CALCULATING SUMMER TIME COOLING LOADS

BY

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CHAPTER I

INTRODUCTION

The following chapters will outline a method whereby the annual cooling load for a specific structure can be estimated. This analysis will be limited to calculating the sensible heat load without regard to any ventilation, people, appliance or lighting load associated with the cooling load. The above limitations were made to allow the discussion herein to be centered around the one variable which is common to all structures no matter what they are used for, that being the cooling load requirements because of climatic conditions.

While the following chapters will be written for a specific type of structure, the method contained herein can be utilized on other types of structures. In order to arrive at a total cooling load required for a specific structure, the person doing the computations shall have not only a knowledge of the type of structure and the climatic environment, but must have a knowledge of the potential use of the structure.

In summarizing, the following chapters will propose a method for calculating the seasonable cooling load caused by the sensible heat gain of a structure. This sensible heat gain will be limited to that heat gain caused by the climatic environment of the structure.

CHAPTER II

METHODS OF CALCULATING COOLING LOAD

Present Methods

The present methods utilized in cooling load calculations are rather incomplete and probably serve best to give an engineer a base line whereby different types and sizes of cooling machines can be compared.

One method is expressed in a paper by A. Eugene Congress (Ref. 1). Mr. Congress states in a paragraph (Ref. 2) entitled, "Determination of Climatic Data and Operation at Various Percentage Loads," - - - "Dry-bulb temperature, rather than wet-bulb or other measurement, is assumed as more nearly representative of changes in cooling load." Ref. 1 goes on to explain how to utilize the dry-bulb temperature to determine the annual energy required for cooling. The primary purpose of determining the annual energy, as illustrated in Ref. 1, was for use in the comparison of different cooling machines. The dry-bulb temperature, while giving an indication of the cooling required, is only a portion of the climatic conditions which make summer cooling a necessity.

Another method of determining the annual cooling load is explained as a portion of the Handbook of Air-Conditioning, Heating and Ventilating (Ref. 3). This method is known as the "Cooling Degree-Days" method. It is derived in like manner and is utilized similarly to the method of calculating the heating load by the "Degree-Day" method. This method of determining cooling load is still in its infancy and should therefore be utilized as a reference. In like manner, to the above evaluation, the cooling degree-day method does not take into account the sun's radiation as a distinct part of the load required for cooling. When determining the cooling load for a small building, the radiation cooling load becomes a large portion of the total climatic cooling load which will be shown in Chapter III.

Proposed Method

The following is a proposed method for calculating the cooling energy required to offset the heat gain due to solar radiation and convective heat transfer from the hot summer air. The basic information will be derived from the Heating, Ventilating and Air-Conditioning Guide (Ref. 4).

Step 1: (Roof)

Divide Table IX (Ref. 5) into its component parts of temperature difference for convective heat transfer and the temperature difference caused by solar radiation. Utilize the temperature difference listed for "Roofs in Shade" as the values for the convective load. The temperature difference for solar radiation can then be determined by taking the difference of shade values and the total sunlit values. Correct the values of temperature difference cuased by convective heat transfer for maximum design conditions and climatic temperature range as outlined in the notes of Table IX (Ref. 5).

Step 2: (Roof)

Make two chronological temperature differential curves for the roof - one for the temperature difference caused by convective heat transfer and the other for the temperature caused by solar radiation. Determine the area under each of these curves.

Step 3: (Walls)

Next, Table X (Ref. 6) is subdivided into its component parts as described in Step 1 above. There will be a radiation temperature difference table for each direction of wall face. The table showing the convection temperature difference will be independent of the direction the wall faces since these values depend only on the ambient air temperature which is common to all walls. The temperature differences caused by convective heat transfer shall be corrected by the directions of the footnotes of Table X (Ref. 6)

Step 4: (Walls)

Construct chronological temperature difference curves for each of the wall temperature difference tables. Determine the area under each of these curves.

Step 5: (Glass)

Calculate the heat gain from the glass area. The heat gain due to window glass is given in Tables XII and XIII of (Ref. 7). Table XII entitled, "Instantaneous Rates of Heat Gain Due to Transmitted Direct and Diffused or Sky Solar Radiation by a Single Sheet of Unshaded Common Window Glass" will be used to determine the heat gain due to solar radiation. Table XIII is entitled, "Instantaneous Rates of Heat Gain by Convection and Radiation from a Single Sheet of Unshaded Common Window Glass" and will be used to determine the convective heat gain from the hot summer air. These tables will be used in their present form and shall be corrected for differences in design conditions.

Step 6: (Glass)

Construct a chronological heat load curve for each of the glass areas. There will be one curve for radiation and one for convective heat gain. The area under each of these curves will be a typical heat load for an August 1 day at design conditions.

Step 7:

Construct a chronological temperature curve for the location of the structure to be cooled. Information required to construct this curve is contained in a Weather Bureau publication entitled, "Daily Normals of Temperature and Heating Degree Days" (Ref. 8).

Construct a curve of the declination of the sun in degrees vs. months. This information can be found in Table VII of Reference 9.

Step 8:

Draw a line on the chronological temperature curve at the interior design dry-bulb temperature. Draw a second line on the chronological temperature curve at the outside design temperature. Complete a rectangle by drawing perpendicular lines from the point of intersection of the interior design dry-bulb temperature line and the temperature curve. The number of cooling days will be those included in this rectangle. The ratio of the area under the ambient temperature curve within the rectangle to the total area of the rectangle will be the ratio of actual required cooling to constant cooling at the design condition.

The portion of the total heat gain caused by hot air convection can be found for the roof and walls by application of the following equation:

$$\text{Convective Heat Load} \quad \frac{\text{BTU}}{\text{Ft}^2\ \text{Season}} =$$

$$\text{Area of Chronological Temperature Curve for Convective Heat Gain Step 2, 4} \quad \frac{{}^{\circ}\text{F Hr}}{\text{Day}}$$

$$\times \quad \text{Conductivity of Structure} \quad \frac{\text{BTU}}{\text{Ft}^2\ \text{Hr}\,{}^{\circ}\text{F}}$$

$$\times \quad \text{Number of Cooling Days per Season} \quad \frac{\text{Days}}{\text{Season}}$$

$$\times \quad \text{Ratio of Actual to Design Conditions}$$

(Eq. II-1)

The convective portion of the total heat gain for the glass area can be found by application of the following:

$$\text{Convective Heat Load} \quad \frac{\text{BTU}}{\text{Ft}^2\ \text{Season}} =$$

$$\text{Area of Chronological Convective Heat Load Curve Step 7} \quad \frac{\text{BTU}}{\text{Ft}^2\ \text{Day}}$$

$$\times \ \text{Number of Cooling Days per Season} \quad \frac{\text{Days}}{\text{Season}}$$

$$\times \ \text{Ratio of Actual to Design Conditions}$$

(Eq. II-2)

Step 9:

Utilizing the curve of sun declination vs. months developed under Step 7, perform the following:

a) Draw a line of constant sun declination through the point of solar declination on the design day.

b) Perpendicular to this line of constant solar declination draw two lines, one at the beginning of the cooling season and the other at the end of the season. These dates depicting the starting and stopping of the cooling season will coincide with the end points of the cooling season established in Step 8.

c) Find the ratio of the area under the declination curve for the cooling season to the total area of the rectangle. This value will be called the declination factor.

d) Utilizing the monthly charts on the percentage of cloud cover contained in the government publication, "Climatography of the United States," (Ref. 10) derive a factor for estimating the cloud cover for the specific area for which the cooling calculations are being derived. This factor may be derived by taking an average of the monthly calculations of cloud cover averages over the cooling season. These averages will be pin-pointed around three cloud scales which are given in tenths of sky covered. Therefore, these averages may be multiplied by their respective cloud scale average and then added together to give a composite cloud cover factor. Since the composite cloud cover factor reflects the per-tage of time cloud cover occurs, the cloud cover factor will therefore be one minus the composite cloud cover factor.

Utilizing the above factors, the radiation load for the structural walls and roof may be found by the following equation:

$$\text{Heat Load Caused by Radiation} \quad \frac{\text{BTU}}{\text{Ft}^2\ \text{Season}} =$$

$$\text{Area of Chronological Temperature Curve for Radiation Heat Gain Step 2, 4} \quad \frac{{}^{o}\text{F Hr}}{\text{Day}}$$

$$\times \quad \text{Conductivity of Structure} \quad \frac{\text{BTU}}{\text{Ft}^2\text{Hr}\,{}^{o}\text{F}}$$

$$\times \quad \text{Number of Cooling Days per Season} \quad \frac{\text{Days}}{\text{Season}}$$

$$\times \quad \text{Declination Factor}$$

$$\times \quad \text{Cloud Cover Factor}$$

(Eq. II-3)

The heat gain caused by radiation on the glass may be found by the following equation:

$$\text{Heat Gain by Radiation thru Glass} \quad \frac{BTU}{Ft^2\ Season} =$$

$$\text{Area of Chronological Heat Load Curve for Radiation thru Glass Step 7} \quad \frac{BTU}{Ft^2\ Day}$$

$$\times \quad \text{Number of Cooling Days per Season} \quad \frac{Days}{Season}$$

$$\times \quad \text{Declination Factor}$$

$$\times \quad \text{Cloud Cover Factor}$$

(Eq. II-4)

Step 10:

Multiply each of the above values by its respective area. These individual loads can then be added giving a total load for the cooling season.

CHAPTER III

DETAILED EXAMPLE OF PROPOSED METHOD

The following is an example of the calculations required to make a load analysis for cooling a specific type of structure. This example will utilize the following ground rules and design conditions:

Location: Wichita Kansas Area

Design Conditions

The cooling load calculated in this example will be only the sensible portion of the total load. There will be no ventilation, appliance or people load considered. The total cooling load calculated will be only that required to offset heat gains caused by ambient air temperature and solar radiation. The outdoor design temperature will be 100° F DB (Ref. 11) and the inside temperature will be maintained at a constant 80° F DB.

Construction of Building

The roof of the building will be constructed of two-inch concrete plus 4 ply felt. The East, North, and West walls are to be constructed of brick veneer with the inside wall finished with 3/8" Gypsum lathe and 1/2" plaster (sand agg.). The South wall will be made of a single sheet of common window glass.

Step 1: (Roof)

The following curves and tables were obtained from the Heating, Ventilating and Air-Conditioning Guide (Ref. 5)

The equivalent temperature differential caused by solar radiation on a flat unshaded roof on approximately an August 1 day is given in Table I and shown on Curve 1.

TABLE I

ΔT CAUSED BY SOLAR RADIATION ON A FLAT ROOF

SUN TIME

	A. M.			P. M.					
Time	8	10	12	2	4	6	8	10	12
ΔT ^{o}F	10	32	46	50	38	20	4	0	0

The equivalent temperature differential caused by ambient air temperature on approximately an August 1 day is given in Table II and shown on Curve 2.

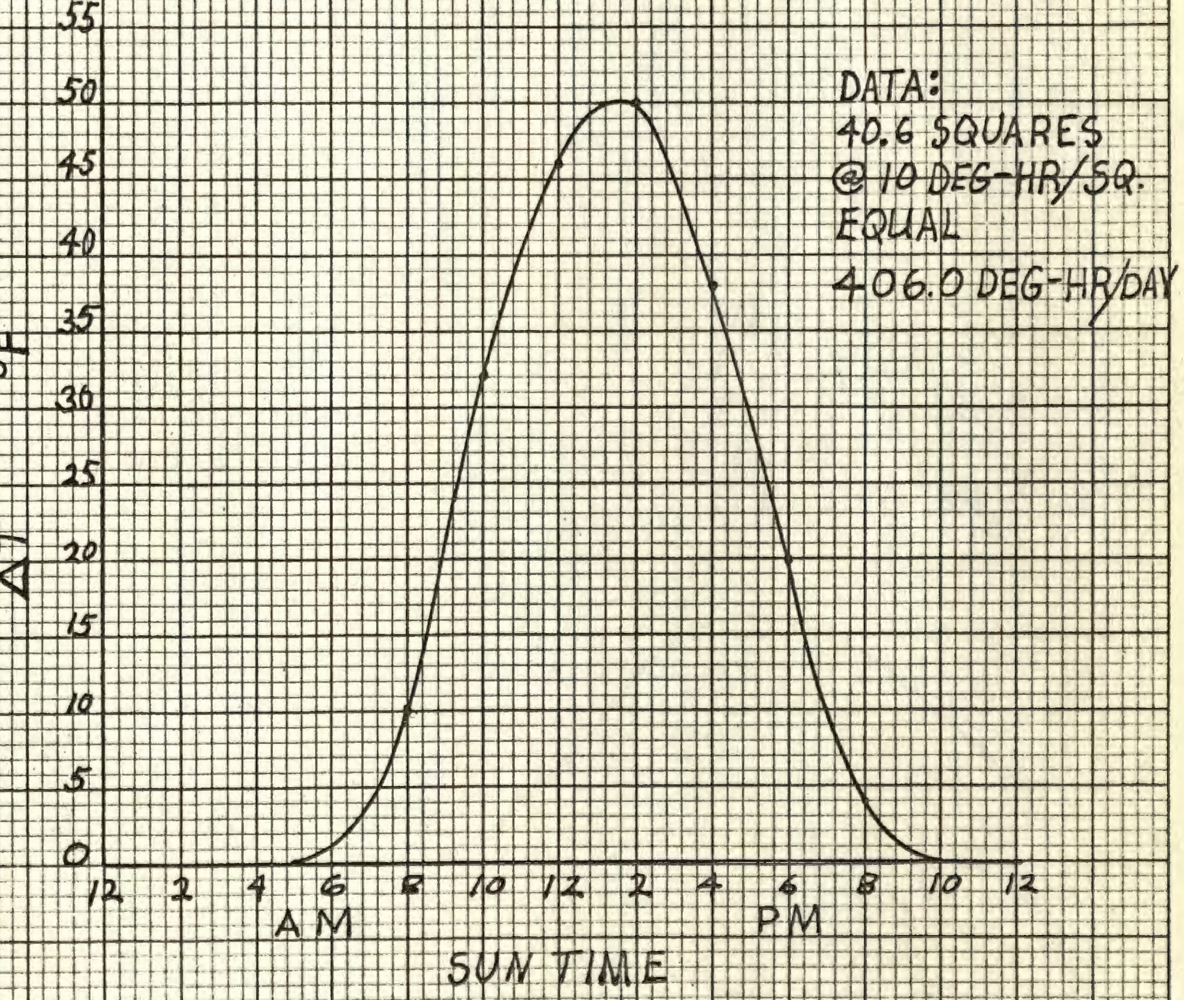
TABLE II

ΔT CAUSED BY CONVECTIVE HEAT TRANSFER ON FLAT ROOF

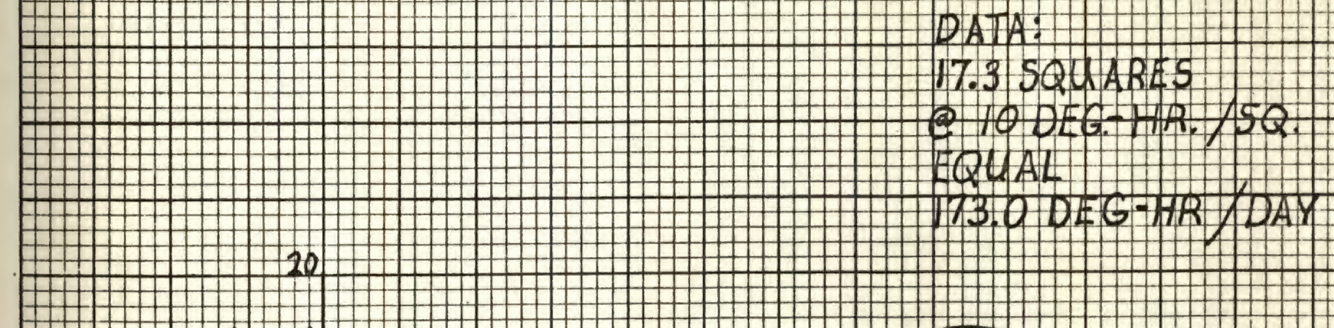
SUN TIME

	A. M.			P. M.					
Time	8	10	12	2	4	6	8	10	12
Uncorrected ΔT ^{o}F	-4	-2	2	8	12	12	10	6	2
Corrections	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1
Corrected Value ΔT ^{o}F	0	2	6	12	16	16	14	10	6

Note: The +5^{o} Correction is required since the difference between the indoor and outdoor design conditions is in excess of 15^{o}. (Ref. 5) The -1^{o} Correction is required since the daily temperature range is in excess of 20^{o}. (Ref. 5)



CURVE 1 - DEGREE-HOURS CAUSED BY RADIATION ON A FLAT ROOF (Step 2)



CURVE 2 - DEGREE-HOURS CAUSED BY CONVECTIVE HEAT TRANSFER
(Step 2) ON A FLAT ROOF

Step 3: (Brick Walls)

The following curves and tables were obtained from the Heating, Ventilating and Air-Conditioning Guide (Ref. 5).

The equivalent temperature differential caused by solar radiation on unshaded walls on approximately an August 1 day is given in Table III and shown for the East and West walls on Curve 3 and Curve 4, respectively. The North wall will have no temperature difference caused by solar radiation since it is in the shade due to its direction.

TABLE III

ΔT CAUSED BY SOLAR RADIATION ON A WALL

SUN TIME

	A. M.			P. M.					
Time	8	10	12	2	4	6	8	10	12
Direction of Wall Face:									
East ΔT ^{o}F	4	16	17	8	2	2	0	0	0
West ΔT ^{o}F	0	0	2	2	8	14	14	6	2
North (Shade) ΔT ^{o}F	0	0	0	0	0	0	0	0	0

The equivalent temperature differential caused by ambient air temperature on approximately an August 1 day is given in Table IV and shown on Curve 5. This data is independent of the direction of the wall face.

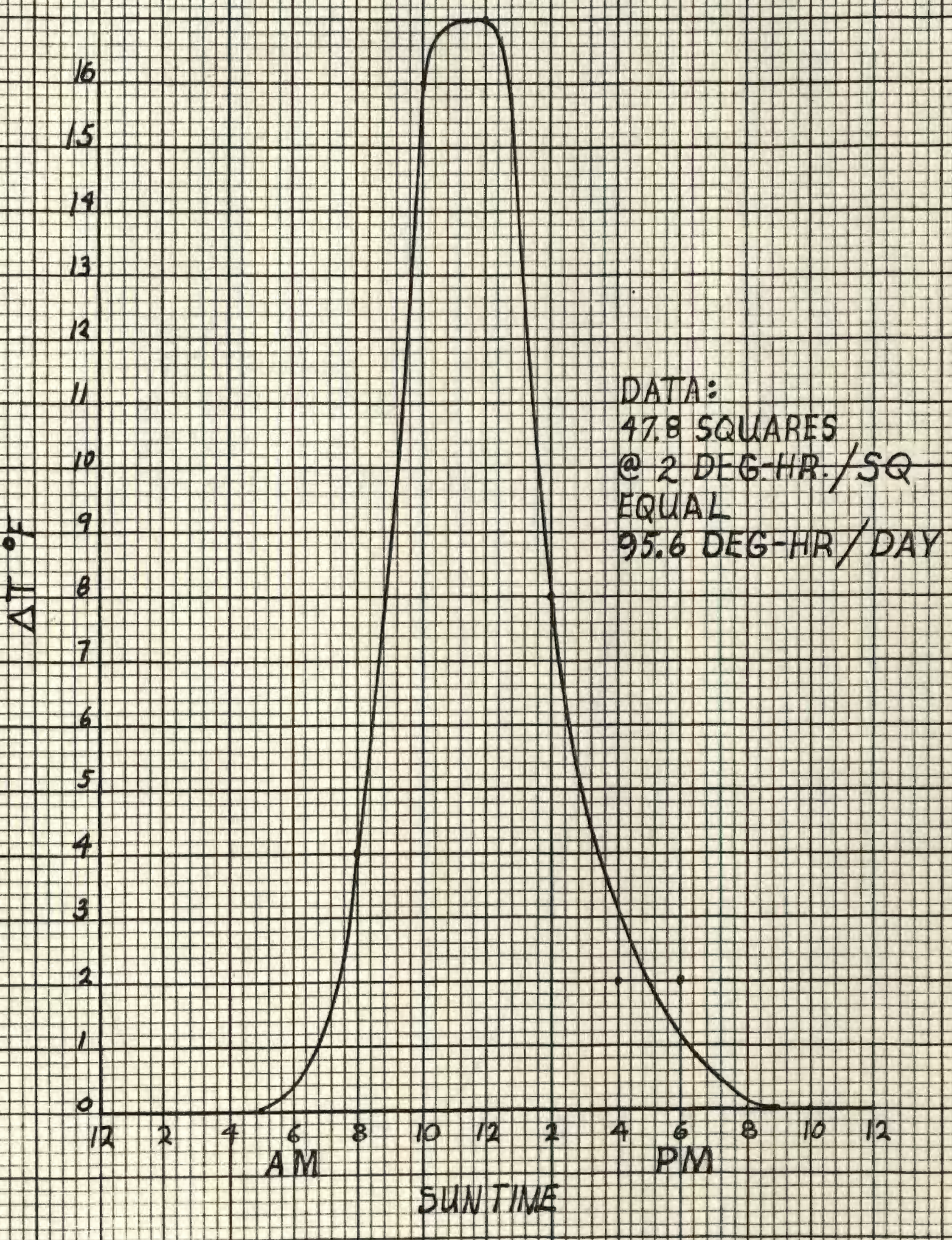
TABLE IV

ΔT CAUSED BY CONVECTIVE HEAT TRANSFER ON A WALL

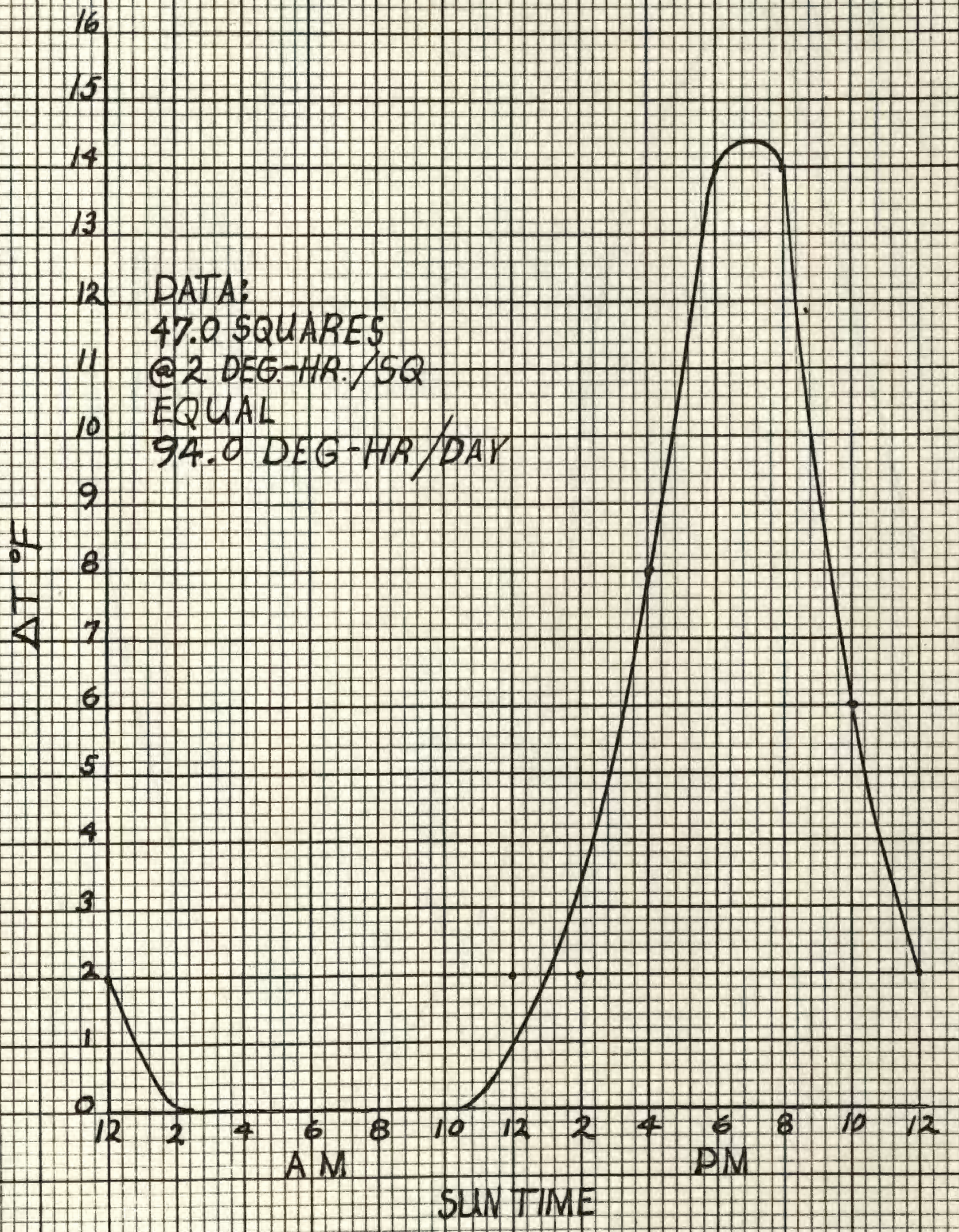
SUN TIME

	A. M.			P. M.					
Time	8	10	12	2	4	6	8	10	12
Uncorrected ΔT F	-4	-2	0	6	10	12	12	8	4
Corrections	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1
Corrected Value ΔT ^{o}F	0	2	4	10	14	16	16	12	8

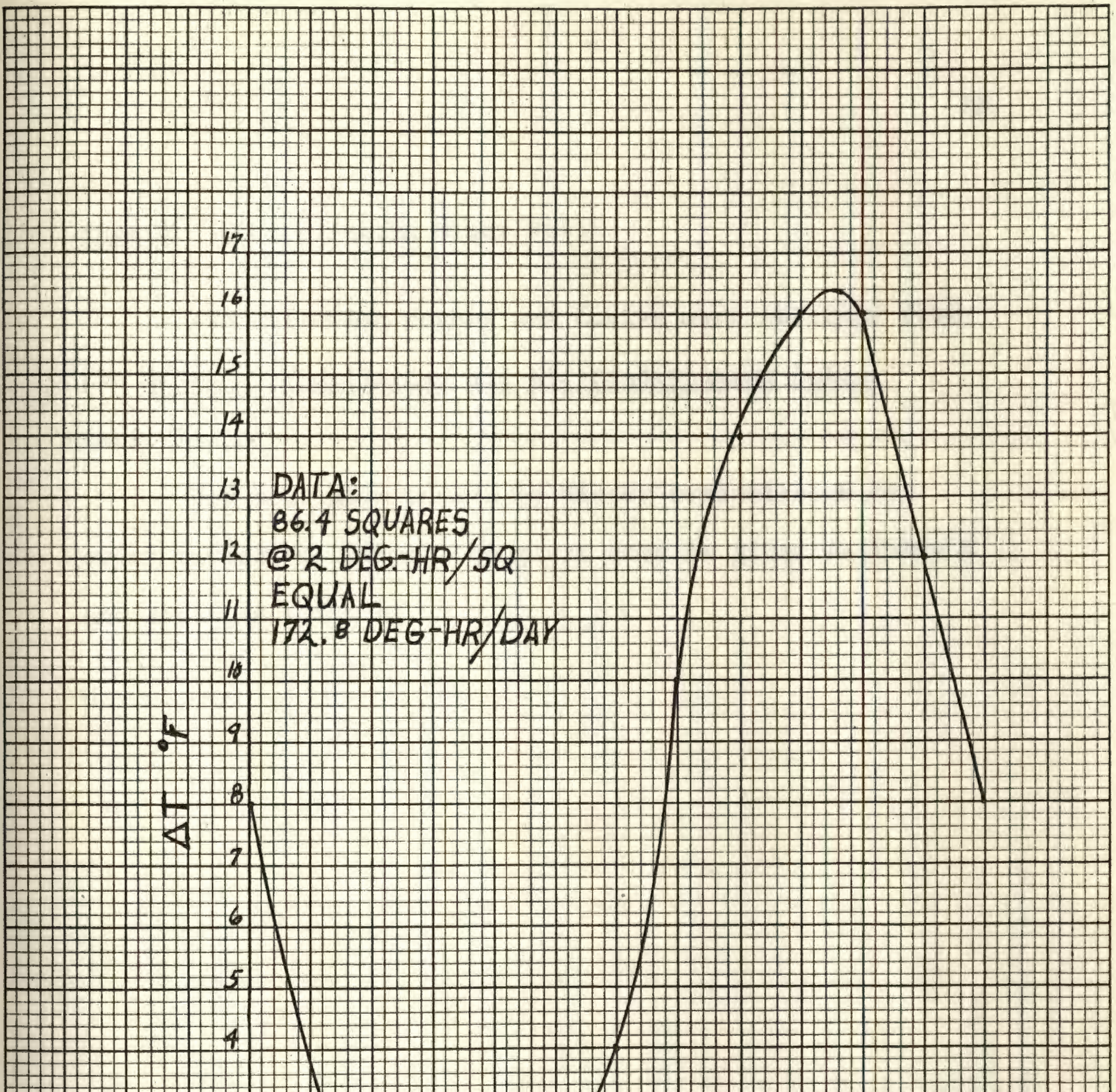
<u>Note</u>: The $+5^{o}$ Correction is required since the difference between the indoor and outdoor design conditions is in excess of 15^{o}. (Ref. 5) The -1^{o} Correction is required since the daily temperature range for the Wichita area is in excess of 20^{o}. (Ref. 6)



CURVE 3 - DEGREE HOURS CAUSED BY RADIATION ON EAST WALL (Step 4)



CURVE 4 - DEGREE HOURS CAUSED BY RADIATION ON WEST WALL (Step 4)



CURVE 5 - DEGREE-HOURS CAUSED BY CONVECTIVE HEAT TRANSFER ON ALL WALLS - (Step 4)

<u>Step 5</u>: (South Facing Glass Wall)

The following curves and tables were obtained from the <u>Heating, Ventilating and Air-Conditioning Guide</u> (Ref. 7).

The heat gain caused by direct transmission of solar radiation through the glass area is given in Table V and shown on Curve 6.

TABLE V

RADIATION HEAT LOAD TRANSMITTED BY GLASS AREA

SUN TIME

A. M.

Time	5	6	7	8	9	10	11	12
BTU/Ft^2 Hr	0	7	11	18	42	69	90	98

P. M.

Time	1	2	3	4	5	6	7	8	9
BTU/Ft^2 Hr	90	69	42	18	11	7	0	0	0

The heat gain caused by ambient temperature conditions on a glass surface is given in Table VI and shown on Curve 7.

TABLE VI

HEAT LOAD CAUSED BY CONVECTIVE HEAT TRANSFER ON GLASS

SUN TIME

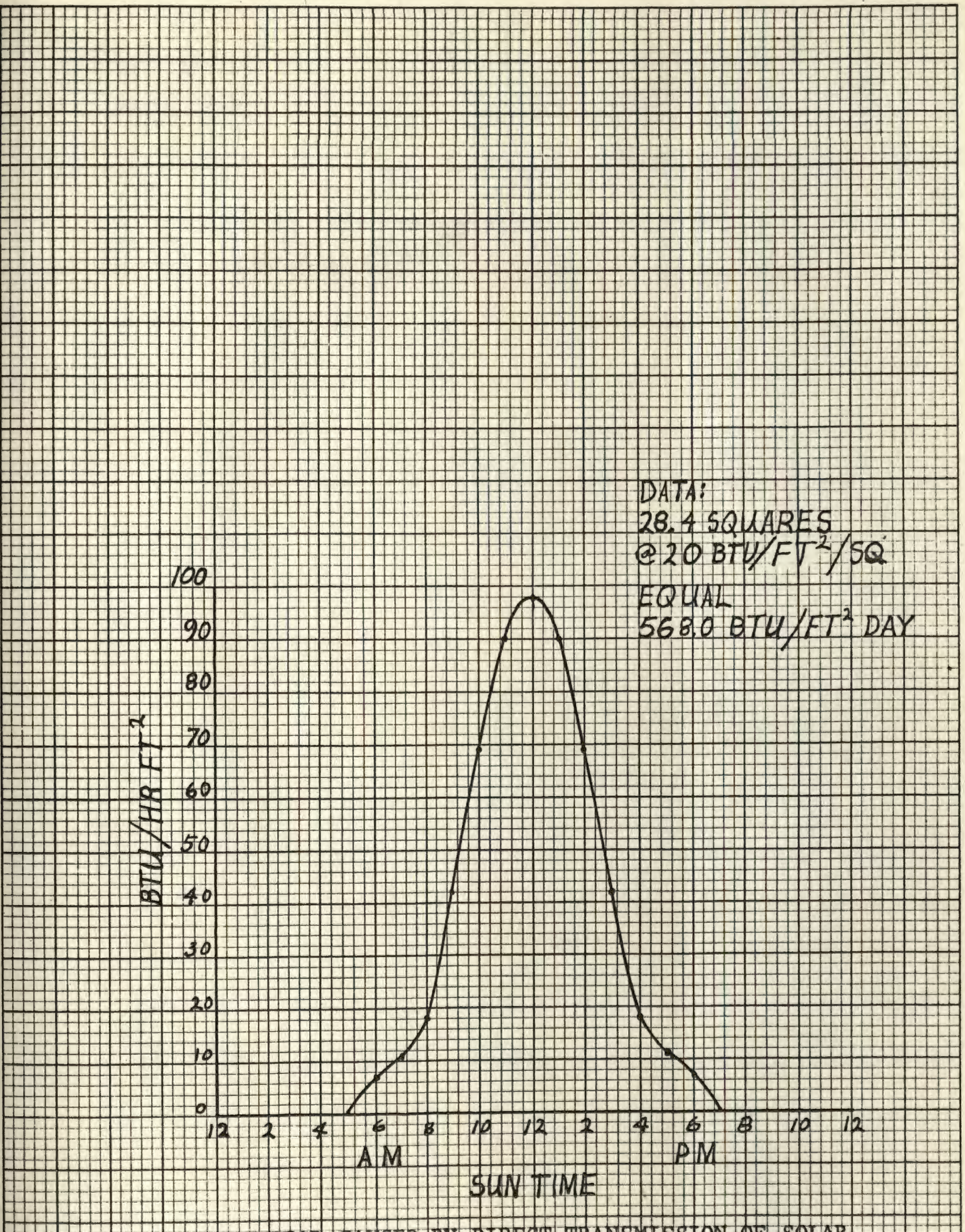
A. M.

Time	5	6	7	8	9	10	11	12
Uncorrected BTU/Ft^2 Hr	-6	-5	-5	-2	1	5	10	14
Corrections	+5	+5	+5	+5	+5	+5	+5	+5
Corrected Value BTU/Ft^2 Hr	-1	0	2	3	6	10	15	19

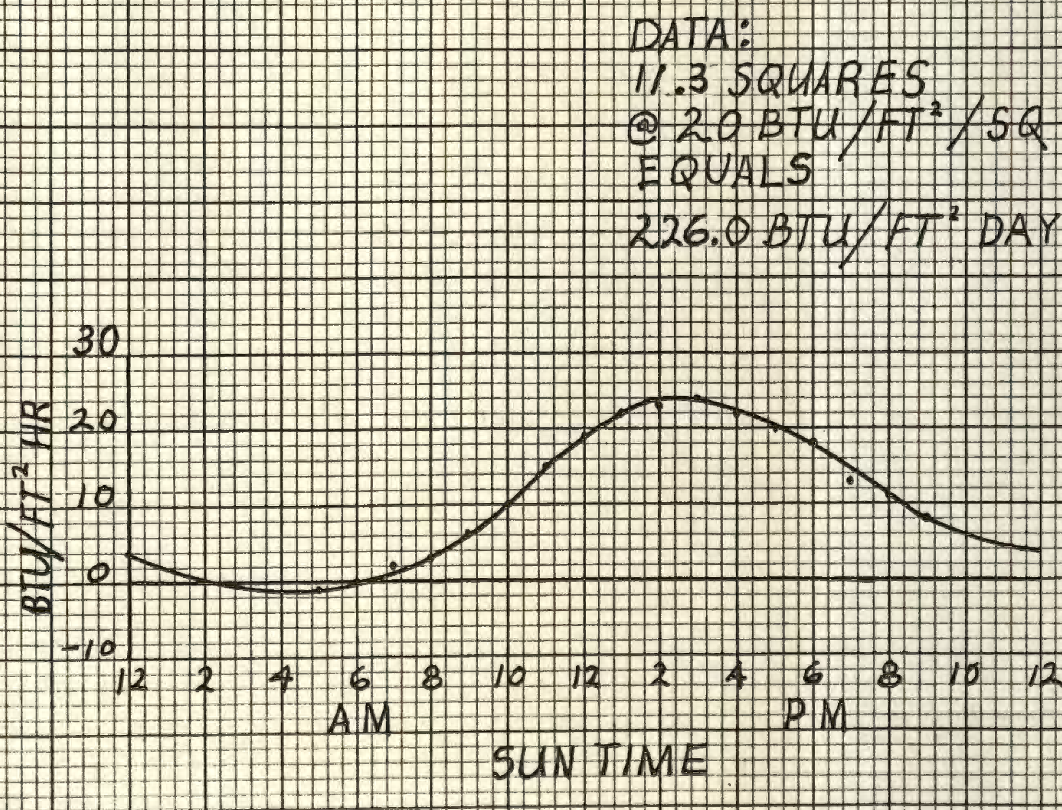
P. M.

Time	1	2	3	4	5	6	7	8	9
Uncorrected BTU/Ft^2 Hr	17	18	19	17	15	13	8	6	3
Corrections	+5	+5	+5	+5	+5	+5	+5	+5	+5
Corrected Value BTU/Ft^2 Hr	22	23	24	22	20	18	13	11	8

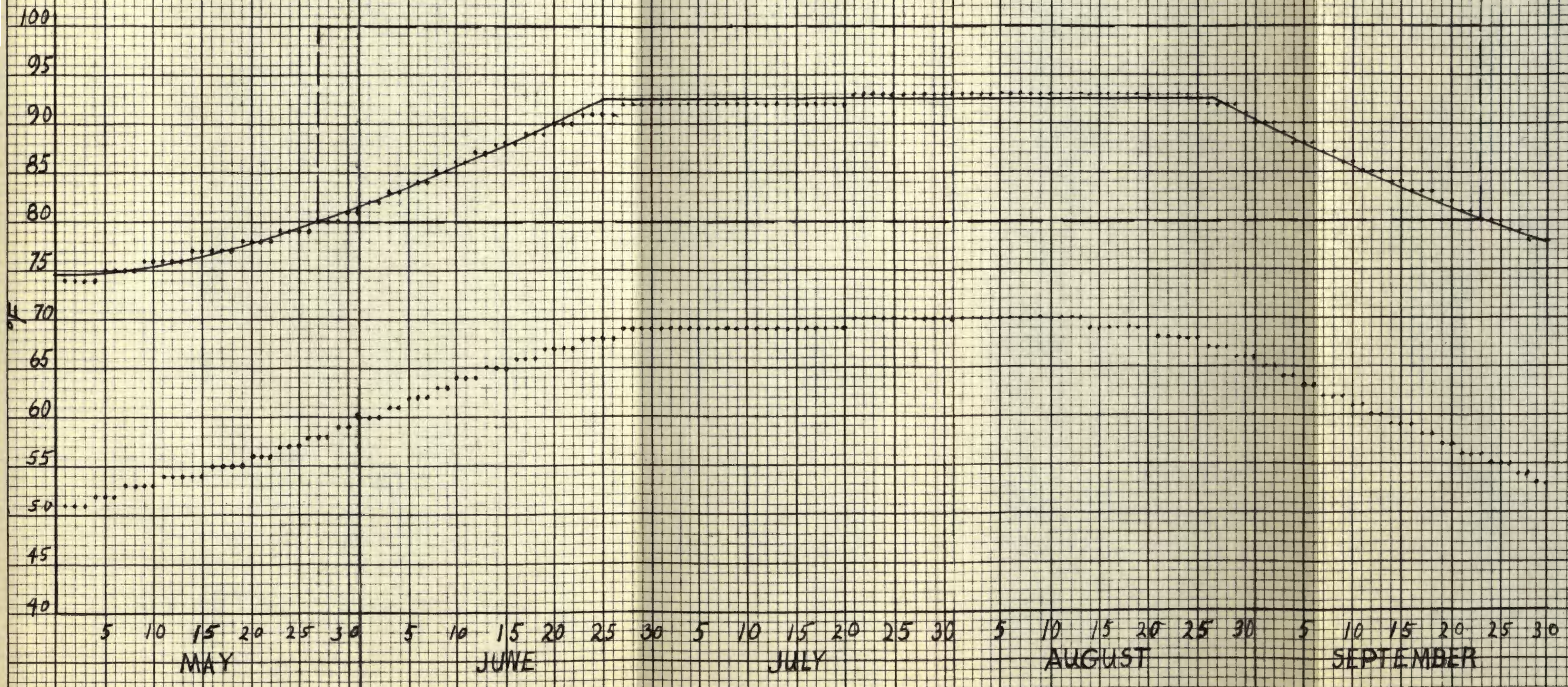
Note: The addition of 5 BTU/Ft^2 Hr to the tabulated values is in accordance with common practice (Ref. 12). The correction is for design conditions in excess of 95^{o}F.



CURVE 6 - HEAT LOAD CAUSED BY DIRECT TRANSMISSION OF SOLAR RADIATION - (Step 6)

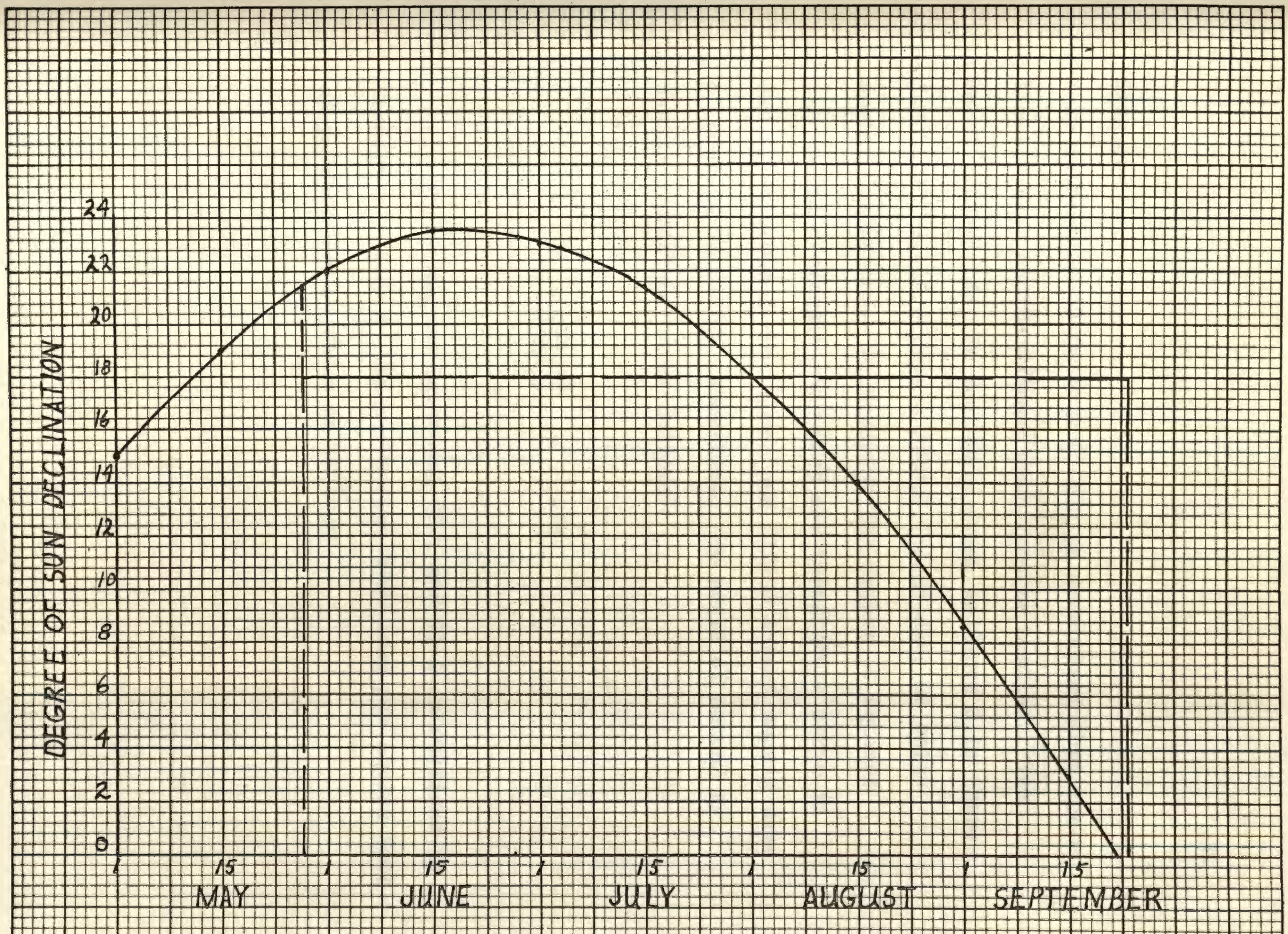


CURVE 7 - HEAT LOAD CAUSED BY CONVECTIVE HEAT TRANSFER ON GLASS (Step 6)



(Step 7)

CURVE V8.11 - CHRONOLOGICAL TEMPERATURE VARIATIONS OVER COOLING SEASON



CURVE 9 - CHRONOLOGICAL SUN DECLINATION OVER COOLING SEASON (Step 7)

Step 8:

By inspection of Curve 8 it can be determined that there are 119 days on the average that require cooling. The total area within the rectangle drawn on Curve 8 is therefore 20.0^{o} x 119.0 days = 2380.0 degree days at total design conditions. By counting the number of squares within the rectangle and under the temperature curve it can be determined that there are 1127.0 actual degree days of cooling required. Therefore, the ratio of actual to design conditions is as follows:

$$\frac{1127.0}{2380.0} = .473$$

Utilizing the Equations II-1 and II-2 as outlined in Chapter II, Step 8, the convective heat load per square foot of surface can be found as follows:

Roof:

Area under Curve 2 = 173.0 ^{o}F Hr/Days

Conductivity of the Roof = $.65 \frac{BTU}{Hr\ Ft^2\ {}^{o}F}$

Number of Cooling Days = $119 \frac{Days}{Season}$

Ratio of Actual to Design Conditions = .473

$$\frac{BTU}{Ft^2\ Season} = \frac{173\ {}^{o}F\ Hr}{Day}\ \frac{.65\ BTU}{Hr\ Ft^2\ {}^{o}F}\ \frac{119\ Days}{Season}\ (.473)$$

$$= 6{,}330.0 \frac{BTU}{Ft^2\ Season}$$

Walls:

Since the direction the walls face makes no difference as to the amount of heat gain by convection, one value will be computed for the brick walls and one value for the glass.

Brick:

$$\text{Area of Curve 5} = 172.8 \; \frac{{}^{\circ}F \; Hr}{Day}$$

$$\text{Conductivity of the Brick Walls} = .27 \; \frac{BTU}{Hr \; Ft^2 \; {}^{\circ}F}$$

$$\text{Number of Cooling Days} = 119 \; \frac{Days}{Season}$$

$$\text{Ratio of Actual to Design Conditions} = .473$$

$$\frac{BTU}{Hr \; Season} = \frac{172.8 \; {}^{\circ}F \; Hr}{Day} \; \frac{.27 \; BTU}{Hr \; Ft^2 \; {}^{\circ}F} \; \frac{119 \; Days}{Season} \; (.473)$$

$$= 2{,}620.0 \; \frac{BTU}{Ft^2 \; Season}$$

Glass:

$$\text{Area under Curve 7} = 226.0 \ \frac{\text{BTU}}{\text{Ft}^2\ \text{Day}}$$

$$\text{Number of Design Days} = 119 \ \frac{\text{Days}}{\text{Season}}$$

Ratio of Actual to Design Conditions = .473

$$\frac{\text{BTU}}{\text{Ft}^2\ \text{Season}} = \frac{226.0\ \text{BTU}}{\text{Ft}^2\ \text{Day}} \ \frac{119\ \text{Days}}{\text{Season}} \ (.473)$$

$$= 12{,}700.0 \ \frac{\text{BTU}}{\text{Ft}^2\ \text{Season}}$$

Step 9:

Utilizing the sun declinations shown in Curve 9, calculate the declination factor as follows:

Area under Declination Curve Inside Rectangle

= 126.5 Squares

Area within Rectangle = 140.4 Squares

$$\text{The Declination Factor} = \frac{126.5}{140.4} = .880$$

Utilize the following table (Ref. 10) for determining the cloud factor:

Month	Cloud Scale in Tenths		
	0 -3	4 - 7	8 - 10
April	39%	12%	14%
May	36	14	50
June	45	18	38
July	49	18	32
August	57	17	26
September	62	11	26
Average	48	15	37

Take the average of the range of cloud scale times the average occurrence and add the values to obtain the Composite Cloud Factor:

$$(.2)(.48) + (.55)(.15) + (.9)(.37) = .096 + .083 + .333$$

$$= .512 = \text{Composite Cloud Factor}$$

The cloud cover factor can then be obtained by taking one minus the composite cloud cover factor.

$$\text{Cloud Cover Factor} = (1 - .512) = .488$$

Utilizing Equations II-3 and II-4, calculate the heat gain due to radiation as follows:

Roof:

Area under Curve 1 = $406.0 \ \frac{{}^{o}F \ Hr}{Day}$

Conductivity of the Roof = $.65 \ \frac{BTU}{Hr \ Ft^2 \ {}^{o}F}$

Number of Cooling Days = $\frac{119 \ Days}{Season}$

Declination Factor = .880

Cloud Cover Factor = .488

$$\frac{BTU}{Ft^2 \ Season} = \frac{406.0 \ {}^{o}F \ Hr}{Day} \ \frac{.65 \ BTU}{Hr \ Ft^2 \ {}^{o}F} \ \frac{119 \ Days}{Season} \ (.880)$$

$$(.488) = 13{,}500.0 \ \frac{BTU}{Ft^2 \ Season}$$

Walls:

The North Wall will receive no heat gain due to solar radiation since it is in the shade. The amount received by the East and West Walls is as follows:

East Wall:

Area under Curve 3 = $95.6^{o}F$ Hr/Day

Conductivity of Walls = $.27 \; \frac{BTU}{Hr\ Ft^2\ {}^oF}$

Number of Cooling Days = $\frac{119 \text{ Days}}{\text{Season}}$

Declination Factor = .880

Cloud Cover Factor = .488

$$\frac{BTU}{Ft^2 \text{ Season}} \quad \frac{95.6^oF \text{ Hr}}{\text{Day}} \quad .27 \quad \frac{BTU}{Hr\ Ft^2\ {}^oF} \quad \frac{119 \text{ Days}}{\text{Season}}$$

$$(.880)(.488) = 1{,}320.0 \quad \frac{BTU}{Ft^2 \text{ Season}}$$

West Wall:

Area under Curve 4 = 94.0 ^{o}F Hr/Day

Conductivity of Wall = .27 $\frac{BTU}{Hr\ Ft^2\ {}^{o}F}$

Number of Cooling Days = $\frac{119\ Days}{Season}$

Declination Factor = .880

Cloud Factor = .488

$$\frac{BTU}{Ft^2\ Season} = \frac{94.0\ {}^{o}F\ Hr}{Day} \quad \frac{.27\ \ BTU}{Hr\ Ft^2\ \ {}^{o}F} \quad \frac{119\ Days}{Season}$$

$$(.880)\ (.488) = 1,300.0 \quad \frac{BTU}{Ft^2\ Season}$$

Radiation through Glass can be found as follows:

Area under Curve 6 = 568.0 $\frac{BTU}{Ft^2 \ Day}$

Number of Cooling Days = $\frac{119 \ Days}{Season}$

Declination Factor = .880

Cloud Factor = .488

$$\frac{BTU}{Ft^2 \ Season} = 568.0 \ \frac{BTU}{Ft^2 \ Day} \ \frac{119 \ Days}{Season}$$

$$(.880)\ (.488) = 29{,}000 \ \frac{BTU}{Ft^2 \ Season}$$

SUMMARY

In summary, the following values were calculated:

Roof:

Convection	6,330.0	$\frac{BTU}{Ft^2\ Season}$
Radiation	13,500.0	$\frac{BTU}{Ft^2\ Season}$

Walls:

East:

Convection	2,620.0	$\frac{BTU}{Ft^2\ Season}$
Radiation	1,320.0	$\frac{BTU}{Ft^2\ Season}$

North:

Convection	2,620.0	$\frac{BTU}{Ft^2\ Season}$
Radiation	0	

SUMMARY (Cont'd)

West:

Convection	2,620.0	$\frac{BTU}{Ft^2\ Season}$
Radiation	1,300.0	$\frac{BTU}{Ft^2\ Season}$

South (All Glass):

Convection	12,700.0	$\frac{BTU}{Ft^2\ Season}$
Radiation	29,000.0	$\frac{BTU}{Ft^2\ Season}$

CHAPTER IV

VALIDITY OF PROPOSED METHOD

In order to check the accuracy of the proposed method of calculating the seasonal cooling loads, the Kansas Gas and Electric Company was contacted for available cooling cost information on air-conditioning systems presently in operation. The only available cost figures were on annual operating costs of all electrical usage. However, considering that air-conditioning will occur during the months of May, June, July, August and September, and that the air-conditioning costs are added to a reasonably stable electrical load, the difference between the average of months from October through April and the air-conditioning months will give an approximate cooling cost figure.

It was found that for a building of 167,000 Ft^2 of floor space the cost of cooling will be about \$4,119.87. The cost of electricity in the quantities being purchased by a building of this size is approximately \$.016/Kw-Hr.

Therefore, $\dfrac{\$4,119.87}{\$.016/\text{Kw-Hr}} = 257{,}000$ Kw-Hr.

Converting this figure to BTU/Sq.Ft. and at the same time disallowing a 20% factor for air handling, the cooling required per square foot should be as follows:

$$(257{,}000 \text{ Kw-Hr})(3{,}412 \ \frac{\text{BTU}}{\text{Kw-Hr}})(\frac{1}{167{,}000 \text{ Ft}^2})(.80)$$

$$= 4200 \ \frac{\text{BTU}}{\text{Ft}^2}$$

Utilizing the proposed method of cooling load determination, find the load per square foot for a twelve-story structure. The structure shall have a 100 ft. square base and 10 foot per story.

	BTU/Season
Roof	
Convection	63,300,000
Radiation	135,000,000
Walls	
East:	
Convection	31,400,000
Radiation	15,850,000
West:	
Convection	31,400,000
Radiation	15,600,000
North:	
Convection	31,400,000
Radiation	0
South (Glass):	
Convection	76,400,000
Radiation	174,000,000
TOTAL -	574,300,000 BTU/Season

Note: The load values for the southern exposure were divided by .5 since the southern glass exposure of the building used for validation is known to be much less than one-half the total area.

By dividing this value by 120,000 Ft^2, we find that the cooling load per Ft^2 is 4,780 BTU/Ft^2.

This value of 4,780 BTU/Ft^2 will compare favorably with the actual load figure of 4,200 BTU/Ft^2 if consideration is given to the fact that the actual figures are for a building of much heavier construction.

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