NASA TM-83239

NASA Technical Memorandum 83239

NASA-TM-83239 19820022832

NECAP 4.1 - NASA'S ENERGY-COST ANALYSIS PROGRAM INPUT MANUAL

Ronald N. Jensen

May 1982

National Aeronautics and Space Administration

Langley Research Center
Hampton, Virginia 23665

DISPLAY 18/2/5
82N30708*# ISSUE 21 PAGE 2993 CATEGORY 44 RPT#: NASA-TM-83239 NAS 1.15:83239 82/05/00 127 PAGES UNCLASSIFIED DOCUMENT
UTTL: NECAP 4.1: NASA's Energy-Cost Analysis Program input manual
AUTH: A/JENSEN, R. N.
CORP: National Aeronautics and Space Administration. Langley Research Center, Hampton, Va. AVAIL.NTIS SAP: HC A07/MF A01
MAJS: /*COMPUTER PROGRAMS/*COST ANALYSIS/*ENERGY CONSUMPTION/*USER MANUALS (COMPUTER PROGRAMS)
MINS: / ALGORITHMS/ ENERGY CONSERVATION/ HEAT TRANSFER/ SPACE COOLING (BUILDINGS)/ SPACE HEATING (BUILDINGS)/ STRUCTURAL DESIGN/ TEMPERATURE
ABA: R.J.F.
ABS: The computer program NECAP (NASA's Energy Cost Analysis Program) is described. The program is a versatile building design and energy analysis tool which has embodied within it state of the art techniques for performing thermal load calculations and energy use predictions. With the program, comparisons of building designs and operational alternatives for new or existing buildings can be made. The major feature of the program is the response factor technique for calculating the heat transfer through the building surfaces which accounts for the building's mass. The program expands the response factor technique into a space response factor to account for internal building temperature swings; this is extremely important in determining true building loads and energy consumption when
ENTER:

TABLE OF CONTENTS

N82-30708#

TABLE OF CONTENTS

Section 1

INTRODUCTION

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

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

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

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

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

- Provide built in default values for most input data.

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

- The Variable Temperature module and System and Equipment Simulation module were brought together into one module to allow dynamic simulation and interaction (feedback) between the space, its distribution system, and the heating and cooling plant equipment. In the previous version of NECAP, the hourly space temperatures and system heating/cooling loads were calculated using given heating/cooling capacities. Because of varying plant equipment capacity due to ambient conditions, scheduling, distribution system control options, etc., "loads-not-met" resulted in the old program. "Loads-not-met" were not accounted for in space temperature drift above or below the allowed temperature range.

- Modify the thermostat and ventilation schedule input.
- Improve fan on/off code.
- Addition of process loads.
- Modify the weather tape system.
- Use system component part load performance curves.
- Default CFM, chiller size, and boiler size data.
- Provide an executive summary for energy.
- Print out a temperature frequency chart.
- Add more flexibility to print out.
- Change the glass shade coefficient.
- Correct air infiltration coefficients, fan efficiencies, and floor panel heating algorithms.

The new program is documented in the following manuals:

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

TM 83239, Input Manual - Details the input requirements.

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

TM 83241, Fast Input Manual and Example - Gives a fast method of input.

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

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

Program modifications were directed specifically at program improvements and not at a complete rework of the program structure. We wish to acknowledge the contributions made by the project's contractor, GARD, Inc. of Niles, IL, for the various changes and documentation in the program performed under contract NASW-3307. The program's maintenance contractor, Computer Sciences Corporation, of Hampton, Virginia also assisted in program updates and documentation.

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

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

Ronald N. Jensen
Mail Stop 443
NASA, Langley Research Center
Hampton, VA 23665

NECAP-4.1 is made up of the following program modules:

NECAP Input Processor (NIPP)
Thermal Load Analysis (TLAP)
Systems Energy Simulation (SESP)
Owning and Operating Cost (ESCON)

1.2 INPUT CODE

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

L11-4 = 3, @ 10, 270;

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

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

Implicit definition is done one of 5 ways:

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

The last method would cause the entire variable list of the omitted card to take on default values. Examples are illustrated in Section 4 and in the defaults are given in the last column of the input instructions.

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

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

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

SECTION 2

THERMAL LOADS ANALYSIS PROGRAM INPUT DATA FORMAT

(FORMS L1/1 THROUGH L18/3)

L1 TLAP TITLE CARD

GENERAL DESCRIPTION:

For the TLAP program, five (5) headers are used as job descriptors. These are the Facility Name, the Facility Location, the Engineer's Name, the Project Number and the Date. Each header has its own card. If any of the headers are not included, they will default to the following:

Header	Default Value
Facility Name	Blanks
Facility Location	Blanks
Engineer's Name	Blanks
Project Number	Blanks
Date	Date of execution

This card is repeatable (maximum of 5). Extra title cards are ignored.
Titles can be composed of any character except for the variable list terminators, the semi-colon (;) and the slash (/).

```
Example:  L1=Building 12, General Offices/ Hampton, Virginia/ Smith;
          L1=Project 1710/
             March 18, 1980;
```

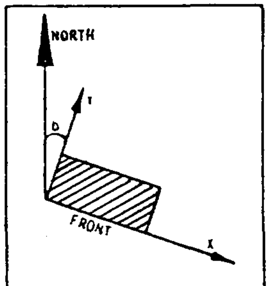
NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Program Header: The length limit of the Facility Name, Facility Location, and the Engineer's Name is 35 characters. The Project Number and the Date are limited to 15 characters. Excessive header lengths will be truncated to the maximum allowed.		see comments	see above

L2: GENERAL BUILDING DATA CARD

GENERAL DESCRIPTION:

Data on this card applies to the entire building. The first six variables establish coefficients for solar insolation calculations. The seventh describes the type of analysis to be performed. The last four are system design parameters. They are used to estimate design air quantities based on peak loads. The design parameters are used only in TLAP and the results of their use are not passed to the systems energy simulation program (SESP). This card is non-repeatable.
Those variables defaulted use local data for a given city which is obtained from NECAP weather tapes.

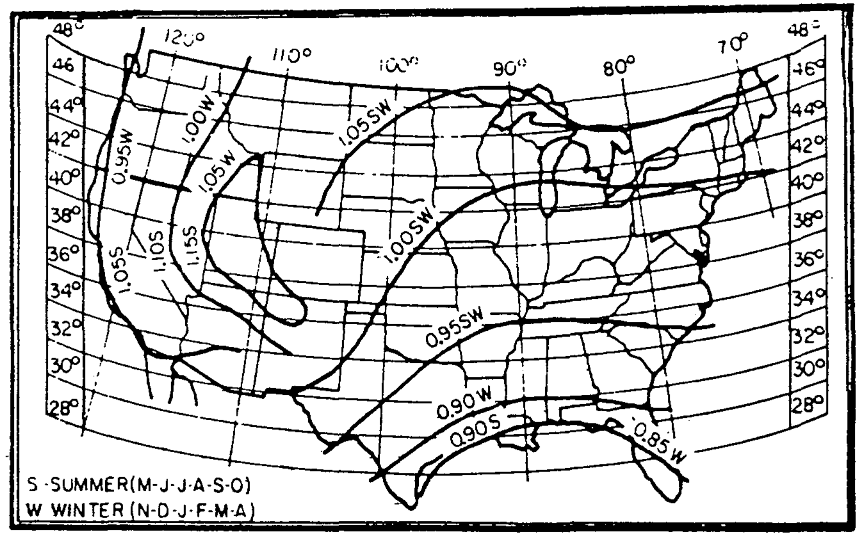
NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Building Azimuth Angle: Building azimuth angle expresses the orientation of the building relative to the points of the compass. It is defined as the clockwise angle from north to the direction in which the back of the building faces. Or, if 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 page L2/2 for further explanation. By changing the value of the building azimuth angle, the user can investigate the effects of locating the building at different orientations.	degrees	0. to 360.	0.0
2	Job Processing Code: 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	-	1. to 3.	3



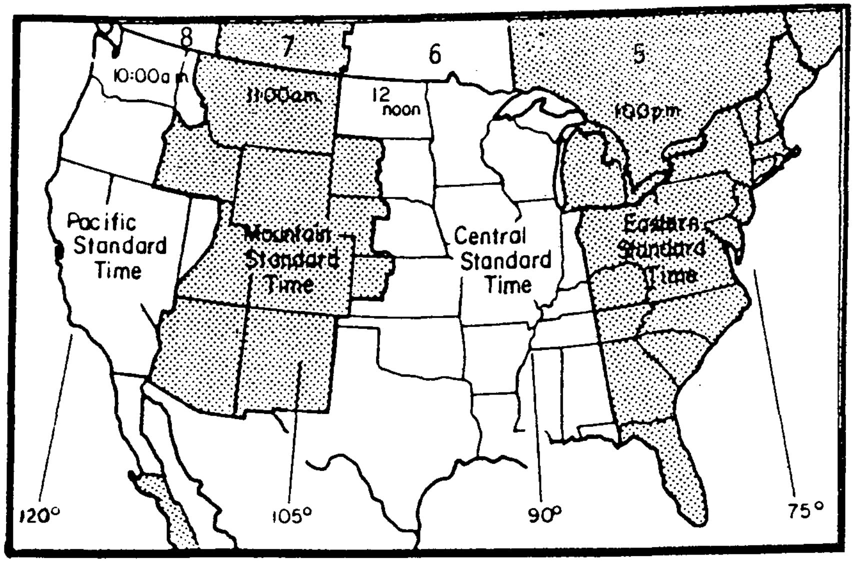
Building Azimuth Angle (b)

EXAMPLE:

Building Front Facing	Azimuth
South	0^{0}
West	90^{0}
North	180^{0}
East	270^{0}



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

L2 GENERAL BUILDING DATA CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
3	Ventilation Air Rate: Estimated rate at which outside air is introduced into building. Calculated on a zone-by-zone basis 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 estimate capacity of cooling and heating plants. It is also a parameter in crack infiltration analysis.	CFM/FT^2	0.0 to 10.0	0.1
4	Estimated Total Fan Pressure: Estimated building total fan pressure is used in conjunction with the calculated total building 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.	inches of water	0.to 15.	2.0
5	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 programs.	^oF	40.to 70.	55.0
6	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.	^oF	80.to 200.	120.0
7	Latitude: Latitude location of the building under study. Used to calculate solar insolation data. For continental U.S., the latitude varies from 25^o at southern Florida to 48^o at northern Washington state. (Hampton = 37.0)	degrees	-90.to90. Except 0.	WEATH TAPE

L2: GENERAL BUILDING DATA CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
8	Longitude: Longitudinal location of the building under study. Used to calculate solar insolation data. For continental U.S., the longitude varies from 66^o in Maine to 124^o in California. (Hampton = 76.3)	degrees	1. to 360.	WEATH TAPE
9	Time Zone Number: A coded number ranging from 4 to 8 (see page L2/2) indicating which geographic time zone the building is operating in. Used to calculate hour angle of sun. (Hampton = 5.)	-	4 to 8	WEATH TAPE
10	Clearness Number for Summer: Atmospheric clearness number or haze factor for geographic location in question. See map on page L2/2 for typical values for non-industrial atmosphere. Used to adjust solar insolation data. (Hampton = .96)	-	0.90 to 1.15	WEATH TAPE
11	Clearness Number for Winter: Same as above except for winter. (November through April). (Hampton = .96)	-	0.84 to 1.05	WEATH TAPE

L3 WEATHER DATA CARD

GENERAL DESCRIPTION:

The first five variables describe the simulation period for the hourly load analysis. The defaulted weather data is read by TLAP from weather files.

The last nine variables on this card describe the design day conditions to be simulated for the design load analysis. The design load analysis is performed for the months from March through December. The summer design day is simulated for July and August. The winter day is in December. The design days for the other months are calculated between these extremes. The results of the design load analysis are not provided for use by SESP.

The card is non-repeatable.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Starting Month of Study	month	1 to 12	1
2	Starting Day of Study	day	1 to 31	1
3	Ending Month of Study	month	1 to 12	12
4	Ending Day of Study	day	1 to 31	31
5	Special Schedule Length (time off at end of year)	days	0 to 365	0
6	Altitude Above Sea Level: Height of building above sea level. Used to calculate psychrometric properties of outside air. (Hampton = 17)	FT	0. to 10,000.	WT
7	Summer Design Dry-Bulb Temperature: July/August summer desgin day maximum dry-bulb temperature. (Hampton = 91)	^{o}F	50. to 150	WT

L3 WEATHER DATA CARD

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
8	Summer Daily Dry-Bulb Temperature Range: Number of degrees of swing of dry-bulb temperature during the July/August summer design day. (Hampton = 18)	^oF	0. to 30.	WT
9	Summer Dew Point Temperature; July/August summer design day average dew point temperature. This is assumed to remain constant throughout the design day. (Hampton = 71.5)	^oF	30.to 90.	WT
10	Summer Windspeed: July/August summer design day windspeed. Used to calculate outside surface film coefficient and infiltration air loads. (Hampton = 11)	MPH	0. to 25	WT
11	Winter Desgin Dry=Bulb Temperature December winter design day minimum dry-bulb temperature. Hourly dry-bulb temperatures for this design day are calculated using typical diurnal cycle. (Hampton = 22)	^oF	-50.to 75	WT
12	Winter Daily Dry-Bulb Temperature Range: Number of degrees of swing of dry-bulb temperature during the December winter design day. (Hampton = 3)	^oF	0. to 30	3.
13	Winter Dew Point Temperature: Average dew point temperature for the December winter design day. Assumed to remain constant throughout the design day. (Hampton = 13)	^oF	-50to 75	WT
14	Winter Windspeed: Assumed windspeed for the December winter design day. Used to calculate outside surface film coefficient and infiltration. (Hampton = 12)	MPH	0.to 25	WT

L4 HOURLY PRINTOUT CARD

GENERAL DESCRIPTION:

A printout of the hourly weather data and calculated space loads can be requested with this card. The printout begins on the first hour of the starting day and ends on the last hour of the ending day. Up to four separated printout periods can be requested. This card is non-repeatable. If omitted, the program assumes no printouts requested.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Starting Month and Day of Printout No. 1	-	1 to 12	0
2		-	1 to 31	0
3	Ending Month and Day of Printout No. 1	-	1 to 12	0
4		-	1 to 31	0
5	Starting Month and Day of Printout No. 2	-	1 to 12	0
6		-	1 to 31	0
7	Ending Month and Day of Printout No. 2	-	1 to 12	0
8		-	1 to 31	0
9	Starting Month and Day of Printout No. 3	-	1 to 12	0
10		-	1 to 31	0
11	Ending Month and Day of Printout No. 3	-	1 to 12	0
12		-	1 to 31	0

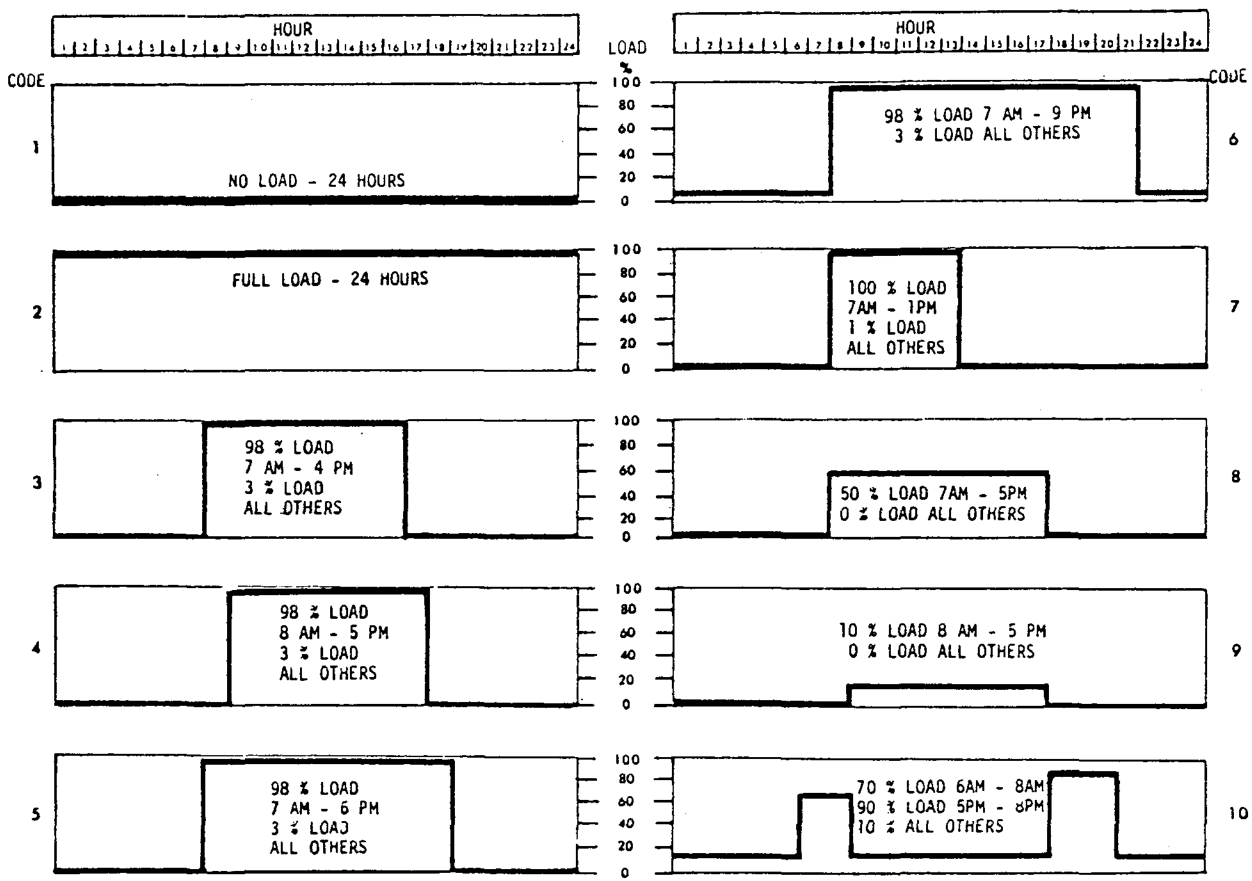
L5 WEEKLY SCHEDULE CARD

GENERAL DESCRIPTION:

Three types of space loads: people, lighting, and equipment, can be simulated as functions of the hour of the day and of the day of the week. This card defines the set of 24 hour profiles that make up a weekly schedule.
This card is repeatable (maximum of 15). The number to be associated with a specific weekly schedule is defined by the user as the repetition number or defined by the program as determined by the order of appearance in the deck.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Sunday Schedule Code: 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 page L5/2 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 L6.	-	1 to 20	1
2	Weekday Schedule Code: Monday through Friday Same remarks as above apply. (Weekday defaults to 4)	-	1 to 20	4
⋮		⋮	⋮	⋮
7	Saturday Schedule Code: Same remarks as above apply.	-	1 to 20	1
8	Holiday Schedule Code: Same remarks as above apply.	-	1 to 20	1
9	Special Holiday Schedule Code: Same remarks as above apply.	-	1 to 20	1

STANDARD CODED SCHEDULES



L6 DAILY PROFILE CARD

GENERAL DESCRIPTION:

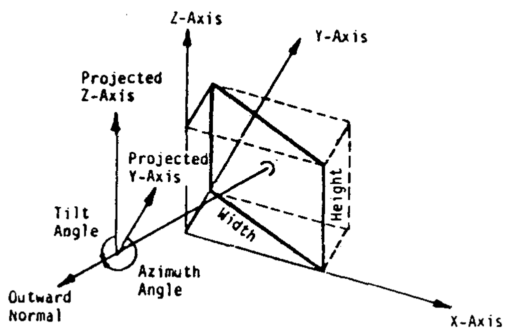
The user defines any non-standard 24-hour load profiles on this card. The profiles are simulated as fractions of full load.
This card is repeatable (maximum of 10).

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Fraction of load for 12 midnight to 1 AM	Decimal	0.0 to 1.0	0.0
2	Fraction of load for 1 AM to 2 AM	"	"	"
3	Fraction of load for 2 AM to 3 AM	"	"	"
4	Fraction of load for 3 AM to 4 AM	"	"	"
⋮	⋮	⋮	⋮	⋮
23	Fraction of load for 10 PM to 11 PM	"	"	"
24	Fraction of load for 11 PM to 12 Midnight	"	"	"

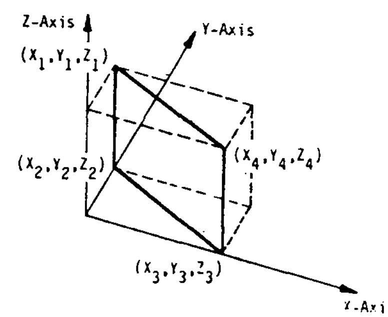
L7 SHADING SURFACE CARD

GENERAL DESCRIPTION:

The shading of the building by external structures can be simulated by the use of this card. The shading surfaces described will affect only those surfaces which explicitly call them.
Two methods can be used to describe the shading surfaces, a short form and a long form. The short form can only be used for rectangular shapes. The variables necessary for short description are shown below. The long form can be used to define any surface shape. Its variables are also illustrated below. Up to 16 vertices can be coded. Page L7/5 illustrates some correct and incorrect ways of ordering the vertices. This card is repeatable. (Maximum of 10)



Short Form

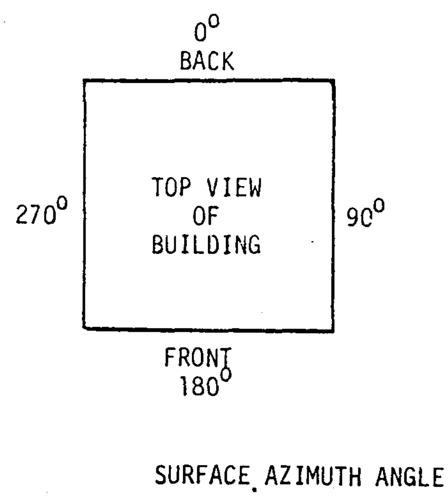


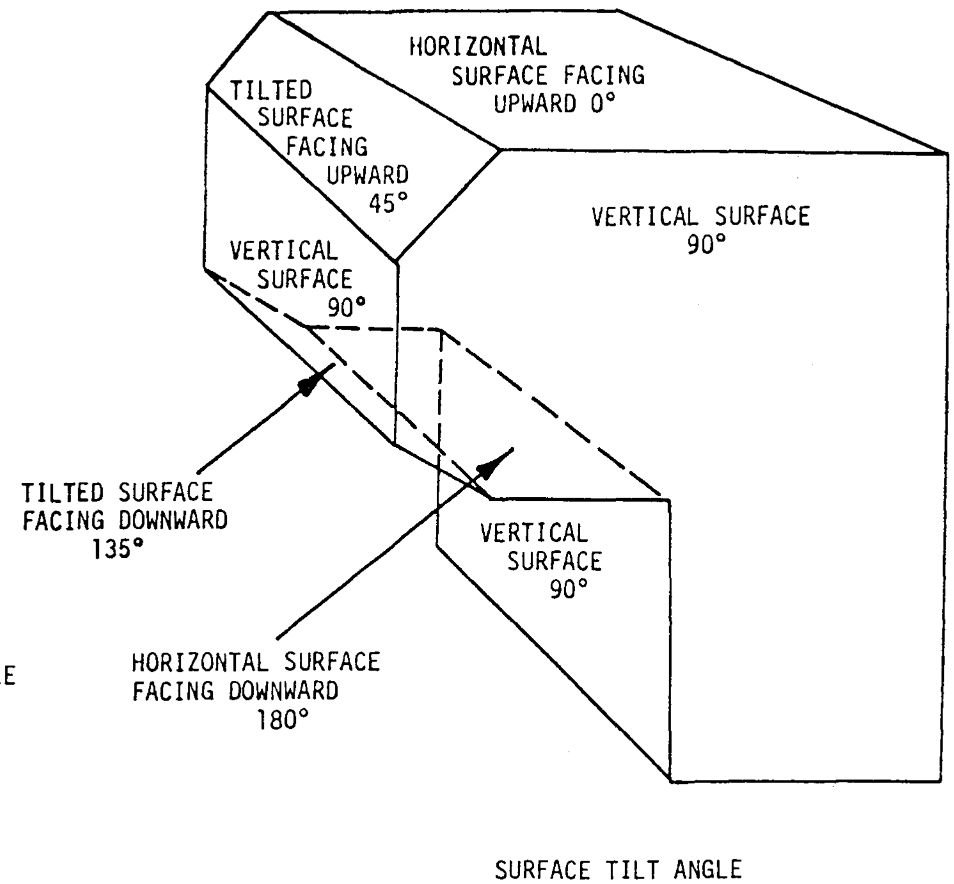
Long Form

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Form Description Code: 0 = short form 1 = long form	-	0 or 1	0
2	Surface Transmittance: Fraction of sunlight that can pass through the shading surface 0.0 none (opaque) 1.0 all (clear) >0.0 but <1.0 fractional amount	-	0.0 to 1.0	0.0

L7 SHADING SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the short form is used, the following variables complete the card.			
3	Lower lefthand vertex X-coordinate value	FT.	-	0.0
4	Lower lefthand vertex Y-coordinate value	FT.	-	0.0
5	Lower lefthand vertex Z-coordinate value	FT.	-	0.0
6	Height (vertical dimension) of surface: If omitted then the width becomes surface area	FT.	-	1.0
7	Width (horizontal dimension) of surface: If omitted then the height becomes surface area	FT.	-	1.0
8	Azimuth angle of surface: 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 page L7/3 for further explanation.	Degrees	0.to 360.	180.0
9	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^o and 180^o, as shown on page L7/3.	Degrees	0.to 180.	90.0


0°
BACK
270°
TOP VIEW
OF
BUILDING
90°
FRONT
180°
SURFACE AZIMUTH ANGLE

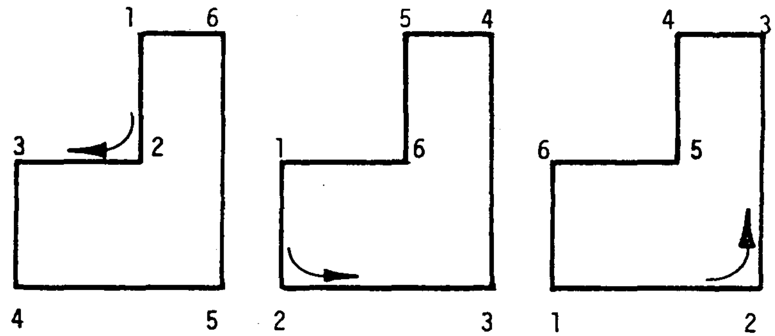

HORIZONTAL
SURFACE FACING
UPWARD 0°
TILTED
SURFACE
FACING
UPWARD
45°
VERTICAL SURFACE
90°
VERTICAL
SURFACE
90°
TILTED SURFACE
FACING DOWNWARD
135°
VERTICAL
SURFACE
90°
HORIZONTAL SURFACE
FACING DOWNWARD
180°
SURFACE TILT ANGLE

L7 SHADING SURFACE CARD (continued)

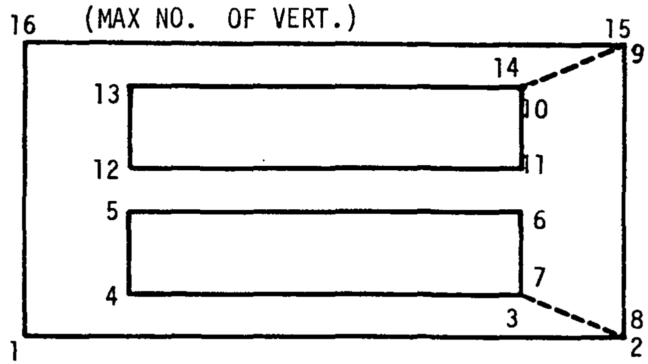
NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the long form is used then the following group of variables is repeated for each vertex.			
3	x,y,and z - coordinate values for vertex no. 1	FT.	-	0.0
4		FT.	-	0.0
5		FT.	-	0.0
6	x,y,and z - coordinate values for vertex no. 2	FT.	-	0.0
7		FT.	-	0.0
8		FT.	-	0.0
.	.	.	.	.
48	x,y, and z - coordinate values for vertex no. 16	FT.	-	0.0
49		FT.	-	0.0
50		FT.	-	0.0

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

EXAMPLES:



WRONG RIGHT RIGHT



WALL WITH TWO WINDOWS

L8: STANDARD RESPONSE FACTOR CARD

GENERAL DESCRIPTION:

Several types of delayed heat transfer surfaces are built into the program. These surfaces are referenced by this card. The built-in surfaces are described on page L8/2. Up to 16 codes can be used. This card is non-repeatable.

**If no non-standard surfaces are used (L9 and L10 cards omitted), the L8 card may be omitted and the card will default to 1,2,...,16; thus, all the standard surfaces are provided. If the L8, L9, or L10 card is used, then each field of L8 defaults to zero.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Standard surface code no. 1: 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 but should be specified only once and must be a number from 1 to 16 in accordance with the type of construction.	-	1 to 16	0 or 1
2	Standard surface code no. 2 Same remarks as above apply	-	1 to 16	0 or 2
⋮	⋮	⋮	⋮	⋮
16	Standard surface code no. 16 (if necessary)	-	1 to 16	0 or 16
				Refer to **

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

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

L9 MATERIAL CARD

GENERAL DESCRIPTION:

The materials used in user-defined delayed surfaces are described on this card. The different materials are combined to form the delayed surfaces on card L10. One card is required for each unique material. Air spaces and the inside air film should be included. The resistance due to the outside air film is calculated each hour as a function of wind speed and should not be considered as a material.
Table on page L9/2 contains typical values.
This card is repeatable. (Maximum of 30)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Material Thickness: If material has no thermal mass (e.g. air space) leave this blank	FT.	-	0.0
2	Material Thermal Conductivity: If material has no thermal mass (e.g. air space) leave this blank	Btu/hr-ft^2-^{o}F	-	0.0
3	Material Density: If material has no thermal mass (e.g. air space) leave this blank	LB/FT^3	-	0.0
4	Material Specific Heat Capacity: If material has no thermal mass (e.g. air space) leave this blank	Btu/lb-^{o}F	-	0.0
5	Material Thermal Resistivity: Enter a value here only if material has no thermal mass (e.g. air space).	Hr-ft^2-^{o}F/Btu	-	0.0
6	Material Name: Alphanumeric description of material. (See NOTE)	-	30 Characters	(Blank)
	NOTE: First character must be a letter.			

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.

L10 USER-DEFINED RESPONSE FACTOR CARD

GENERAL DESCRIPTION:

The user builds non-standard delayed surfaces from the materials described on L9 cards. The L9 card's repetition number is used as the material index. Order the materials on the card from the outside layer to the inside. Up to 10 materials can be used to describe a surface. This card is repeatable. (Maximum of 10)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Material Index 1: The outside material is always listed first. Note that the outside air film is calculated each hour as a function of wind speed. Do not include it as a material.	-	1 to 30	0
2	Material Index 2	-	1 to 30	0
⋮	⋮	⋮	⋮	⋮
10	Material Index 10: (If necessary)	-	1 to 30	0

The following definition pertains to cards L11, L12, and L13. These cards describe the surfaces which make up the building exterior.
<u>Exterior Surface Description</u>: The user is given two methods for describing an exterior 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 (long form) 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 (short form) 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 on the appropriate card 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.

Method 2 has a simplified option. It requires that the card be flagged with the Letter F and insert four items near the beginning of the card. The fields input are:

L11-F = , surface area, surface code , azimuth, tilt;
L12-F = , surface area, heat transfer coef., azimuth, tilt;
L13-F = , surface area, shading coef. , azimuth, tilt;

The surface cannot have shading. The surface area is given in lieu of its width, and the height is defaulted to 1.0.

L11 DELAYED SURFACE CARD

GENERAL DESCRIPTION:

Delayed heat transfer surfaces are thick exterior above ground 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.
As described on page L11/0 there are two methods of describing a surface, the long and short forms. The first eight data items are common to both forms. The ninth item, no. of vertices, is used to describe the variables that complete the card. If the no. of vertices is less than three, then a short form is assumed. If greater than or equal to 3 then the long form is assumed.
Each surface requires a separate card. This card is repeatable. (Maximum of 75).
A special variable, the similar surface index, can be used to repeat properties of any surface. If used, the index causes the program to copy from the referenced surface card onto the card being processed. Only those variables that were defaulted before record termination are reset.

Example L11-3= 0,5,0.7,0.5,3,@4,180,90,30,25;
L11-4= 3,@10,270;
Card L11-4 becomes, because of the similar surface index, equivalent to typing
L11-4= 0,5,0.7,0.5,3,@4,180,90,270;
Note that the '25' on card L11-3 is not carried over to L11-4 because L11-4 terminated before reaching that position.

The fast form only uses Items 12, 2, 10, and 11 (in that order) and does not use the similar surface or shading options.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Similar Surface Index: To decrease input time, user can use this feature if building envelope contains delayed heat transfer surfaces which have identical values. When using similar surface feature, if any surface parameters are left blank, values entered for reference surface will be used automatically.	-	-	0

L11 DELAYED SURFACE CARD (continued)

<table>
<tr><th>NO.</th><th>VARIABLE DESCRIPTION AND COMMENTS</th><th>UNITS</th><th>LIMITS</th><th>DEFAULT</th></tr>
<tr><td>2</td><td>Response Factor Surface Code Number:
This code corresponds to the order of appearance of the response factor surfaces. Standard surfaces, if they are included in the data deck, are sequenced in the order that they are entered on the L8 card. User-defined surface code numbers are calculated by the equation below:
Surface Code Number = (Number of standard surfaces) plus (Card L10 repetition number)
Example: L8 = 5,7,3;
:
L10-1 ....;
L10-2 ......;
Results in
<u>Surface Code Number</u> — <u>Response Factor Surface</u>
1 — Standard surface 5
2 — Standard surface 7
3 — Standard surface 3
4 — User-defined surface L10-1
5 — User-defined surface L10-2</td><td>-</td><td>-</td><td>8</td></tr>
<tr><td>3</td><td>Surface Exterior Absorptivity:
Indicates the surface's ability to absorb incident solar radiation. This property is mainly a function of the surface color and texture. 1 equals totally absorbant. See page L11/3 for typical values.</td><td>-</td><td>0.0 to 1.0</td><td>0.75</td></tr>
<tr><td>4</td><td>Reflectivity of Ground Facing Surface:
Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. 1 equals totally reflective. See page L11/3 for typical values.</td><td>-</td><td>0.0 to 1.0</td><td>0.20</td></tr>
</table>

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

DELAYED SURFACE
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

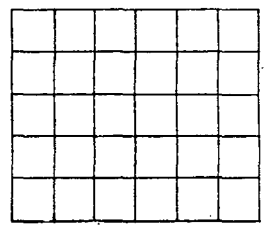
Values in ( ) are infiltration values at 7½ mph wind normal to the surface. Data from 1972 ASHRAE handbook of fundamentals, pg.339.
the basic equation $Q = C*A*\Delta P^N$.

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

L11 DELAYED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
5	Surface Roughness Index: User indicates the exterior roughness of the surface by using a code which varies from 1.0 (rough) to 6.0 (smooth). See page L11/3 for typical values. Program uses this information along with wind velocity data to calculate the outside film coefficient each hour.	-	1 to 6	2
6	Infiltration Flow Coefficient: A function of surface construction, this allows an estimate to be made of the 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 space card L17. See page L11/3 for typical values of infiltration flow coefficient for delayed surfaces.	-	-	0.0
7	Number of X-Divisions in Surface: If the surface being described is shaded, 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. 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 it's 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 L14).	-	1 to 50	1

L11 DELAYED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
8	Number of Y-Divisions in Surface: Same as for x-divisions only in height dimension. An example of both is shown below.  Since the output is printed having 5 characters/inch on the horizontal (x) and 6 lines/inch on the vertical (y), if true perspective pictures are to be shown use x and y divisions that are proportional to the width and height and multiply the "y" divisions by 1.2.	-	1 to 50	1
9	Number of Vertices: If less than 3 then short form is assumed. If greater than or equal to 3 then long form is assumed.	-	0 to 10	1

L11 DELAYED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the short form is used, the following variables complete the card.			
10	Surface Azimuth Angle: Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. See page L7/3.	Degrees	0. to 360.	180.0
11	Surface Tilt Angle: Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0^{o} (facing sky) and 180^{o} (facing ground). See page L7/3.	Degrees	0. to 180.	90.
12	Surface Height (Vertical Dimension): If omitted then width becomes surface area	FT.	-	1.0
13	Surface Width (Horizontal Dimension): If omitted then height becomes surface area	FT.	-	1.0
14	Lower lefthand vertex X-coordinate value	FT.	-	0.0
15	Lower lefthand vertex Y-coordinate value	FT.	-	0.0
16	Lower lefthand vertex Z-coordinate value	FT.	-	0.0
17	Index of Added Shading Surface 1: A shading surface described on an L7 card will shade this surface. The index is the 'card repetition number' of the appropriate L7 card. Up to 5 shading surfaces can be added. Additional ones continue on this card as variables 18-21.	-	-	None

L11 DELAYED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the long form is used, the following variables complete the card.			
10	X, Y, and Z-Coordinates of Vertex No. 1: For comments refer to page L7/1. Up to 10 vertices can be used.	FT.	-	0.0
11		FT.	-	0.0
12		FT.	-	0.0
13	X, Y, and Z-Coordinates of Vertex No. 2:	FT.	-	0.0
14		FT.	-	0.0
15		FT.	-	0.0
⋮	⋮	⋮	⋮	⋮
	X, Y, and Z-Coordinates of the last vertex	FT.	-	0.0
		FT.	-	0.0
		FT.	-	0.0
	Index of Added Shading Surface 1: See notes on page L11/5.	-	-	0

L12 QUICK SURFACE CARD

GENERAL DESCRIPTION:

Quick heat transfer surfaces are thin exterior aboveground surfaces that experience hourly changes in temperature but have little or no heat storage effect (e.g., metal doors). They are simulated with the steady state method.
As described on page L11/0 there are two methods of describing a surface, the long and short forms. The first eight (8) data items are common to both forms. The ninth item, no. of vertices, is used to describe the variables that complete the card.
Each surface requires a separate card. This card is repeatable (maximum of 25). A special variable, the similar surface index, can be used to repeat properties of any surface. If used, the index causes the program to copy from the referenced surface card onto the card being processed. Only those variables that were defulated before record termination are reset.

Example: L12-3=0,0.25,0.7,0.5,3,@4,180,90,30,25;
L12-4=3,@10,270;
Card L12-4 becomes, because of the similar surface index, equivalent to typing
L12-4=0,0.25,0.7,0.5,3,@4,180,90,270;
Note that the '25' on card L12-3 is not carried over to L12-4 because L12-4 terminated before reaching that position.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Similar Surface Index: To decrease input time, user can use this feature if building envelope contains quick heat transfer surfaces which have identical values. When using similar surface feature, if any surface parameters are left blank, values entered for reference surface will be used automatically.			0
2	Heat Transfer Coefficient: 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. See L12/16	Btu/hr-ft^2-^{o}F		0.0

L12 QUICK SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
3	Surface Exterior Absorptivity: Indicates the surface's ability to absorb incident solar radiation. This property is mainly a function of the surface color and texture. 1 equals totally absorbant. See page L11/3 for typical values.	-	0.0 to 1.0	0.75
4	Reflectivity of Ground Facing Surface: Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. 1 equals totally reflective. See page L11/3 for typical values.	-	0.0 to 1.0	0.20
5	Surface Roughness Index: User indicates the exterior roughness of the surface by using a code which varies from 1.0 (rough) to 6.0 (smooth). See page L11/3 for typical values. Program uses this information along with wind velocity data to calculate the outside film coefficient each hour.	-	1 to 6	2
6	Infiltration Flow Coefficient: A function of surface construction, this allows an estimate to be made of the 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 space card L17. See page L12/3 for typical values of infiltration flow coefficient for quick surfaces.	-	-	0.0
7	Number of x-Divisions in Surface: Refer to page L11/4 for comments.	-	1 to 50	1
8	Number of y-Divisions in Surface: Refer to page L11/5 for comments	-	1 to 50	1
9	Number of Vertices: If less than 3 then short form is assumed. If greater than or or equal to 3 then long form is assumed.	-	0 to 10	1

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. the basic equation $Q = C * P * \Delta P^N$.

Q is Air Flow Rate
C is Flow Coefficient, per linear 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

L12 QUICK SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the short form is used, the following variables complete the card.			
10	Surface Azimuth Angle: Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. See page L7/3.	Degrees	0. to 360.	180.0
11	Surface Tilt Angle: Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0^o (facing sky) and 180^o (facing ground). See page L7/3.	Degrees	0. to 180.	90.
12	Surface Height (Vertical Dimension): If omitted then width becomes surface area.	FT.	-	1.0
13	Surface Width (Horizontal Dimension): If omitted then height becomes surface area.	FT.	-	1.0
14	Lower lefthand vertex X-coordinate value	FT.	-	0.0
15	Lower lefthand vertex Y-coordinate value	FT.	-	0.0
16	Lower lefthand vertex Z-coordinate value	FT.	-	0.0
17	Index of Added Shading Surface 1: A shading surface described on an L7 card will shade this surface. The index is the 'card repetition number' of the appropriate L7 card. Up to 5 shading surfaces can be added. Additional ones continue on this card as variables 18-21.	-	-	0

L12 QUICK SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the long form is used, the following variables complete the card.			
10	Z, Y, and Z-Coordinates of Vertex No. 1: For comments refer to page L7/1. Up to 10 vertices can be used.	FT.	-	0.0
11		FT.	-	0.0
12		FT.	-	0.0
13	X, Y, and Z-Coordinates of Vertex No. 2:	FT.	-	0.0
14		FT.	-	0.0
15		FT.	-	0.0
⋮	⋮	⋮	⋮	⋮
	X, Y, and Z-Coordinates of the last vertex	FT.	-	0.0
		FT.	-	0.0
		FT.	-	0.0
	Index of Added Shading Surface 1: See notes on page L11/5.		-	0

EXAMPLES OF HEAT TRANSFER COEFFICIENTS
FOR QUICK SURFACES

DESCRIPTION	TYPICAL COEFFICIENT
Hollow Wood Door	0.451
Insulated Wood Door	0.160
Solid Wood Door	0.392
Hollow Metal Door	0.625
Insulated Metal Door	0.177
Solid Metal Door	1.469

L13 GLAZED SURFACE CARD

GENERAL DESCRIPTION:

Glazed/glass surfaces are clear or translucent surfaces which transfer heat through conduction as well as through transmission of solar rays.
As described on page L11/0 there are two methods of describing a surface, the long and short forms. The first ten (10) data items are common to both forms. The eleventh (11) item, no. of vertices, is used to describe the variables that complete the card.
Each surface requires a separate card. This card is repeatable. (Maximum of 35).
A special variable, the similar surface index, can be used to repeat properties of any surface. If used, the index causes the program to copy from the referenced surface card onto the card being processed. Only, those variables that were defaulted before record termination are reset.

Example: L13-3 = 0,0.95,0.5,0.5,0.2,@5,2,1,1,180,90,30,25;
L13-4 = 3,@14, 500;
Card L13-4 becomes, because of the similar surface index, equivalent to typing
L13-4 = 0,0.95,0.5,0.5,0.2,@5,2,1,1,180,90, 500,1;
Note that the '25' on card L13-3 is not carried over to L13-4 because L13-4 was terminated before that position was reached.

2-36

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Similar Surface Index: To decrease input time, user can use this feature if building envelope contains glazed heat transfer surfaces which have identical values. When using similar surface feature, if any surface parameters are left blank, values entered for reference surface will be used automatically.	-	-	0

L13 GLAZED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
2	ASHRAE Shading Coefficient:	-	0. to 1.	1.0

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:

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

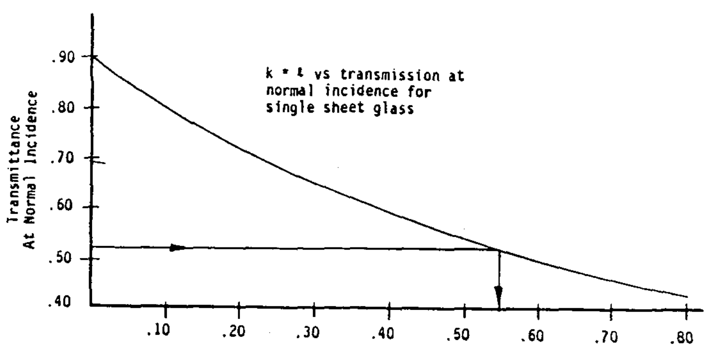
The calculation of window solar load in TLAP is a 2-step process:

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 on page L13/3. The shading coefficient of unshaded 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.

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	$\kappa * \ell = 1.00$



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

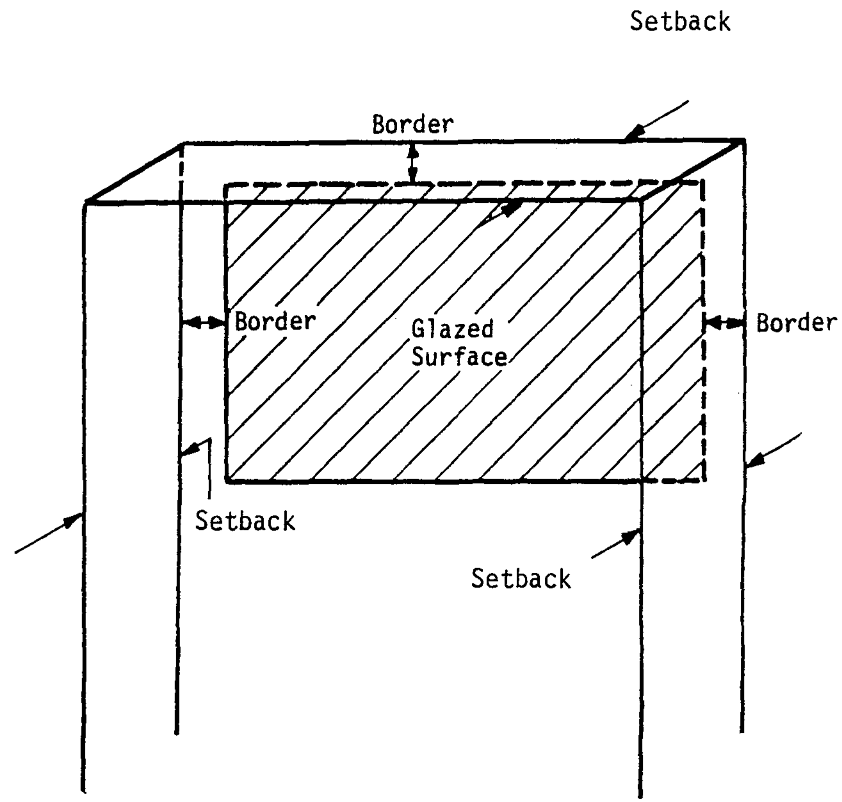
L13 GLAZED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
3	Form Factor between Window and Sky: 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 shown on page L13/5.	-	0. to 1.	0.5
4	Form Factor between Window and Ground: 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 shown on page L13.5.	—	0. to 1.	0.5
5	Reflectivity of Ground Facing Surface: Indicates the ability of ground to reflect ground diffuse radiation onto surfaces facing it. 1 equals totally reflective. See page L11/3 for typical values.	-	0.0 to 1.0	0.20
6	Window Setback: 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. See page L13/ 5.	IN.	-	0.0
7	Window Border: 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 page L13/5 for details.	IN.	-	0.0

FORM FACTOR

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

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



L13/5

L13 GLAZED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
8	**Infiltration Flow Coefficient:** A function of surface construction, this allows an estimate to be made of the 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 space card L17. See page L13/7 for typical values of infiltration flow coefficient for glazed surfaces.	-	-	0.0
9	**Number of X-Divisions in Surface:** Refer to page L11/4 for comments.	-	1 to 50	1
10	**Number of Y-Divisions in Surface:** Refer to page L11/5 for comments.	-	1 to 50	1
11	**Number of Panes of Glass:** The program will simulate single or double glazed window systems.	-	1 or 2	1
12	**Glass Code:** 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 of the incident angle of solar radiation 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. Table on page L13/3 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 on page L13/3 with this value, move to right until curve is intersected, move downward to abscissa and read $\kappa * \ell$ value. Choose a code from table on page L13/3 which has a $\kappa * \ell$ value closest to that desired.	-	1 to 8	1

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.
the basic equation $Q=C*P*\Delta P^N$.

Q is Air Flow Rate, cfm
C is Flow Coefficient, per linear 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

L13 GLAZED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
13	Number of vertices: If less than 3 then short form is assumed. If greater than or equal to 3 then long form is assumed.	-	0 to 10	1
	If the short form is used, the following variables complete the card.			
14	Surface Azimuth Angle: Compass orientation of the surface as determined by the clockwise angle made between the Y-axis and the surface outward normal vector. See page L7/3.	Degrees	0. to 360.	180.0
15	Surface Tilt Angle: Angle made between Z-axis (vertical axis) and outward normal vector of surface. May vary between 0^{o} (facing sky) and 180^{o} (facing ground). See page L7/3.	Degrees	0. to 180.	90.
16	Surface Height (Vertical Dimension): If omitted then width becomes surface area.	FT.	-	1.0
17	Surface Width (Horizontal Dimension): If omitted then height becomes surface area.	FT.	-	1.0
18	Lower lefthand vertex X-coordinate value	FT.	-	0.0
19	Lower lefthand vertex Y-coordinate value	FT.	-	0.0
20	Lower lefthand vertex Z-coordinate value	FT.	-	0.0
21	Index of Shading Surface 1: A shading surface described on an L7 card will shade this surface. The index is the 'card repetition number' of the appropriate L7 card. Up to 5 shading surfaces can be added. Additional ones continue on this card as variables 22-25.	-	-	0

L13 GLAZED SURFACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the long form is used, the following variables complete the card.			
14	X, Y, and Z-Coordinates of Vertex No. 1: For comments refer to page L7/1. Up to 10 vertices can be used.	FT.	-	0.0
15		FT.	-	0.0
16		FT.	-	0.0
17	X, Y, and Z-Coordinates of Vertex No. 2	FT.	-	0.0
18		FT.	-	0.0
19		FT.	-	0.0
⋮	⋮	⋮	⋮	⋮
	X, Y, and Z-Coordinates of the last Vertex	FT.	-	0.0
		FT.	-	0.0
		FT.	-	0.0
	Index of Added Shading Surface 1: See notes on page L11/5.	-	-	0

2-44

L14 SHADOW PICTURE CARD

GENERAL DESCRIPTION:

An option with shadow analysis is to have the program generate pictures of the shading of any exterior surface. Pictures are generated for the first day of the requested month. If the sun would never shine on the specific surface because of the surface azimuth angle or the sun has not risen during the requested hour, then pictures will not be generated.
This card is repeatable. (Maximum of 20).
This card requires a surface index to identify which surface is to be pictured. The surface index is part of the card label. Valid characters are a 'D' for delayed surface pictures, a 'Q' for quick surface pictures, and a 'G' for glazed/glass surface pictures.

Examples: L14-D = 5,8,11;
L14-G = 1,7,12/G=1,2,14;

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Surface Number: This is the card repetition number of the shaded surface to be pictured.	-		0
2	Picture Month: Pictures are made for the first day of the month.	-	1 to 12	1
3	Picture Hour: (24 hour clock) The hour of day for which pictures are to be shown.	-	1 to 24	1

L15 INTERNAL/UNDERGROUND SURFACE CARD

GENERAL DESCRIPTION:

Internal surfaces are interior walls or floors which separate different temperature zones. The zone temperatures are assumed to remain constant or to change slowly allowing the separating wall to be treated as a steady state heat transfer surface.
Underground surfaces are below-grade walls or floors whose exterior is exposed to soil. These are also treated as steady state heat transfer surfaces. The temperature difference is between the internal zone temperature and the monthly ground temperature (see card L16).
This is a repeatable card. (Maximum of 100 cards, 70 internal and 30 underground).
This card requires a surface index as part of the label. Valid characters are an 'I' for internal surfaces and an 'U' for underground surfaces.
For underground surfaces the heat transfer coefficient should include the effect of any soil between the surface exterior and the point where the ground temperature is being measured.

Examples: L15-I = 100,0.3,1,2/100,0.3,1,3/100,0.3,1,4;
L15-U = 10000,0.1;

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Surface Area	FT^2	-	0.0
2	Heat Transfer Coefficient: Includes inside air film. For underground surfaces this should include soil effects.	Btu/hr-ft^2-^oF	-	0.0
3	Zone Index for Internal Surface: Zone index of zone on one side of internal surface. Not necessary for underground surfaces.	-	-	1
4	Zone Index: Zone index of zone on other side of internal surface.	-	-	2

EXAMPLES OF HEAT TRANSFER COEFFICIENTS FOR

:INTERNAL SURFACES

DESCRIPTION	TYPICAL COEFFICIENT
8" Hollow Concrete Block Wall	0.298
12" Hollow Concrete Block Wall	0.276
Gypsum Board Wall	0.315
Wood Floor w/tile	0.348
Wood Floor w/carpet	0.208
Floors between spaces	
4" Ltwgt. Concrete w/floor tile	0.332
4" Ltwgt. Concrete w/carpet	0.202
4" Ltwgt. Concrete w/floor tile and Acoustical tile	0.205
4" Ltwgt. Concrete w/carpet and Acoustical tile	0.146

:UNDERGROUND SURFACE

Concrete Slab	0.050

L16 GROUND TEMPERATURE CARD

GENERAL DESCRIPTION:

If underground surfaces are described on card type L15, then monthly ground temperatures are required to calculate heat flow. The first temperature described is for the first month of the analysis. If a design load analysis is requested then all twelve months have to be defined. Up to 12 temperatures can be encoded onto the card. If a zero is entered or card is skipped, the data will default to the NECAP Weather Data input file.
This card is non-repeatable.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Ground temperature for first month of analysis	°F	-	WT
2	Ground temperature for second month of analysis	°F	-	WT
⋮	⋮	⋮	⋮	⋮
	Ground temperature for last month of analysis	°F	-	WT

L17 SPACE CARD

GENERAL DESCRIPTION:

This card describes the characteristics of the individual spaces. Generally a space is defined as a zone or zones controlled by one thermostat. Each unique space requires a separate card. Spaces that have identical loads, e.g., spaces on intermediate floors of a multiple story building and having the same exposure, can be described only once by using the 'additional identical spaces' variable. A 'similar space index' that works in the same manner as the 'similar surface index' described on pages L11/1, L12/1, and L13/1 can be used to copy identical values from one space card to another. Unlike the 'similar surface index' though, the 'similar space index' will copy over all defaulted values.

Example: L17-2= 0,2000,20000,50,75,10,450,1,1,1.00,5;
L17-3= 2,1500,15000;
Card L17-3 becomes, because of the similar space index, equivalent to typing
L17-3= 0,1500,15000,50,75,10,450,1,1,1.00,5;

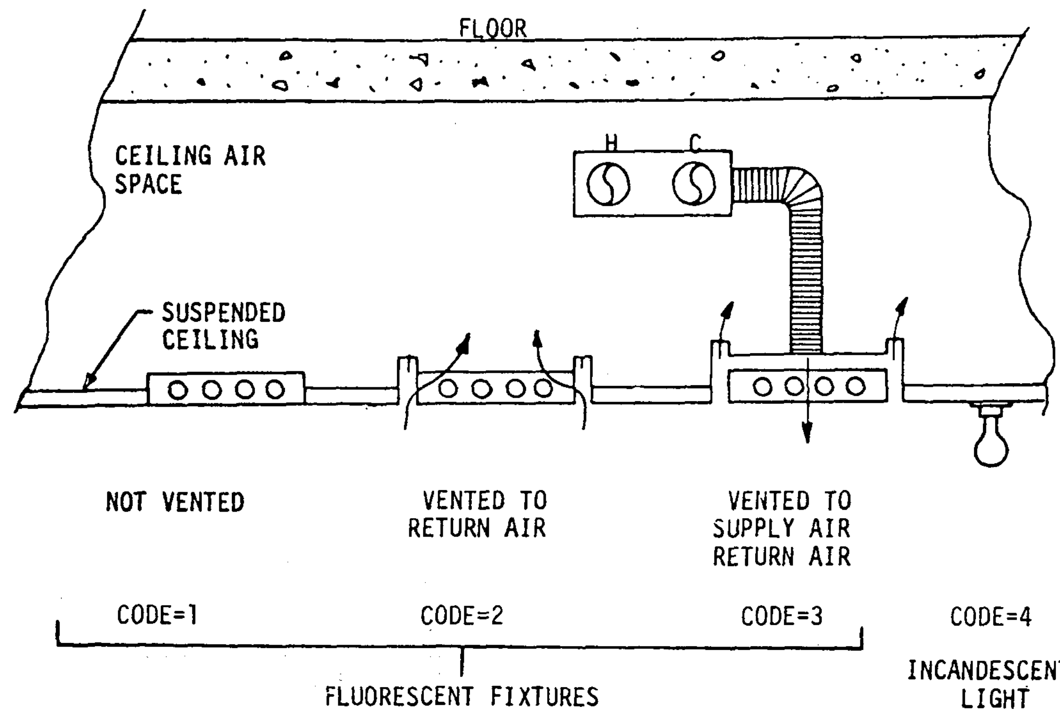
This card is repeatable. (Maximum of 35)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Similar Space Number: To decrease input time, user can use this feature if building contains spaces with identical characteristics. When using the similar space feature, all the space parameters defaulted will be reset to the reference space values.	-	-	0
2	Space Floor Area: Total square footage of zone floor area. This is used to calculate, when applicable, ventilation air load, lighting load, equipment load, etc.	FT^2	-	0.0
3	Space Volume: When the air change method for calculating zone infiltration load is specified, 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.	FT^3	-	If 0 or blank, V=10.0* SPACE FLOOR AREA

L17 SPACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
4	Weight of Floor in Space: 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.	Lb/ft^2	-	60.0
5	Space Temperature: 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. The effects of thermostat deadbands or throttling ranges, equipment scheduling, night setback, etc., will be calculated as part of SESP.	^oF	-	72.0
6	Maximum Number of People: Maximum number of persons that will occupy the space.	-	-	0.0
7	People Activity Level: Metabolic heat (sensible and latent) given off by one person (BTU/HR). See page L17/3 for typical values for various working levels.	Btu/hr	-	450.0
8	People Schedule Index: Identify here the repetition number of the schedule which is to be used to schedule occupancy of the space. Refer to card L5.	-	-	1
9	Type of Light Fixture: 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. Types are shown on page L17/4.	-	-	1

Kind of Work	Activity	Metabolic Rate Btu/hr
	Sleeping..............	250
	Sitting quietly........	400
	Sitting, moderate arm and trunk movements.... (e.g., desk work, typing)	450-550
Light Work	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


FLOOR
CEILING AIR SPACE
H
C
SUSPENDED CEILING
NOT VENTED
VENTED TO RETURN AIR
VENTED TO SUPPLY AIR RETURN AIR
CODE=1
CODE=2
CODE=3
CODE=4
FLUORESCENT FIXTURES
INCANDESCENT LIGHT

L17/4

L17 SPACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
10	Percent of Light Heat to Space: If light fixture is mounted in a suspended ceiling, not all of the light heat is transferred into the space below, some is transfered 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.	Decimal	0.0 to 1.0	1.0
11	Lighting Load Catagory No. 1: The user is given the option of entering the lighting load for the space either in watts per square foot of floor area or in total kilowatts for the space. If values are enter in both catagories, program will sum the two together to get total space lighting load.	Watts/Ft^2	-	0.0
12	Lighting Load Catagory No. 2: See comments for lighting load no. 1.	KW	-	0.0
13	Lighting Schedule Index: Identify here the repetition number of the schedule which is to be used to schedule the use of lighting for the space. Refer to card L5.	-	-	1
14	Equipment Load Catagory No. 1: 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. The program will sum all 4 of these quantities together to arrive at the total space equipment load.	Watts/Ft^2	-	0.0
15	Equipment Load Catagory No. 2	KW	-	0.0

L17 SPACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
16	Equipment Load Catagory No. 3 (Sensible Loads)	Btu/Hr	-	0.0
17	Equipment Load Catagory No. 4 (Latent Loads)	Btu/Hr	-	0.0
18	Equipment Schedule Index: Identify here the repetition number of the schedule which is to be used to schedule the use of equipment loads for the space. Refer to card L5.	-	-	1
19	Type of Infiltration Analysis: Three choices are available for calculating space infiltration loads. 0. None 1. Air change method 2. Crack method	-	0 to 2	0
20	Infiltration Rate: Enter a value here only if air change method has been specified as the method of infiltration analysis. The number of air changes per hour to be entered is that estimated for a 10 mph wind. Each hour the program will adjust this air change rate as a function of the actual wind speed read from weather data.	No. of air changes per hour	0. to 10.	0.0
21	Height Above or Below Neutral Zone: Enter a value here only if the crack method has been specified for infiltration analysis. 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.	FT.	-	0.0

L17 SPACE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
22	Space Exhaust Air Quantity: Enter a value here only if the crack method has been specified for infiltration analysis. 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.	CFM	-	0.0
23	Number of Additional Identical Spaces: If the building contains other spaces that are identical to the one described on this card, the user would enter here the number of <u>additional</u> identical spaces.	-	-	0
24	Plenum Indicator: 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..	-	0 or 1	0
25	Load Summation Index: 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. 1 = no, do not include 0 = 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.	-	0 or 1	0

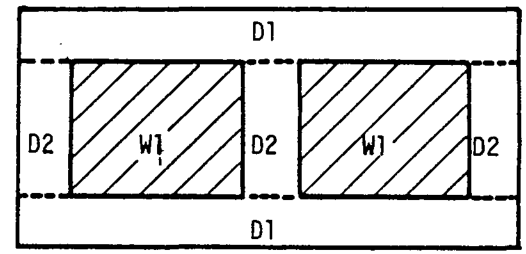
L18 SPACE ENVELOPE CARD

GENERAL DESCRIPTION:

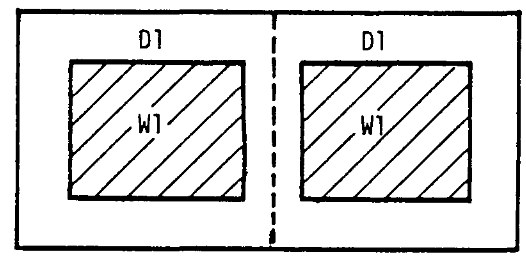
This card is used to build up the space envelope from the previously defined delayed, quick, glazed, internal, and underground surfaces. Indices can be used as many times as needed thereby taking advantage of the repetitiveness of certain surfaces. An example is illustrated on pages L18/2. As many as 30 indices can be used on a card.
This card is repeatable. (Maximum of 175 cards, 5 cards for 35 spaces).
This card requires a surface index as part of a label. Valid characters are a 'D' for delayed surfaces, a 'G' for glazed surfaces, an 'I' for internal surfaces, a 'Q' for quick surfaces, and an 'U' for underground surfaces.
The repetition number of the card is the space number which the surface encloses. A surface type can be used only once on a surface. The label default characteristics of the program can be used to simplify typing. Different techniques are shown on page L18/3.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Surface Index No. 1: This is the repetition number of the appropriate L11, L12, L13, L15-I, or L15-U card.	-	-	0
2	Surface Index No. 2: See above.	-	-	0
. . .		. . .	. . .	. . .
30	Surface Index No. 30: If necessary.	-	-	0

Two methods for breaking the wall into delayed surfaces and glazed surfaces are:

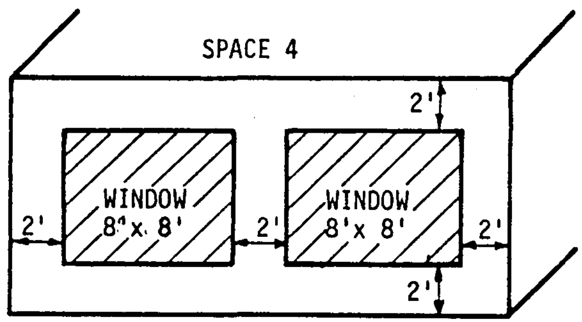


Alternative 1



Alternative 2

Pictured below is one wall of space 4 having two windows and 2' borders around windows.



If this is the only wall making up space 4 then the cards containing the data would be:

Alternative 1:
    L18-4-D=2*1,3*2/G=2*1;

Alternative 2:
    L18-4-D=2*1/G=2*1;

EXAMPLES OF USE OF CARD L18

Example 1

```
L18-1-D=3*1,2/G 3*1,3;
```

Is the same as the two cards

```
L18-1-D=3*1,2;
L18-1-G=3*1,3;
```

Example 2

```
L18-D=3*1,2/2*3,4/1,2,3;
```

Is the same as the three cards

```
L18-D-1=3*1,2;
L18-D-2=2*3,4;
L18-D-3=1,2,3;
```

Example 3

```
L18-1-D=3*1,2/2-G=2*2,3/3*3;
```

Is the same as the three cards

```
L18-1-D=3*1,2;
L18-2-G=2*2,3;
L18-1-G=3*3;
```

SECTION 3

SYSTEMS ENERGY SIMULATION PROGRAM INPUT DATA FORMAT

(FORMS S1/1 THROUGH S20/2)

S1: SESP TITLE CARD

GENERAL DESCRIPTION:

The SYSTEM ENERGY SIMULATION Program has one header card as a job descriptor. If omitted, the header card will default to the TLAP facility name, card L1-1, when both TLAP and SESP input data are processed together. If neither card is included then the default header will be blanks.
The header can be composed of any character except for the variable list terminators, i.e., a semi-colon(;) or a slash(/). The header is limited to 35 characters. Extra characters are ignored.
This card is non-repeatable. Extra title cards are ignored.

Example: S1:Building 12, Variable Volume;

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Program Header	-	see above	see above

S2: GENERAL DATA CARD

GENERAL DESCRIPTION:

The time period to be simulated by the systems run is coded on this card. If the card is omitted then the dates will default to the TLAP dates on card L-3 when both TLAP and SESP input data are processed together. If neither card is included then the dates are defaulted to those shown below. However, during execution, if an SESP date is outside of the TLAP simulation period read from the TLAP output tape, it is reset to the corresponding TLAP date.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Simulation period beginning month	-	1 to 12	1
2	Simulation period beginning day	-	1 to 31	1
3	Simulation period ending month	-	1 to 12	12
4	Simulation period ending day	-	1 to 31	31
5	Output Data File Option Flag: This index is used by the program to print hourly results onto a special output file. If equals 0 then no output file requested. CODE: 0 = No file is produced 1 = Formatted file/hourly data only 2 = Unformatted file	-	0, 1, or 2	0

S3: HOURLY PRINTOUT CARD

GENERAL DESCRIPTION:

An hourly printout of various intermediate values can be requested with this card. Up to nine (9) hourly print periods can be requested. If this card is omitted, the program assumes no hourly printouts requested. Inclusion of the card will cause the program to printout for the period requested, the hourly weather data and the space loads corrected by the zone thermostat.
If print flag 1 is turned on then hourly fan system summaries are printed.
Print flag 2 will print the zone summaries of each fan system.
This card is non-repeatable. If no S3 card is input, it will default to the L4 card.
If no L4 card is input, it will default to no printout.
NOTE: If using four pipe induction, do not select print flag 2 for over 1 day.

NO.	VARIABLE DESCRIPTIONS AND COMMENTS	UNITS	LIMITS	DEFAULTS
1	Beginning month and day of print period no. 1	-	1 to 12	0
2		-	1 to 31	0
3	Ending month and day of print period no. 1	-	1 to 12	0
4		-	1 to 31	0
5	Print flag 1 for print period no. 1	-	0 or 1	0
6	Print flag 2 for print period no. 1	-	0 or 1	0
7	Beginning month and day of print period no. 2	-	1 to 12	0
8		-	1 to 31	0
⋮	(Etc)	⋮	⋮	⋮
	9 sets can be requested			

S4 THERMOSTAT SCHEDULE CARD

GENERAL DESCRIPTION:

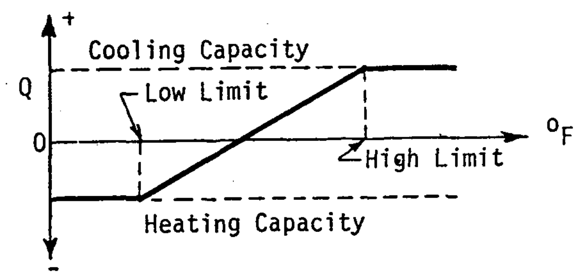
To describe a thermostat schedule, 3 items of information must be defined for every hour of a day. They are the type of thermostat and the high and low limits of the throttling range. Two types of thermostats can be simulated, a proportional or a deadband thermostat. The zone can also be simulated as having no thermostatic control.
This card is repeatable. (Maximum of 20).
The grouping characteristics of the input data can be used effectively on this card.

Example: Given a space requiring maximum ± 2^{o}F temperature deviation around a setpoint of 72^{o}F during occupied hours 7 am to 5 pm. During evening and early morning hours, space temperature should not go below 65^{o}F or above 80^{o}F. The card describing the required thermostatic control would be:
S4=6(2,80,65),10(1,74,70),8(2,80,65);

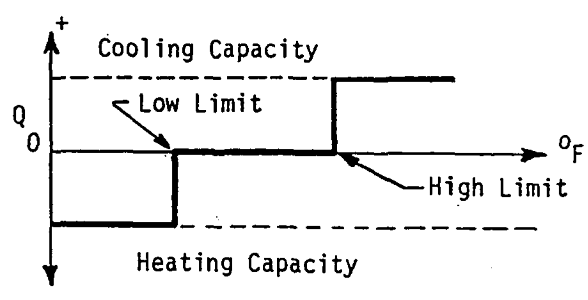
NO.		VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	HOUR 1 SET	Type of Thermostat: 0 = No thermostat. Space temperature is allowed to float in response to external and internal loads. 1 = Proportioning thermostat. This type of thermostat varies the space heating/cooling capacity linearly with 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 S12,variable no. 9). 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 S12,variable no. 10). See diagram below: (Item #1 continued on next page)	-	0,1,or 2	0

S4 THERMOSTAT SCHEDULE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT



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.
See diagram below:



3-5

S4: THERMOSTAT SCHEDULE CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
2	High Limit of Throttling Range for Hour 1: Space temperature at which full cooling capacity is to be supplied. Enter a zero for type 0 thermostat.	°F	-	0.0
3	Low Limit of Throttling Range for Hour 1: Space temperature at which full heating capacity is to be supplied. Enter a zero for type 0 thermostat.	°F	-	0.0
4	Type of Thermostat for Hour 2	-	0,1, or 2	0
5	High and Low Limits of Throttling Range for Hour 2	°F	-	0.0
6		°F	-	0.0
⋮	⋮	⋮	⋮	⋮
70	Type of Thermostat for Hour 24	-	0,1, or 2	0
71	High and Low Limits of Throttling Range for Hour 24	°F	-	0.0
72		°F	-	0.0

S4/3

S5 DAILY OPERATING SCHEDULE CARD

GENERAL DESCRIPTION:

Both ventilation air loads and process energy loads can be simulated as functions of the hour of the day and of the 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 on card S11. Process loads are calculated by multiplying process peak loads (See S19) times the operating schedule factors.
This card is repeatable (Maximum of 10).

Example: S5-1=7*0,10*1.0,7*0; a typical ventilation schedule

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Fraction of Total at Hour 1	Decimal	0.0 to 1.0	0.0
2	Fraction of Total at Hour 2	Decimal	0.0 to 1.0	0.0
⋮	⋮	⋮	⋮	⋮
24	Fraction of Total at Hour 24	Decimal	0.0 to 1.0	0.0

S6: WEEKLY SCHEDULE CARD

GENERAL DESCRIPTION:

This card builds a weekly schedule for either the thermostats or for the operating schedules. There are eight day types, the seven days of the week and holidays. Holidays simulated are 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
October - Columbus Day
11 November - Veteran's Day
November - Thanksgiving Day
25 December - Christmas Day

This card is repeatable. (Maximum of 10).
If there is no weekly thermostat card explicitly defined and there are thermostats described on S4 cards, then the program will write a default weekly thermostat schedule. If an operating schedule is used (i.e., an S5 card exists), then an S6 card is required.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Weekly Schedule Type Index: 0 = Operating schedule (S5 cards) 1 = Thermostat schedule (S4 cards), 2 = Both (S4 and S5 cards)	-	0 or 1	1
2	Schedule Code for Sunday: Enter the repetition number of the appropriate S4 or S5 card.	-	-	1
3	Schedule Code for Monday	-	-	1
:	:	:	:	:
8	Schedule Code for Saturday	-	-	1
9	Schedule Code for Holiday	-	-	1

S7: YEARLY SCHEDULE CARD (THERMOSTATS ONLY)

GENERAL DESCRIPTION:

Thermostats are also scheduled based on the time of the year. Up to 5 weekly thermostat schedules can be combined into a yearly thermostat schedule. The period begins on the user defined day and continues to the first day of the following period. The default starting time for the first period is hour 1, for all the other periods, hour 8785. Hour 8785 represents the first hour after the last day of a leap year.
This card is repeatable. (Maximum of 10).
If omitted from the deck, and thermostats are described on S6 cards, this card will default to the corresponding weekly schedule index for the entire year.

Example: $S7\text{-}1{=}\underbrace{1,1,1}_{\text{1st}},\underbrace{4,1,2}_{\text{2nd}},\underbrace{6,15,3}_{\text{3rd}},\underbrace{10,1,4}_{\text{4th}};$ period

Weekly thermostat schedule 1 will be effective from January 1 to April 1,
Schedule 2 from April 1 to June 15, etc.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Yearly Period 1, Starting Month and Day	-	1 to 12	1
2		-	1 to 31	1
3	Yearly Period 1, Weekly Schedule Code: Enter the repetition number of the appropriate S6 card	-	1 to 10	1
4	Yearly Period 2, Starting Month and Day	-	1 to 12	12
5		-	1 to 31	31
6	Yearly Period 2, Weekly Schedule Code	-	1 to 10	0
13	Yearly Period 5, Starting Month and Day	-	1 to 12	12
14		-	1 to 31	31
15	Yearly Period 5, Weekly Schedule Code	-	1 to 10	0

NOTES FOR SYSTEMS SCHEDULE INPUT CARDS 4, 5, 6, and 7

NECAP can handle different types of thermostats, scheduled with respect to time. Card S4 is used to specify 3 types of thermostats (none, proportional, or dead band), and temperature set points for a 24-hour period.

S4 references the space thermostat, which is referenced via the S6, which is referenced via the S7 card, which is referenced by the space card (S12) in field 8.

When cards S5 and S6 are used the fan system can be kept "on" even though there is no energy required by the DEAD BAND thermostat. The S6 card will be referenced by the S11 card, field 28 if field 27 is set to 3.

Card S6 assigns the S4 or the S5 schedule to the day of the week.

Card S7 assigns S6 cards to a season of the year.

If no schedule cards are used, then NECAP will generate the necessary cards for a DEAD BAND thermostat having a 78° to 70°F temperature spread and the fan and ventilation system on from 7 A.M. to 5 P.M. The other hours of the day, the weekends, and the holidays, the ventilation rate is 0 and the thermostat setting is 95° to 65°F with the fan coming on only if those limits are exceeded.

S4-1=7(2,95,65),10(2,78,70),7(95,65); work day thermostat
S4-2=24(2,95,65) off day thermostat
S5-1=7*0.0,10*1.0,7*0.0; work day ventilation
S5-2=24*0.0; off day ventilation
S6-1=2,2,5*1,2,2; weekly schedule

S7-1=1,1,1; yearly schedule

The fan system card (S11) uses a defaulted S7-1 card for a fan schedule.
The space card (S12) uses a defaulted S7-1 for a yearly thermostat schedule.

S8 TEMPERATURE RESET SCHEDULE CARD

GENERAL DESCRIPTION:

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 S11 by their repetition numbers. (Maximum of 16)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Low Outside Air Temperature: This ambient dry bulb temperature corresponds to the system fluid high temperature.	^oF	-	0.0
2	High Outside Air Temperature: This ambient dry bulb temperature corresponds to the system fluid low temperature.	^oF	-	0.0
3	Low System Fluid Temperature	^oF	-	0.0
4	High System Fluid Temperature	^oF	-	0.0
5	Reset Schedule Label	-	30 characters	(Blank)

S9 MATERIAL CARD

GENERAL DESCRIPTION:

TLAP 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. 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 typical default values that have been built into the program and which are a function of weight of floor (specified on card L17) for floors and ceilings, and weight of furnishings (specified on card S12) 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.
The materials used in user-defined internal heat-storing components are described on this card. The different materials are combined to form the component on card S10. One card is required for each unique material.
Table on page L9/2 contains typical values.
This card is repeatable. (Maximum of 30).

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Material Thickness: If material has <u>no</u> thermal mass (e.g. air space) leave this blank.	FT	-	0.0
2	Material Thermal Conductivity: If material has <u>no</u> thermal mass (e.g. air space) leave this blank.	Btu/hr-ft^2-^{o}F	-	0.0

S9 MATERIAL CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
3	Material Density: If material has <u>no</u> thermal mass (e.g. air space) leave this blank.	lb/ft^3	-	0.0
4	Material Specific Heat Capacity: If material has <u>no</u> thermal mass (e.g. air space) leave this blank.	$Btu/lb\text{-}^oF$	-	0.0
5	Material Thermal Resistivity: Enter a value here only if material has <u>no</u> thermal mass (e.g. air space).	$Hr\text{-}ft^2\text{-}^oF/Btu$	-	0.0
6	Material Name: Alphanumeric description of material.	-	30 characters	(Blank)

S10 USER-DEFINED INTERNAL COMPONENT CARD

GENERAL DESCRIPTION:

The user builds non-standard internal components from the materials described on S9 cards. The S9 card's repetition number is used as the material index. Up to 10 materials can be used to describe a surface. This card is repeatable. (Maximum of 20).

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Material Index 1	-	1 to 30	0
2	Material Index 2	-	1 to 30	0
⋮	⋮	⋮	⋮	⋮
10	Material Index 10: (If necessary)	-	1 to 30	0

S11 FAN DESCRIPTION CARD

GENERAL DESCRIPTION:

This card defines a fan distribution system. There are 13 unique types of fan systems. Complete descriptions of each can be found in the users manual. Not all of the parameters apply to every fan system. The table on page S11/12 highlights applicable parameters and required parameters of a particular fan system. This card is repeatable.(Maximum of 15).

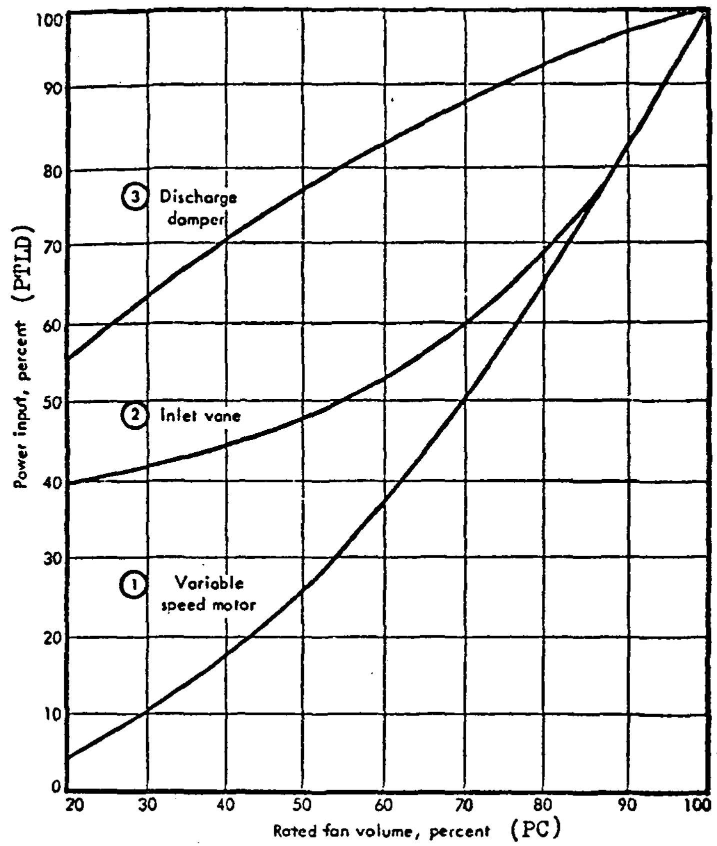
NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Type of Fan Distribution System: Enter the index of the distribution system type. There are 13 types of energy distribution systems available. The code for each distribution system type is listed below. Code — Description 1. Single Zone Fan 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	-	1 to 13	1

S11: FAN DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
2	Number of Zones on System: Enter the number of zones served by this system. This number should correspond with the number of S12 cards which designate this zone as its associated fan. Do not include plenums, if any.	-	-	1
3	System Relative Humidity Setpoint: Enter the setting of the space humidistat. 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 coildehumidification.	% RH	-	10
4	Fixed or Minimum Outside Air: 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 S12) exceeds this value.	SCFM	-	0.

S11 FAN DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
5	Mixed Air Option: 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 coiling coil.	-	1 to 3	1
6	Variable Volume Fan Control Option: Three types of fan air volume control are available on variable volume systems. These control types are shown in the figure on page S11/4.	-	1 to 3	2



Power input, percent (PTLD)
Rated fan volume, percent (PC)
100
90
80
70
60
50
40
30
20
10
0
20
30
40
50
60
70
80
90
100
3 Discharge damper
2 Inlet vane
1 Variable speed motor

S11 FAN DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
7	Hot Deck/AHU Discharge Temperature Control: For certain systems it is the user's option how primary air temperature will be controlled. For these 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 S8). 6. Primary air temperature determined by zone with warmest supply air requirement. If a <u>multi-zone</u> or <u>dual-duct</u> air distribution system is being defined, this term refers to the system's means of <u>hot deck</u> air temperature control. If a <u>reheat fan system</u> is being defined, this term refers to the system's control of <u>primary air</u> leaving the air handling unit (AHU).	-	1 to 3,6	1
8	Cold Deck Temperature Control: See comments above for codes. This term applies to the means of controlling cold deck air temperature for <u>multi-zone</u> and <u>dual duct</u> air systems.	-	1 to 3,6	1
9	Supply Fan Total Pressure: Fan power requirements are calculated using this value, fan efficiency from card S18 and total fan CFM from S12 cards.	inches of H_2O	-	See page S11/12
10	Return Fan Total Pressure: See comment above.	inches of H_2O	-	0.

S11: FAN DESCRIPTION CARD (continued)

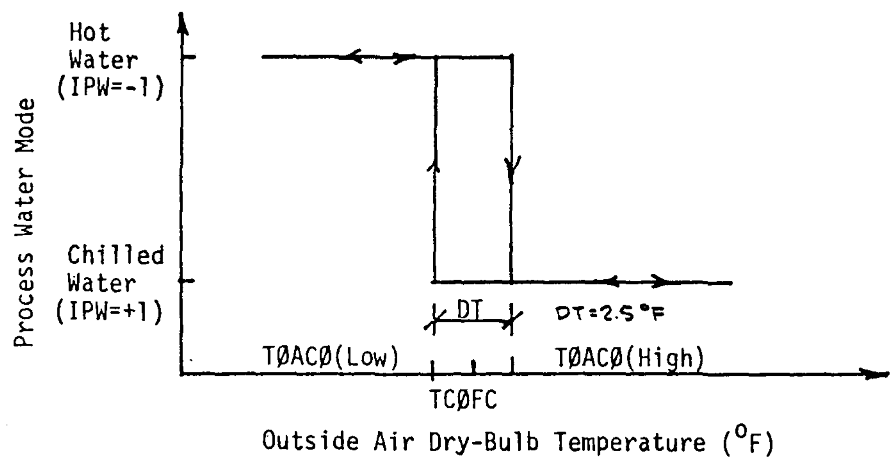
NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
11	Exhaust Fan Total Pressure: See comment above.	inches of H_2O	-	.5
12	VAV Reheat Coil Option: When a variable volume fan system is specified, this term allows the user to specify whether or not reheat coils will be located after variable air volume boxes. The code is as follows: 0 = No reheat coils present 1 = Reheat coils located after VAV Boxes.	-	0 or 1	1.
13	Minimum Air Flow Through VAV Box: 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.	percent	10.to 100.	40
14	Fixed Hot Deck/AHU Discharge Temperature: (2, 3, 4, 11, 12, 13) For six 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 on page	^oF	KFAN(K)= 2,3 KFAN(K)=4 11,12,13	110. 55^o F
15	Fixed Cold Deck Temperature: (1,2,3) Same as above except cold deck only.	^oF	-	55.
16	Reset Schedule Index 1: Depending on the type of fan system this variable will control either the hot deck, the primary air, or the AHU discharge temperature. The index is the repetition number of the appropriate S8, reset schedule, card. See the table on page S11/7 for applicability.	-	0 to 16	0

APPLICATION OF RESET SCHEDULE INDEX VARIABLES

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

S11: FAN DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
17	Reset Schedule Index 2: This term points to the temperature reset schedule which would define cold deck air temperature as a function of ambient dry bulb temperature. See the table on page S11/7 for applicability.	-	0 to 16	0
18	Reset Schedule Index 3: 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.	-	0 to 16	0
19	Reset Schedule Index 4: 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 S15). This reset Schedule Index points to the Temperature Reset Schedule which defines the hot water temperature.	-	0 to 16	0
20	Ratio of Induced to Primary Air: 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).	-	-	2.0
21	Two-Pipe System Changeover Temperature: This is the ambient dry bulb temperature, about which a two-pipe system will change from heating mode to cooling mode and vice versa. To prevent repeated changeover near this temperature, a slight hysteresis (2.5 ^oF) has been built into the changeover mechanism. This is illustrated in the figure on page S11/9.	^oF	-	50.



TWO-PIPE FANCOIL WATERSIDE CHANGEOVER OPERATION

S11: FAN DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
22	Floor Panel Heating System Hot Water Shutoff Temperature: For a floor panel heating system this is the temperature at which the system is shut-off.	^oF	-	50.
23	Two-Pipe System Water Volume: 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.	gals	-	100
24	Location of Floor Heating Panel: This code defines the location of floor heating panels. 1 = Slab on Grade 2 = Intermediate Floor Slab	-	1 or 2	1
25	Floor Heating Panel Area: This is the total area of floor heating panels (all zones on this system).	ft^2	-	0.0
26	Exposed Perimeter of Floor: This is the total exposed length of a floor having a floor panel heating system.	ft	-	0.0
27	Fan System Shut-Off Flag: This code describes the fan system shut-off option to be used. The code is as follows: 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 = Same as 2 but fan uses card S7 schedule.	-	0 to 3	2

S11 FAN DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
28	Ventilation Schedule Index: This index points to the ventilation schedule (card S7 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).	-	0 to 10	0
29	Humidistat Location: This points to the zone where the humidistat is located.	-	-	1
30	DX/Heat Pump Index: This index points to the DX or heat pump defined on card S17. If it is zero (0.0), loads calculated for this fan system will be applied to a central boiler or chiller. Sign index to a negative value if a DX is to be used; sign index to a positive for a heat pump.	-	0 to 10 or 0 to -10	0

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

NOTES: *) S11 Card defaults to this fan system

1) Numbers in chart are default values except field 1

2) Blank spaces do not require a value

3) Spaces that have a zero are optional input

4) Spaces that have an 'X' are required input

S12: SPACE DESCRIPTION CARD

GENERAL DESCRIPTION:

This card attaches the zone loads calculated by TLAP to the correct fan system. Other variables on the card provide a further description of the zone's heating and cooling characteristics.
The third variable is used to distinguish between occupied zones and plenums. The variables that follow the 'plenum indicator' are defined by the value of the 'indicator'.
This card is repeatable. (Maximum of 35).
Duplicate zones on a system can be simulated by the 'zone multiplier' variable.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Fan System Number: Enter here the repetition number of the appropriate fan system card, S11.	-	1 to 15	1
2	Load Program Space Number: This is the index number of the space as it appeared in TLAP. Spaces may be listed in any order.	-	1 to 35	1
3	Plenum Indicator: This variable defines a space as a plenum or an occupied zone. 0 = Occupied zone 1 = Plenum	-	0 or 1	0

S12: SPACE DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the space is not a plenum then the following variables complete the card.			
4	Supply Air Quantity: 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 position, the program will size the supply air flow for the given zone. Supply air is initially set at standard conditions (0.075 lbm/cu.ft.). See page S12/3.	CFM	-	0.0
5	Exhaust Air Quantity: 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.	CFM	-	0.0
6	Baseboard Output: 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 water temperature).	Btu/hr/linear foot	-	0.0
7	Baseboard Radiation Active Length	FT	-	0.0
8	Yearly Thermostat Schedule: Enter the repetition number of the appropriate yearly schedule card, S7. If space has no temperature control the year round, simply enter '0'.	-	0 to 10	1
9	Design Heating Capacity: Heating capacity allotted to the space. If defaulted (nothing entered) in this position, then the program will use heating capacity calculated by the TLAP program. If zero is entered, then capacity is set at 0.	Btu/hr	-	Prog. Sizes

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

S12 SPACE DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
10	Design Cooling Capacity: Cooling capacity allotted to the space. If defaulted (left blank) in this position then the program will use the cooling capacity calculated by the TLAP program. If zero is entered, then capacity is set at 0.	Btu/hr	-	Prog. Sizes
11	Weight of Furnishings: If default values are to be used for internal components, see card S9 description, user <u>must</u> 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.	Lb/ft^2	-	10.0
12	Zone Multiplier: If thermally identical spaces are served by the same fan 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.	-	-	1
13	Load Program Plenum Space Number: 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 TLAP 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 <u>1 to 1 basis</u>. This term is the TLAP Space number of zone which has been modeled as a ceiling plenum for the room space defined by this card.	-	-	0
	Internal Component Each space can have up to 3 distinct user-defined internal components. Internal components can be of 3 types, floor, ceiling, or furnishings.			

S12 SPACE DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
14	Response Factor Index of Floor; if 0, then default to 6" of concrete. Enter the repetition number of the appropriate S10 card.	-	0 to 20	-
15	Area of Floor.	FT^2	-	*
16	Response Factor Index of Ceiling; if 0, then default to 6" of concrete.	-	0 to 20	-
17	Area of Ceiling	FT^2	-	*
18	Response Factor Index of Furnishing; if 0, then default to 3" of paper.	-	0 to 20	**
19	Area of Furnishing	FT^2	-	*
20	Zone Name	-	30 characters	(Blank)

* Default of floor area of L17, F2
** A value here causes F11 to be ignored

S12 SPACE DESCRIPTION CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	If the space is a plenum then the following variables complete the card.			
4	Space Number Below Plenum: Indicate here the number (TLAP index) of space that is below plenum. This allows the proper heat balance to be performed between the plenum and the space each hour.	-	-	1
5	Plenum Airflow: 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.	CFM	-	0.0
6	Weekday Fan Schedule - References S7 for Plenum Air Flow If 0, no air flow	-	0 to 24	0
7	Response Factor Index of Floor; if 0, then default to 6" of concrete. Enter the repetition number of the appropriate S10 card.	-	0 to 20	-
8	Area of Floor. * Default of floor area of L17, F2	FT^2	-	*
9	Response Factor Index of Ceiling; if 0, then default to 6" of concrete.	-	0 to 20	-
10	Area of Ceiling	FT^2	-	*
11	Response Factor Index of Furnishing; if 0, then default to 3" of paper.	-	0 to 20	**
12	Area of Furnishing ** A value here causes F11 to be ignored	FT^2	-	*
13	Plenum Name	-	30 characters	(Blank)

3-32

S13 ENGINE/GENERATOR CARD

GENERAL DESCRIPTION:

On-site power generation can be simulated by SESP. This card defines the number and type of E/G sets. The user can also define the performance of the E/G sets if desired. E/G sets are always running and, if needed, heat energy will be recovered from it.
This card is repeatable. (Maximum of 5).
The first S13 card defines the heating value of the diesel fuel for every E/G set.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Quantity of This Type of E/G sets: If omitted the program will size with a minumum of 2 sets of 500 KW capacity.	-	-	0
2	Type of E/G set: 0 = no on-site power generation 1 = diesel engine 2 = gas engine	-	0 to 2	1
3	Capacity of E/G set: If omitted the program will size with a minimum of 500 KW capacity	-	-	500
4	Heating Value of Diesel Fuel:	Btu/gal	-	140,000
	If user-defined curves are desired then continue filling out the card. Otherwise, terminate it here.			
5	Full Load Fuel Consumption	Gal/hr or Ft^3/hr	-	0.0

S13 ENGINE/GENERATOR CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
6	Percent Fuel Consumption at Idle	Percent	-	0.0
7	" " " " 25% Load	"	-	0.0
8	" " " " 50% Load	"	-	0.0
9	" " " " 75% Load	"	-	0.0
10	" " " " 100% Load	"	-	0.0
11	Heat Recoverable at 100% Load: Value is for one E/G set.	KBtu/hr	-	0.0
12	Percent Heat Recovery at Idle	Percent	-	0.0
13	" " " " 25% Load	"	-	0.0
14	" " " " 50% Load	"	-	0.0
15	" " " " 75% Load	"	-	0.0
16	" " " " 100% Load	"	-	0.0

S14 BOILER CARD

GENERAL DESCRIPTION:

This card describes the facility heating plant. The user has the option of defining a performance curve or of using the built-in curve. If steam is purchased from an outside plant this can be simulated by describing a performance curve of 100% at all loads. If line losses are to be considered then the performance is adjusted accordingly.
This card is repeatable. (Maximum of 5).
Certain numbers are assumed common to all boilers. They are the start-up and shut-down dates, the source of reheat coil energy and the heating value of heating oil. These numbers are defined by the first boiler card.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Quantity of This Type of Boiler	-	-	1
2	Capacity of Boiler	KBtu/hr	-	Program SIZES
3	Month and Day of Start-Up	-	1 to 12	1
4		-	1 to 31	1
5	Month and Day of Shut-Down	-	1 to 12	12
6		-	1 to 31	31
7	Source of Heating Energy: 1 = Gas 2 = Heating Oil 3 = Purchased Steam 4 = Electric	-	1 to 4	3

S14: BOILER CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
8	Source of Reheat Coil Energy: 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 exprssed as reheat loads.	-	0 or 4	0
9	Heating Value of Heating Oil	Btu/gal	-	150,000
	If user-defined curves are desired then continue filling out the card. Otherwise, terminate it here.			
10	Boiler Part Load Performance @ 0% Load	Percent	-	80.0
11	" " " " @ 20% Load	"	-	80.0
12	" " " " @ 40% Load	"	-	80.0
13	" " " " @ 60% Load	"	-	80.0
14	" " " " @ 80% Load	"	-	80.0
15	" " " " @100% Load	"	-	80.0

S15 CHILLER CARD

GENERAL DESCRIPTION:

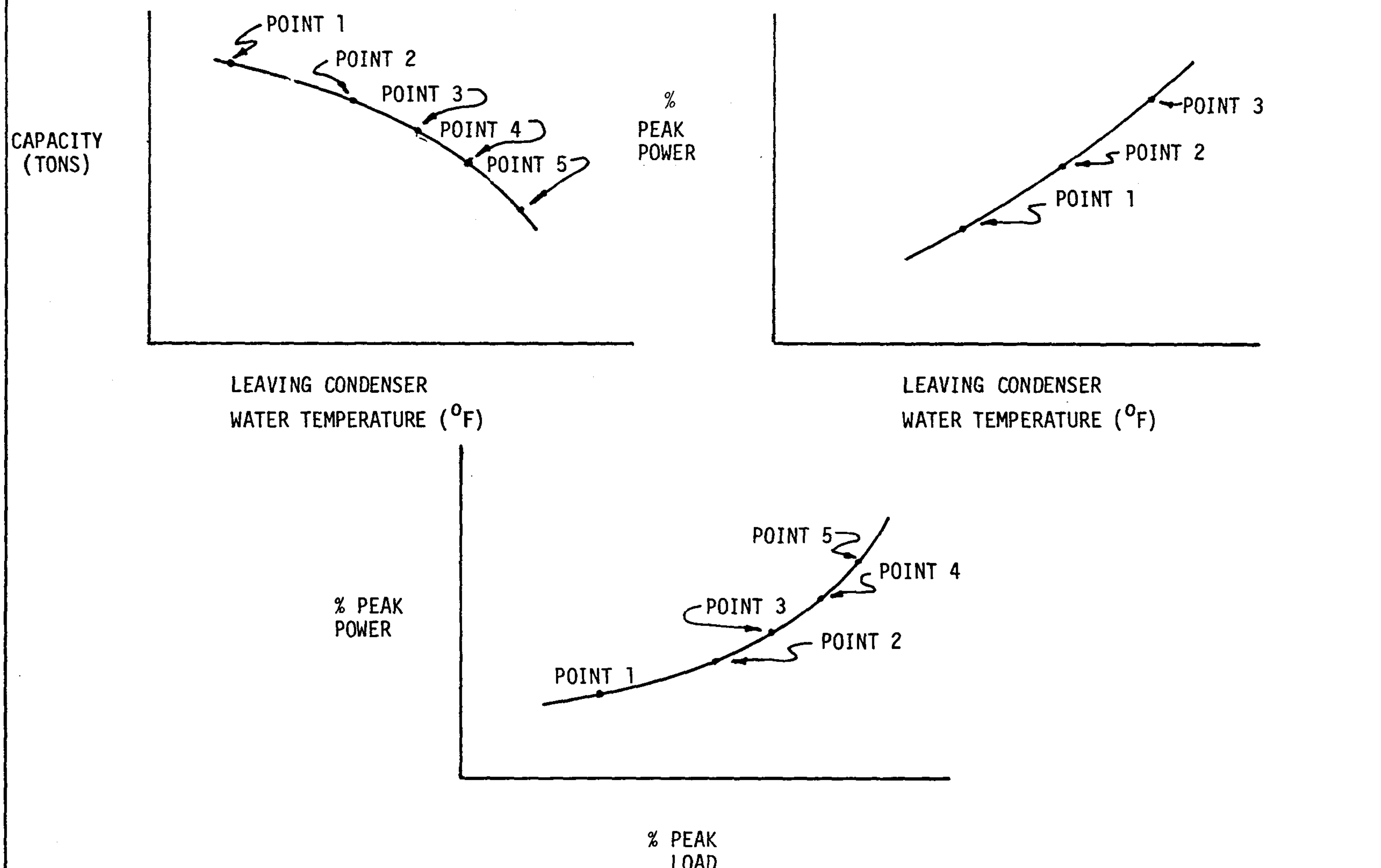
This card describes the facility cooling plant. The user has the option of defining a performance curve or of using the built-in curve.
This card is repeatable. (Maximum of 5).
Certain numbers are assumed common to all chillers. They are the start-up and shut-down dates, the minimum part load cut-off, and the chilled water set point temperature. These numbers are defined by the first chiller card. If there is no cooling plant to be simulated, then a S15 card must be used (S15=0,0; no cooling)
NOTE: Refer Page S15/5 for defaulted operating curves.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Type of Chiller: 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	-	0 to 5	1
2	Quantity of This Type of Chiller	-	-	1
3	Capacity of Chiller:	tons	-	Program SIZES
4	Month and Day of Chiller Start-Up (also use for DX equipment).	-	1 to 12	1
5		-	1 to 31	1

S15 CHILLER CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
6	Month and Day of Chiller Shut-Down	-	1 to 12	12
7		-	1 to 31	31
8	Source of Chiller Energy: 1 = Gas 2 = Oil 3 = Steam 4 = Electricity	-	1 to 4	4 for types 1,2,&3 3 for 4 & 5
9	Minimum Part Load Cut-Off If the load to the central chiller drops below this percent of peak capacity, the cooling load will be deferred until the next hour.	Percent	10.to 100.	10.
10	Chilled Water Setpoint Temperature: Enter here the temperature of chilled water as it leaves the chiller.	^oF	32.to 50.	45.
	If operating curves are to be used (either user defined or defaulted) then continue filling out card. Else, stop here.			
11	Chiller Energy Use Rate	KW/TON or LB STM/TON	>0	-
	If user-defined curves are desired then continue filling out the card. If default curves are to be used (See page 3-41), stop here.			
12	Number of % Chiller Capacity vs. Condenser Water Temperature Data Points. See page S15/3.	-	0 to 5	0
13	% Chiller Capacity Point 1	%	-	0.0
14	Leaving Condenser Water Temperature for Capacity Point 1	^oF	-	0.0

EXAMPLE OF USER-DEFINED CHILLER CURVES



S15/3

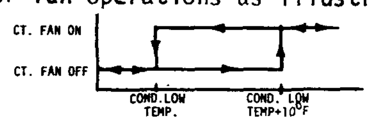
NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
15	% Chiller Capacity Point 2	%	-	0.0
16	Leaving Condenser Water Temperature for Capacity Point 2	^oF	-	0.0
.	% Chiller Capacity Point 5 (if necessary)	%	-	0.0
.	Leaving Condenser Water Temperature for Capacity Point 5 (if necessary)	^oF	-	0.0
	Number of % Chiller Power vs. Condenser Water Temperature Data Points. See page S15/3.	-	0 to 5	0
	% Chiller Power Point 1	%	-	0.0
	Leaving Condenser Water Temperature for Power Point 1	^oF	-	0.0
⋮	⋮	⋮	⋮	⋮
	% Chiller Power Point 5 (if necessary)	%	-	0.0
	Leaving Condenser Water Temperature for Power Point 5 (if necessary)	^oF	-	0.0
	Number of % Chiller Power vs % Peak Load Data Points. See page S15/3.	-	0 to 5	0
	% Chiller Peak Power Point 1	-	-	0.0
	% Chiller Peak Load Point 1	-	-	0.0
⋮	⋮	⋮	⋮	⋮
	% Chiller Peak Power Point 5 (if necessary)	-	-	0.0
	% Chiller Peak Load Point 5 (if necessary)	-	-	0.0

CHILLER DEFAULTED OPERATING CURVES																																		
CHILLER TYPE	# POINTS	% CAPACITY VERSUS LEAVING CONDENSER WATER TEMPERATURE										# POINTS	% PEAK POWER VERSUS LEAVING CONDENSER WATER TEMPERATURE										# POINTS	% PEAK POWER VERSUS % PEAK LOAD									
		1		2		3		4		5			1		2		3		4		5			1		2		3		4		5	
RECIPROCATING	5	100	65	100	95	100	97	100	100	20	130	5	90	65	100	95	104	97	109	100	120	105	5	35	10	45	40	90	90	100	100	120	110
HERMETIC CENTRIFUGAL	5	100	65	100	95	100	97	100	100	10	120	5	93	65	100	95	104	97	109	100	120	105	5	25	10	40	40	89	90	100	100	110	105
OPEN CENTRIFUGAL	5	100	65	100	90	100	95	100	100	10	110	5	25	65	42	90	72	95	100	100	100	110	5	25	10	42	40	72	70	100	100	120	110
STEAM ABSORPTION	5	102	65	98	90	82	98	69	101	35	103	5	100	65	97	90	86	98	80	101	52	103	5	14	10	39	40	65	70	100	100	110	125
STEAM TURBINE	5	100	65	100	90	100	95	100	100	10	110	5	60	65	88	90	94	95	100	100	100	110	5	50	10	62	40	87	70	100	100	110	110

S16 COOLING TOWER CARD

GENERAL DESCRIPTION:

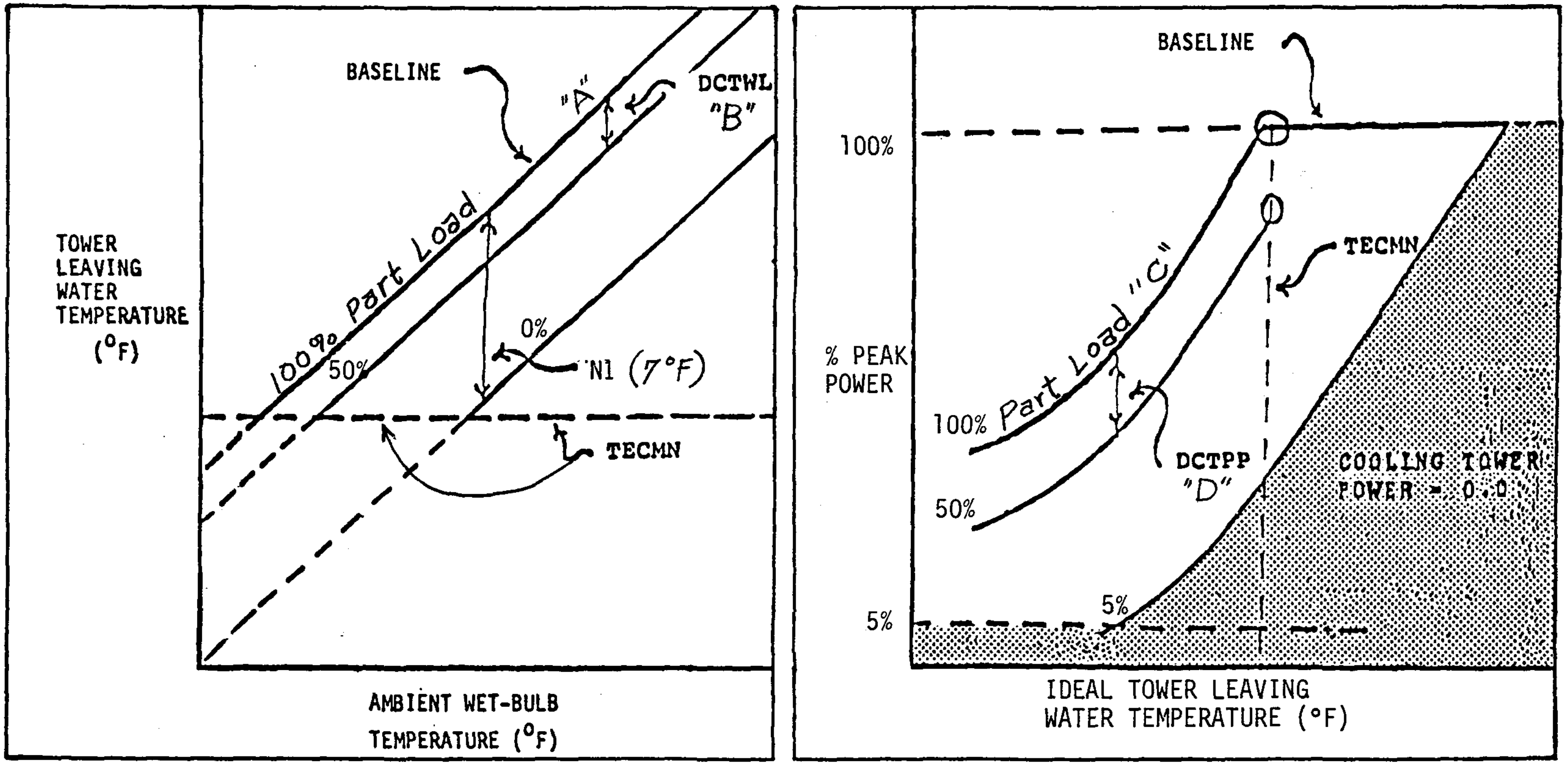
This card describes the cooling tower to be tied with all of the chillers. The user has the option of defining a performance curve or of using the built-in curve.
This card is non-repeatable.
Only the first three variables are necessary for built-in performance.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Cooling Tower Water Low Limit Temperature: 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.  	°F	75. to 90.	75.
2	Condenser Water Temperature Rise:	°F	5. to 20.	10.
3	Cooling Tower Peak Power If equal to 0. then program will size. The cooling tower fan is allowed to function during times of chiller operation.	KW	-	PROGRAM WILL SIZE

S16 COOLING TOWER CARD (continued)

	NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
		If user-defined curves are desired then continue filling out the card. Otherwise, terminate it here.			
	4	Number of Leaving Tower Water Temperature vs. Ambient Wet-bulb Temperature at 100% Load Data Points. See page S16/3.	-	0 to 5	0
	5	Leaving Tower Water Temperature Point 1 (100% Load)	^oF	-	0.0
	6	Ambient Wet-bulb Point 1	^oF	-	0.0
"A"	.	⋮	⋮	⋮	⋮
		Leaving Tower Water Temperature Point 5 (if necessary)	^oF	-	0.0
		Ambient Wet-bulb Point 5 (if necessary)	^oF	-	0.0
		Number of Δ Leaving Tower Water Temperature vs. % Peak Load Data Points. See page S16/3.	-	0 to 5	0
		Change in Leaving Tower Water Temperature for Part Load 1A	^oF	-	0.0
		Part Load 1A	percent	-	0.0
"B"		⋮	⋮	⋮	⋮
		Change in Leaving Tower Water Temperature for Part Load 5A (if necessary)	^oF	-	0.0
		Part Load 5A (if necessary)	percent	-	0.0
		Number of Cooling Tower % Peak Power vs. Leaving Tower Water Temperature at 100% Load Data Points. See page S16/3.	-	0 to 5	0
		Cooling Tower % Peak Power Point 1	percent	-	0.0
"C"		Leaving Tower Water Temperature Point 1	^oF	-	0.0
		⋮	⋮	⋮	⋮

EXAMPLE OF USER-DEFINED
COOLING TOWER CURVES



DCTWL: CHANGE IN LEAVING TOWER WATER TEMPERATURE
DCTPP: CHANGE IN TOWER % PEAK POWER
TECMN: COOLING TOWER WATER LOW LIMIT TERMPERATURE
N1: TYPICAL 7°F APPROACH

S16 COOLING TOWER CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	Cooling Tower % Peak Power Point 5 (if necessary)	percent	-	0.0
	Leaving Tower Water Temperature Point 5 (if necessary)	^oF	-	0.0
	Number of Δ Tower % Peak Power vs. % Peak Load Data Points. See page S16/3.	-	0 to 5	0
	Change in Tower % Peak Power for Part Load iB	percent	-	0.0
"D"	Part Load 1B	percent	-	0.0
	⋮	⋮	⋮	⋮
	Change in Tower % Peak Power for Part Load 5B (if necessary)	percent	-	0.0
	Part Load 5B (if necessary)	percent	-	0.0

S17: DX/HEAT PUMP CARD

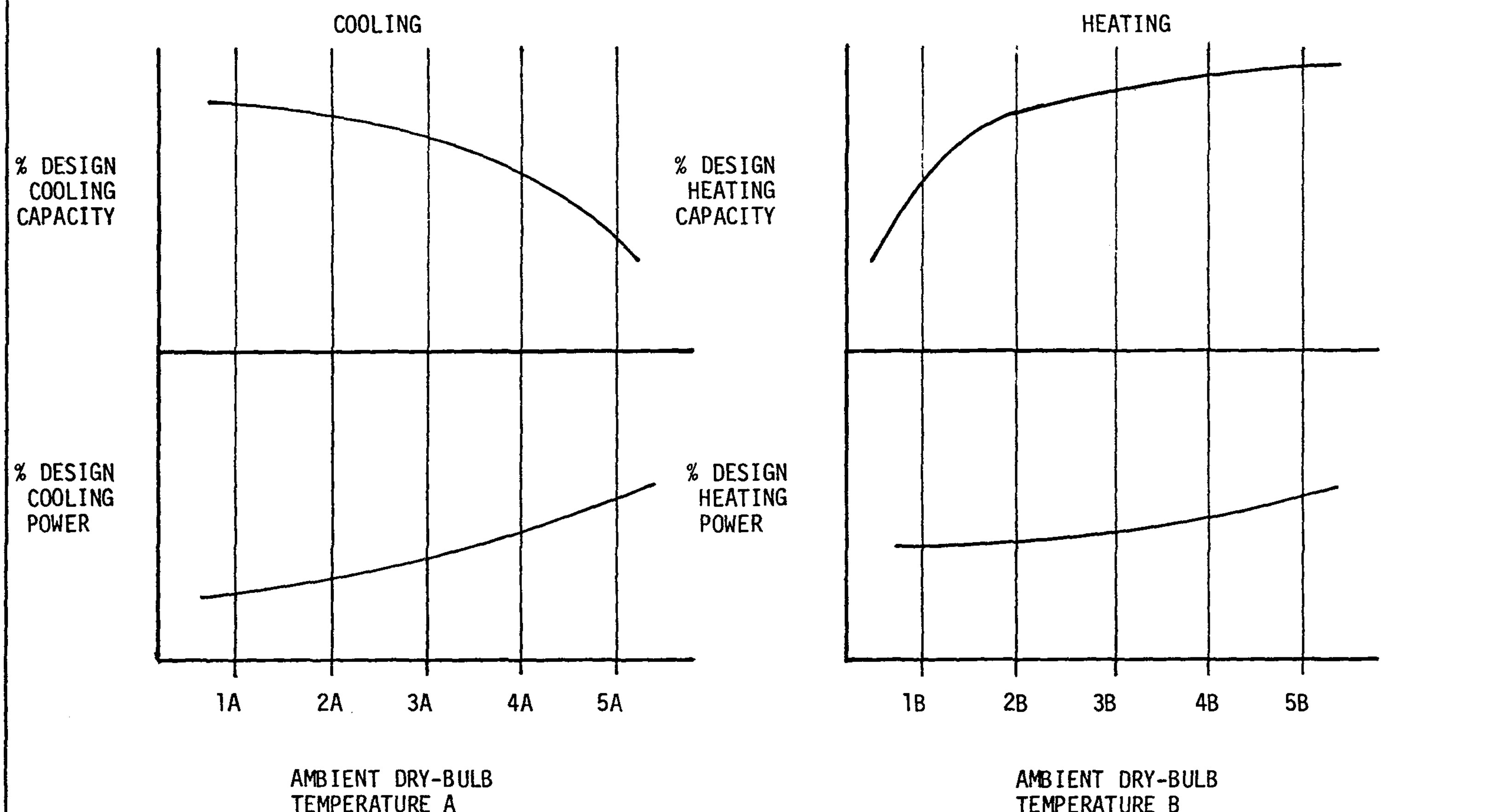
GENERAL DESCRIPTION:

Direct expansion units and heat pumps are defined on this card. The unit is linked to a specific fan system by the 'DX/Heat Pump Index' on card S11. DX and heat pump units do not apply to all systems available in the program. Refer to page S11/12 for application.
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. 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. 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 S14 and S15.
This card is repeatable. (Maximum of 10).

NOTE: **All of the heating and cooling performance data points will either be supplied by user or all will be defaulted. There is no mixing of user and defaulted data points. The defaulted data points are on page S17/4.** If defaults are used the input specification is:
For DX only: Chiller capacity, chiller power;
For HP : Chiller capacity, chiller power, heating capacity, heating power;

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Design Cooling Capacity	KBtu/hr	-	Program SIZES
2	Design Cooling Power If user defined data points continue filling out card, else stop here.	KW	-	Program SIZES
3	Number of Cooling Performance Data Points. See page S17/2.	-	1 to 5	Refer NOTE
4	Ambient Dry-bulb Temperature at Point 1A	°F	-	Refer NOTE
5	% of Design Cooling Capacity at Ambient Temperature 1A	percent	-	Refer NOTE
6	% of Design Cooling Power at Ambient Temperature 1A	percent	-	Refer NOTE
:	:	:	:	:
	Ambient Dry-bulb Temperature at Point 5A (if necessary)	°F	-	Refer NOTE

EXAMPLE OF USER-DEFINED
DX/HEAT PUMP CURVES



S17/2

S17 DX/HEAT PUMP CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
	% of Design Cooling Capacity at Ambient Temperature 5A (if necessary)	percent	-	Refer NOTE
	% of Design Cooling Power at Ambient Temperature 5A (if necessary)	percent	-	Refer NOTE
	If Defining a Heat Pump continuing filling out the card. Otherwise, terminate the card here.			Refer NOTE
	Design Heating Capacity For air to air heat pump only.	KBtu/hr	-	Refer NOTE
	Design Heating Power For air to air heat pump only. Include compressor, outside fan power, electric defrost power (if used). If user defined data points continue filling out card, else stop here.	KW	-	Refer NOTE
	Number of Heating Performance Data Points For air to air heat pump only. See page S17/2.	-	1 to 5	Refer NOTE
	Ambient Dry-bulb Temperature at Point 1B	^oF	-	Refer NOTE
	% of Design Heating Capacity at Ambient Temperature 1B 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.	percent	-	Refer NOTE
	% of Design Heating Power at Ambient Temperature 1B	percent	-	Refer NOTE
	⋮	⋮	⋮	⋮
	Ambient Dry-bulb Temperature at Point 5B (if necessary)	^oF	-	Refer NOTE
	% of Design Heating Capacity at Ambient Temperature 5B (if necessary)	percent	-	Refer NOTE
	% of Design Heating Power at Ambient Temperature 5B (if necessary)	percent	-	Refer NOTE

DX/HEAT PUMP DEFAULTED HEATING & COOLING DATA POINTS

COOLING

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

HEATING

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

S18 PUMP DESCRIPTION CARD

GENERAL DESCRIPTION:

Pump head information is used in sizing pump motors. If a particular pump is not to be simulated, enter 0.0 head pressure. The fan and pump efficiency term is used to size the supply, return, and exhaust air fans of each system as well as associated pumps.
This card is non-repeatable.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Boiler Pump Head	FT	-	50.0
2	Chilled Water Pump Head	FT	-	40.0
3	Condenser Water Pump Head	FT	-	30.0
4	Fan and Pump Motor Efficiency	Percent	1.to 100.	85.0

S19: PROCESS LOAD CARD

GENERAL DESCRIPTION:

Energy consumption not related to the heating or cooling of the facility can be simulated for complete energy usage picture. Process loads are tabulated separately along with being summed with the facility total. This card is repeatable.(Maximum of 10).

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	Peak Process Load: Enter the peak or reference load for the particular process. Units for peak load are as defined in the energy source code table below.	see table below	-	0.0
2	Energy Source Code: This term defines the type of energy source the process operation uses. It is defined as follows: ENERGY SOURCE DEFINITION CODE / UNITS / DESCRIPTION 0 / KBTU / Indirect Process (Load to Boiler) 1 / THERMS / Gas 2 / K-GALS / Heating Oil 3 / K-LBS / Purchased Steam 4 / KW / Electricity	-	0 to 4	0
3	Operating Schedule Index: Enter the repetition number of the appropriate S7 operating schedule, card.	-	1 to 10	1.0

S20 MISCELLANEOUS DATA CARD

GENERAL DESCRIPTION:

This card defines the floor panel heating system, the properties of purchased or cooling equipment steam, and of external lighting.

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
1	General Steam Pressure: This term is used in defining purchased steam as a heat source, process steam, and absorption steam for type 4 chillers. If out of range of the limits, the steam pressure <u>and</u> temperature will default to 12 psig, 245^{o}F.	psig	2.to 12.	12.0
2	General Steam Temperature: See above comments.	^{o}F	-	245.0
3	Turbine Steam Pressure: For a type 5, steam turbine open centrifugal, chiller this term must be defined.	psig	-	125.
4	Turbine Steam Temperature: See above comments.	^{o}F	-	353.
5	Turbine Speed: See above comments.	rpm	-	3600.
6	External Lighting Power: External lighting is on from sunset to sunrise.	KW	-	0.

S20 MISCELLANEOUS DATA CARD (continued)

NO.	VARIABLE DESCRIPTION AND COMMENTS	UNITS	LIMITS	DEFAULT
7	Type of Floor Covering: The floor covering type code is as follows: Code — Description 1. Bare concrete 2. Tile 3. Carpeting	-	1 to 3	1
8	Floor Insulation Conductance	Btu/hr-^oF-ft^2	-	0.0
9	Floor Insulation Thickness	Ft	-	0.0

SECTION 4

CARD FORMAT

LABEL DESCRIPTION FOR NECAP
INPUT PREPROCESSOR PROGRAM

General Notes:

The label is composed of four parts:

- Program index
- Card index
- Surface index
- Repetition number

Each part can appear only once in a label.
The program index and card index are mandatory for each label.*
The surface index is mandatory depending on the card.
The repetition number is always optional.
The first non-blank character on a label must be a program index.*
The program index must be immediately followed by the card index.
All parts except for the program index-card index combination must be separated from each other by dashes.
Blanks embedded within a label are ignored unless it follows the program index.
The label is terminated by an equals.

Examples:

Valid Labels	Invalid Labels	
'L1-1='	'L1-6-='	2nd dash implies longer label but equals terminates it.
'L14-D-1='	'L3-1-4='	Too many numbers
'L17-7='	'L 3='	Blank after program index
'L18-I='	'L14-3D='	Surface index and repetition number not separated by a dash
'L10='		
'L15-3-U='	'L='	No card index
'L7-2='	'10L-4='	Label does not begin with program index

* The slash character on the variable list will cause the last label decoded to be repeated. In this case, therefore, these rules do not apply.

LABEL DESCRIPTION (CONT.)

Label Part	Symbols	Function and Notes
Program index	'L', 'S'	Designates the program input being described. 'L' is for TLAP 'S' is for SESP
Card index	0 thru 9	Specifies the data set being defined. Maximum of 18 unique TLAP data sets 20 unique SESP data sets
Surface index	'D', 'G', 'I', 'Q', 'U'	Defines the type of surface being described: 'D' is for delayed surfaces 'G' is for glazed surfaces 'I' is for internal surfaces 'Q' is for quick surfaces 'U' is for underground surfaces
Repetition number	0 thru 9	Defines the sequence of cards with duplicate labels. If omitted the program will calculate.
Separator	'-' (dash)	Separates label parts.
Terminator	'=' (equal)	Separates the card label from the variable list.
Comment	'C'	Designates card as a comment card. Data on this card will be ignored.

Example:	Valid Labels	Invalid Labels
	'S3='	'P7-3=' Wrong program index
	'S12-1='	'S23-7=' Card index too large
	'L17-20='	'L18-S=' Invalid surface index
	'L14-D-7='	'L15-D-Q=' Too many surface indices
	'L3='	'L11-D=' Not a surface card
		'L2-3=' Not a repeatable card

VARIABLE LIST DESCRIPTION FOR NECAP
INPUT PREPROCESSOR PROGRAM

General Notes:

The variable list is a series of numbers that represent specific data items.
The numbers are separated by commas or blanks.
A series of blanks between characters is treated as a single comma.
Blanks that precede or follow a comma are ignored.
The repetition of a particular number can be represented using the multiplier symbol.
The repetition of a set of numbers can be represented by the group indices. No group can appear within another group.
Data items can be bypassed or defaulted by using the skip index or by printing a series of commas.
Decimal points are optional for whole numbers.
The variable list is terminated with either a slash or a semi-colon.
Termination of the list before all the variables have been defined will cause the remainder to be defaulted.
Certain cards can contain a title or name. Titles are assumed to be the last item on a record with a maximum of 35 characters; they can be composed of any characters but must not begin with a number.

Examples:

```
=10.3,7,4*2,75;
=@5,8.,23.2,6,@3,1;
=3(2,100,50),10(1,80,75),5(1,85,75),1,90,70,5(2,100,50)/
```

Note: The equal sign is used to indicate the end of the card label.

Part	Symbol	Function and Notes
Number	0 thru 9	Represents a specific data item.
Separator	',' (comma)	Defines the order and position of the data items.
Multiplier	'*' (asterisk)	Used to repeat a specific data item within the data set. Must be immediately preceded by a positive integer (number without a decimal point) which is the number of repetitions. Must be immediately followed by the data item. Example: 3*0.7 is equivalent to 0.7,0.7,0.7 4* 1 is invalid because of the embedded blank.

VARIABLE LIST DESCRIPTION (CONT.)

Part	Symbol	Function and Notes
Group indices	'(' (left parenthesis) ')' (right parenthesis)	Used to repeat a group of data items within the data set. The left parenthesis begins the group definition; the right one ends it. The left parenthesis is preceded by the group multiplier, a positive integer (number without a decimal point), which is the number of repetitions. The group multiplier if omitted will default to 1. Any valid variable list symbol except for another group index can be used within a group. Examples: 2(3,6.3) is equivalent to 3,6.3,3,6.3
Skip index	'@' (at sign)	Used to bypass the definition of data items. Must be immediately followed by a positive integer (number without a decimal point) which is the number of variable positions to skip over. Example: @2 is equivent to ,,, @3. is invalid because the skip number has decimal point.
Negative sign	'-' (dash)	Used to denotes data items whose values are less than zero.
Decimal point	'.' (period)	Used to denote decimal fractions.
Terminators	';' (semi-colon) '/' (slash)	Designates the end of the variable list definition. The semi-colon ends processing of the card and indicates a new label begins on the following card. Any characters that follow a semi-colon on a card are ignored. The slash ends processing of the variable list. New data can immediately follow a slash. Unlike the semi-colon, the slash does not reset the label but will continue using the last decoded label. Thus a new label does not have to follow a slash.

VARIABLE LIST DESCRIPTION (CONT.)

Part	Symbol	Function and Notes
		The slash can be followed by an entirely new label or any of its parts. Only those label parts decoded after a slash will be modified for the new label. A slash cannot be followed by a blank label i.e., an equals or a series of blanks plus an equals. Examples: L17-1=,, /2= This is equivalent to a label of 'L17-2=' L14-D=,,,,, /G= This is equivalent to a label of 'L14-G=' L11=,,,,, /,,,,,, No label is equivalent to a label of 'L11-2=' Note the first label is read as 'L11-1=' L15-I=,,,, /,,,,, No label in this case is equivalent to a label of 'L15-I-2='

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-83239		

4. Title and Subtitle	
NECAP 4.1 - NASA'S ENERGY-COST ANALYSIS PROGRAM INPUT MANUAL	5. Report Date May 1982
	6. Performing Organization Code 992-24-01-01
7. Author(s) Ronald N. Jensen	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665	11. Contract or Grant No.
	13. Type of Report and Period Covered Technical Memorandum
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

NASA'S Energy-Cost Analysis Program (NECAP) is a powerful computerized method to determine and to minimize building energy consumption. The program calculates hourly heat gain or losses taking into account the building thermal resistance and mass, using hourly weather and a "response factor" method. Internal temperatures are allowed to vary in accordance with thermostat settings and equipment capacity.

NECAP 4.1 is a updated version of NECAP published in 1975 (see CR2590, Parts I and II). It has a simplified input procedure and numerous other technical improvements. Documentation consists of a Users Manual, Engineering Manual, Input Manual, Fast Input Manual and Example, Engineering Flow Chart Manual and an Operations Manual (specifically for LaRC's Computer System).

This input manual details the procedures and data required for data input. Several examples are given.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Energy Energy Conservation Energy Analysis Air Conditioning and Heating	Unclassified - Unlimited Subject Category 44

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	130	A07

For sale by the National Technical Information Service, Springfield, Virginia 22161