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Weather Analysis for Crop Drying

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COLUMBIA, MISSOURI

CONTENTS

SUMMARY

Frequency distributions of information pertinent to crop drying are presented for Columbia, Mo. A method has been outlined by which punched cards carrying hourly weather data may be processed to obtain information used in designing crop drying equipment.

Frequency distributions are shown for air that has been unheated and for air that has been heated to increase the dry-bulb temperature by 15°F and 25°F.

Information that can be obtained from the frequency distributions consists of:

(a) The amount of heat that would be expected to be avaialble in the air during various calendar periods when a crop of a given moisture content is expected to be dried.

(b) The expected temperature of the undried portion of the crop during the drying process.

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INTRODUCTION

As research concerning crop drying has progressed, the need for detailed information regarding the effect of weather has become more and more apparent. The design of crop drying equipment, especially that type of equipment associated with in-storage drying, is dependent on expected weather conditions during the drying operation.

In recent years several investigators have analyzed weather data as it pertains to crop drying. Schmidt and Waite have published maps of the United States showing mean and standard deviations of wet bulb temperatures and mean wet bulb depressions for each month of the year (14). Schmidt and Hukill have made an analysis of wet bulb depression from weather data for the state of Iowa (13). Zachariah and Lipper investigated the crop drying potential of weather at Topeka, Kans. (17). Schaper, Isaacs and Dale evaluated the heat available for drying in natural air using data from various locations in Indiana (12).

This bulletin presents results of an analysis of Columbia, Mo., weather data. The data have been processed to determine and statistically analyze two variables associated with drying crops with in-storage drying equipment. The variables are: (a) the capacity that the air has to receive and carry off moisture when forced through the stored crop, and (b) the temperature of the undried portion of the crop mass during the drying process.

THE DRYING PROCESS

Farm crops (hay and grain) consist of hygroscopic material and when the vapor pressure of the moisture in the crop and the vapor pressure of the water in the air are equal, there is no moisture transfer between the crop and the air. The moisture content of the crop when it is in equilibrium with the surrounding atmosphere is called the equilibrium moisture content. Likewise, the relative humidity of the surrounding atmosphere is called the equilibrium relative humidity at the existing temperature (4).

Figure 1* is a cross-sectional sketch of a crop storage structure equipped for drying. Air is forced into a plenum chamber beneath the crop mass; it moves upward through a perforated floor, through the crop, and exits at the top surface. The drying process may require several days or weeks. The sketch indicates three zones that exist in a crop mass at any intermediate time between the beginning and end of the process.

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*See Appendix for figures and tables.

Zone B is the drying zone, and in this zone some of the moisture in the crop is being transferred to the air. Zone B is established at the bottom of the bin in the beginning hours of the drying period and moves up through the crop until it reaches the surface. The crop below zone B is dry and transfers no moisture to the drying air. The dried crop forms zone A. (For a complete discussion of the drying zone see references 4 and 8.)

The crop in zone C has not begun to dry and, therefore, has its original moisture content. Air leaving the top of the bin has a relative humidity that is the same as the equilibrium relative humidity of the original grain moisture content. For the purposes of this bulletin the term "equilibrium relative humidity" will be assocated with the *undried* portion of the grain mass (original moisture content).

The equilibrium relative humidity is a function of grain temperatures as well as grain moisture. For example Hall and Rodriquez-Arias (5) found that corn at a moisture content of 16.7 percent (wet basis) would have equilibrium relative humidities of 82, 87, and 89 percent for corn temperatures of 60, 80, and 100°F, respectively.

The crop in the structure and the entering air may be considered an isolated system from the standpoint of heat transfer. Farm crops have some insulation value and temperature changes of the ambient air outside the structure would have an appreciable effect on only that crop within an inch or two of the outside walls when air is passing through the mass.

Sensible heat that might be brought into the structure with the crop mass will have a negligible effect on the drying process for two reasons. First, the crop will be very near to ambient air temperature at the time of harvest and, therefore, can not be cooled to any extent when the same ambient air is forced through the mass. Second, the amount of sensible heat that could be utilized is negligible when compared to the total heat required to dry the crop. For example, cooling a bushel of grain 10°F may release 300 Btu of sensible heat for drying purposes, which would remove something less than 0.3 pounds of water. Drying shelled corn from 24 to 17 percent moisture (wet basis) requires the removal of 8.4 pounds of water per bushel.

The assumption that there is no external heat source indicates that the process of water removal in zone B (Fig. 1) could be considered adiabatic. Some heat might be expected from respiration, but the amount that would be available through respiration from grain that is kept relatively cool would be negligible (1, 11). However, heat available due to respiration of hay should not be neglected when hay drying systems are designed.

Another factor that influences the drying process is the amount of heat required to evaporate a pound of moisture from crops. This is very nearly the same as that required to evaporate a pound of water from a free water surface when crop moisture contents are relatively high. For relatively dry grains (12 percent moisture, wet basis), the heat required to vaporize a pound of water from the grain may be 10 to 13 percent higher than that required to evaporate a pound of water at a free water surface (9, 16).

While factors mentioned above must be noted when the drying process is analyzed, they are difficult to evaluate quantitatively and for practical purposes they can be considered negligible (6). The drying process is then adiabatic, and since the heat of vaporization must come from the sensible heat in the air, the process is considered to be accomplished at a constant wet bulb temperature (7). Air passing through the drying zone is considered to be cooled at a constant wet bulb temperature until the air relative humidity is equal to the equilibrium relative humidity corresponding to the moisture content and temperature of the grain in zone C.

MATHEMATICAL MODEL

An air and water vapor mixture passing through the stored crop will undergo a change to the extent that moisture is added to or taken from the mixture, with a simultaneous decrease or increase in dry bulb temperature. Since the process is considered to be adiabatic, and taking place at a constant wet bulb temperature, the path of the change will follow a constant wet bulb temperature line on a psychrometric chart (3).

The punched cards prepared by the U.S. Weather Bureau and used in this study carried (with other data) the wet-bulb and dry-bulb temperatures. The difference in these temperatures (wet-bulb depression) can be used as a measure of the drying potential of the air if the equilibrium relative humidity is 100 percent. However, if the equilibrium relative humidity is below 100 percent, the dry-bulb temperature of air passing through a crop will change (at constant wet-bulb temperature) until the equilibrium relative humidity state is reached. If the temperature at this point is called t_x ("equilibrium" temperature) and the original dry-bulb temperature is called t, then $(t - t_x)$ can be used as an index of moisture transfer potential. When this difference is positive, the crop is being dried, and when the difference is negative, moisture is being added to the crop.

For any given wet-bulb temperature and equilibrium relative humidity, t_x is located (referring to the psychrometric chart) on the wet-bulb temperature line at the point where this line crosses the line representing the equilibrium relative humidity. Calculation of t_x involves the solution of simultaneous equations that represent the wet-bulb temperature lines and the relative humidity lines on the psychrometric chart, given initial dry bulb and wet bulb temperatures.

The wet-bulb line equation selected for this study is (2):

$$p = p_w - (P - p_w) \frac{C_p}{L'E} (T - T_w) \tag{1}$$

where

p = pressure of water vapor, millibars;
P_w = saturation pressure of water vapor at temperature T_w, millibars;

P = atmospheric pressure, assumed to be = 1013.125 millibars;
C_p = specific heat of dry air, 0.2369 calories per gram per degree C;
L′ = heat of vaporization of water at T_w, calories per gram (Heat of sublimation when T_w is less than 273.16 deg K);
E = specific gravity of water vapor, 0.6225;
T = dry-bulb temperature, deg K; and
T_w = wet-bulb temperature, deg K.

The relative humidity line equation selected is (10):

$$p = 0.01\varphi e^{(A - B/T - C\ln T)} \tag{2}$$

where

p = pressure of water vapor, millibars;
φ = equilibrium relative humidity (percent);
T = dry-bulb temperature, deg K;
e = base of natural logarithms; and
A, B, and C are constants.

For $T > 273.16$ deg K;
A = 56.8104;
B = 6887;
C = 5.31.

For $T \leq 273.16$ deg K;
A = 27.2197;
B = 6258.3;
C = 0.445.

The solution of the simultaneous equations was accomplished with an electronic computer, using a relaxation technique similar in form to Newton's method. A value of t_x was estimated and the equation of the tangent to the relative humidity line at the estimated value of t_x was determined. This equation and the equation of the wet-bulb line being considered were solved simultaneously for a "better" estimated value of t_x. This process was repeated until there was no appreciable change in successive calculated values of t_x. The first estimate of t_x used in each case was the wet-bulb temperature. The last operation of the computer converted the values of t_x from degree Kelvin to degrees Fahrenheit.

When t_x is plotted as a function of t_w (wet-bulb temperature, deg F) for a particular equilibrium relative humidity, the relationship is shown to be essentially linear within a temperature range of 15 to 100°F. (Fig. 1).

The mathematical model or expression for t_x is then

$$t_x = a + b\, t_w \tag{3}$$

The values of the constants a and b are dependent on the equilibrium relative humidity. Table 1 lists the numerical values of these constants for equilibrium relative humidities of 50, 60, 70, 80, 90, and 100 percent. Fig. 2 is a plot of "equilibrium" temperature (t_x) versus wet bulb temperature (t_w) for the same equilibrium relative humidities.

Systems that dry crops in storage may use natural (unheated) air or may use air that has been tempered by the addition of supplemental heat. Two levels of supplemental heat were included in this study. The dry-bulb air temperature was increased 15°F for one level and 25°F for the other. New wet-bulb temperatures resulting from the increase in the dry-bulb temperature can be expressed by the following empirical equations:

$$t'_w = 10.7 + 0.91\ t_w \qquad (4)$$

$$t''_w = 17.5 + 0.85\ t_w \qquad (5)$$

where t'_w is the computed wet-bulb temperature when the air temperature is increased 15°F and t''_w is the computed wet bulb value when the temperature increase is 25°F. These expressions represent lines fitted to data obtained graphically from the psychrometric chart. Substantially correct values were obtained for a range of wet-bulb temperatures of 20°F to 90°F. Wet-bulb temperatures calculated by their use may be in error by 1° when original wet-bulb temperatures are below 32°F. Figure 3 is a plot of equations 4 and 5.

Two categories of output were computed. First, the temperature change that would take place if the air were passed through a crop mass was computed to estimate the capacity of the air to evaporate moisture. Second, the temperature the air would have as it left the crop was computed. This can be considered to be the temperature of the undried portion of the crop mass. Crop mass temperature is an important factor in estimating the time in which the crop may mold or otherwise deteriorate.

The expression for the temperature change in the air passing through the crop mass $(t - t_x)$ can be expanded by combining equations 3, 4, and 5, and becomes

for unheated air: $t - (a + b\ t_w)$ (6);

for air temperature increased 15°F: $(t + 15) - [a + b(10.7 + 0.91\ t_w)]$ (7);
and

for air temperature increased 25°F: $(t + 25) - [a + b(17.5 + 0.85\ t_w)]$ (8).

Values of $(t - t_x)$ for each hour of the day for the three air conditions, and for each of the six values of equilibrium relative humidities were computed. The machine output was the sum of the 24 hourly values.

An expression for the Btu per pound of air available for drying (24 hour average) is

$$\frac{\sum_{1}^{24} (t - t_x)\ (0.24)}{24}$$

where 0.24 is the specific heat of the air in Btu per pound of air per degrees F. Daily average values so obtained were entered on punched cards.

The second category of output was the average temperature the undried portion of a crop mass would have if the air were forced through the mass. The second term in equations 6, 7, and 8 expresses this temperature. Daily averages, based on the 24 hourly values, were computed for each of the air conditions and equilibrium relative humidities. These values were entered on the same cards (chronologically arranged) as were the data for available drying capacity. Card-sorting machines were used to prepare frequency distributions from these data.

EXTENT OF STUDY

Input data in this study were hourly values of temperature on Weather Bureau punched cards, covering 25 years of record, beginning in 1934 and ending in 1959, at Columbia, Mo.

For some of the early years of the study the punched cards carried dry-bulb and dew-point temperatures, but did not include wet-bulb temperature. A standard Weather Bureau program was used to carry out calculations of wet bulb temperatures on these older cards. The same program is currently used by the Weather Bureau to process weather data coming from stations where remote equipment is used that yields only dew-point and dry-bulb temperatures.

DISCUSSION OF DATA

Frequency distributions are presented in Tables 2 through 14, and sample plots of the data are presented in Figures 4 through 27.

Each table lists the frequency distribution of the daily average value of the factor indicated. The distributions are listed for each month of the period from May through November. The tables are divided into three portions; the distributions for natural (unheated) air, and the distributions considering the air to be heated to increase the dry bulb temperature 15°F and 25°F.

Since 25 years of data were used, the distributions are of 750 or 775 (depending on the number of days in the month) daily averages.

Table 2 shows the distribution of daily average relative humidity. This table not only shows the seasonal variation of daily average relative humidity, but shows the effect of heating the air so that its dry bulb temperature is increased 15°F and 25°F. With the dry bulb temperature increased only 15°F, there are very few occurrences of daily average humidities above 60 percent. When the air temperature is increased 25°F, the daily average is seldom over 45 percent.

This table can be compared to equilibrium moisture-relative humidity data for any farm crop at a given moisture content to determine the probability that air conditions are such that drying can be accomplished with unheated air. It also provides information that can be compared to the equilibrium data to determine the probability that a given final moisture of the crop being dried can be obtained. The probability of overdrying when the air temperature is increased by the use of supplemental heat can also be obtained from Table 2.

Tables 3 to 8 inclusive carry the distributions of the heat available for drying, per pound of air, for various equilibrium relative humidities. For example, Table 3 indicates the probability that there will be available for drying a certain number of Btu's per pound of air supplied to a crop that has a moisture content and temperature such that the equilibrium relative humidity is 100 percent. Stated in another way, if the air passing through a crop at some moisture content and temperature leaves the top of the crop mass at 100 percent relative humidity, then the probability of there being a certain amount of heat available per pound of air for drying is given in Table 3.

Tables 4 to 8 give the same type of information as given in Table 3 for relative humidities of 90, 80, 70, 60, and 50 percent.

These tables are useful in choosing air flow rates when crop drying equipment is designed. For example, suppose that hay with a moisture content and temperature in equilibrium with air at 100 percent relative humidity is to be dried using unheated air. Suppose further that the equipment is designed to finish the drying process within a chosen time limit if a daily average of 1.1 Btu's per pound of air is available each day of the drying period. Table 3 shows that in May we can expect to find daily averages of less than 1.1 Btu's per pound of air available 20.4 percent of the time. In this case, the designer has the option of providing more air flow or of having the drying time extended past his selected time limit approximately one-fifth of the time.

Figures 4 through 10 are plots of the frequency distribution of the daily averages of heat available for drying per pound of air for the seven months of the study. These particular figures are for an equilibrium relative humidity of 70 percent. Figures 11 through 17 are plots of similar distributions for an equilibrium realtive humidity of 100 percent. The figures carry the same data found on the corresponding tables and are given as sample plots and also to show graphically the effect of adding supplemental heat to the drying air.

Tables 9 to 14 inclusive carry the distributions of the daily average of the temperature of the undried portion of the crop mass. This is the temperature referred to previously as t_x.

Data in these tables are also useful in the design of crop drying equipment. Time limits set on the drying operation are dependent on the temperature of the undried crop mass during the drying period. Mold growth and deterioration are a function of the temperature as well as the moisture content of a crop (15). The crop equipment design engineer can use these tables to estimate the percentage of time the crop temperature may exceed a chosen design temperature.

Steele and Saul (15) show that as grain temperature increases from 65°F to 80°F the deterioration rate is increased by more than 50 percent. The tables show that when the drying air is heated 15°F and 25°F that the chances for exit temperatures of 80°F or higher are considerably greater than with natural air.

The faster deterioration with higher drying temperatures may be offset by the increased drying rate resulting from the fact that more heat is available for drying when the drying air is heated. These two factors must be balanced by the designer in selecting air flow rates.

Figures 18 through 24 are plots of the frequency distribution of daily average "equilibrium" temperatures for May through November. These plots are for an equilibrium relative humidity of 70 percent. Figures 25 through 31 are similar plots of distribution for an equilibrium relative humidity of 100 percent. These figures are sample plots of data found in Tables 9 through 14. These plots not only show the distribution graphically, but show the marked effect of adding supplemental heat.

A word of caution should be added to the discussion of these data. It should be understood that theoretical conditions may not always be obtained in drying operations. The actual temperature drop $(t - t_x)$ may not be as high as indicated theoretically. If this happens, the "equilibrium" temperature will be higher than indicated theoretically and the heat available for drying will be less than indicated theoretically. These possibilities can be compensated for by reasonable factors of safety in design values. It should also be remembered that the data presented here are based on 25 years of weather records at Columbia, Mo. They may not be representative of drying conditions in other geographic areas.

APPENDIX

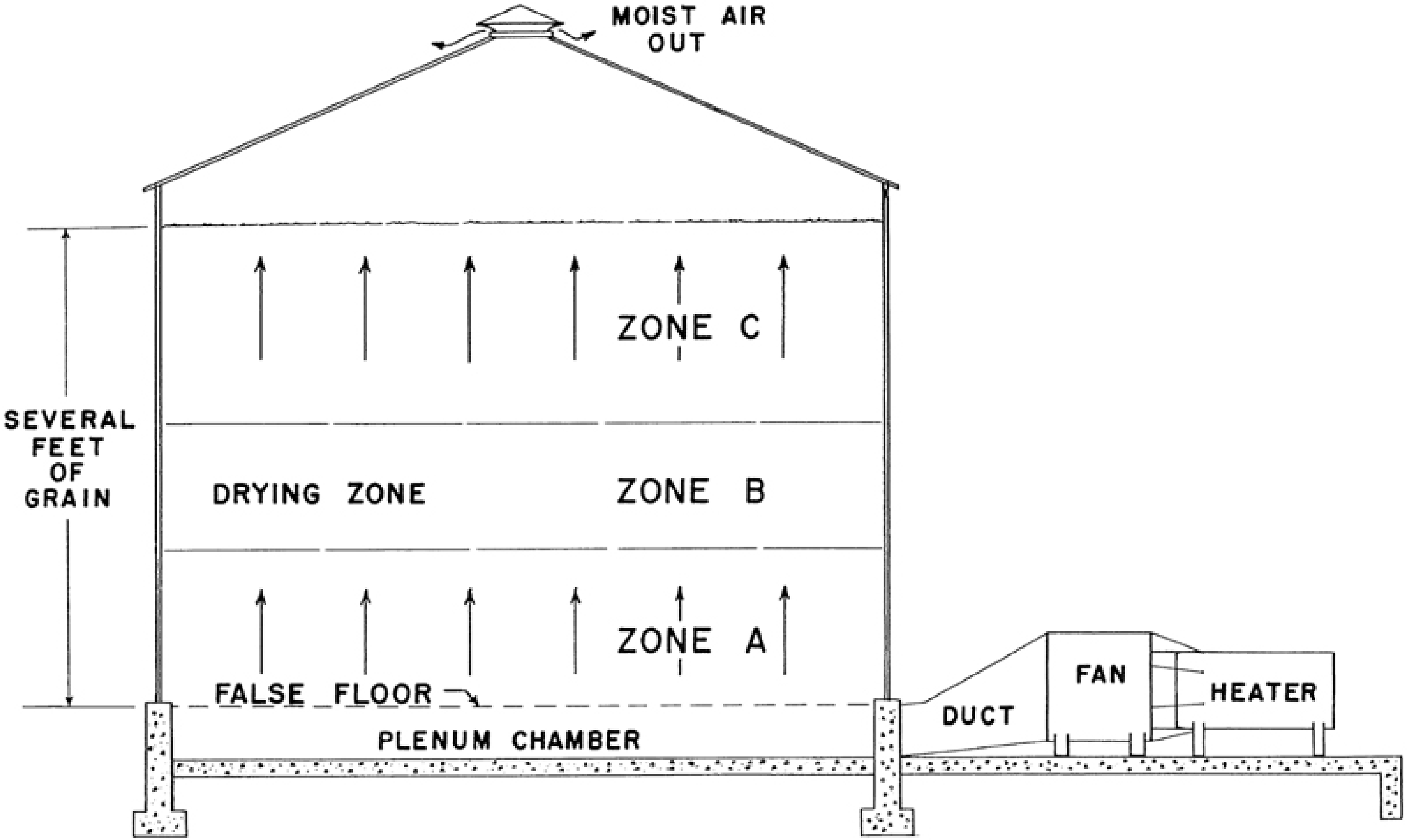

Fig. 1 – A typical farm grain drying system. Heated or unheated air from the fan is forced into a plenum chamber, through a perforated metal false floor, and up through the grain. Zone B is a drying zone that is formed early in the drying period and "moves" from the bottom to the top of the bin.
Grain in Zone A is dry, and grain in Zone C has not yet begun to dry.

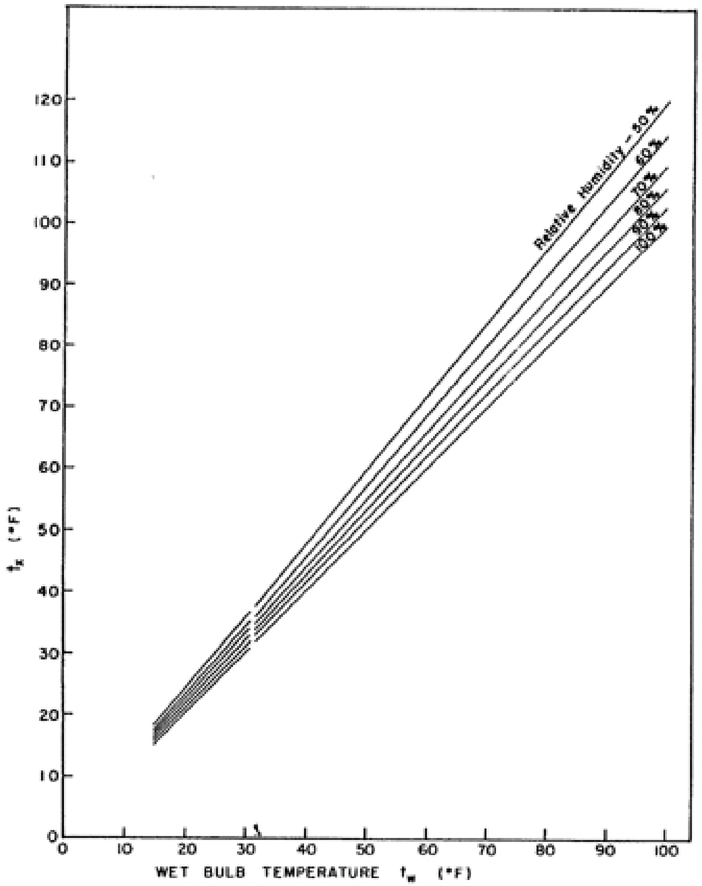

Fig. 2 - "Equilibrium" temperature (t_x) is the dry bulb temperature at the intersection of wet bulb temperature (t_w) lines and relative humidity lines on the psychrometric chart. Here, t_x is shown as a function of t_w and relative humidity.

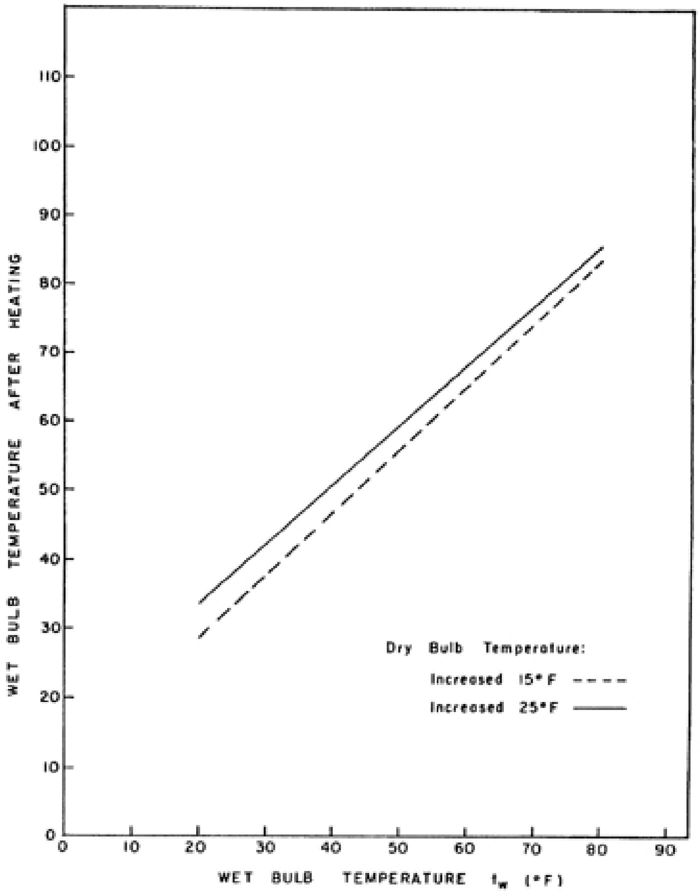

Fig. 3 - Air that has been tempered by increasing the dry bulb temperature will have a higher wet bulb temperature after it is heated. The approximate relation between the wet bulb temperatures before and after the addition of heat is shown.

TABLE 1 - VALUES OF THE CONSTANTS a AND b USED IN THE CALCULATION OF "EQUILIBRIUM" TEMPERATURE (t_x)

Equilibrium Relative Humidity	t>32 F		t≤32 F	
	a	b	a	b
50	-0.6618	1.2094	0.8812	1.1698
60	-0.1573	1.1503	0.7730	1.1259
70	0.0812	1.1025	0.6177	1.0881
80	0.1523	1.0628	0.4309	1.0552
90	0.1130	1.0291	0.2226	1.0260
100	0.0000	1.0000	0.0000	1.0000

TABLE 2 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE RELATIVE HUMIDITY COLUMBIA, MISSOURI, 1934-1959

	Class Intervals of Percent Relative Humidity																			
Month	0.0 to 5.0	5.1 to 10.0	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0
Dry Bulb Temperature Unchanged																				
May								0.5	3.0	5.3	8.9	10.1	13.3	14.0	13.0	12.5	7.8	6.5	3.7	1.4
June							0.4	0.3	1.7	1.5	4.9	7.7	13.2	16.1	15.7	14.0	13.5	7.6	3.1	0.3
July						0.1	1.5	3.4	3.5	3.5	4.5	9.1	14.4	17.1	15.2	13.2	8.0	4.3	1.7	0.5
Aug.						0.1	0.7	1.4	1.8	2.7	4.9	10.4	13.0	19.5	17.4	12.5	7.4	4.3	3.2	0.7
Sept.						0.3	0.7	1.2	2.6	7.2	7.6	8.3	12.8	15.6	14.2	9.0	7.4	6.8	5.1	1.2
Oct.					0.4	0.4	1.1	1.9	3.6	7.4	8.5	11.7	15.1	15.1	12.0	4.6	7.0	5.2	4.0	2.0
Nov.					0.1	0.1	0.5	0.6	2.7	4.1	6.2	12.6	14.0	16.6	11.4	10.3	7.4	5.6	4.5	3.3
Dry Bulb Temperature Increased 15°F																				
May					1.0	7.6	15.2	23.3	22.3	17.5	10.5	2.3	0.2			0.1				
June				0.3	0.7	2.4	8.1	19.9	25.8	24.4	15.1	2.4		0.1	0.4	0.3	0.1			
July				0.3	5.0	5.2	8.0	19.8	28.4	22.0	9.3	1.8		0.1		0.1				
Aug.				0.3	2.1	3.6	7.7	21.5	31.4	21.0	9.3	2.9	0.1			0.1				
Sept.				0.4	2.4	9.2	13.2	21.8	23.0	15.1	11.2	3.6	0.1							
Oct.			0.4		1.2	3.4	11.2	17.7	25.5	18.8	9.7	8.1	4.0							
Nov.			0.1	0.5	2.4	8.1	19.2	27.6	19.5	12.4	7.6	2.6								
Dry Bulb Temperature Increased 25°F																				
May				6.3	19.5	30.9	25.5	15.7	1.9				0.1	0.1						
June			0.3	1.9	7.5	27.7	34.1	25.1	2.5	0.1	0.4	0.4								
July			0.3	7.2	10.5	32.1	33.5	14.3	1.8	0.1	0.1			0.1						
Aug.			0.4	3.2	9.0	28.9	39.8	15.4	3.1		0.1			0.1						
Sept.			0.4	5.6	19.7	31.2	22.6	17.4	3.1											
Oct.		0.3	1.9	8.6	23.8	34.0	15.7	12.5	3.2											
Nov.		0.1	0.6	6.3	27.1	35.7	18.7	9.7	1.8											

TABLE 3 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE BTU PER POUND OF AIR AVAILABLE FOR DRYING WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 100%

	Class Intervals of Btu Per Pound of Air																	
Month	-6.9 to -6.0	-5.9 to -5.0	-4.9 to -4.0	-3.9 to -3.0	-2.9 to -2.0	-1.9 to -1.0	-0.9 to 0.0	0.1 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 to 4.0	4.1 to 5.0	5.1 to 6.0	6.1 to 7.0	7.1 to 8.0	8.1 to 9.0	9.1 to 10.0	10.1 to 11.0
Dry Bulb Temperature Unchanged																		
May								20.4	45.7	29.5	4.3	0.1						
June								20.7	44.6	26.8	6.0	1.6	0.3					
July								14.7	38.9	31.0	8.0	4.9	2.4	0.1				
Aug.								10.9	44.6	32.0	8.7	3.2	0.6					
Sept.								18.7	42.3	27.4	9.6	1.4	0.6					
Oct.								23.0	47.0	23.5	6.3	0.2						
Nov.								49.4	41.8	8.3	0.5							
Dry Bulb Temperature Increased 15°F																		
May										11.5	38.8	38.2	10.6	0.9				
June										4.5	33.7	44.9	12.7	3.3	0.9			
July										0.8	20.8	46.2	19.8	7.7	3.9	0.8		
Aug.										2.5	23.1	45.8	21.6	4.3	2.4	0.3		
Sept.										9.3	32.5	38.2	15.3	3.7	1.0			
Oct.										18.9	42.3	28.1	9.7	1.0				
Nov.									10.8	48.9	30.8	9.0	0.5					
Dry Bulb Temperature Increased 25°F																		
May											2.3	21.8	45.7	26.3	3.6	0.3		
June											0.1	13.3	40.5	34.8	8.4	2.5	0.4	
July												3.1	29.2	43.3	14.1	6.3	3.4	0.6
Aug.												5.3	33.9	40.6	14.7	3.6	1.8	0.1
Sept.											0.6	18.1	41.3	26.7	10.7	1.9	0.7	
Oct.											5.1	35.0	37.9	18.3	3.6	0.1		
Nov.									0.1	6.5	37.8	35.8	17.2	2.3	0.3			

TABLE 4 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE BTU PER POUND OF AIR AVAILABLE FOR DRYING WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 90%

Month	Class Intervals of Btu Per Pound of Air																	
	-6.9 to -6.0	-5.9 to -5.0	-4.9 to -4.0	-3.9 to -3.0	-2.9 to -2.0	-1.9 to -1.0	-0.9 to 0.0	0.1 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 to 4.0	4.1 to 5.0	5.1 to 6.0	6.1 to 7.0	7.1 to 8.0	8.1 to 9.0	9.1 to 10.0	10.1 to 11.0
	Dry Bulb Temperature Unchanged																	
May							4.0	34.7	43.4	16.1	1.8							
June							2.8	37.6	43.5	12.3	3.0	0.8						
July							1.3	25.4	44.8	16.3	7.9	3.6	0.7					
Aug.							2.9	25.4	45.9	19.5	3.9	2.1	0.3					
Sept.							5.4	26.2	43.8	18.5	5.0	1.1						
Oct.							6.0	31.4	44.5	16.3	1.7	0.1						
Nov.							8.3	58.4	29.4	3.8	0.1							
	Dry Bulb Temperature Increased 15°F																	
May									2.1	27.1	43.9	23.4	3.4	0.1				
June									0.1	20.8	44.6	26.9	5.7	1.6	0.3			
July										8.1	38.1	36.6	9.5	5.2	2.4	0.1		
Aug.										10.1	44.0	32.5	9.5	3.1	0.8			
Sept.									0.4	19.9	44.7	24.6	8.6	1.5	0.3			
Oct.									1.9	32.8	42.5	19.1	3.6	0.1				
Nov.								0.1	25.3	48.5	22.4	3.6	0.1					
	Dry Bulb Temperature Increased 25°F																	
May											9.5	34.2	41.2	13.7	1.4			
June										0.1	1.6	28.8	45.5	18.8	4.1	1.1		
July											1.3	14.9	44.7	25.4	7.9	4.3	1.5	
Aug.											0.8	17.8	47.0	25.9	5.0	3.1	0.4	
Sept.											7.1	31.5	39.9	16.5	4.0	1.0		
Oct.											16.4	39.8	31.6	11.2	1.0			
Nov.									2.0	32.4	40.3	20.8	4.1	0.4				

TABLE 5 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE BTU PER POUND OF AIR AVAILABLE FOR DRYING WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 80%

	Class Intervals of Btu Per Pound of Air																	
Month	-6.9 to -6.0	-5.9 to -5.0	-4.9 to -4.0	-3.9 to -3.0	-2.9 to -2.0	-1.9 to -1.0	-0.9 to 0.0	0.1 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 to 4.0	4.1 to 5.0	5.1 to 6.0	6.1 to 7.0	7.1 to 8.0	8.1 to 9.0	9.1 to 10.0	10.1 to 11.0
Dry Bulb Temperature Unchanged																		
May							17.0	44.1	32.5	6.3	0.1							
June							21.5	44.7	26.3	5.7	1.7	0.1						
July							11.2	41.8	31.3	8.4	5.5	1.8						
Aug.							12.9	44.6	31.8	6.9	3.2	0.6						
Sept.						0.6	18.1	38.9	29.9	10.6	1.5	0.4						
Oct.							16.8	44.8	28.1	9.5	0.8							
Nov.							22.2	59.4	17.3	1.0	0.1							
Dry Bulb Temperature Increased 15°F																		
May									11.4	39.2	37.4	11.1	0.9					
June								0.1	5.5	38.9	42.1	10.1	2.8	0.5				
July									2.0	25.9	45.9	14.7	7.2	3.6	0.7			
Aug.									3.5	28.3	44.9	17.3	3.6	2.1	0.3			
Sept.									10.0	32.4	38.2	15.3	3.3	0.8				
Oct.									12.5	40.7	33.2	12.4	1.2					
Nov.								0.6	45.5	40.2	12.8	0.9						
Dry Bulb Temperature Increased 25°F																		
May										1.7	23.4	46.2	24.9	3.5	0.3			
June										0.1	18.0	43.5	30.0	6.1	2.0	0.3		
July											7.4	35.3	40.0	8.4	5.9	2.7	0.3	
Aug.											8.1	40.3	36.7	10.4	3.5	1.0		
Sept.										0.4	19.0	44.0	25.6	9.0	1.4	0.6		
Oct.										3.0	33.5	41.3	18.5	3.6	0.1			
Nov.									0.6	26.7	41.2	23.6	7.8	0.1				

TABLE 6 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE BTU PER POUND OF AIR AVAILABLE FOR DRYING WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 70%

	Class Intervals of Btu Per Pound of Air																	
Month	-6.9 to -6.0	-5.9 to -5.0	-4.9 to -4.0	-3.9 to -3.0	-2.9 to -2.0	-1.9 to -1.0	-0.9 to 0.0	0.1 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 to 4.0	4.1 to 5.0	5.1 to 6.0	6.1 to 7.0	7.1 to 8.0	8.1 to 9.0	9.1 to 10.0	10.1 to 11.0
Dry Bulb Temperature Unchanged																		
May						3.9	35.9	41.7	16.8	1.7								
June					0.5	7.9	43.2	35.9	9.7	2.4	0.4							
July						5.0	31.8	40.6	12.1	7.0	3.2	0.3						
Aug.						6.3	30.7	44.1	13.3	4.1	1.5							
Sept.						8.0	27.2	41.9	17.5	4.6	0.8							
Oct.						6.3	24.1	47.2	19.6	2.7	0.1							
Nov.						2.2	37.6	52.5	7.1	0.6								
Dry Bulb Temperature Increased 15°F																		
May								0.8	27.2	42.1	24.6	5.2	0.1					
June								0.3	30.3	45.7	18.4	4.1	1.2					
July									16.7	43.1	25.9	8.1	4.9	1.3				
Aug.								0.1	17.5	48.8	25.2	4.9	3.2	0.3				
Sept.								1.0	23.7	44.8	22.8	6.4	1.0	0.3				
Oct.								2.6	30.8	44.5	18.8	3.2	0.1					
Nov.								11.4	56.6	27.9	4.0	0.1						
Dry Bulb Temperature Increased 25°F																		
May										12.8	40.6	36.1	9.9	0.6				
June									0.3	7.3	42.5	38.5	9.2	1.7	0.5			
July									2.4	26.9	46.4	13.3	6.7	3.6	0.7			
Aug.										3.9	31.6	42.5	16.0	3.6	2.1	0.3		
Sept.									2.5	18.1	42.6	26.4	9.2	1.1	0.1			
Oct.										17.9	45.0	26.7	9.8	0.6				
Nov.									6.2	39.1	38.1	14.2	2.3	0.1				

TABLE 7 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE BTU PER POUND OF AIR AVAILABLE FOR DRYING WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 60%

	Class Intervals of Btu Per Pound of Air																	
Month	-6.9 to -6.0	-5.9 to -5.0	-4.9 to -4.0	-3.9 to -3.0	-2.9 to -2.0	-1.9 to -1.0	-0.9 to 0.0	0.1 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 to 4.0	4.1 to 5.0	5.1 to 6.0	6.1 to 7.0	7.1 to 8.0	8.1 to 9.0	9.1 to 10.0	10.1 to 11.0
Dry Bulb Temperature Unchanged																		
May					0.1	25.5	40.7	28.5	5.2									
June					0.7	35.2	40.5	18.9	3.6	1.1								
July					0.7	24.3	40.0	22.0	7.7	4.6	0.7							
Aug.					1.4	25.5	44.8	21.7	3.6	2.7	0.3							
Sept.					1.0	22.5	39.9	26.0	9.0	1.5	0.1							
Oct.					1.7	16.0	39.4	32.3	9.7	0.9								
Nov.						13.2	56.1	28.8	1.8	0.1								
Dry Bulb Temperature Increased 15°F																		
May								17.0	44.4	32.6	5.9	0.1						
June							0.1	20.1	45.4	26.4	6.1	1.6	0.3					
July								10.1	40.3	33.2	9.0	5.3	2.1					
Aug.								12.3	43.8	32.2	7.9	3.2	0.6					
Sept.								17.5	40.3	29.0	11.1	1.5	0.6					
Oct.								19.4	45.5	25.7	9.1	0.4						
Nov.								36.7	50.8	11.5	1.0							
Dry Bulb Temperature Increased 25°F																		
May									5.7	34.6	43.2	14.8	1.7					
June								0.1	1.6	34.7	44.4	14.8	3.5	0.9				
July									0.7	19.8	44.7	22.3	7.3	4.5				
Aug.									1.8	21.5	47.2	22.3	4.2	2.7	0.3			
Sept.									2.9	19.7	35.2	27.9	10.3	3.2	0.8			
Oct.									8.5	34.7	39.9	14.6	2.2	0.1				
Nov.									31.4	48.1	18.5	1.9	0.1					

TABLE 8 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE BTU PER POUND OF AIR AVAILABLE FOR DRYING WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 50%

	Class Intervals of Btu Per Pound of Air																	
Month	-6.9 to -6.0	-5.9 to -5.0	-4.9 to -4.0	-3.9 to -3.0	-2.9 to -2.0	-1.9 to -1.0	-0.9 to 0.0	0.1 to 1.0	1.1 to 2.0	2.1 to 3.0	3.1 to 4.0	4.1 to 5.0	5.1 to 6.0	6.1 to 7.0	7.1 to 8.0	8.1 to 9.0	9.1 to 10.0	10.1 to 11.0
	Dry Bulb Temperature Unchanged																	
May					15.2	37.2	34.7	12.4	0.5									
June				0.1	29.2	41.9	22.7	4.7	1.3	0.1								
July				0.1	22.3	41.6	22.3	7.7	5.3	0.7								
Aug.				0.6	19.5	45.6	25.7	5.5	2.5	0.6								
Sept.				0.3	19.3	31.9	31.7	14.3	2.1	0.4								
Oct.				0.4	11.0	22.6	45.2	18.3	2.4	0.1								
Nov.					3.1	25.0	58.3	11.0	2.1	0.5								
	Dry Bulb Temperature Increased 15°F																	
May						11.2	41.2	35.6	11.6	0.4								
June					0.1	14.4	42.8	34.0	6.7	1.6	0.4							
July						8.7	38.7	34.4	9.5	6.2	2.4	0.1						
Aug.						10.1	41.0	35.9	8.6	3.6	0.8							
Sept.						13.3	33.7	35.9	14.0	2.5	0.6							
Oct.						10.3	35.2	40.0	12.8	1.6	0.1							
Nov.						10.0	60.3	26.5	3.1	0.1								
	Dry Bulb Temperature Increased 25°F																	
May							1.3	31.5	44.2	20.3	2.7							
June						0.1	0.1	33.2	45.7	16.5	3.3	1.1						
July							0.3	19.8	43.1	23.7	7.2	5.2	0.7					
Aug.							1.1	20.2	48.7	22.6	4.3	2.8	0.3					
Sept.							1.5	24.7	44.3	22.2	6.1	1.1	0.1					
Oct.							2.8	28.4	46.3	19.1	3.3	0.1						
Nov.							7.7	56.4	31.2	4.6	0.1							

TABLE 9 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE t_x ("EQUILIBRIUM" TEMPERATURE) WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 100%

Month	Class Intervals of t_x ("Equilibrium" Temperature)																				
	0.0 to 5.0	5.1 to 10.0	10.1 to 15.0	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0	100.1 to 105.0
	Dry Bulb Temperature Unchanged																				
May								0.9	4.4	10.1	19.9	26.6	22.7	13.2	2.2						
June										0.7	3.2	11.5	21.5	34.2	26.1	2.8					
July											0.1	3.2	13.5	29.7	43.8	9.7					
Aug.											1.0	6.0	16.7	29.1	44.0	3.2					
Sept.								0.4	1.4	7.4	16.1	20.4	23.5	22.2	8.6						
Oct.						0.4	2.8	5.0	15.3	20.5	19.4	18.8	12.5	4.6	0.7						
Nov.				3.2	4.6	11.7	17.8	21.3	17.8	12.3	5.6	4.2	1.5								
	Dry Bulb Temperature Increased 15°F																				
May									0.3	3.1	8.4	21.0	28.9	24.0	13.0	1.3					
June											0.3	3.0	11.7	23.3	37.8	23.2	0.7				
July												0.1	3.2	14.2	37.6	41.5	3.4				
Aug.												0.8	6.0	18.8	31.9	41.2	1.3				
Sept.										1.0	5.3	16.1	23.1	25.6	23.1	5.8					
Oct.								0.9	4.0	12.4	21.1	23.2	20.8	13.0	4.3	0.3					
Nov.				0.1	1.0	2.4	5.1	16.4	20.8	25.0	14.6	7.9	5.2	1.5							
	Dry Bulb Temperature Increased 25°F																				
May										0.4	3.9	11.4	25.2	30.2	22.1	6.7	0.1				
June												0.6	6.1	14.1	32.3	40.0	6.9				
July													0.4	6.6	23.0	48.5	21.5				
Aug.													1.4	11.2	24.6	49.6	13.2				
Sept.										0.1	1.0	8.2	20.3	24.8	28.0	17.0	0.6				
Oct.									1.1	4.3	16.4	23.3	24.0	20.7	8.2	2.0					
Nov.					0.1	0.8	1.8	5.5	17.2	24.1	24.4	15.0	5.6	5.0	0.5						

TABLE 10 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE t_x ("EQUILIBRIUM" TEMPERATURE) WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 90%

Month	Class Intervals of t_x ("Equilibrium" Temperature)																		
	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0	100.1 to 105.0	105.1 to 110.0
Dry Bulb Temperature Unchanged																			
May				0.3	3.2	5.3	12.6	21.0	25.0	17.3	10.5	4.5	0.3						
June							0.3	2.1	7.6	14.8	28.8	35.7	10.7						
July									1.4	7.9	21.3	41.8	27.6						
Aug.								0.6	2.8	11.9	21.0	39.9	23.8						
Sept.					0.3	0.7	5.1	12.9	19.2	21.5	23.0	15.6	1.7						
Oct.				1.7	4.2	12.2	17.7	12.1	18.3	16.1	6.0	2.4	0.3						
Nov.	2.6	4.2	9.9	16.8	18.8	20.1	12.8	7.2	4.7	2.8	0.1								
Dry Bulb Temperature Increased 15°F																			
May						0.1	1.2	6.5	15.2	27.7	25.2	18.8	5.2	0.1					
June								0.3	0.8	8.0	15.7	33.6	35.3	6.3					
July										1.1	8.2	25.1	45.5	20.1					
Aug.									0.3	2.1	13.1	25.9	45.8	12.8					
Sept.							0.7	3.5	10.8	22.1	22.8	25.8	13.7	0.6					
Oct.					0.5	3.4	7.8	19.5	22.8	21.2	17.1	5.8	1.9						
Nov.	0.1	0.8	2.1	4.7	14.1	20.6	21.8	17.2	10.2	4.8	3.5	0.1							
Dry Bulb Temperature Increased 25°F																			
May							0.3	1.3	8.0	20.8	29.8	25.2	13.4	1.2					
June									0.3	2.4	10.8	24.4	38.1	23.3	0.7				
July											2.8	14.2	37.4	42.9	2.7				
Aug.										0.6	5.5	18.5	31.6	39.6	4.2				
Sept.								0.8	4.3	14.6	24.4	26.0	23.9	6.0					
Oct.						0.4	3.8	9.4	20.4	25.4	21.3	14.6	4.4	0.3					
Nov.		0.1	0.2	1.7	4.6	13.6	22.1	23.7	17.6	9.4	5.0	2.0							

TABLE 11 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE t_x ("EQUILIBRIUM" TEMPERATURE) WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 80%

	Class Intervals of t_x ("Equilibrium" Temperature)																	
Month	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0	105.1 to 110.0
	Dry Bulb Temperature Unchanged																	
May					0.3	1.7	5.9	11.4	23.0	24.8	20.1	11.1	1.7					
June							0.3	0.8	5.9	11.5	22.3	31.4	25.5	2.3				
July									0.4	4.6	14.0	31.6	40.0	9.4				
Aug.									1.5	8.3	18.0	26.9	42.2	3.1				
Sept.					0.1	0.7	3.3	8.2	18.6	19.2	22.0	20.4	7.5					
Oct.				1.6	3.4	9.4	16.8	19.0	18.9	18.1	8.9	3.5	0.4					
Nov.	2.1	4.0	8.1	15.0	18.7	18.8	14.6	9.5	3.8	4.4	1.0							
	Dry Bulb Temperature Increased 15°F																	
May							0.8	4.3	10.7	21.9	27.3	22.5	11.7	0.8				
June									0.5	4.4	12.1	24.1	36.5	21.3	1.1			
July										0.1	4.5	15.6	36.0	39.5	4.3			
Aug.										1.3	7.4	19.5	30.7	39.7	1.4			
Sept.							0.3	1.4	7.9	15.8	22.8	23.2	22.4	6.2				
Oct.						2.7	5.1	16.9	21.1	20.8	19.9	9.8	3.4	0.3				
Nov.	0.1	0.4	1.5	4.2	10.1	18.8	21.6	19.4	12.9	5.2	4.5	1.3						
	Dry Bulb Temperature Increased 25°F																	
May								0.9	5.3	12.9	27.2	27.1	19.9	6.6	0.1			
June										0.9	7.1	14.4	31.6	38.3	7.7			
July											1.0	6.7	23.6	46.3	22.4			
Aug.											2.1	12.1	23.9	46.8	15.1			
Sept.								0.4	2.2	8.9	21.5	24.1	26.1	16.0	0.8			
Oct.							2.7	5.4	18.0	22.6	23.3	19.0	7.0	2.0				
Nov.			0.3	1.2	3.8	9.5	20.5	23.2	19.2	12.8	4.7	4.5	0.3					

TABLE 12 - FREQNEUCY DISTRIBUTION (%) OF DAILY AVERAGE t_x ("EQUILIBRIUM" TEMPERATURE) WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 70%

Month	Class Intervals of t_x ("Equilibrium" Temperature)																		
	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0	105.1 to 110.0	110.1 to 115.0
								Dry Bulb Temperature Unchanged											
May					0.3	0.9	4.4	9.2	17.9	23.7	20.8	16.1	6.3	0.4					
June								0.5	2.7	8.3	13.1	27.3	33.8	14.3					
July									0.1	2.0	8.0	20.8	39.4	28.9	0.8				
Aug.									0.8	3.6	11.8	21.7	36.6	24.8	0.7				
Sept.						0.6	1.5	6.8	13.5	19.3	19.3	21.9	14.6	2.5					
Oct.				0.9	3.2	5.2	16.3	17.7	18.6	17.3	13.8	5.1	1.8	0.1					
Nov.	1.8	3.3	5.8	14.2	17.4	18.9	15.3	11.2	5.3	4.5	2.2	0.1							
								Dry Bulb Temperature Increased 15°F											
May							0.3	2.8	6.7	16.8	25.6	24.0	17.3	6.2	0.3				
June									0.7	1.6	8.0	15.0	31.3	34.4	9.0				
July											1.3	9.3	24.3	40.6	24.5				
Aug.										0.4	2.7	12.5	26.2	39.8	18.4				
Sept.							0.1	0.8	4.2	13.2	19.7	21.9	24.0	15.0	1.1				
Oct.						1.5	3.5	11.7	18.0	22.3	19.5	16.0	5.5	2.0					
Nov.	0.1	0.1	1.8	3.6	6.7	15.6	20.8	20.7	14.5	8.5	4.9	2.6	0.1						
								Dry Bulb Temperature Increased 25°F											
May								0.3	3.1	8.6	20.1	28.3	23.5	14.1	2.0				
June										0.3	2.8	10.7	21.6	34.9	27.9	1.8			
July											0.1	2.9	13.6	30.9	44.5	8.0			
Aug.											0.8	5.2	16.8	30.5	44.3	2.4			
Sept.									0.1		0.8	5.2	16.8	30.4	44.2	2.4			0.1
Oct.							1.2	3.9	12.8	20.6	22.6	19.6	14.0	4.8	0.5				
Nov.			0.3	1.0	2.7	5.4	17.2	21.9	22.3	14.7	7.6	4.9	2.0						

TABLE 13 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE t_x ("EQUILIBRIUM" TEMPERATURE) WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 60%

Month	Class Intervals of t_x ("Equilibrium" Temperature)																		
	15.1 to 20.0	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0	100.1 to 105.0	110.1 to 115.0
Dry Bulb Temperature Unchanged																			
May						0.6	3.2	5.7	13.4	21.2	22.8	18.7	11.0	3.4					
June								0.3	0.8	6.5	10.5	20.1	28.6	27.9	5.3				
July										0.7	4.2	12.3	25.9	38.8	18.1				
Aug.									0.3	1.5	7.9	15.7	24.5	39.9	10.2				
Sept.						0.3	0.7	4.0	10.0	17.5	17.4	21.0	19.9	9.2					
Oct.				0.5	2.6	3.8	12.1	14.8	20.1	16.9	16.1	8.5	3.8	0.8					
Nov.	1.4	2.8	4.5	12.7	15.8	18.2	16.9	11.3	7.8	3.3	4.1	1.2							
Dry Bulb Temperature Increased 15°F																			
May							0.1	1.0	4.9	10.5	21.3	25.2	21.7	12.3	3.0				
June										0.7	4.0	10.9	20.7	31.2	29.3	3.2			
July											0.1	3.7	13.2	27.8	41.5	13.7			
Aug.											1.3	6.5	16.0	27.5	43.2	5.5			
Sept.								0.6	1.9	7.6	16.2	19.6	22.7	21.5	9.9				
Oct.						0.5	3.4	5.6	16.9	20.5	19.5	17.7	10.9	4.2	0.8				
Nov.		0.3	1.4	2.4	4.6	14.2	18.6	20.8	15.9	11.5	4.9	4.0	1.4						
Dry Bulb Temperature Increased 25°F																			
May									1.2	5.2	12.0	25.0	26.5	19.5	10.3	0.3			
June											0.9	6.4	11.9	26.5	36.9	17.1	0.3		
July												0.6	5.0	17.6	39.0	36.0	1.8		
Aug.												1.8	9.9	20.4	33.3	33.5	1.1		
Sept.									0.6	2.5	8.5	20.4	20.6	24.9	19.1	3.4			
Oct.							0.4	3.1	6.0	19.0	20.3	21.4	18.5	8.2	2.8	0.3			
Nov.			0.1	0.8	1.7	5.0	12.3	19.9	21.9	17.1	11.8	4.2	4.7	0.5					

TABLE 14 - FREQUENCY DISTRIBUTION (%) OF DAILY AVERAGE t_x ("EQUILIBRIUM" TEMPERATURE) WHEN CROP MOISTURE AND TEMPERATURE ARE SUCH THAT THE EQUILIBRIUM RELATIVE HUMIDITY IS 50%

	Class Intervals of t_x ("Equilibrium" Temperature)																		
Month	20.1 to 25.0	25.1 to 30.0	30.1 to 35.0	35.1 to 40.0	40.1 to 45.0	45.1 to 50.0	50.1 to 55.0	55.1 to 60.0	60.1 to 65.0	65.1 to 70.0	70.1 to 75.0	75.1 to 80.0	80.1 to 85.0	85.1 to 90.0	90.1 to 95.0	95.1 to 100.0	100.1 to 105.0	105.1 to 110.0	110.1 to 115.0
Dry Bulb Temperature Unchanged																			
May					0.4	1.0	4.9	9.4	16.8	12.2	19.6	16.0	9.4	1.3					
June								0.5	2.7	7.5	11.9	23.2	29.9	21.6	2.7				
July									0.1	1.5	6.3	15.1	30.9	36.0	10.1				
Aug.									0.8	3.1	12.3	18.0	23.7	28.6	3.5				
Sept.					0.1	0.7	2.2	6.4	12.9	16.8	18.1	20.2	16.4	6.2					
Oct.			0.1	1.9	3.1	7.9	15.1	17.2	16.3	16.1	13.6	5.6	2.8	0.3					
Nov.	1.3	2.4	4.1	9.4	15.1	16.2	17.1	13.1	10.3	4.2	4.0	2.7	0.1						
Dry Bulb Temperature Increased 15°F																			
May							0.6	2.7	6.2	14.1	24.1	22.2	18.2	10.6	1.3				
June									0.3	0.9	6.9	11.7	24.3	31.9	22.1	1.9			
July											1.0	5.3	15.1	33.1	37.2	8.3			
Aug.										0.4	2.4	9.7	18.0	29.1	37.9	2.5			
Sept.							0.1	0.8	4.0	10.7	18.4	18.9	21.9	19.2	6.0				
Oct.					0.1	2.0	3.6	12.1	16.1	21.2	17.7	16.4	7.1	3.4	0.3				
Nov.	0.1	0.9	2.2	4.1	9.5	16.1	18.9	19.1	12.8	7.9	4.2	3.7	0.5						
Dry Bulb Temperature Increased 25°F																			
May								0.5	2.8	6.8	16.5	25.0	23.5	17.9	6.6	0.4			
June										0.3	2.0	7.5	14.1	28.5	35.3	12.3			
July												1.3	6.6	20.0	41.1	30.4	0.6		
Aug.											0.4	2.7	12.2	21.6	38.6	24.1	0.4		
Sept.								0.1	0.8	4.7	12.9	19.4	21.0	23.1	15.6	2.4			
Oct.							1.7	3.8	12.2	18.3	21.8	18.5	15.7	6.0	1.9	0.1			
Nov.		0.1	0.4	1.2	4.0	8.6	16.7	19.9	20.5	13.6	8.0	4.0	2.9	0.1					

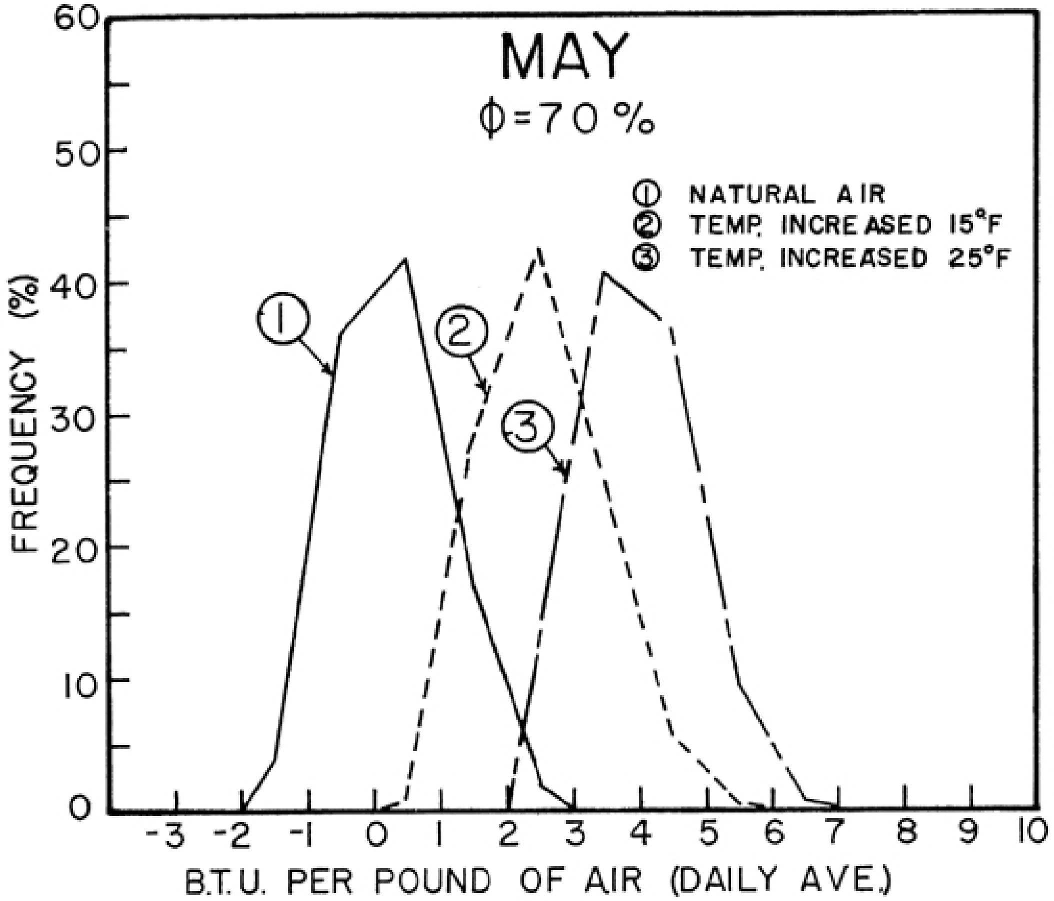
MAY
ϕ=70 %
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
FREQUENCY (%)
60
50
40
30
20
10
0
-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
B.T.U. PER POUND OF AIR (DAILY AVE.)
1
2
3

Fig. 4

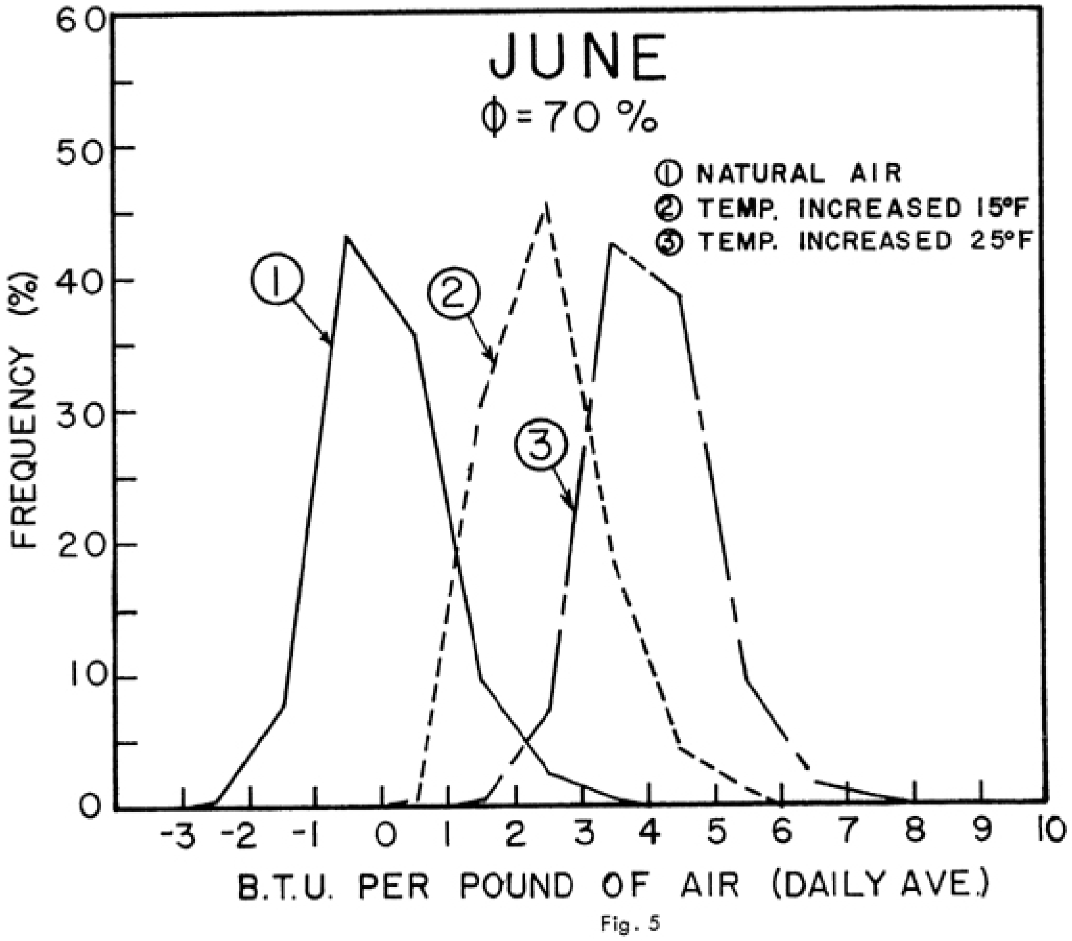
JUNE
ϕ=70 %
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
FREQUENCY (%)
60
50
40
30
20
10
0
-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
B.T.U. PER POUND OF AIR (DAILY AVE.)
1
2
3

Fig. 5

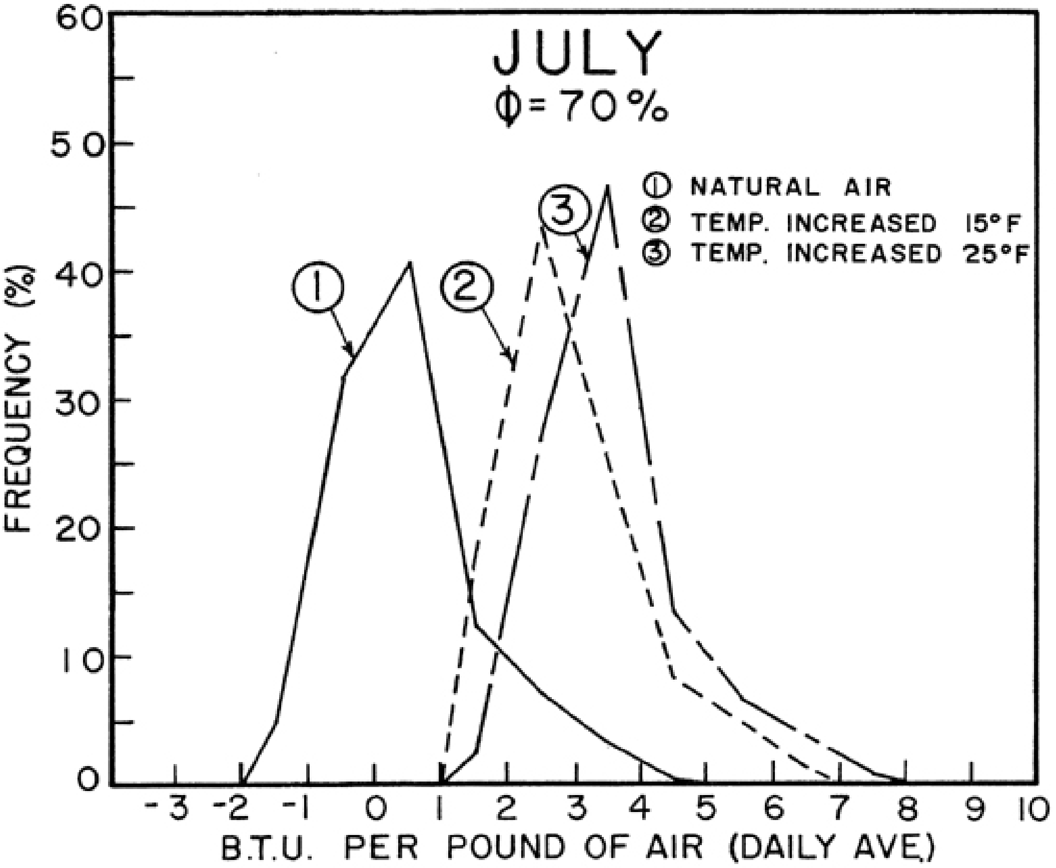
JULY
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
1
2
3
FREQUENCY (%)
0
10
20
30
40
50
60
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
B.T.U. PER POUND OF AIR (DAILY AVE.)

Fig. 6

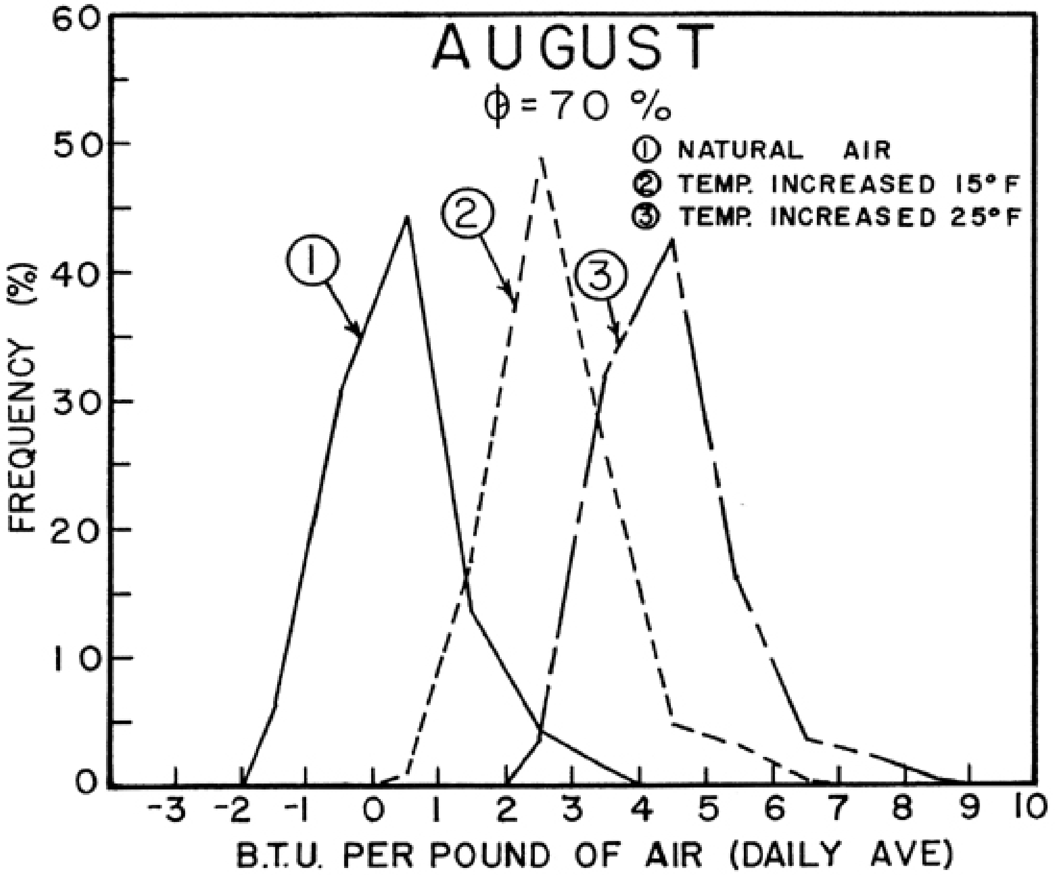
AUGUST
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
1
2
3
FREQUENCY (%)
0
10
20
30
40
50
60
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
B.T.U. PER POUND OF AIR (DAILY AVE)

Fig. 7

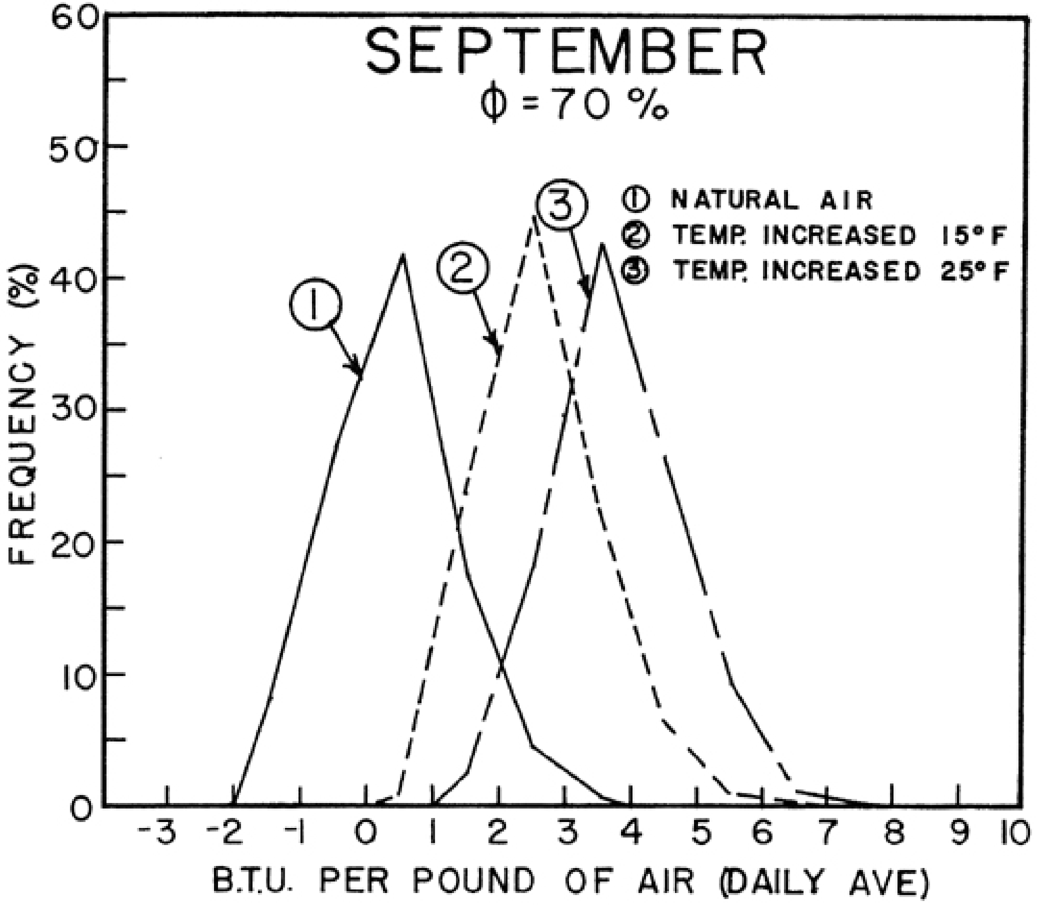
SEPTEMBER
φ=70%
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
FREQUENCY (%)
0
10
20
30
40
50
60
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
B.T.U. PER POUND OF AIR (DAILY AVE)

Fig. 8

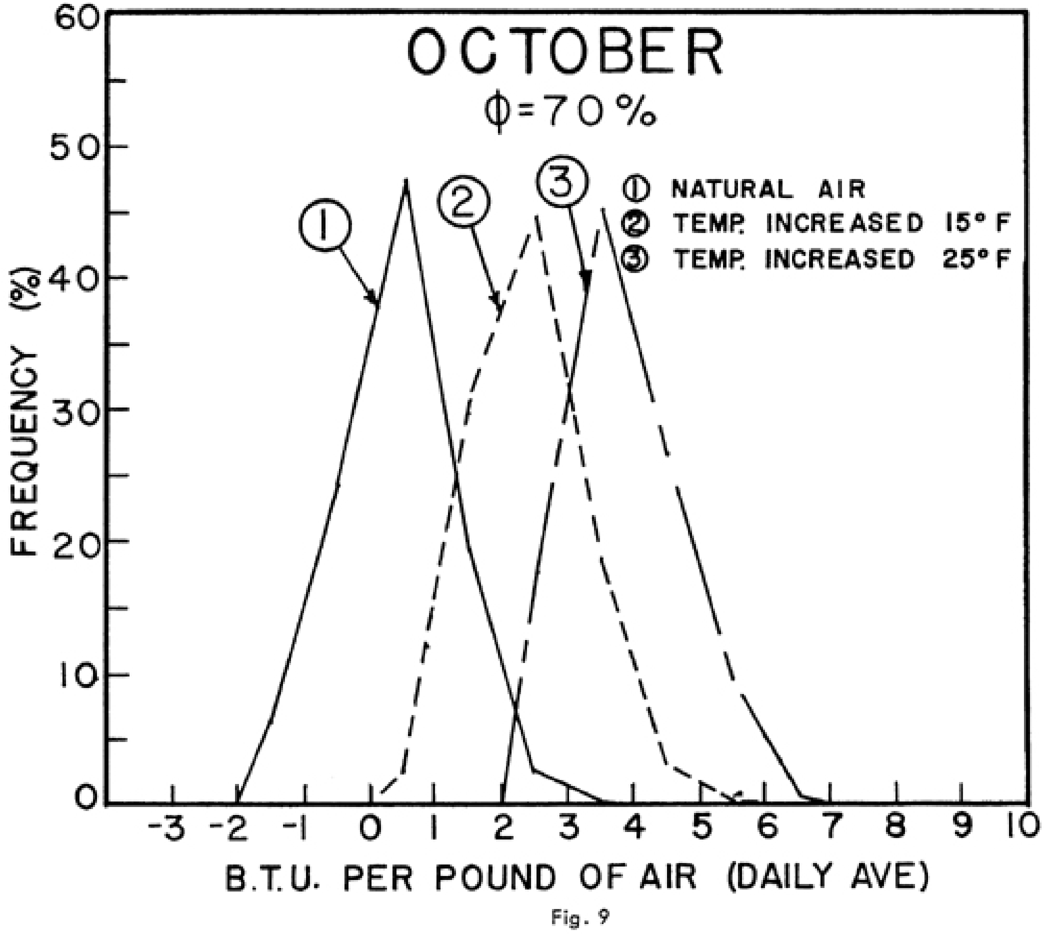
OCTOBER
φ=70%
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
FREQUENCY (%)
0
10
20
30
40
50
60
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
B.T.U. PER POUND OF AIR (DAILY AVE)

Fig. 9

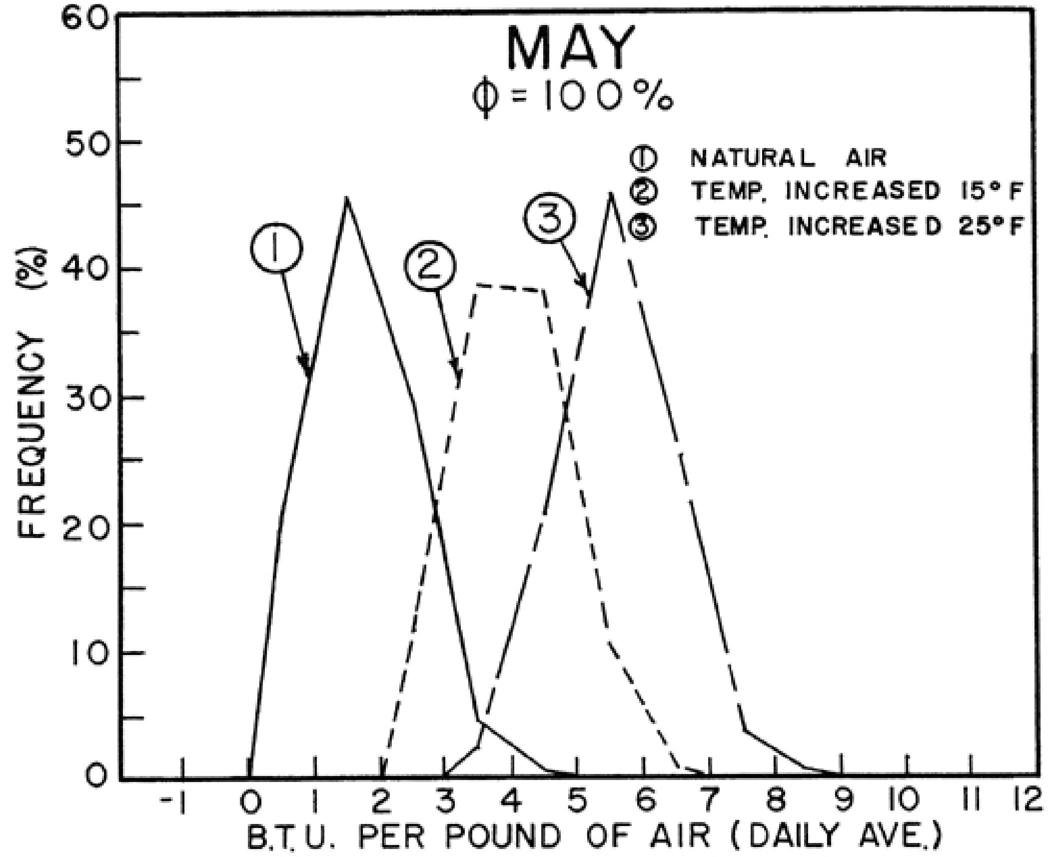
MAY
ϕ = 100 %
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
①
②
③
FREQUENCY (%)
60
50
40
30
20
10
0
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE.)

Fig. 11

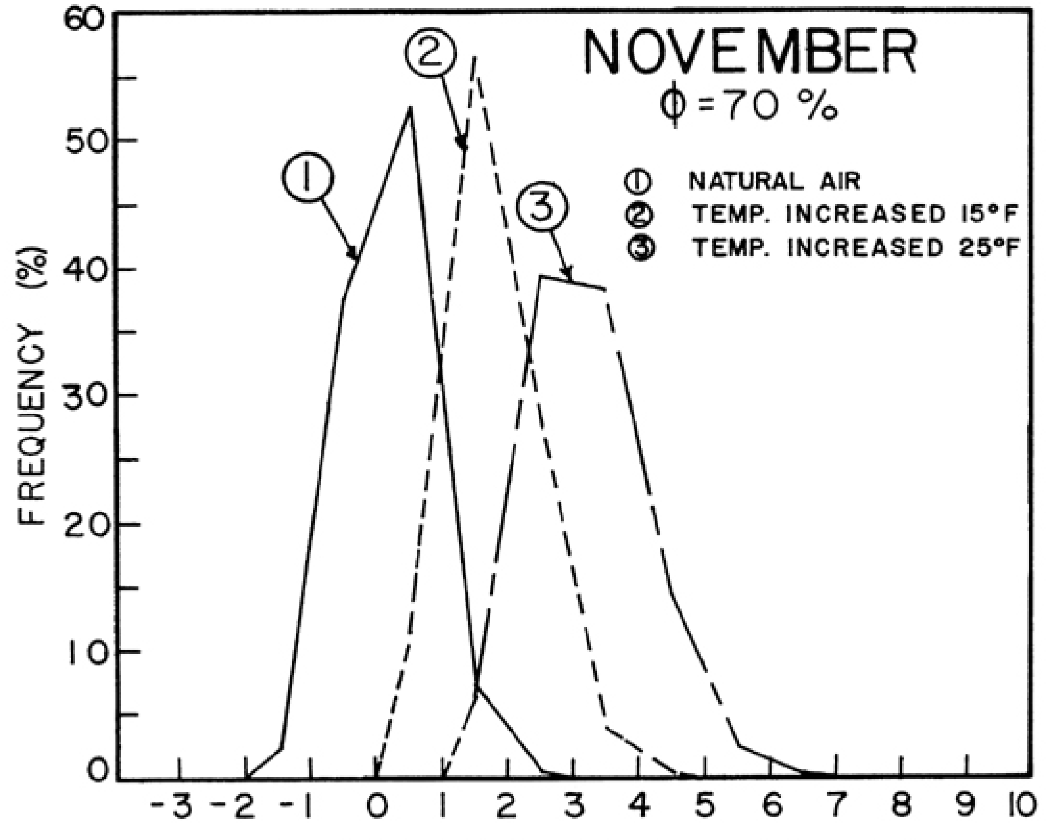
NOVEMBER
ϕ = 70 %
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
①
②
③
FREQUENCY (%)
60
50
40
30
20
10
0
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
B.T.U. PER POUND OF AIR (DAILY AVE)

Fig. 10

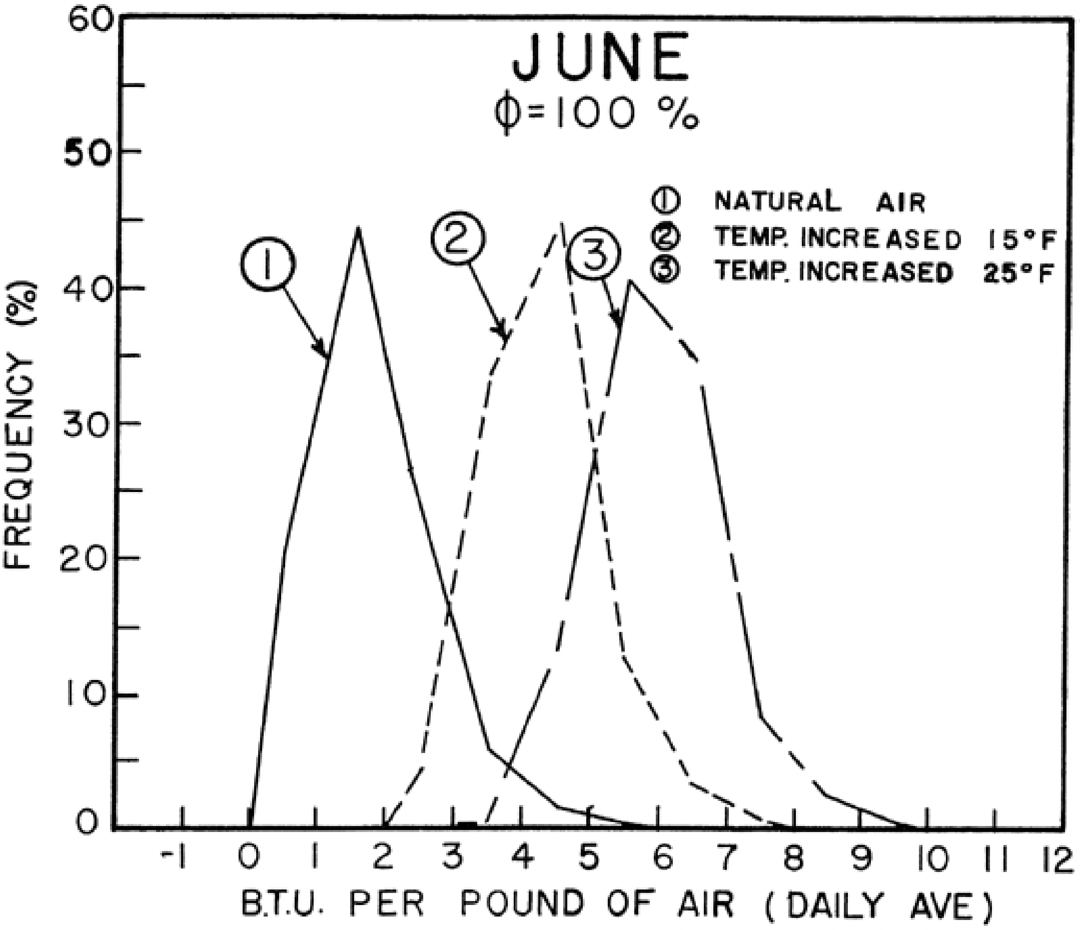
JUNE
φ=100 %
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
60
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE)

Fig. 12

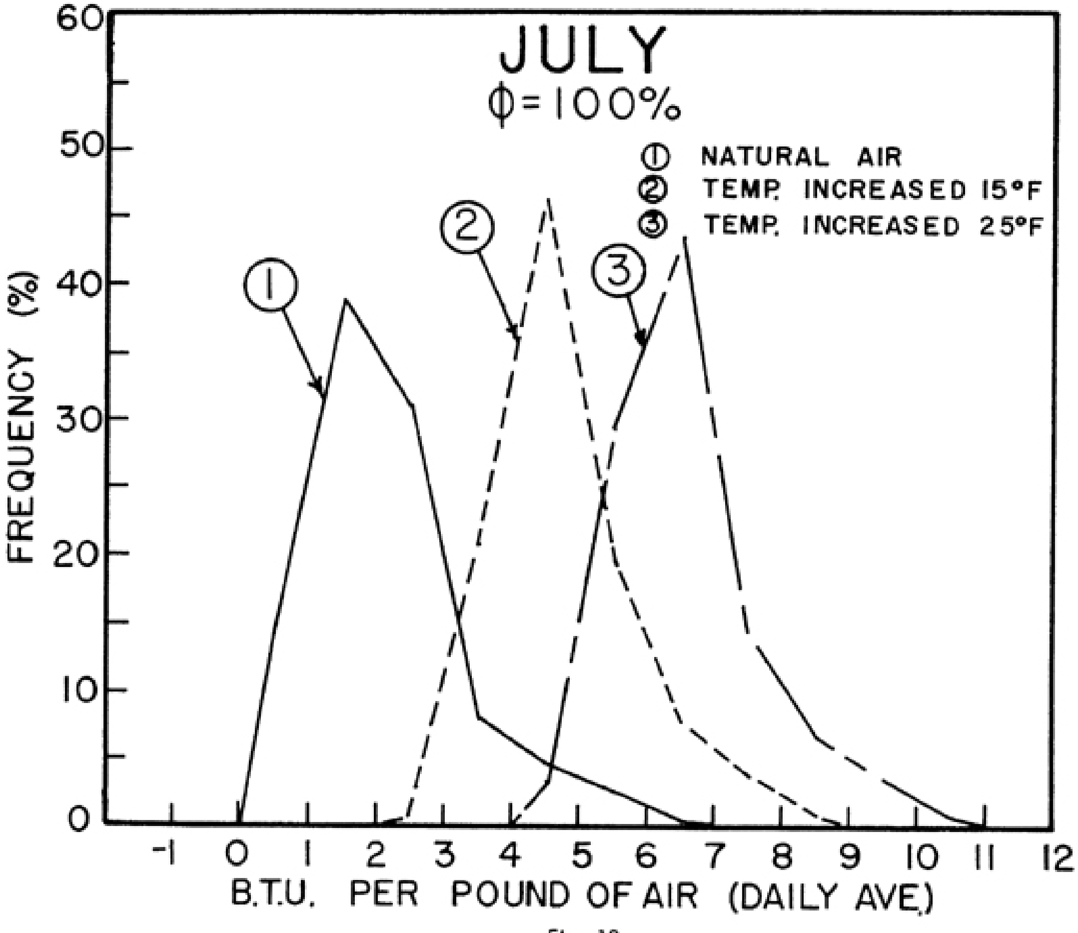
JULY
φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
60
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE)

Fig. 13

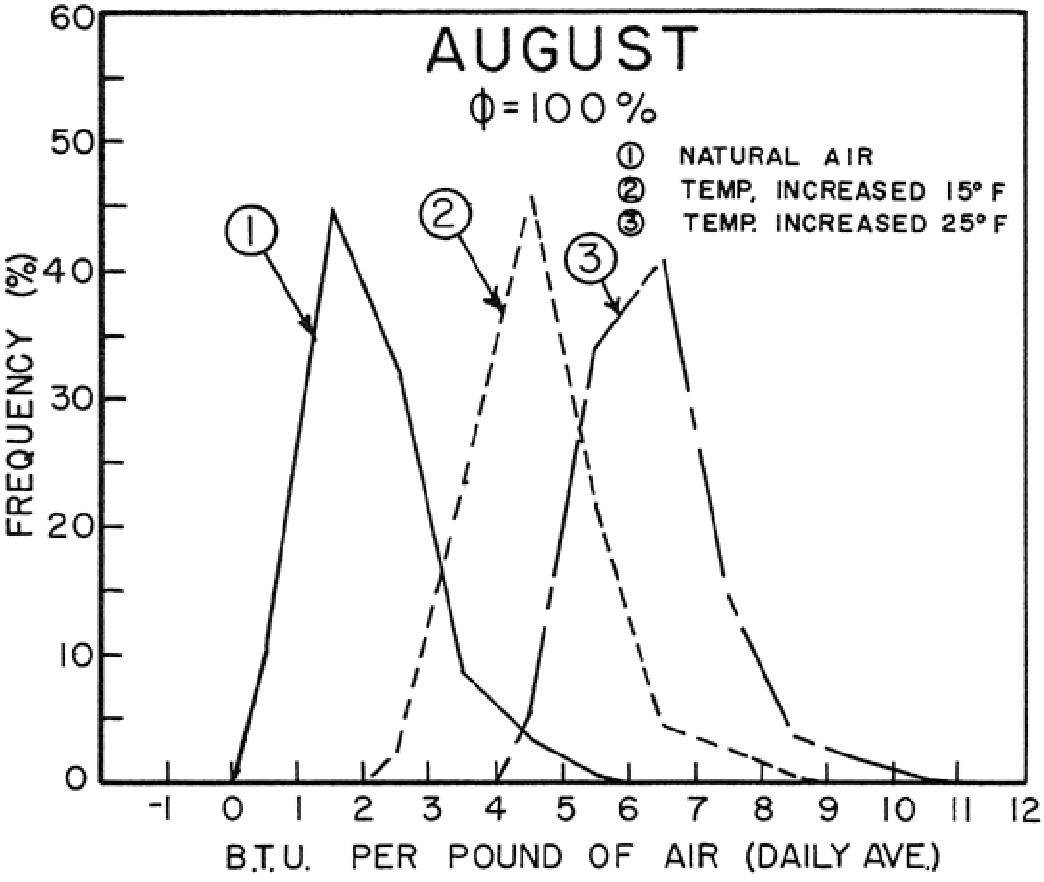
AUGUST
ϕ=100%
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
60
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE.)

Fig. 14

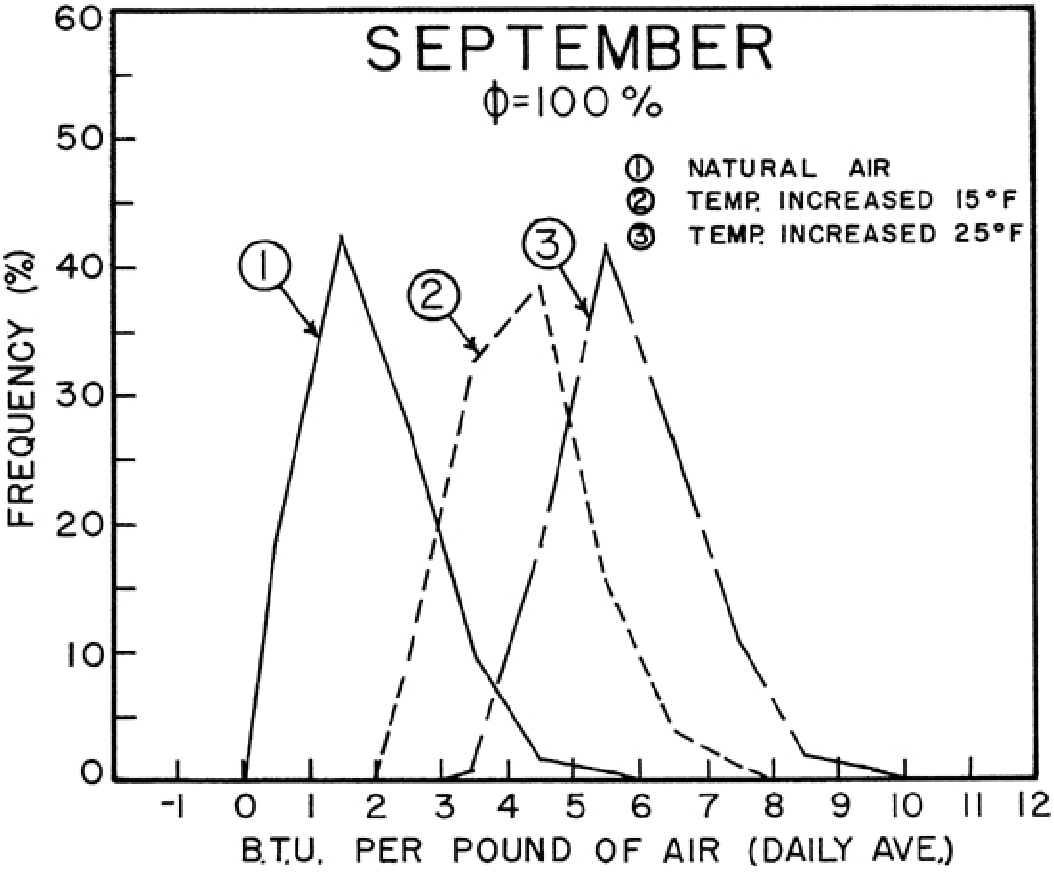
SEPTEMBER
ϕ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
60
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE.)

Fig. 15

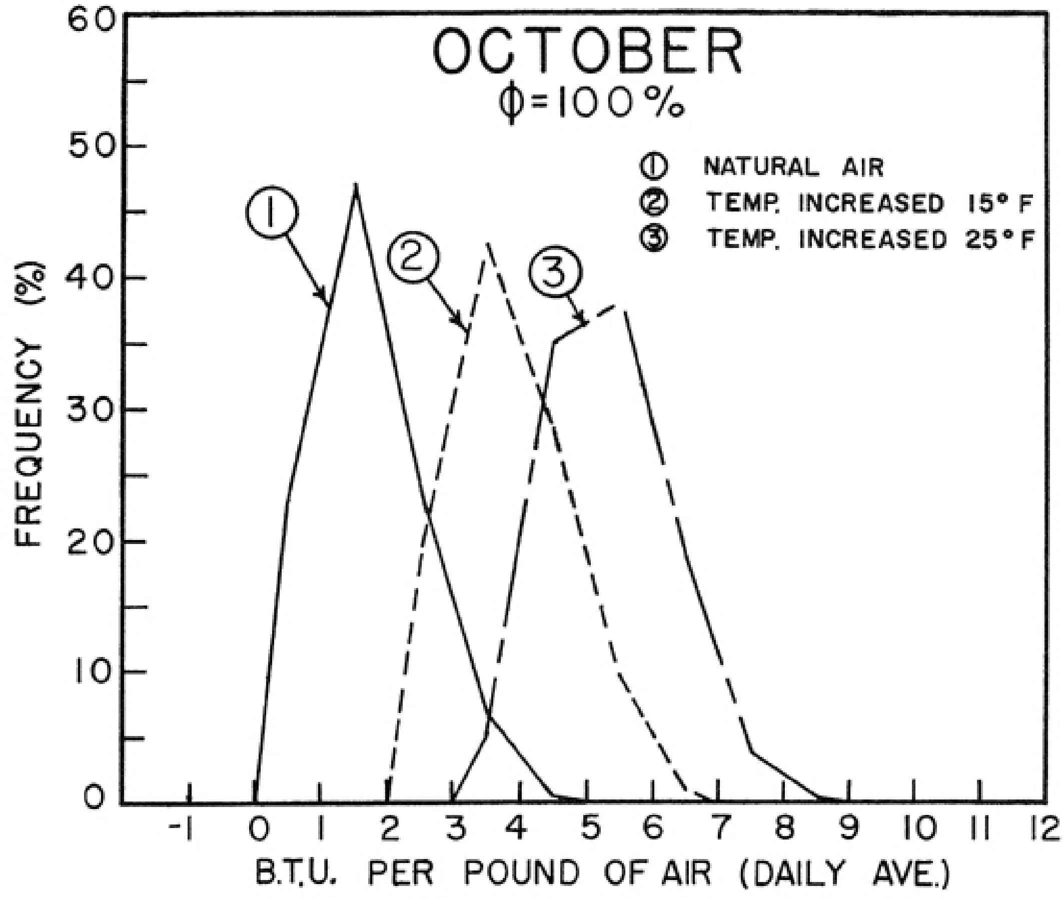
OCTOBER
φ=100%
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
1
2
3
FREQUENCY (%)
0
10
20
30
40
50
60
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE.)

Fig. 16

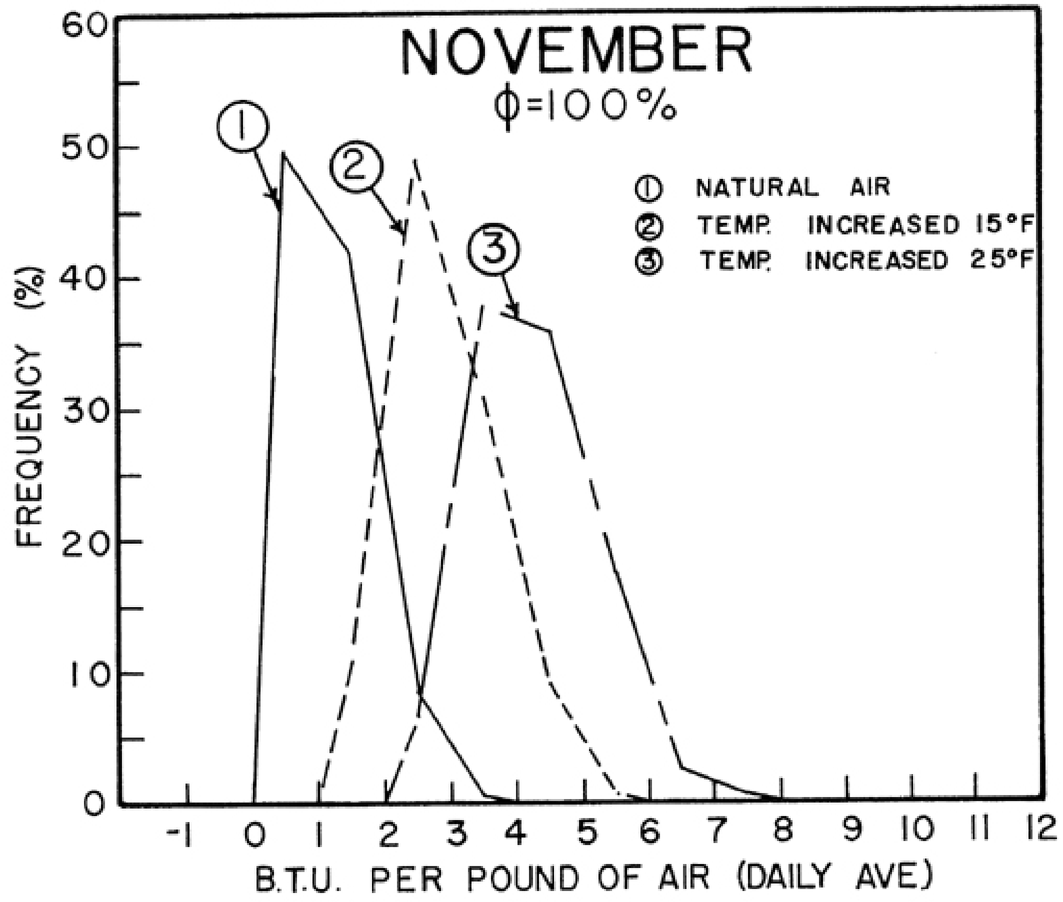
NOVEMBER
φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
1
2
3
FREQUENCY (%)
0
10
20
30
40
50
60
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
B.T.U. PER POUND OF AIR (DAILY AVE.)

Fig. 17

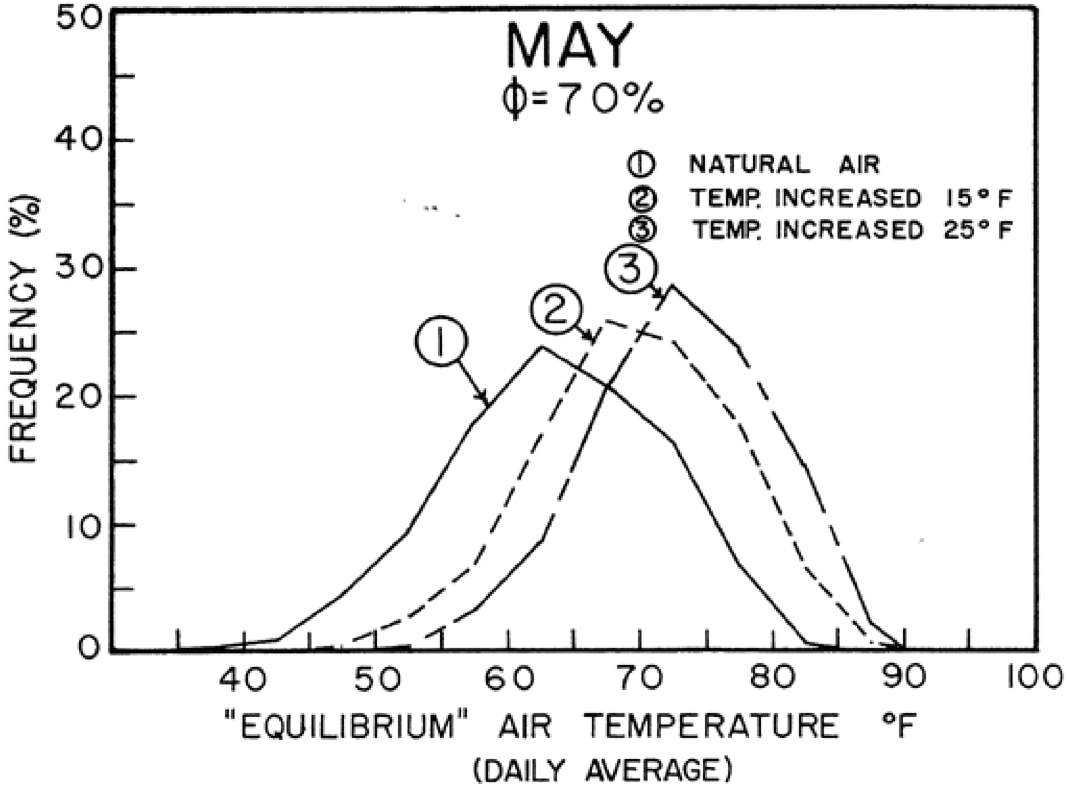
MAY
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
40
50
60
70
80
90
100
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 18

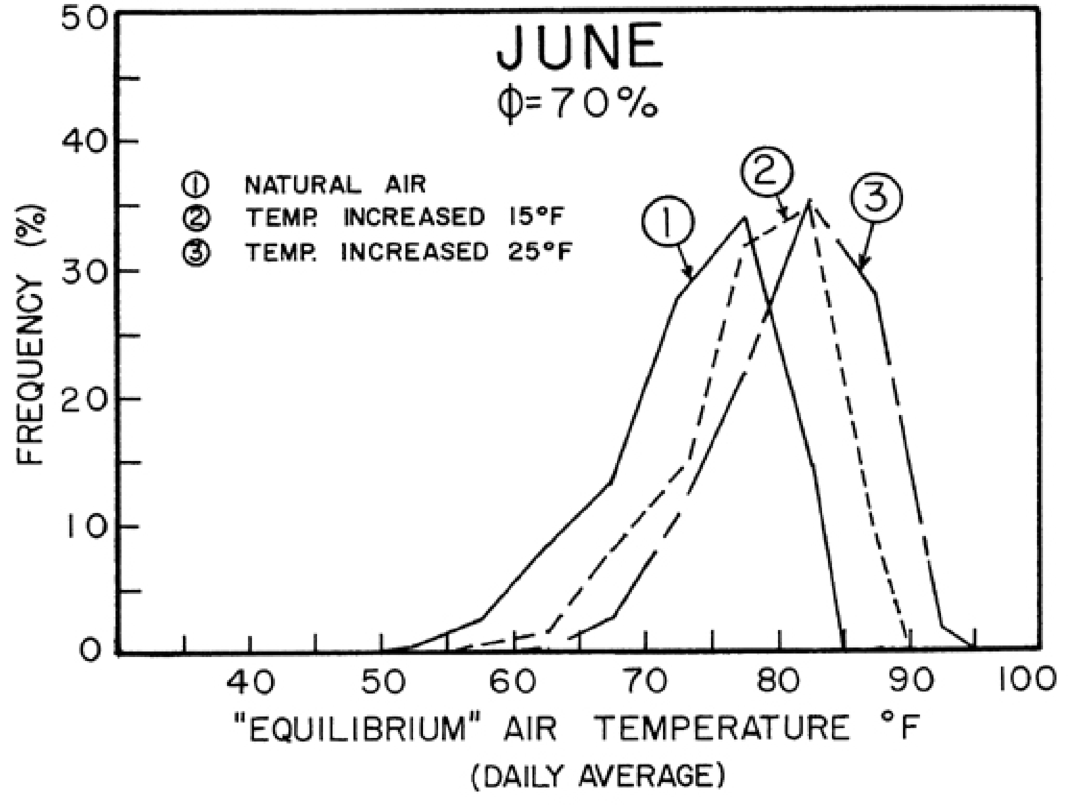
JUNE
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
40
50
60
70
80
90
100
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 19

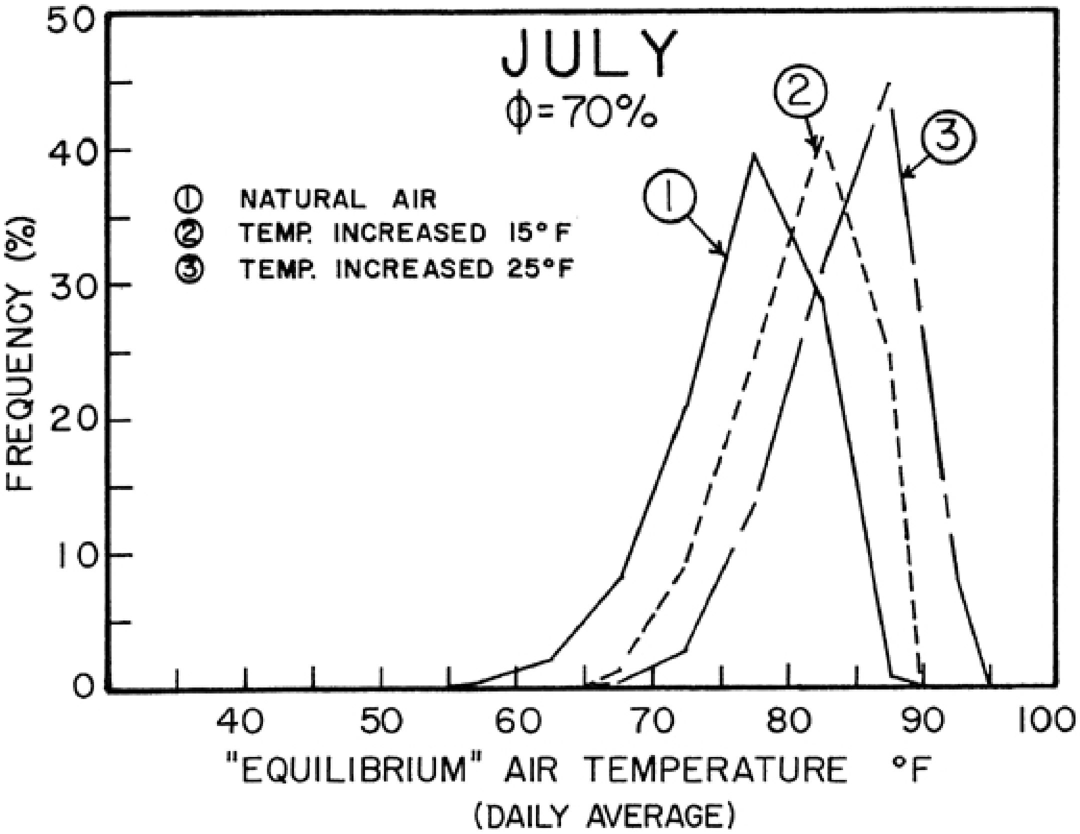
JULY
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
40
50
60
70
80
90
100
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 20

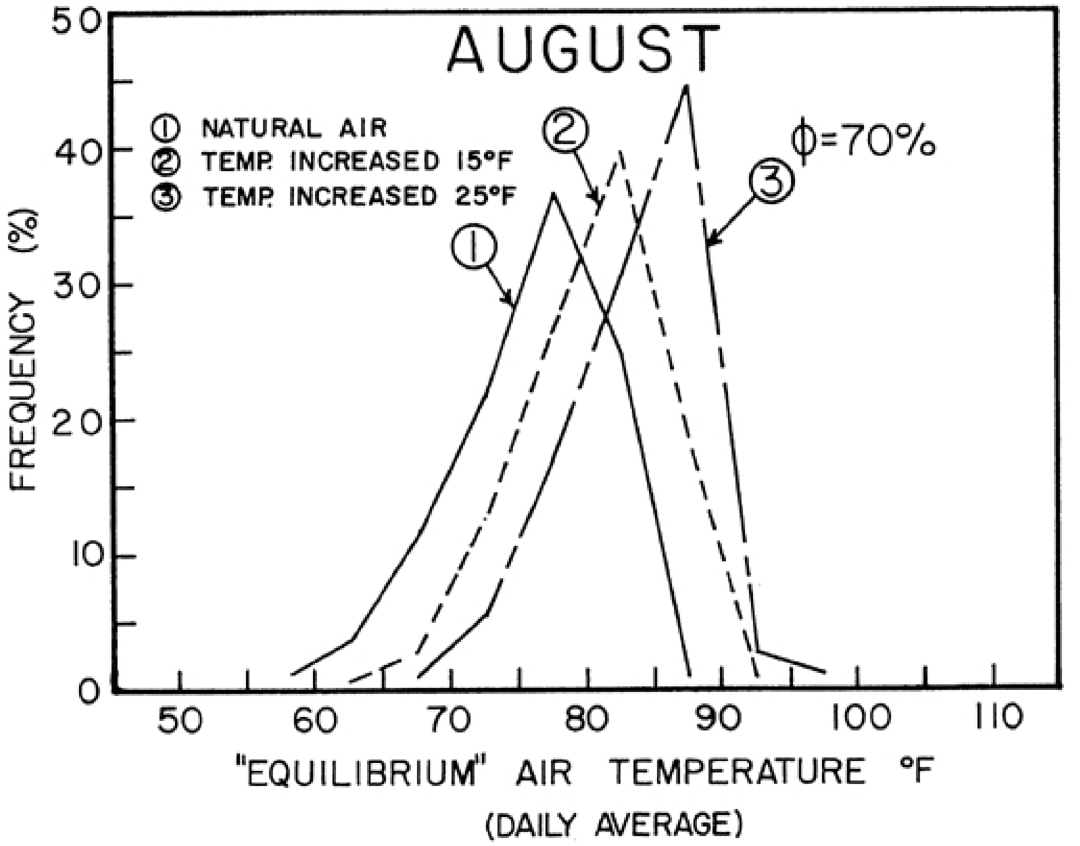
AUGUST
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
ϕ=70%
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
50
60
70
80
90
100
110
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 21

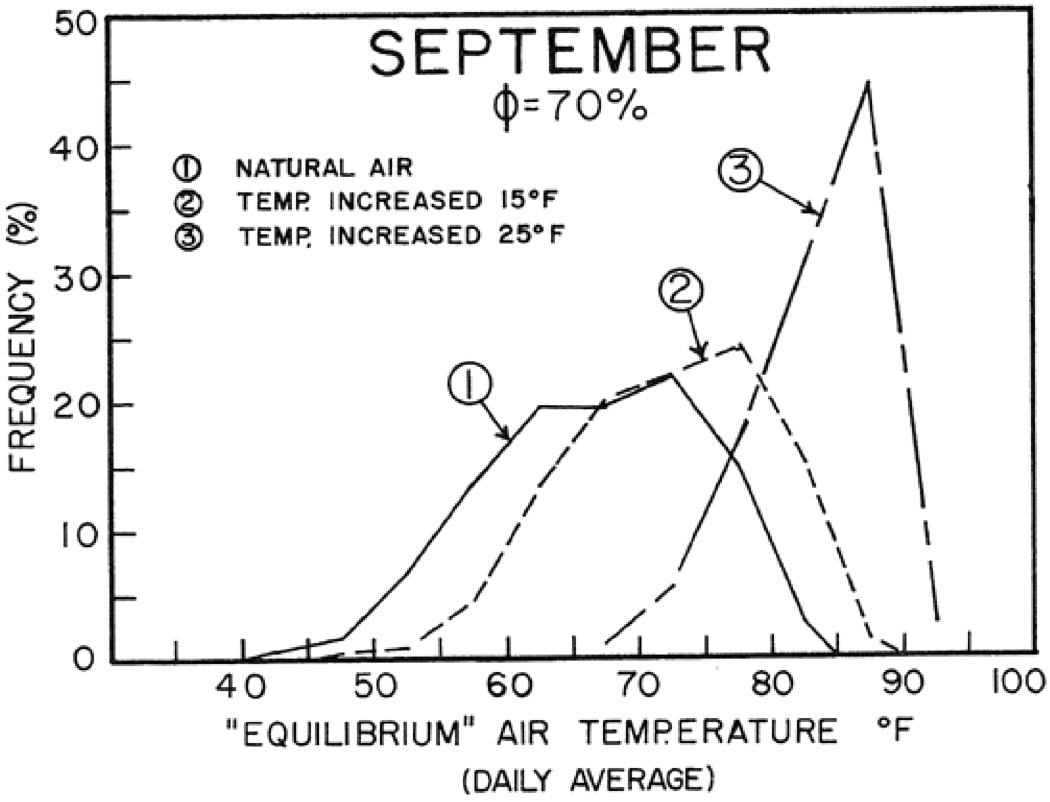
SEPTEMBER
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
40
50
60
70
80
90
100
"EQUILIBRIUM" AIR TEMP.ERATURE °F
(DAILY AVERAGE)

Fig. 22

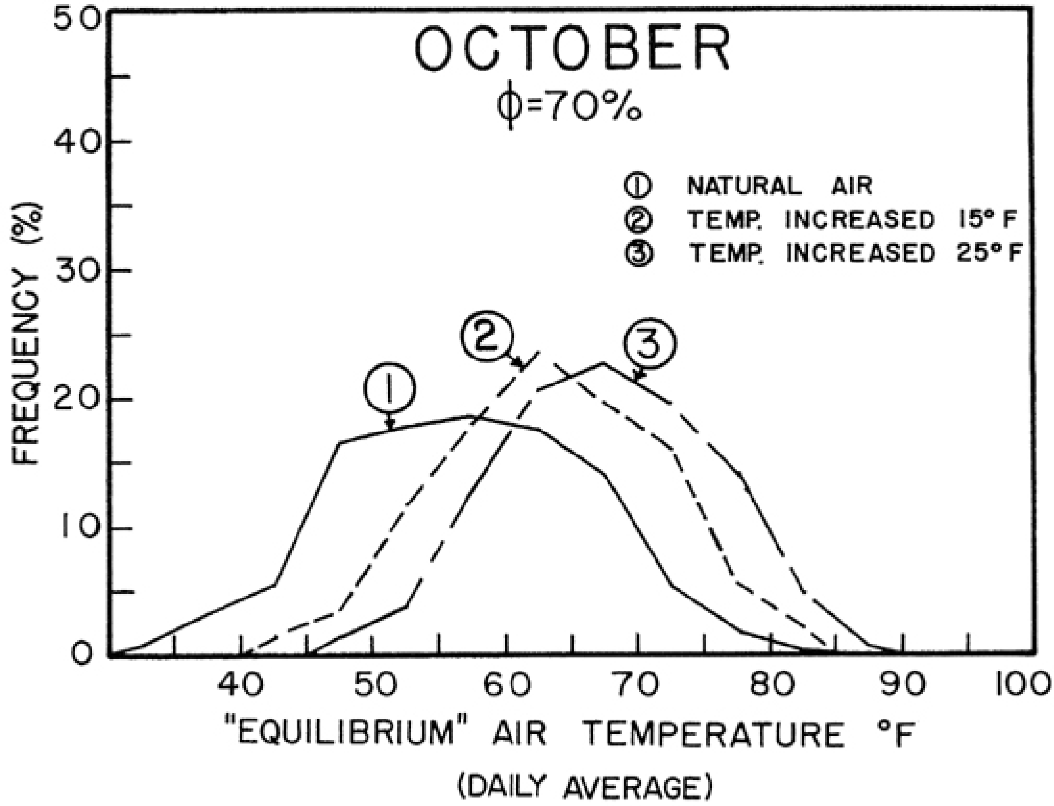
OCTOBER
ϕ=70%
① NATURAL AIR
② TEMP. INCREASED 15° F
③ TEMP. INCREASED 25° F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
40
50
60
70
80
90
100
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 23

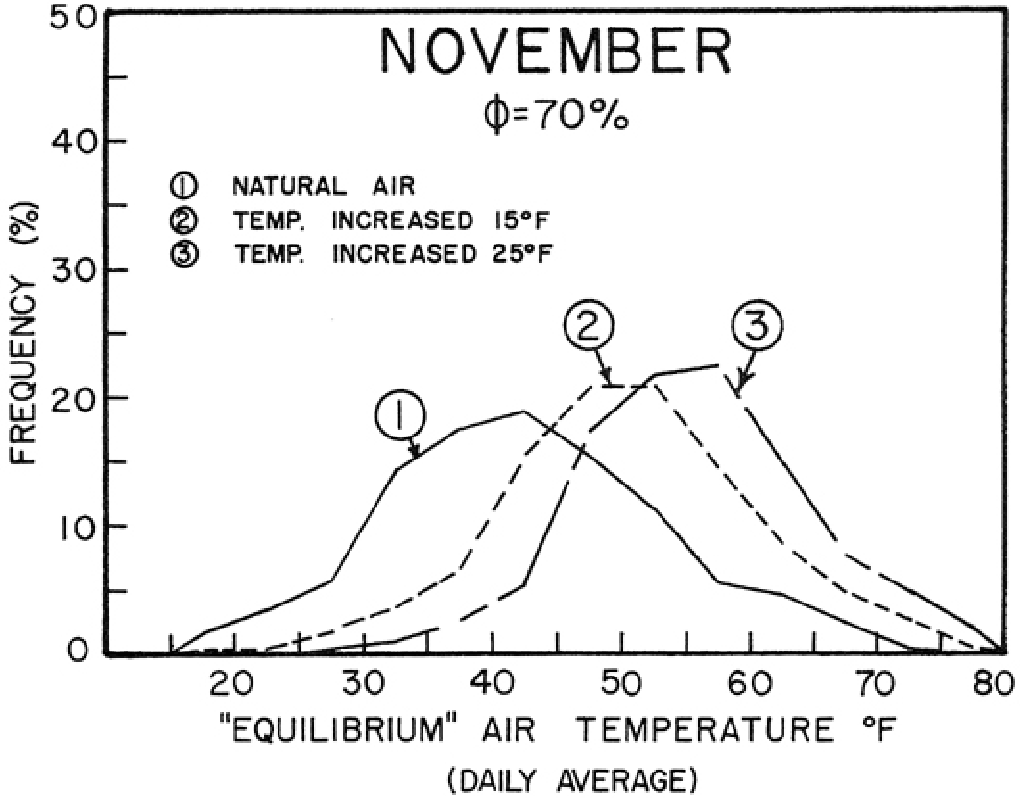
NOVEMBER
Φ=70%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
20
30
40
50
60
70
80
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 24

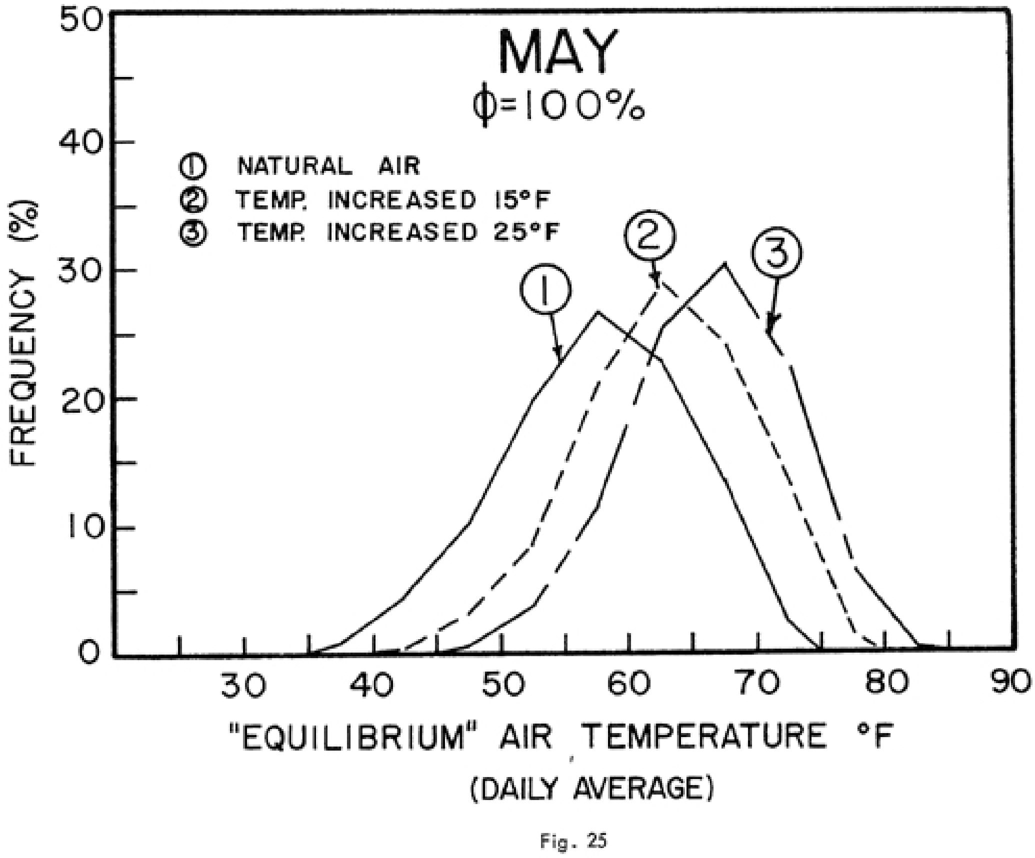
MAY
Φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
30
40
50
60
70
80
90
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 25

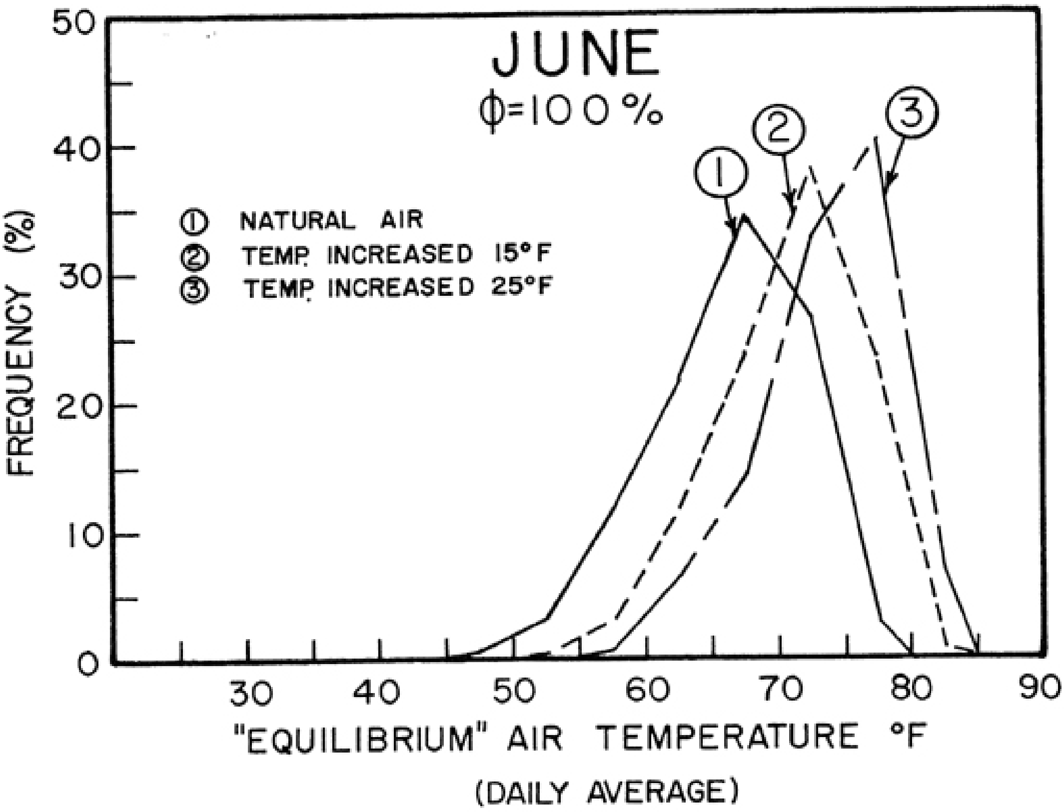
JUNE
ϕ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
30
40
50
60
70
80
90
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 26

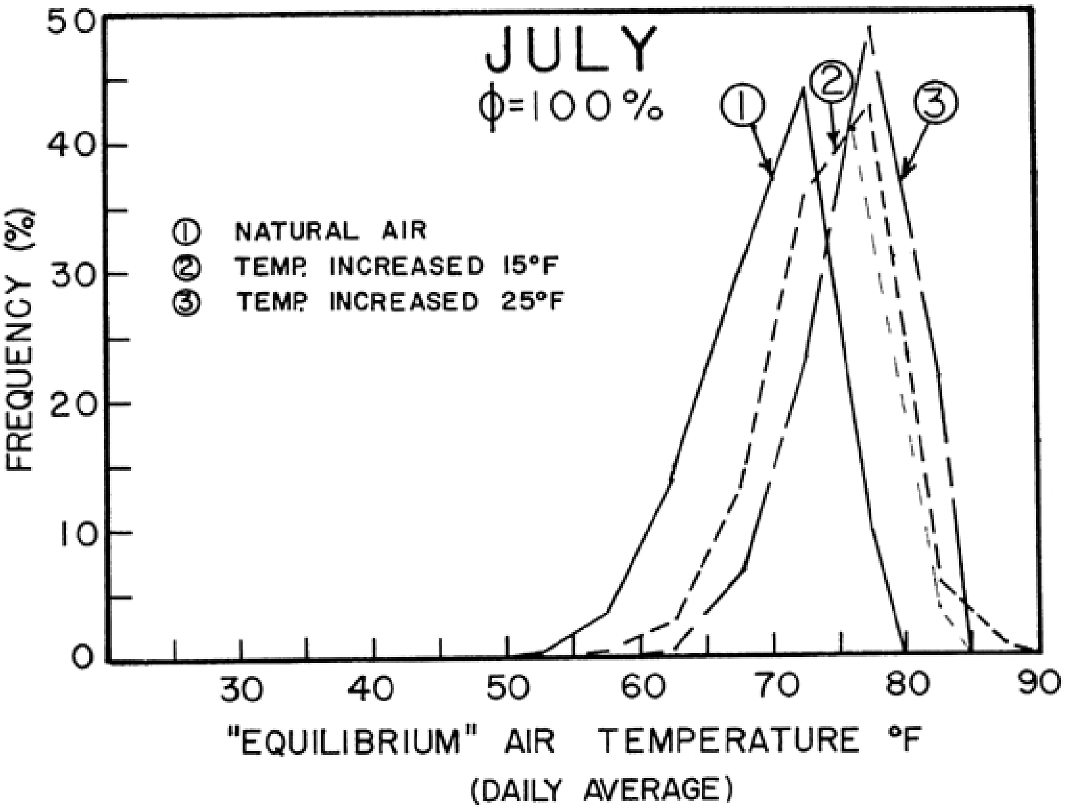
JULY
ϕ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
30
40
50
60
70
80
90
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 27

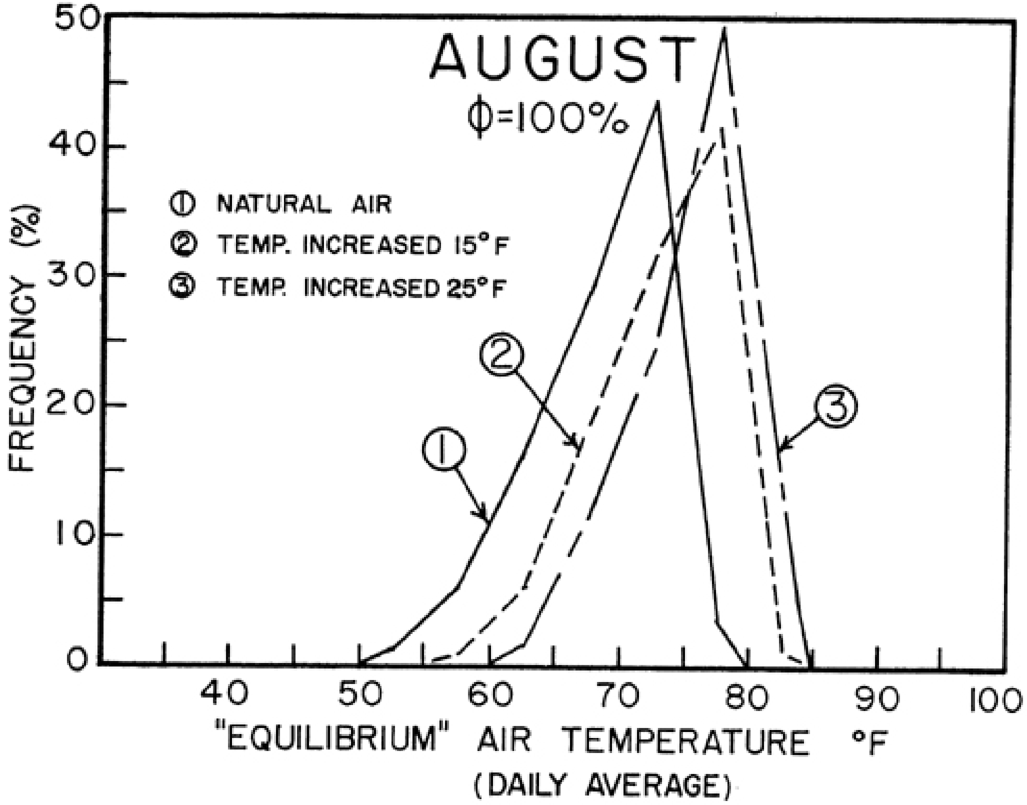
AUGUST
Φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
FREQUENCY (%)
0
10
20
30
40
50
40
50
60
70
80
90
100
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)
①
②
③

Fig. 28

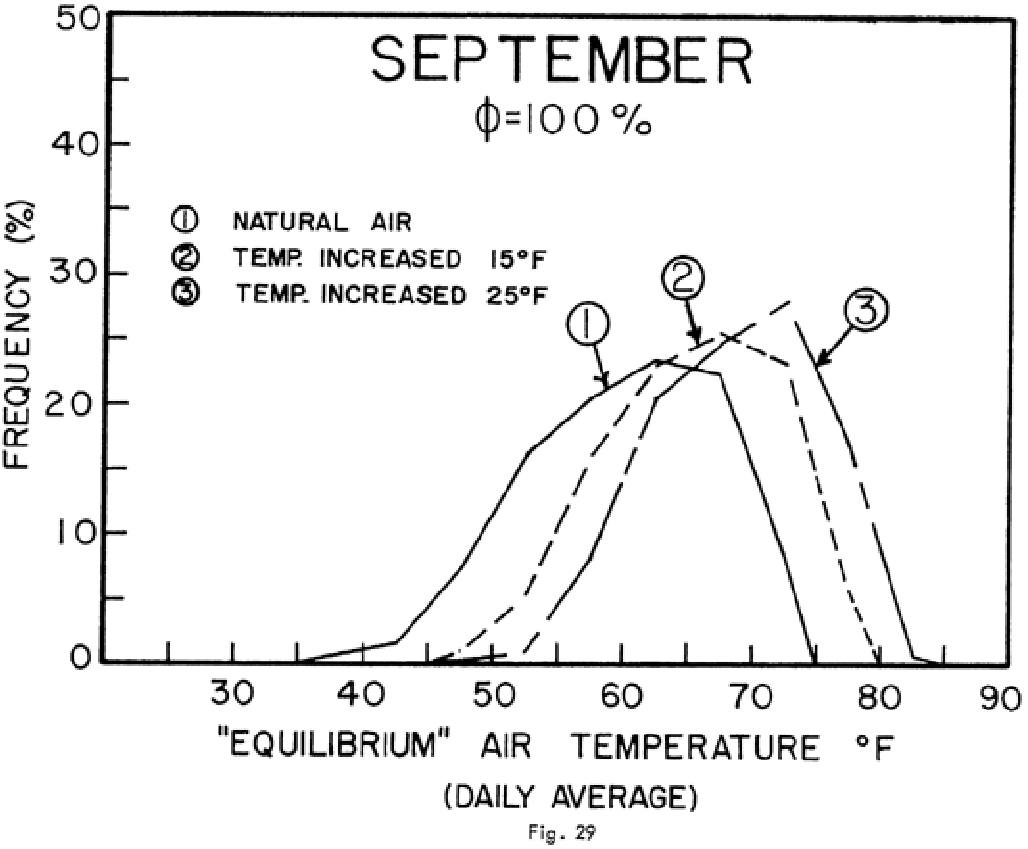
SEPTEMBER
Φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
FREQUENCY (%)
0
10
20
30
40
50
30
40
50
60
70
80
90
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)
①
②
③

Fig. 29

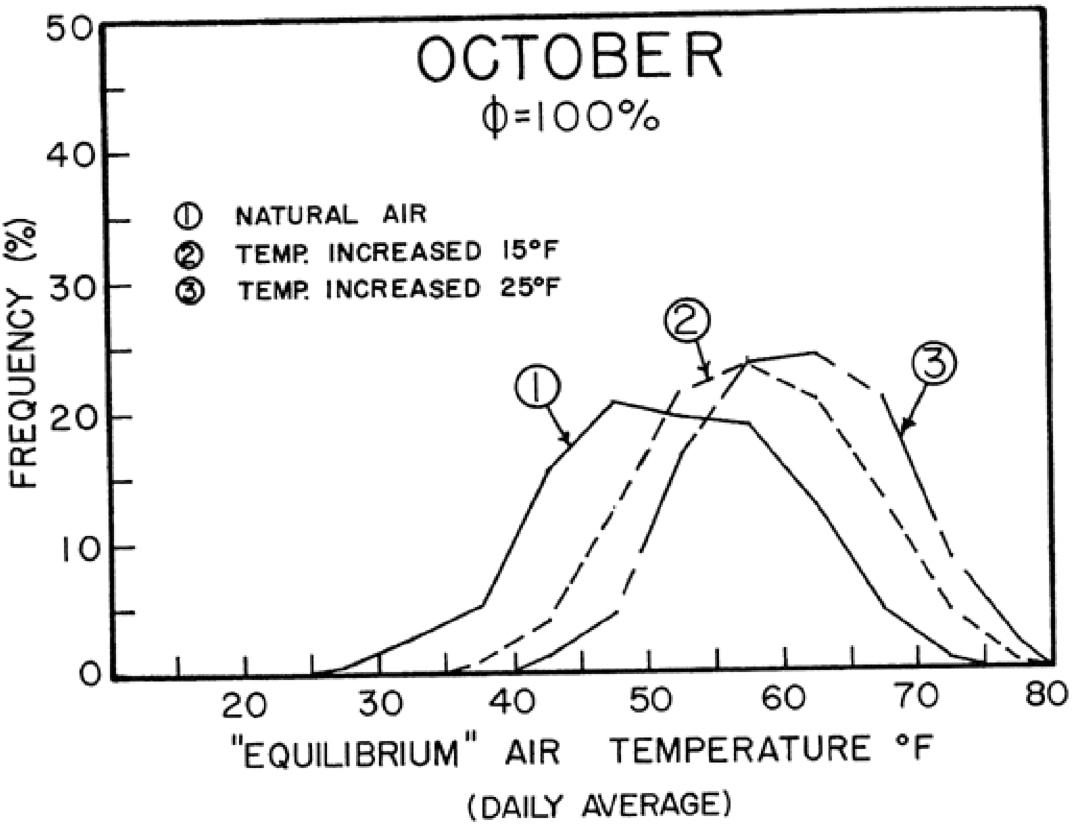
OCTOBER
φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
20
30
40
50
60
70
80
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 30

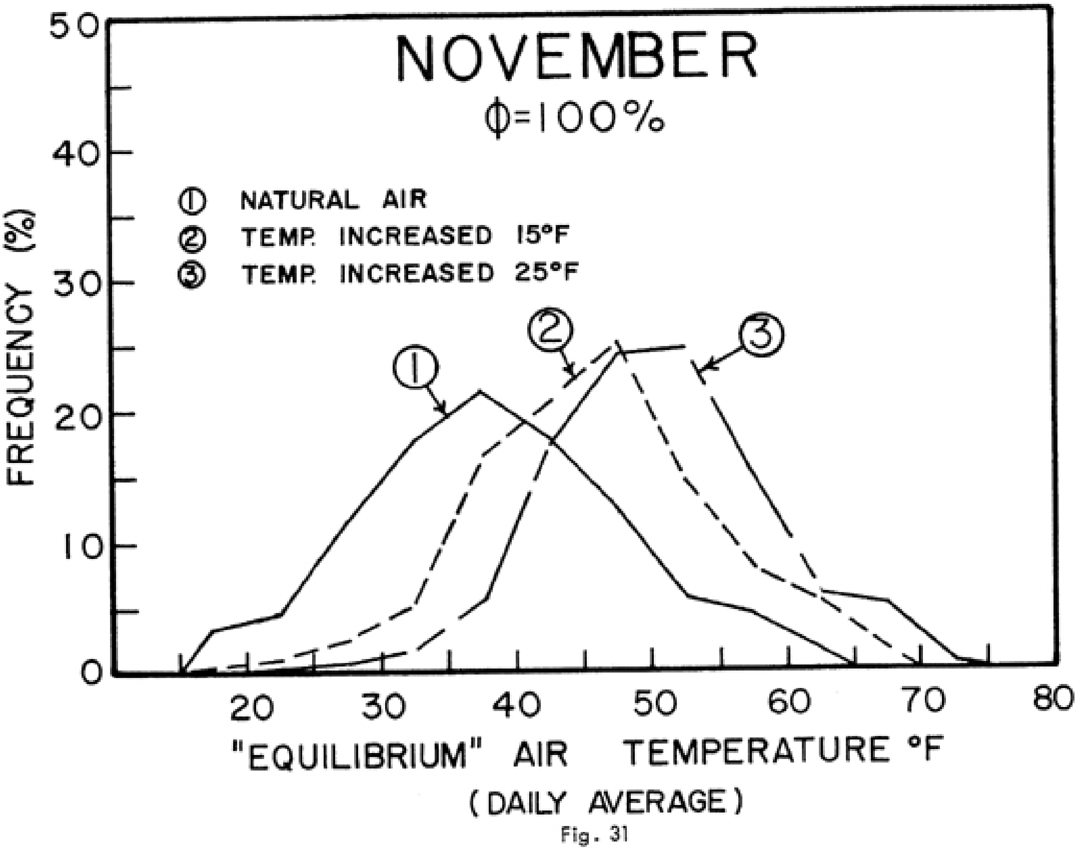
NOVEMBER
φ=100%
① NATURAL AIR
② TEMP. INCREASED 15°F
③ TEMP. INCREASED 25°F
①
②
③
FREQUENCY (%)
0
10
20
30
40
50
20
30
40
50
60
70
80
"EQUILIBRIUM" AIR TEMPERATURE °F
(DAILY AVERAGE)

Fig. 31

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