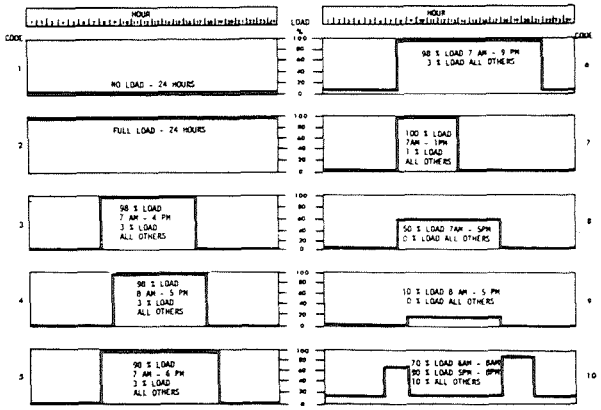
  Number of different 24-hour profile operating schedule combinations (Sunday, weekday, Saturday, holiday) to be used for scheduling use of people, lights and equipment.

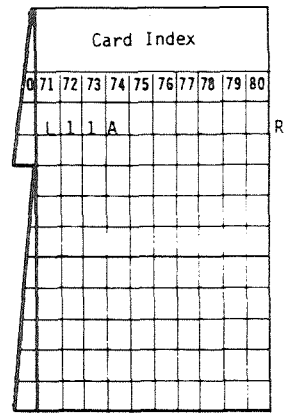
CARD TYPE L-11A
OPERATING SCHEDULE DEFINITION

OPERATING SCHEDULE DEFINITION



STANDARD TWENTY-FOUR HOUR PROFILES





Note: Repeat card type L-11A as many times as indicated in card type L-11.

- Sunday Schedule Code (1-20) (Cols. 1-5)

  Coded number from 1-20 that indicates which 24-hour profile is to be used for Sunday. A coded number from 1-10 indicates that a standard 24-hour profile already stored in program is to be used. See diagram above for definition of these standard profiles. A coded number from 11-20 indicates a non-standard profile to be defined by user will be used. These will be defined using card type L-11B.

- Weekday Schedule Code (1-20) (Cols. 6-10)

  Same remarks as above apply.

- Saturday Schedule Code (1-20) (Cols. 11-15)

  Same remarks as above apply.

- Holiday Schedule Code (1-20) (Cols. 16-20)

  Same remarks as above apply.

- Label (Cols. 21-30)

  Alphanumeric information describing how operating schedule is to be used.

CARD TYPE L-11B
NON-STANDARD TWENTY-FOUR HOUR PROFILES

NON-STANDARD TWENTY-FOUR HOUR PROFILES

CODE 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	12 MID-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 1 B
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

NOTE: CARD L12 NOT REQUIRED

Note: If no non-standard schedules are to be used, skip card type L-11B

1 AM	Cols. 1- 3	Fraction ranging from 0.0 to 1.0 indicating what portion of the 100% operating level exists each hour.
2 AM	4- 6	
3 AM	7- 9	
4 AM	10-12	
5 AM	13-15	
6 AM	16-18	
7 AM	19-21	
8 AM	22-24	
9 AM	25-27	
10 AM	28-30	
11 AM	31-33	
12 Noon	34-36	
1 PM	37-39	
2 PM	40-42	
3 PM	43-45	
4 PM	46-48	
5 PM	49-51	
6 PM	52-54	
7 PM	55-57	
8 PM	58-60	
9 PM	61-63	
10 PM	64-66	
11 PM	67-69	
12 Midnight	70-72	

CARD TYPE L-12
COMMON SHADING

COMMON SHADING SURFACES

NOTE: REPEAT THIS FORM FOR EACH COMMON SHADING SURFACE. CARD L12 REQUIRED ONLY ONCE.

No. Common Shading Surfaces	(shaded)	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	1	2	R

DEFINITION OF COMMON SHADING SURFACES (If there are no common shading surfaces, do not include card type L12A and L12B.)

- Number of Common Shading Surfaces (Cols. 1-10)

  Number of common shading surfaces to be used. A common shading surface is any surface, either part of the building or detached from the building, that shades at some time more than one heat transfer surface to be described later. Examples are adjacent buildings, overhangs, penthouse walls, facing walls of L-shaped buildings, etc.

CARD TYPE L-12A and L-12B
DEFINITION OF COMMON SHADING SURFACES

COMMON SHADING
SURFACE NO._____ LABEL_____

No. Vertices	Transmittance 0. (Opaque) to 1. (Clear)	Label (Alphanumeric)		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 1 2 A

SHORT FORM

LONG FORM

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
							L 1 2 B

(If more L12B cards are required, use an Added Shading Continuation Form.)

Note: Repeat card types L-12A and L-12B as many times as indicated on card type L-12.

CARD TYPE L-12A

- Number of Vertices (Cols. 1-10)

  0. Not allowable
  1. Rectangular surface, short from description
  2. Not allowable
  3. Triangular surface, long form description only
  4. Rectangular surface, long form description
  > 4. Irregular shaped surface, (L-shaped, surfaces with cutouts, etc), long form description only.

- Transmittance (0. -1.0) (Cols. 11-20)

  Fraction of sunlight that can pass through the common shading surface
  0.0 none (opaque)
  1.0 all (clear)
  > 0.0 but < 1.0 fractional amount

- Label (Cols. 21-30)

  Alphanumeric description of the common shading surface

CARD TYPE L-12B (Short Form)

Can be used only when surface is rectangular and no. of vertices is set equal to 1.0 on card type L-12A

- Vertex Coordinate (Feet)-X (Cols. 1-10)

  Lower lefthand vertex X-coordinate value.

- Vertex Coordinate (Feet)-Y (Cols. 11-20)

  Lower lefthand vertex Y-coordinate value

- Vertex Coordinate (Feet)-Z (Cols. 21-30)

  Lower lefthand vertex Z-coordinate value

- Height (Feet) (Cols. 31-40)

  Height (vertical dimension) of surface

- Width (Feet) (Cols. 41-50)

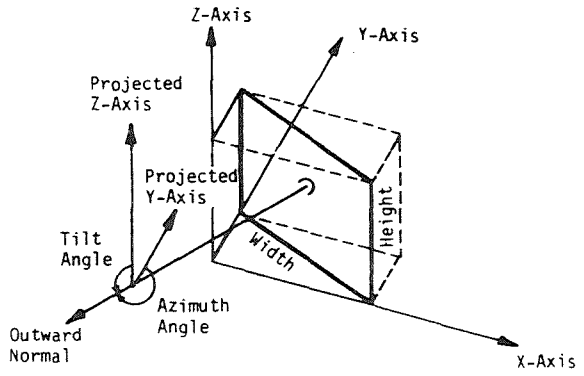
  Width (horizontal dimension) of surface

- Surface Azimuth Angle (Degrees) (Cols. 51-60)

  Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. May vary between 0°-360°.

- Surface Tilt Angle (Degrees) (Cols. 61-70)

  Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0° (Facing sky) to 180° (Facing ground).



Short Form

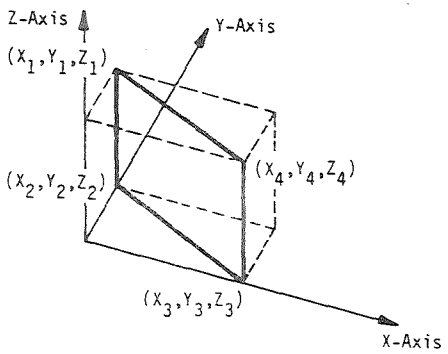
NOTES:

1. All columns apply. (1-70)
2. Number of Vertices equals 1.0.
3. X, Y, Z, coordinates refer to location of rectangular surface when viewed from building exterior.

CARD TYPE L-12B (Long Form)

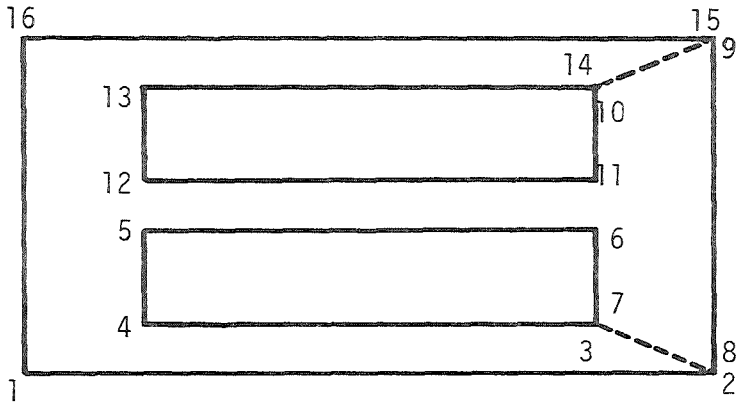
May be used any time the no. of vertices on card type L-12A is 3.0 or greater. Repeat card type L-12B for each surface vertex.

X-Coordinate	(Cols. 1-10)
Y-Coordinate	(Cols. 11-20)
Z-Coordinate	(Cols. 21-30)

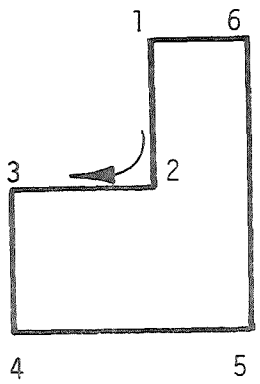


Long Form

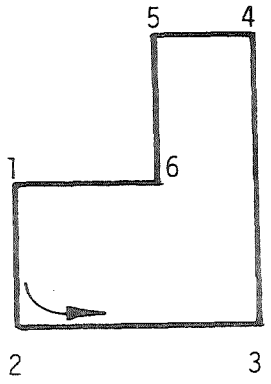
CAUTION: Order vertices such that you always make a lefthand turn when proceeding to vertex 3 from vertex 2.



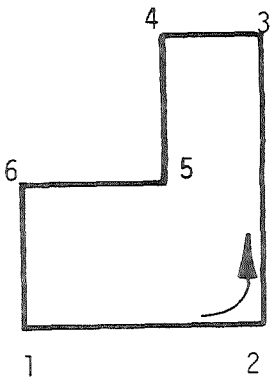
WALL WITH TWO WINDOWS



WRONG



RIGHT



RIGHT

CARD TYPE L-13
RESPONSE FACTOR SURFACES

RESPONSE FACTOR SURFACES

Total No. Of Response Factor Surface Types	No. Of Standard Surface Types To Be Used		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 1 3 R

- Total Number of Response Factor Surface Types (Cols. 1-10)

  Number of different types of response factor surfaces to be used to describe the construction of exterior wall and roof sections.

- Number of Standard Surface Types to be Used (Cols. 11-20)

  Coded into the program are 16 standard surfaces (10 wall types and 6 roof types) which the user can reference simply by using a code from 1 to 16. The quantity specified here indicates how many of these standard surfaces are to be used. Refer to next section which describes card type L-13A for description of standard surfaces.

CARD TYPE L-13A
STANDARD RESPONSE FACTOR SURFACES

STANDARD RESPONSE FACTOR SURFACES
NOTE: REPEAT CARD TYPE L13A NUMBER OF TIMES INDICATED ON CARD TYPE L13, COLUMNS 11-20.

Standard Surface Code (1. - 16.)										Label (Alphanumeric)																
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

CODE	TYPE	LAYER DESCRIPTION
1	Wall	Wood Drop Siding 3/4" Sheating Board 4" Air Space 1/2" Gypsum Board Inside Air
2	Wall	Wood Drop Siding 3/4" Sheating Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
3	Wall	4" Face Brick 1/2" Air Space 3/4" Sheating Board 4" Fiberglass Insulation 1/2" Gypsum Board Inside Air
4	Wall	8" Concrete Block Inside Air
5	Wall	12" Solid Concrete Inside Air
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 Metal
10	Wall	Metal Sliding 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 Sheating Attic Air Space 6" Insulation Gypsum Board Inside Air

Card Index									
71	72	73	74	75	76	77	78	79	80
L	1	3	A						

Note: Card type L-13A must be repeated for each standard surface defined on card type L-13, columns 11-20 .

- Standard Surface Code (1-16) (Cols. 1-10)

  All standard response factor surfaces to be used must be specifically identified here so that the surface response factor data can be loaded into working storage for use by the program. Standard surfaces codes do not have to be called out in sequential order, should be specified only once and must be a number from 1 to 16 in accordance with the type of contruction desired.

- Label (Cols. 11-30)

  Alphanumeric information identifying the surface being described.

CARD TYPE L-13B

NON-STANDARD RESPONSE FACTOR SURFACES

NON-STANDARD RESPONSE FACTOR SURFACES

NOTE: 1. REPEAT CARD SETS L13B THROUGH L13D FOR EACH DIFFERENT NON-STANDARD CONSTRUCTION TYPE.
2. USE RESPONSE FACTOR PROGRAM TO GENERATE CARD TYPES L13C AND L13D.
3. SURFACE CODES 17-25 RESERVED FOR ADDITIONAL STANDARD SURFACES TO BE ADDED LATER.

Non-standard Surface Code (26. and up)	Label (Alphanumeric)		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 1 3 B

Note: Repeat this card along with sets of card types L-13C and L-13D, the number of times indicated on card type L-13 by subtracting (Total Number of Response Factor Surface Types-Number of Standard Response Factor Surface Types).

- Non-Standard Surface Code (26 and up) (Cols. 1-10)

  For each non-standard response factor surface entered, a numbered code 26 or higher must be specified. This code will be used later to identify delayed heat-transfer surface construction (see card type L-14B, Columns 61-70)

- Label (Cols. 11-30)

  Alphanumeric information identifying the surface being described.

CARD TYPE L-13C and L-13D
NON-STANDARD RESPONSE FACTOR SURFACE DESCRIPTION

No. time Response Grps	Common Ratio		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 1 3 C

TIME RESPONSE GROUPS

	X	Y	Z		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
1					L 1 3 D
2					
3					
4					
5					

100 MAX

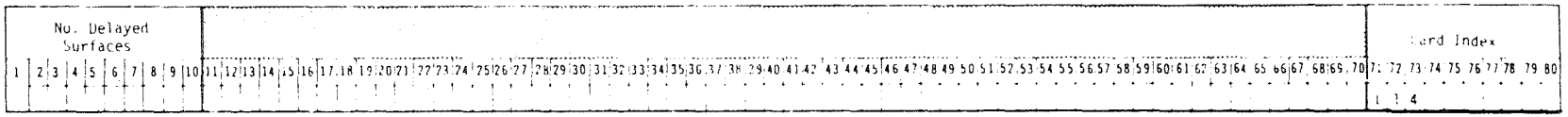
Use the Response Factor Program to generate these data cards and then insert the punched cards into the Load Analysis Program input deck at this point. See section 2 of this manual for further discussion.

EXAMPLE

```
3.0      1.0                                                          L13
3.0      WALL CONSTRUCTION-1                                          L13A
26.0     WALL CONSTRUCTION-2                                          L13B
  5        0.2764726221                                               L13C
        0.9413793355          0.0759544167          0.8566887090     L13D
       -0.7394342626          0.0865389870         -0.4784727683     L13D
       -0.0044131528          0.0241313100         -0.1319499516     L13D
       -0.0012201159          0.0066716189         -0.0364805491     L13D
       -0.0003373286          0.0018445200         -0.0100858731     L13D
27.0     ROOF-1                                                       L13B
  8        0.8508217837                                               L13C
        0.8514929357          0.0013354699          1.3403373103     L13D
       -0.7541613522          0.0100479075         -0.2256730001     L13D
       -0.0009524806          0.0117530147         -0.1537586384     L13D
       -0.0007922742          0.0101304076         -0.1297921446     L13D
       -0.0006735845          0.0086231001         -0.1103990864     L13D
       -0.0005730854          0.0073368394         -0.0939290199     L13D
       -0.0004875931          0.0062423463         -0.0799168284     L13D
       -0.0004148548          0.0053111243         -0.0679949776     L13D
```

CARD TYPE L-14
DELAYED HEAT TRANSFER SURFACES

DELAYED HEAT TRANSFER SURFACES



- No. Delayed Surfaces . (Cols. 1-10)

  This is the total number of distinct delayed heat transfer surfaces that will be used to help describe the building shell. Since computer running time is proportional to this quantity, the user should attempt to minimize the number of delayed surfaces by

  1) making use of repetitive wall or roof features, i.e., identify delayed heat transfer segments that have identical characteristics (surface area, construction, orientation, tilt, interior space temperature, etc.), define it to the computer only once so that heat transfer calculations are done only once each hour, then reuse the results as many times as necessary to build up a space.

  2. defining the delayed surfaces areas small enough such that all other delayed surfaces of the same exposure can be represented as multiples of this reference surface.

NOTE: Repeat card type L-14A for each delayed heat transfer surface to be described.

CARD TYPE L-14A
DELAYED SURFACE DESCRIPTION

DELAYED SURFACES
NOTE: REPEAT THIS INPUT FORM FOR EACH DELAYED SURFACE.

DELAYED
SURFACE No. _____ LABEL _____

Surface Exterior Absorptivity	Ground Reflectivity Facing Surface	Infiltration Flow Coefficient	Label (Alphanumberic)		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 1 4 A

- Surface Exterior Absorptivity (0.0 to 1.0) (Cols. 1-10)

  Indicates the surface ability to absorb incident solar radiation. This property is mainly a function of the surface color and texture. See table below for typical values.

- Ground Reflectivity Facing Surface (0.0 to 1.0) (Cols. 11-20)

  Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. See table below for typical values.

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

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

- Infiltration Flow Coefficient (Cols. 21-30)

A function of surface construction, this allows an estimate to be made of amount of infiltration that enters the building through a surface. This quantity should only be specified if crack infiltration analysis is to be specified on Card Type L-21E. See table below for typical values of infiltration flow coefficient for delayed surfaces.

DELAYED SURFACE
SUGGESTED INFILTRATION FLOW COEFFICIENTS (C)

DESCRIPTION		C
1. 13" brick with plastered surface (.01 cfh/sq.ft.)		.004
2. 13" brick, furring, lath & plaster	(0.09)	.025
3. Frame wall, lath, & plaster	(0.05)	.016
4. 4" brick-6" concrete block-painted	(0.11)	.034
5. 8" cement block-painted both sides	(0.32)	.095
6. 8" brick - plain-poor workmanship	(3.2)	.949
7. 16" shingles on shiplap w/building paper	(0.71)	.211
8. 16" shingles on shiplap	(5.3)	1.582
9. 16" shingles on 1x4 boards on 5" CT	(23.0)	1.856

Values in ( ) are infiltration values at 7½ mph wind normal to the surface. Data from 1972 ASHRAE handbook of fundamentals, pg.339. SCOUT uses the basic equation $Q = C*A*\Delta P^N$.

Q is Air Flow Rate, cfm
C is Flow Coefficient, per unit area of wall surface
A is Flow Opening Area, sq. ft.
N is Pressure exponent; is set at 0.8 for delayed surfaces
ΔP is Pressure Difference, in. water

- Label (Cols. 31-50)

Alphanumeric description of surface.

CARD TYPE L-14B
DELAYED SURFACE DESCRIPTION

No. Vertices in Surfaces	No.Divisions Along Width Dimension For Shade Analysis	No.Division Along Height Dimension For Shade Analysis	No.Common Shading Surfaces Excluded	No. Shading Surfaces Added to Surface	Surface Roughness Index (See Form 07)	Response Factor Surface 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 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 1 4 B

- No. Vertices in Surface (Cols. 1-10)

  0. Not allowable
  1. Rectangular surface, short form description
  2. Not allowable
  3. Triangular surface, long form description only
  4. Rectangular surface, long form description
  >4. Irregular shaped surface (L-shaped, surfaces with cutouts, etc.), long form description only

  See further discussion under card type L-12A and L-12B.

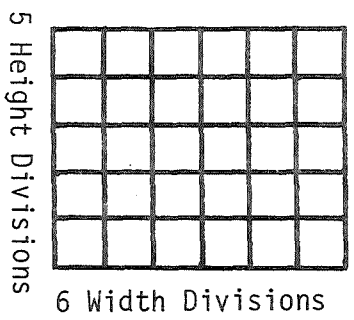
- No. Divisions Along Width Dimension For Shade Analysis (Cols. 11-20)

  If the surface being described here is shaded by a common shading surface described previously or by an added shading surface to be described on card types L-14E and L-14F, the user must indicate here how fine a grid the surface should be divided into along its width dimension. Program running time is a function of how fine a grid is used, the finer the grid the more the computer time required. If surface never experiences any shading, enter 1.0 .

- No. Divisions Along Height Dimension for Shade Analysis (Cols. 21-30)

  If surface being described here is shaded by a common shading surface described previously or by an added shading surface to be described on card types L-14E and L-14F, the user must indicate here how fine a grid the surface should be divided into along its height dimension. Program running time is a function of how fine a grid is used, the finer the grid the more the computer time required. If surface never experiences any shading, enter 1.0 .

EXAMPLE



Surface shaded by some other surface.

During the first day of each month and for each hour of that day, a shade analysis is done for each surface specified by user. The computer breaks the surface into the grid size specified, interrogates the midpoint of each grid square to determine if its shaded or not shaded, and then determines the fraction of the surface which is shaded by dividing the number of grid squares shaded by the total number of grid squares. These surface shade factors are then used for the remainder of the month. If user desires, a picture of the surface indicating shaded area can be printed for visual examination (see card type L-14G and L-14H).

- No. Common Shading Surfaces Excluded (Cols. 31-40)

  Due to location of common shading surfaces with respect to the delayed surface being described here, some of the common shading surfaces will probably never cast shadows on the delayed surface. To save the computer the effort of doing needless calculations, the user can lockout those common shading surfaces not required. The user indicates here how many are to be locked out or excluded and then defines exactly which ones by using card type L-14D.

- No. of Shading Surface Added to Surface (Cols. 41-50)

  The delayed heat transfer surface being described in this section of input data may have side fins, columns or overhangs that shade only this one delayed surface. These shade surfaces are referred to as shading surfaces added to the delayed surface. The user indicates here how many there are being added, and on card type L-14E and L-14F describes the geometric data. If no added shading surfaces are being considered, leave this field blank or enter 0.0.

- Surface Roughness Index (1-6) (Cols. 51-60)

  User indicates the exterior roughness of the surface by using a code which varies from 1.0 (rough) to 6.0 (smooth). See table below for typical values. Program uses this information along with wind velocity data to calculate the outside film coefficient each hour.

CODE FOR EXTERIOR SURFACE FINISH

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

INCREASING SMOOTHNESS

- Response Factor Surface Code (Cols. 61-70)

  The code entered here should correspond to one of the response factor surfaces codes described previously on card types L-13A or L-13B.

CARD TYPE L-14C

DELAYED SURFACE GEOMETRY

DELAYED SURFACE GEOMETRY
(May be long form or short form. See notes at the bottom of Input Form LA/S-04. If surface shading is not considered, use short form and leave X, Y, Z coordinates blank. Program will then automatically locate surface at origin with proper tilt and azimuth angles.)

VERTICE COORDINATES (FEET)			Height (FEET)	Width (FEET)	Azimuth Angle (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
							L 1 4 C

A delayed surface can be described geometrically using either a long form or short form method. All comments made under card type L-12B apply here also.

CARD TYPE L-14D

COMMON SHADING SURFACES EXCLUDED

COMMON SHADING SURFACES EXCLUDED (If all or none are excluded, skip card type L14D.)

Indices of Common Shading Surfaces Excluded (Index is defined by order of appearance on Input Form LA/S-04.)	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 1 4 D

NOTE: If all or none of the common shading surfaces are excluded or if building has no common shading surface, skip this card.

- Indices of Common Shading Surfaces Excluded

  User should call out the index of each common shading surface that is to be excluded. Index is defined by the order in which common shading surfaces were defined. Space has been allotted for 14 exclusions (7 per card). If more are required use as many of card type L-14D as necessary.

CARD TYPE L-14E and L-14F

ADDED SHADING SURFACES

ADDED SHADING SURFACES (If there are no added shading surfaces, skip card types L14E and F. Card type L14F may be long form or short form.)

No. Vertices	Transmittance 0. (Opaque) to 1. (Clear)	Label (Alphanumeric)		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 1 4 E

VERTICE COORDINATES (FEET)			Height (FEET)	Width (FEET)	Azimuth Angle (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
							L 1 4 F

(If additional card types L14E and F are required, use ADDED SHADING CONTINUATION FORM)

NOTE: 1. If number of added shading surfaces = 0 (refer to card type L-14B, columns 41-50), skip these cards.
2. If number of added shading surfaces is greater than 0.0, then repeat card types L-14E and L-14F for each added surface.

All comments contained under card types L-12A and L-12B apply here also.

CARD TYPE L-14G

DELAYED SURFACE PICTURES

DELAYED SURFACE PICTURES

No. Delayed Surface Pictures																																																																							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	1	4	G						

- No. Delayed Surface Pictures (Cols. 1-10)

  If user desires to have a shadow picture printed so that a visual inspection can be made of what the program has determined for any hour, indicate here the total number of delayed surface pictures that are desired. If none are desired, or if shade analysis is being omitted, enter 0.0.

CARD TYPE L-14H

DELAYED SURFACE PICTURE DEFINITION

DELAYED SURFACE PICTURE DEFINITION (If no delayed surface pictures are required, skip card type L14H.)

Month (1-12)	Hour of Day (1-24)	Delayed Surface 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	71 72 73 74 75 76 77 78 79 80
			L 1 4 H

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	

NOTE: Repeat this card for each picture specified above.

- Month (1-12) (Cols. 1-10)
- Hour of Day (1-24) (Cols. 11-20)

If times are specified during which either
1) sun has not risen, or
2) sun has risen but has not moved forward of the surface plane.

the program will automatically bypass the shadow calculations, set shade factor equal to 1.0, and no shadow picture printed.

- Delayed Surface Index (Cols. 21-30)

Surface index corresponds to order in which delayed surfaces were defined.

CARD TYPE L-15
QUICK HEAT TRANSFER SURFACES

QUICK HEAT TRANSFER SURFACES

No. Quick Surfaces		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 1 5

- <u>No. Quick Surfaces</u> (Cols. 1-10)

  This is the total number of distinct quick heat transfer surfaces that will be used to help describe the building shell. These are surfaces such as doors, metal sections, etc. that have small heat storage capacities and can be treated as steady state heat transfer surfaces. The same procedures that were explained for minimizing delayed surface input data also apply here, i.e., making use of repetative features.

NOTE: Repeat card types L-15A through L-15F for each quick heat transfer surface to be described.

CARD TYPE L-15A
QUICK SURFACE DESCRIPTION

QUICK SURFACES
NOTE: REPEAT THIS INPUT FORM FOR EACH QUICK SURFACE.

QUICK
SURFACE No._____ LABEL _____

Surface Exterior Absorptivity	Ground Reflectivity Facing Surface	Heat Transfer Coefficient (BTU/HR.F.FT^2)	Infiltration Flow Coefficient	Label (Alphanumeric)		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 1 5 A

- Surface Exterior Absorptivity (0.0 to 1.0) (Cols. 1-10)

  Indicates the surface ability to absorb incident solar radiation. This property is mainly a function of the surface color and texture. See table below for typical values.

- Ground Reflectivity Facing Surface (0.0 to 1.0) (Cols. 11-20)

  Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. See table below for typical values.

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

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

- Heat Transfer Coefficient (BTU/Hr - Sq. Ft. - ^{o}F) (Cols. 21-30)

  Overall heat transfer coefficient (U-FACTOR) excluding exterior air film.

- Infiltration Flow Coefficient (Cols. 31-40)

A function of surface construction, this allows an estimate to be made of amount of infiltration that enters the building through or around a surface. This quantity should only be specified if crack infiltration analysis is to be specified on card type L-21E. See table below for typical values of infiltration flow coefficient for quick surfaces.

QUICK SURFACE
SUGGESTED INFILTRATION FLOW COEFFICIENT (C)

DESCRIPTION		C
1. 1/8" crack	(6.5 cfm/lf)	40.0
1/4" crack	(13.1)	80.0
1/2" crack	(26.2)	120.0
2. Door - Residential (3x7) type		
closed w/WS	(20 cfm/unit)	6.1
average use without WS	(100)	30.5
average use with WS	(80)	24.4
3. Door - Office (3.5x7) type		
closed	(25)	7.3
open 10% of time	(50)	14.6
open 25% of time	(310)	90.2
open 50% of time	(1250)	362.8
open 10% of time and vestibule	(35)	10.2
4. Door - Revolving type		
average use	(100)	30.5
5. Garage or Shipping Room Door		
No use	(120)	12.2
Average use	(450)	27.4

Values in ( ) are infiltration values at 7½ mph wind normal to the surface. Data from 1972 ASHRAE Handbook of Fundamentals, pg. 340 and Carrier Design Handbook, pg. 1-91. SCOUT uses the basic equation $Q = C * P * \Delta P^N$.

Q is Air Flow Rate
C is Flow Coefficient, per lineal foot of perimeter
P is Surface perimeter
N is Pressure Exponent, is set at 0.5 for Quick Surfaces
ΔP is pressure difference, in. water

- Label (Cols. 41-50)

Alphanumeric description of surface.

CARD TYPE L-15B
QUICK SURFACE DESCRIPTION

No. Vertices In Surfaces	No. Divisions Along Width Dimension For Shade Analysis	No. Divisions Along Height Dimension For Shade Analysis	No. Common Shading Surfaces Excluded	No. Shading Surfaces Added To Surface	Surface Roughness Index (see Form 07)		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 1 5 B

(Heat transfer coefficient should not include exterior air film.)

- No. Vertices in Surface (Cols. 1-10)

  0. Not allowable
  1. Rectangular surface, short form description
  2. Not allowable
  3. Triangular surface, long form description only
  4. Rectangular surface, long form description
  >4. Irregular shaped surface (L-shaped, surfaces with cutouts, etc.), long form description only

  See further discussion under card type L-12A and L-12B.

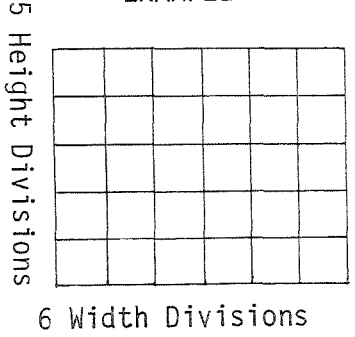
- No. Divisions Along Width Dimension for Shade Analysis (Cols. 11-20)

  If the surface being described here is shaded by a common shading surface described previously or by an added shading surface to be described on card types L-15E and L-15F, the user must indicate here how fine a grid the surface should be divided into along its width dimension. Program running time is a function of how fine a grid is used, the finer the grid the more the computer time required. If surface never experiences any shading, enter 1.0 .

- No. Divisions Along Height Dimension for Shade Analysis (Cols. 21-30)

  If surface being described here is shaded by a common shading surface described previously or by an added shading surface to be described on card types L-15E and L-15F the user must indicate here how fine a grid the surface should be divided into along its height dimension. Program running time is a function of how fine a grid is used, the finer the grid the more the computer time required. If surface never experiences any shading, enter 1.0 .

EXAMPLE



Surface shaded by some other surface.

During this first day of each month and for each hour of that day, a shade analysis is done for

each surface specified by user. The computer breaks the surface into the grid size specified, interrogates the midpoint of each grid square to determine if its shaded or not shaded, and then determines the fraction of the surface which is shaded by dividing the number of grid squares shaded by the total number of grid squares. These surface shade factors are then used for the remainder of the month. If user desires, a picture of the surface indicating shaded area can be printed for visual examination (see card type L-15G and L-15H).

- No. Common Shading Surfaces Excluded (Cols. 31-40)

  Due to location of common shading surfaces with respect to the quick surface being described here, some of the common shading surfaces will probably never cast shadows on the quick surface. To save the computer the effort of doing needless calculations, the user can lockout those common shading surfaces not required. The user indicates here how many are to be locked out or excluded and then defines exactly which ones by using card type L-15D.

- No. of Shading Surfaces Added to Surface (Cols. 41-50)

  The quick heat transfer surface being described in this section of input data may have side fins, columns or overhangs that shade only this one quick surface. These shade surfaces are referred to as shading surfaces added to the quick surface. The user indicates here how many there are being added, and on card types L-15E and L-15F describes the geometric data. If no added shading surfaces are being considered, leave this field blank or enter 0.0.

- Surface Roughness Index (1-6) (Cols. 51-60)

  User indicates the exterior roughness of the surface by using a code which varies from 1.0 (rough) to 6.0 (smooth). See table below for typical values. Program uses this information along with wind velocity data to calculate the outside film coefficient each hour.

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

INCREASING SMOOTHNESS

CARD TYPE L-15C

QUICK SURFACE GEOMETRY

QUICK SURFACE GEOMETRY

(May be long or short form. See notes at bottom of input form LA/S-04. If surface shading is not considered, use short form and leave X,Y,Z coordinate blank. Program will then automatically locate surface at origin with proper tilt and azimuth angles.)

VERTICE COORDINATES (FEET)			Height (FEET)	Width (FEET)	Azimuth Angle (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
							L 1 5 C

A quick surface can be described geometrically using either a long form or short form method. All comments made under card type L-12B apply here also.

COMMON SHADING SURFACES EXCLUDED

COMMON SHADING SURFACES EXCLUDED (If none or all excluded, skip card type L15D.)

Indices of Common Shading Surfaces Excluded (Index is defined by order of appearance on input form LA/S-04.)	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 1 5 D

NOTE: If all or none of the common shading surfaces are being excluded or if building has no common shading surfaces, skip this card.

- Indices of Common Shading Surfaces Excluded

  User should call out the index of each common shading surface that is to be excluded. Index is defined by the order in which common shading surfaces were defined. Space has been allotted for 14 exclusions (7 per card). If more are required use as many of card type L-15D as necessary.

CARD TYPE L15-E and L-15F

ADDED SHADING SURFACES

ADDED SHADING SURFACES (If there are no added shading surfaces, skip card types L15E and L15F. Card type L15F may be long or short form.)

No. Vertices	Transmittance 0. (Opaque) to 1. (Clear)	Label (Alphanumeric)		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 1 5 E

VERTICE COORDINATES (FEET)			Height (FEET)	Width (FEET)	Azimuth Angle (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
							L 1 5 F

(If additional card types L14E and F are required, use ADDED SHADING CONTINUATION FORM.)

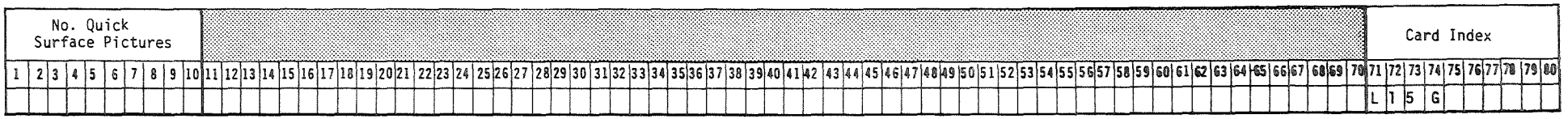
NOTE: 1. If number of added shading surfaces = 0 (refer to card type L-15B, columns 41-50), skip these cards.

2. If number of added shading surfaces is greater than 0.0, then repeat card types L-15E and L-15F for each added surface.

All comments contained under card types L-12A and L-12B apply here also.

CARD TYPE L-15G
QUICK SURFACE PICTURES

QUICK SURFACE PICTURES



- No. Quick Surface Pictures (Cols. 1-10)

  If user desires to have a shadow picture printed so that a visual inspection can be made of what the program has determined for any hour, indicate here the total number of quick surface pictures that are desired. If none are desired, or if shade analysis is being omitted, enter 0.0.

CARD TYPE L-15H
QUICK SURFACE PICTURE DEFINITION

QUICK SURFACE PICTURE DEFINITION (If no quick surface pictures are required, skip card type L15H.)

Month (1-12)	Hour of Day (1-24)	Quick Surface 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 1 5 H

NOTE: Repeat this card for each picture specified above.

- Month (1-12) (Cols. 1-10)
- Hour of Day (1-24) (Cols. 11-20)

  If times are specified during which either
  1) sun has not risen, or
  2) sun has risen but has not moved forward of the surface plane,

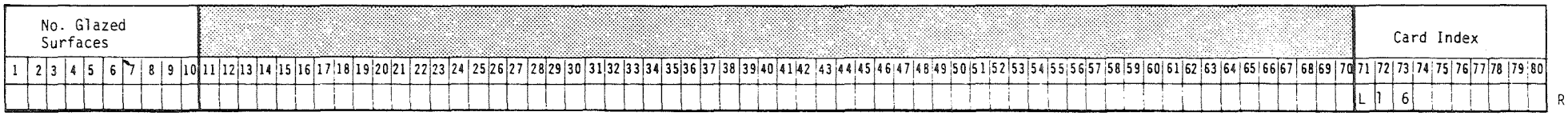
  the program will automatically bypass the shadow calculations, set shade factor equal to 1.0, and no shadow picture printed.

- Quick Surface Index (Cols. 21-30)

  Surface index corresponds to order in which quick surfaces were defined.

CARD TYPE L-16
GLAZED HEAT TRANSFER SURFACES

GLAZED HEAT TRANSFER SURFACES



- No. Glazed Surfaces (Cols. 1-10)

  This is the total number of distinct glazed heat transfer surfaces that will be used to help describe the building shell. The same procedures that were explained for minimizing delayed surface input data also apply here, i.e., making use of repetative features.

  NOTE: Repeat card types L-16A through L-16F for each glazed heat transfer to be described.

CARD TYPE L-16A
GLAZED SURFACE DESCRIPTION

GLAZED SURFACES

GLAZED SURFACE NO. _____ LABEL _____

NOTE: REPEAT THIS INPUT FORM FOR EACH GLAZED SURFACE

ASHRAE Shading Coefficient	Window/sky Form Factor	Window/Ground Form Factor	Ground Reflectivity	Setback (INCHES)	Border (INCHES)	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 1 6 A

- Shading Coefficient

(0.0 to 1.0) (Cols. 1-10)

The shading coefficient, a rather simple term in concept, has been the subject of considerable misinterpretation. The ASHRAE 1972 Handbook of Fundamentals defines a shading coefficient (SC) as the ratio of the heat gain through a glazing system under a specific set of conditions to the solar heat gain through a single light of double-strength sheet glass under the same set of conditions, i.e.,

$$SC = \frac{\text{Solar heat gain of specific glazing system}}{\text{Solar heat gain of double-strength glass}}$$

Therefore, the heat gain of a specific glazing system (e.g. heat absorbing glass with venetian blinds) may be calculated as follows:

$$\text{Solar heat gain for specific glazing system} = \text{Solar heat gain for double strength glass} * SC$$

The calculation of window solar load in SCOUT is a 2-step process:

1) Transmission and absorption factor for direct and diffuse radiation are determined each hour as a function of angle of sun incidence and type of glass.

2) Transmission and absorption factors are modified by multiplying the factors determined in step 1 by the shade coefficient.

This procedure allows the user to describe glass data to the program in several ways as indicated below.

GLASS + SHADING DEVICE

METHOD	DESCRIPTION	ALLOWABLE GLASS CODE	ALLOWABLE SHADE COEFFICIENT	REMARKS
3	Use cataloged properties plus shading coefficient for shade device	1-8	Greater than 0	Shading coefficient for shading device alone
4	Use clear glass plus shading coefficient for glass and shade device	1	Greater than 0	ASHRAE data in tables 15, 16, 17 & 19 of 1972 Handbook of fundamentals (ch.22) must be adjusted to exclude effect of transmission and absorption of standard glass before using. Numbers from those Tables may not be used directly

The shading coefficient of double-strength glass is, by definition, equal to unity (1.0). Shading coefficient (SC) for various glass types given in Table 12 (p 400) of the ASHRAE Handbook of Fundamentals are in accord with the above equation. "Shading Coefficients" given in Tables 15, 16, 17 and 19 for windows and coverings (venetian blinds, roller shades, sunscreens and draperies) are NOT

GLASS ONLY (NO SHADING DEVICE)

METHOD	DESCRIPTION	ALLOWABLE GLASS CODE	ALLOWABLE SHADE COEFFICIENT	REMARKS
1	Use cataloged glass properties	1-8	Blank or 1	Shading Coefficient By-passed
2	Use clear glass properties + shade coefficient	1	Greater than 0 but less than 1	Follows ASHRAE definition of S.C. See Table 12 of 1972 Handbook of fundamentals

in accord with the above equation. The term defined in these tables represent the fraction of incident radiation striking the glass and which makes its way through the glass and window covering and enters the room. In using these tables to derive shading coefficients for use by SCOUT, the effects of the shading device alone must be extracted by the user. The information in the GUIDE was based on calorimeter tests of shading devices on standard glass. Test data with other glass types is not generally available.

- Window/Sky Form Factor (0.0 to 1.0) (Cols. 11-20)

  This area factor indicates what portion of the total diffuse radiation entering the glazed system is from the sky. Mainly a function of the surface tilt angle, typically the window/sky form factor takes on values as follows:

TILT ANGLE	POSITION	W/S FACTOR
0°	Parallel and Facing Sky	1.0
90°	At Right Angles to Sky and Ground	0.5
180°	Parallel and Facing Ground	0.0

- Window/Ground Form Factor (0.0 to 1.0) (Cols. 21-30)

  This area factor indicates what portion of the total diffuse radiation entering the glazed system is from the ground. Mainly a function of the surface tilt angle, typically the window/ground form factor takes on values as follows:

TILT ANGLE	POSITION	W/G FACTOR
0°	Parallel and Facing Sky	0.0
90°	At Right Angles to Sky and Ground	0.5
180°	Parallel and Facing Ground	1.0

- Ground Reflectivity Facing Surface (0.0 to 1.0) (Cols. 31-40)

  Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. See table below for typical values.

REFLECTANCE OF GROUND SURFACES
FOR VISIBLE RADIATION

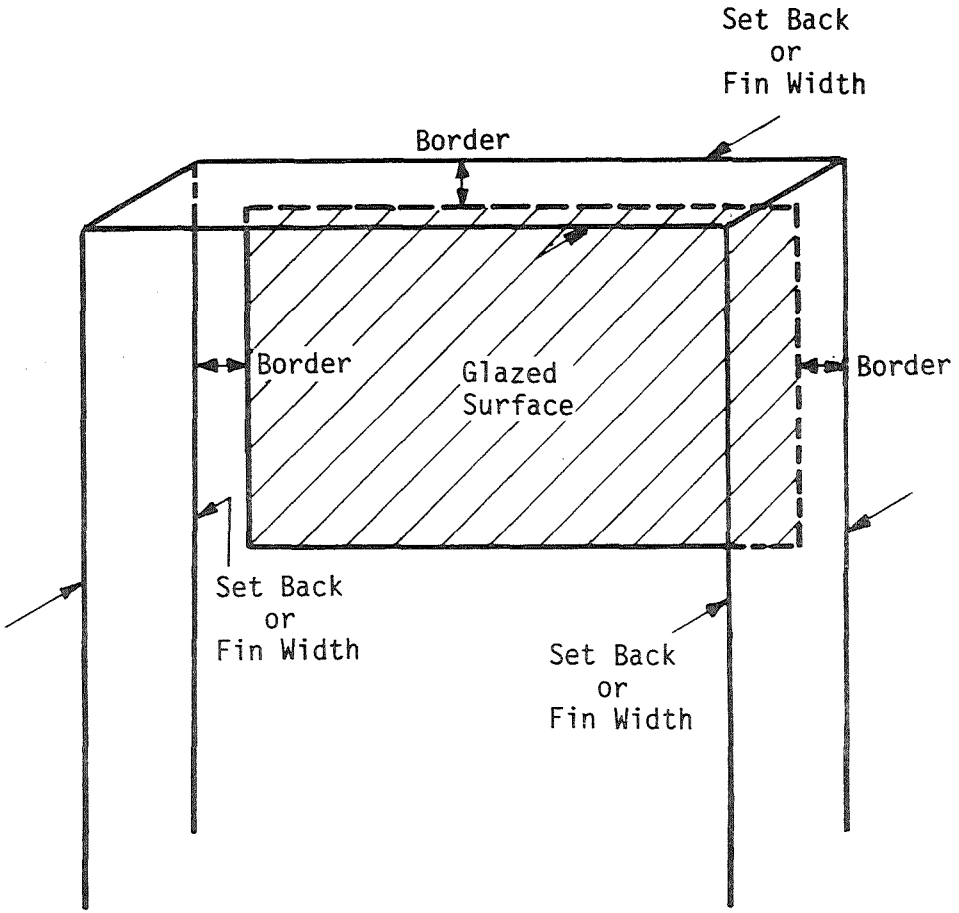
SURFACE	REFLECTANCE
Ocean	0.05
Bituminous Concrete	0.07
Wheat Field	0.07
Dark Soil	0.08
Green Field	0.12-0.25
Grass, Dry	0.20
Crushed Rock Surface	0.20
Concrete, Old	0.24
Concrete, Light Colored	0.30

- Setback (inches) (Cols. 41-50)

  For applications where glazed surfaces are setback into a wall or have fins around the top and sides, the user can use this parameter to allow the program to automatically generate 3 added shading surfaces. These added shading surfaces are given indices 1, 2 and 3. Additional added shading surfaces described with card types L-16E and L16F would be given indices of 4, 5, etc. See sketch below for details. The setback feature may be used only with "Short form" window geometry description.

- Border (inches) (Cols. 51-60)

  If shade fins described using "setback" parameter above, are not set at the edge of the glazed surface but are setback some distance from the edge, this parameter specifies how far the fins are to be moved away and up from glazed surface boundaries. See sketch below for details. The border feature may be used only with "Short form" window geometry description.



- Infiltration Flow Coefficient (Cols. 61-70)

  A function of surface construction, this allows an estimate to be made of amount of infiltration that enters the building through or around a surface. This quantity should only be specified if crack infiltration analysis is to be specified on card type L-21E. See table below for typical values of infiltration flow coefficient for glazed surfaces.

GLAZED SURFACE
SUGGESTED INFILTRATION FLOW COEFFICIENTS (C)

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

Values in ( ) are infiltration values at 7-1/2 mph wind normal to the surface.
Data from Carrier Design Handbook, pg.1-95 and 1-96.
SCOUT uses the basic equation $Q=C*P*\Delta P^{N}$.

Q is Air Flow Rate, cfm
C is Flow Coefficient, per lineal foot of perimeter
P is Surface Perimeter, ft
N is Pressure Exponent; is set at 0.66 for Glazed Surfaces
ΔP is Pressure Difference, in water

CARD TYPE L-16B
GLAZED SURFACE DESCRIPTION

No. Vertices In surface	No. Divisions Along Width Dimension For Shade Analysis	No. Divisions Along Height Dimension For Shade Analysis	No. Common Shading Surfaces Excluded	No. Shading Surfaces Added to surface	No. Panes of Glass (1.-2.)	Window type Index (See Form 11)	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 1 6 B

- No. Vertices in Surface (Cols. 1-10)

  0. Not allowable
  1. Rectangular surface, short form description
  2. Not allowable
  3. Triangular surface, long form description only
  4. Rectangular surface, long form description
  >4. Irregular shaped surface (L-shaped, surfaces with cutouts, etc.), long form description only

  See further discussion under card type L-12A and L-12B.

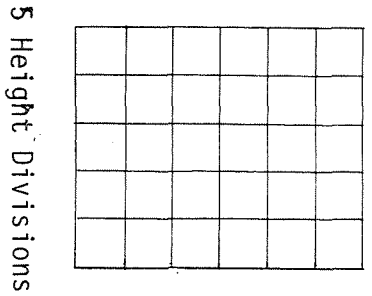
- No. Divisions Along Width Dimension For Shade Analysis (Cols. 11-20)

  If the surface being described here is shaded by a common shading surface described previously or by an added shading surface to be described on card types L-16E and L-16F, the user must indicate here how fine a grid the surface should be divided into along its width dimension. Program running time is a function of how fine a grid is used, the finer the grid the more the computer time required. If surface never experiences any shading, enter 1.0 .

- No. Divisions Along Height Dimension For Shade Analysis (Cols. 21-30)

  If surface being described here is shaded by a common shading surface described previously or by an added shading surface to be described on card types L-16E and L-16F, the user must indicate here how fine a grid the surface should be divided into along its height dimension. Program running time is a function of how fine a grid is used, the finer the grid the more the computer time required. If surface never experiences any shading, enter 1.0 .

EXAMPLE



During the first day of each month and for each hour of that day, a shade analysis is done for

each surface specified by user. The computer breaks the surface into the grid size specified, interrogates the midpoint of each grid square to determine if its shaded or not shaded, and then determines the fraction of the surface which is shaded by dividing the number of grid squares shaded by the total number of grid squares. These surface shade factors are then used for the remainder of the month. If user desires, a picture of the surface indicating shaded area can be printed for visual examination (see card type L-16G and L-16H).

- No. Common Shading Surfaces Excluded (Cols. 31-40)

  Due to location of common shading surfaces with respect to the glazed surface being described here, some of the common shading surfaces will probably never cast shadows on the glazed surface. To save the computer the effort of doing needless calculations, the user can lockout those common shading surfaces not required. The user indicates here how many are to be locked out or excluded and then defines exactly which ones by using card type L-16D

- No. of Shading Surfaces Added to Surface (Cols. 41-50)

  The glazed heat transfer surface being described in this section of input data may have side fins, columns or overhangs that shade only this one glazed surface. These shade surfaces are referred to as shading surfaces added to the glazed surface. The user indicates here how many there are being added, and on card types L-16E and L-16F describes the geometric data. If no added shading surfaces are being considered, leave this field blank or enter 0.0.

- Number of Panes of Glass (1. or 2.) (Cols. 51-60)

  How many panes of glass does the glazed surface have?

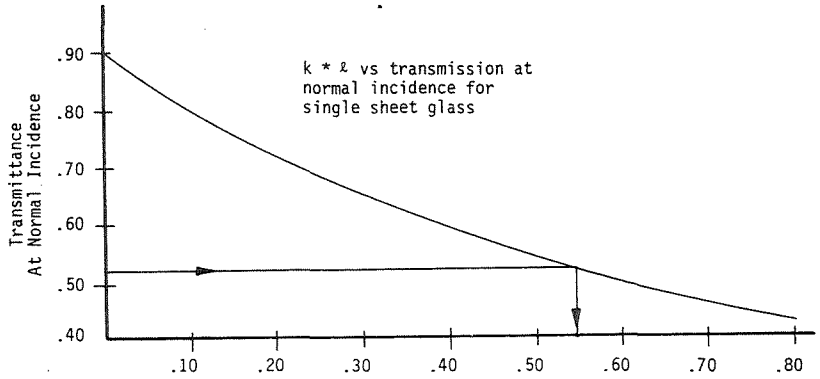
- Window Type Index (1. - 8.) (Cols. 61-70)

  For the program to calculate proper transmission, absorption and reflection factors, the user must specify the type of glass. These three factors, as a function the angle of sun incident, have been determined for 8 types of glass, single and double glazed, and are set within the program. The 8 types are catagorized according to their ($\kappa * \ell$) value where κ is thickness and ℓ is extinction coefficient. The table below lists the allowable program codes & corresponding $\kappa * \ell$ value.

GLASS CODES
FOR VALUES OF ($\kappa * \ell$)

CODE	MEANING
1	$\kappa * \ell = 0.05$ 1/8" sheet
2	$\kappa * \ell = 0.10$
3	$\kappa * \ell = 0.15$ 1/4" reg.plate
4	$\kappa * \ell = 0.20$
5	$\kappa * \ell = 0.40$
6	$\kappa * \ell = 0.60$
7	$\kappa * \ell = 0.80$ 50% transparent H.A. plate
8	$\kappa * \ell = 1.00$

To determine glass code desired, obtain from glass manufacturer or 1972 ASHRAE Handbook of Fundamentals, pg. 400 the transmission at normal incidence. Enter ordinate of curve below with this value, move to right until curve is intersected, move downward to abscissa and read $\kappa * \ell$ value. Choose a code from table above which has a $\kappa * \ell$ value closest to that desired.



CARD TYPE L-16C
GLAZED SURFACE GEOMETRY

GLAZED SURFACE GEOMETRY

(May be long form or short form. See notes at the bottom of input form LA/S-04. If surface shading is not considered, use short form and leave X,Y,Z coordinate blank. Program will then automatically locate surface at origin with proper tilt and azimuth angles.)

VERTICE COORDINATES (FEET)			Height (FEET)	Width (FEET)	Azimuth Angle (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
							L 1 6 C

A glazed surface can be described geometrically using either a long form or short form method. All comments made under card type L-12B apply here also.

CARD TYPE L-16D
COMMON SHADING SURFACES EXCLUDED

COMMON SHADING SURFACES EXCLUDED (If none or all are excluded, skip card type L16D)

Indices of shading surfaces excluded (Index is defined by order of appearance on Input Form LA/S-04.)	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 1 6 D

NOTE: If all or none of the common shading surfaces are being excluded or if building has no common shading surface, skip this card.

- Indices of Common Shading Surfaces Excluded

  User should call out the index of each common shading surface that is to be excluded. Index is defined by the order in which common shading surfaces were defined. Space has been allotted for 14 exclusions (7 per card). If more are required use as many of card type L-16D as necessary.

CARD TYPE L-16E and L-16F
ADDED SHADING SURFACES

ADDED SHADING SURFACES (If there are no added shading surfaces, skip card types L16E and F. Card type L16F may be long or short form.)

No. Vertices	Transmittance 0. (Opaque) to 1. (Clear)	Label (Alphanumeric)		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 1 6 E

VERTICE CO-ORDINATES (FEET)			Height(FEET)	Width (FEET)	Azimuth Angle (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
							L 1 6 F

(If additional card types L16E and F are required use ADDED SHADING CONTINUATION FORM.)

NOTE:
1. If number of added shading surfaces = 0 (refer to card type L-16B, column 41-50), skip these cards.
2. If number of added shading surfaces is greater than 0.0, then repeat card types L-16E and L-16F for each added surface.

All comments contained under card types L-12A and L-12B apply here also.

CARD TYPE L-16G
GLAZED SURFACE PICTURES

GLAZED SURFACE PICTURES

No. Glazed Surface Pictures																																																																						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	1	6	G						

- **No. Glazed Surface Pictures** (Cols. 1-10)

  If user desires to have a shadow picture printed so that a visual inspection can be made of what the program has determined for any hour, indicate here the total number of delayed surface pictures that are desired. If none are desired or if shade analysis is being omitted, enter 0.0.

CARD TYPE L-16H
GLAZED SURFACE PICTURE DEFINITION

GLAZED SURFACE PICTURE DEFINITION (If no glazed surface picture are required skip card type L16H.)

Month (1-12)	Hour of Day (1-24)	Glazed Surface 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 1 6 H

NOTE: Repeat this card for each picture specified above.

- Month (1-12) (Cols. 1-10)
- Hour of Day (1-24) (Cols. 11-20)

If times are specified during which either
1) sun has not risen, or
2) sun has risen but has not moved forward of the surface plane,
the program will automatically bypass the shadow claculations, set shade factor equal to 1.0, and no shadow picture printed.

- Glazed Surface Index (Cols. 21-30)

Surface index corresponds to order in which delayed surfaces were defined.

CARD TYPE L-17

INTERNAL HEAT TRANSFER SURFACES

INTERNAL SURFACES

No. Internal Heat Transfer Surfaces		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 7

R

(If there are no internal surfaces, skip card type L17A.)

- <u>No. Internal Heat Transfer Surfaces</u> (Cols. 1-10)

  The user will need to identify internal heat transfer surfaces only if there are interior walls across which there is a temperature difference, i.e., an interior wall that separates two spaces being maintained at different setpoint temperatures. If no internal surfaces are to be used, set this quantity at 0.0, otherwise,

NOTE: Repeat card type L-17A for each internal heat transfer surface to be described.

CARD TYPE L-17A

DESCRIPTION OF INTERNAL SURFACES

Index No.	Surface Area	Heat Transfer Coefficient (BTU/HR-^{o}F-FT^{2})	ADJOINING SPACES		Label (Alphanumeric)		Card Index
			Space 1	Space 2			
	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
1							L 1 7 A
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

(Heat transfer coefficient should include air film on both sides.)

- Surface Area (sq.ft.) (Cols. 1-10)

  Total area of surface through which heat is transferred.

- Heat Transfer Coefficient (BTU/HR-sq.ft.-F) (Cols. 11-20)

  Overall heat transfer coefficient (U-factor) for surface including air film on both sides.

- Adjoining Spaces- Space 1 (Cols. 21-30)

  Indicate the space index of space on one side of wall. Indices of spaces are defined by order of description on card types L-21A through L-21L.

- Adjoining Spaces - Space 2 (Cols. 31-40)

  Index of second space adjoining wall.

- Label (Cols. 41-60)

  Alphanumeric description of surface.

CARD TYPE L-18

UNDERGROUND WALLS

UNDERGROUND WALLS

No. Underground Walls																																																																						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	1	8								R

(If no underground walls are required, skip card type L18A.)

- <u>No. Underground Walls</u> (Cols. 1-10)

  Buildings which have walls that are soil backed will require the use of underground walls. Indicate with this variable the total number of distinct underground wall sections to be described using card type L-18A.

NOTE: Repeat card type L-18A for each underground wall to be described.

CARD TYPE L-18A

DESCRIPTION OF UNDERGROUND WALLS

INDEX NO.	Wall Area	Heat Trans. Coeff. (BTU/HR-^{o}F-FT^{2})	Label (Alphanumeric)		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
1					L 1 8 A
2					
3					
4					
5					
6					
7					
8					
9					
10					

- Wall Area (sq. ft.) (Cols. 1-10)

  Total area of surface through which heat is transferred.

- Heat Transfer Coefficient (BTU/HR-SQ.FT.-F) (Cols. 11-20)

  Overall heat transfer coefficient (U-factor) for surface including inside air film.

- Label (Cols. 21-40)

  Alphanumeric description of surface.

CARD TYPE L-19

UNDERGROUND FLOORS

UNDERGROUND FLOORS

No. Underground Floors	(shaded)	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 1 9 R

(If no underground floors are required, skip card type L19A.)

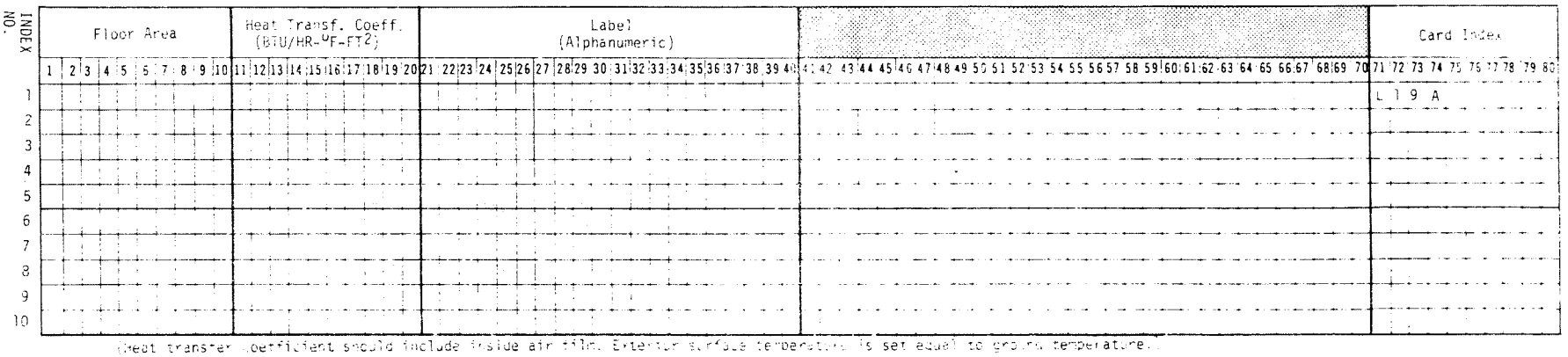
- <u>No. Underground Floors</u> (Cols. 1-10)

  Buildings which have soil backed floors (e.g., slab-on-grade) will require the use of underground floors. Indicate with this variable the total number of distinct underground floor sections to be described using card type L-19A.

NOTE: Repeat card type L-19A for each underground floor to be described.

CARD TYPE L-19A

DESCRIPTION OF UNDERGROUND FLOORS



- Floor Area (sq. ft.) (Cols. 1-10)

  Total area of surface through which heat is transferred.

- Heat Transfer Coefficient (BTU/HR-SQ.FT.-F) (Cols. 11-20)

  Overall heat transfer coefficient (U-factor) for the surface including inside air film.

- Label (Cols. 21-40)

  Alphanumeric description of surface.

CARD TYPE L-20

GROUND TEMPERATURE

GROUND TEMPERATURE (^{o}F) (If no underground walls or floors are required, skip card type L20.)

Jan. / July	Feb. / August	March / September	April / October	May / November	June / December		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 0
							L 2 0

NOTE: If no underground walls or floors are used, skip card type L-20.

- Ground Temperature (^{o}F)

  These temperatures are used to calculate heat flow through underground walls and floors.

FIRST CARD

COLUMNS	MONTH
1-10	January
11-20	February
21-30	March
31-40	April
41-50	May
51-60	June

SECOND CARD

COLUMNS	MONTH
1-10	July
11-20	August
21-30	September
31-40	October
41-50	November
51-60	December

CARD TYPE L-21

SPACES

SPACES

Number of Spaces		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 1

R

NOTE: CARD TYPE L21 SHOULD APPEAR ONLY ONCE.

- Number of Spaces (Cols. 1-10)

  This quantity represents the total number of spaces in building for which load calculations are required. If the building contains spaces that have identical loads, e.g., spaces on intermediate floors of a multiple story building and having same exposure, describe it only once and use the space repetition feature on card type L-21F, columns 61-70. Generally, a space would be defined as a zone or zones controlled by one thermostat. Since computer computation time is a function of the number of spaces for which load calculations are required, every effort should be made to minimize this quantity.

CARD TYPE L-21A
GENERAL DATA

SPACE DESCRIPTION

Space Floor Area (FT^2)	Space Volume (FT^3)	Weight of Floor (LB/FT^2)	Space Temperature (°F)	Include in bldg load? (0=NO, 1=YES)	Is space a plenum?	Label (Alphanumeric)	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 1 A R

- Space Floor Area (sq.ft.) (Cols. 1-10)

  Total square footage of zone floor area. This is used to calculate, when applicable, ventilation air load, lighting load, equipment load, etc.

- Space Volume (cu.ft.) (Cols. 11-20)

  When the air change method for calculating zone infiltration load is specified on card type L-21E, the space volume is used to calculate the total air change rate in CFM. If the air change method for determining infiltration load is not used, leave this quantity blank or enter 0.0.

- Weight of Floor (LB/SQ. FT.) (Cols. 21-30)

  Physical weight (LBS.) of a square foot of floor area. This is not density but actual floor weight, This quantity along with proper weighting factors is used to calculate the zone air load each hour.

- Space Temperature (°F) (Cols. 31-40)

  Temperature at which space is to be maintained the year around. This temperature is used as a reference temperature when calculating space heat gains and heat losses. If the user wishes to investigate the effects of thermostat deadbands or throttling ranges, equipment scheduling, night setback, etc., use should be made of the Temperature Variation Program. The Temperature Variation Program will adjust the basic hourly load data calculated by the Load Analysis Program for all of these effects and create a new set of corrected hourly load data.

- Include In Building Load? (0. or 1.) (Cols. 41-45)

  The user is given the option here of indicating whether or not this space's load should be included when determining building total heating and cooling capacity.

  0. = no, do not include
  1. = yes, do include

  Through this feature, the user is given the ability of not only investigating the basic building under study, but other spaces can be defined which are variations of the basic spaces, e.g., a different kind of glass, window shading, different lighting level, etc. However the loads of a space not included in the building load summary are still written to the load tape.

- Is Space A Plenum? (0. or 1.) (Cols. 46-50)

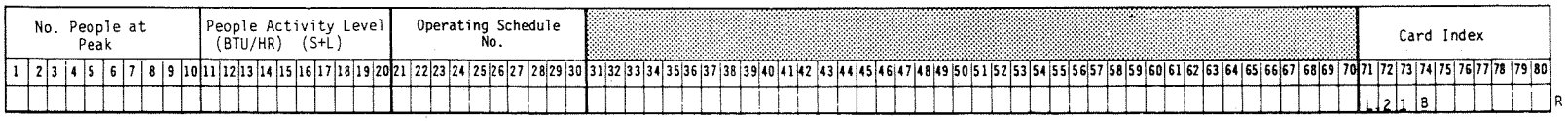
  If space is a return air plenum or a ceiling air space, enter 1.. If not, enter 0.. This will allow the program to determine the proper amount of total building conditioned floor area for calculation of ventilation air load and cfm per sq. ft..

- Label (Cols. 51-70)

  Alphanumeric Description of space.

CARD TYPE L-21B

OCCUPANCY LOADS



- No. People At Peak (Cols. 1-10)

  Maximum number of persons that will occupy the space.

- People Activity Level (BTU/HR) (Cols. 11-20)

  Metabolic heat (sensible and latent) given off by one person (BTU/HR).
  See table below for typical values for various working levels.

Kind of Work	Activity	Metabolic Rate Btu/hr
Light Work	Sleeping.....	250
	Sitting quietly.....	400
	Sitting, moderate arm and trunk movements.... (e.g., desk work, typing)	450-550
	Sitting, moderate arm and leg movements..... (e.g., playing organ, driving car in traffic)	550-650
	Standing, light work at machine or bench, mostly arms.....	550-650
Moderate Work	Sitting, heavy arm and leg movements.....	650-800
	Standing, light work at machine or bench, some walking about.....	650-750
	Standing, moderate work at machine or bench, some walking about.....	750-1000
	Walking about, with moderate lifting or pushing.....	1000-1400
Heavy Work	Intermittent heavy lifting, pushing or pulling..... (e.g., pick and shovel work)	1500-2000
	Hardest sustained work.....	2000-2400

- Operating Schedule No. (Cols. 21-30)

  Identify here the operating schedule number of schedule which is to be used to schedule occupancy of the space. Refer to card types L-11A and L-11B.

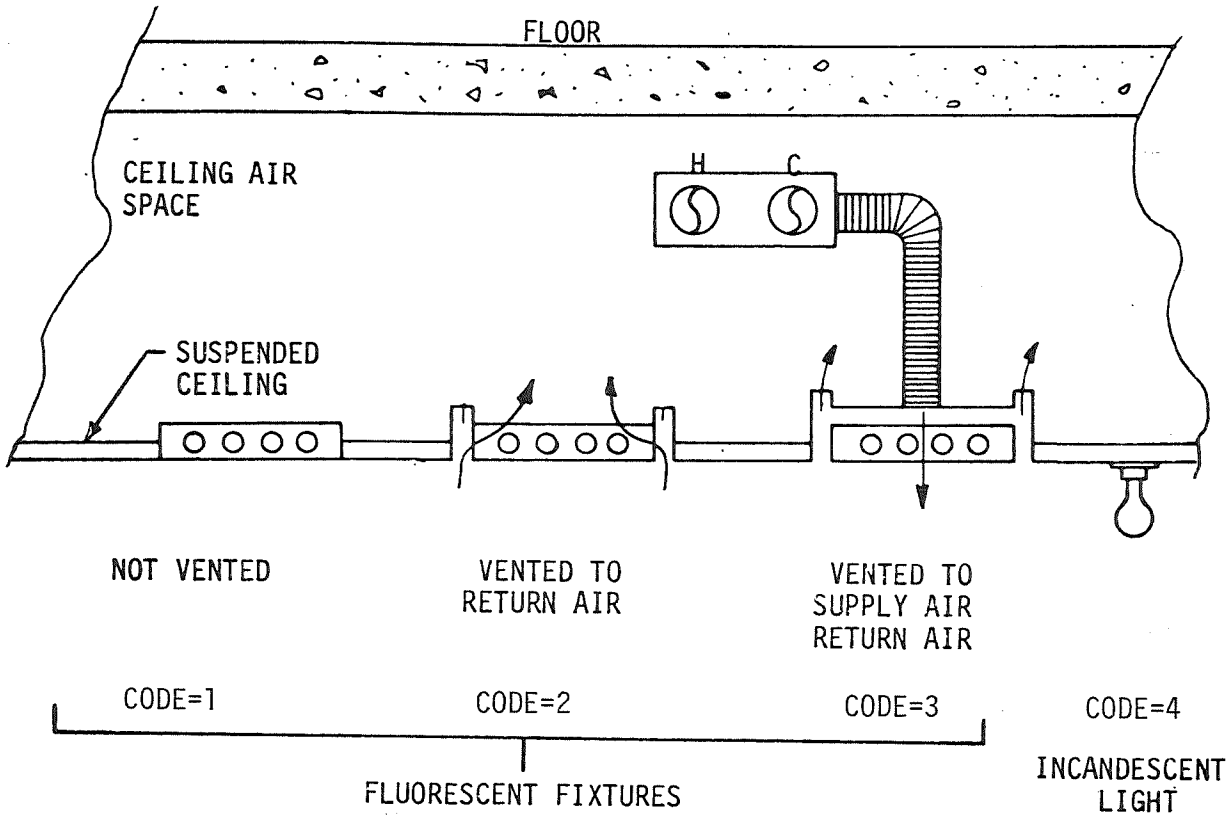
CARD TYPE L-21C

LIGHTING LOADS

Type of Light Fixture (1. - 4.)	Fraction of Light Heat to Space	Lighting Load (WATTS/FT^2)	Lighting Load (KW)	Operating Schedule No.	LIGHT FIXTURE 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 42 43 44 45 46 47 48 49 50	1. Not vented 2. Vented to ret. air 3. Vented to sup. & ret. air 4. Incandescent	71 72 73 74 75 76 77 78 79 80
						L 2 1 C R

- Type of Light Fixture (1.-4.) (Cols. 1-10)

The user is given 4 types of lighting fixtures to choose from. Corresponding weighting factors are stored within program to transfer lighting load to space air and plenum air.



- Fraction of Light Heat To Space (0.0 - 1.0) (Cols. 11-20)

  If light fixture is mounted in a suspended ceiling, not all of the light heat is transferred into the space below, some is transferred into the ceiling air space above. Consult manufacturers data for proper value. Typically, this value ranges from 0.3 to 0.6 for suspended ceiling fixtures and 1.0 for fixtures mounted totally within space such as type 4 above. The remaining portion of the light heat not transferred to the space is assumed to be a return air load on the distribution system.

- Lighting Load (WATTS/SQ. FT.) (Cols. 21-30)

  The user is given the option of entering the lighting load for the space either in watts per square foot of floor area (columns 21-30) or in total kilowatts (columns 31-40) for the space. If values are enter in both catagories, program will sum the two together to get total space lighting load.

- Lighting Load (Kilowatts) (Cols. 31-40)

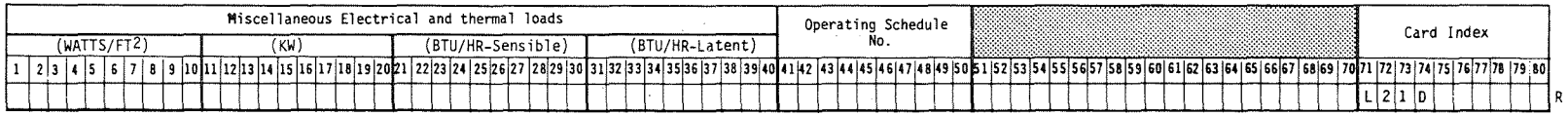
  See comments directly above.

- Operating Schedule No. (Cols. 41-50)

  Identity here the operating schedule number of schedule which is to be used to schedule the use of lighting for the space. Refer to card type L-11A and L-11B.

CARD TYPE L-21D

EQUIPMENT LOADS



- Miscellaneous Electrical and Thermal Loads

Very often there is equipment (computers, office machines, reproduction equipment, etc.) or process loads that are adding to the total thermal load of the space. The user is given 4 catagories in which to enter these loads. They are:

1. Watts/sq.ft. - Columns 1-10
2. Kilowatts - Columns 11-20
3. BTU/HR (sensible) - Columns 21-30
4. BTU/HR (latent) - Columns 31-40

The program will sum all 4 of these quantities together to arrive at the total space equipment load.

- Operating Schedule No. (Cols. 41-50)

Identify here the operating schedule number of schedule which is to be used to schedule the use of equipment loads for the space. Refer to card type L-11A and L-11B.

CARD TYPE L-21E

INFILTRATION LOAD

Type of Infiltration Analysis (0.-2.)	Infiltration Rate (No. of Air Changes)	Height above (-) or below Neutral Zone (FT)	Space Exhaust Air (CFM)	INFILTRATION CODE 0. None 1. Air change method (columns 11-20 req'd) 2. Crack method (columns 21-40 req'd)	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		71 72 73 74 75 76 77 78 79 80
					L 2 1 E R

- Type of Infiltration Analysis (0. - 2.) (Cols. 1-10)

  Three choices are available for calculating space infiltration loads.

  0. None
  1. Air change method
  2. Crack method

- Infiltration Rate (No. of Air Changes) (Cols. 11-20)

  Enter a value here only if air change method has been specified in columns 1-10.

  The number of air changes per hour to be entered is that estimated for a 10 mph wind. Each hour program will adjust this air change rate as a function of the actual wind speed read from weather data.

- Height Above (-) Or Below Neutral Zone (Ft.) (Cols. 21-30)

  Enter a value here only if the crack method has been specified in columns 1-10.

  This value is used to calculate infiltration rate due to stack effect. If zone lies above the neutral zone, height should be entered with a (-) sign. If zone lies below neutral zone, height should be entered with a (+) sign.

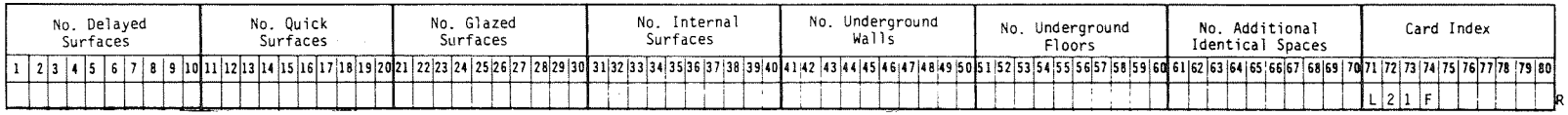
- Space Exhaust Air (CFM) (Cols. 31-40)

  Enter a value here only if the crack method has been specified in columns 1-10.

  Amount of exhaust air that is being taken out of space and directly dumped to outside by exhaust fans, etc. This quantity when subtracted from the ventilation air allotted for this space, represents the amount of interior pressurization that is taking place within the space to offset infiltration.

CARD TYPE L-21F

MAKEUP OF SPACE ENVELOPE



This card along with card types L-21G through L-21L are used to build up the space envelope. On card type L-21G the user indicates the quantities of each surface type that are to be used. On card types L-21G through L-21L the user indicates which specific surfaces are to be used.

- No. Delayed Surfaces (Cols. 1-10)

  Total number of delayed surface sections which will be used to describe space envelope. This number indicates how many indices are to be read from card type L-21G.

- No. Quick Surfaces (Cols. 11-20)

  Total number of quick surface sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21H.

- No. Glazed Surfaces (Cols. 21-30)

  Total number of window sections which will be used to describe space envelope. This number indicates how many window indices are to be read from card type L-21I

- No. Internal Surfaces (Cols. 31-40)

  Total number of internal surface sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21J .

- No. Underground Walls (Cols. 41-50)

  Total number of underground wall sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21K.

- No. Underground Floors (Cols. 51-60)

  Total number of underground floor sections which will be used to describe space envelope. This number indicates how many surface indices are to be read from card type L-21L.

- No. Additional Identical Spaces (Cols. 61-70)

  If building contains other spaces that are identical to the one described here on card types L-21A through L-21L, the user would enter here the number of additional identical spaces there are. This will save computer computation time and will be used in calculating the total building load each hour.

CARD TYPE L-21G Through L-21L
INDICES OF SPACE SURFACES

INDICES OF SPACE SURFACES

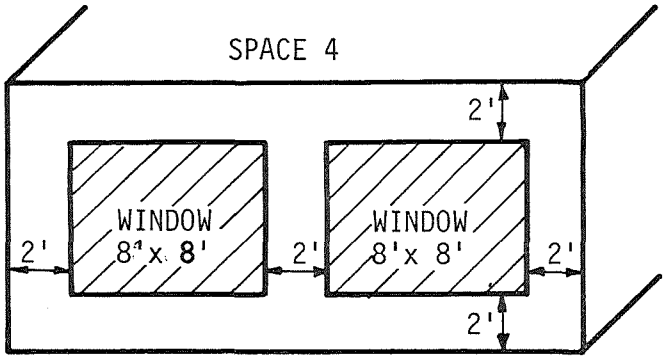
- Begin new card for each surface type.
- If a surface type is not included, skip that card index type.

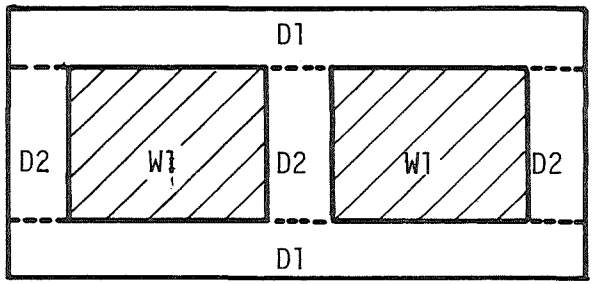
- Delayed _____ L21G
- Quick _____ L21H
- Glazed _____ L21I
- Internal _____ L21J
- Underground Walls _____ L21K
- Underground Floors _____ L21L

Card Index

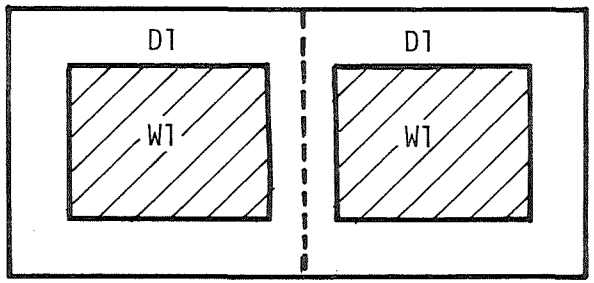
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

As the program read the data describing delayed, quick, glazed, internal, underground floor and and underground wall surfaces, an index was defined corresponding to the order to which the surfaces were entered. If 15 delayed surfaces were used, the program cataloged the data using indices 1-15. If 10 glazed surfaces were used the programs cataloged the data using indices 1-10. On card types L-21G through L-21L the user must call out the indices of those surfaces which are to be used to build up the space envelop. Indices can be used as many times as needed thereby taking advantage of the repetitiveness of certain surfaces. For example, pictured below is one wall of space 4 having two windows and 2' borders around windows.





Alternative 1



Alternative 2

Two alternate methods are illustrated for breaking the wall into delayed surfaces and glazed surfaces. If this was the only wall making up Space 4, card types L-21G and L-21I would contain data as follows:

Alternative 1

1.	1.	2.	2.	2.	L-21G
1.	1.				L-21I

Alternative 2

1.	1.				L-21G
1.	1.				L-21I

The space envelope surface indices must be entered in the order indicated in table below. If more than one card type is required, use as many as required. If use of a given card type is not required, skip that card.

SURFACE TYPE	USE CARD TYPE
DELAYED H.T.S.	L-21G
QUICK H.T.S.	L-21H
GLAZED H.T.S.	L-21I
INTERNAL H.T.S.	L-21J
UNDERGROUND WALLS	L-21K
UNDERGROUND FLOORS	L-21L

5.2.3 Hourly Weather Data

If an hourly load analysis for determining energy requirements is being sought, the Load Analysis Program With Shadows requires hourly weather data to be supplied in one form of a magnetic tape. For the years and cities available, refer to the SCOUT Access and Control Guide.

5.3 OUTPUT REPORT DESCRIPTION

The Load Analysis Program With Shadows prints out, at various states 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 Load Analysis Program With Shadows. 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 - Zone 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 Hourly Results Report Column Labels
9. Report L9 - Summary of Hourly Results
10. Report L10 - Summary of Recommended Space Heat Extraction and Addition Rates
11. Report L11 - Surface Shadow Calculations and Picture

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

- REPORT L1 - ECHO OF CARD INPUT DATA

To give the user a hard copy record of the card input data read each time the program is used, the first report coming out will always be a summary of card input data read. An example of this report is shown in Figure 5.6. This report will occupy several pages depending upon the size of the input data deck.

- REPORT L2 - TITLE PAGE - DESIGN LOAD ANALYSIS

Whenever a design load anlaysis 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.

- REPORT L3 - SUMMARY OF DESIGN DAY WEATHER

As indicated by Figure 5.8, 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. 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.

- REPORT L4 - ZONE LOAD SUMMARY

At the end of the design load or hourly load analysis, a summary (see Figure 5.9) detailing the components of the peak heating and cooling load is printed for each building zone. An explanation of each item follows:

1. Zone No. - defined by order of input.
2. Zone Repetition Factor - defined by input L-21F.
3. Area - defined by input L-21A.
4. Volume - defined by input L-21A.
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°.
8. Ceilings - summation of transmission loads through delayed and quick surfaces with tilt angles less than 45°.
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°.
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.

- REPORT L5 - BUILDING LOAD SUMMARY

Report L5 (see Figure 5.10) is similar to Report L4 except results are for time when the building load peaked. Additional items include:

1. Return Air - summation of zone 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.

- REPORT L6 - TITLE PAGE - HOURLY ENERGY ANALYSIS

Report L6 (see Figure 5.11) is similar to Report L2 except that it is produced only at the time an hourly energy analysis is begun.

- 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 5.12 for an example report.

- REPORT L8 - SUMMARY OF HOURLY RESULTS REPORT COLUMN LABELS

Reports L8 and L9 are companion reports. Report L8 (see Figure 5.13) indicates the hourly weather and zone load data that is calculated by the program and written each hour by the Load Analysis Program With Shadows onto an output tape. This report also is an aid in interpreting the data that is printed as part of Report L9.

- REPORT L9 - SUMMARY OF HOURLY RESULTS

Report L9 (see Figure 5.14) is an optional output and summarizes weather data and calculated zone loads for each hour of the analysis.

- REPORT L10 - SUMMARY OF RECOMMENDED SPACE HEAT EXTRACTION AND ADDITION RATES

The Temperature Variation Program requires as input to it, the maximum heating and cooling capacities provided to each space. Report L10 (Figure 5.15) lists the recommended capacities based upon hourly energy analysis results. These quantities are taken directly from item 19 of Report L4 for each zone.

- REPORT L11 - SURFACE SHADOW CALCULATIONS AND PICTURE

At the user's option, shadow pictures similar to that shown in Figure 5.16 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.

THERE ARE 12 WINDOW SURFACES

WINDOW NO. 1							
FACTORS =	0.75	0.50	0.50	0.20	0.0	0.0	0.0
INDICES =	1.00	15.00	1.00	10.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	85.00	-45.00	31.00	6.00	150.00	180.00	90.00
DELETED INDICES =	1.00	2.00	3.00	4.00	6.00	7.00	8.00
	9.00	10.00	11.00				
WINDOW NO. 2							
FACTORS =	0.75	0.50	0.50	0.30	0.0	0.0	0.0
INDICES =	1.00	5.00	1.00	8.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	-5.00	0.0	17.00	6.00	60.00	180.00	90.00
DELETED INDICES =	1.00	3.00	4.00	5.00	7.00	8.00	10.00
	11.00						
WINDOW NO. 3							
FACTORS =	0.75	0.50	0.50	0.30	0.0	0.0	0.0
INDICES =	1.00	5.00	1.00	8.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	322.00	140.00	17.00	6.00	60.00	0.0	90.00
DELETED INDICES =	1.00	3.00	4.00	5.00	6.00	9.00	10.00
	11.00						
WINDOW NO. 4							
FACTORS =	0.75	0.50	0.50	0.30	0.0	0.0	0.0
INDICES =	1.00	5.00	1.00	8.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	266.00	-5.00	17.00	6.00	60.00	180.00	90.00
DELETED INDICES =	1.00	3.00	4.00	5.00	6.00	9.00	10.00
	11.00						
WINDOW NO. 5							
FACTORS =	0.75	0.50	0.50	0.20	0.0	0.0	0.0
INDICES =	1.00	5.00	1.00	8.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	55.00	140.00	17.00	6.00	60.00	0.0	90.00
DELETED INDICES =	1.00	3.00	4.00	5.00	7.00	8.00	10.00
	11.00						
WINDOW NO. 6							
FACTORS =	0.80	0.50	0.50	0.30	0.0	0.0	0.0
INDICES =	1.00	15.00	1.00	10.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	85.00	-45.00	14.00	9.00	150.00	180.00	90.00
DELETED INDICES =	1.00	2.00	3.00	5.00	6.00	7.00	8.00
	9.00	10.00	11.00				
WINDOW NO. 7							
FACTORS =	0.75	0.50	0.50	0.20	0.0	0.0	0.0
INDICES =	1.00	15.00	1.00	6.00	0.0	2.00	3.00
X, Y, Z, HEIGHT, WIDTH, AZIMUTH, TILT =	235.00	140.00	17.00	6.00	150.00	0.0	90.00
DELETED INDICES =	1.00	3.00	4.00	5.00	10.00	11.00	

Figure 5.6 REPORT L1 (TYPICAL)

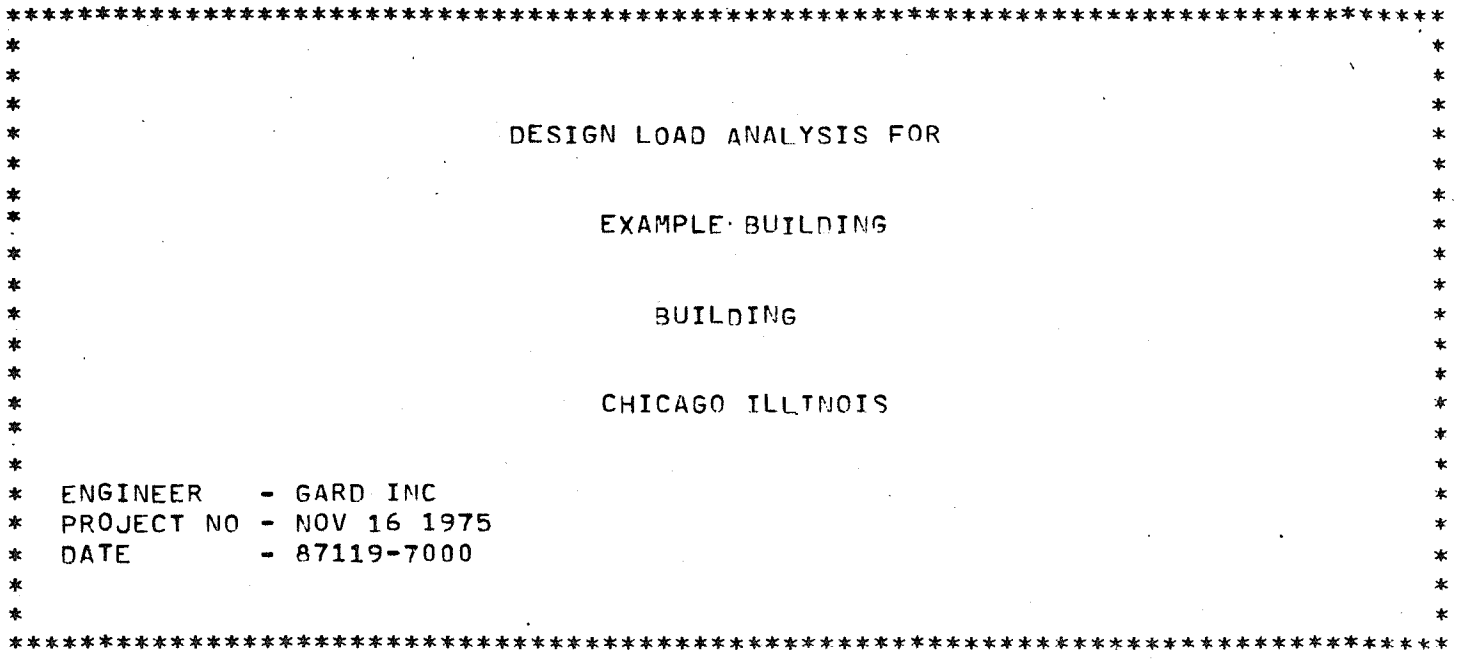


Figure 5.7 REPORT L2 (TYPICAL)

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 TEMPERATURE = 92.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 16.
4. AVERAGE DEW-POINT TEMPERATURE = 74.
5. AVERAGE WIND SPEED = 11.

WINTER DAY INPUT PARAMETERS
1. MONTH ASSUMED TO BE DECEMBER
2. MINIMUM DRY-BULB TEMPERATURE = 20.
3. DAILY SWING OF DRY-BULB TEMPERATURE = 0.
4. AVERAGE DEW-POINT TEMPERATURE = 19.
5. AVERAGE WIND SPEED = 13.

	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	65.	65.	64.	64.	64.	65.	66.	67.	68.	70.	72.	74.	76.	78.	79.	78.	77.	77.	75.	73.	71.	69.	67.	65.
WBT	62.	62.	61.	61.	61.	62.	63.	64.	65.	67.	69.	71.	71.	72.	72.	72.	72.	72.	71.	70.	68.	66.	64.	62.
APRIL																								
DBT	69.	69.	68.	68.	68.	69.	70.	71.	72.	74.	76.	78.	80.	82.	83.	82.	81.	81.	79.	77.	75.	73.	71.	69.
WBT	66.	66.	65.	65.	65.	66.	67.	68.	69.	71.	72.	73.	73.	74.	74.	74.	74.	74.	73.	73.	72.	70.	68.	66.
MAY																								
DBT	74.	74.	73.	73.	73.	74.	75.	76.	77.	79.	81.	83.	85.	87.	88.	87.	86.	86.	84.	82.	80.	78.	76.	74.
WBT	71.	71.	70.	70.	70.	71.	72.	73.	73.	74.	74.	75.	75.	76.	76.	76.	76.	76.	75.	75.	74.	74.	73.	71.
JUNE																								
DBT	77.	77.	76.	76.	76.	77.	78.	79.	80.	82.	84.	86.	88.	90.	91.	90.	89.	89.	87.	85.	83.	81.	79.	77.
WBT	74.	74.	73.	73.	73.	74.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	74.
JULY																								
DBT	78.	78.	77.	77.	77.	78.	79.	80.	81.	83.	85.	87.	89.	91.	92.	91.	90.	90.	88.	86.	84.	82.	80.	78.
WBT	75.	75.	74.	74.	74.	75.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	75.
AUGUST																								
DBT	78.	78.	77.	77.	77.	78.	79.	80.	81.	83.	85.	87.	89.	91.	92.	91.	90.	90.	88.	86.	84.	82.	80.	78.
WBT	75.	75.	74.	74.	74.	75.	75.	75.	76.	76.	77.	77.	78.	78.	78.	78.	78.	78.	77.	77.	76.	76.	75.	75.
SEPTEMBER																								
DBT	76.	76.	75.	75.	75.	76.	77.	78.	79.	81.	83.	85.	87.	89.	90.	89.	88.	88.	86.	84.	82.	80.	78.	76.
WBT	73.	73.	72.	72.	72.	73.	74.	74.	74.	75.	76.	76.	77.	77.	77.	77.	77.	77.	76.	76.	75.	75.	74.	73.
OCTOBER																								
DBT	71.	71.	70.	70.	70.	71.	72.	73.	74.	76.	78.	80.	82.	84.	85.	84.	83.	83.	81.	79.	77.	75.	73.	71.
WBT	68.	68.	67.	67.	67.	68.	69.	70.	71.	72.	72.	73.	73.	74.	74.	74.	74.	74.	73.	73.	72.	72.	70.	68.
NOVEMBER																								
DBT	64.	64.	63.	63.	63.	64.	65.	66.	67.	69.	71.	73.	75.	77.	78.	77.	76.	76.	74.	72.	70.	68.	66.	64.
WBT	61.	61.	60.	60.	60.	61.	62.	63.	64.	66.	68.	70.	71.	72.	72.	72.	72.	72.	71.	69.	67.	65.	63.	61.
DECEMBER																								
DBT	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
WBT	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	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 5.8 REPORT L3 (TYPICAL)

HOURLY [illegible] RESULTS FOR
EXAMPLE BUILDING
CHICAGO ILLINOIS

SPACE NO. 2

SPACE REPETITION FACTOR 1

AREA (SQ.FT.) 2750.

VOLUME (CU.FT.) 27500.

SUMMER COOLING PEAK
DBT/WBT/HR OF DAY/DATE 97 / 75 / 13 / JULY 1

WINTER HEATING PEAK
DBT/WBT/HR OF DAY/DATE -14 / -14 / 21 / JAN. 23

	***** SUMMER LOAD ***** SENSIBLE (BTUH)	LATENT (BTUH)	WINTER LOAD (BTUH)
WALLS	1799.	0.	-13681.
CEILINGS	0.	0.	0.
WINDOW CONDUCTANCE	11534.	0.	-71224.
WINDOW SOLAR	6762.	0.	0.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND WALLS	0.	0.	0.
UNDERGROUND FLOORS	970.	0.	-9295.
OCCUPANTS	5591.	5337.	5943.
LIGHT TO SPACE	18402.	0.	2251.
EQUIPMENT TO SPACE	1966.	0.	417.
INFILTRATION	121.	117.	-2244.
TOTAL	47143.	5454.	-87832.

TOTAL SPACE COOLING 52597. BTUH
TOTAL SPACE HEATING -87832. BTUH

SUPPLY AIR AT 50 F AT DIFFUSER	1912. CFM	0.70 CFM/SQ.FT.
SUPPLY AIR AT 55 F AT DIFFUSER	2390. CFM	0.87 CFM/SQ.FT.
SUPPLY AIR AT 120 F AT DIFFUSER	1566. CFM	0.57 CFM/SQ.FT.
SUPPLY AIR AT 140 F AT DIFFUSER	1084. CFM	0.39 CFM/SQ.FT.

Figure 5.9 REPORT L4 (TYPICAL)

BUILDING LOAD SUMMARY FOR
EXAMPLE BUILDING
CHICAGO ILLINOIS

SPACE NOS. 1 THRU 11

TOTAL FLOOR AREA (SQ.FT.) 101700.

TOTAL VOLUME (CU.FT.) 1363000.

SUMMER COOLING PEAK
DBT/WBT/HR OF DAY/DATE 96 / 75 / 14 / JULY 1

WINTER HEATING PEAK
DBT/WBT/HR OF DAY/DATE -6 / -6 / 4 / FEB. 22

	***** SUMMER LOAD ***** SENSIBLE (BTUH)	LATENT (BTUH)	WINTER LOAD (BTUH)
WALLS	31289.	0.	-190078.
CEILINGS	241258.	0.	-410653.
WINDOW CONDUCTANCE	46735.	0.	-257332.
WINDOW SOLAR	35388.	0.	6166.
QUICK SURFACES	0.	0.	0.
INTERNAL SURFACES	0.	0.	0.
UNDERGROUND WALLS	0.	0.	0.
UNDERGROUND FLOORS	11072.	0.	-103896.
OCCUPANTS	95822.	90724.	23618.
LIGHT TO SPACE	292390.	0.	12735.
EQUIPMENT TO SPACE	191046.	0.	13845.
INFILTRATION	4928.	5313.	-72065.
SUBTOTAL	949927.	96038.	-977660.
RETURN AIR	292390.	0.	12735.
FAN HEAT	65351.	0.	65351.
VENTILATION AIR	252712.	267728.	-1231832.
TOTAL	1560378.	363766.	-2131405.

TOTAL BUILDING COOLING 1924144. BTUH 160.3 TONS
TOTAL BUILDING HEATING -2131405. BTUH -2131.4 MBH

	******* VARIABLE VOLUME SYSTEM *******		******* CONSTANT VOLUME SYSTEM *******	
SUPPLY AIR AT 50 F AT DIFFUSER	38534. CFM	0.38 CFM/SQ.FT. MAX.	40702. CFM	0.40 CFM/SQ.FT. CONST.
SUPPLY AIR AT 55 F AT DIFFUSER	48168. CFM	0.47 CFM/SQ.FT. MAX.	50877. CFM	0.50 CFM/SQ.FT. CONST.
SUPPLY AIR AT 120 F AT DIFFUSER	17435. CFM	0.17 CFM/SQ.FT. MAX.	20753. CFM	0.20 CFM/SQ.FT. CONST.
SUPPLY AIR AT 140 F AT DIFFUSER	12070. CFM	0.12 CFM/SQ.FT. MAX.	14367. CFM	0.14 CFM/SQ.FT. CONST.

Figure 5.10 REPORT L5 (TYPICAL)

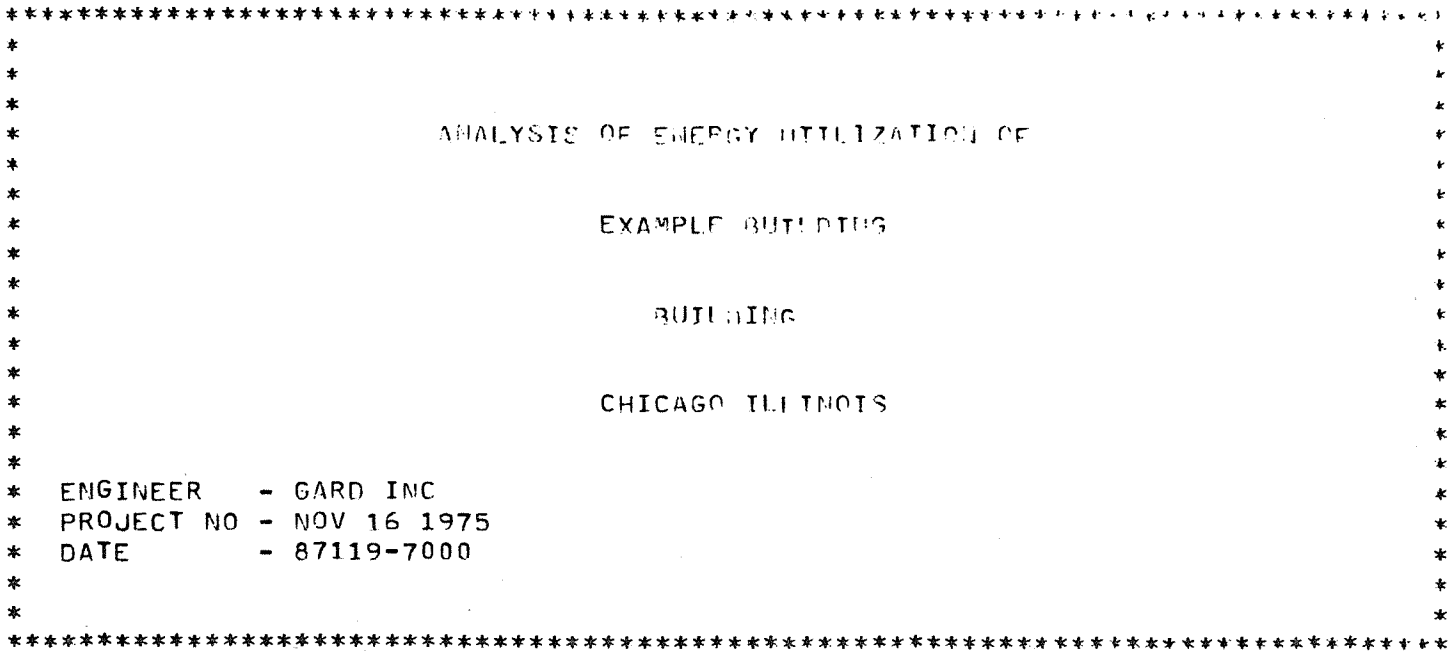


Figure 5.11 REPORT L6 (TYPICAL)

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                              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  1/ 1/1963. *
*                                                                           *
*                                                                           *
* - THE LENGTH OF THIS STUDY IS 365 DAYS.                                   *
*                                                                           *
*                                                                           *
* - THE INITIAL OUTSIDE SURFACE TEMPERATURE IS 17 DEGREES FAHRENHEIT.       *
*                                                                           *
*                                                                           *
*****************************************************************************
```

Figure 5.12 REPORT L7 (TYPICAL)

```
*****************************************************************************
*                                                                           *
*                                                                           *
*                          IN THE FOLLOWING PAGES                           *
*                                                                           *
*                                                                           *
*                 THE FIRST LINE OF EACH PRINTED BLOCKS GIVES.              *
*                                                                           *
*   TIME            - HOURS, STANDARD TIME FROM FIRST HOUR OF JANUARY       *
*   MONTH           - MONTH OF YEAR                                         *
*   DAY INDEX 1     - DAY OF MONTH                                          *
*   DAY INDEX 2     - DAY OF  WEEK(1-7)                                     *
*   HOUR            - HOUR OF DAY (1-24)                                    *
*   SUN INDEX       - IF EQUAL TO ONE SUN IS DOWN, IF EQUAL TO ZERO SUN IS UP *
*   DRY-BULB TEMP.  - DEGREES FAHRENHEIT                                    *
*   WET-BULB TEMP.  - DEGREES FAHRENHEIT                                    *
*   WIND VELOCITY   - KNOTS                                                 *
*   HUMIDITY RATIO  - LBS WATER PER LB DRY-AIR                              *
*   PRESSURE        - INCHES OF MERCURY                                     *
*   DENSITY         - LBS DRY-AIR PER CUBIC FOOT                            *
*   ENTHALPY        - BTU PER LB DRY-AIR                                    *
*   DAY INDEX 3     - TYPE OF DAY(1-9),                                     *
*   CLOUD COVER MODIFIER - FRACTION OF TOTAL SOLAR RADIATION INCIDENT       *
*                          UPON A HORIZONTAL SURFACE                        *
*                                                                           *
*               THE FOLLOWING LINES OF EACH PRINTED BLOCKS GIVES            *
*                                                                           *
*   SPACE NUMBER                                                            *
*   SPACE SENSIBLE LOAD - BTU PER HOUR                                      *
*   SPACE LATENT LOAD   - BTU PER HOUR                                      *
*   PLENUM RETURN AIR LIGHTING LOAD    - BTU PER HOUR                       *
*   SPACE LIGHTING AND EQUIPMENT POWER - KILOWATTS                          *
*   INF. SENSIBLE LOAD  - BTU PER HOUR                                      *
*   INF. LATENT LOAD    - BTU PER HOUR                                      *
*                                                                           *
*                                                                           *
*****************************************************************************
*            NOTE - THE LOADS EXCLUDES OUTSIDE VENTILATION AIR LOADS        *
*****************************************************************************
```

Figure 5.13 REPORT L8 (TYPICAL)

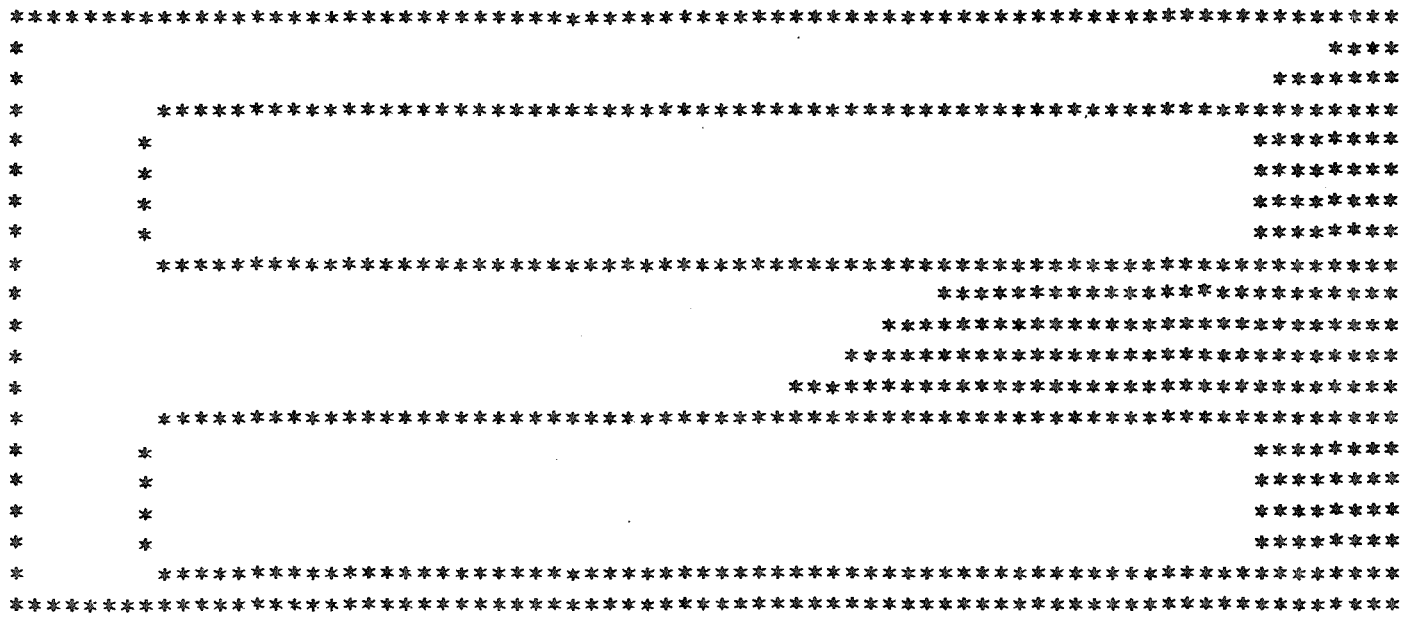
97	1	5	7	1	1	30.	28.	6.	0.002666	29.56	0.079668	10,06	7	0.380
1	-22323.25		2001.28		13918.37				0.29	-1728.28	0.0			
2	-50057.44		200.13		1457.50				0.02	-2865.54	0.0			
3	-40296.37		160.10		1252.53				0.02	-246.26	0.0			
4	-48035.85		200.13		1457.50				0.02	-2865.54	0.0			
5	-69133.13		160.10		1252.53				0.02	-246.26	0.0			
6	-163791.63		0.0		0.0				0.0	-805.93	0.0			
7	-19041.74		0.0		0.0				0.0	-71.64	0.0			
8	-16764.81		0.0		0.0				0.0	-62.68	0.0			
9	-19238.69		0.0		0.0				0.0	-71.64	0.0			
10	-16343.81		0.0		0.0				0.0	-62.68	0.0			
11	-5309.40		0.0		0.0				0.0	-9402.57	0.0			
98	1	5	7	2	1	29.	27.	5.	0.002543	29.55	0.079819	9.69	7	0.272
1	-27483.43		2001.28		12108.98				0.29	-1475.04	0.0			
2	-50476.74		200.13		1268.03				0.02	-2445.67	0.0			
3	-40515.27		160.10		1089.70				0.02	-210.17	0.0			
4	-48324.94		200.13		1268.03				0.02	-2445.67	0.0			
5	-70068.13		160.10		1089.70				0.02	-210.17	0.0			
6	-165397.75		0.0		0.0				0.0	-687.84	0.0			
7	-19220.24		0.0		0.0				0.0	-61.14	0.0			
8	-16894.68		0.0		0.0				0.0	-53.50	0.0			
9	-19392.74		0.0		0.0				0.0	-61.14	0.0			
10	-16517.02		0.0		0.0				0.0	-53.50	0.0			
11	-7543.82		0.0		0.0				0.0	-8024.85	0.0			
99	1	5	7	3	1	29.	27.	5.	0.002542	29.56	0.079846	9.69	7	0.272
1	-31972.79		2001.28		10534.81				0.29	-1475.54	0.0			
2	-51158.36		200.13		1103.18				0.02	-2446.50	0.0			
3	-40940.60		160.10		948.04				0.02	-210.25	0.0			
4	-48865.73		200.13		1103.18				0.02	-2446.50	0.0			
5	-71160.19		160.10		948.04				0.02	-210.25	0.0			
6	-167296.13		0.0		0.0				0.0	-688.08	0.0			
7	-19426.53		0.0		0.0				0.0	-61.16	0.0			
8	-17051.13		0.0		0.0				0.0	-53.52	0.0			
9	-19577.39		0.0		0.0				0.0	-61.16	0.0			
10	-16714.34		0.0		0.0				0.0	-53.52	0.0			
11	-9520.68		0.0		0.0				0.0	-8027.57	0.0			
100	1	5	7	4	1	29.	27.	0.	0.002666	29.56	0.079831	9.82	7	0.272
1	-35878.56		2001.28		9165.28				0.29	0.0	0.0			
2	-44289.98		200.13		959.77				0.02	0.0	0.0			
3	-35782.82		160.10		824.80				0.02	0.0	0.0			
4	-42524.79		200.13		959.77				0.02	0.0	0.0			
5	-67298.81		160.10		824.80				0.02	0.0	0.0			
6	-168568.13		0.0		0.0				0.0	0.0	0.0			
7	-19579.26		0.0		0.0				0.0	0.0	0.0			
8	-17163.51		0.0		0.0				0.0	0.0	0.0			
9	-19711.02		0.0		0.0				0.0	0.0	0.0			
10	-16864.52		0.0		0.0				0.0	0.0	0.0			
11	-11265.02		0.0		0.0				0.0	0.0	0.0			
101	1	5	7	5	1	28.	27.	0.	0.002667	29.55	0.079967	9.58	7	0.272
1	-39276.55		2001.28		7973.79				0.29	0.0	0.0			
2	-44763.05		200.13		835.00				0.02	0.0	0.0			
3	-36074.07		160.10		717.57				0.02	0.0	0.0			
4	-42895.41		200.13		835.00				0.02	0.0	0.0			
5	-68214.31		160.10		717.57				0.02	0.0	0.0			
6	-168475.31		0.0		0.0				0.0	0.0	0.0			
7	-19612.25		0.0		0.0				0.0	0.0	0.0			
8	-17174.31		0.0		0.0				0.0	0.0	0.0			
9	-19727.22		0.0		0.0				0.0	0.0	0.0			
10	-16909.75		0.0		0.0				0.0	0.0	0.0			
11	-12762.48		0.0		0.0				0.0	0.0	0.0			

Figure 5.14 REPORT L9 (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	-59016.	314746.
2	-132668.	63036.
3	-87832.	47143.
4	-129278.	55195.
5	-148883.	54111.
6	-347137.	202998.
7	-40240.	19682.
8	-35245.	16570.
9	-40474.	18535.
10	-34687.	16114.
11	-108259.	195235.

Figure 5.15 REPORT L10 (TYPICAL)



THE PRECEDING SHADOW PICTURE IS FOR
QUICK SURFACE NUMBER 1 OF SPACE NUMBER 1
AT 700 HOUR OF THE FIRST DAY OF SEP.

AREA OF THE SURFACE = 2179.24 FT**2
SHADED AREA OF THE SURFACE = 761.08 FT**2

Figure 5.16 REPORT L11 (TYPICAL)

SECTION 6
TEMPERATURE ANALYSIS PROGRAM

6.1 OBJECTIVE AND DESCRIPTION

The zone loads calculated by the Load Analysis Program or Load Analysis Program With Shadows are determined on the basis of the following two assumptions:

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

2) Zone temperature is always maintained at its specified setpoint.

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

1) Throttling range or deadband of the thermostat.

2) Thermostat setback or setup

3) Undersized equipment that cannot always satisfy loads in zone.

4) Shutdown of equipment during specified periods.

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

Utilizing such information as the type of thermostat, seasonal scheduling, operating characteristics of thermostat, heating and cooling capacity available at each zone, and seasonal start-up/shutdown dates for the heating and cooling plant, the Temperature Analysis Program corrects the basic loads calculated by the Load Analysis Program or Load Analysis Program With Shadows for these effects and generates a new set of corrected hourly zone loads. The user should not underestimate the effect that this Temperature Analysis Program can have on final results. Many users feel that this program is the most powerful

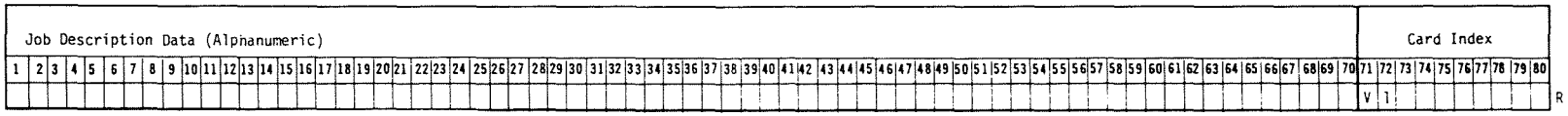
and useful program in the SCOUT series.

6.2 INPUT DATA DESCRIPTION

When attempting to simulate the temperature variation that occurs within a zone from hour to hour, all surfaces and objects having mass, and therefore thermal inertia, have to be considered. For this reason, the Temperature Analysis Program requires the user to define some additional building data that was not required by the Load Analysis Program or Load Analysis Program With Shadows, i.e., data on internal floors, ceilings and furnishings. If the user desires not to go into this detail, an alternate approach can be used, i.e., make use of typical default values built into the program.

Before filling in the Input Forms required for the Temperature Analysis Program, the user should take time to read the remaining parts of this section describing the data required.

CARD TYPE V-1
JOB DESCRIPTION DATA



- **Job Description Data** (Cols. 1-70)

  Alphanumeric descriptor describing job to be processed. Used as label for output reports.

CARD TYPES V-2 AND V-3
SPECIAL HOURLY PRINTOUT

SPECIAL HOURLY PRINTOUT

Number of Print Periods (0-12)	Number of Zones on input Tape		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
			V 2 R

Start Printing Date (Month/Day)	Stop Printing Date (Month/Day)	Repeat Card V3 as many times as indicated on Card V2 (skip Card V3 if no special printouts desired).	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
/	/		V 3
/	/		
/	/		
/	/		
/	/		
/	/		
/	/		
/	/		
/	/		
/	/		
/	/		
/	/		

NOTE: FILL IN ALL INDICATED COLUMNS, ENTER ZERO IF NECESSARY. NO DECIMAL POINT REQUIRED.

Note:

1. If number of printouts desired is equal to zero, skip card type V-3.
2. Card type V-3 must be repeated number of times indicated on card type V-2.

CARD TYPE V-2

- Number of Print Periods (0-12) (Cols. 1-10)

  Number of different periods for which an hourly listing of weather and calculated space loads and temperatures are desired.

- Number of Zones on Input Tape (Cols. 11-20)

  This value is required for the TAP Data Check Program.

CARD TYPE V-3

- Start Printing Date (Month/Day) (Cols. 1-2,4-5)

  Month and day at which printout is to start. Fill in all columns indicated; use zeros if necessary. No decimal point required.

- Stop Printing Date (Month/Day) (Cols. 11-12,14-15)

  Month and day at which printout is to stop. Fill in all columns indicated; use zeros if necessary. No decimal point required.

CARD TYPES V-4 AND V-5
BOILER/CHILLER SCHEDULING

BOILER/CHILLER SCHEDULING

Boiler/Chiller Operation Schedule Index (Cols. 1–10)	Cols. 11–70 (shaded)	Card Index (Cols. 71–80)
		V 4

Chiller/Boiler Index Code

1.0 = Yes, Card V5 is required.
0.0 = No, Skip to Card V6, program assumes equipment continuously available.

Boiler Shutdown Date (Month/Day) (Cols. 1–10)	Boiler Startup Date (Month/Day) (Cols. 11–20)	Chiller Startup Date (Month/Day) (Cols. 21–30)	Chiller Shutdown Date (Month/Day) (Cols. 31–40)	Cols. 41–70 (shaded)	Card Index (Cols. 71–80)
__ / __	__ / __	__ / __	__ / __		V 5

NOTE: FILL IN ALL INDICATED COLUMNS, ENTER ZERO IF NECESSARY. NO DECIMAL POINT REQUIRED.

CARD TYPE V-4

- Boiler/Chiller Operation Schedule Index (Cols. 1-10)

  User is given the option of specifying when the chiller and boiler are online and capable of providing heating or cooling to building if required.

  0. = no scheduling desired, program will assume chiller and boiler are available the year round to provide heating and cooling when required. Skip card type V-5.

  1. = user desires to specify use of chiller and boiler. Card type V-5 is required.

CARD TYPE V-5

- Boiler Shutdown Date (Month/Day) (Cols. 1-2,4-5)

  Month and day at which boiler will be shut down. Boiler will be assumed online from January 1 until the shutdown date.

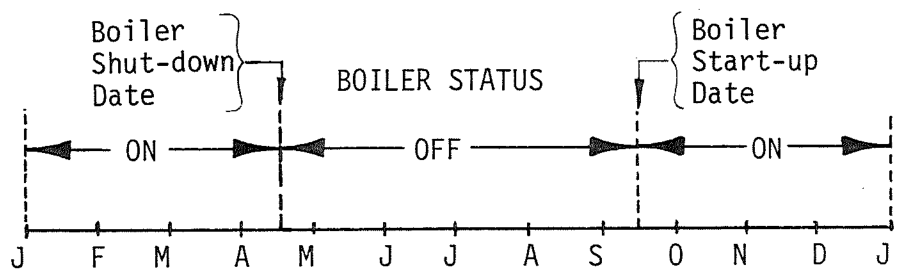
- Boiler Startup Date (Month/Day) (Cols. 11-12,14-15)

  Month and day at which boiler will be brought online again. Boiler will be assumed available from this date until the end of year.

Example

Boiler shutdown date = April 15
Boiler startup date = September 15

Program would schedule use of boiler as follows:



- Chiller Startup Date (Month/Day)(Cols. 21-22,24-25)

  Month and day at which chiller startup will take place. Chiller will be assumed offline from January 1 until this date.

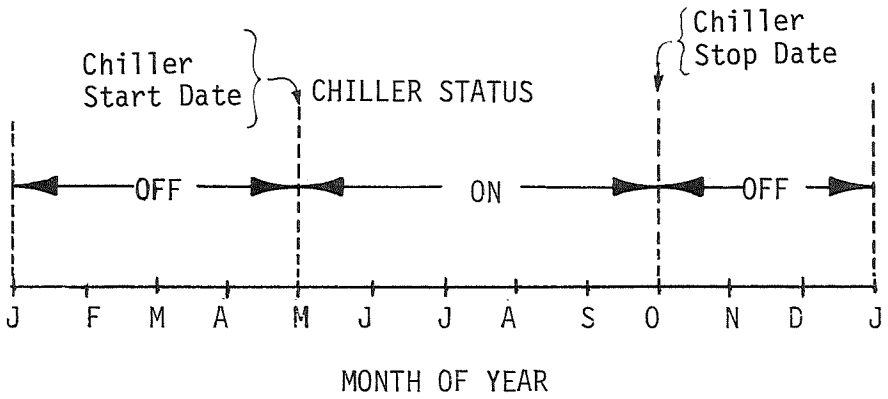
- Chiller Shutdown Date (Month/Day)
  (Cols. 31-32,34-35)

  Month and day at which chiller shutdown will take place. Chiller will be assumed offline from this date until end of year.

  Example

  Chiller startup date = May 1
  Chiller shutdown date = September 31

  Program would schedule use of chiller as follows:



CARD TYPE V-6
OPTIONAL FLOORS, CEILINGS AND FURNISHINGS

Number of User-Defined Floor Types	Number of User-Defined Ceiling Types	Number of User-Defined Furnishing Types		Card Index
1-10	11-20	21-30	31-70	71-80
				V 6

R

The Load Analysis Program described earlier calculates basic hourly space loads based upon an assumed constant internal temperature and therefore the user was not required to supply information about internal heat-storing components such as interior floors, ceilings and furnishings. These were assumed to have the same constant temperature as the space and hence had no effect on space loads. With the Temperature Analysis Program, however, the effects of these internal heat storage components must be accounted for in determining adjusted loads and resultant space temperatures each hour. The user is given the option of

1) describing the characteristics of these components in the form of response factor data, or
2) using ty pical default values that have been built into the program and which are a function of weight of floor (specified on card type L-21A) for floors and ceilings, and weight of furnishings (specified on card type V-13) for space furnishings.

It is difficult to imagine a case where option 1 would be desired, since as long as the proper values for weight of floor and weight of furnishings are used, the results of option 2 will be just as accurate as option 1.

- Number of User-Defined Floor Types (Cols. 1-10)

  Indicate here the number of different interior floor constructions that are to be defined using card types V-7 and V-8. If user desires to use default values built into program, enter a value of 0.0 and skip card types V-7 and V-8.

- Number of User-Defined Ceiling Types (Cols.11-20)

  Indicate here the number of different interior ceiling constructions that are to be defined using card types V-9 and V-10. If user desires to use default values built into program, enter a value of 0.0 and skip card types V-9 and V-10.

- Number of User-Defined Furnishing Types (Cols. 21-30)

  Indicate here the number of different furnishing types that are to be defined using card types V-11 and V-12. If user desires to use default values built into program, enter a value of 0.0 and skip card types V-11 and V-12.

CARD TYPES V-7 AND V-8
OPTIONAL FLOOR RESPONSE FACTOR DATA

OPTIONAL FLOOR RESPONSE FACTOR DATA

(If number of user-defined floor types = 0.0, skip Cards V7 and V8.
Otherwise use response factor program to generate Cards V7 and V8.)

No Time Response Grps	Common Ratio	(shaded)	Card Index
1–3	4–23	24–70	71–80
			V 7

Time Response Groups: X	Time Response Groups: Y	Time Response Groups: Z	(shaded)	Card Index
1–20	21–40	41–60	61–70	71–80
1				V 8
2				
3				
4				
5				
6				
7				
8				
9				
10				

↓ 100 Max.

Notes: 1. If number of user-defined floors equals 0.0 (card type V-6), skip card types V-7 and V-8.

2. If number of user-defined floors is greater than 0.0, card types V-7 and V-8 must be repeated for each floor specified. Use the Response Factor Program to generate these data cards and then insert the punched cards into the Temperature Analysis Program input deck at this point.

CARD TYPES V-9 AND V-10
OPTIONAL CEILING RESPONSE FACTOR DATA

OPTIONAL CEILING RESPONSE FACTOR DATA (If number of user-defined ceiling types = 0.0, skip Cards V9 and V10. Otherwise use response factor program to generate Cards V9 and V10.)

No Time Response Grps	Common Ratio		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
			V 9

	Time Response Groups				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
1					V 1 0
2					
3					
4					
5					
6					
7					
8					
9					
10					

100 Max.

Notes: 1. If number of user-defined ceilings equals 0.0 (Card type V-6), skip card types V-9 and V-10.

2. If number of user-defined ceilings is greater than 0.0, card types V-9 and V-10 must be repeated for each ceiling specified. Use the Response Factor Program to generate these data cards and then insert the punched cards into the Temperature Analysis Program input deck at this point.

CARD TYPES V-11 AND V-12
OPTIONAL FURNISHING RESPONSE FACTOR DATA

OPTIONAL FURNISHING RESPONSE FACTOR DATA (If number of user-defined furnishing types = 0.0, skip Cards V11 and V12. Otherwise use response factor program to generate Cards V11 and V12.)

No Time Response Grps	Common Ratio		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	
			V	1 1

Time Response Groups			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
			V 1 2

1
2
3
4
5
6
7
8
9
10
↓
100 Max.

Notes: 1. If number of user-defined furnishing types equals 0.0 (card type V-6), skip card types V-11 and V-12.

2. If number of user-defined furnishing types is greater than 0.0, card types V-11 and V-12 must be repeated for each furnishing type specified. Use the Response Factor Program to generate these data cards and then insert the punched cards into the Temperature Analysis Program input deck at this point.

CARD TYPE V-13
SPACE DESCRIPTION DATA

SPACE DESCRIPTION DATA

NOTE: REPEAT FORM V04 FOR EACH SPACE.

Number of User-Defined Floors in Space (0-3)	Number of User-Defined Ceilings in Space (0-3)	Number of User-Defined Furnishings in Space (0-1)	Weight-of-Furnishings in Space (lbs/sq 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	
					V 1 3	R

Note: Repeat this card for each space.

- Number of User-Defined Floors in Space (0-3) (Cols. 1-10)

If card types V-7 and V-8 were used to define optional floors, indicate here how many floor sections are to be used to describe floor of the space in question. The floor index and area should be described using card type V-14. To use floor default values, enter 0.0 and skip card type V-14.

- Number of User-Defined Ceilings in Space (0-3) (Cols. 11-20)

If card types V-9 and V-10 were used to define optional ceilings, indicate here how many ceiling sections are to be used to describe ceiling of the space in question. The ceiling index and area should be described using card type V-15. To use ceiling default values, enter 0.0 and skip card type V-15.

- Number of User-Defined Furnishings in Space (0-1) (Cols. 21-30)

If card types V-11 and V-12 were used to define optional furnishings, indicate here if the space in question is to use this data.

0 = no
1 = yes

To use furnishing default values, enter 0.0 and skip card type V-16.

- Weight-of-Furnishings in Space (lbs/sq ft) (Cols. 31-40)

If default values are to be used for furnishings (value of 0.0 specified in columns 21-30), user must enter a value here for weight-of-furnishings per square foot of space floor area so that proper quantity or mass of furnishings can be calculated.

CARD TYPE V-14
OPTIONAL FLOOR DATA

OPTIONAL FLOOR DATA (If number of user-defined floors = 0.0, skip Card V14.)

Floor No. 1		Floor No. 2		Floor No. 3			Card Index
Response Factor Index	Area (sq. ft.)	Response Factor Index	Area (sq. ft.)	Response Factor Index	Area (sq. ft.)		
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
							V 1 4

- <u>Floor Section No. 1</u>
<u>Response Factor Index</u> (Cols. 1-10)

  Floor index corresponds to order in which optional floors were described using card types V-7 and V-8.

- <u>Floor Section No. 1 Area (sq. ft.)</u> (Cols. 11-20)

- <u>Floor Section No. 2</u>
<u>Response Factor Index</u> (Cols. 21-30)

  Floor index corresponds to order in which optional floors were described using card types V-7 and V-8.

- <u>Floor Section No. 2 Area (sq. ft.)</u> (Cols. 31-40)

- <u>Floor Section No. 3</u>
<u>Response Factor Index</u> (Cols. 41-50)

  Floor index corresponds to order in which optional floors were described using card types V-7 and V-8.

- <u>Floor Section No. 3 Area (sq. ft.)</u> (Cols. 51-60)

OPTIONAL CEILING DATA (If number of user-defined ceilings = 0.0, skip Card V15.)

Ceiling No. 1		Ceiling No. 2		Ceiling No. 3			Card Index
Response Factor Index	Area (sq. ft.)	Response Factor Index	Area (sq. ft.)	Response Factor Index	Area (sq. ft.)		
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
							V 1 5

- <u>Ceiling Section No. 1 Response Factor Index</u> (Cols. 1-10)

  Ceiling index corresponds to order in which optional ceilings were described using card types V-9 and V-10.

- <u>Ceiling Section No. 1 Area (sq. ft.)</u> (Cols. 11-20)

- <u>Ceiling Section No. 2 Response Factor Index</u> (Cols. 21-30)

  Ceiling index corresponds to order in which optional ceilings were described using card types V-9 and V-10.

- <u>Ceiling Section No. 2 Area (sq. ft.)</u> (Cols. 31-40)

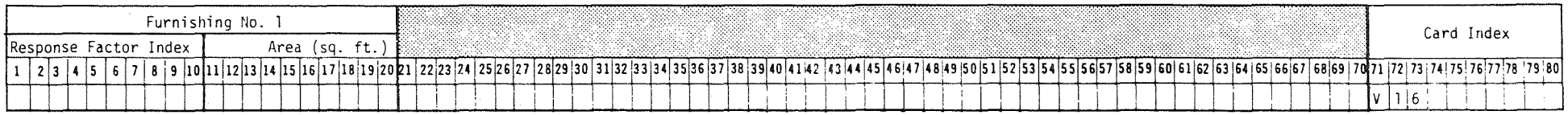
- <u>Ceiling Section No. 3 Response Factor Index</u> (Cols. 41-50)

  Ceiling index corresponds to order in which optional ceilings were described using card types V-9 and V-10.

- <u>Ceiling Section No. 3 Area (sq. ft.)</u> (Cols. 51-60)

CARD TYPE V-16
OPTIONAL FURNISHING DATA

OPTIONAL FURNISHING DATA (If number of user-defined furnishings = 0.0, skip Card V16.)



- Furnishing Response Factor Index (Cols. 1-10)

  Furnishing index corresponds to order in which optional furnishings were described using card types V-11 and V-12.

- Furnishing Area (sq. ft.) (Cols. 11-20)

CARD TYPES V-17 AND V-18
THERMOSTAT SCHEDULES

Number of Thermostat Schedules (1-5)		CARD INDEX	
1 2 3 4 5 6 7 8 9 10	11–70	71 72 73 74 75 76 77 78 79 80	
		V 1 7	R

WEEK DAY SCHEDULE

HOUR OF DAY	Thermostat Type (0,1,2)	High Limit of Throttling Range (^{o}F)	Low Limit of Throttling Range (^{o}F)	Thermostat Type (0,1,2)	High Limit of Throttling Range (^{o}F)	Low Limit of Throttling Range (^{o}F)		CARD INDEX	HOUR OF DAY
	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	
1								V 1 8	2
3								V 1 8	4
5								V 1 8	6
7								V 1 8	8
9								V 1 8	10
11								V 1 8	12
13								V 1 8	14
15								V 1 8	16
17								V 1 8	18
19								V 1 8	20
21								V 1 8	22
23								V 1 8	24

WEEKEND AND HOLIDAY SCHEDULE

NOTE: ALL CARD TYPES V18 INDICATED ABOVE ARE REQUIRED INPUT DATA.

HOUR OF DAY	Thermostat Type (0,1,2)	High Limit of Throttling Range (^{o}F)	Low Limit of Throttling Range (^{o}F)	Thermostat Type (0,1,2)	High Limit of Throttling Range (^{o}F)	Low Limit of Throttling Range (^{o}F)		INDEX CARD	HOUR OF DAY
	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	
1								V 1 8	2
3								V 1 8	4
5								V 1 8	6
7								V 1 8	8
9								V 1 8	10
11								V 1 8	12
13								V 1 8	14
15								V 1 8	16
17								V 1 8	18
19								V 1 8	20
21								V 1 8	22
23								V 1 8	24

CARD TYPE V-17

- Number of Thermostat Schedules (1-5) (Cols. 1-10)

  Total number of different types of thermostat operating schedules that will be used to describe the temperature control schemes for various thermal zones of the building. This variable indicates how many sets of card type V-18 are to be read.

CARD TYPE V-18

Description of Thermostat Schedules

Note: A set of 24 cards, type V-18, is required for each thermostat schedule indicated on card type V-17.

Each thermostat schedule is made up of temperature control data for 24 hours of a weekday operation and 24 hours of a weekend/holiday operation. For each hour of both day types, the user must define 3 items of information.

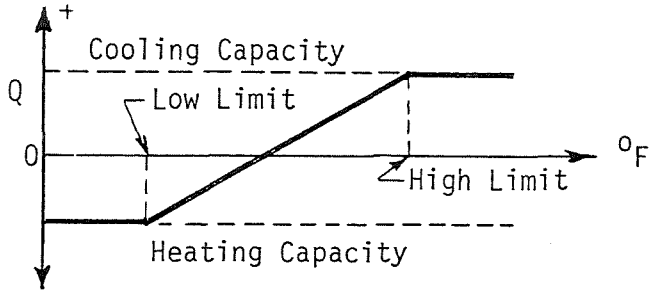
- Thermostat Type (0,1,2) (Cols. 1-10,31-40)

0. = No Thermostat

Space has no temperature control and temperature is allowed to float in response to skin and internal loads.

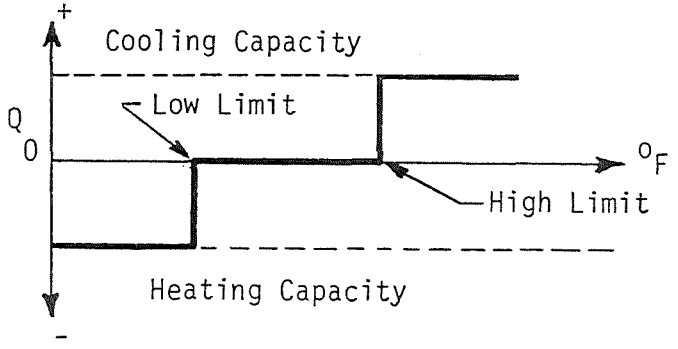
1. = Throttling Range Thermostat

A proportional type thermostat action which varies the space heating/cooling capacity linearly with space temperature deviation from setpoint temperature. When space temperature is at the low limit of the throttling range, the space is supplied with the full heating capacity allotted to it (see card type V-19, Cols. 11-20). When the space temperature is at the high limit of the throttling range, the space is supplied with the full cooling capacity allotted to it (see card type V-19, Cols. 21-30).



2. = Deadband Thermostat

Thermostat with full-on or full-off type action only. As long as space temperature is within the deadband area, no heating or cooling is supplied to the space. When space temperature drops below the low limit of the throttling range, the space is supplied with the full heating capacity allotted to the space. When space temperature rises above the high limit of the throttling range, the space is supplied with the full cooling capacity allotted to the space.



- High Limit of Throttling Range (°F) (Cols. 11-20,41-50)

Space temperature at which full cooling capacity is to be supplied. Not required for type 0 thermostat.

- Low Limit of Throttling Range (°F) (Cols. 21-30,51-60)

Space temperature at which full heating capacity is to be supplied. Not required for type 0 thermostat.

Example

Given a space requiring maximum ± 2°F temperature deviation around a setpoint of 72°F during occupied hours 7 AM to 5 PM. During evening and early morning hours, space temperature should not get below 65°F or above 80°F. Same 65°F/80°F limits apply during weekend/holiday operation. Input data describing these conditions would be as follows:

Weekday

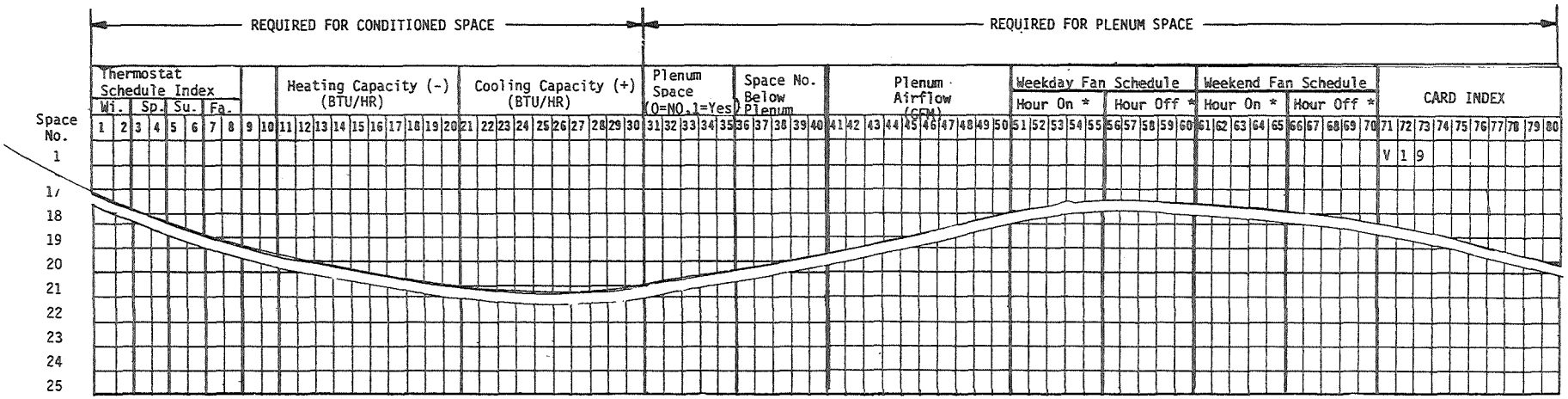
```
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
1.  74.  70.      1.  74.  70.
1.  74.  70.      1.  74.  70.
1.  74.  70.      1.  74.  70.
1.  74.  70.      1.  74.  70.
1.  74.  70.      1.  74.  70.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
```

Weekend/Holiday

```
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
2.  80.  65.      2.  80.  65.
```

CARD TYPE V-19
SPACE OPERATIONAL DATA

SPACE DESCRIPTION DATA



One card type V-19 is required for each space or plenum. For conditioned spaces, only columns 1-30 are required. For return air plenums above conditioned spaces, only columns 31-65 are required.

FOR CONDITIONED SPACES

- Thermostat Schedule Index No.

The user is given the option of varying the temperature control characteristics of the space based upon the 4 seasons of the year. The index required here is that corresponding to the order in which the thermostat schedules were described using card types V-18. Index should be entered as follows.

Winter	1/1 to 3/31	(Cols. 1-2)
Spring	4/1 to 6/30	(Cols. 3-4)
Summer	7/1 to 9/30	(Cols. 5-6)
Fall	10/1 to 12/31	(Cols. 7-8)

Do not use decimal point when entering schedule indices. All indicated columns must be filled in. Use zeros when necessary. If space has no temperature control the year round, simply enter "00" for all four seasons.

- Heating Capacity (Btu/hr) (Cols. 11-20)

Heating capacity allotted to the space. See Load Analysis Program output for heating capacity required to meet peak load.

- Cooling Capacity (Btu/hr) (Cols. 21-30)

Cooling capacity allotted to the space. See Load Analysis Program output for cooling capacity required to meet peak load.

FOR PLENUM SPACES

- Plenum Space ? (0-1) (Cols. 31-35)

0. = no
1. = yes

- Space No. Below Plenum (Cols. 36-40)

  Indicate here the number (index) of space that is below plenum. This allows the proper heat balance to be performed between the plenum and the space each hour.

- Plenum Airflow (cfm) (Cols. 41-50)

  If plenum is being used as a ceiling return air plenum, enter here the amount of air that is being sent through it from space below. If not being used as a return air plenum, enter a value of 0.0.

- Weekday Fan Schedule - Hour On (1-24) (Cols. 51-55)

  Hour of day that return air fan is turned on.

- Weekday Fan Schedule - Hour Off (1-24) (Cols. 56-60)

  Hour of day that return air fan is turned off.

- Weekend Fan Schedule - Hour On (1-24) (Cols. 61-65)

  Hour of day that return air fan is turned on.

- Weekend Fan Schedule - Hour Off (1-24) (Cols. 66-70)

  Hour of day that return air fan is turned off.

6.3 OUTPUT REPORT DESCRIPTION

Results from the Temperature Analysis Program are summarized on 4 types of reports. At the user's option, additional reports can be called for which allows for tracking of hourly results. The 5 reports include:

1) Report T1 - Echo of Building Description Data Read From Input Tape.
2) Report T2 - Echo of Card Input Data.
3) Report T3 - Summary of Hourly Results.
4) Report T4 - Zone Temperature Frequency Distribution Summary.
5) Report T5 - Summary of Temperature Variation Calculations.

- Report T1 - Echo of Building Description Data Read From Input Tape

Certain building description data is passed to the Temperature Analysis Program via the input tape. A listing of this data is provided for permanent record. This report may run several pages in length and is similar to that shown in Figure 6.1.

- Report T2 - Echo of Card Input Data

Report T2 (Figure 6.2) summarizes all card input data read. This report also can run several pages.

- Report T3 - Summary of Hourly Results

For any one day or period of days, the user may obtain a record of hourly calculations performed by the Temperature Analysis Program.

For each day specified, a report similar to that shown in Figure 6.3 will be printed summarizing hourly weather parameters and end-of-hour zone conditions. Specific items listed are:

1. Weather

   a) Hour of day
   b) DBT - ambient dry-bulb temperature, °F
   c) WBT - ambient wet-bulb temperature, °F

d) SUN - 1 indicates sundown;
- 0 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. Zone Parameters

a) Zone Number
b) Zone Temperature - resulting end-of-hour condition, °F
c) High Temperature - number of degrees above setpoint temperature to upper limit of thermostat throttling range, °F
d) Low Temperature - number of degrees below setpoint temperature to lower limit of thermostat throttling range, °F
e) Temperature Correction - Zone temperature minus setpoint temperature, °F
f) Heating Capacity - defined on Card Index V-19, Btu/hr
g) Cooling Capacity - defined on Card Index V-19, 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 Load Analysis Program, Btu/hr
j) Thermostat Type - defined on Card Index V-18
k) Schedule Type - defined on Card Index V-19

The user can request Report T3 for as many as 12 time periods, with each time period being one day or many days in length.

• Report T4 - Zone Temperature Frequency Distribution Summary

Report T4 (Figure 6.4) gives the user a record of the temperature history for each zone. The number of times that the end-of-hour zone temperature fell within each of 17 five-degree temperature bands is indicated.

• Report T5 - Summary of Temperature Analysis Calculations

Report T5 (Figure 6.5) enumerates for each building zone the extreme loads and temperatures that occurred for the period of analysis. In particular, the data listed thereon includes:

1. Zone number.

2. Maximum Heat Addition, will be either equal to or less than the quantity specified in Card Index V-19.

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 Card Index V-19.

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

6. Lowest Zone Temperature - lowest temperature that occurred in zone during period of analysis.

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

8. Highest Zone Temperature - highest temperature that occurred in zone during period of analysis.

9. Hour/Day/Month - time that highest zone 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 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.

```
************************************
************************************
*****                          *****
*****   ECHO OF INPUT DATA     *****
*****    FOR  TEMPERATURE      *****
*****   VARIATION  PROGRAM     *****
*****                          *****
************************************
************************************
```

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

IDEN1= EXAMPLE BUILDING
IDEN2= CHICAGO ILLINOIS
IDEN3=GARD INC
IDEN4=NOV 16 1975
IDEN5=87119-7000

NO. OF TYPES OF RESPONSE FACTOR SURFACES NRF= 3

RESPONSE FACTOR INDEX= 1 NRFT= 25 RATIO=0.807547

5.176073	0.000006	0.864743
-3.268599	0.000783	-0.523716
-0.758776	0.004748	-0.156670
-0.385837	0.009246	-0.049076
-0.211006	0.011334	-0.016987
-0.125053	0.011339	-0.007070
-0.080512	0.010274	-0.003746
-0.055768	0.008839	-0.002440
-0.040857	0.007394	-0.001794
-0.031106	0.006090	-0.001395
-0.024266	0.004973	-0.001109
-0.019210	0.004041	-0.000890
-0.015339	0.003274	-0.000717
-0.012308	0.002649	-0.000578
-0.009904	0.002142	-0.000467
-0.007982	0.001731	-0.000377
-0.006438	0.001398	-0.000304
-0.005196	0.001129	-0.000246
-0.004194	0.000912	-0.000198
-0.003387	0.000737	-0.000160
-0.002735	0.000595	-0.000129
-0.002208	0.000480	-0.000105
-0.001783	0.000388	-0.000084
-0.001440	0.000313	-0.000068
-0.001163	0.000253	-0.000055

RESPONSE FACTOR INDEX= 2 NRFT= 9 RATIO=0.220498

1.928372	0.009259	0.608847
-1.784894	0.057222	-0.431025
-0.029191	0.030789	-0.056285
-0.005604	0.007656	-0.011268
-0.001214	0.001715	-0.002449
-0.000267	0.000379	-0.000539
-0.000059	0.000084	-0.000119

Figure 6.1 REPORT T1 (TYPICAL)

*****ECHO OF CARD INPUT DATA*****

EXAMPLE BUILDING 1 YEAR RUN 1963 CHICAGO WEATHER

PRINTOUT OPTION= 2
PRINT START DATE= 1/ 5 PRINT STOP DATE= 1/ 5
PRINT START DATE= 8/ 5 PRINT STOP DATE= 8/ 5

NO. OF USER-DEFINED FLOOR TYPES NDF= 0
NO. OF USER-DEFINED CEILING TYPES NDC= 0
NO. OF USER-DEFINED FURNISHING TYPES NDFU= 0

ADDITIONAL SPACE DESCRIPTION DATA

SPACE NO.	NO. OF ADDITIONAL USER-DEFINED SURFACES FLOORS	CEILINGS	FURNISHINGS	WEIGHT OF FURNISHINGS	FLOOR DATA	CEILING DATA	FURNISHING DATA
1	0	0	0	10.0			
2	0	0	0	10.0			
3	0	0	0	10.0			
4	0	0	0	10.0			
5	0	0	0	10.0			
6	0	0	0	0.0			
7	0	0	0	0.0			
8	0	0	0	0.0			
9	0	0	0	0.0			
10	0	0	0	0.0			
11	0	0	0	10.0			

NO. OF THERMOSTAT SCHEDULES= 1

SCHD. TYPE	DAY TYPE	HOUR OF DAY	THERM TYPE	HI LIMIT	LOW LIMIT
1	WEEKDAY				
		1	2	85.0	65.0
		2	2	85.0	65.0
		3	2	85.0	65.0
		4	2	85.0	65.0
		5	2	85.0	65.0
		6	2	85.0	65.0
		7	1	77.0	73.0
		8	1	77.0	73.0
		9	1	77.0	73.0
		10	1	77.0	73.0
		11	1	77.0	73.0
		12	1	77.0	73.0
		13	1	77.0	73.0
		14	1	77.0	73.0
		15	1	77.0	73.0
		16	1	77.0	73.0
		17	1	77.0	73.0
		18	2	85.0	65.0
		19	2	85.0	65.0
		20	2	85.0	65.0
		21	2	85.0	65.0
		22	2	85.0	65.0
		23	2	85.0	65.0

Figure 6.2 REPORT T2 (TYPICAL)

DATE= 8/ 5	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= 70	WBT= 65	SUN= 1	HOA= 30.4	PATM= 29.42	VEL= 6.0	CC= 0.680				
	1	83.5	10.0	-10.0	8.53	53000.	900000.	0.	135279.	2	1
	2	83.9	10.0	-10.0	8.89	120000.	110000.	0.	16364.	2	1
	3	83.6	10.0	-10.0	8.63	100000.	110000.	0.	12231.	2	1
	4	84.0	10.0	-10.0	9.03	120000.	110000.	0.	17742.	2	1
	5	84.4	10.0	-10.0	9.40	100000.	110000.	0.	23890.	2	1
	6	79.4			4.39	0.	0.	0.	-7584.	2	0
	7	79.7			4.73	0.	0.	0.	367.	2	0
	8	79.4			4.41	0.	0.	0.	39.	2	0
	9	79.6			4.62	0.	0.	0.	496.	2	0
	10	79.7			4.72	0.	0.	0.	469.	2	0
	11	122.3	10.0	-10.0	47.35	0.	0.	0.	63594.	2	1
HOUR OF DAY= 2	DBT= 70	WBT= 65	SUN= 1	HOA= 30.4	PATM= 29.42	VEL= 5.0	CC= 0.709				
	1	83.4	10.0	-10.0	8.39	53000.	900000.	0.	123457.	2	1
	2	83.6	10.0	-10.0	8.60	120000.	110000.	0.	14927.	2	1
	3	83.3	10.0	-10.0	8.32	100000.	110000.	0.	11218.	2	1
	4	83.8	10.0	-10.0	8.75	120000.	110000.	0.	16200.	2	1
	5	84.2	10.0	-10.0	9.15	100000.	110000.	0.	21659.	2	1
	6	79.2			4.20	0.	0.	0.	-11150.	2	0
	7	79.5			4.50	0.	0.	0.	-81.	2	0
	8	79.2			4.19	0.	0.	0.	-314.	2	0
	9	79.4			4.41	0.	0.	0.	39.	2	0
	10	79.5			4.51	0.	0.	0.	77.	2	0
	11	119.0	10.0	-10.0	43.99	0.	0.	0.	55666.	2	1
HOUR OF DAY= 3	DBT= 70	WBT= 65	SUN= 1	HOA= 30.4	PATM= 29.42	VEL= 5.0	CC= 0.652				
	1	83.2	10.0	-10.0	8.24	53000.	900000.	0.	122521.	2	1
	2	83.3	10.0	-10.0	8.29	120000.	110000.	0.	13569.	2	1
	3	83.0	10.0	-10.0	8.00	100000.	110000.	0.	10255.	2	1
	4	83.5	10.0	-10.0	8.46	120000.	110000.	0.	14748.	2	1
	5	83.9	10.0	-10.0	8.88	100000.	110000.	0.	19482.	2	1
	6	79.0			4.00	0.	0.	0.	-15413.	2	0
	7	79.3			4.25	0.	0.	0.	-590.	2	0
	8	79.0			3.95	0.	0.	0.	-730.	2	0
	9	79.2			4.18	0.	0.	0.	-449.	2	0
	10	79.3			4.29	0.	0.	0.	-371.	2	0
	11	116.3	10.0	-10.0	41.29	0.	0.	0.	48690.	2	1
HOUR OF DAY= 4	DBT= 69	WBT= 65	SUN= 1	HOA= 30.4	PATM= 29.41	VEL= 6.0	CC= 0.652				
	1	83.1	10.0	-10.0	8.08	53000.	900000.	0.	117357.	2	1
	2	82.9	10.0	-10.0	7.93	120000.	110000.	0.	11684.	2	1
	3	82.7	10.0	-10.0	7.66	100000.	110000.	0.	8094.	2	1
	4	83.1	10.0	-10.0	8.12	120000.	110000.	0.	12334.	2	1
	5	83.6	10.0	-10.0	8.56	100000.	110000.	0.	16955.	2	1
	6	78.8			3.81	0.	0.	0.	-17578.	2	0
	7	79.0			4.02	0.	0.	0.	-911.	2	0
	8	78.7			3.72	0.	0.	0.	-983.	2	0
	9	79.0			3.96	0.	0.	0.	-772.	2	0
	10	79.1			4.07	0.	0.	0.	-658.	2	0
	11	113.8	10.0	-10.0	38.78	0.	0.	0.	42605.	2	1

Figure 6.3 REPORT T3 (TYPICAL)

SPACE TEMPERATURE FREQUENCY DISTRIBUTION SUMMARY

SPACE NO.	BELOW 50	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-109	110-114	115-119	120-124	ABOVE 124
	* * * * * * * * * * * * * TEMPERATURE OCCURRANCE BANDS (F) * * * * * * * * * * * * *																
1	0	0	0	0	0	2713	5156	889	2	0	0	0	0	0	0	0	0
2	0	0	0	0	2146	1978	3903	628	105	0	0	0	0	0	0	0	0
3	0	0	0	0	2224	2358	3672	457	49	0	0	0	0	0	0	0	0
4	0	0	0	0	2156	2070	3839	607	88	0	0	0	0	0	0	0	0
5	0	0	0	50	2635	2223	3253	548	51	0	0	0	0	0	0	0	0
6	0	0	0	570	1855	2712	3521	102	0	0	0	0	0	0	0	0	0
7	0	0	597	1227	1677	2339	2704	216	0	0	0	0	0	0	0	0	0
8	0	0	666	1231	1712	2472	2521	158	0	0	0	0	0	0	0	0	0
9	0	0	640	1214	1697	2397	2624	188	0	0	0	0	0	0	0	0	0
10	0	14	683	1221	1726	2353	2586	177	0	0	0	0	0	0	0	0	0
11	0	0	0	0	14	108	357	729	1301	1549	1408	1155	826	595	391	239	98

NOTE - ACTUAL SPACE TEMPERATURES ARE ROUNDED TO NEAREST WHOLE DEGREE BEFORE BEING PLACED INTO PROPER TEMPERATURE OCCURRANCE BAND.

Figure 6.4 REPORT T4 (TYPICAL)

SUMMARY OF VARIABLE TEMPERATURE LOAD CALULATIONS

EXAMPLE BUILDING 1 YEAR RUN 1963 CHICAGO WEATHER

SPACE NO.	*******HEATING******** MAX. HEAT ADDITION (BTU/HR)	HOUR/DAY/MO	********COOLING******** MAX. HEAT EXTRACTED (BTU/HR)	HOUR/DAY/MO	***LOWEST SPACE TEMP.*** TEMP. (F)	HOUR/DAY/MO	***HIGHEST SPACE TEMP.*** TEMP. (F)	HOUR/DAY/MO
1	-48497.	7/24/ 1	900000.	7/ 3/ 6	70.7	24/31/12	84.5	21/30/ 6
2	-120000.	7/ 2/ 1	110000.	7/10/ 6	65.0	1/ 2/ 1	85.0	12/ 2/ 6
3	-100000.	7/ 2/ 1	98196.	7/ 1/ 7	65.0	1/ 2/ 1	85.0	15/ 2/ 6
4	-120000.	7/ 2/ 1	110000.	7/ 1/ 7	65.0	1/ 2/ 1	85.0	14/ 2/ 6
5	-100000.	7/ 2/ 1	110000.	7/ 3/ 6	60.2	7/24/ 1	85.0	18/ 2/ 6
6	0.	1/ 2/ 1	0.	1/ 2/ 1	60.8	7/24/ 1	82.0	17/30/ 6
7	0.	1/ 2/ 1	0.	1/ 2/ 1	55.0	6/24/ 1	82.3	17/30/ 6
8	0.	1/ 2/ 1	0.	1/ 2/ 1	54.8	6/24/ 1	82.0	18/30/ 6
9	0.	1/ 2/ 1	0.	1/ 2/ 1	55.0	6/24/ 1	82.0	18/30/ 6
10	0.	1/ 2/ 1	0.	1/ 2/ 1	53.6	9/24/ 1	81.7	18/30/ 6
11	0.	1/ 2/ 1	0.	1/ 2/ 1	65.9	24/31/12	129.5	23/30/ 6

TOTAL BUILDING SENSIBLE HEAT EXTRACTIONS AND ADDITIONS FOR VARIABLE TEMPERATURE ANALYSIS
HEATING = -511351296.
COOLING = 925833728.

NOTE - THE ABOVE HEAT EXTRACTIONS AND ADDITIONS DO NOT INCLUDE
THE EFFECTS OF OUTSIDE VENTILATION AIR.

Figure 6.5 REPORT T5 (TYPICAL)

SECTION 7

SYSTEMS ANALYSIS PROGRAM

7.1 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, certain process loads, and inefficiencies caused by control schedules, the building's hourly heating and/or cooling requirement will be different from the summation of the hourly space transmission and internal loads. The purpose of the Systems Analysis Program is therefore three-fold (See figure 7.1)

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

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

3. Based upon part-load operating characteristics of all energy-consuming equipment, determine the building's hourly, 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 7.1. Schematic diagrams along with brief explanations of operation are illustrated in Figures 7.2 through 7.14. A number of energy conversion systems and types of equipment are available. They are described in paragraph 7.2.2.

TABLE 7.1

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

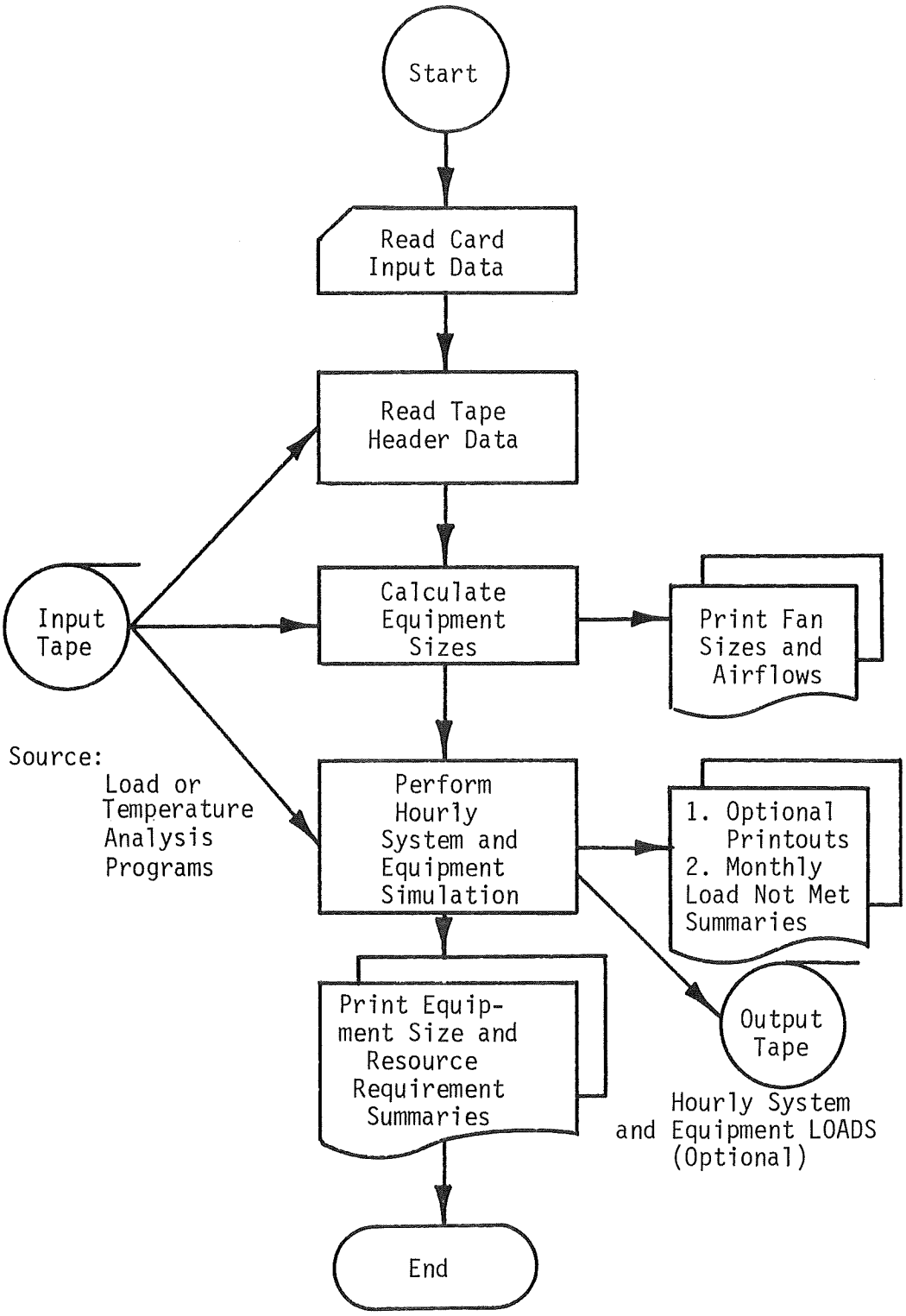


Figure 7.1 SYSTEMS ANALYSIS PROGRAM MACRO FLOW DIAGRAM

7.2 DESCRIPTION OF SYSTEMS

7.2.1 DESCRIPTION OF ENERGY DISTRIBUTION SYSTEMS

DISTRIBUTION SYSTEM NO. 1
SINGLE ZONE FAN SYSTEM WITH FACE AND BY-PASS DAMPERS (see Figure 7.2)

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

- Optional return air fan simulation
- Humidifier simulation
- The mixed air control options
- Baseboard heat as supplemental heat to each zone
- Optional heat recovery device (sensible and latent heat)
- Exhaust air from each zone
- Scheduled ventilation air
- User or program sizing of zone supply air flows.

DISTRIBUTION SYSTEM NO. 2
MULTI-ZONE FAN SYSTEM (see Figure 7.3)

The components of the multi-zone fan system include a mixed air section, preheat coil, blow-thru fan section, heating and cooling coils in parallel, and a humidifier. Hot and cold air streams are mixed as required at the unit. The specific functioning and options of this fan system are 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 supplemental heat to each zone
- Preheat coil. This will function to raise the mixed air dry-bulb temperature to a preset minimum ($40^{o}F$).
- 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.

- Exhaust air from each zone
- Scheduled ventilation air
- Optional heat recovery device (sensible and latent heat)
- User or program sizing of zone supply air flows.

DISTRIBUTION SYSTEM NO. 3
DUAL DUCT FAN SYSTEM (see Figure 7.4)

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 in mixing boxes usually located near the zone it serves. 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 supplemental heat to each zone
- Preheat coil. This will function to raise the mixed air dry-bulb temperature to a predefined minimum ($40^{o}F$).
- 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.
- Exhaust air from each zone.
- Scheduled ventilation air.
- Optional heat recovery device (sensible and latent heat).
- User or program sizing of zone supply air flows.

DISTRIBUTION SYSTEM NO. 4
SINGLE ZONE FAN SYSTEM WITH SUB-ZONE REHEAT (see Figure 7.5)

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

Elements and operating characteristics of this fan system include:

- Optional return air fan simulation
- Humidifier
- Three outside air/return air options with the economizer attempting to equal required cold deck temperature
- Baseboard heating as supplemental heat to each zone
- Primary heating coil
- Cooling coil with face and by-pass dampers
- Air temperature leaving air handler controlled by thermal requirements of central zone
- Fan air quantities vary: zone supply air quantities remain constant due to operation of all-air induction box
- Reheat coils.
- Exhaust air from each zone
- Scheduled ventilation air
- Optional heat recovery device (sensible and latent heat)
- User or program sizing of zone supply air flows.

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. 5
UNIT VENTILATOR (see Figure 7.6)

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

Elements and operating characteristics of this system include:

- Humidifier
- Fixed outside air quantity may be modified by Ventilation Scheduling (as function of time of day, day of week).
- Exhaust air from each zone.
- Optional heat recovery device (sensible and latent heat).
- User or program sizing of zone supply air flows.

DISTRIBUTION SYSTEM NO. 6
UNIT HEATER (see Figure 7.7)

This simulation is primarily designed for a unit heater serving one zone (i.e., a unit heater free-standing in a room). It may, however, be extended to simulate a number of zones (i.e., an air handler with supply and return ductwork to several zones). This system is not capable of introducing outside air. If used to serve a number of zones, note that supply air temperature is determined by the first zone. Reheating for the others does not occur.

DISTRIBUTION SYSTEM NO. 7
FLOOR PANEL HEATING SYSTEM (see Figure 7.8)

The floor panel heating system is designed to simulate either on-grade slabs or intermediate slabs as shown in the sketches in Figure 7.8. 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 (see Figure 7.9)

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

- The blower runs continuously (unless turned off by the T.V. 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 (see Figure 7.10)

A four-pipe fan coil system circulates water through two distribution systems (a hot and a chilled water circuit). The fan coil unit, consisting of a blower and usually two coils, is controlled by a space thermostat which regulates coil flow. A net heat gain in the space causes the thermostat to allow flow through the cooling coil, and prohibit flow through the heating coil; for a net heat loss, the 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 T.V. program).

DISTRIBUTION SYSTEM NO. 10
TWO-PIPE INDUCTION UNIT FAN SYSTEM (see Figure 7.11)

The two-pipe induction system utilizes air and circulated water to achieve temperature control. The induction unit itself consists of a nozzle which injects primary air into a mixing chamber. 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.
- Exhaust air from each zone
- Scheduled ventilation air
- Optional heat recovery device (sensible and latent heat)
- User or program sizing of zone supply air flows

DISTRIBUTION SYSTEM NO. 11
FOUR-PIPE INDUCTION UNIT FAN SYSTEM (see Figure 7.12)

The four-pipe induction system is comprised of a primary supply air and hot and chilled water distribution networks feeding air-water induction-type therminal devices. The primary air which is held at a constant temperature (at about 55°F) serves to control humidity in the space as well as provide ventilation air as required. This primary air is mixed with recirculated room air at the terminal unit. Room air is tempered by first passing it through a coil in the induction unit which may heat or cool it as required such that the mixed air delivered to the space satisfies thermal requirements. The coil is controlled by a thermostat which 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
- Exhaust air from each zone
- Scheduled ventilation air
- Optional heat recovery device (sensible and latent heat)
- User or program sizing of zone supply air flows.

DISTRIBUTION SYSTEM NO. 12
VARIABLE VOLUME FAN SYSTEM WITH OPTIONAL REHEAT (see Figure 7.13)

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.

Other characteristics and options available with this fan system are as follows:

- Optional return air fan
- Humidifier
- Three outside air/return air options
- Baseboard heating as supplemental heating for each zone
- Exhaust air from each zone
- Scheduled ventilation air
- Optional heat recovery device (sensible and latent heat)
- User or program sizing of zone supply air flows.

DISTRIBUTION SYSTEN NO. 13
CONSTANT VOLUME REHEAT FAN SYSTEM (see Figure 7.14)

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

- Optional return air fan
- Humidifier
- Three outside air/return air options
- Baseboard heating as supplemental heating to each zone
- Primary air temperature control options:
  1) Fixed discharge temperature
  2) Air temperature determined by room requiring coolest air. This is achieved by a solid state-type temperature control system which monitors temperatures of spaces served by the unit.
  3) Reset temperature as an inverse function of outside air temperature.
- Exhaust air from each zone
- Scheduled ventilation air
- Optional heat recovery device (sensible and latent heat)
- User or program sizing of zone supply air flows.

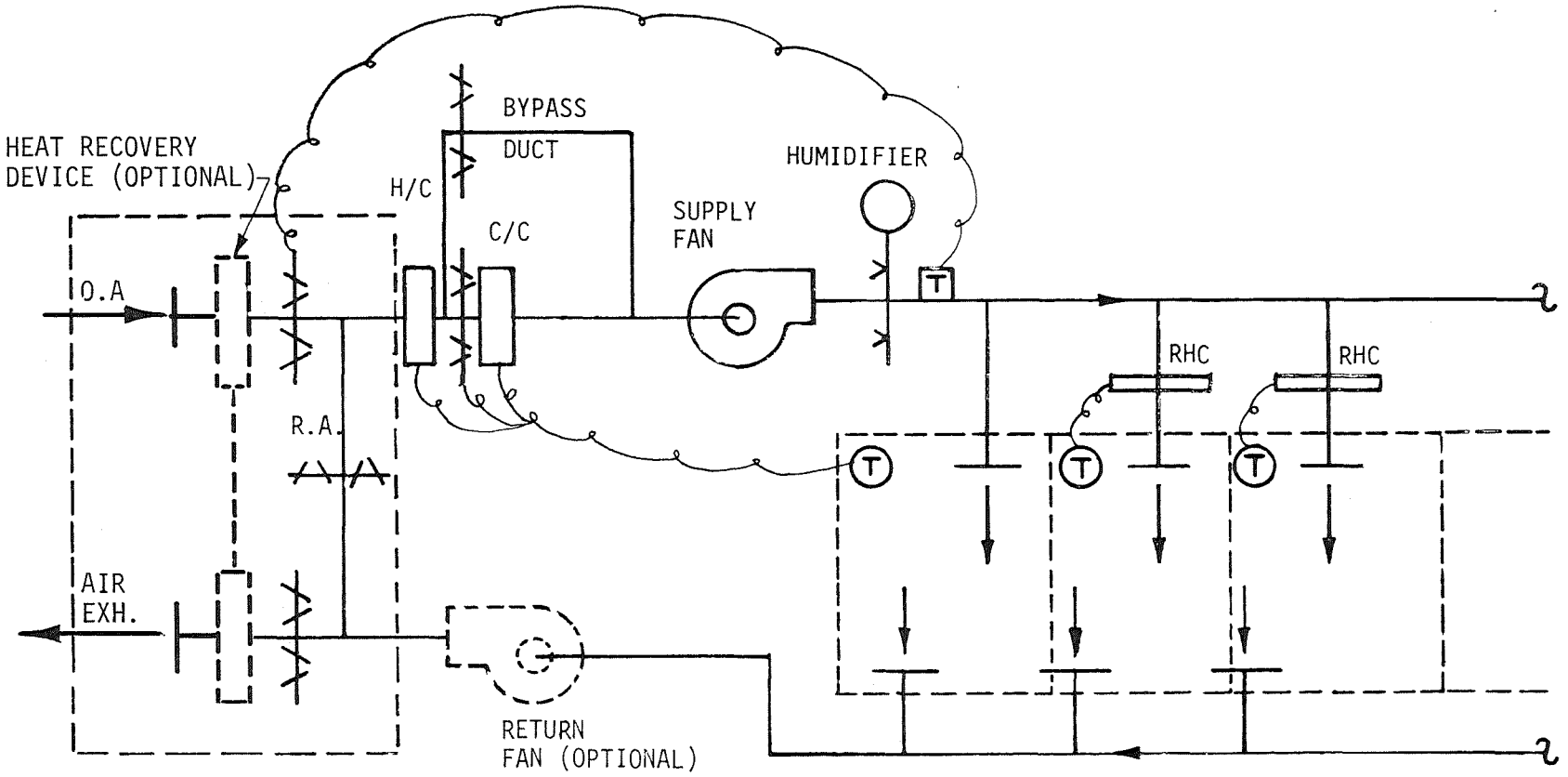


Figure 7.2 SINGLE ZONE FAN SYSTEM WITH FACE AND BYPASS DAMPERS (DISTRIBUTION SYSTEM NO. 1)

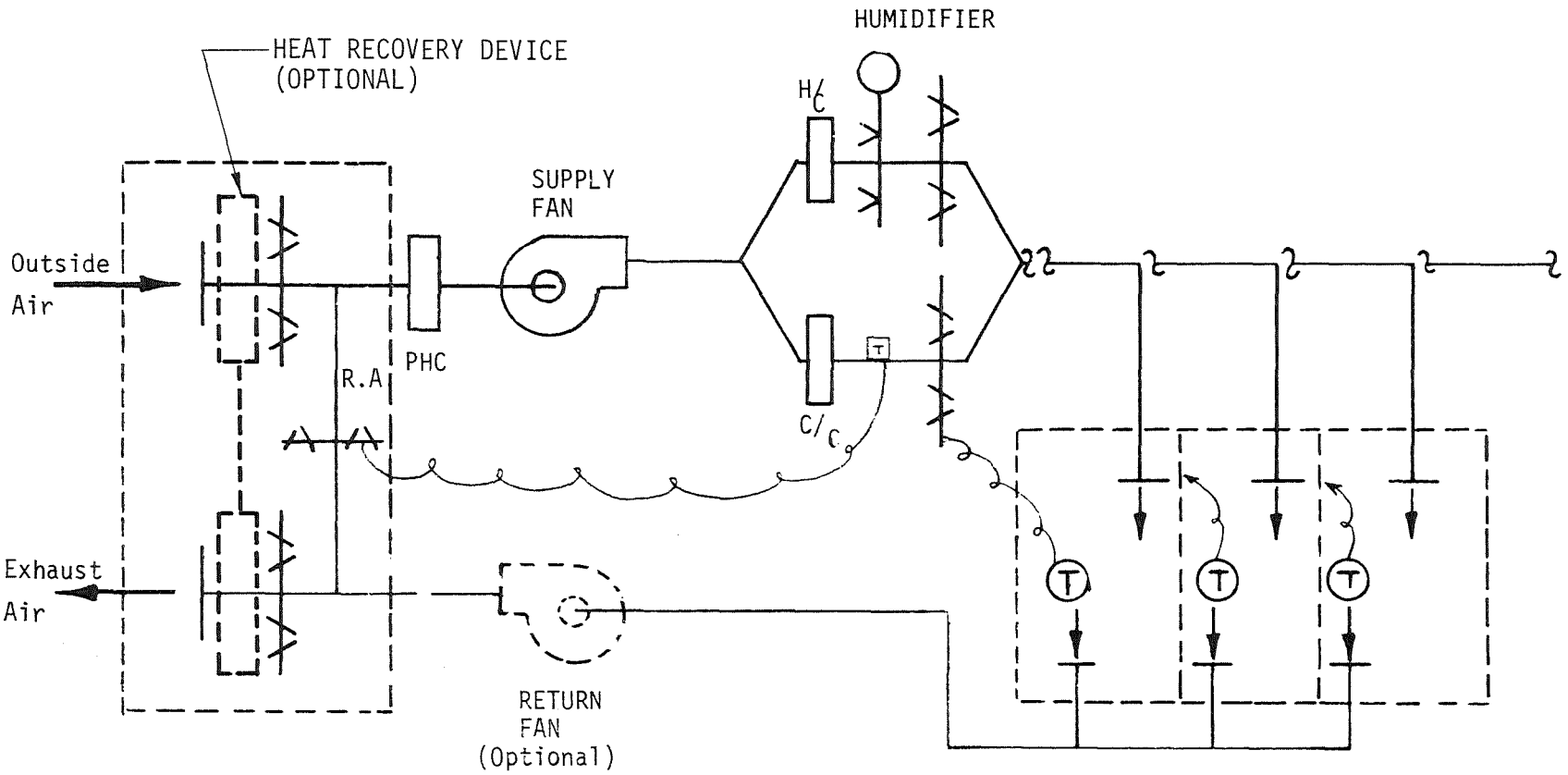


Figure 7.3 MULTI-ZONE FAN SYSTEM (DISTRIBUTION SYSTEM NO. 2)

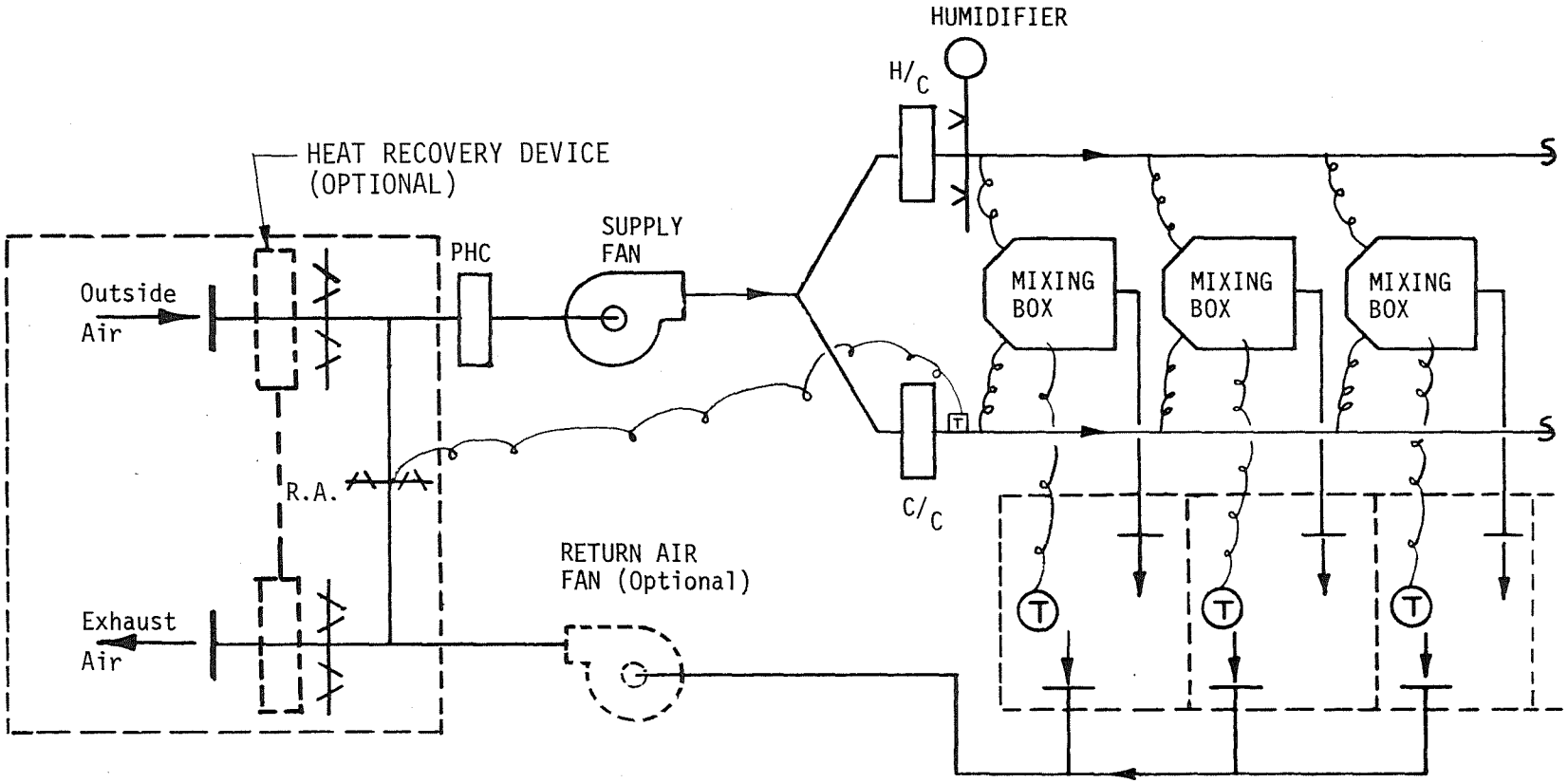


Figure 7.4 DUAL DUCT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 3)

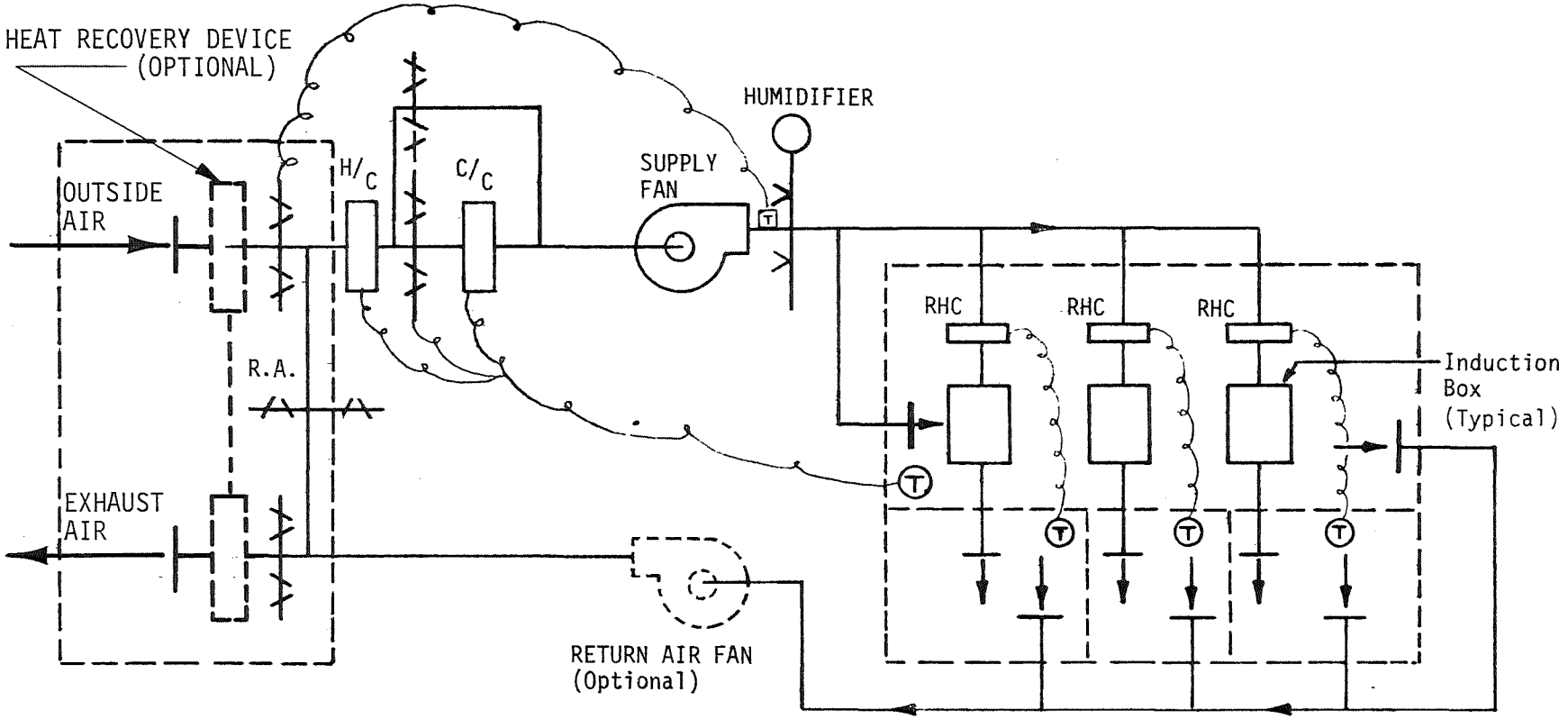


Figure 7.5 SINGLE ZONE FAN SYSTEM WITH SUB-ZONE REHEAT (DISTRIBUTION SYSTEM NO. 4)

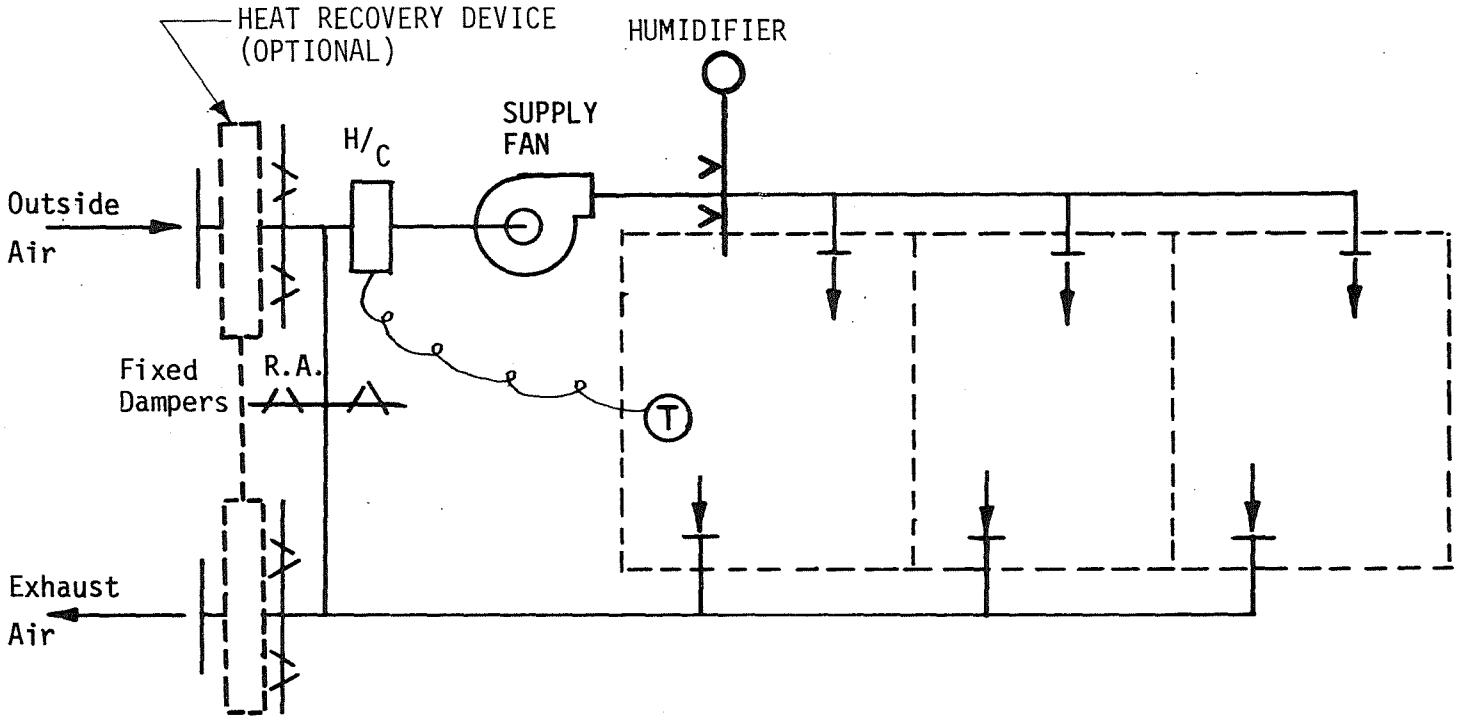
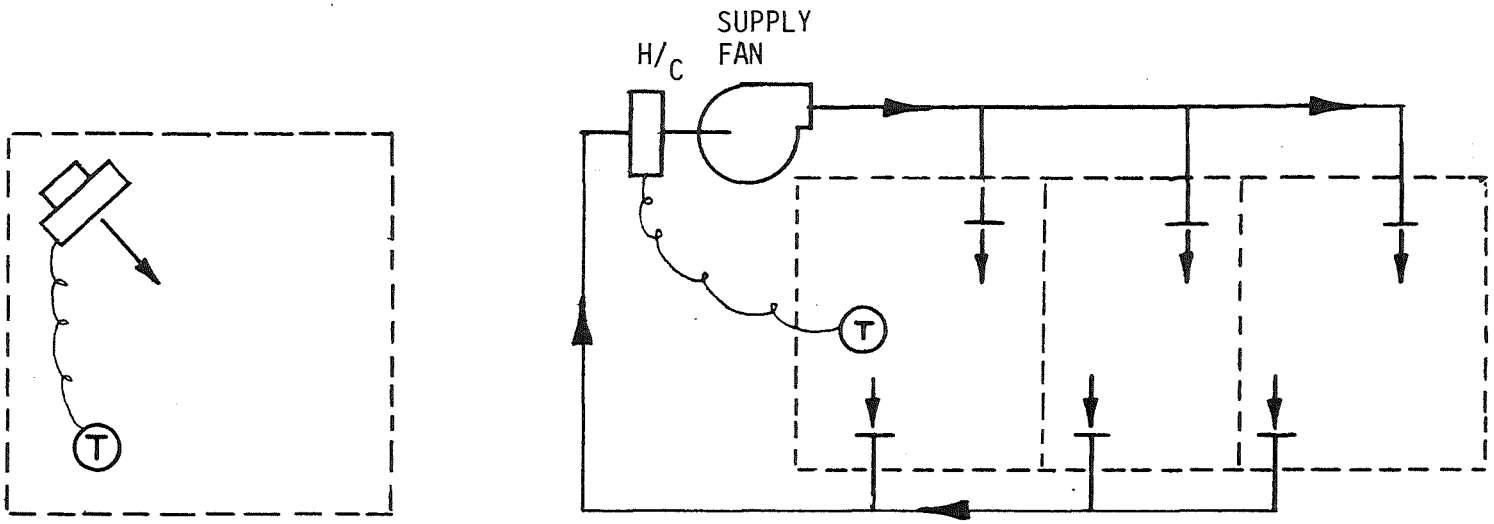


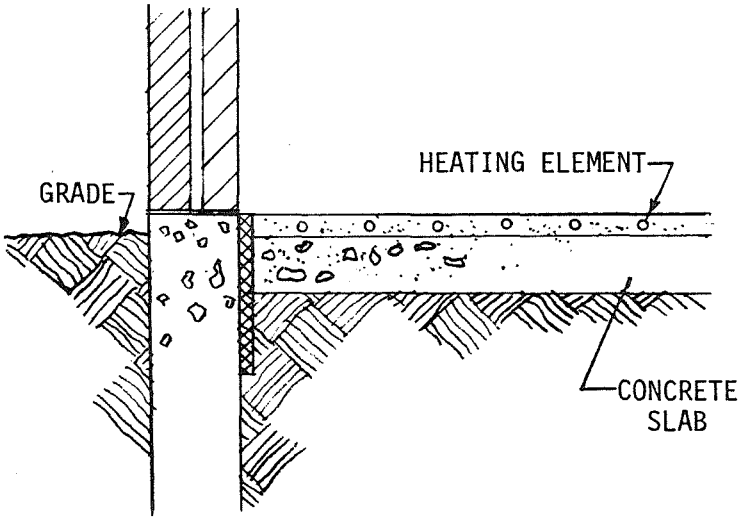
Figure 7.6 UNIT VENTILATOR (DISTRIBUTION SYSTEM NO. 5)



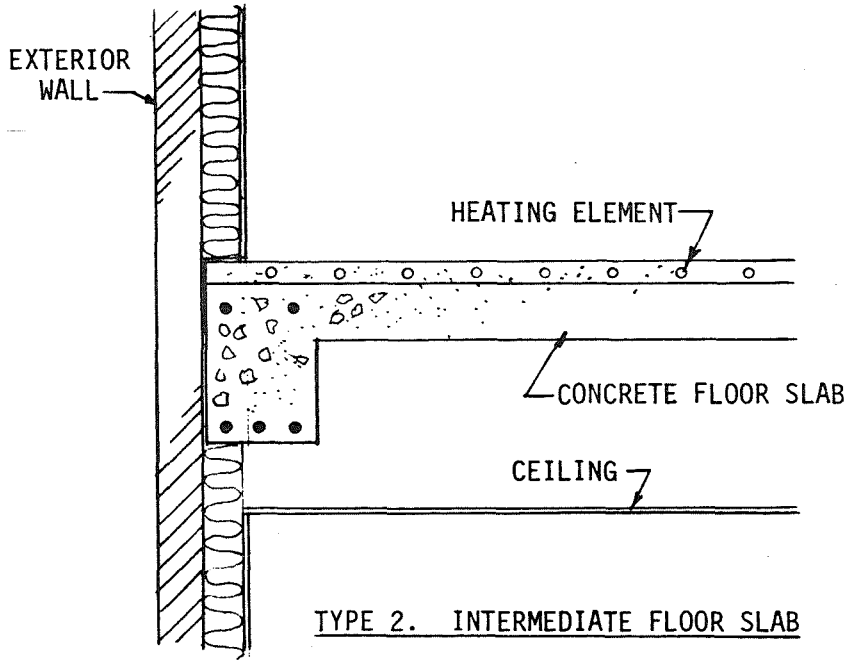
ONE-ZONE SCHEMATIC

MULTIPLE-ZONE SCHEMATIC

Figure 7.7 UNIT HEAT DISTRIBUTION SYSTEM (SYSTEM NO. 6)



TYPE 1. ON-GRADE FLOOR SLAB



TYPE 2. INTERMEDIATE FLOOR SLAB

Figure 7.8 FLOOR PANEL HEATING SYSTEM (DISTRIBUTION SYSTEM NO. 7)

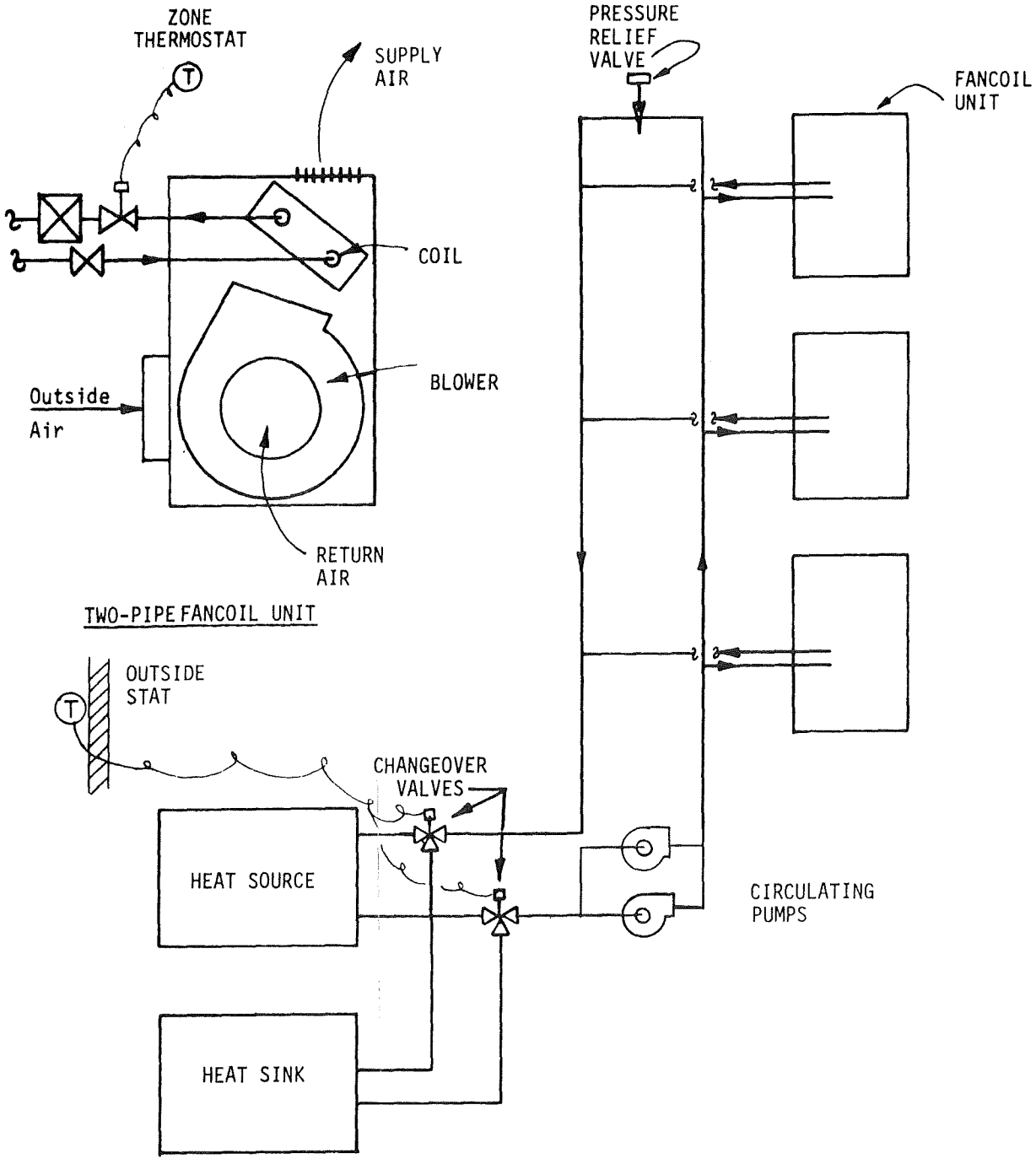


Figure 7.9 TWO-PIPE FANCOIL SYSTEM (DISTRIBUTION SYSTEM NO. 8)

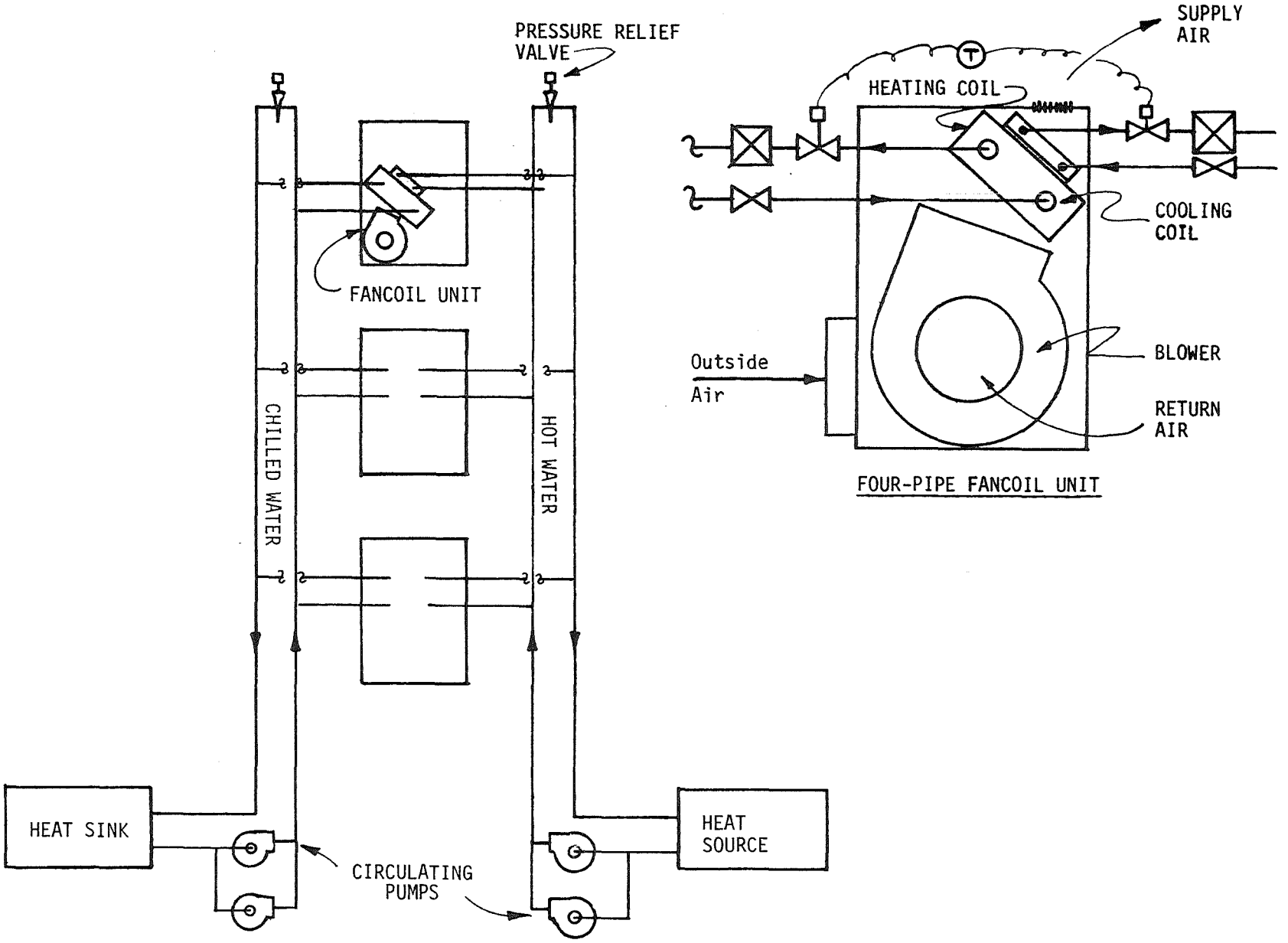


Figure 7.10 FOUR-PIPE FANCOIL SYSTEM (DISTRIBUTION SYSTEM NO. 9)

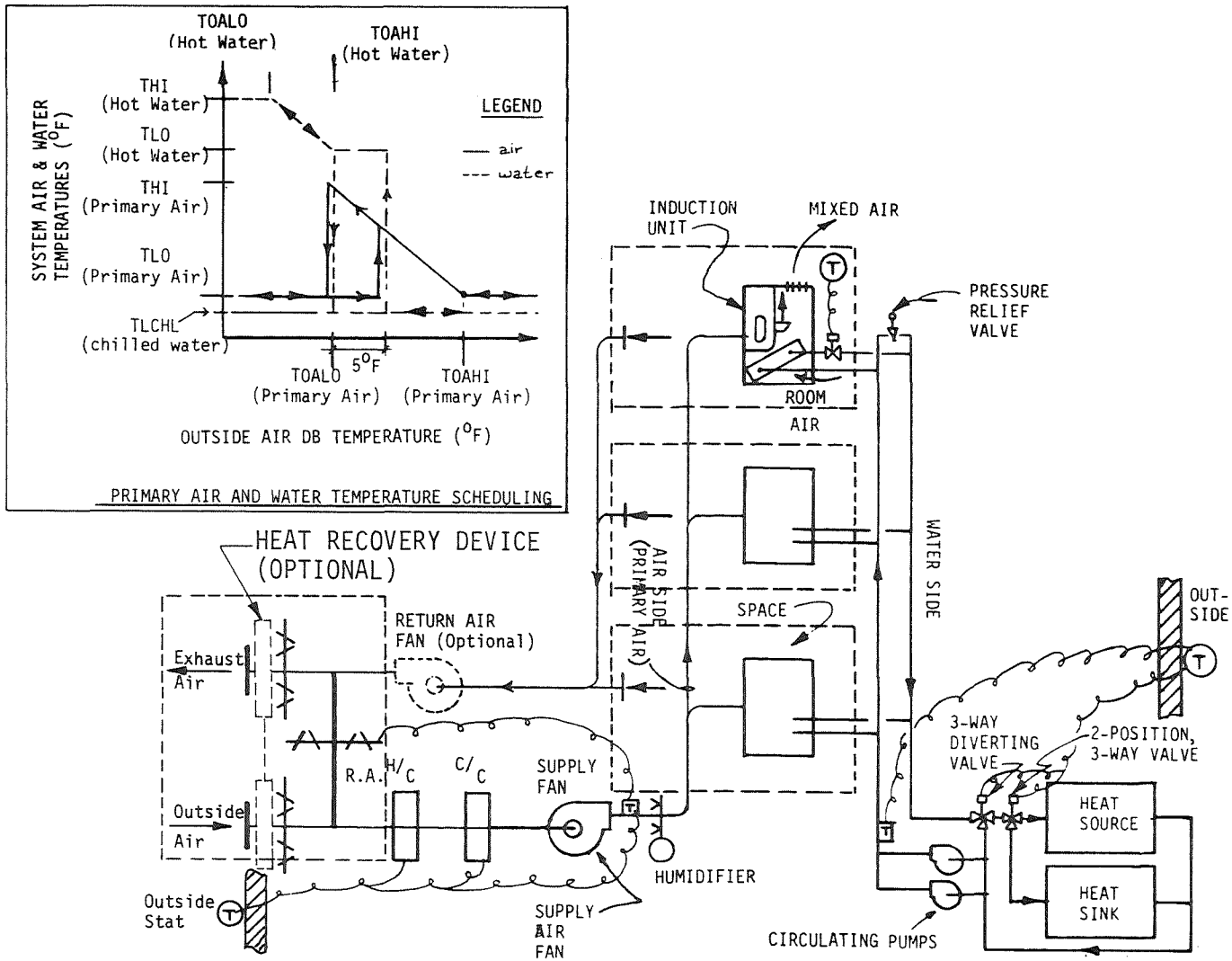


Figure 7.11 TWO-PIPE INDUCTION UNIT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 10)

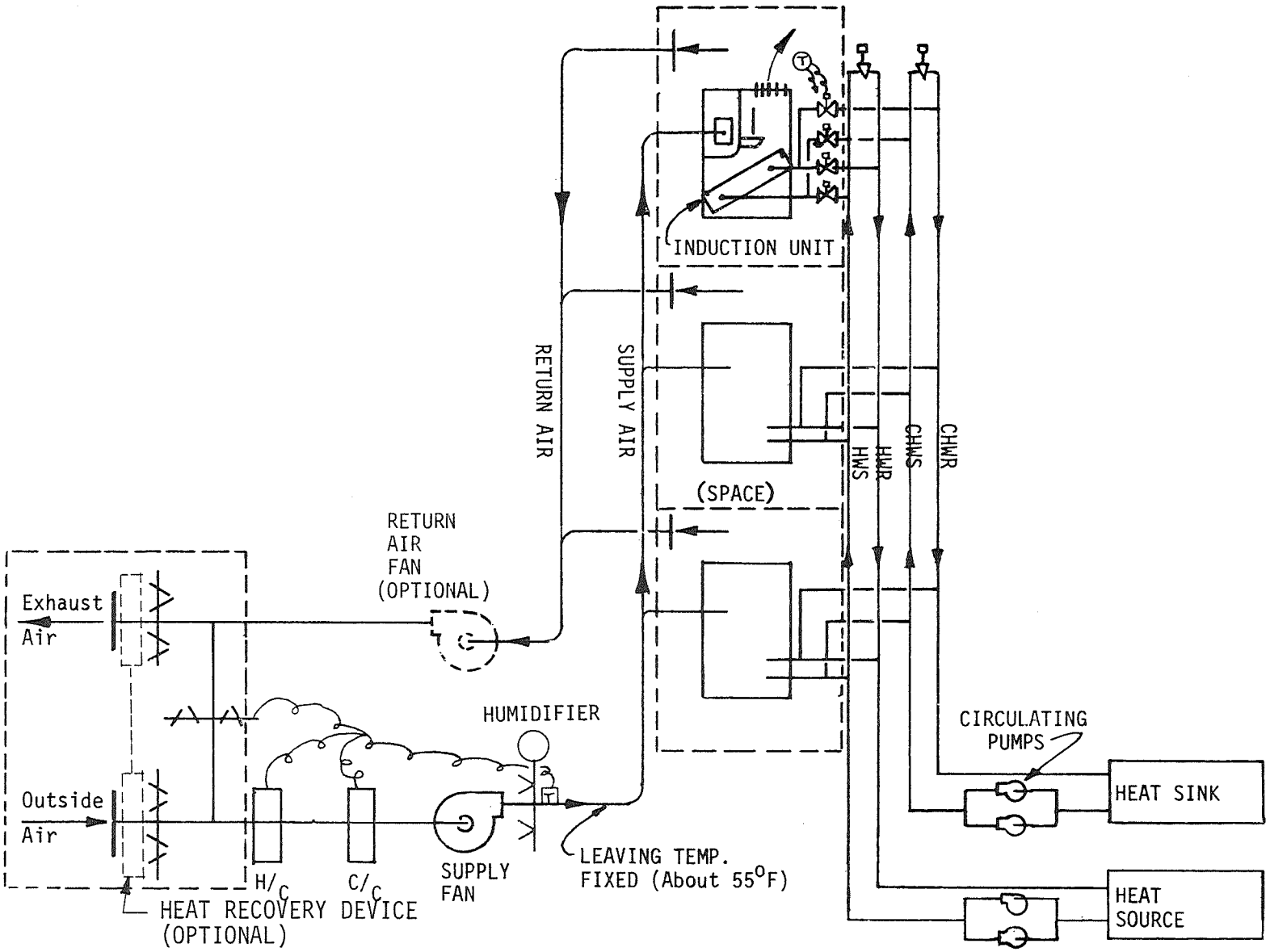


Figure 7.12 FOUR-PIPE INDUCTION UNIT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 11)

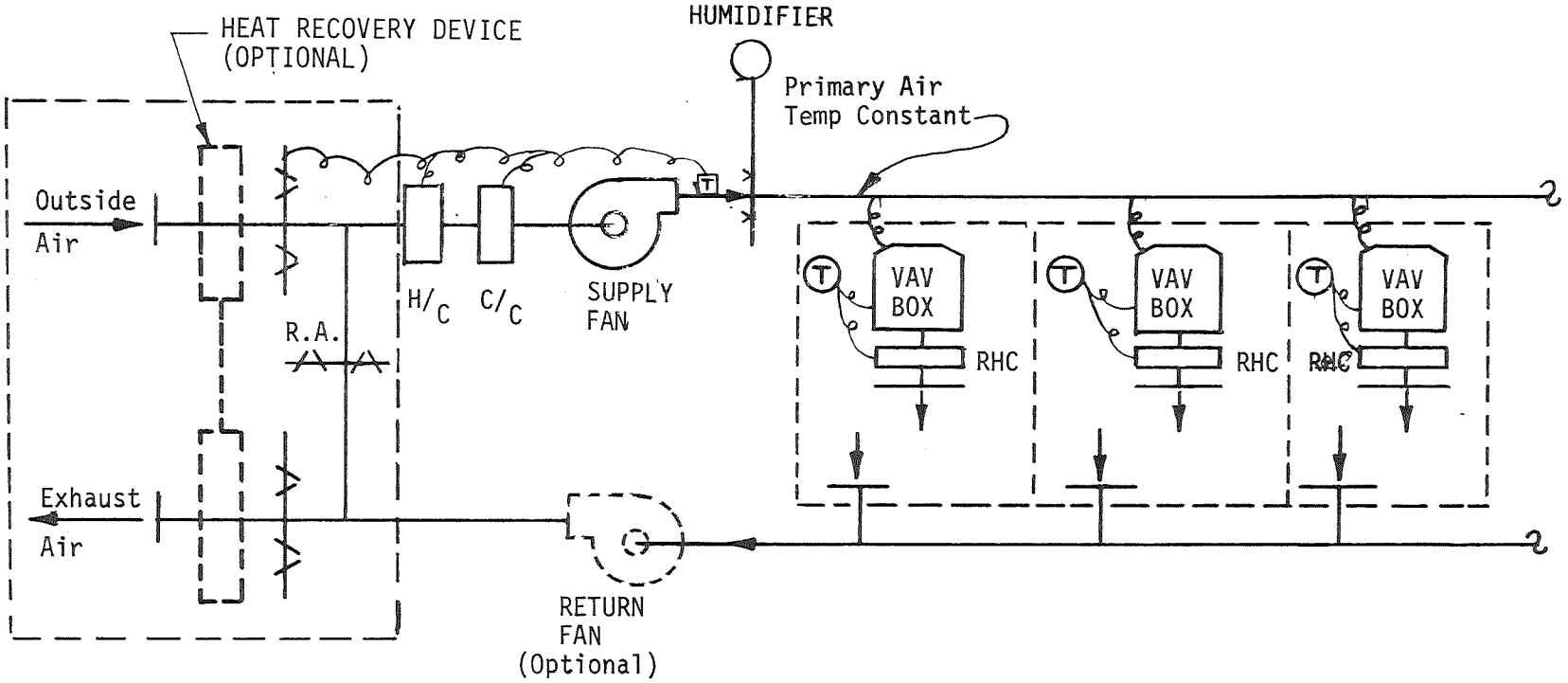


Figure 7.13 VARIABLE VOLUME FAN SYSTEM WITH OPTIONAL REHEAT (DISTRIBUTION SYSTEM NO. 12)

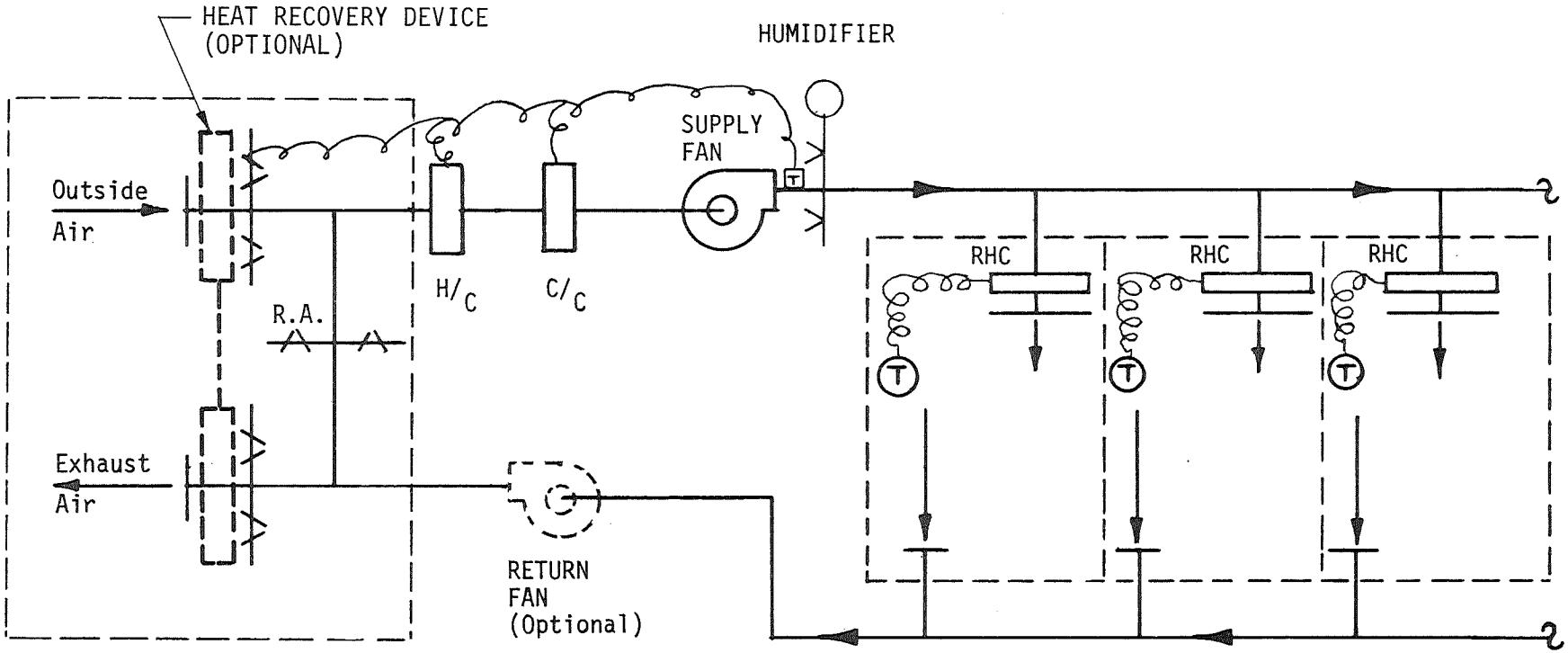


Figure 7.14 CONSTANT VOLUME REHEAT FAN SYSTEM (DISTRIBUTION SYSTEM NO. 13)

7.2.2 DESCRIPTION OF ENERGY CONVERSION SYSTEMS

Thermal loads calculated by the energy distribution system segment of the program are then handled by the energy conversion system segment. In simulating energy conversion systems, a number of options are available to the user. (see Table 7.2)

There are basically two types of energy conversion systems available - (1) a central plant serving one or more distribution systems and (2) unitary equipment serving one fan system.

An all-inclusive schematic diagram of the equipment simulation segment's capabilities is given in Figure 7.15. Obviously, all of the program's capabilities would not be generally used in one run. In modeling a system, the user need define only those parts of the system required. Those undefined portions will be de-activated and hence not simulated.

There are differences in the handling of thermal loads by central and unitary equipment to calculate fuel resources needed to meet these loads. Table 7.3 itemizes the load handling techniques used for central equipment, DX unitary equipment, and heat pump unitary equipment. Note that main heating coil and central cooling coil loads are processed differently.

TABLE 7.2

ENERGY CONVERSION SYSTEMS

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

* One Unit serves one Fan System

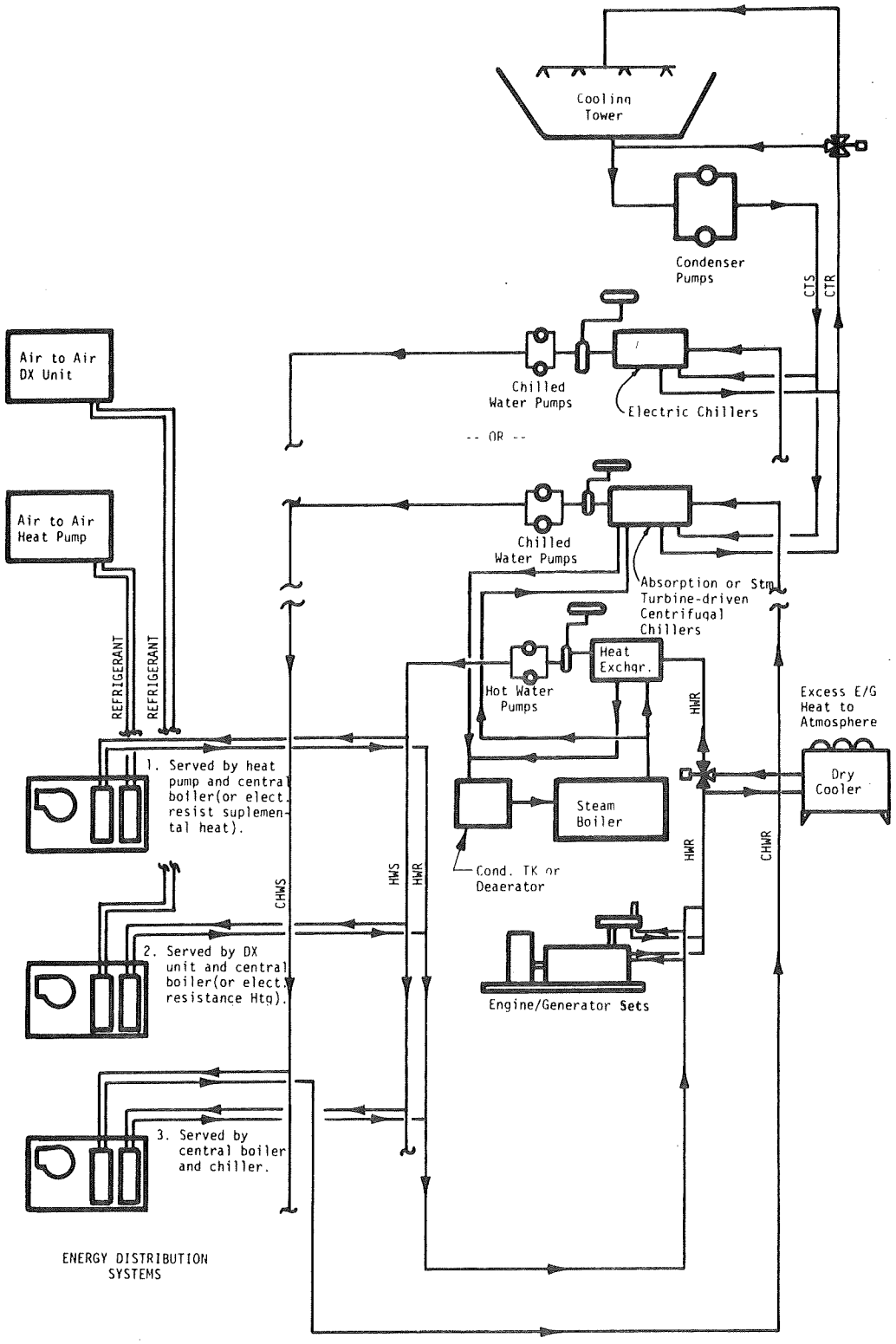


Figure 7.15 SYSTEMS ANALYSIS PROGRAM. EQUIPMENT SIMULATION SCHEMATIC DIAGRAM.

Table 7.3 ENERGY CONVERSION SYSTEM LOAD HANDLING

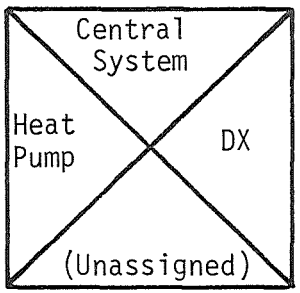
Load Source	Energy Distribution System Load Handling On Monthly Load Summary Table		Load Handling Equipment				
			Central Equipment			Unitary Equipment	
	Heating	Cooling	Reheat Coils	Boiler	Central Chiller	Heat Pump	DX Unit
Main Heating coil (or Hot Deck Coil)	√		*√	√		√	
Preheat Coil	√			√			
Reheat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

LEGEND

√ = Applies

- = DNA

* = Supplemental Heating Load



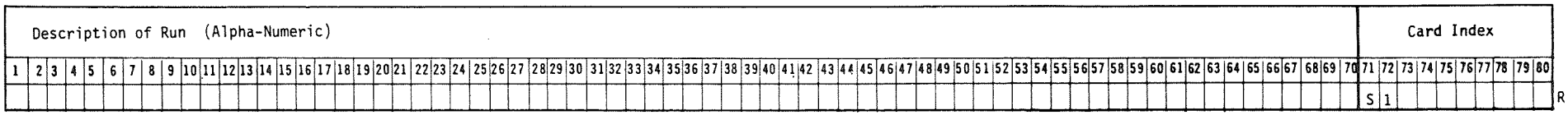
7.3 INPUT DATA DESCRIPTION

This section is devoted to a detailed explanation of all input variables to the Systems Analysis Program.

The card types used in the Systems Analysis Program are as follows:

Card type	
S-1	Description of run
S-2	Job control parameters
S-3	Job control parameters
S-4	Hourly print periods
S-5	Temperature reset schedules
S-6A	Ventilation schedules
S-6B	Non-Standard twenty-four hour profiles
S-7A	Energy Distribution System Data
S-7B	Energy Distribution System Data
S-7C	Energy Distribution System Data
S-7D	Energy Distribution System Data
S-7E	Energy Distribution System Data
S-8	Space Data
S-9	Primary equipment description
S-10	Boiler description
S-11	Chiller description
S-12	Pump Heads
S-13	Miscellaneous
S-14	Steam & steam turbines
S-15	Floor panel heating systems
S-16A	DX and heat pump design characteristics
S-16B	Cooling performance data
S-16C	Heating performance data
S-17	Process Loads

CARD TYPE S-1



- Description of Run (Cols. 1-70)

  Both alpha, numeric, and special characters (* . , / $ - +) may be entered in this 70 column field to describe the run. This information is printed at the top of the input recap report. As additional identification, five ID terms are carried through from the LOAD run. The user may also identify each primary equipment combination by another input form appearing on card type S-9.

CARD TYPE S-2

JOB CONTROL PARAMETERS

JOB CONTROL PARAMETERS

Begin Analysis Month/Day	End Analysis Month/Day	Number of Hourly Print Periods	Number of Reset Schedules	Number of Operating Schedule Types	Number of Zones On Input Tape		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 2

R

- <u>Begin Analysis (month/day)</u> (Cols. 1-5)

  This is the day the hourly analysis may begin. Enter the month of the year in cols. 1 and 2 (01 thru 12)
  Enter the day of the month in cols. 4 and 5 (01 thru 31)
  If the first entry on the input tape occurs earlier than the start date, the tape will space ahead to the first hour of the day the hourly system analysis is to begin.
  If the first entry on the input tape is later in the year than the begin analysis date, the analysis will begin at the first entry.
  If the program is to size distribution system equipment and/or engine/generator sets, all information on the input tape will be scanned by the sizing routine regardless of begin and end analysis dates. The tape will then be rewound and spaced forward to the first hour of the day on which the analysis is to begin.

- <u>End Analysis (month/day)</u> (Cols. 11-15)

  This is the day the hourly analysis may end. Enter the month of the year in cols 11 and 12 (01 thru 31)
  Enter the day of the month in cols 14 and 15 (01 thru 31)
  If the last entry on the input tape occurs later than the end analysis date, the hourly system analysis will terminate after the last hour of the end analysis date.
  If the last entry of the input tape occurs before the end analysis date, the hourly analysis will terminate after the last input tape entry.

- <u>Number of Hourly Print Periods</u> (Cols. 21-30)

  The term indicates the number of Hourly Print Period Cards (Card Type S-4) which are to be read. From 0 to 14 print periods may be defined.

- <u>Number of Reset Schedules</u> (Cols. 31-40)

  This term defines the number of Temperature Reset Schedule cards (Card Type S-5) to be read. Up to 5 reset schedules are allowed.

- <u>Number of Operating Schedule Types</u> (Cols. 41-50)

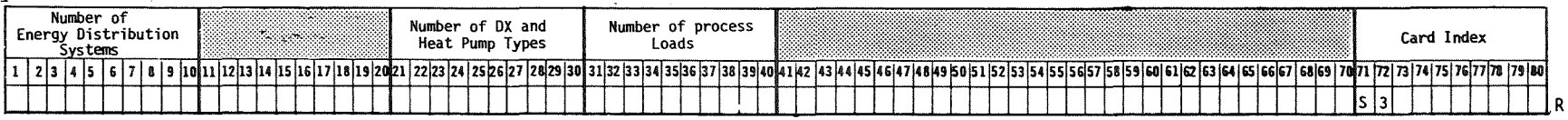
  The variable denotes the number of Operating Schedule cards (Card Type S-6A) which are to be read. Up to 10 operating schedules are allowed

- <u>Number of Zones on Input Tape</u> (Cols. 51-60)

  The variable represents the total number of spaces (plenum spaces, also) found on the input tape.

CARD TYPE S-3

JOB CONTROL PARAMETERS



- Number of Energy Distribution Systems (Cols. 1-10)

  The term indicates the number of Energy Distribution Systems(Card Types S-7A through S-7E) to be included in this run. From 1 to 20 Distribution Systems may be defined.

- Reserved (Cols. 11-20)

- Number of DX and Heat Pump Types (Cols.21-30)

  This term defines the number of DX and Heat Pump types (Card Type 16A) to be used. From 0 to 20 DX and Heat Pump types may be input.

- Number of Process Loads (Cols.31-40)

  Indicate how many process load input cards (Card Type S-17) are to be used. This number ranges from 0 to 10.

CARD TYPE S-4

HOURLY PRINT PERIODS

HOURLY PRINT PERIODS (If number of hourly print periods=0., skip card type S-4)

Begin Print Month/Day	Finish Print Month/Day	Print-1 (Weather & Hourly Loads) 0.=Off/1.=On	Print-2 (System Data) 0.=Off/1.=On	Print-3 (Component Data) 0.=Off/1.=On		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
1 / /	/ /					S 4
2 / /	/ /					
3 / /	/ /					
4 / /	/ /					
5 / /	/ /					
6 / /	/ /					
7 / /	/ /					
8 / /	/ /					
9 / /	/ /					
10 / /	/ /					
11 / /	/ /					
12 / /	/ /					
13 / /	/ /					
14 / /	/ /					

- Begin Print (month/day) (Cols. 1-5)

  This is the day a print period may begin.
  Enter the month of the year in cols. 1 and 2
  Range:(01 through 12 ,where 01= Jan.,
  02= Feb., etc.)

  Enter the day of the month in cols. 4 and 5
  Range: (01 through 31)

- Finish Print (month/day) (Cols. 11-15)

  This is the last day of the print period.

  Enter the month of the year in cols. 11 and 12.

  Enter the day of the month in cols. 14 and 15.

- Print - 1 (Weather and Hourly Loads) (Cols. 21-30)

  To print weather data, distribution system loads, and central plant input, enter 1.0 in this field.

- Print - 2 (System Data) (Cols. 31-40)

  If hourly performance information from each distribution system is desired, enter 1.0 in this field.

- Print - 3 (Component Data) (Cols. 41-50)

  If hourly performance information of various distribution system components is desired, enter 1.0 in this field.

  NOTE

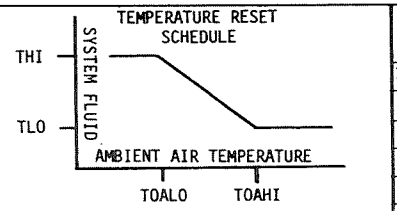
  Judicious use should be made of print periods as they are capable of generating voluminous output. For most cases, activating Print-1 only will provide sufficient information.

CARD TYPE S-5

TEMPERATURE RESET SCHEDULES

TEMPERATURE RESET SCHEDULES (If number of reset schedules=0.,skip card type S-5)

Reset Schedule No.	Low Outside Air Temp.(°F) (TOALO)										High Outside Air Temp.(°F) (TOAHI)										Low System Fluid Temp.(°F) (TLO)										High System Fluid Temp.(°F) (THI)										Schedule Label (Alpha-Numeric)										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	71	72	73	74	75	76	77	78	79	80
1																																																			S	5							
2																																																										
3																																																										
4																																																										
5																																																										



All temperature reset schedules are defined at this point. They are used to simulate ambient reset thermostats. Application is made in calculating boiler water temperature for a number of hydronic system references as well as air temperature reset for use with fan systems. The schedules are addressed on card type S-7C by their index numbers which are defined by order of appearance of this card type.

- Low Outside Air Temperature (°F) (TØALØ) (Cols. 1-10)

  This ambient dry bulb temperature corresponds to the system fluid high temperature.

- High Outside Air Temperature (°F) (TOAHI) (Cols. 11-20)

  This ambient dry bulb temperature corresponds to the system fluid low temperature.

- Low System Fluid Temperature (°F) (TLO) (Cols. 21-30)

- High System Fluid Temperature (°F) (THI) (Cols. 31-40)

- Schedule Label (Alphanumeric) (Cols. 41-50)

  This field is given to assist the user in identifying reset schedules.

CARD TYPE S-6A

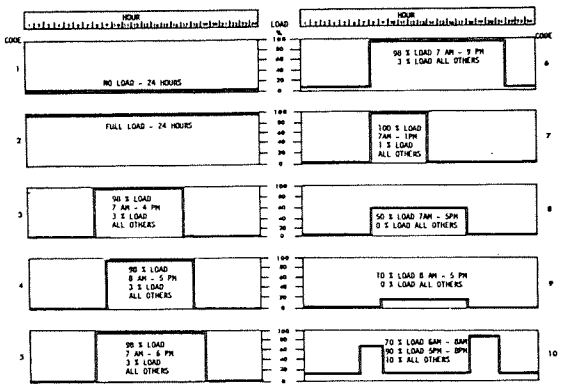
OPERATING SCHEDULE DEFINITION

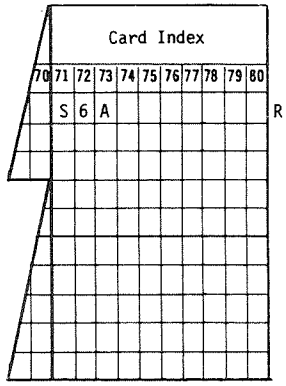
OPERATING SCHEDULES (If number of operating schedule types=0., skip card types S-6A and S-6B)

OPERATING SCHEDULE NO.	Sun. (1.-20.)					Weekday (1.-20.)					Sat. (1.-20.)					Holiday (1.-20.)					Label (Alpha-Numeric)										
	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
1																															
2																															
3																															
4																															
5																															
6																															
7																															
8																															
9																															
10																															

(Operating schedules are applied to ventilation and process load scheduling.)

STANDARD TWENTY-FOUR HOUR PROFILES





The operating schedules define below allow the user to simulate ventilation and process load requirements which change as a function of time of day and day of week.
The factors defined here are used to redefine ventilation rates by multiplying them times the fixed or minimum outside air volume entered in the distribution system description. Process loads are calculated by muliplying process peak loads (See S-17) times the operating schedule factors. Note that 10 (standard) twenty-four hour profiles have been built into the program. These are referenced by index numbers 1 through 10. The user may define up to 10 additional (or non-standard) twenty-four hour profiles which are referenced by index numbers 11 through 20.

- Sunday (1-20) (Cols. 1-5)

  Enter the twenty-four hour profile index to be used on Sundays.

- Weekday (1-20) (Cols. 6-10)

  Enter the twenty-four hour profile index to be used on weekdays (Monday through Friday)

- Saturday (1-20) (Cols. 11-15)

  Enter the twenty-four hour profile to be used on Saturdays

- Holidays (1-20) (Cols. 16-20)

  Enter the twenty-four hour profile to be used on holidays. This schedule will be used for the following U.S. holidays:
  1 January - New Year's Day
  22 February - Washington's Birthday
  30 May - Memorial Day
  4 July - Independence Day
  - September - Labor Day
  - November - Thanksgiving
  25 December - Christmas

- Label (alpha-numeric) (Cols. 21-30)

  This term is provided for the user's convenience in identifying ventilation schedule types.

CARD TYPE S-6B

NON-STANDARD TWENTY-FOUR HOUR PROFILES

NON-STANDARD TWENTY-FOUR HOUR PROFILES

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	12 MID-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																									S 6 B
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

Use one of these card types for each non-standard twenty-four hour profile referenced in defining ventilation and process schedules. In controlling ventilation the term entered here will be used as factors to modify minimum or fixed outside air quantities. In controlling process loads, these terms will modify peak process loads given on card type S-17. Enter a value between 0.0 and 1.0 in each of the three-column fields for each hour of the day.

Ventilation Example: The fixed outside air quantity of a unit ventilator in a restaurant is 20,000 cfm. However when the building is closed closed, the system reverts to 100% recirculation (no outside air). To model this, enter multiplication factor of 1.0 during open hours and 0.0 during closed hours on card type S6B. If for some reason the system were to be throttled back to 10% of the fixed value when closed, enter .10 for those hours.

ENERGY DISTRIBUTION SYSTEM DEFINITION

To define a distribution system and its associated zones, card types S-7 (A thru E) and S-8 are used. Card types S-7 (A thru E) pertain to distribution systems; Card type S-8 is used to describe zones. For each distribution system, the following format is used:

CARD TYPE	
S-7A S-7B S-7C S-7D S-7E	Distribution System Data
S-8 ⋮ S-8	Zone Description Data for the above system (one card for each zone)
S-7A S-7B etc.	REPEAT FOR NEXT DISTRIBUTION SYSTEM.

CARD TYPE S-7A

ENERGY DISTRIBUTION SYSTEM DATA

ENERGY DISTRIBUTION SYSTEM DATA SYSTEM NO:_____ SYSTEM TYPE:_____

Type of Distribution System	No. Zones on System	Relative Humidity Set Point (%)	Fixed or Min. Outside Air (SCFM)	Mixed Air Option	Variable Volume Fan Control Type		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 7 A R

- Type of Distribution System (Cols. 1-10)

Enter the index of the distribution system type in this field. At present, there are 13 types of energy distribution systems available. The code for each distribution system type is listed below.

DISTRIBUTION SYSTEM TYPES

Code	Description
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

This applies to all system types.

- Number of Zones on System (Cols. 11-20)

Enter here the number of zones served by this system. This number will correspond with the number of zones (card type S-8) defined immediately following the distribution system description data. Number should not include associated return air plenums, if any. This applies to all system types.

- Relative Humidity Setpoint (% R.H.) (Cols. 21-30)

Enter here the setting of the space humidistat. The humidistat is located in the first zone of this system. The function of the humidistat is to control a central system humidifier which may add steam to the supply air stream. It does not control cooling coil operation.
This applies to system types,1,2,3,4,5,10,11,12,13.

- Fixed or Minimum Outside Air (scfm) (Cols. 31-40)

This value represents the total outside air handled by the distribution system.
For central air handling systems having a fixed ventilation air control, this variable represents that air quantity.
For central air handling systems having economizer cycle control of outside air, this term is the minimum outside air quantity.
For two and four-pipe fancoil systems, this term is the total outside air quantity of all fancoil units on that system. A weighted distribution to all fancoils based on cfm is made. This term will be reset if the sum of the zone exhaust air quantities on this system(See card S-8) exceeds this value.

This applies to system types 1,2,3,4,5,8,9, 10,11,12,13.

- Mixed Air Option (Cols. 41-50)

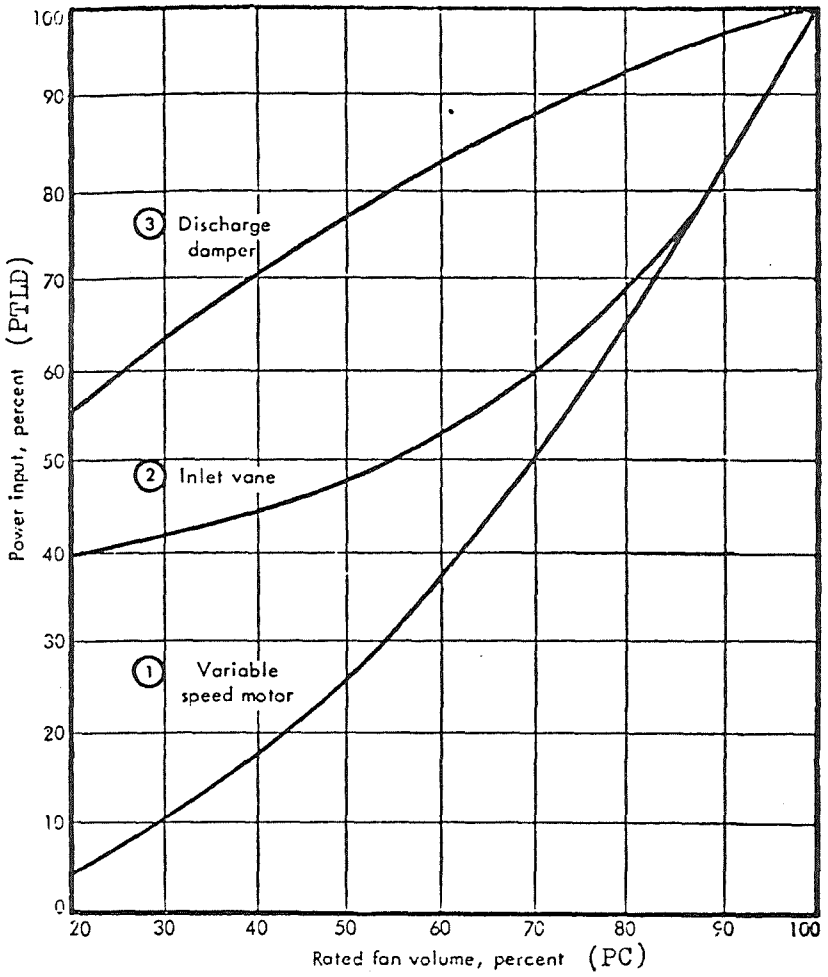
In certain energy distribution systems, the user is given the option of describing the type of mixed air control to be used. Three types of mixed air control are available. They are coded as follows:

Code	Description
1.	Outside air as fixed percentage of total air flow.
2.	Enthalpy/temperature type Economizer control This compares outside and return air enthalpy values. If outside air enthalpy is greater than return air enthalpy, outside air is set at minimum. If it is less than return air enthalpy, the temperature based economizer cycle controller is allowed to function. (See below for description.)
3.	Temperature type Economizer Control. The temperature based economizer controller functions to set return and outside air dampers such that the resulting mixed air temperature condition imposes no load on the cooling coil.

This applies to system types 1,2,3,4,10,11,12,13.

- Variable Volume Fan Control Type (Cols. 51-60)

Three types of fan air volume control are available on variable volume system. These control types are given in the figure below:



The significance of these three types of control in terms of fan power savings is indicated in the figure.

This applies to system types 4 and 12. If not specified on a required system, it defaults to type 2 control (inlet vane damper).

CARD TYPE S-7B

ENERGY DISTRIBUTION SYSTEM DATA (cont'd)

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 Discharge	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 7 B R

TEMPERATURE CONTROL MODES

On three fan system types (multi-zone (2), dual-duct (3), and reheat (13)), it is the user's option how primary air temperature will be controlled. For these three systems, the temperature control mode terms define the type of control to be used. The four temperature control options available are as follows:

Code	Description
1.	Pre-defined constant air temperature
2.	Primary air temperature determined by zone with coldest supply air requirements.
3.	Primary air temperature reset as per reset schedule (card type S-5)
6.	Primary air temperature determined by zone with warmest supply air requirement.

- Hot Deck or AHU Leaving Air (Cols. 1-10)

If a multi-zone or dual-duct air distribution system is being defined, this term refers to the system's means of hot deck air temperature control. Applicable control mode indices would be 1., 3., or 6.
If a reheat fan system is being defined, this term refers to the system's control of primary air leaving the air handling unit (AHU). Applicable control mode indices in this case would be 1., 2., or 3.

- Cold Deck (Cols. 11-20)

This term applies to the means of controlling cold deck air temperature for multi-zone and dual duct air systems. Control mode indices which apply are 1., 2., and 3.

TOTAL FAN PRESSURES (INCHES/H_2O)

Fan Power requirements (Hp fan) are calculated by the following equation

$$Hp_{fan} = \frac{scfm*head}{6346*Eff}$$

where scfm - air flow rate (Scfm)
head - total resistance (static and velocity pressures) (inches)
Eff - fan motor efficiency

The user has control of all of these variables in defining an air system's characteristics. Total fan pressures for supply, return, and exhaust fans are entered at this point.

- Supply Fan Pressure (inches H_2O) (Cols. 21-30)

This applies to all energy distribution system types except no. 7 (Floor Panel Heating).

- Return Fan Pressure (inches H_2O) (Cols. 31-40)

This term applies to distribution system types 1, 2, 3, 4, 10, 11, 12, 13

- Exhaust Fan Pressure (inches H_2O) (Cols. 41-50)

  This applies to all distribution system types except no. 7 (Floor Panel Heating).

- Variable Volume Reheat Coil Option (Cols. 51-60)

  When a variable volume fan system is specified, this term allows the user to specify whether or not reheat coils will be located after variable air volume boxes. The code is as follows:

Code	Description
0.	No reheat coils present
1.	Reheat coils located after VAV Boxes.

  This term applies to distribution system number 12.

- Variable Volume Box Minimum Air Flow (%) (Cols. 61-70)

  To maintain minimum ventilation requirements, the user may wish to set a lower limit on a zone's air flow. This term allows the user to simulate a minimum air flow setting. It is expressed as a percentage and applies to all VAV Boxes on the system. Minimum value = 10%.
  It applies to distribution system number 12.

CARD TYPE S-7C

ENERGY DISTRIBUTION SYSTEM DATA (cont'd)

FIXED AIR TEMPERATURES (°F)		TEMPERATURE RESET SCHEDULE INDICES				Induction Unit Induced/Primary Air Ratio	Card Index
Hot Deck or AHU Discharge	Cold Deck	Hot Deck Schedule or AHU Discharge Schedule	Cold Deck Schedule	Baseboard Radiation Schedule	Two-Pipe H.W Schedule		
1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
							S 7 C

FIXED AIR TEMPERATURES (^{o}F)

For seven of the thirteen distribution systems available, the user may select fixed hot and/or cold deck air temperatures. Although discharge air temperatures may be selected by the user, for the energy consumption analysis, if the program sizes zone and system air flows, it will be done according to the schedule in the table below.

Since the use of fixed air temperatures varies somewhat from one distribution to the next, the proper use of these variables is explained below on a per system basis for each deck temperature available.

- **Hot Deck or AHU Discharge Fixed Air Temperature** (Cols. 1-10)

  * System Types 2 and 3 (multi-zone and dual duct fan systems)

    This term refers to the hot deck leaving air temperature. It is required if the hot deck temperature control mode (see card type S-7B) is set at 1. (pre-defined constant air temperature).

  * System Type 11 (four pipe induction unit fan system).

    Primary air leaving this system's air handling unit remains fixed throughout the analysis. If the program sizes air flows, it uses the design temperatures in the table below When used in describing this system, this term defines the primary air temperature used in the annual analysis.

  * System Type 12 (variable volume fan system with optional reheat)

    Primary air temperature for this system remains constant throughout the analysis. If the program sizes air flows, it uses the design temperatures in the table below. Note, however, that the variable volume air system's primary function is for cooling. When operating in the heating mode, the zone sees minimum air flow. Without a reheat coil, no heating will be supplied. Even with a reheat coil, the zone will experience only a nominal heating effect due to the reduced air flow. When zones which do have heating loads throughout the year are used, they should be equipped with a supplemental heat source. This term defines the temperature of primary air leaving the air handler.

  * System Type 13 (constant volume reheat fan system)

    If the AHU leaving temperature control mode is set at 1. (pre-defined constant air temperature), this term defines that value. Note, however, that if the program sizes air flows, it is done according to the table below. Setting this term lower than the primary air cooling design

HEATING & COOLING PRIMARY AIR DESIGN TEMPERATURES
USED BY PROGRAM TO SIZE ZONE AIR FLOWS

SYSTEM TYPE	SYSTEM SYMBOL	PRIMARY AIR COOLING DESIGN (°F)	PRIMARY AIR HEATING DESIGN (°F)	INDUCED AIR	
				HEATING (°F)	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.	-	-

temperature will result in more reheat coil energy expenditure than necessary. Setting this term higher than the primary air cooling design temperature will result in some cooling loads not met since this system has no re-cooling capability.

- Cold Deck Fixed Air Temperature (Cols. 11-20)

  * System Type 1 (Single zone fan system with Face and Bypass Dampers)

    This system uses face and by-pass dampers to control primary air temperature. The cold deck temperature term is used to define the temperature of air leaving the cooling coil. It remains constant throughout the analysis. If the program sizes air flows, a value greater than the primary air cooling design temperature may result in some cooling loads not being met.

  * System Types 2 and 3 (multi-zone and dual duct fan systems)

    This term refers to the cold deck leaving air temperature. It is required if the cold deck temperature control mode (see card type S-7B) is set a 1. (pre-defined constant air temperature). If the program sizes air flows, they will be based on the temperatures given in the table above. Departure from these values may cause excessive loads or loads not met.

  * System Type 4 (single zone fan system with sub-zone reheat).

    This system uses face and by-pass dampers to control primary air temperature. The cold deck temperature term is used to define the temperature of air leaving the cooling coil. It remains constant throughout the analysis. If the program sizes air flows, a value greater than the primary air cooling design temperature may result in cooling loads not being met.

TEMPERATURE RESET SCHEDULE INDICES

The reset schedules defined on card type S-5 are applied to various functions by four temp-

erature reset schedule index variable on card S-7C. The use of these terms is summarized in the Application Of Reset Schedule Index Variables table below.

- Hot Deck or AHU Discharge Temperature Reset Schedule Index (Cols. 21-30)

  * System Types 2 and 3 (multi-zone and dual duct fan systems)

  As applied to system types 2 and 3, this term references the reset schedule which defines hot deck leaving air temperature. This variable will be required if the hot deck temperature control mode (cols. 1-10 of card type S-7B) is set at 3.

  * System Type 10 (two pipe induction unit fan system)

  Primary air and water temperatures for this system vary with ambient dry bulb temperature as indicated in the figure below.

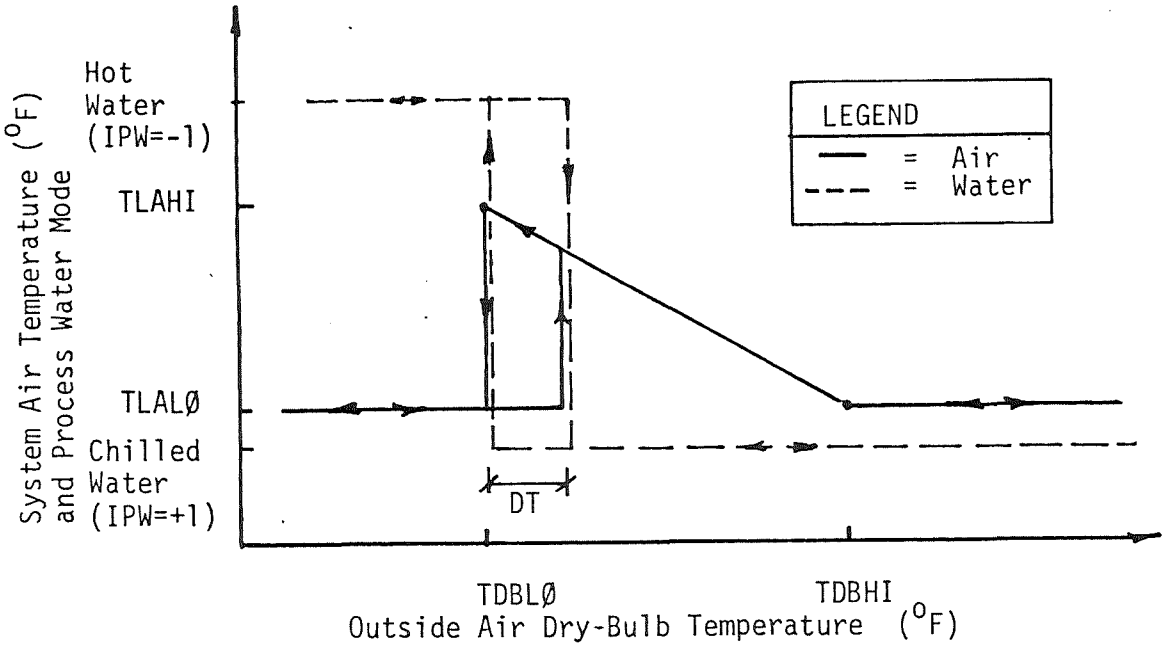


ILLUSTRATION OF MODE 4 TEMP FUNCTION FOR CONTROLLING TWO-PIPE INDUCTION UNIT SYSTEM TEMPERATURES

APPLICATION OF RESET SCHEDULE INDEX VARIABLES

SYSTEM NUMBER	SYSTEM	RESET SCHEDULE INDEX TERMS (CARD TYPE S-7C)			
		RESET-1 COL 21-30	RESET-2 COL 31-40	RESET-3 COL 41-50	RESET-4 COL 51-60
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	----

The AHU discharge temperature index as applied to the 2-pipe induction unit fan system pertains to the sloped portion of the air temperature curve. The reset temperature schedule referenced should be defined such that the low outside air temperature (cols. 1-10 of card type S-5) equals TDBLO in the above figure. Note also that a hysteresis has been built into the air and water control. The value of DT is set in the program at 5 ^{o}F

* System Type 13 (constant volume reheat fan system).

As applied to the reheat fan system, this term points to the reset schedule which defines the AHU discharge temperature. It will be required if the AHU discharge temperature control mode (Cols. 1-10 of card type S-7B) is set at 3.

● Cold Deck Temperature Reset Schedule Index (Cols. 31-40)

This term applies to system types 2 and 3 (multizone and dual duct fan systems). It points to the temperature reset schedule which would define cold deck air temperature as a function of ambient dry bulb temperature if the cold deck temperature control mode (cols. 11-20 of card type S-7B) were set at 3.

● Baseboard Radiation Temperature Reset Schedule Index (Cols. 41-50)

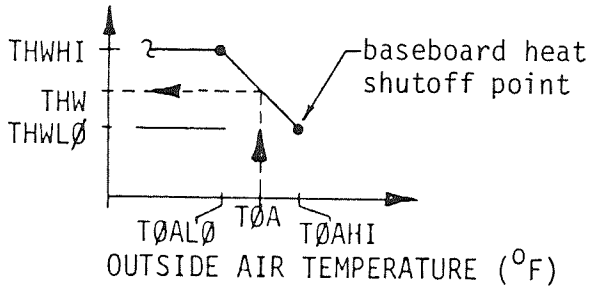
This index points to the temperature reset schedule which defines the hot water temperature of the baseboard heating circuit in spaces defined by this fan system. The baseboard heating system is separated from and operates independant of the primary energy distribution system described on the S-7 cards. The effect of temperature resetting is to vary the amount of heat added by the baseboard heating system inversely with outside air temperature according to the following equation:

$$H = c\left[\frac{(t_s - t_a)}{(215-65)}\right]^n$$

where

H - heat output (BTU/hr)
C - A constant determined by test (BTU/hr-^{o}F^{n})
t_s - Average temperature of hot water (^{o}F)
t_a - Entering air temperature (^{o}F)
n - Temperature difference exponent a value determined by test. It is set internally at 1.4 (baseboard radiation)
215 - Average hot water temperature at standard conditions (^{o}F)
65 - Entering air temperature at standard conditions (^{o}F)

The operation of the baseboard heating system is illustrated in the figure below.



BASEBOARD HEATING HOT WATER TEMPERATURE OPERATION

The Baseboard Radiation Schedule Index applies to energy distribution types 1, 2, 3, 4, 8, 9, 10, 11, 12, 13 .

- Two-Pipe Hot Water Temperature Reset Schedule Index (Cols. 51-60)

  Two energy distribution system types (two-pipe fancoil system, and Two-Pipe Induction unit fan system) employ hydronic system changeover as a means of operation. To calculate the energy required to change the system water from heating mode to cooling mode and vice versa, it is necessary to know hot water temperature at changeover (the cold water temperature is input on card type S-11.). The two-pipe reset Schedule Index points to the Temperature Reset Schedule which defines the hot water temperature. This term applies to energy distribution system types 8 and 10.

- Induction Unit, Induced/ Primary Air Ratio (Cols. 61-70)

  The ratio of induced/primary air is used in the simulation of induction unit fan systems to define induced air flow rates (i.e. induced air = ratio * primary air).
  This term is required by system types 10 and 11.

CARD TYPE S-7D

ENERGY DISTRIBUTION SYSTEM DATA (cont'd)

Two-pipe Fan-Coil Changeover Temp.(^{o}F)	2-Pipe ind.change-over or flr. panel shutoff temp. (^{o}F)	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 7 D R

- Two-pipe Fan Coil Change over Temperature (^{o}F) (Cols. 1-10)

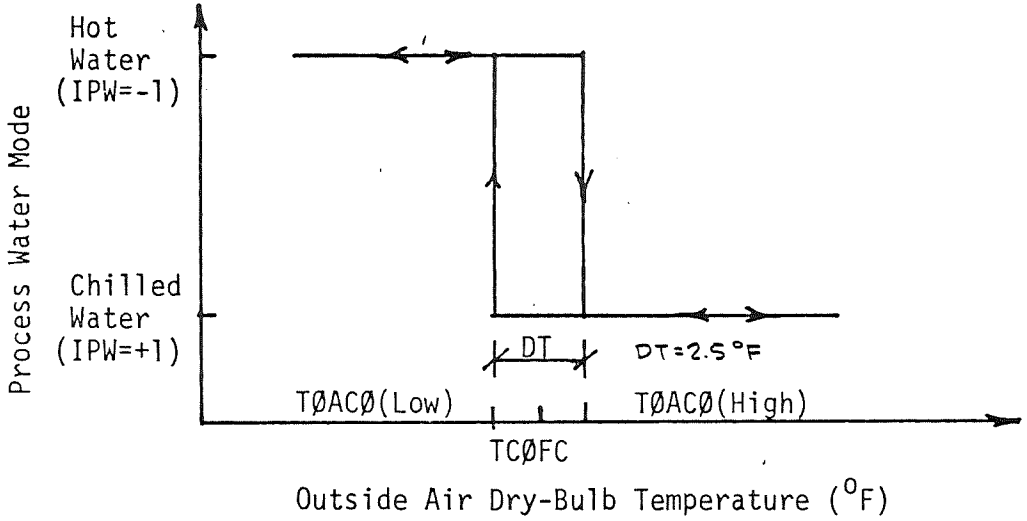
This is the ambient dry bulb temperature, about which a two-pipe fancoil system will change from heating mode to cooling mode and vice versa. To prevent repeated changeover near this temperature, a slight hysteresis (2.5 ^{o}F) has been built into the changeover mechanism. This is illustrated in the figure below.

This term applies to system type 8.

- Two-Pipe Induction Unit Changeover or Floor Panel Heating shut-off Temperature (^{o}F) (Cols. 11-20)

* System Type 7 (floor panel heating system)

As applied to the floor panel heating system, this is the temperature at which the system is shut off.



TWO-PIPE FANCOIL WATERSIDE CHANGEOVER OPERATION

* System Type 10 (two-pipe induction unit fan system)

As applied to the two-pipe induction unit fan system, this variable is the ambient dry-bulb temperature at which the water circulated to the induction units changes from chilled to hot. The value of this term should (but does not have to) equal the low outside air temperature (cols 1-10 of card type S-5) of the temperature reset schedule controlling AHU primary air discharge temperature.

- Two-Pipe System Water Volume (gals) (Cols. 21-30)

This term is used to calculate the energy required to change a two-pipe hydronic system from heating mode to cooling mode and vice versa. The variable applies to system types 8 and 10.

- Floor Heating Panel Location (Cols. 31-40)

This code defines the location of floor heating panels.

Code	Description
1.	Slab on Grade
2.	Intermediate Floor Slab

The term applies to system type 7.

- Floor Heating Panel Area (Ft^2) (Cols. 41-50)

This is the total area of floor heating panels (all zones on this system)
The term applies to system type 7.

- Exposed Perimeter (lin. ft.) (Cols. 51-60)

This is the total exposed length of a floor having a floor panel heating system.
The term applies to system type 7.

CARD TYPE S-7E

ENERGY DISTRIBUTION SYSTEM DATA (continued ~~concluded~~)

Fan System Shut-off Index	Ventilation Schedule Index	HEAT RECOVERY DEVICE EFFICIENCY		DX or Heat Pump Index No.		Card Index
		Sensible Heat	Latent Heat			
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 7 E R

- Fan System Shut-off Index (Cols. 1-10)

This code describes the fan system shut-off option to be used. The code is as follows:

Code	Description
0.	Fan always runs/baseboard heating may be on.
1.	Fan may be shut off/baseboard heating may be on.
2.	Both fan and baseboard heating may be shut off.
3.	Fan always shut off/baseboard heating may be on.

If the index equals 1. or 2., system shut-off is possible. To use the periodic system shut-off feature (code equals 1. or 2.), the input tape to the System Analysis Program must have come from the Temperature Variation Program. It is in the Temperature Variation Program that system shut-off is scheduled. It should be noted that system shut-off scheduling is done on a per zone basis in the Temperature Variation Program. Therefore, the user must exercise care in using the same shut-off schedule for all zones to be served by the same energy distribution system in the Systems Analysis Program. The technique used in determining whether or not a fan system will be shut off is to sum the absolute value of sensible loads for all zones served by the given system. If the value is 0.0 (a zero load will be calculated by TVP for zones with systems shut off), the fan will be shut off.

If the index equals 3., the fan system will be shut off for the entire year while the baseboard heating system will be allowed to function.

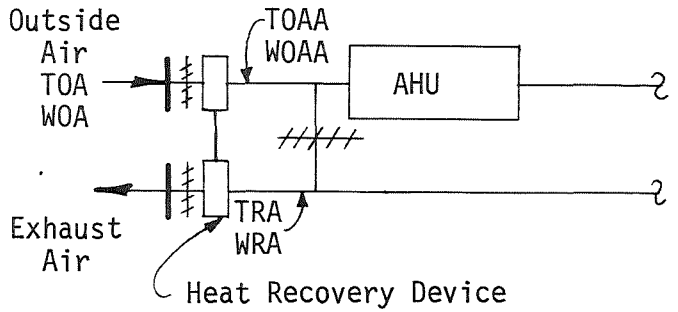
This term applies to system types 1, 2, 3, 4, 8, 9, 10, 11, 12, 13.

- Ventilation Schedule Index (Cols. 11-20)

This index points to the ventilation schedule (card type S-6A) which defines fixed or minimum outside air quantities as a function of time. The ventilation schedule modifies minimum or fixed outside air quantities. If it is desired to keep this value constant enter zero (0.0).

This term applies to system types 1, 2, 3, 4, 5, 10, 11, 12, 13.

HEAT RECOVERY DEVICE EFFICIENCY



Heat Recovery Device Location

The simulation of heat recovery between exhaust and outside air has been written in general terms. The heat recovery device may be on air to air heat exchanger, run around coils, heat pipes, thermal wheel, etc. Since these devices have characteristic sensible and latent heat transfer efficiencies, a specific type of device may be defined by entering the efficiency values of that device. If a heat recovery device is not required, enter zeros or blanks for sensible and latent heat transfer efficiencies. The function of the device is to modify outside air dry bulb temperature and humidity ratio to approach a desired mixed air dry bulb temperature condition. The device is controlled such that it will be shut off if its operation would have caused over heating of the mixed air stream. Since controls are based on sensible heat, if latent heat transfer is desired, sensible heat transfer efficiency must be greater than 0.

- Sensible Heat Recovery Efficiency (Cols. 21-30)

Sensible heat recovery efficiency (EFF_S) is defined as follows:

$$EFF_S = \frac{(TOAA-TOA)}{(TRA-TOA)}$$

where

TOAA - adjusted ambient dry bulb temp (^oF)
TOA - Ambient dry bulb temp (^oF)
TRA - return air dry bulb temp (^oF)

This term applies to system types 1, 2, 3, 4, 5, 10, 11, 12, 13.

- Latent Heat Recovery Efficiency (Cols. 31-40)

Latent heat recovery efficiency (EFF_L) is defined as follows:

$$EFF_L = \frac{(WOAA - WOA)}{(WRA - WOA)}$$

where

WOAA - adjusted outside air humidity ratio $\frac{(Lbm\text{-}H_2O)}{(Lbm\text{-dry air})}$
WOA - outside air humidity ratio $\frac{(Lbm\text{-}H_2O)}{(Lbm\text{-dry air})}$
WRA - return air humidity ratio $\frac{(Lbm\text{-}H_2O)}{Lbm\text{-dry air})}$

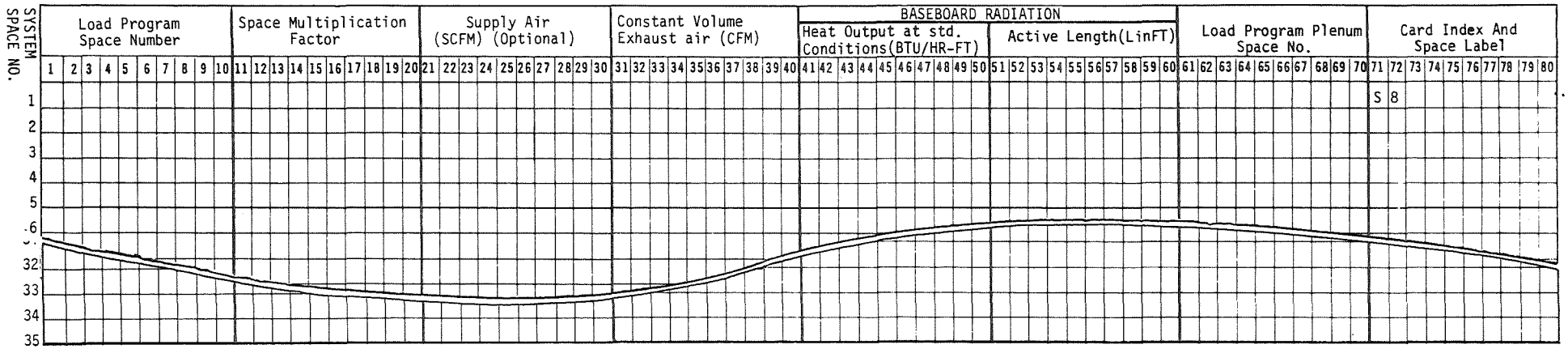
This term applies to system types 1, 2, 3, 4, 5, 10, 11, 12, 13.

- DX or Heat Pump Index (Cols. 41-50)

This index points to the DX or heat pump defined on card type S-16A. If it is zero (0.0), loads calculated for this fan system will be applied to a central boiler or chiller.
This term applies to system types 1, 2, 3, 4, 5, 6, 7, 8, 12, 13.
See card type S-16 discussion for further insight into DX and heat pump applications.

CARD TYPE S-8

SPACE DATA



Immediately following each energy distribution system description, place a Space Data card for each zone on that system.

- Load Program Space Number (Cols. 1-10)

This is the index number of the space as it appears in the LOAD and Temperature Variation Programs. Spaces may be listed in any order; they may appear more than once or not at all. This feature allows the user to analyze several building configurations in the same LOAD and TV runs and sort them out in the Systems Analysis Program.
This term applies to all distribution system types.

- Space Multiplication Factor (Cols. 11-20)

If thermally identical spaces are served by the same distribution system, the space may be defined once and the appropriate multiplication factor applied to it. If a blank or zero is encountered in this field, the program resets the term to 1.0.
This variable applies to all distribution system types.

- Supply Air (cfm) (optional) (Cols. 21-30)

The user is given the option of pre-sizing zone supply air flows or having them sized by the program. If a blank or zero is entered in this field, the program will size the supply air flow for the given zone.
If a zone is allowed to "float" for the entire year in the Temperature Variation Program, that zone, if used in the Systems Analysis Program, must have a pre-sized supply air flow. (zones allowed to float have no thermal load on which to base supply air flow).
Supply air is initially set at standard conditions (0.075 lbm/cu. ft.)
This term applies to system types 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13.

- Constant Volume Exhaust Air (cfm) (Cols. 31-40)

This air quantity is exhausted from the space at a constant rate. It is initially defined at standard conditions (0.075 lbm/cu.ft.). Since the air systems are considered balanced, the minimum supply air quantity will not be less

than this amount.
This term applies to system types 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13.

- Baseboard Radiation Heat Output at Standard Conditions (BTU/HR-Lin. ft.) (Cols. 41-50)

  Values for this term are obtained by test. It appears in manufacturer's literature. Enter the heat output per linear foot at standard conditions (65°F entering air temperature and 215 °F average water temperature).
  This term applies to system types 1, 2, 3, 4, 8, 9, 10, 11, 12, 13.

- Baseboard Radiation Active Length (ft) (Cols. 51-60)

  This term applies to system types 1, 2, 3, 4, 8, 9, 10, 11, 12, 13.

- Load Program Plenum Space Number (Cols. 61-70)

  In modeling a building, it is possible to simulate the thermodynamics of a return air plenum having heat transfer characteristics of its own. The plenum is defined in the Load program as a separate zone. It is linked to a particular room space by means of this variable. In applying the plenum analysis option, relate plenum and room zones on a 1 to 1 basis.
  This term is the Load Program Space number of zone which has been modeled as a ceiling plenum for the room space defined by this card.
  This term applies to system types 1, 2, 3, 4, 5, 10, 11, 12, 13.

- Card Index/Space Name (Alpha-numeric) (Cols. 71-80)

  Enter the card type number (S8) and space name data in this 10 column alpha-numeric field.
  This term applies to all system types.

CARD TYPE S-9

PRIMARY EQUIPMENT DESCRIPTION

PRIMARY EQUIPMENT DESCRIPTION (REPEAT CARD TYPE S9 FOR EACH PRIMARY EQUIPMENT COMBINATION.)

System Identification (Alpha-Numeric)	COOLING EQUIPMENT		HEATING EQUIPMENT		ON-SITE POWER GENERATION		Card Index
	Chiller Type	Source of Chiller Energy	Source of General Heating Energy	Source of Reheat Coil Energy	Number of Engine/ Generator Sets	Type of Engine/ Generator Set	
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 9 R

- System Identification (alpha-numeric) (Cols. 1-10)

  This alpha-numeric label field is provided to describe the primary equipment combination being run.

- Chiller Type (Cols. 11-20)

  Five chiller types are simulated by the program. The ID code for them is as follows:

Code	Description
0.	None (for Unitary Equipment only)
1.	Reciprocating
2.	Hermetic Centrifugal
3.	Open Centrifugal
4.	Steam Absorption
5.	Steam Turbine driven Open Centrifugal

- Source of Chiller Energy (Cols. 21-30)

  Allowable Chiller energy types are coded as follows:

Code	Description
0.	From Steam Boiler
3.	Purchased Steam
4.	Electricity

  Acceptable chiller type/chiller energy combinations are given below.

- Source of General Heating Energy (Cols. 31-40)

  Boiler energy types use the following code:

Code	Description
1.	Gas
2.	Heating Oil
3.	Purchased Steam
4.	Electric

- Source of Reheat Coil Energy (Cols. 41-50)

  Reheat coil energy may be handled in two ways. The energy code is as follows:

Code	Description
0.	From Boiler
4.	Electric Resistance

  When simulating DX and heat pump units, central fan system heating loads may appear as reheat loads. In the case of DX units, all heating loads are expressed as reheat loads. For heat pumps, heating loads in excess of the heat pumps instantaneous heating capacity are handled by supplemental heating. Supplemental heating loads are also expressed as reheat loads.

CHILLER TYPE		ENERGY SOURCE	
Hermetic Reciprocating	(1.)*	Electricity	(4.)
Hermetic Centrifugal	(2.)	Electricity	(4.)
Open Centrifugal	(3.)	Electricity	(4.)
Steam Absorption	(4.)	From Steam Boiler	(0.)
		Purchased Steam	(3.)
Open Centrifugal with Steam Turbine	(5.)	From Steam Boiler	(0.)
		Purchased Steam	(3.)

* Numbers in parentheses indicate chiller and energy type indices.

- Number of Engine/ Generator Sets (Cols. 51-60)

If on-site power generation is to be provided, this term is the number of engine/generators available. If it is set to zero (0.0), the program will calculate this term based on a minimum of two engine/generator sets and a maximum generator size of 500 KW. If the program sizes E/G sets, it does not include any heating and cooling electrical power.

- Type of Engine/ Generator Set (Cols. 61-70)

The code used in defining engine/generator set type is as follows:

Code	Description
0.	None (No on-site power generation)
1.	Diesel engine
2.	Gas engine

CARD TYPE S-10

BOILER

BOILERS

Number of Boilers	Size of each Boiler (MBH)	Seasonal Heating Start-up Month/Day *	Seasonal Heating Shut-down Month/Day *	Heating Value Heating Oil(BTU/GAL)	Boiler Performance Type	Boiler Peak Efficiency (%)	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 1 0 R

* Applies to Boilers and Heat pump heating

- Number of Boilers (Cols. 1-10)

  If this field is left blank, it will be reset to 1.0.

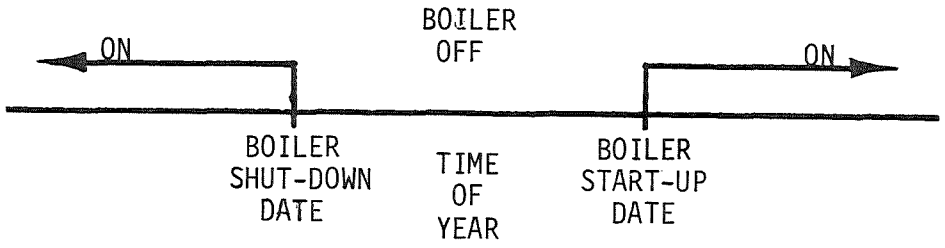
- Size of Each Boiler (MBH) (Cols. 11-20)

- Seasonal Heating Start-up(Month/Day) (Cols. 21-25)

  This is the day the Heating is turned on. The values used here should coincide with seasonal heating operating dates in the Temperature Variation Program.
  Enter the month of the year in Cols. 21 and 22. (01 thru 12).
  Enter the day of the month in Cols. 24 and 25. (01 thru 31).
  If the heater is to be on all year, enter 01/01 here. If the heater is to be off all year, enter 12/31.

- Seasonal Heating Shut-down (Month/Day) (Cols. 31-35)

  This is the day the heating is turned off.
  Enter the month of the year in Cols. 31 and 32 (01 thru 31).
  Enter the day of the month in Cols. 34 and 35 (01 thru 31).
  If the heater is to be on all year, enter 01/01 here. If the heater is to be off all year, enter 01/01 .



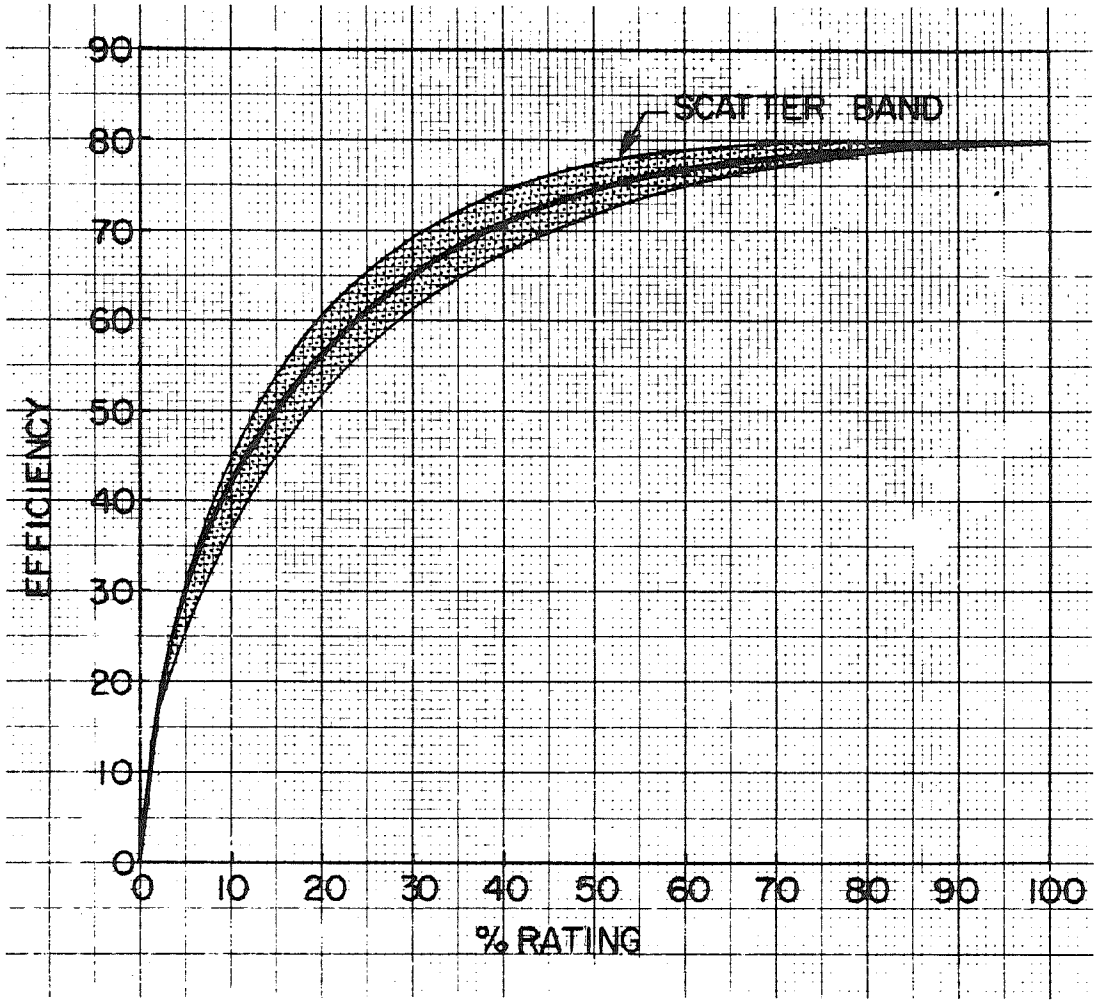
BOILER SEASONAL OPERATION

- Heating Value of Heating Oil (BTU/Gal) (Cols. 41-50)

  This term is used if heating oil is specified on card type S-9. If this field is left blank, a default value of 150,000 BTU/Gal. will be used.

- Boiler Performance Type (Cols. 51-60)

  To allow greater flexibility in defining boiler part load performance characteristics, two types of performance are available.
  Type 1 is that of a constant efficiency boiler. Input fuel is linearly proportional to load throughout the operating range.
  Type 2 is a curve extracted from studies done by Ohio State University into natural gas-fired boilers. Boiler efficiency for this type varies with its load (See Figure below).



Excerpt from " A study of Gas-fired Heating Plants", project EES-269X, Engineering Experiment Station, Ohio State University, December, 1969, pg.129.

- Boiler Efficiency (%) (Cols. 61-70)

Enter here the boiler's peak efficiency. To define the boiler curve shown in the Ohio State report, enter 2 for performance type and 80.0 for boiler efficiency. Allowable Range for boiler efficiency: 0.0 to 100.0 .

CARD TYPE S-11

CHILLERS

CHILLERS

Number of Chillers	Size of each Chiller(TONS)	Seasonal Cooling Start-up Month/Day **	Seasonal Cooling Shut-down Month/Day **	Min. Part Load Chiller Cut-off(%)	Chilled Water Set Point Temp.(°F)	Cooling Tower Water Low Limit Temp.(°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	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 1 1 R

** Applies to Chillers, DX, and Heat pump cooling.

- Number of Chillers (Cols. 1-10)

  If this field is left blank, a default value of 1.0 will be used.

- Size of Each Chiller (TONS) (Cols. 11-20)

  The minimum value for this term is 50 tons, when using Built-in Central Chiller routine. However when no central chiller is present, this term may be set to 0.0. Note that the cooling tower fan is sized as a function of this term as given below:

$$Bhp_{ct\ fan} = \frac{(Cool'g\ capy) \times 300. \times 1.0}{(6346. \times Eff.)}$$

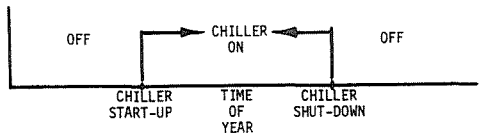
  The cooling tower fan is allowed to function during times of chiller operation.

- Seasonal Cooling Start UP (Cols. 21-25)

  Seasonal Cooling operating dates should coincide with those used in the Temperature Analysis Program. This effects Chiller, DX, and Heat pump cooling operation.
  Enter the month of the year in Cols. 21 and 22 and the day of the month in Cols. 24 and 25.

- Seasonal Cooling Shut-down (Cols. 31-35)

  Enter the month of the year in Cols. 31 and 32 and the day of the month in Cols. 34 and 35.



CHILLER SEASONAL OPERATION

- Minimum Part Load Chiller Cut Off(%) (Cols. 41-50)

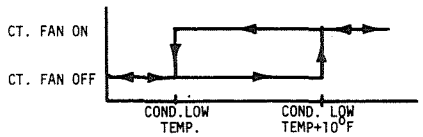
  If the load to the central chiller drops below this percent of peak capacity, the cooling load will be deferred until the next hour.
  Range : 0.001 to 100%.
  Default : 10%

- Chilled Water Set Point Temperature(°F) (Cols. 51-60)

  Enter here the temperature of chilled water as it leaves the chiller.
  Range: 40 °F to 50 °F.
  Default: 45 °F.

- Cooling Tower Water Low Limit Temperature (°F) (Cols. 61-70)

  Enter the minimum entering condenser water temperature. This term controls chiller operation and cooling tower fan cycling for the built-in Cooling Tower. A ten degree hysteresis is built into cooling tower fan operations as illustrated below.
  Range: 75 °F to 90 °F.
  Default: 75 °F.



COOLING TOWER FAN CONTROL
(For Built-in Tower)

CARD TYPES S-12

PUMP HEADS

PUMP HEADS

Total Boiler Water Pump Head(FT)	Total Chilled Water Pump Head (FT)	Total Condenser Water Pump Head(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 1 2

R

Pump head information is used in sizing pump motors by the following equation:

$$BHP = \frac{GPM * Head}{(3962. * Eff_p * 0.6)}$$

where

BHP - pump motor brake horsepower (Bhp)
GPM - Water flow rate (Gpm)
Head - Pump head (ft)
3962. - a constant (Gal-Ft./Min-Bhp.)
Eff_p - Pump motor efficiency
0.6 - Pump Efficiency

If a particular pump is not to be simulated, enter 0.0 head pressure.

- Total Boiler Water Pump Head (ft) (Cols. 1-10)
- Total Chilled Water Pump Head (ft) (Cols. 11-20)
- Total Condenser Water Pump Head (ft) (Cols. 21-30)

CARD TYPE S-13

MISCELLANEOUS

MISCELLANEOUS

External Lighting Power (KW)	Fan & Pump Motor Efficiency (%)	Heating Value Diesel Fuel(BTU/GAL)	Peak Base Power Requirement of Bldg. (KW) *	BOILER ** AUXILIARIES(HP)		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 1 3 R

* Required for engine/generator sizing. If blank and engine/generators are used, peak value will be calculated from load tape.

** Boiler auxiliaries operate unless turned off by Heating seasonal Shut-down term(Card S-10). If -1.0 is entered, Boiler auxiliaries will be sized by the program.

- External Lighting Power (kw) (Cols. 1-10)

  This power requirement is added to that of the building from sunset to sunrise.

- Fan and Pump Motor Efficiency (%) (Cols. 11-20)

  This term is used by the program in sizing fan and pump motors
  Default: 85%

- Heating Value of Diesel Fuel (BTU/Gal) (Cols. 21-30)

  Diesel fuel heating value applies to the energy content of diesel fuel-fired engine/generator sets.
  Default: 140,000. BTU/Gal

- Peak Building Base Power Requirement (kw) (optional) (Cols. 31-40)

  This is the peak internal power requirement of all zones included in the System analysis. Definition of this term is optional. If it is not specified and on-site power generation is used, it will be determined by the program.

- Boiler Auxillaries (Hp) (Cols. 41-50)

  This term accounts for miscellaneous electrical loads associated with boilers. The user may determine this value or it may be sized by the program. Entering -1.0 here will cause the program to calculate this term. It will be sized using the following equation :

$$HPBLA = \frac{CAPH * 1000.0}{(33472 * 20.)}$$

  where: HPBLA - Boiler auxillary HP
  CAPH - Boiler Capacity (MBH)

  Boiler auxillaries will operate unless turned off by the heating seasonal shut-down term (See Card Type S-10)

CARD TYPE S-14

STEAM AND STEAM TURBINES

STEAM & STEAM TURBINES

GENERAL HEATING PURCHASED STEAM		CHILLER ENTERING STEAM*		STEAM TURBINE	PROCESS ENTERING STEAM		Card Index
Steam Pressure(PSIG)	Temperature(^oF)	Entering Steam Pressure(PSIG)	Entering Temp.(^oF)	Speed (RPM)	Steam Pressure(PSIG)	Temperature(F^o)	
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 1 4

R

* Refers to either Absorption Chiller or Steam Turbine driven Centrifugal Chiller.

- General Heating Purchased Steam Preasure (PSIG) (Cols. 1-10)

This term is used in defining purchased steam as a heat source for general heating energy requirements. It is not used if the source of general heating energy (See Card Type S-9) is other than purchased steam.

- General Heating Purchased Steam Temperature (Cols. 11-20)

Enter the temperature of purchased steam. If this entry is 0. or blank, General Heating Purchased Steam pressure will be reset to 125. psig; temperature will be reset to 353 ^oF. This term is used only if purchased steam for general heating energy is specified on Card Type S-9. Also note that if the steam requirements of an absorbtion chiller or steam turbine driven centrifugal chiller are to be handled as Chiller Input Heat From Central Plant, the general heating purchased steam pressure should be equal to or greater than that of the chiller.

CHILLER ENTERING STEAM

- Pressure (Cols. 21-30)

- Temperature (Cols. 31-40)

These terms refer to either an absorption chiller or a steam turbine driven centrifugal chiller. Since the appropriate type of steam varies between these chillers, these input terms must be coordinated with the type of chiller selected. For an absorption chiller, the pressure range is from 2 to 12 psig. If the steam pressure is out of range, chiller entering steam conditions will default to 12 psig, 245 ^oF. For a Steam Turbine Driven Open Centrifugal Chiller, a wide range of steam pressure is appropriate depending on the specific turbine selected. If chiller entering steam is not defined when this type of chiller is specified, entering conditions will default to 125 psig, 353 ^oF.

- Steam Turbine Speed (Rpm) (Cols. 41-50)

Range: 1750 to 6000 Rpm.
Default value: 3600 Rpm.

PROCESS ENTERING STEAM

- Pressure (Psig) (Cols. 51-60)
- Temperature (^oF) (Cols. 61-70)

These variables applies to process steam entering conditions (See Card Type S-17).
Leaving conditions are assumed to be saturated condensate at atmosphere pressure (180. Btu/lb)
Defaults: 125 psig, 353 ^oF.

CARD TYPE S-15

FLOOR PANEL HEATING SYSTEMS

FLOOR PANEL HEATING SYSTEMS

Type of Floor Covering	Floor Insulation Conductance $(BTU/HR-^{o}F - FT^2)$	Floor Insulation Thickness (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 1 5 R

The variables on this card type need only be used if a floor panel heating system is used as an energy distribution system.

- Type of Floor Covering (Cols. 1-10)

  The floor covering type code is as follows:

Code	Description
1.	Bare concrete
2.	Tile
3.	Carpeting

- Floor Insulation Conductance $(BTU/Hr-^{o}F-Ft^2)$ (Cols. 11-20)
- Floor Insulation Thickness (ft) (Cols. 21-30)

CARD TYPES S-16A, S-16B, S-16C
DX AND HEAT PUMP SYSTEMS

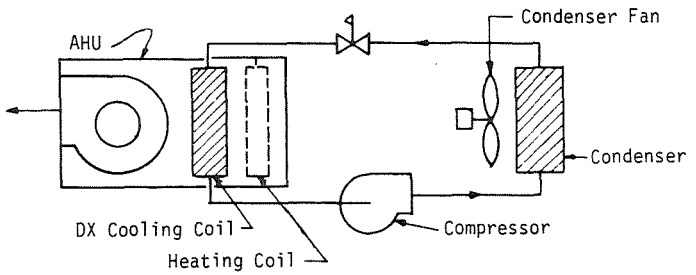
DX AND HEAT PUMP SYSTEM APPLICATIONS

DX and heat pumps are defined on card types S-16A, S-16B, and S-16C. One unit is completely defined by each set of S-16 cards.
The unit is linked to a specific fan system by the index on card type S-7E. The index number of a unit is determined by its order of appearance in the card input deck.
Repeat S-16 type cards in the following manner:

S-16A S-16B : S-16C :	INDEX NO. 1
S-16A S-16B : S-16C :	INDEX NO. 2
S-16A etc	INDEX NO. 3

DX and heat pump units do not apply to all energy distribution systems available in the program. The table below indicates proper use of these units.

AIR TO AIR DIRECT EXPANSION UNIT



AIR-TO-AIR DX UNIT SIMULATED

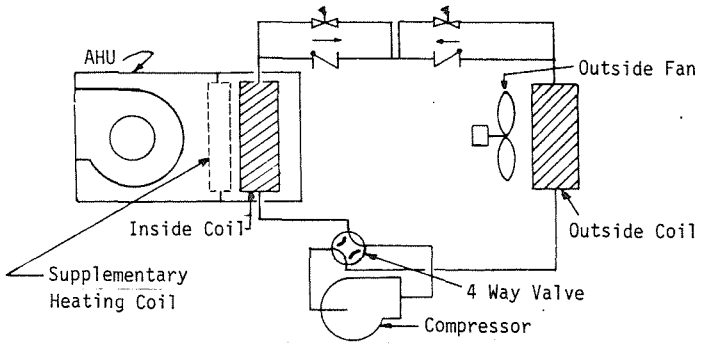
AIR-TO-AIR DX UNIT SCHEMATIC DIAGRAM

The DX unit, when linked to an air handler, processes the thermal loads of the AHU's central cooling coil. Air handler heating loads in this application are handled in the same manner as are reheat coil loads (i.e. to central boiler or electric resistance heating as defined by the reheat coil index). Cooling loads not met by the DX unit are tabulated separately in the load not met summary. Heating loads to a central boiler are processed in accordance with the capacity of the boiler. Heating loads handled by electric resistance heating coils are always met. Cooling is scheduled seasonally via the start-up and shut off dates on card S-11.

DISTRIBUTION SYSTEM APPLICATIONS
FOR DX AND HEAT PUMP SYSTEMS

SYSTEM NAME	DX	HEAT PUMP	REMARKS
1-SZFB	✓	✓	-
2-MZS	✓		- Heat Pump Does Not Apply as Heating & Cooling Loads Occur Simultaneously
3-DDS	✓		-
4-SZRH	✓	✓	-
5-UVT		✓	-
6-UHT		✓	-
7-FPH		✓	- Heating Only
8-2PFC	✓	✓	-
9-4PFC			- May have simultaneous heating and cooling loads.
10-2PIU			- Recooling at Terminal Unit
11-4PIU			- Requires Hydronic System
12-VAVS	✓	✓	-
13-RHFS	✓	✓	-

AIR-TO-AIR HEAT PUMP



AIR-TO-AIR HEAT PUMP SCHEMATIC DIAGRAM

The heat pump, when linked to an air handler, processes (to the extent of its capacity) the thermal loads of the AHU's heating and cooling coils. Cooling loads not met by the heat pump are tabulated separately in the load not met summary. Heating loads not met by the heat pump are processed by a supplemental heating coil. The supplemental heating load is handled in the same manner as reheat coil loads. Cooling and heating seasonal operation is scheduled seasonally via the start-up and shut-off dates on cards S-10 and S-11.

CARD TYPE S-16A

DX AND HEAT PUMP DESIGN CHARACTERISTICS

DX AND HEAT PUMP DESIGN CHARACTERISTICS.

Unit Type Index	Design Cooling Capacity (MBH)	Design Cooling Power (KW)	No. Cooling Performance Data Points	Design Heating Capacity (MBH)	Design Heating Power (KW)	No. Heating Performance Data Points	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 1 6 A R

- Unit Type Index (Cols 1-10)

  This index identifies the unit as either DX or heat pump.
  This code is given below:

Code	Description
1.	Air-to-air DX unit
2.	Air-to-air Heat Pump Unit

- Design Cooling Capacity (MBH) (Cols. 11-20)

- Design Cooling Power (kw) (Cols. 21-30)

- Number of Cooling Performance Data Points (Cols. 31-40)

  Range: 1 to 5.

- Design Heating Capacity (MBH) (Cols. 41-50)

  For Air to Air Heat Pump only.

- Design Heating Power (kw) (Cols. 51-60)

  For Air to Air Heat Pump only
  Include compressor, outside fan power, electric defrost power (if used).

- Number of Heating Performance Data Points (Cols. 61-70)

  For Air to Air Heat Pump only.
  Range: DX - 0.
  Heat Pump - 1. to 5.

CARD TYPE S-16B

COOLING PERFORMANCE DATA

COOLING PERFORMANCE DATA

Ambient Reference Temp. (°F)	Percent Design Cooling Capacity At Ref. Temp.	Percent Design Cooling Power At Ref. Temp.		Card Index									
1–10	11–20	21–30	31–70	71	72	73	74	75	76	77	78	79	80
				S	1	6	B						

Use for definition of DX and heat pump cooling characteristics
Order these cards by either increasing or descreasing ambient reference temperatures.

- Ambient Reference Temperature (° db F) (Cols. 1-10)
- Percent Design Cooling Capacity at Reference Temperature (Cols. 11-20)
- Percent Design Cooling Power at Reference Temperature (Cols. 21-30)

CARD TYPE S-16C

HEATING PERFORMANCE DATA

(for Heat Pumps Only)

HEATING PERFORMANCE DATA (FOR HEAT PUMPS ONLY)

Ambient Reference Temp. (°F)	Percent Design Heating Capacity At Ref. Temp.	Percent Design Heating Power At Ref. Temp.		Card Index
1–10	11–20	21–30	31–70	71–80
				S16C

Use only for definition of heat pump heating characteristics.
Order these cards by either increasing or decreasing ambient reference temperature.
If a defrost cycle is used (reversing refrigerant flow for a short while), the percent design heating term should be derated accordingly.
at low ambient reference temperatures.

- Ambient Reference Temperature (° db F) (Cols. 1-10)
- Percent Design Heating Capacity at Reference Temperature (Cols. 11-20)
- Percent Design Heating Power at Reference Temperature (Cols. 21-30)

CARD TYPE S-17

PROCESS LOAD

PROCESS LOADS

	Peak Load (*) (1-10)	Energy Source Code (11-20)	Operating Schedule Number (21-30)	Label (Alpha - Numeric) (31-40)	(41-70)	Card Index (71-80)
1						S17
2						
3						
4						
5						
6						
7						
8						
9						
10						

* Peak load energy units defined by energy source code used.

- **Peak Load** (Cols. 1-10)

  Enter the peak or reference load for the particular process. Units for peak load are as defined in the energy source.
  Code table below.

- **Energy Source Code** (Cols. 11-20)

  This term defines the type of energy source the process operation uses. It is defined as follows:

ENERGY SOURCE DEFINITION

CODE	UNITS	DESCRIPTION
0	MBH	Indirect Process (Load to Boiler)
1	MBH	Gas
2	MBH	Heating Oil
3	MBH	Purchased Steam
4	KW	Electricity

- **Operating Schedule Number** (Cols. 21-30)

  Process loads may be varied as a function of time of day and day of week. Enter the number of the operating schedule (Card Type S-6A) which applies to the particular load.

- **Label (Alpha-Numeric)** (Cols. 31-40)

  This ten column field is provided for user convenience in identifying process loads.

7.4 OUTPUT REPORT DESCRIPTION

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

1. Report S1 - Title Page
2. Report S2 - Recap of Card Input Data
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.

7.4.1 Report S1 - Title Page

The Title Page (Figure 7.16) introduces the energy utilization analysis output and indicates the facility name, location, project number, engineer and date.

7.4.2 Report S2 - Recap of Card Input Data

Report S2 (Figures 7.17 - 7.21) summarizes the card input data and default values used by the System Analysis 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.

7.4.3 Report S3 - Summary of Energy Distribution System Characteristics

During the first part of the energy analysis phase, the Systems and Equipment Simulation Program may calculate the rate of supply air required by each zone to meet peak heating and cooling loads. Report S3 (Figure 7.22) summarizes these results on a per-distribution system basis. Items printed on report include:

1. System Number - defined by order of input.
2. Type - description of distribution system.
3. Supply Fan HP - determined using summation of calculated air flows for each distribution system and total supply fan pressure.

4. Return Fan HP - determined using summation of calculated air flow minus summation of zone exhaust air flows (input card S-8) for each distribution system and total return fan pressure.

5. Exhaust Fan HP - calculated using summation of zone exhaust air flows for each distribution system and total exhaust fan pressure.

6. Number of zones on a given distribution system.

7. Total Supply Air Flows - user-defined or determined from zone peak heating and cooling loads read from input tape and design supply air temperatures. (See table under input card description for S-7c, Section 7.3.)

8. Minimum Outside Air Flows - sum of zone requirements

9. Exhaust Air Flows - sum of zone exhaust air quantities

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

7.4.4 Report S4 - Summary of Zone Air Flows

Report S4 (Figure 7.23) 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.

2. Zone Number - increases sequentially from 1 to number of zones on given system.

3. Load Space Number - defined by input.

4. Multiplication Factor - allows the user to handle repetitive zones.

5. Supply CFM - determined from peak heating and cooling loads read from input tape and design supply air temperatures.

6. Exhaust CFM - defined by input.

7. Set Point Temperature - defined by load program input.

7.4.5 Report S5 - Summary of Hourly Calculations

If the user desires to track the hourly calculations performed by the Systems Analysis Program during the simulation phase, the optional report S5 (Figure 7.24) can be generated by defining print periods. The

length of this report can be considerable depending upon the size of analysis and the number of print periods defined.

7.4.6 Report S6 - Summary of Loads Not Met

At the end of each month, Report S6 (Figure 7.25) 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 if 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
3. System Zone Number - increases sequentially from 1 to number of zones on given distribution system.
4. Multiplication Factor - number of times zone is repeated on system.
5. Cooling Load Not Met - sum 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 - sum 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.

7.4.7 Report S7 - Summary of Equipment Capacities

Report S7 (Figure 7.26) summarizes the equipment capacities that were calculated by the program and used to determine the building's total hourly demand for energy.

7.4.8 Report S8 - Monthly and Annual Energy Summary

At the conclusion of the analysis period, a 4-part report (Figures 7.27 through 7.30) is printed detailing the building's monthly and annual demand and consumption of all forms of energy. If a given type of energy or resource is not used, it will not be printed. A brief explanation of items follows:

1. Heating Loads

   a) Bldg. Htg. - met directly w/heat pump

   b) Bldg. Htg. - from Central Plant (includes air systems baseboard heating, and steam humidifiers).

   c) Indirect process - from Central Plant.

   d) Chiller Input Heat from Central Plant (absorption chiller steam or steam turbine driven centrifugal chiller steam). If purchased steam is used, this entry will not appear and cooling steam requirements will be expressed as "Purchased Steam-Cool".

   e) Engine Generator Heat (excess heat produced by E/G sets which maybe used to offset Central Plant Heating Loads.

      1. Used Heat - the excess E/G heat used to offset boiler heating requirements

      2. Wasted Heat - the excess E/G heat over and above the current hour's Central Plant heating load.

   f) Net Central Plant Heating Load (includes building heat + indirect process + chiller heat - Engine/Generator used heat)

2. Cooling Loads

   a) Bldg. Cooling - met directly by DX or heat pump.

   b) Bldg. Cooling - from central chiller

3. Electricity

   a) Lights and building equipment

      1. Internal

      2. External

   b) Heat (includes Central Plant heating load, boiler electric auxiliaries, hot water pumps, and heat pump heating power).

   c) Cool (includes chillers, water pumps, cooling tower fan, DX power, and heat pump cooling power).

   d) Fan power requirements

   e) Process electricity

   f) Total Electricity.

4. Gas

   a) Heat - represents the quantity of natural gas required for the central boiler to meet (or attempt to meet) Net Central Plant Heating Load.

   b) Generation - gas to power gas-fired engine generator sets

   c) Process gas

   d) Total

5. Purchased Steam

   a) Heat (____psig, ____Deg. F. Entering) - represents the quantity of steam required to meet Net Central Plant Heating Load if purchased steam is used as the heat source (note. If purchased steam is used for cooling this will be handled in item 5-b, below).

   b) Cool (___psig, ____Deg. F. Entering) - represents purchased steam used to power an absorption chiller or steam turbine driven open centrifugal chiller. If the heat to power this equipment comes from the Central Plant boiler (s), this entry will not appear and the thermal requirements will be included as "Chiller Input Heat From Central Plant".

   c) Process Steam (____psig, ____Deg. F. Entering) - represents steam requirements of purchased process steam.

6. Oil

   a) Heat (fuel input due to net Central Plant heating load). If Central Plant boiler fuel is heating oil, boiler requirements will appear under this entry.

b) Process oil

c) Total

7. Diesel Fuel

a) Generation - represents diesel fuel requirements for electrical power generation

8. City Water includes water from steam humidification and cooling tower make-up water.

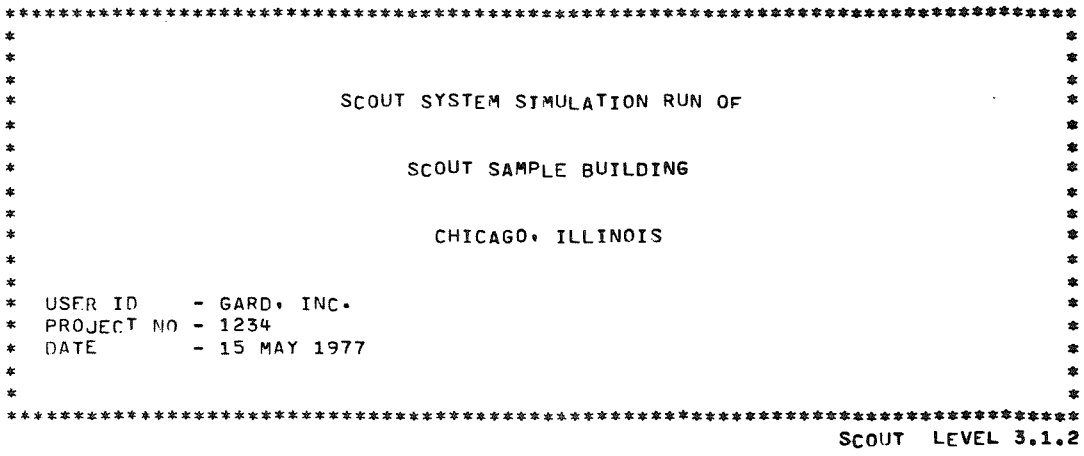


Figure 7.16 REPORT S1 - TITLE PAGE

```
********************************************** RECAP OF CARD INPUT DATA **********************************************
                                                                                NOTE--ALTHOUGH SOME VARIABLES APPEAR
                                                                                      AS INTEGERS IN THIS LISTING,
                                                                                      NUMERIC CARD INPUT DATA WITH
                                                                                      FEW EXCEPTIONS ARE READ AS REAL
                                                                                      NUMBERS.
                                                                                      DEFAULT VALUES FOR CERTAIN VARIABLES
                                                                                      ARE SUBSTITUTED AS REQUIRED
                                                                                      AND APPEAR IN THIS LISTING.

CARD TYPE-1.
DESCRIPTION OF RUN.
        SCOUT SAMPLE BUILDING - CHICAGO,ILLINOIS                                        S1


CARD TYPE-2,3.
      1/ 1  - MONTH AND DAY AT WHICH SIMULATION MAY BEGIN.
     12/31  - MONTH AND DAY AT WHICH SIMULATION MAY END.
          0  - NUMBER OF HOURLY PRINT PERIODS (CARD TYPE S-4).
          0  - NUMBER OF RESET SCHEDULES TO BE READ (CARD TYPE S-5).
          2  - NUMBER OF VENTILATION SCHEDULE TYPES (CARD TYPE S-6A).

          2  - NO. OF ENERGY DISTRIBUTION SYSTEMS.
          0  - NUMBER OF DX AND HEATPUMP TYPES.
          2  - NUMBER OF PROCESS LOADS.

CARD TYPE-4.
HOURLY PRINT PERIODS.
  INDEX    BEGIN PRINT     FINISH PRINT    PRINT SWITCHES    (0=OFF/1=ON)
   NO.      (MO./DAY)       (MO./DAY)       PRINT-1    PRINT-2    PRINT-3

CARD TYPE-5.
TEMPERATURE RESET SCHEDULES.
  SCHEDULE      TOALO      TOAHI        TLO         THI         ** LABEL **
   NUMBER


CARD TYPE-6A.
VENTILATION SCHEDULES.

SCHEDULE TYPE  1

     INDICES (SUN, WKDAY, SAT, HOL)        1.        11.        1.        1.ELEVATOR

               HOUR    -- 1-- 2-- 3-- 4-- 5-- 6-- 7-- 8-- 9--10--11--12--13--14--15--16--17--18--19--20--21--22--23--24
               SUN     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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
               MON     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.500.100.050.300.150.050.050.050.200.500.050.050.050.0 0.0 0.0 0.0
               TUE     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.500.100.050.300.150.050.050.050.200.500.050.050.050.0 0.0 0.0 0.0
               WED     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.500.100.050.300.150.050.050.050.200.500.050.050.050.0 0.0 0.0 0.0
               THU     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.500.100.050.300.150.050.050.050.200.500.050.050.050.0 0.0 0.0 0.0
               FRI     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.500.100.050.300.150.050.050.050.200.500.050.050.050.0 0.0 0.0 0.0
               SAT     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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
               HOL     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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
SCHEDULE TYPE  2

     INDICES (SUN, WKDAY, SAT, HOL)        1.        12.        1.        1.HW HEATER

               HOUR    -- 1-- 2-- 3-- 4-- 5-- 6-- 7-- 8-- 9--10--11--12--13--14--15--16--17--18--19--20--21--22--23--24
               SUN     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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
               MON     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.550.550.500.550.900.600.800.700.750.300.300.500.050.0 0.0 0.0 0.0
               TUE     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.550.550.500.550.900.600.800.700.750.300.300.500.050.0 0.0 0.0 0.0
               WED     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.550.550.500.550.900.600.800.700.750.300.300.500.050.0 0.0 0.0 0.0
               THU     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.550.550.500.550.900.600.800.700.750.300.300.500.050.0 0.0 0.0 0.0
               FRI     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.550.550.500.550.900.600.800.700.750.300.300.500.050.0 0.0 0.0 0.0
               SAT     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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
               HOL     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 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
```

Figure 7.17 REPORT S2 - RECAP OF CARD INPUT DATA

```
*****************************************************************************************************************
SYSTEM NUMBER  2.      (DDS )
CARD TYPE-7.
                                                                    NOTE--AN 'R' TO THE LEFT OF A VARIABLE INDICATES
                                                                          IT MAY BE REQUIRED TO DEFINE THE GIVEN ENERGY
                                                                          DISTRIBUTION SYSTEM.
R          3  - DISTRIBUTION SYSTEM TYPE NUMBER.
R         12  - NUMBER OF ZONES ON SYSTEM.
R        30.  - RELATIVE HUMIDITY SET POINT (PCT).
R      3760.  - MINIMUM OUTSIDE AIR (SCFM).
R          2  - MIXED AIR OPTION. (1=FIXED.O.A., 2=ENTH/TEMP.E.C., 3=TEMP.E.C.)
           0  - VAR.VOL. FAN CONTROL INDEX (1=VAR.SPD.MTR., 2=INLET.DPR., 3=DISCH.DPR.)

R          6  - TEMPERATURE CONTROL MODE-1 (HOT DECK OR AHU LVG) INDEX.
R          2  - TEMPERATURE CONTROL MODE-2 (COLD DECK) INDEX.
R      4.000  - SUPPLY FAN PRESSURE (IN.H2O).
R      1.500  - RETURN FAN PRESSURE (IN.H2O).
R      1.000  - EXHAUST FAN PRESSURE (IN.H2O).
           0  - VAR.VOL. REHEAT COIL OPTION (0=NO COIL, 1=REHEAT COIL).
          0.  - VAR.VOL. BOX MINIMUM AIR FLOW (PCT.).

R        0.0  - FIXED AIR TEMPERATURE-1 (HOT DECK OR AHU LVG).
R        0.0  - FIXED AIR TEMPERATURE-2 (COLD DECK).
R          0  - TEMPERATURE RESET SCHEDULE INDEX-1 (HOT DECK OR AHU LVG).
R          0  - TEMPERATURE RESET SCHEDULE INDEX-2 (COLD DECK).
R          0  - TEMPERATURE RESET SCHEDULE INDEX-3 (BASEBOARD HEATING).
           0  - TEMPERATURE RESET SCHEDULE INDEX-4 (2-PIPE H.W.).
         0.0  - INDUCTION UNIT INDUCED/PRIMARY AIR RATIO.

         0.0  - 2-PIPE FANCOIL CHANGEOVER TEMP. (DEG.F.).
         0.0  - 2-PIPE INDUCTION UNIT CHANGEOVER TEMP. (DEG.F.).
         0.0  - 2-PIPE SYSTEM WATER VOLUME (GALS.).
          0.  - FLOOR HEATING PANEL LOCATION (1=SLAB ON GRADE, 2=INTERMEDIATE SLAB).
         0.0  - FLOOR HEATING PANEL AREA COVERED (SQ.FT.).
         0.0  - FLOOR HEATING PANEL EXPOSED PERIMETER (LIN.FT.).

R          2  - FAN SYSTEM SHUT-OFF INDEX (0.=FAN ON, 1.=FAN MAY BE OFF/BBD.HTG.ON, 2.=FAN AND BBD.HTG.MAY BE OFF,
                                           3.=FAN OFF/BBD.HTG.MAY BE ON.)
R          0  - VENTILATION SCHEDULE INDEX.
R        0.0  - HEAT RECOVERY DEVICE SENSIBLE HEAT EFFICIENCY (PCT.).
R        0.0  - HEAT RECOVERY DEVICE LATENT HEAT EFFICIENCY (PCT.).
R          0  - DX OR HEAT PUMP TYPE INDEX.

CARD TYPE-8.
SPACE DATA.
```

SYSTEM SPACE NO.	LOAD PGM SPACE NO.	MULTIPLCN FACTOR	SUPPLY AIR (SCFM) (OPTIONAL)	EXHAUST AIR (SCFM)	**BASEBOARD RADIATION** HEAT OUTPUT (BTU/HR)	LENGTH (FT.)	PLENUM SPACE NO.	SPACE LABEL
1	1.	1	0.	0.	0.	0.	0	S8 BOT.S
2	2.	1	0.	0.	0.	0.	0	S8 BOT.W
3	3.	1	0.	0.	0.	0.	0	S8 BOT.N
4	4.	1	0.	0.	0.	0.	0	S8 BOT.E
5	6.	10	0.	0.	0.	0.	0	S8 INT.S
6	7.	10	0.	0.	0.	0.	0	S8 INT.W
7	8.	10	0.	0.	0.	0.	0	S8 INT.N
8	9.	10	0.	0.	0.	0.	0	S8 INT.E
9	11.	1	0.	0.	0.	0.	0	S8 TOP.S
10	12.	1	0.	0.	0.	0.	0	S8 TOP.W
11	13.	1	0.	0.	0.	0.	0	S8 TOP.N
12	14.	1	0.	0.	0.	0.	0	S8 TOP.E

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

Figure 7.18 REPORT S2 (CONT'D) - RECAP OF CARD INPUT DATA

```
**********************************************************************************************************************************
PRIMARY EQUIPMENT DESCRIPTION.
CASE NUMBER  1.
CARD TYPE-9.
CONV.SYS.1   - SYSTEM IDENTIFICATION LABEL.
       2.    - CHILLER TYPE INDEX  (1=RECIP, 2=HERM.CENT., 3=OPEN.CENT., 4=STM.ABS., 5=CENT.STM.TURB.).
       4.    - SOURCE OF CHILLER ENERGY , (1=GAS, 2=OIL, 3=STM, 4=ELEC).
       1.    - SOURCE OF HEATING ENERGY , (1=GAS, 2=OIL, 3=STM, 4=ELEC).
       0.    - SOURCE OF REHEAT COIL ENERGY ,  (0=SAME AS BOILER, NE.0=ELEC).
       0.    - NUMBER OF ON-SITE GENERATOR SETS.
       0.    - E/G SET TYPE INDEX (0=NONE, 1=DIESEL, 2=GAS).
**********************************************************************************************************************************

CARD TYPE-10.
BOILER DATA.
         2   - NUMBER OF BOILERS.
    2000.0   - SIZE OF EACH BOILER (MBH).
      1/ 1   - MONTH AND DAY OF SEASONAL BOILER START-UP.
     12/31   - MONTH AND DAY OF SEASONAL BOILER SHUT-DOWN.
  150000.0   - HEATING VALUE HEATING OIL.
         2   - BOILER PERFORMANCE TYPE (1=LINEAR, 2=OHIO STATE CURVE).
     80.00   - BOILER PEAK EFFICIENCY (PCT).

CARD TYPE-11.
  CHILLER DATA.
         2   - NUMBER OF CHILLERS.
     275.0   - SIZE OF EACH CHILLER (TONS).
      1/ 1   - MONTH AND DAY OF SEASONAL CHILLER START-UP.
     12/31   - MONTH AND DAY OF SEASONAL CHILLER SHUT-DOWN.
      20.0   - MINIMUM PART LOAD CUT-OFF FOR CHILLERS (PER CENT).
      45.0   - CHILLED WATER SET POINT TEMP. (DEG.F.).
      75.0   - COOLING TOWER WATER LOW LIMIT TEMPERATURE (DEG.F.).

CARD TYPE-12  PUMP HEADS.
      80.0   - TOTAL BOILER WATER PUMP HEAD (FT.).
      60.0   - TOTAL CHILLED WATER PUMP HEAD (FT.).
      60.0   - TOTAL CONDENSER WATER PUMP HEAD (FT.).

CARD TYPE-13.
MISCELLANEOUS DATA.
       0.0   - EXTERNAL LIGHTING POWER (KW).
      85.0   - FAN AND PUMP MOTOR EFFICIENCY (PER CENT).
  145000.0   - HEATING VALUE DIESEL FUEL.
             - PEAK BUILDING BASE POWER TO BE CALCULATED BY PROGRAM.
     1.500   - BOILER AUXILIARIES (HP)
      12.0   - ABSORPTION CHILLER ENTERING STEAM PRESSURE (PSIG)
     245.0   - ABSORPTION CHILLER ENTERING STEAM TEMPERATURE (DEG.F.)

CARD TYPE-14.
STEAM AND STM. TURBINE DATA.
      15.0   - GENERAL HEATING PURCHASED STEAM PRESSURE (PSIG)
     250.0   - GENERAL HEATING PURCHASED STEAM TEMPERATURE (DEG.F.)
      12.0   - STEAM TURBINE ENTERING STEAM PRESSURE (PSIG).
     245.0   - STEAM TURBINE ENTERING STEAM TEMPERATURE (DEG.F.).
    3500.0   - STEAM TURBINE SPEED (RPM).
      15.0   - PROCESS STEAM ENTERING STEAM PRESSURE (PSIG)
     250.0   - PROCESS STEAM ENTERING STEAM TEMPERATURE (DEG.F.)

CARD TYPE-15
 FLOOR PANEL HEATING DATA.
         0   - FLOOR COVERING INDEX (1=BARE, 2=TILE, 3=CARPET).



     0.0     - FLOOR INSULATION CONDUCTANCE.
     0.0     - FLOOR INSULATION THICKNESS.
CARD TYPE-17.
PROCESS LOADS.
              ENERGY   OPERATING
              SOURCE   SCHEDULE
 PEAK LOAD     CODE       NO.     LABEL

      175.0      4          1   ELEVATOR
       48.0      4          2   HW.HEATER
```

Figure 7.19 REPORT S2 (CONT'D) - RECAP OF CARD INPUT DATA

SCOUT SAMPLE BUILDING CHICAGO, ILLINOIS 15 MAY 1977 1234
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF ENERGY DISTRIBUTION SYSTEM CHARACTERISTICS.

SYSTEM NO.	TYPE	****** TOTAL FAN HP ****** SUPPLY	RETURN	EXHAUST	NO. OF ZONES	**TOTAL SYSTEM AIR FLOWS (CFM)** SUPPLY	MIN.O.A.	EXH.SYSTEM	PER-CENT MIN.O.A.
1	VAVS	64.6	22.2	1.3	3	87090.	7515.	7200.	8.6
2	DDS	99.4	37.3	0.0	12	134092.	3760.	0.	2.8

Figure 7.20 REPORT S3 - SUMMARY OF ENERGY DISTRIBUTION SYSTEM CHARACTERISTICS

SCOUT SAMPLE BUILDING — CHICAGO, ILLINOIS — 15 MAY 1977 — 1234
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF ZONE AIR FLOWS

FAN SYSTEM	ZONE NUMBER	LOAD SPACE NUMBER	MULT FACTOR	SUPPLY CFM	EXHAUST CFM	SET POINT TEMP.
1	1	5	1	6767.	600.	72.
1	2	10	10	7302.	600.	72.
1	3	15	1	7302.	600.	72.
2	1	1	1	4956.	0.	72.
2	2	2	1	1497.	0.	72.
2	3	3	1	3182.	0.	72.
2	4	4	1	1266.	0.	72.
2	5	6	10	5064.	0.	72.
2	6	7	10	1533.	0.	72.
2	7	8	10	3329.	0.	72.
2	8	9	10	1302.	0.	72.
2	9	11	1	4913.	0.	72.
2	10	12	1	1492.	0.	72.
2	11	13	1	3245.	0.	72.
2	12	14	1	1263.	0.	72.

Figure 7.21 REPORT S4 - SUMMARY OF ZONE AIR FLOWS

PRINT SWITCH 1

WEATHER:	HOUR	MO	DAY	DOW	HOD	SUN	T-DB	T-WB	VEL	HUM.RATIO	BAROM. PRESS.	DENSITY	ENTHALPY	D-CODE	C/C-MOD
	4810	7	20	5	9	0	66	57	9	0.00797	29.790	0.07416	24.529	5	0.908

DISTRIB. SYSTEMS:	NO.	COOLING	MAIN HEATING	REHEAT	PREHEAT	BASEBD.HTG.	HUMID.H2O	BASE POWER	FAN POWER
	1	1781285.0	0.0	0.0	0.0	0.0	0.0	560.9	71.1
	2	1201516.0	0.0	-28082.2	0.0	0.0	0.0	284.1	53.8
	3	0.0	0.0	0.0	0.0	0.0	0.0	17.5	0.0

CENTRAL PLANT:	COOLING	NET HEATING	ELECT. HTG.	ELECT.CLG.	ELECT.TOTAL	GAS TOTAL	OIL TOTAL	DIESEL FUEL
	2982.8	-23345.8	6.6	180.9	1243.1	1.6	0.0	0.0

PRINT SWITCH 2

SYSTEM NO. 2...VARIABLE VOLUME FAN SYSTEM.
ALFA= 0.74TMA=54.33WMA= 0.006DMA= 0.075DRA(K)= 0.073WRA(K)= 0.006TRA=69.79
WSUP= 0.006WLVG= 0.006TLVG= 55.00DLVG=0.0751

J	QL(L)	QLITE(L)	QSI(I)	ZMAS(I)	TS(I)	WZ(I)	QCLNM(I)	QCPNM(I)	IHCNM(I)	QHLNM(I)	QHPNM(I)	IHHNM(I)
1	3333.	0.	23875.	6454.	55.0	0.0063	0.	0.	0	0.	0.	0
2	800.	0.	5583.	1509.	55.0	0.0063	0.	0.	0	0.	0.	0
3	3333.	0.	31661.	8558.	55.0	0.0061	0.	0.	0	0.	0.	0
4	800.	0.	7306.	1975.	55.0	0.0062	0.	0.	0	0.	0.	0
5	3333.	0.	25518.	6898.	55.0	0.0062	0.	0.	0	0.	0.	0
6	800.	0.	5962.	1612.	55.0	0.0062	0.	0.	0	0.	0.	0
7	3333.	0.	33007.	8922.	55.0	0.0061	0.	0.	0	0.	0.	0
8	800.	0.	7627.	2062.	55.0	0.0061	0.	0.	0	0.	0.	0
9	3333.	0.	19353.	5231.	55.0	0.0064	0.	0.	0	0.	0.	0
10	800.	0.	4335.	11348.	68.5	0.0058	0.	0.	0	0.	0.	0
11	3333.	0.	27480.	7428.	55.0	0.0062	0.	0.	0	0.	0.	0
12	800.	0.	6108.	1651.	55.0	0.0062	0.	0.	0	0.	0.	0
13	1600.	0.	5405.	1837.	58.1	0.0066	10950.	1987.	6	0.	0.	0

Print Switch - 2 Variables

ALFA = fraction of outside air
TMA = mixed air temperature (°F)
WMA = mixed air humidity ratio (lb-H_2O/lb.air)
DMA = mixed air density (lbs/Ft^3)
DRA = return air density (lbs/Ft^3)
WRA = return air humidity ratio (lbs-H_2O/lb.air)
TRA = return air temperature (°F)
WSUP = humidity ratio of air after humidifier (lbs-H_2O/lbs.air)
WLVG = humidity ratio of air leaving air handler (lb-H_2O/lb.air)
TLVG = temperature of air leaving air handler (°F)
DLVG = density of air leaving air handler (lbs/Ft^3)
J = system zone sequence number

QL = Zone latent load (BTU)
QLITE = Light heat to zone (BTU)
QSI = Sum of zone sensible load and sensible infiltration loads (BTU)
ZMAS = Mass flow of air to zone (lbs.air)
TS = Temperature of supply air entering zone (°F)
WZ = Zone humdiity ratio (lbs.H_2O/lbs.air)
QCLNM = Monthly zone cooling loads not met-consumption (BTU)
QCPNM = Monthly zone cooling loads not met-peak (BTU)
IHCNM = Monthly zone cooling loads not met-hours
QHLNM = Monthly zone heating loads not met-consumption (BTU)
QHPNM = Monthly zone heating loads not met-peak (BTU)
IHHNM = Monthly zone heating loads not met-hours

Figure 7.22 REPORT S5 - SUMMARY OF HOURLY CALCULATIONS

MONTH	SYSTEM	SYSTEM ZONE NO.	MULTIPLICATION FACTOR	****** COOLING NOT MET ******* LOAD(MBTU)	PEAK(MBH)	HOURS	****** HEATING NOT MET ******* LOAD(MBTU)	PEAK(MBH)	HOURS
DEC	1	1	1	0.	0.	0	0.	0.	0
DEC	1	2	10	0.	0.	0	0.	0.	0
DEC	1	3	1	0.	0.	0	0.	0.	0
DEC	2	1	1	0.	0.	0	0.	0.	0
DEC	2	2	1	0.	0.	0	0.	0.	0
DEC	2	3	1	0.	0.	0	0.	0.	0
DEC	2	4	1	0.	0.	0	0.	0.	0
DEC	2	5	10	0.	0.	0	0.	0.	0
DEC	2	6	10	0.	0.	0	0.	0.	0
DEC	2	7	10	0.	0.	0	0.	0.	0
DEC	2	8	10	0.	0.	0	0.	0.	0
DEC	2	9	1	0.	0.	0	0.	0.	0
DEC	2	10	1	0.	0.	0	0.	0.	0
DEC	2	11	1	0.	0.	0	0.	0.	0
DEC	2	12	1	0.	0.	0	0.	0.	0
DEC		CHILLERS AND BOILERS		0.	0.	0	-520122.	-7900.	163
ANN	1	1	1	0.		0	0.		0
ANN	1	2	10	0.		0	0.		0
ANN	1	3	1	0.		0	0.		0
ANN	2	1	1	0.		0	0.		0
ANN	2	2	1	50.		28	0.		0
ANN	2	3	1	12.		11	0.		0
ANN	2	4	1	158.		37	0.		0
ANN	2	5	10	216.		11	0.		0
ANN	2	6	10	738.		33	0.		0
ANN	2	7	10	697.		24	0.		0
ANN	2	8	10	1923.		45	0.		0
ANN	2	9	1	24.		11	0.		0
ANN	2	10	1	77.		34	0.		0
ANN	2	11	1	75.		26	0.		0
ANN	2	12	1	188.		45	0.		0
ANN		CHILLERS AND BOILERS		0.		0	-2829743.		1141

Figure 7.23 REPORT S6 - SUMMARY OF LOADS NOT MET

SCOUT SAMPLE BUILDING CHICAGO, ILLINOIS 15 MAY 1977 1234
SYSTEM SIMULATION AND ENERGY ANALYSIS

SUMMARY OF EQUIPMENT SIZES

TYPE OF CHILLER	=	HERMETIC CENTRIFUGAL
NO. OF CHILLERS	=	2
SIZE OF CHILLERS	=	275.0 TONS
TYPE OF BOILER	=	GAS
NO. OF BOILERS	=	2
SIZE OF BOILERS	=	2000.0 MBTU
TOTAL HEATING CAPACITY	=	4000.0 MBTU
TOTAL COOLING CAPACITY	=	550.0 TONS

IF USED, TERMINAL REHEAT ENERGY SAME SOURCE AS BOILER.

COOLING TOWER FAN REQUIREMENT 165000. CFM 1.0 IN. S.P. 30.6 HP

BOILER AUXILIARY HORSEPOWER REQUIREMENT (FAN,BLOWER,PUMP) 1.5 HP

TOTAL FAN PLANT HORSEPOWER FOR BUILDING 224.9 HP

SUMMARY OF PUMP SIZES

LOCATION	TOTAL GPM	TOTAL HEAD (FT)	TOTAL HP
CHILLED WATER	1320.	60.0	39.2
CONDENSER WATER	1650.	60.0	49.0
HEATING WATER	400.	80.0	15.8

Figure 2.24 REPORT S7 - SUMMARY OF EQUIPMENT CAPACITIES

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

FACILITY - SCOUT SAMPLE BUILDING — DATE - 15 MAY 1977
CITY - CHICAGO, ILLINOIS — PROJECT - 1234
USER - GARD, INC. — SYS. LABEL - CONV.SYS.1

ENERGY CONSUMPTION

	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
HEATING LOADS						
BLDG.HTG. - FROM CENTRAL PLANT (INCL. AIR SYSTEMS, BASEBD.HTG., AND STM.HUMIDIFIERS)						
DEMAND (MBH)	-14722.8	-13573.3	-10348.6	-8472.1	-5831.7	-6545.7
CONS. (MBTU)	-2519414.0	-2264158.0	-2269458.0	-1772285.0	-1096991.0	-743097.2
NET CENTRAL PLANT HEATING LOAD (BLDG.HT + IND.PROC + CHLLR.HT - E/G.HT.)						
DEMAND (MBH)	-4000.0	-4000.0	-4000.0	-4000.0	-4000.0	-4000.0
CONS. (MBTU)	-1799772.0	-1641329.0	-1846582.0	-1643667.0	-1080434.0	-720295.9
COOLING LOADS						
BLDG. CLG. - FROM CENTRAL CHILLER						
DEMAND (MBH)	0.0	759.6	1788.2	2766.2	3287.5	3643.7
CONS. (MBTU)	0.0	3660.3	21812.1	99553.9	496854.4	719752.4
ELECTRICITY						
LIGHTS AND BUILDING EQUIPMENT						
INTERNAL						
DEMAND(KW)	839.7	839.7	839.7	839.7	839.7	839.7
CONS.(KWH)	214770.5	203987.9	232093.2	205048.6	223431.8	222571.3
HEAT (INCL. CENT.PLT.HTG. LOAD, BLR.AUXIL., HOT WATER PUMPS, AND HEATPUMPS)						
DEMAND(KW)	12.9	12.9	12.9	12.9	12.9	12.9
CONS.(KWH)	9617.5	8997.0	9617.5	9307.3	9617.5	9307.3
COOL (INCL. CHILLERS, WATER PUMPS, COOLING TOWER FAN, DX, AND HEATPUMPS)						
DEMAND(KW)	88.6	125.2	158.1	212.1	250.9	296.0
CONS.(KWH)	65896.4	61813.0	66786.7	67660.5	88637.1	99344.1
FANS						
DEMAND(KW)	167.7	167.7	167.7	167.7	167.7	167.7
CONS.(KWH)	96947.9	90702.1	97050.3	93813.1	97027.9	93977.4
PROCESS ELECTRICITY						
DEMAND(KW)	113.9	113.9	113.9	113.9	113.9	113.9
CONS.(KWH)	14823.4	14117.6	16235.2	14117.6	15529.3	15529.3
TOTAL						
DEMAND(KW)	1153.6	1181.6	1219.6	1273.7	1310.9	1358.0
CONS.(KWH)	402055.8	379617.6	421782.8	389946.9	434243.4	440529.3

Figure 7.25 REPORT S8 - MONTHLY AND ANNUAL ENERGY USE SUMMARY

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

FACILITY - SCOUT SAMPLE BUILDING — DATE - 15 MAY 1977
CITY - CHICAGO, ILLINOIS — PROJECT - 1234
USER - GARD, INC. — SYS. LABEL - CONV.SYS.1

ENERGY CONSUMPTION

	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
HEATING LOADS							
BLDG.HTG. - FROM CENTRAL PLANT (INCL. AIR SYSTEMS, BASEBD.HTG., AND STM.HUMIDIFIERS)							
DEMAND (MBH)	-5733.9	-3337.3	-6484.8	-8423.3	-9566.8	-11899.7	
CONS. (MBTU)	-361083.1	-302381.1	-532794.1	-1041647.3	-1502646.0	-2155505.0	-16561459.0
NET CENTRAL PLANT HEATING LOAD (BLDG.HT + IND.PROC + CHLLR.HT - E/G.HT.)							
DEMAND (MBH)	-4000.0	-3337.3	-4000.0	-4000.0	-4000.0	-4000.0	
CONS. (MBTU)	-355639.4	-302381.1	-522757.3	-924916.8	-1258933.0	-1635455.0	-13732160.0
COOLING LOADS							
BLDG. CLG. - FROM CENTRAL CHILLER							
DEMAND (MBH)	3893.3	3823.4	3578.7	3085.0	940.8	0.0	
CONS. (MBTU)	1034957.9	1075652.0	730438.7	180642.3	2451.0	0.0	4365772.0
ELECTRICITY							
LIGHTS AND BUILDING EQUIPMENT							
INTERNAL							
DEMAND(KW)	839.7	839.7	839.7	839.7	839.7	839.7	
CONS.(KWH)	206109.1	232093.2	205048.5	223431.9	213709.8	205048.4	2587140.0
HEAT (INCL. CENT.PLT.HTG. LOAD, BLR.AUXIL., HOT WATER PUMPS, AND HEATPUMPS)							
DEMAND(KW)	12.9	12.9	12.9	12.9	12.9	12.9	
CONS.(KWH)	9617.5	9617.5	9307.3	9617.5	9307.3	9617.5	115548.3
COOL (INCL. CHILLERS, WATER PUMPS, COOLING TOWER FAN, DX, AND HEATPUMPS)							
DEMAND(KW)	322.7	313.9	294.7	234.8	131.1	88.6	
CONS.(KWH)	121630.8	124321.5	101220.6	73959.5	63876.9	65896.4	1001043.4
FANS							
DEMAND(KW)	167.7	167.7	167.7	167.7	167.7	167.7	
CONS.(KWH)	96959.9	97150.9	93881.9	97069.2	93899.1	96914.3	1145393.0
PROCESS ELECTRICITY							
DEMAND(KW)	113.9	113.9	113.9	113.9	113.9	113.9	
CONS.(KWH)	14117.6	16235.2	14117.6	15529.3	14823.4	14117.6	179293.0
TOTAL							
DEMAND(KW)	1384.7	1376.2	1356.7	1292.2	1153.8	1153.7	
CONS.(KWH)	448434.8	479418.2	423575.8	419607.3	395616.4	391594.2	5026418.0

Figure 7.26 REPORT S8 (CONT'D) - MONTHLY AND ANNUAL ENERGY USE SUMMARY

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

FACILITY - SCOUT SAMPLE BUILDING
CITY - CHICAGO, ILLINOIS
USER - GARD, INC.

DATE - 15 MAY 1977
PROJECT - 1234
SYS. LABEL - CONV.SYS.1

ENERGY CONSUMPTION

	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
GAS						
HEAT						
DEMAND (THERMS/HR)	50.0	50.0	50.0	50.0	50.0	50.0
CONS.(THERMS)	22923.8	20973.5	23485.7	21020.2	14156.4	9577.3
TOTAL						
DEMAND (THERMS/HR)	50.0	50.0	50.0	50.0	50.0	50.0
CONS.(THERMS)	22923.8	20973.5	23485.7	21020.2	14156.4	9577.3
PURCHASED STEAM						
OIL						
CITY WATER						
DEMAND (K-GALS/HR)	1.4	1.3	1.0	0.8	0.8	0.7
CONS. (K-GALS)	135.5	127.2	150.6	134.6	155.0	163.7

Figure 7.27 REPORT S8 (CONT'D) - MONTHLY AND ANNUAL ENERGY USE SUMMARY

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

FACILITY - SCOUT SAMPLE BUILDING
CITY - CHICAGO, ILLINOIS
USER - GARD, INC.

DATE - 15 MAY 1977
PROJECT - 1234
SYS. LABEL - CONV.SYS.1

ENERGY CONSUMPTION

	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
GAS							
HEAT							
DEMAND (THERMS/HR)	50.0	42.2	50.0	50.0	50.0	50.0	
CONS.(THERMS)	5213.0	4516.3	7276.8	12349.7	16274.9	20920.4	178667.8
TOTAL							
DEMAND (THERMS/HR)	50.0	42.2	50.0	50.0	50.0	50.0	
CONS.(THERMS)	5213.0	4516.3	7276.8	12329.7	16274.9	20920.4	178667.8
PURCHASED STEAM							
OIL							
CITY WATER							
DEMAND (K-GALS/HR)	0.7	0.6	0.7	0.9	0.9	1.1	
CONS. (K-GALS)	179.6	182.3	139.0	77.1	77.1	111.0	1632.7

Figure 7.28 REPORT S8 (CONT'D) - MONTHLY AND ANNUAL ENERGY USE SUMMARY

SECTION 8
COST ANALYSIS PROGRAM

8.1 OBJECTIVE AND DESCRIPTION

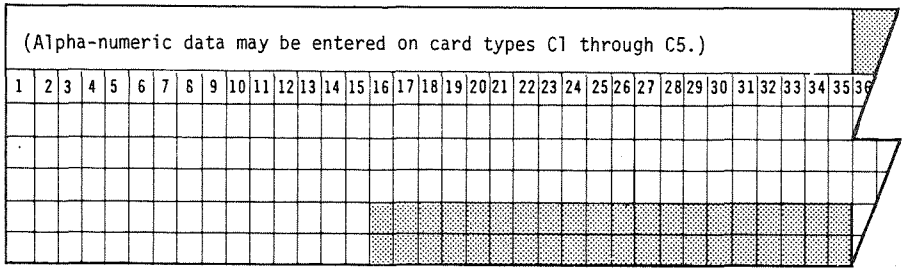
The Cost Analysis Program performs a life cycle cost analysis for each alternative analyzed by the Systems Analysis Program. Life cycle costs are those expenditures which occur singularly or periodically over the life of the building and includes cost of energy, equipment first-costs and replacement costs which occur when the expected equipment life is less than the building life, 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 Cost Analysis Program to accurately and automatically account for these factors.

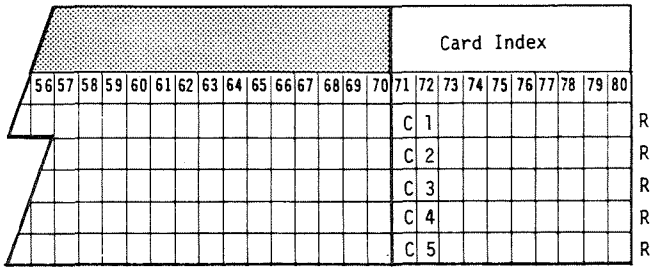
8.2 INPUT DATA DESCRIPTION

Only punched card input data is required for the Cost Analysis Program. Instructions for the entering of this data onto the Input Forms are contained on the following pages.

CARD TYPE C-1 through C-5
JOB IDENTIFICATION



IDENTIFICATION OF ID TERMS
FACILITY NAME
FACILITY LOCATION
USER ID
PROJECT NUMBER
DATE



CARD TYPE C-1

- Facility Name (Cols. 1-35)

  Alphanumeric information identifying the building being studied. Also used for report labeling.

CARD TYPE C-2

- Facility Location (Cols. 1-35)

  Alphanumeric information identifying the city in which the building is located. Also used for report labeling.

CARD TYPE C-3

- User Identification (Cols. 1-35)

  Alphanumeric information identifying the name of the user. Also used for report labeling.

CARD TYPE C-4

- Project Number (Cols. 1-15)

  Alphanumeric information identifying the project number associated with job. Also used for report labeling.

CARD TYPE C-5

- Date (Cols. 1-15)

  Alphanumeric information identifying date of run. Also used for report labeling.

CARD TYPE C-6
BUILDING LIFE AND COST ESCALATION FACTORS

Building Life (Yrs.)(1-60)	Annual Interest Rate (%)	Annual Increase Of Labor Cost (%)	Annual Increase Of Material Cost(%)	Annual Increase Of Floor Space Cost(%)	Annual Increase Of Energy Cost (%)		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	
							C 6	R

- <u>Building Life (Yrs) (1-60)</u> (Cols. 1-10)

  Expected useful life of building.

- <u>Annual Interest Rate (%)</u> (Cols. 11-20)

  Rate of annual interest used to reflect the time value of money.

- <u>Annual Increase of Labor Cost (%)</u> (Cols. 21-30)

  Expected annual increase in cost of labor.

- <u>Annual Increase of Material Cost (%)</u> (Cols. 31-40)

  Expected annual increase in cost of purchased materials and parts.

- <u>Annual Increase of Floor Space Cost (%)</u> (Cols. 41-50)

  Expected annual increase in cost of floor space.

- <u>Annual Increase of Energy Cost (%)</u> (Cols. 51-60)

  Expected annual increase in energy cost (electricity, gas, oil, coal, diesel fuel etc.)

CARD TYPE C-7
CASE STUDIES

No. Cases To Be Analyzed (1-5)		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
		C 7

R

NOTE: REPEAT CARD TYPES C8 THROUGH C10B FOR EACH CASE TO BE ANALYZED.

- <u>No. Cases To Be Analyzed (1-5)</u> (Cols. 1-10)

  A life cycle cost analysis can be performed for as many as 5 sets (cases) of cost data. Each case requires a set of card types C-8 through C-10B describing

  1) Energy Catagories (C-9 and C-9A)
     a) Utility Rate Schedule Data(C-9B to C-9D)
     b) Utility Useage Data (C-9E to C-9G)
  2) Equipment Catagories (C-9)
     a) Installed Costs
     b) Maintenance Costs } C-10A & C-10B
     c) Equipment Life

CARD TYPE C-8
CASE DESCRIPTION

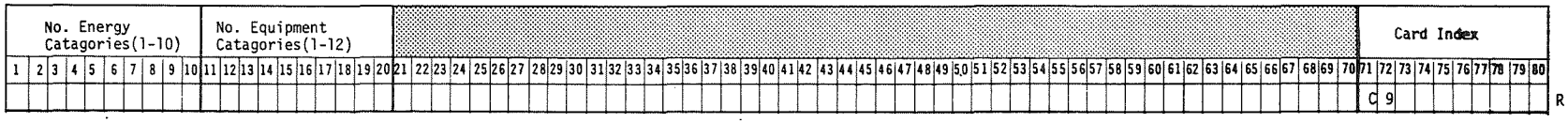
Case Description Data (Alphanumeric)																																																																					Card Index									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62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

R

- **Case Description Data** (Cols. 1-70)

  Alphanumeric description of case to be analyzed.

CARD TYPE C-9
NUMBER OF ENERGY AND EQUIPMENT CATAGORIES



- No. of Energy Catagories (1-10) (Cols. 1-10)

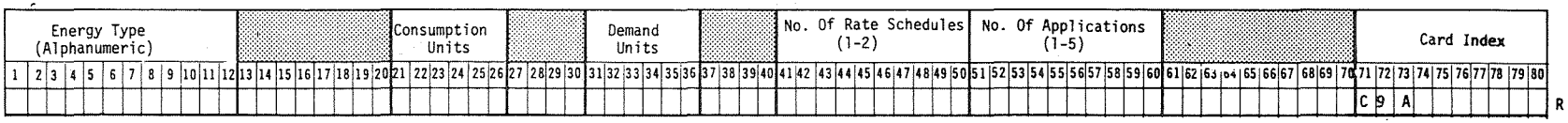
  Generally this corresponds to the number of utility meters (gas, electricity, oil, etc) installed within the building to record building utility useage. Each energy catagory requires a set of data for monthly energy useage and utility rate structure. When attempting to define the number of energy catagories to be used refer to the monthly energy summary table that is provided as output by the Systems Analysis Program.

- No. of Equipment Catagories (1-12) (Cols. 11-20)

  The user can break out his equipment into as many as 12 major equipment catagories. These catagories have not been predefined. Usually equipment will be grouped into catagories having similar useful lifes and maintenance periods. Each equipment catagory requires data on

  1) installed cost
  2) expected useful life
  3) annual maintenance
  4) major overhaul

CARD TYPE C-9A
ENERGY CATAGORY DATA



- Energy Type (Cols. 1-12)

  Alphanumeric description of energy type, e.g.,

  Electricity
  Natural Gas
  Oil
  Diesel Fuel
  Steam
  Water

- Consumption Units (Cols. 21-26)

  Units of measure to be used to enter monthly consumption data and rate schedule data, e.g.,

Electricity	KW-HRS
Natural Gas	Therms
Oil	Gals
Diesel Fuel	Gals
Steam	K Lbs (1000's Lbs)
Water	K Gals (1000's Gals)

- Demand Units (Cols. 31-36)

  Units of measure to be used to enter monthly demand data and rate schedule data. Usually, this is only required for electricity, in which case the units are KW.

- No. of Rate Schedules (1-2) (Cols. 41-50)

  For any energy catagory, at most, two sets of rate schedules would be required, one rate schedule for consumption and one rate schedule for demand. Usually, only electricity will require both a consumption and demand schedule to be entered.

- No. of Applications (1-5) (Cols. 51-60)

  One form of energy may be used for several applications within a building with each application metered separately but yet billed at the same utility rate schedule. For those cases where the same rate schedule is applied to more than one application, the user can enter up to 5 sets of utility data and key them to the same rate schedule. Enter here the number of applications which will be entered.

CARD TYPE C-9B through C-9D
DEFINITION OF RATE SCHEDULES

Rate No.	No. Break-Points	Cons(1) or Dem(2)	Breakpoint 1 Quantity	Breakpoint 1 $/Unit	Breakpoint 2 Quantity	Breakpoint 2 $/Unit	Breakpoint 3 Quantity	Breakpoint 3 $/Unit	Breakpoint 4 Quantity	Breakpoint 4 $/Unit	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
											C 9 B

R

			Breakpoint 5 Quantity	Breakpoint 5 $/Unit	Breakpoint 6 Quantity	Breakpoint 6 $/Unit	Breakpoint 7 Quantity	Breakpoint 7 $/Unit	Breakpoint 8 Quantity	Breakpoint 8 $/Unit	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
											C 9 C

			Breakpoint 9 Quantity	Breakpoint 9 $/Unit	Breakpoint 10 Quantity	Breakpoint 10 $/Unit		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
								C 9 D

Rate No.	No. Break-Points	Cons(1) or Dem(2)	Breakpoint 1 Quantity	Breakpoint 1 $/Unit	Breakpoint 2 Quantity	Breakpoint 2 $/Unit	Breakpoint 3 Quantity	Breakpoint 3 $/Unit	Breakpoint 4 Quantity	Breakpoint 4 $/Unit	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
											C 9 B

			Breakpoint 5 Quantity	Breakpoint 5 $/Unit	Breakpoint 6 Quantity	Breakpoint 6 $/Unit	Breakponit 7 Quantity	Breakpoint 7 $/Unit	Breakpoint 8 Quantity	Breakpoint 8 $/Unit	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
											C 9 C

			Breakpoint 9 Quantity	Breakpoint 9 $/Unit	Breakpoint 10 Quantity	Breakpoint 10 $/Unit		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
								C 9 D

NOTES:

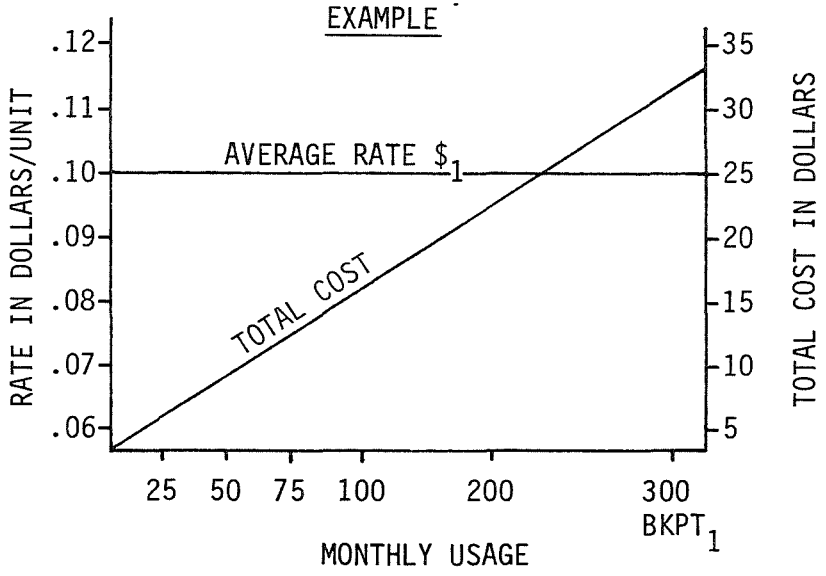
1. Repeat card sets C-9B, C-9C and C-9D as many times as indicated on card type C-9A, Columns 41-50.
2. Omit card types C-9C and C-9D if not required, i.e., number of breakpoints are equal to or less than 4.

Utility rate schedules are generally structured in one of the following forms:

a) Straight line basis

The price charged per unit of useage is constant and not a function of the total number of units used.

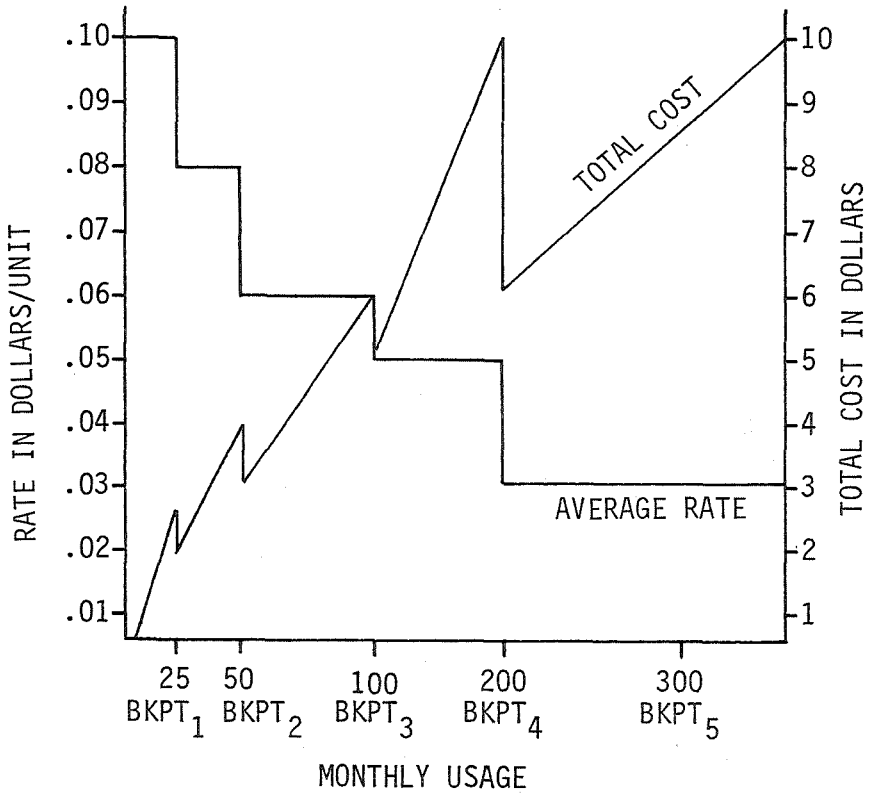
EXAMPLE



b) Step basis

The price charged per unit of useage is not constant but is dependent upon the particular step within which the total consumption falls.

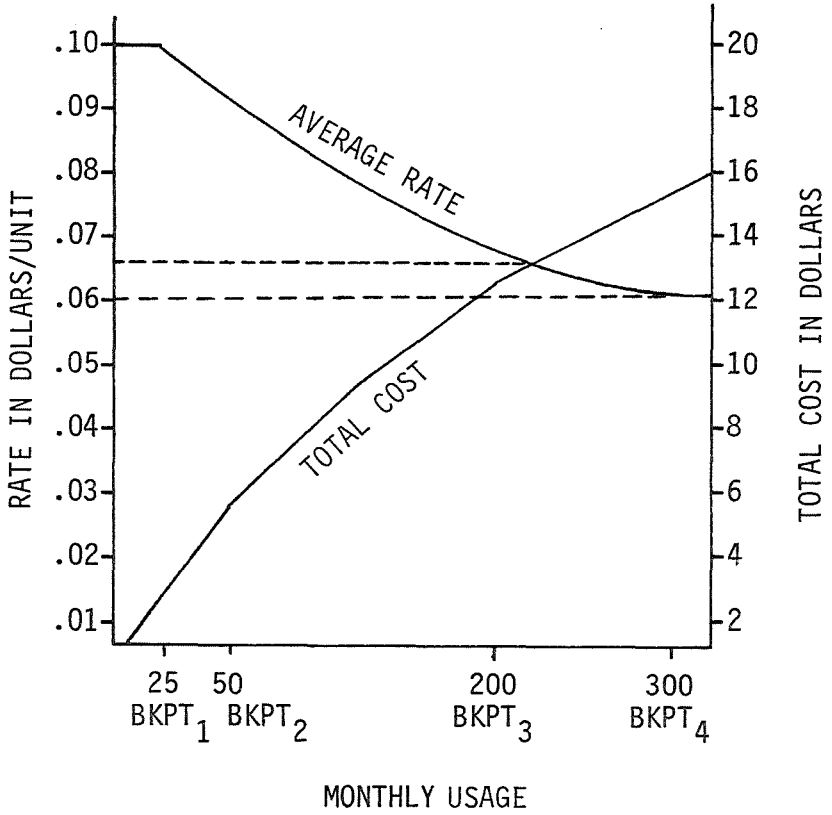
EXAMPLE



c) Block basis

A certain specified price per unit is charged for all or any part of a block of such units, and reduced prices per unit are charged for all or any part of succeeding blocks of such units, each such reduced price per unit applying only to a particular block or portion therefore.

EXAMPLE



Local utility companies would have to be contacted to determine which basis applies and what the breakpoints values are. A straight line basis requires only one set of breakpoint data. Step and block basis however, require several sets of breakpoint data, with a maximum of 10 breakpoints allowed.

- Rate No. (Cols. 1-4)

Any number assigned by the user to allow this rate schedule to be keyed into on card type C-9E, columns 31-40 and 51-60.

- No. of Breakpoints (1-10) (Cols. 5-7)

  This indicates the total number of sets of data to be read from card types C-9B, C-9C and C-9D.

- Consumption of Demand Data (1,2) (Cols. 8-10)

  Indicate whether the data being entered is for consumption or demand charge calculation.

  1. = consumption
  2. = demand

- Breakpoint Data

  For each breakpoint the corresponding energy quantity and $/unit must be entered. Use only as many breakpoints that are required. If card type C-9C or C-9D are not required, eliminate them.

CARD TYPE C-9E
ENERGY APPLICATION DATA

Energy Use Label (Alphanumeric)	Consumption Basis (1-3)	Consumption Rate No. (See Card C9B)	Demand Basis (1-3)	Demand Rate No. (See Card C9B)	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
					C 9 E R

NOTE: Repeat card types C-9E through C-9G for each energy application specified on card type C-9A, columns 51-60.

- Energy Use Label (Cols. 1-30)

  Alphanumeric description of how or where energy is being used.

- Consumption Basis (1-3) (Cols. 31-40)

  Basis upon which the utility consumption costs are to be calculated

  1.= straight line basis
  2.= step basis
  3.= block basis

- Consumption Rate No. (Cols. 41-50)

  Indicate which set of rate schedule data applies by keying into the proper rate no. which was specified on card type C-9B, columns 1-4.

- Demand Basis (1-3) (Cols. 51-60)

  Basis upon which the utility demand costs are to be calculated

  1.= straight line basis
  2.= step basis
  3.= block basis

  If demand calculations do not apply, leave this blank.

- Demand Rate No. (Cols. 61-70)

  Indicate which set of rate schedule data applies by keying into the proper rate no. which was specified on card type C-9B, columns 1-4. If demand calculations do not apply, leave this blank.

CARD TYPE C-9F and C-9G
MONTHLY CONSUMPTION DATA

	January	February	March	April	May	June	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	
							C 9 F	R

	July	August	September	October	November	December	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	
							C 9 G	R

Since utility bills are calculated at monthly periods, the user must enter here the monthly consumption data for the energy application in question. The units of this data must correspond to those that were specified on card type C-9A, columns 21-26. These quantities can be obtained directly from the monthly energy summary table provided as output by the Systems Analysis Program. This monthly data must be entered as follows:

CARD TYPE C-9F

January	cols.	11-20
February		21-30
March		31-40
April		41-50
May		51-60
June		61-70

CARD TYPE C-9G

July	cols.	11-20
August		21-30
September		31-40
October		41-50
November		51-60
December		61-70

Even though the user may not enter data for a full 12 months, both cards are required.

CARD TYPE C-9F and C-9G
MONTHLY DEMAND DATA

	January	February	March	April	May	June	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
							C 9 F

	July	August	September	October	November	December	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
							C 9 G

For some types of energy, e.g., electricity, a monthly charge is made for the peak useage or demand that occurred during each month. If calculation of demand charges is not required, skip these cards. If they are required however, obtain monthly demand quantities directly from the monthly energy summary table provided as output by the Systems Analysis Program. This monthly demand data must be entered as follows:

CARD TYPE C-9F

January	cols.	11-20
February		21-30
March		31-40
April		41-50
May		51-60
June		61-70

CARD TYPE C-9G

July	cols.	11-20
August		21-30
September		31-40
October		41-50
November		51-60
December		61-70

Even though the user may not enter data for a full 12 months, both cards are required.

CARD TYPE C-10A and C-10B
EQUIPMENT CATAGORY DESCRIPTION

Equipment Label (Alphanumeric) (1-30)	Installed Cost ($) (31-40)	Expected Life (Yrs.) (41-50)	Salvage Value? (0.=No, 1.=Yes) (51-60)	Major Overhaul Period (Yrs.) (61-70)	Card Index (71-80)
					C 1 0 A

ANNUAL MAINTENANCE		MAJOR OVERHAUL		Occupied Floor Space Cost($) (41-50)		Card Index (71-80)
Labor ($) (1-10)	Material($) (11-20)	Labor($) (21-30)	Material($) (31-40)			
						C 1 0 B

NOTE: One set of card types C-10A and C-10B are required for each equipment catagory specified on card type C-9, column 11-20.

CARD TYPE C-10A

- Equipment Label (Cols. 1-30)

  Alphanumeric description of equipment catagory.

- Installed Cost ($) (Cols. 31-40)

  Total installed cost for all equipment included in this catagory.

- Expected Life (Yrs) (Cols. 41-50)

  Expected useful life of equipment within this catagory. This value will be compared to expected building life and replacement costs calculated accordingly.

- Salvage Value (0,1) (Cols. 51-60)

  The user is given the option of having the salvage value of equipment considered at the end of the building life. If at the end of the building life the equipment has some useful life left, then the equipment has some value left and possibily may be resold. This resale value is figured on the basis of straight depreciation over the expected life of the equipment. The user indicates his choice as follows:

  0. = no
  1. = yes

- Major Overhaul Period (Yrs) (Cols. 61-70)

  Number of years of equipment operation after which major overhaul of the equipment will be required. The cost of labor and material required should be indicated on the next card, columns 21-40.

CARD TYPE C-10B

- Annual Maintenance - Labor ($) (Cols. 1-10)

  Cost of labor to be expended each year maintaining the equipment. Over the life of the building these costs will be automatically escalated on basis of data entered on card type C-6.

- Annual Maintenance - Material ($) (Cols. 11-20)

  Cost of material to be expended each year maintaining the equipment. Over the life of the building these costs will be automatically escalated on basis of data entered on card type C-6.

- Major Overhaul - Labor ($) (Cols. 21-30)

  Cost of labor to be expended during each major overhaul of the equipment. Costs are escalated on basis of data entered on card type C-6.

- Major Overhaul - Material ($) (Cols. 31-40)

  Cost of material to be expended during each overhaul of the equipment. Costs are escalated on basis of data entered on card type C-6.

- Occupied Floor Space Cost ($) (Cols. 41-50)

  If floor area occupied by equipment could be used for other useful purposes, this opportunity cost can be accounted for here. These costs are escalated over the life of the building on the basis of data entered on card type C-6.

CARD TYPE C-11
CASH FLOW COMPARISONS

COMPARISON NO.	Base Case No. (1-5)	Compared To Case No. (1-5)		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
1				C 1 1
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Each case for which life cycle costs were calculated can be compared directly on the basis of years-to-payback. The user indicates here on each card which two cases are to be compared and which is the base case. Case no. corresponds to order in which they were entered.

- Base Case No. (1-5) (Cols. 1-10)
- Compared To Case No. (1-5) (Cols. 11-20)

8.3 OUTPUT REPORT DESCRIPTION

The Cost Analysis Program provides the user with the following:

1. Report C1 - Title Page (Figure 8.1).
2. Report C2 - Echo of Utility Rate Schedule Data (Figure 8.2).
3. Report C3 - Summary of Annual Utility Costs (Figure 8.3).
4. Report C4 - Echo of Building Life and Cost Escalation Factors (Figure 8.4).
5. Report C5 - Annuity Cost Report (Figure 8.5).
6. Report C6 - Cash Flow Comparisons (Figure 8.6).

A set of Reports C1 through C5 are received for each alternative studied. Report C6 compares alternatives.

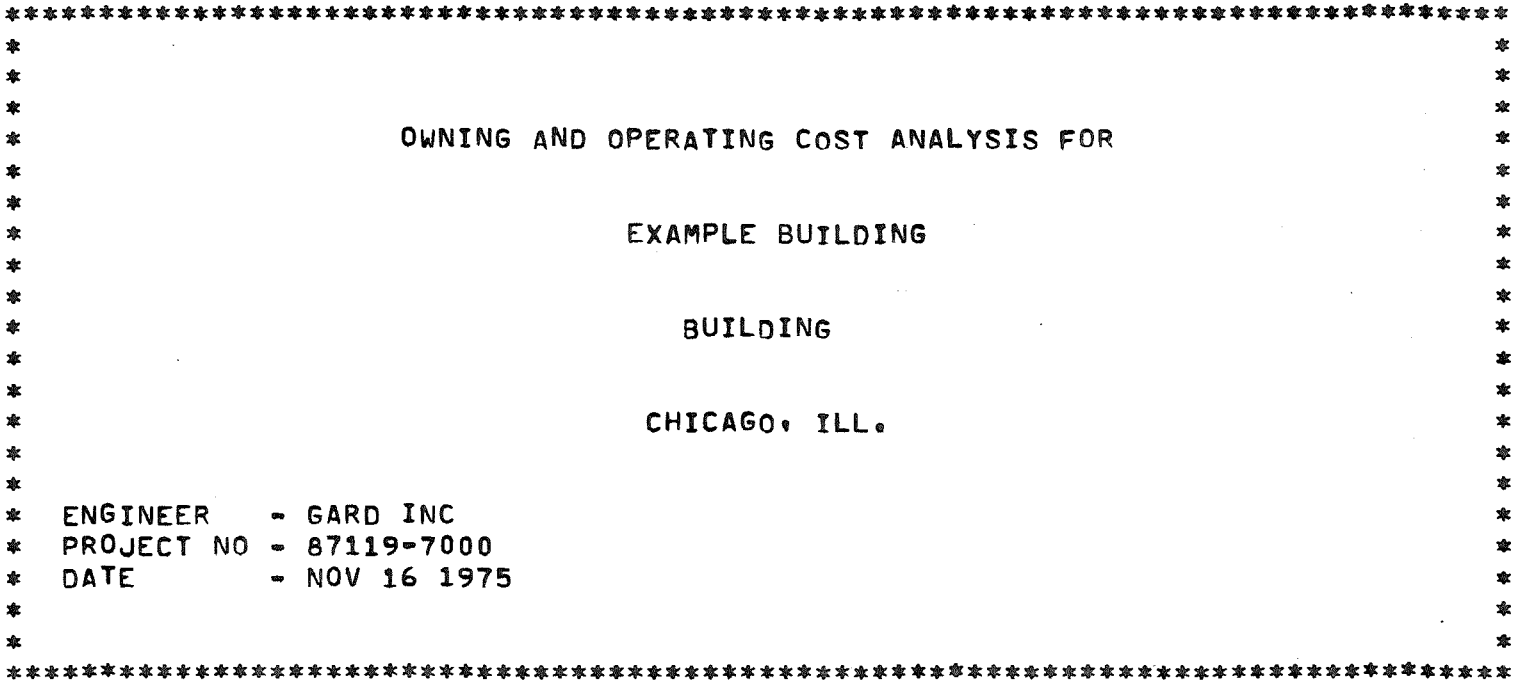


Figure 8.1 REPORT C1 (TYPICAL)

SAMPLE PROBLEM NO. 3

UTILITY RATE SCHEDULE FOR ELECTRICITY

RATE NO 1.

STEP NO.	1	2	3	4	5	6	7	8	9	10
BREAKPOINT	10.	500.	2500.	6000.	30000.	100000.	50000.			
$/KW-HRS	0.090	0.032	0.029	0.018	0.014	0.010	0.008			

RATE NO 2.

STEP NO.	1	2	3	4	5	6	7	8	9	10
BREAKPOINT	25.	200.	1000.	3500.	15000.	100000.				
$/KW	0.0	2.000	1.800	1.650	1.450	1.350				

Figure 8.2 REPORT C2 (TYPICAL)

SAMPLE PROBLEM NO. 3

O P E R A T I N G C O S T C A L C U L A T I O N

ENERGY FORM - ELECTRICITY
CATAGORY - BUILDING BASE POWER

	******** CONSUMPTION ******** RATE NO. 1 BASIS - BLOCK		********** DEMAND ********** RATE NO. 2 BASIS - BLOCK		*** TOTAL ***
	USEAGE (KW-HRS)	COST ($)	USEAGE (KW)	COST ($)	COST ($)
JAN.	85808.5	1032.	524.7	934.	1966.
FEB.	79158.8	965.	524.7	934.	1900.
MAR.	89281.0	1066.	524.7	934.	2001.
APR.	83345.1	1007.	524.7	934.	1941.
MAY	82144.0	995.	524.7	934.	1929.
JUNE	82143.0	995.	524.7	934.	1929.
JULY	79449.7	968.	521.8	929.	1897.
AUG.	85014.3	1024.	521.8	929.	1953.
SEPT	80206.9	976.	516.2	919.	1895.
OCT.	82844.2	1002.	524.7	934.	1936.
NOV.	84011.6	1014.	524.7	934.	1948.
DEC.	86395.8	1038.	524.7	934.	1972.
	999802.6	12081.		11188.	23269.

AVERAGE ANNUAL UNIT COST = $ 0.023/KW-HRS

Figure 8.3 REPORT C3 (TYPICAL)

SAMPLE PROBLEM NO. 3

***** INPUT PARAMETERS USED IN LIFE CYCLE COST CALCULATIONS *****

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 8.4 REPORT C4 (TYPICAL)

SAMPLE PROBLEM NO. 3

OPERATING COST SUMMARY

	CONSUMPTION ($)	DEMAND ($)	TOTAL COST ($)	ANNUITY ($)
STEAM				
HEATING	2346.	0.	2346.	
COOLING	4069.	0.	4069.	
	6416.		6416.	21984.
ELECTRICITY				
BUILDING BASE POWER	12081.	11188.	23269.	79733.
GRAND TOTALS			29684.	101716.

OWNING AND MAINTENANCE COST SUMMARY

	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
COOLING SIDE EQUIP.	90000.	90	YES	10	900.	225.	18000.	9000.	8000.	145092.
HEATING SIDE EQUIP.	20000.	90	YES	10	200.	50.	1000.	1000.	2000.	16737.
AIR SIDE EQUIP.	200000.	90	YES	10	2000.	500.	10000.	10000.	10000.	133104.
TOTAL SYSTEMS AND EQUIPMENT ANNUITY										294933.

*TOTAL OWNING AND OPERATING ANNUITY 396649. 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 8.5 REPORT C5 (TYPICAL)

C A S H F L O W A N A L S I S
COMPARISON NO. 1

BASE SYSTEM (NO. 1)
SAMPLE PROBLEM NO. 3

COMPARED SYSTEM (NO. 2)
SAMPLE PROBLEM NO. 4

	****** ANNUAL CASH FLOW ****** BASE SYSTEM ($)	COMPARED SYSTEM ($)	NET DIFFERENCE ($)	CUMULATIVE DIFFERENCE ($)	
0	-310000.	-340000.	-30000.	-30000.	
1	-108973.	-104041.	4932.	-25068.	
2	-120393.	-115026.	5368.	-19700.	
3	-133079.	-127240.	5838.	-13862.	
4	-147177.	-140830.	6346.	-7516.	
5	-162854.	-155961.	6893.	-623.	
5.1				0.	***BREAKEVEN POINT***
6	-180298.	-172817.	7482.	6859.	
7	-199721.	-191606.	8115.	14974.	
8	-221359.	-212566.	8793.	23767.	
9	-245480.	-235961.	9519.	33286.	
10	-272214.	-260334.	11880.	45167.	
11	-302418.	-291296.	11123.	56289.	
12	-335960.	-323958.	12002.	68292.	
13	-373445.	-360510.	12935.	81227.	
14	-415365.	-401444.	13921.	95147.	
15	-462274.	-447315.	14959.	110106.	
16	-514798.	-498750.	16048.	126154.	
17	-573648.	-556463.	17185.	143339.	
18	-639628.	-621262.	18365.	161704.	
19	-713648.	-694065.	19583.	181287.	
20	-823873.	-798667.	25206.	206493.	
21	-890077.	-867983.	22094.	228588.	
22	-994986.	-971624.	23363.	251950.	
23	-1112975.	-1088359.	24616.	276566.	
24	-1245758.	-1219924.	25834.	302400.	
25	-1395279.	-1368293.	26986.	329386.	
26	-1563752.	-1535714.	28038.	357424.	
27	-1753694.	-1724745.	28949.	386373.	
28	-1967964.	-1938297.	29667.	416040.	
29	-2209821.	-2179690.	30131.	446171.	
30	-2565477.	-2521904.	43573.	489744.	
31	-2791641.	-2761659.	29982.	519726.	
32	-3140641.	-3111470.	29171.	548897.	
33	-3535461.	-3507751.	27710.	576607.	
34	-3982352.	-3956908.	25444.	602051.	
35	-4488448.	-4466247.	22201.	624252.	
36	-5061889.	-5044129.	17760.	642012.	
37	-5711962.	-5700084.	11878.	653890.	
38	-6449274.	-6445014.	4260.	658150.	
39	-7285938.	-7291379.	-5441.	652709.	
40	-8510711.	-8484000.	26711.	679420.	

NOTE... BREAKEVEN POINTS ARE INDICATORS OF PAYBACK OF INVESTED CAPITAL. HOWEVER, COSTS OF CAPITAL AND TAX EFFECTS ARE NOT INCLUDED.

Figure 8.6 REPORT C6 (TYPICAL)