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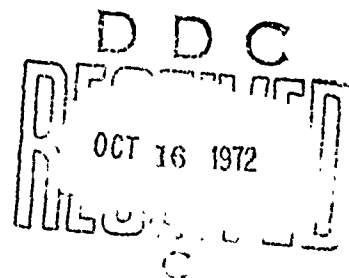*Final Report*   *June 1972*

PARAMETRIC STUDY OF THERMAL PROBLEMS IN DENSELY POPULATED SHELTERS

CONTRACT DAHC20-71-C-0290
DCPA Work Unit 1215D

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Menlo Park, California 94025 · U.S.A.

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Stanford Research Institute	Unclassified
333 Ravenswood Avenue	2b. GROUP
Menlo Park, California 94025	(Not applicable)

3. REPORT TITLE

PARAMETRIC STUDY OF THERMAL PROBLEMS
IN DENSELY POPULATED SHELTERS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

Final Report

5. AUTHOR(S) *(First name, middle initial, last name)*

Frank C. Allen

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
June 1972	102	68

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
DAHC20-71-C-0290	None
b. PROJECT NO. 1200	
c. Task 1210	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d. DCPA Work Unit 1215D	SRI Project URU-1218

10. DISTRIBUTION STATEMENT

Approved for Public Release; Distribution Unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Defense Civil Preparedness Agency Washington, D.C. 20301

13. ABSTRACT

Thermal problems treated analytically in this report relate to transfer of metabolic heat from human bodies to a shelter environment and to some effects of population density on optimum clothing, skin wetness, limits for thermal equilibrium, and contributions made by each of six processes for heat/mass transfer. These processes include: radiation and convection at skin or clothing surfaces, heat conduction through clothing, respiratory heat exchange, vapor diffusion through dry skin, and evaporation of sweat at wet skin surfaces. Thermal equilibrium is maintained in cool environments by modifying thermal resistance of clothing and in warm environments by adjusting the ratio of wet to total skin areas. Also, an analysis of moist-air mixing processes is used to evaluate operational requirements for partial recirculation of ventilating air during cold weather. Analyses and computations are based on correlated data from the scientific literature. Results are presented graphically in 9 figures and numerically in 18 tables.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Shelters						
Survival						
Thermal environment						
Thermal problems						
Population density						
Environmental control						
Metabolic heat						
Thermal equilibrium						
Temperature						
Humidity						
Radiation						
Convection						
Evaporation						
Insensible weight loss						
Clothing						
Heat transfer						
Ventilation						
Air distribution						
Psychrometric process						
Partial recirculation						
Air mixing						
Cold weather						

SUMMARY

Introduction

The problems investigated in this study relate to the effects of population density on the transfer of metabolic heat and moisture from sedentary persons to the environment in shelters. Also, parameters associated with nonuniform (varistate) environments and partial recirculation of ventilating air during cool or cold seasons are evaluated.

Metabolic Heat Transfer

To maintain deep-tissue and skin-surface temperatures within ranges compatible with acceptable levels of comfort, the human body must reject heat to the environment by one or more physical processes in accordance with equations for thermal equilibrium,

$$S = M - W - (R_s + C_s + C_r) - (E_w + E_d + E_r) = 0$$

in which quantities are energy rates, as follows:

S = heat storage (positive if mean body temperature tends to increase)

M = metabolic energy expenditure (100 kcal/hr for a sedentary person having a skin surface area of 2 square meters)

W = external work performed (zero for sedentary persons)

R_s = heat transfer by radiation at exposed surfaces of skin or clothing

C_s = heat transfer by convection at exposed surfaces of skin or clothing

C_r = heat associated with change in temperature of respired air

E_w = heat transfer by evaporation of sweat at wet skin areas

E_d = heat transfer by diffusion of water vapor through dry skin areas

E_r = heat of vaporization associated with moisture added to respired air.

The components of sensible heat, $(R_s + C_s + C_r)$, and latent heat, $(E_w + E_d + E_r)$, are positive if the process tends to cool the body.

Each of the heat transfer processes has been evaluated, together with appropriate coefficients, by reference to scientific literature, and the results are used to synthesize a program for computing metabolic parameters under selected conditions. The program is based on maintenance of model skin temperatures under all combinations of conditions for which thermal equilibrium is possible by varying either the insulating value of clothing or the evaporative cooling effect associated with sweat gland activity. The threshold for regulatory secretion of sweat corresponds to the temperature at which the required insulating value of clothing is just zero. At higher temperatures, sweat rates and skin wetness are increased to develop the required evaporative cooling effect. A limit for thermal equilibrium is reached when either the skin is completely wet or a maximum sweat rate is attained. Within an air temperature range of $10^\circ C$ $(50^\circ F)$ to $52^\circ C$ $(125.6^\circ F)$, model skin temperatures for sedentary persons vary from $32^\circ C$ $(89.6^\circ F)$, at which skin is typically dry, to $36^\circ C$ $(96.8^\circ F)$, at which skin may be completely wet in a humid environment.

Computed values of metabolic data relating to sedentary persons are tabulated in the report for the nine combinations of conditions listed in Table S-1. For each of nine values of air temperature and three values of relative humidity, the numerical tables include the following items of metabolic data:

- Saturated vapor pressure at mean skin temperature

- Latent heat transfer

- Sensible heat transfer

- Heat storage

- Heat transfer by radiation at exposed surfaces

- Heat transfer by convection at exposed surfaces

- Sensible heat transfer associated with respiration

- Latent heat transfer associated with respiration

- Latent heat transfer by vapor diffusion through dry skin

- Latent heat transfer by evaporation at wet skin areas

- Partial pressure of water vapor in the environment

- Thermal resistance of clothing needed for thermal equilibrium in cool environment

- Ratio of wet to total skin areas

S-2

DATA FOR NUMERICAL TABLES OF METABOLIC PARAMETERS

TABLE NUMBER	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
SKIN TEMPERATURE, T3, AT AIR TEMPERATURE, T, (CELSIUS) $T3=34$	X								
$T3=34+1.5*ATN(0.1967*(T-31))$		X	X	X	X	X	X	X	X
ATTENUATION FACTOR, F3, FOR VAPOR DIFFUSION THROUGH CLOTHED SKIN AREAS $F3=1.0$	X	X	X		X	X	X		
$F3=1/(1+0.1*K2)$				X				X	
$F3=1/(1+0.2*K2)$									X
MEAN RADIANT TEMPERATURE, T1, IN OCCUPIED SPACE (CELSIUS) $T1=T$	X	X	X	X	X	X			X
$T1=T3 \quad OR \quad T1=T2$							X		
$T1=(T3+T)/2 \quad OR \quad T1=(T2+T)/2$								X	
CONVECTION COEFFICIENT, H1, FOR EXPOSED SKIN OR CLOTHING KCAL/(HR*SQ M*°C)	4.0	4.0	4.0	3.4	5.0	7.0	4.0	4.0	4.0
EVAPORATION COEFFICIENT, E1, FOR WET SKIN AREAS KCAL/(HR*SQ M*MMHG)	8.0	8.0	8.0	6.8	10.0	14.0	8.0	8.0	8.0
RELATIVE AIR VELOCITY, V1 CENTIMETERS/SECOND	15	15	15	10	23	45	15	15	15
FEET/MINUTE	30	30	30	20	45	90	30	30	30

T3=SKIN TEMPERATURE, T2=CLOTHING TEMPERATURE, T=AIR TEMPERATURE (CELSIUS)
K2=THERMAL RESISTANCE OF CLOTHING (CLO UNITS)

- Temperature gradient through clothing.

Relationships among metabolic parameters are illustrated graphically in the report by Figures 4, 5, and 6, which are based on conditions shown for Tables A-3 and A-4 in Table S-1.

Effects of Population Density

If ventilating air is supplied to an unoccupied, insulated room through openings at one end and removed through openings at the opposite end, temperatures and longitudinal air velocities in the space should be virtually uniform, and the mean radiant temperature should be equal to the air temperature. The entry of people into this room would divert air to levels near the ceiling because people partially obstruct air flow near the floor level. If the population becomes dense and overhead clearance is relatively large, most of the air may flow through the overhead space. Air velocities near the floor may then approach the low values associated with natural convection, and coefficients for transfer of metabolic heat and moisture would be proportionately reduced. The increase in population density would also cause a change in mean radiant temperature to a value that is intermediate between mean wall surface temperature and the mean temperature of exposed skin or clothing surfaces. The magnitude of these effects is closely related to quantities that are evaluated in the study of metabolic parameters under the conditions listed in Table S-1. Tabulated values of relative air velocity include 20, 30, 45, and 90 feet per minute. Values are tabulated at an air velocity of 30 feet per minute with mean radiant temperatures that are:

- Equal to air temperature

- Equal to the temperature of exposed skin or clothing surfaces

- The mean of air temperature and the temperature of exposed skin or clothing.

Shelter Ventilation

When ventilating air is well distributed in accordance with the distributi a of heat loads in an occupied space, the environment may approach spatial uniformity. On the other hand, if the ventilating air moves horizontally through the space from one boundary to an opposite boundary, environmental conditions will change gradually as metabolic heat and moisture are added along the air stream. The environmental temperature adjacent to the boundary along which air is supplied to the space will be essentially

the same as the supply air temperature. If the ventilating system supplies only atmospheric (outside) air to the space, shelter temperatures during wintertime may be warm at the end from which air is exhausted, but may be far below the prescribed minimum of 50°F near the end to which air is supplied. This study demonstrates that a minimum temperature of 50°F in the occupied space of a shelter that has insulated or massive walls can be maintained during very cold weather by partial recirculation of ventilating air, a mixing process that utilizes metabolic heat for tempering fresh air.

Ventilation process lines, each of which shows the locus of environmental states along a path of air flow, are determined on the basis of a pair of linear equations that approximate metabolic data derived in the section on Metabolic Parameters. These equations are:

$$\rho = 0.25 \text{ when } T \leq 82.5°F$$

and

$$\rho = 0.06T - 4.7 \text{ when } T \geq 82.5°F$$

where

$$\rho = \text{ratio of latent to total metabolic heat}$$

$$T = \text{air temperature of local environment.}$$

Several ventilation process lines, each of which approaches the value $T = 95°F$ asymptotically, are shown graphically on Figure 7 in the report. This figure also includes isoventilation lines that relate the temperature of exhaust (or recirculated) air to ventilating rate, when fresh or mixed air is supplied to the occupied space at a temperature of 50°F.

A computer program that simulates the process for mixing fresh and recirculated air was developed on the basis of a nonuniform environment and used to evaluate parameters associated with the partial recirculation process when the mixed (supply) air temperature is 50°F and the fresh air temperature varies from +50°F to -50°F. The results are shown graphically on Figure S-1 and numerically in Appendix B of the report.

The effects of heat transmission through building elements on surface temperatures, interactions among metabolic parameters, partial recirculation of air, and the configuration of ventilating systems should be investigated in depth.
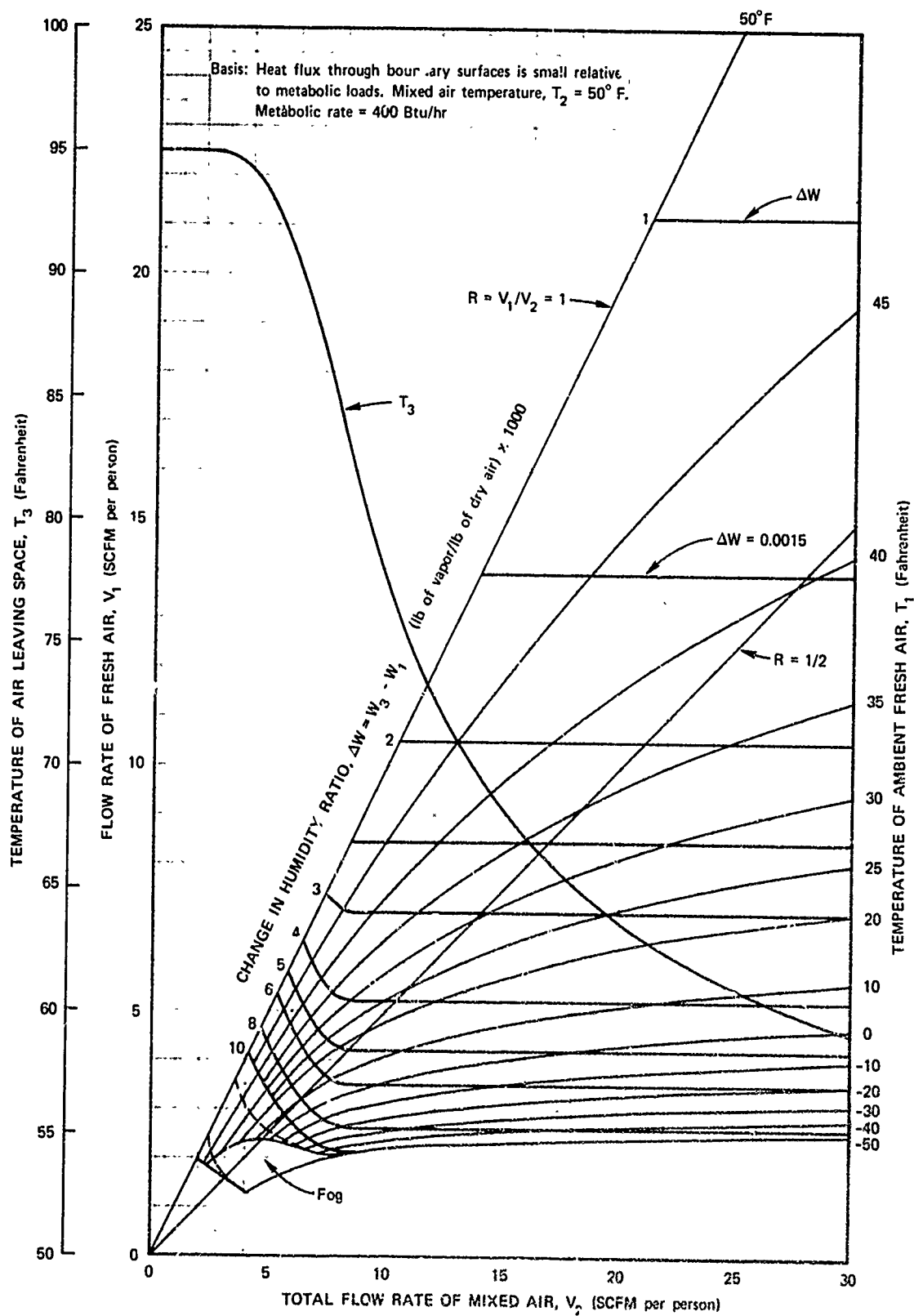
FIGURE S-1 . VENTILATION OF AN OCCUPIED SPACE WITH MIXED
FRESH AND RECIRCULATED AIR AT 50°F

ABSTRACT

The thermal problems considered in these studies are associated with
the transfer of metabolic heat and moisture from the human body to a
shelter environment and with the effects thereon of population density.
The studies are also concerned with the requirements and rationale for
partial recirculation of ventilating air in shelters during cool and cold
weather.

An analytical model for thermal metabolism is developed and used to
evaluate metabolic parameters under several conditions of shelter oc-
cupancy. This model includes the effects of six processes for transfer
of metabolic heat: radiation at skin or clothing surfaces, convection
at skin or clothing surfaces, heat conduction through clothing, respiratory
heat exchange, vapor diffusion through dry skin, and evaporation of
sweat from wet skin surfaces. Thermal equilibrium is maintained in
cool environments by modifying the thermal resistance of clothing, and
in warm environments by adjusting the ratio of wet to total skin surface,
that is, the rate of evaporative cooling. The parameters are correlated
graphically, and supplementary data are included in numerical tables.

Ventilation process lines for varistate environments are shown on
a psychrometric chart, together with isoventilation lines for an initial
or mixed air temperature of $50^{\circ}F$, as supplied to the shelter. Parameters
associated with partial recirculation of air when ambient conditions are
less than or equal to $50^{\circ}F$ are compared graphically.

CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

If a shelter or other occupied space is to remain habitable, means must be provided for maintaining an environment that is capable of supporting essential metabolic processes. Thus, oxygen consumed must be replaced, excessive concentrations of carbon dioxide and other noxious constituents must not be allowed to develop, and the transfer of metabolic heat and moisture to the environment must be possible with near-normal body temperatures. In general, elementary control of a shelter environment can be accomplished most economically by ventilation with air from the surrounding atmosphere.

Per capita ventilating rates required to maintain an environment in which the effective temperature is equal to or less than a stated value during at least a stated percentage of the hours in an average year have been determined for shelters in various climatic locations.[1]* Criteria based on these determinations have been promulgated for application to shelters;[2] these criteria specify that effective temperatures in occupied shelters shall be 82° FET or less during at least 90 percent of the days in an average year. It is further specified that the minimum temperature in a shelter environment shall not be less than 50°F. Capacities of ventilation systems determined under these criteria vary from 5 SCFM per person in Alaska to 40 SCFM per person along part of the Gulf coast of Texas.† These criteria are based on analyses in which the environment is assumed to be spatially uniform. Air entering an occupied space is

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* References are listed at the end of the report

† The unit SCFM refers to standard cubic feet per minute, that is, air having a dry density of 0.075 lb/ft^3.

1

assumed to mix completely and instantaneously with air in the space. The shelter structure is assumed to be perfectly insulated or "adiabatic."

Assumption of a uniform environment is consistent with air conditioning practice, in which air is usually well distributed within occupied spaces by a system of ducts and diffusion outlets. A more realistic assumption for the case of shelters would be that air will not be distributed in proportion to heat loads, but that heat and moisture will be added gradually to air stream as it passes through occupied spaces--in particular, through large, densely-populated spaces. Some effects of this gradual addition of heat and moisture to ventilating air have been demonstrated experimentally in the monoman calorimeter,[3] and analytically in a study of ventilating and mixing processes in shelters.[4]

Studies documented herein are concerned with the reciprocal effects of population density in a shelter on the thermal environment and the physical processes for transfer of metabolic heat from the human body to its surroundings. The studies include the derivation of a set of quantitative requirements for seasonal recirculation of ventilating air in shelters. Problems associated with population density stem from the facts that human bodies obstruct the normal flow of ventilating air and change the mean radiant temperature within an occupied space. These effects usually interfere to some degree with transfer of metabolic heat and therefore tend to modify the effective temperature or other index of environmental habitability. A meaningful study of these problems can only be made in conjunction with an evaluation of all significant physical processes for transfer of metabolic heat and moisture and the physiological reactions that can control these processes. The usual partition of metabolic heat into sensible and latent fractions is not sufficient for the purpose. A major effort has therefore been devoted to development of an analytical model for metabolic interactions with the environment.

2

II METABOLIC PARAMETERS

Seasonal and spatial variations in temperature may be relatively
large if an occupied shelter is ventilated with outside air and no
apparatus is provided for supplementary heating or cooling. Temperatures
in occupied spaces may rise to 100°F or more during warm seasons or fall
to 50°F or less during cold seasons. To maintain a tolerable degree of
comfort throughout this wide range of environmental conditions, clothing
that is adapted to the prevailing condition must be worn. Thus, heavy
or multilayered clothing would be optimum when the temperature is 50°F,
and light (or no) clothing would be optimum during hot weather. This
situation is not adequately represented by metabolic data for nude and
clothed persons in technical literature in which the term "clothed"
implies clothing that is suited to normal room temperatures. Thus, at
lower temperatures, the data include either a large storage component
or a high metabolic rate to obtain a heat balance. Moreover, published
data evaluate only the sensible and latent components of metabolic heat.
Such data do not provide information on the relative contributions made
to thermal equilibrium by radiation, convection, and the several modes
of evaporation.

For almost 50 years, the effective temperature index (ET) has
served as a means for evaluating habitability of an environment.[5] This
index, which considers the effects of temperature, humidity, and air
motion, was determined empirically from subjective responses of persons
during short exposures in test environments. In 1947, Yaglou suggested
that mean skin temperature could be used as an index of comfort.[6] Since
that time there has been a continuing effort to devise a comprehensive
index of comfort based on measurable physiological quantitites. This

3

effort has led to a better understanding of processes and control mechanisms for transfer of metabolic heat and moisture, and has resulted in the development of several methods for evaluating environments with regard to human comfort.[7-14] Recent investigators have defined rational relationships for the diffusion of water vapor through dry skin, a process that has been controversial since Sanctorius first measured weight loss associated with insensible perspiration in the seventeenth century.[11-15] Evaluation of this diffusion process and the process for latent heat transfer in the respiratory tract are of special interest in connection with the present study because these phenomena should be sensitive to changes in environmental humidity. Earlier sources of metabolic data have indicated that humidity has no significant effect on the partition of metabolic heat.[9,16-18]

For the purposes of this study, empirical expressions that define six processes for transfer of metabolic heat and moisture are evaluated by reference to technical and scientific literature to establish a reasonable level of confidence in the results. These expressions are then used to synthesize a computer program for calculation of combined effects and resultant parameters. The six contributory processes are as follows:

- Heat and moisture transfer in the respiratory tract

- Vapor diffusion through dry skin surface

- Evaporation of sweat from wet skin surfaces

- Convection from exposed surfaces of skin or clothing

- Radiation from exposed surfaces of skin or clothing

- Heat conduction through clothing.

Insofar as possible, data from original sources are interpreted and reduced to a common denominator in accordance with definitions and procedures outlined in recent biological handbooks.[19-20]

4

Most of the available data on energy expenditure, work capacity, and pulmonary ventilation is based on indirect calorimetry; that is, metabolic rates are deduced from measurements of breathing volume, temperature, pressure and changes in oxygen and carbon dioxide concentration during respiration. A value of 4.825 kilogram calories per liter of oxygen consumed is often used for this purpose.[19] However, the true energy equivalent for oxygen varies with the respiratory quotient (RQ), which is the volumetric ratio of carbon dioxide produced to oxygen consumed. The normal range of variation for this energy/oxygen equivalent can be illustrated by constructing a triaxial graph based on a set of linear equations derived by MacHattie.[21,22] This graph, which is shown in Figure 1, has three coordinate scales to represent the composition of a mixture of metabolized nutrients; that is, percentages of typical carbohydrates, fats, and proteins. Curves for other parameters are superimposed on this triaxial grid and are identified in Figure 1. According to Weir,[23] an average diet will result in metabolism of 10 to 15 percent of proteins with an RQ of about 83 percent. The energy equivalent for oxygen, K, would then be slightly more than 4.8 kilogram calories per liter of oxygen, STPD.[*] Under STPD conditions, oxygen has a density of 1.4277 grams per liter, or 0.08915 pounds per cubic foot.[24] The parameters evaluated in Figure 1 are typical for normal subjects engaged in sedentary activities, but may not be representative for persons having metabolic disorders (such as diabetes) or persons engaged in strenuous activities. Severe exercise and the onset of muscular

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[*] The abbreviation STPD refers to the standard volume of a gas measured in the dry state at a pressure of one atmosphere and a temperature 0°C. Breathing volumes are usually measured in the expired ATPS state, but reported in the BTPS state. ATPS refers to a volume of air in the saturated state at ambient temperature and pressure; BTPS refers to a volume of air in the saturated state at normal body temperature and ambient atmospheric pressure.
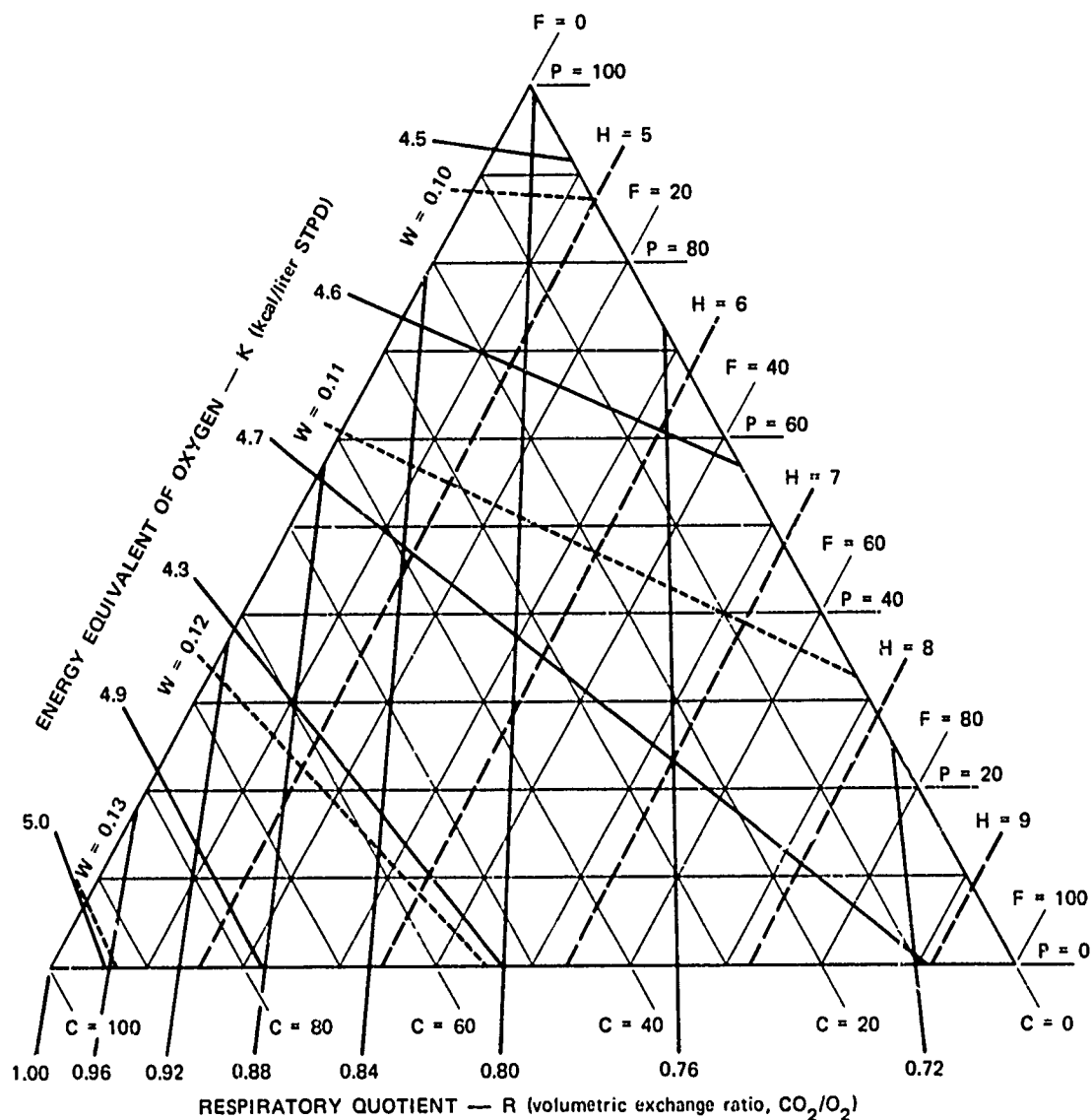
C, F and P are, respectively, the percentages of carbohydrate, fat and protein metabolized in a mixture of these fuels

H is caloric value of the metabolized mixture (kcal/gram).

W is quantity of metabolic water produced (grams/kcal).

Based on data from Reference 21.

FIGURE 1   BASIC PARAMETERS ASSOCIATED WITH ENERGY METABOLISM

fatigue are characteristically accompanied by the formation of blood lactates and an RQ greater than unity.[25] With regard to the storage of drinking water in shelters, it is interesting to note that the metabolic process produces about 0.12 grams of water per kilogram calorie of energy expenditure. For a man having an average metabolic rate of 75 kcal/hr, this is about 0.48 lb/day or 0.057 gal/day.

Respiratory Heat Exchange

Volume and Mass of Inspired Air

Respiratory heat exchange includes a sensible heat fraction (identified with the difference between the temperatures of inspired and expired air) and a latent heat fraction (associated with the change in moisture content of respired air). The magnitude of both effects is proportional to the rate of pulmonary ventilation, which in turn is proportional to the rate of energy expenditure or the oxygen consumption. Experimental data from nine sources are plotted in Figure 2. These data have been reduced to the STPD condition and converted from the expired to the inspired state, as necessary. A respiratory quotient of 85 percent was assumed in treating data that did not include values for this parameter.[23] For the purpose of evaluating respiratory heat exchange, an equation that relates the inspired mass of dry air to the metabolic rate will be convenient.

In Figure 2, Curve A (dashed) represents data from a series of tests reported in 1912 by Douglas and Haldane in which one subject (Douglas) walked in the laboratory and on grass at speeds of 2 to 5 miles per hour.[26] Curve B (short lines) represents average values from basal metabolism tests made by Boyer and Bailey of 500 normal subjects.[27] Curves C and D (solid lines) represent data from Asmussen and Nielsen for activities in which arm action (Curve C) or leg action (Curve D) is predominant.[28] The increased pulmonary ventilation associated with arm

7
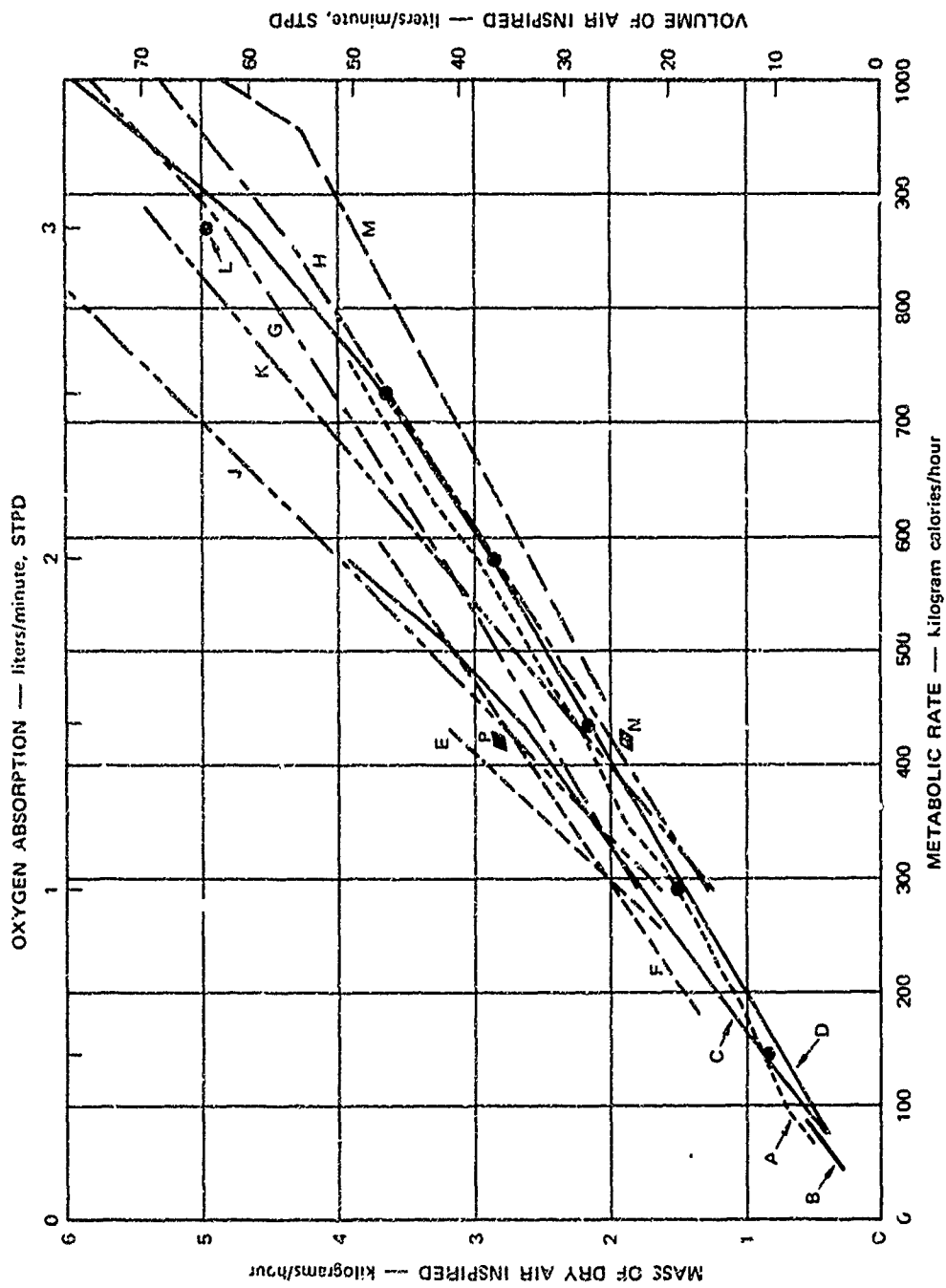
FIGURE 2   RELATIONSHIP OF PULMONARY VENTILATION TO ENERGY EXPENDITURE

motion is ascribed to mechanical manipulation of the rib cage. Curves E and F (dashed lines) represent data from Liddell for mining tasks that involve arm action (Curve E) and walking tasks (Curve F).[29] Curves G, H, J, and K (broken lines) represent data from Hermansen and Saltin.[30] Curves G and H are for trained athletes exercising on a bicycle ergometer (Curve G) or a treadmill (Curve H). Curves J and K are for untrained students exercising on a bicycle ergometer (Curve J) or a treadmill (Curve K). The trained athletes can extract more oxygen from a given quantity of air. Curve L (heavy dots) represents a series of tests for one subject exercising on a bicycle ergometer, first in the normal upright position and then while seated in an easy chair in a reclining position.[31,32] The results in these two positions were virtually identical. Curve M is the lower boundary of plotted data from 611 tests with 86 subjects, as reported by 11 investigators.[33] These tests involved walking, running and bicycling. The upper boundary of the data would interfere with identity of curves C, J, and F. Lines through the origin and the diamonds, N and P, would represent values of 2.0 and 3.0 for the "ventilatory equivalent for oxygen." This quantity can be defined numerically as the number of liters of air expired in the BTPS state for each 100 cubic centimeters of oxygen used in the STPD state.[19] In general, the venti- latory equivalent for oxygen associated with healthy persons engaged in normal activities will remain within the range of 2 to 3.[34] According to Knipping and Moncrieff,[34] lower values are characteristic for sleeping persons, and higher values may be associated with nervous tension or with the presence of such health disorders as heart disease, diabetes, anemia, and tuberculosis.

On the basis of data in Figure 2, a reasonable approximation for the mass of dry air inspired by people in shelters is

$$G = 0.006M \qquad (1)$$

9

where

G = mass of dry air inspired (kilograms/hr)

M = metabolic rate (kilogram calories/hr).

If the subjects are athletes and the activity involves little or no arm motion, $G = 0.005M$ may be a better approximation. Equation (2) is used in subsequent computations relating to respiratory heat losses and shelter ventilation. The mass velocity of dry air inspired by a sedentary individual having a metabolic rate of 100 kcal/hr (397 Btu/hr) is therefore 0.60 kg/hr (1.32 lb/hr).

Properties of Respired Air

To evaluate the contribution made by respiration in the transfer of metabolic heat and moisture, a logical relationship between the properties of inspired and expired air must be educed from the mass of literature relating to insensible weight loss or insensible perspiration. Insensible weight loss includes the moisture loss by diffusion through dry skin, the moisture added to respired air, and the differential mass associated with oxygen uptake and carbon dioxide rejection. For the purposes of this study, the experimental data and supporting information developed by Cole are most useful.[35-38] Cole's data were obtained with subjects breathing either dried air or air saturated with moisture at temperatures of $-30°C$ to $+50°C$. On the basis of his investigations, Cole derived several conclusions that are pertinent to this study, as follows:

* Saturated air inspired at body temperature ($37°C$) is expired in the same condition.

* Air in the lungs is saturated with water vapor at body temperature.

* The upper respiratory tract serves as an efficient device for heat recovery. For example, during inspiration of cold air,

10

surfaces of the upper respiratory tract (nasal mucosa) are chilled. During expiration, these chilled surfaces are warmed by heat and moisture extracted from the expired air.

* The condition of expired air is independent of the rate of pulmonary ventilation.

* Within terrestrial limits, changes in altitude have little effect upon the condition of respiratory air.

* The body loses more heat and moisture during oral than during nasal breathing at room temperature.

* During nasal breathing, remote thermal stimuli can modify blood flow to nasal mucosa and raise or lower the temperature of inspired air in the pharynx and expired air at the anterior nares. A comparable effect is not exhibited during oral breathing. For example, during nasal breathing at room temperature, immersion of the feet in warm water at $45^{\circ}C$ is accompanied by an increase of $2^{\circ}C$ to $3^{\circ}C$ in the temperature of expired air. Local heating (or cooling) of the dorsal region of the back is also accompanied by an increase (or decrease) in expired air temperature.

Cole's conclusions were generally confirmed by Ingelstedt.[39] The recovery of heat in the upper respiratory tract was well demonstrated by Seeley.[40] The temperatures of expired air indicated by Cole are in good agreement with values obtained by Seeley[40] and Webb,[41,42] but are generally lower than data at moderate and high termperatures obtained by Burch[43,44] and McCutchan and Taylor.[45] The experimental procedures of both Burch and McCutchan and Taylor were based on oral breathing, and the expired air was usually found to be less than saturated. In analyzing data on heat removed from the body by respiration, Burch included the effect of decomposition of carbonic acid. An analysis of heat exchange by Caldwell,

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11

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11

Gomez, and Fritts[46] shows that this endothermic reaction is counteracted by an exothermic effect arising from the combination of oxygen with blood.

Figure 3 shows a model for respiratory parameters associated with a wide range of environmental conditions. Within the range of inspired air temperatures extending from -30°C to $+50^\circ$C, the solid lines labeled 0% and 100% are a good representation for Cole's data.[38] The curves are extrapolated below and above this range. It is assumed that expired air temperatures associated with inspired air having relative humidities between 0 and 100 percent can be determined by linear interpolation. Therefore, in accordance with Cole's postulate that expired air is virtually saturated, the two solid curves on Figure 3 completely define the condition of expired air associated with any given condition of inspired air within these wide limits. With reference to Figure 3, the equation for expired air temperature is

$$T_e = U_o + \phi_i U/100, \qquad (2)$$

where

T_e = expired air temperature ($^\circ$C)

ϕ_i = relative humidity of inspired air (percent)

U_o = expired air temperature when $\phi_i = 0\%$ ($^\circ$C)

$U = U_s - U_o$ = the maximum difference in expired air temperatures associated with humidity of inspired air ($^\circ$C)

U_s = expired air temperature when $\phi_i = 100\%$ ($^\circ$C).

The lower curve is a linear function of T_i, the temperature of inspired air,

$$U_o = 28 + 0.1 T_i \qquad (3)$$
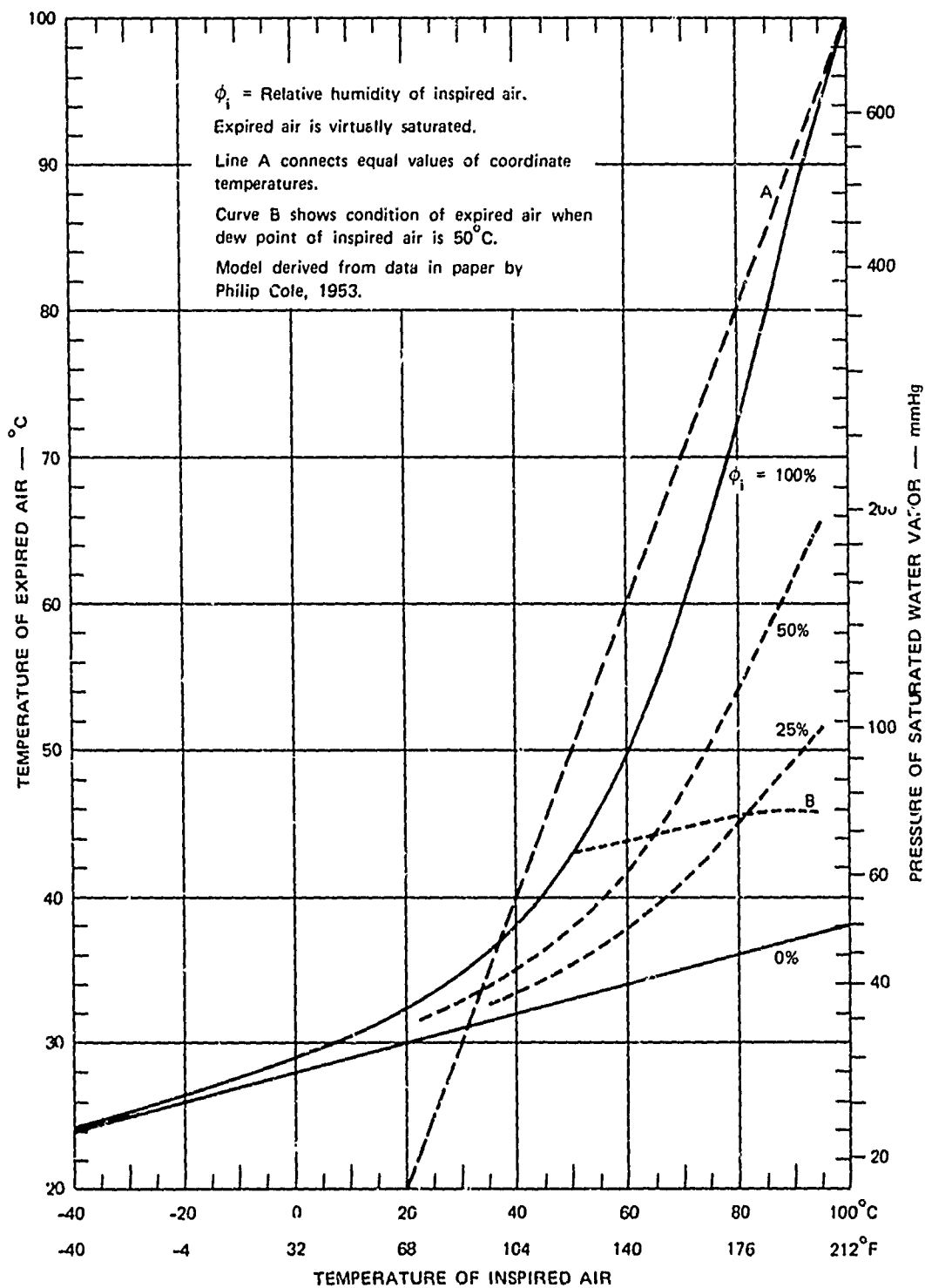
FIGURE 3   THERMAL PROPERTIES OF RESPIRED AIR

13

and the temperature difference, U, is an exponential function of T_i,

$$U = \exp(0.040819T_i + 0.0001325T_i{}^2 - 0.0000000128T_i{}^4) \qquad (4)$$

The numerical coefficients in Eq.(4) were determined by the following criteria:

- $T_e = 29^\circ C$ when $T_i = 0^\circ C$.

- $T_e = 37^\circ C$ when $T_i = 37^\circ C$.

- $T_e = 100^\circ C$ when $T_i = 100^\circ C$.

- $dT_e/dT_i = 1$ when $T_i = 100^\circ C$.

The first two criteria are salient data points that in themselves determine an exponential equation, $U = e^{0.045073T_i}$, which suggests that

$$T_e > T_i \text{ when } T_i > 87^\circ C.$$

The third and fourth criteria merge the two temperatures at $100^\circ C$ and avoid this apparent incongruity.

Values of respiratory parameters based on Eq. (2), (3), and (4) are shown in Table 1 for a pulmonary ventilation rate of one kilogram of inspired dry air per hour, which from Eq. (1) corresponds to a metabolic rate of about 167 kilogram calories per hour. Column 1 shows the relative humidity of inspired air, and Column 2 is the humidity ratio times 100. Each group of three relative humidities is identified with an inspired air temperature and a corresponding saturation pressure, PS. Column 3 is the humidity ratio of expired air times 100, and Column 4 is the temperature of expired air on the Celsius scale. Column 5 is the mass of moisture added to or extracted from the respired air in grams per hour. Column 6 is the latent heat of vaporization for moisture added or extracted, in kilogram calories per hour. Column 7 is the sensible heat associated with the temperature difference, $T_e - T_i$, in kilogram

14

TABLE 1

PROPERTIES OF RESPIRED AIR

INSPIRED AIR RH%	W*100	EXPIRED AIR W*100	SATEMP	MOISTX GRM/HR	LATENT KCL/HR	SENSEX KCL/HR	EXPRES MMHG
INSPIRED AIR TEMP= -50.0 C, PS= +2.9514E-02 MMHG							
0	0.00000	1.78125	+23.00	+17.81	+10.34	+17.82	21.066
50	0.00121	1.79052	+23.08	+17.59	+10.38	+17.84	21.173
100	0.00243	1.79985	+23.17	+17.97	+10.43	+17.87	21.280
INSPIRED AIR TEMP= -40.0 C, PS= +9.6252E-02 MMHG							
0	0.00000	1.89535	+24.00	+18.95	+10.99	+15.64	22.375
50	0.00396	1.90911	+24.12	+19.05	+11.05	+15.67	22.533
100	0.00792	1.92296	+24.23	+19.15	+11.11	+15.70	22.692
INSPIRED AIR TEMP= -30.0 C, PS= +2.8488E-01 MMHG							
0	0.00000	2.01605	+25.00	+20.16	+11.69	+13.46	23.755
50	0.01172	2.03648	+25.16	+20.25	+11.74	+13.50	23.988
100	0.02344	2.05709	+25.33	+20.34	+11.79	+13.54	24.223
INSPIRED AIR TEMP= -20.0 C, PS= +7.7387E-01 MMHG							
0	0.00000	2.14368	+26.00	+21.44	+12.42	+11.27	25.209
50	0.03183	2.17439	+26.23	+21.43	+12.41	+11.33	25.557
100	0.06369	2.20552	+26.47	+21.42	+12.41	+11.39	25.911
INSPIRED AIR TEMP= -10.0 C, PS= +1.9480E+00 MMHG							
0	0.00000	2.27862	+27.00	+22.79	+13.20	+9.07	26.739
50	0.08016	2.32579	+27.34	+22.46	+13.01	+5.17	27.272
100	0.16053	2.37384	+27.67	+22.13	+12.82	+9.26	27.815
INSPIRED AIR TEMP= +0.0 C, PS= +4.5813E+00 MMHG							
0	0.00000	2.42126	+28.00	+24.21	+14.02	+6.87	28.349
50	0.18882	2.49560	+28.50	+23.07	+13.35	+7.01	29.186
100	0.37879	2.57202	+29.00	+21.93	+12.69	+7.15	30.044
INSPIRED AIR TEMP= +10.0 C, PS= +9.2049E+00 MMHG							
0	0.00000	2.57202	+29.00	+25.72	+14.88	+4.67	30.044
50	0.38058	2.69259	+29.76	+23.12	+13.37	+4.88	31.393
100	0.76585	2.81835	+30.52	+20.52	+11.87	+5.09	32.795
INSPIRED AIR TEMP= +20.0 C, PS= +1.7531E+01 MMHG							
0	0.00000	2.73131	+30.00	+27.31	+15.80	+2.46	31.826
50	0.72895	2.93270	+31.19	+22.04	+12.74	+2.78	34.066
100	1.47519	3.14767	+32.38	+16.72	+9.66	+3.10	36.441
INSPIRED AIR TEMP= +30.0 C, PS= +3.1826E+01 MMHG							
0	0.00000	2.89961	+31.00	+29.00	+16.76	+0.25	33.699
50	1.33631	3.24539	+32.90	+19.09	+11.03	+0.72	37.516
100	2.73131	3.62895	+34.79	+8.98	+5.18	+1.22	41.703
INSPIRED AIR TEMP= +37.0 C, PS= +4.7076E+01 MMHG							
0	0.00000	3.02304	+31.70	+30.23	+17.47	-1.31	35.066
50	1.99761	3.53557	+34.35	+15.38	+8.88	-0.67	40.688
100	4.12780	4.12780	+37.00	+0.00	+0.00	+0.00	47.076
INSPIRED AIR TEMP= +40.0 C, PS= +5.5338E+01 MMHG							
0	0.00000	3.07740	+32.00	+30.77	+17.78	-1.98	35.666
50	2.36176	3.68623	+35.06	+13.24	+7.64	-1.25	42.324
100	4.90995	4.40563	+38.12	-5.04	-2.91	-0.49	50.033
INSPIRED AIR TEMP= +50.0 C, PS= +9.2554E+01 MMHG							
0	0.00000	3.26519	+33.00	+32.65	+18.86	-4.20	37.733
50	4.05564	4.36138	+37.95	+3.06	+1.76	-3.12	49.564
100	8.67709	5.79688	+42.90	-28.80	-16.55	-1.93	64.474
INSPIRED AIR TEMP= +60.0 C, PS= +1.4946E+02 MMHG							
0	0.00000	3.46354	+34.00	+34.64	+19.99	-6.44	39.904
50	6.82673	5.47634	+41.90	-13.50	-7.76	-4.83	61.200
100	15.33683	8.58126	+49.80	-67.56	-38.69	-2.98	91.657
INSPIRED AIR TEMP= +70.0 C, PS= +2.3379E+02 MMHG							
0	0.00000	3.67300	+35.00	+36.73	+21.19	-8.69	42.181
50	11.38460	7.42856	+47.26	-39.56	-22.69	-6.39	80.669
100	27.87069	14.91301	+59.51	-129.58	-73.86	-3.49	146.129
INSPIRED AIR TEMP= +80.0 C, PS= +3.5528E+02 MMHG							
0	0.00000	3.89420	+36.00	+38.94	+22.46	-10.94	44.570
50	19.10717	10.94783	+54.10	-81.59	-46.63	-7.90	113.123
100	55.15957	32.06338	+72.21	-230.96	-130.81	-3.34	257.014

15

calories per hour. Column 8 is the vapor pressure of saturated water vapor in expired air in millimeters of mercury. The values in Columns 5, 6 and 7 may be either positive or negative, and should be multiplied by 0.60 for a metabolic rate of 100 kcal/hr.

The range of inspired air temperatures in Figure 3 extends upward to 100°C (212°F). If the relative humidity is very low, air at this high temperature can be breathed without pain or injury;[45] in fact, whole body exposure in such an environment can be tolerated for a short time, as in a sauna bath.[47,48] In saturated air, tolerance time for whole body exposure would be short at 40°C (104°F), and at dew point temperatures on the order of 50°C (122°F), condensation of hot water on the skin or nasal mucosa may be painful. Lind[49] found that respiratory discomfort was first apparent in saturated air at 39°C (102°F) in connection with mine rescue operations. Killick (quoted by Lind) had noted incipient discomfort at 54.5°C (130°F) for men at rest and 51.5°C (125°F) for men at work. Haldane noted that respiration in saturated air at 54.5°C (130°F) was slightly painful, at 48.9°C (120°F) work has hardly possible, and at 45°C (113°F) breathing was not difficult. On Figure 3, curve B (dashed line) is the locus of points having a dew point of 50°C (122°F). Therefore, curve B is essentially an upper limit for transient exposure during a fire in a hot confined environment. On Figure 3, the curve for ϕ_i = 100 percent at inspired air temperatures higher than 50°C is needed for interpolation when the relative humidity of inspired air is less than 100 percent.

Diffusion of Moisture Through Dry Skin

A simple diffusion concept for the insensible loss of moisture through dry skin can be defined in terms of latent heat loss by the relationship,

16

$$H_d = K_d A_d (P_s - P_v), \tag{5}$$

where

H_d = metabolic heat dissipated in vaporization of diffusing moisture (kcal/hour)

A_d = area of dry skin (m^2)

P_s = saturation pressure at skin temperature (mmHg)

P_v = partial pressure of water vapor in air (mmHg)

K_d = diffusion constant [$kcal/(hr.m^2.mmHg)$]

to obtain experimental data in which this relatively small effect is not obscured, sweat gland activity must be suppressed. This has been accomplished in several sets of experiments planned for the purpose by

- Performing tests at environmental temperatures in which active sweating does not occur[50-52]

- Using drugs (such as atropine) that inhibit sweating.[53,54]

- Selecting subjects who do not have sweat glands.[55]

When environmental temperatures are within the range of $21^{\circ}C$ to $28^{\circ}C$, with skin temperatures less than $34^{\circ}C$, the values of K_d in Eq. (5) are characteristically within the range of 0.2 to 0.5 [$kcal/(hr.m^2.mmHg)$].[50-53] In general, the indicated values of K_d tend to increase with air or skin temperature, but higher values obtained at air temperatures above $29^{\circ}C$ or skin temperatures above $34^{\circ}C$ may reflect the effects of sweat gland activity.[51-53] The works of some investigators suggest a more complex relationship than that defined by Eq. (5).[53,56,57]

For the purposes of this study, a value of 0.35 [$kcal/(hr.m^2.mmHg)$] is used for the diffusion constant, K_d, in Eq. (5). This is consistent

with the value used in some recent studies of human comfort.[12,14] The diffusion of moisture through skin surfaces is essentially a mass transfer process that can be halted by an impervious covering. It is also quite apparent that the process can be attenuated by layers of clothing in proportion to the effective permeability of the skin clothing system.[13,14] Some of the computations in the present study of metabolic parameters include an attenuation factor, F_e, the magnitude of which is inversely proportional to the insulating value of clothing,

$$F_e = \frac{1}{1 + 0.1\,K_c} \qquad (6)$$

where K_c is the thermal resistance of clothing in "clo" units. A clothing ensemble that has a resistance of 1 clo would have a surface-to-surface temperature difference of $0.18^\circ C$ when conductive heat flux is 1 kcal/(hr.m^2).

Evaporation of Sweat

The production and evaporation of sweat is a metabolic process that is used under physiological control for maintaining thermal equilibrium in a warm environment. When evaporative cooling is needed, the control mechanism adjusts the wetted area of skin surfaces in accordance with the requirement.[59,60] Under any given set of environmental conditions, this cooling effect attains a maximum value when skin surfaces become completely wet or when the maximum rate of sweat production is reached. The maximum sustained rate of sweat product. for a "standard" man is about one liter per hour, and the potential cooling effect of this fluid is about 600 kcal/hr or 2400 Btu/hr.[9] Metabolic requirements for lesser rates of evaporative cooling may be limited by vapor pressure differentials or relative velocities of air motion in the environment. The effect is defined by the equation

$$E_{max} = h_e A_e (P_s - P_v) \qquad (7)$$

where

E_{max} = metabolic heat dissipated by evaporation of sweat when skin surfaces are completely wet.

A_e = effective area of skin surface (m^2)

P_s = saturation pressure at skin temperature (mmHG)

P_v = partial pressure of water vapor in air (mmHg)

h_e = evaporative heat transfer coefficient [kcal/hr.m^2.mmHg)].

The evaporative heat transfer coefficient, h_e, and the convective heat transfer coefficient, h_c, are both sensitive to air velocity and can be correlated through the Lewis relation.[61] In connection with metabolic heat/mass transfer

$$h_e \approx 2h_c \qquad (8)$$

when the coefficients are expressed in units of [kcal/(hr.m^2.mmHg)] and [kcal/(hr.m^2.^{o}C)]. This relationship has been demonstrated by Woodcock[62] and Brebner, Kerslake, and Waddell.[63,64]

Convective Heat Exchange

The transfer of metabolic heat by convection can be determined by the equation,

$$H_c = h_c A_c (T_c - T_a) \qquad (9)$$

where

H_c = heat transfer at exposed surfaces of skin or clothing (kcal/hr)

19

A_c = effective area of exposed skin or clothing surfaces (m^2)

T_c = mean temperature of exposed surfaces (${}^{\circ}C$)

T_a = temperature of environmental air (${}^{\circ}C$)

h_c = convection heat transfer coefficient [$kcal/hr.m^2.{}^{\circ}C$)]

The convective heat transfer coefficient, h_c, is sensitive to variations in relative air velocity. For numerical computations in connection with this study, a basic value of h_c = 4.0 is assumed to be representative for sedentary persons in shelters. According to Fanger[11] and Winslow, Gagge, and Herrington,[65] this value is appropriate for a relative air velocity of about 15 cm/s or 30 ft/min. For purposes of comparison, other computations are made in which h_c is assigned values of 3.4, 5.0, and 7.0 $kcal/(hr.m^2.{}^{\circ}C)$. These supplementary values are associated respectively with relative air velocities of about 11, 23, and 45 cm/s or 21, 45 and 90 ft/min. The value of h_c = 3.4 $kcal/(hr.m^2.{}^{\circ}C)$ or h_c = 0.7 $Btu/(hr.ft^2.{}^{\circ}F)$ is the minimum value obtained with very low velocities of ventilating air in a monoman calorimeter in which radiant heat transfer is suppressed by a reflective interior surface.[3] Spontaneous movements by the sedendary test subjects created sufficient relative motion to prevent the occurrence of lower values for the convection coefficient. The effective surface area for conductive heat transfer is

$$A_c = F_c A_s,\qquad(10)$$

where

A_s = effective area of skin surface, i.e., the total skin surface excluding areas insulated by chair seats or backs (m^2)

F_c = the ratio of exposed surface areas for clothed and nude persons.

In this study the value of F_c is determined by the equation[11,12]

$$F_c = 1 + 0.1 K_c \qquad (11)$$

where K_c is the insulating value of clothing in clo units.

Radiative Heat Exchange

In this study the transfer of metabolic heat from skin or clothing surfaces to the environment is determined in accordance with the Stefan-Boltzmann law in preference to a linear approximation.[66,67] This permits a more realistic comparison of relative effects over a wide range of temperatures. The fundamental equation is

$$H_r = A_r K_r (T_r^4 - T_w^4) \qquad (12)$$

where

H_r = heat transfer by radiation to or from exposed surfaces of skin or clothing (kcal/hr)

A_r = effective area of exposed skin or clothing surfaces (m^2)

T_r = mean <u>absolute</u> temperature of exposed skin or clothing surfaces (^{o}K)

T_w = mean radiant temperature of walls, furnishings and other surfaces "seen" by the subject, including other people (^{o}K)

K_r = the product of thermal emissivity of exposed skin and clothing surfaces (ϵ) and the Stefan-Boltzmann constant (σ).

The effective area, A_r, of skin and clothing surfaces for heat transfer by radiation is influenced by posture and is appreciably less than the aggregate area of skin or clothing surfaces.[67,68] Thus,

$$A_r = F_r A_c \qquad (13)$$

where A_c is defined by Eq. (10) and F_r is a dimensionless correction factor. In the present study, computations relating to the transfer of metabolic heat by radiation will be based on the values, $F_r = 0.65$, which is appropriate for an individual in a seated position,[11,67,68] and $K_r = 4.8 \times 10^{-8}$ kcal/(hr.m^2.$^{\circ}$C^4), which implies an effective emissivity of about 98 percent.[11,24] To simulate the effects of a densely populated space, computations will include several values for T_w, the mean radiant temperature of the environment ($^{\circ}$K), as follows:

• $T_w = T_a + 273$

• $T_w = T_s + 273$

• $T_w = (T_s + T_a)/2 + 273$

where T_a and T_s are the air and mean skin temperatures ($^{\circ}$C), respectively.

Heat Conduction Through Clothing

The sensible heat conducted through clothing corresponds to that transferred to the environment by convection and radiation at exposed surfaces. The fundamental equation is

$$H_o = A_o(T_s - T_o)/(0.18K_c)$$

where

H_o = heat flux through clothing (kcal/hour)

A_o = skin surface area excluding parts insulated by contact with furnishing (m^2)

T_s = mean skin temperature ($^{\circ}$C)

T_o = mean temperature of exposed clothing surfaces ($^{\circ}$C)

K_c = thermal resistance of clothing (clo units).

22

In this study, the thermal resistance of clothing, K_c, is an independent variable used to maintain thermal equilibrium at environmental temperatures below the threshold for sweating or evaporative regulation. Evaporative regulation is reserved for persons who are virtually nude.

Simultaneous Effects

The results of this study of relationships among metabolic parameters were obtained with a computer program in which the effects of the component processes for heat transfer are combined to interact and to proceed simultaneously. The program was synthesized under the following criteria:

- People in the shelter space are engaged in sedentary activities and are in thermal equilibrium with the prevailing environment.

- When environmental conditions of temperature and humidity are above the threshold at which the evaporation of sweat becomes necessary for maintaining thermal equilibrium, the people are virtually nude. Below this threshold, thermal equilibrium is maintained by adding increments of clothing, as necessary. Below this threshold, transfer of metabolic moisture is associated with the mechanisms of respiration and diffusion through dry skin, but not with sweat gland activity.

- At any air temperature, T_a $^\circ$C, the mean skin temperature, T_s $^\circ$C, is defined by the equation

$$T_s = 34 + 1.5 \arctan[0.1967(T_a - 31)].\qquad(15)$$

  Skin temperatures determined with Eq. (15) are shown by the curve at the top of Figure 4. Several skin temperatures are 89.6°F, 91.4°F, 93.2°F, 95.0°F and 96.8°F when air temperatures are, respectively, 50.0°F, 80.6°F, 87.8°F, 95.0°F and 125.6°F.

23

The objective in using a curve of the shape defined by Eq. (15) is to simulate a well-defined transition between the zone of cool environments, in which thermal equilibrium is maintained by variations in clothing insulation, and the zone of warm environments, in which thermal equilibrium is maintained by production and evaporation of sweat.

- At any environmental state there are two rates of latent heat transfer that are associated with active sweating. One, E_{req}, is the rate of evaporative cooling required to maintain thermal equilibrium. The other, E_{max}, is the maximum rate of evaporative cooling that can be attained in the environment when the skin is completely wet, as defined by Eq. (7). The skin wetness is here defined as the ratio,

$$R_w = \frac{E_{req}}{E_{max}} \qquad (16)$$

where the quantities E_{req} and E_{max} include the evaporation of sweat, but do not include vapor diffused through dry skin nor moisture transferred in the respiratory tract. However, moisture continues to diffuse through any dry portion of skin surface in accordance with Eq. (5). Heat storage and a consequent rise in body temperature would occur only when $E_{req} > E_{max}$, and the rate of heat storage is then

$$S = E_{max} - E_{req} \quad kcal/hr \qquad (17)$$

The condition, $E_{req} = E_{max}$ determines a limiting environmental state for which the "relative strain index" is unity.[8]

24

Graphic Comparison of Metabolic Data

Computations needed for the graphic comparison of data relating to each of the contributing processes for metabolic heat transfer are based on the following set of physical and physiological parameters:

Barometric pressure $\quad\quad\quad\quad\quad\quad$ = 1.0 atmosphere

Body temperature $\quad\quad\quad\quad\quad\quad$ = 37°C

Metabolic rate, M $\quad\quad\quad\quad\quad\quad$ = 100 kcal/hr

External work $\quad\quad\quad\quad\quad\quad\quad$ = 0

Skin surface (DuBois correlation) = 2.0 m^2

Effective skin surface, A_s $\quad\quad\quad$ = 1.9 m^2

Radiation area of nude skin, A_r $\quad$ = 1.3 m^2

Radiation coefficient, K_r $\quad\quad\quad$ = 4.8×10^{-8} (invariant)

Convection coefficient, h_c $\quad\quad\quad$ = 4.0 kcal/(hr.m^2.$^{\circ}$C)

Evaporation coefficient, h_e $\quad\quad$ = 8.0 kcal/(hr.m^2.mmHg)

Pulmonary ventilation, G $\quad\quad\quad$ = 0.60 kg of dry air inspired
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ per hour.

Results of the computations are presented in Figures 4 through 6. All computed data are shown as functions of air and wall temperature over the range of 0°C to 80°C. All data that are plotted as solid or dashed lines or curves are based on values of moisture diffusion through dry skin that are not atter   ed by clothing. In addition, each figure shows two or more rows of prominent dots that indicate the effect of attenuating this diffusion process by the factor, F_e, as defined by Eq. (6). There is no attenuating effect when the thermal resistance of clothing is 0 clo units.

25

Skin and clothing temperatures, surface-to-air temperature differences, required insulating values for clothing, and ratios of wet to total skin areas are shown in Figure 4. In the cool zone, the temperature gradient from exposed clothing surfaces to the surrounding air is relatively small and does not change very much with air temperature. The effects of extreme changes in relative humidity are not very important. The thermal resistance of clothing required at $10^{o}C$ ($50^{o}F$), the minimum temperature for a shelter environment, is about 3 clo units.

In the warm zone, skin-to-air temperature differences increase rapidly with temperature but are unaffected by changes in relative humidity. However, the ratio of wet to total skin surface is very sensitive to changes in relative humidity. When this ratio becomes 1.0, no further increase in the rate of evaporative cooling is possible.

The sensible/total and latent/total metabolic heat ratios are evaluated in Figure 5. The effect of changes in relative humidity on the heat ratios at air temperatures of about 25° is significant. The postulated effect of clothing on the diffusion of vapor through dry skin is also significant. This attenuating effect is indicated by the rows of dots in the lower left corner. These dots relate to the adjacent curves for 0 to 100 percent relative humidity.

In connection with warm environments, the broken lines determine values for the latent/total metabolic heat ratio when the required rate of evaporative cooling is greater than the maximum attainable (that is, thermal equilibrium is not possible and an increase in body temperature is inevitable). The broken lines and the solid lines intersect at state points where $E_{req} = E_{max}$ and skin surfaces are completely wet.

Contributions made by six heat transfer processes to maintenance of thermal equilibrium are evaluated in Figure 6 for three values of relative humidity--0, 50 and 100 percent. Heat transfer rates are expressed on

26
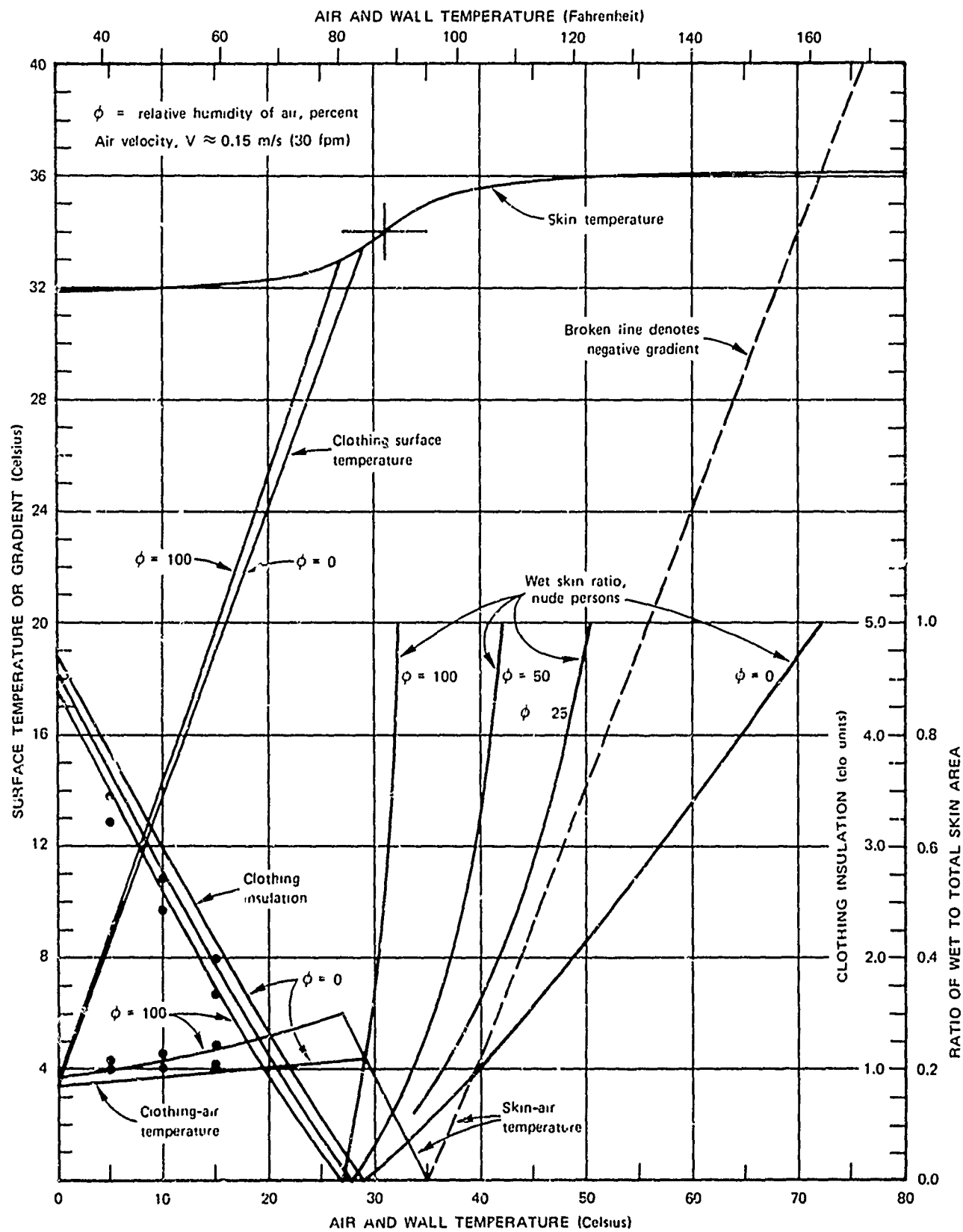
FIGURE 4   CHARACTERISTIC TEMPERATURES AND RELATED METABOLIC PARAMETERS
FOR SEDENTARY PERSONS IN THERMAL EQUILIBRIUM

27
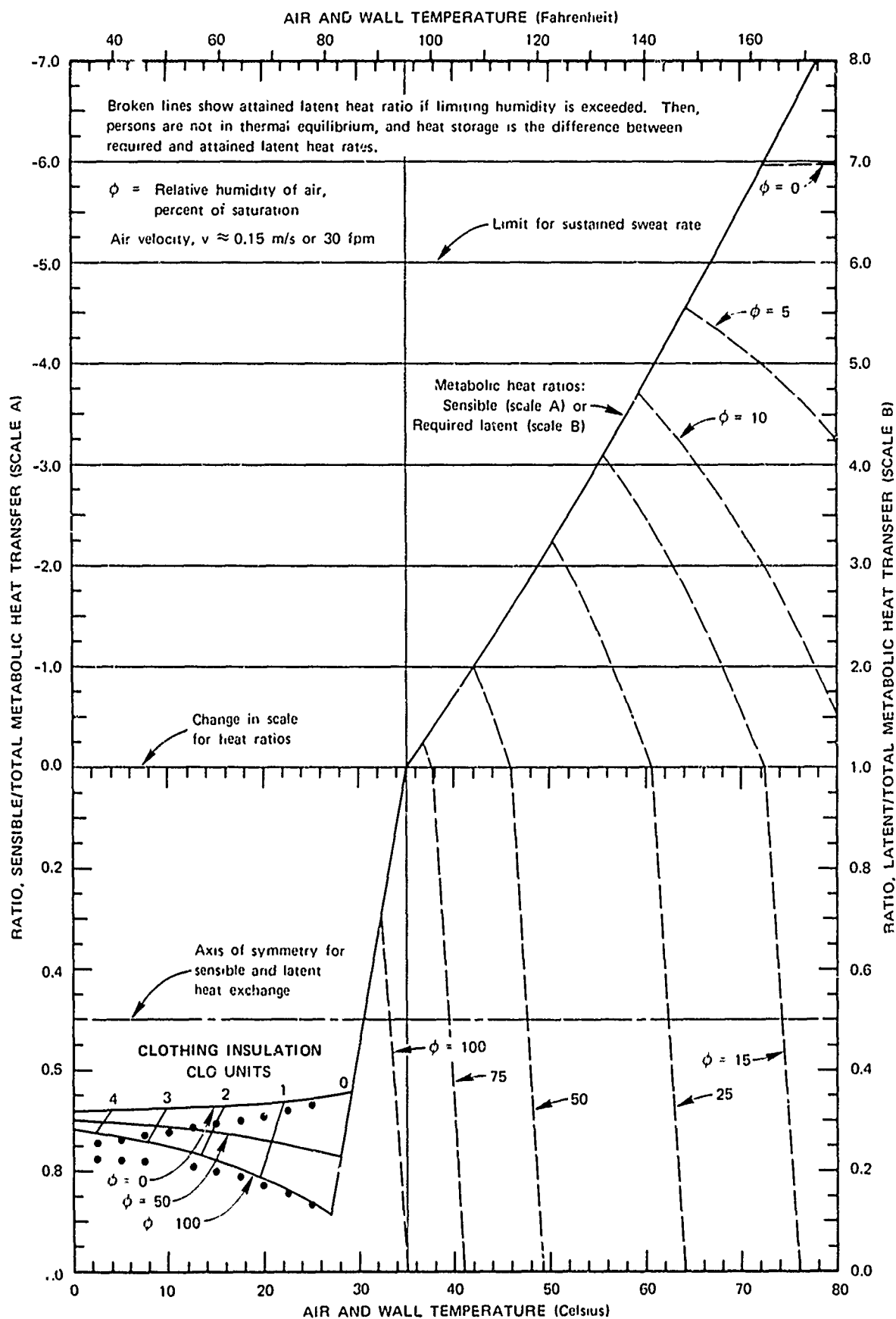
FIGURE 5   TRANSFER OF METABOLIC HEAT TO A TYPICAL ENVIRONMENT
FROM SEDENTARY PERSONS IN OPTIMUM CLOTHING

28
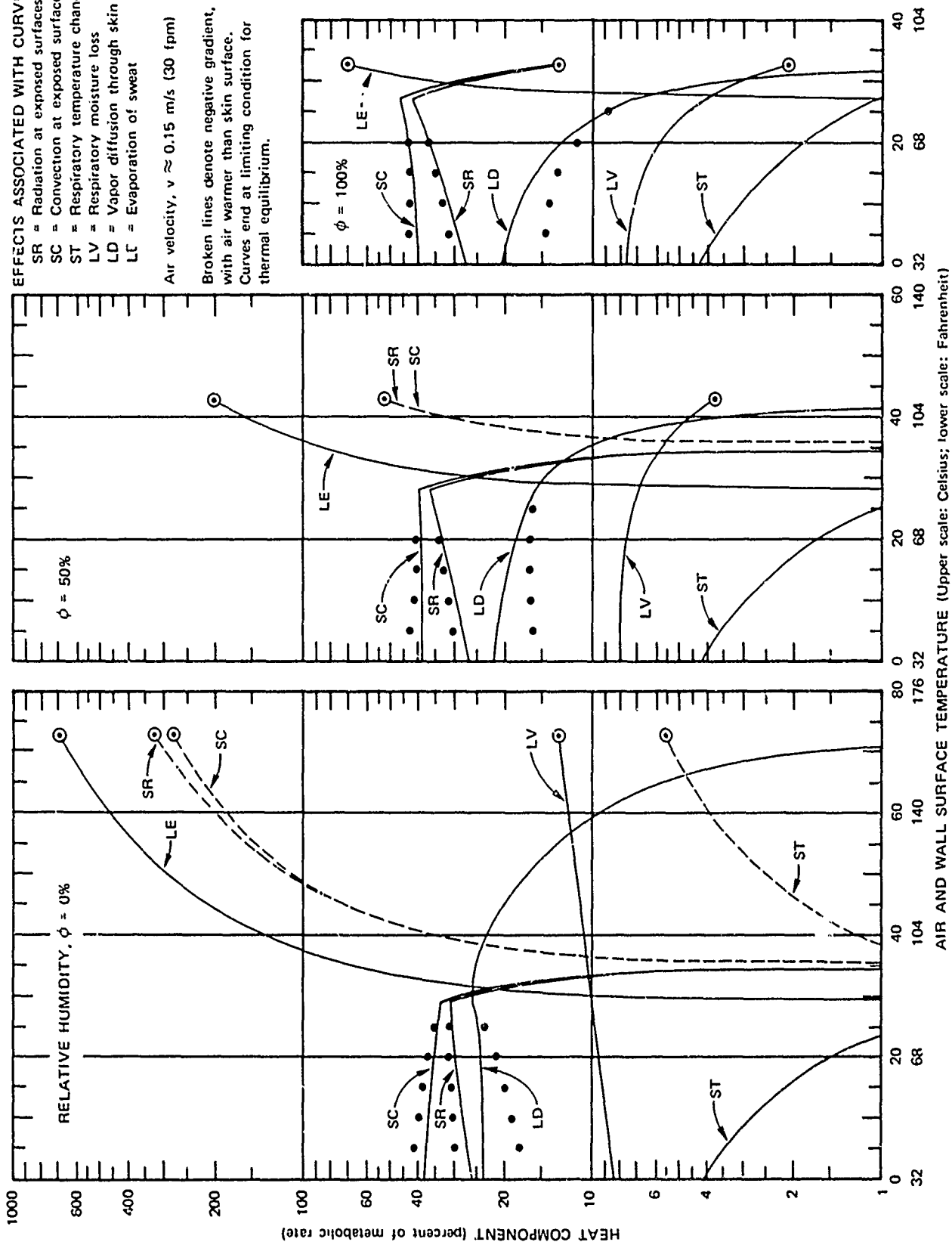
FIGURE 6   COMPONENTS OF METABOLIC HEAT ASSOCIATED WITH THERMAL EQUILIBRIUM
FOR SEDENTARY PERSONS IN OPTIMUM CLOTHING

29

a logarithmic scale ι percentages of metabolic rate as functions of air and wall temperatures. Each curve is identified by a symbol in accordance with explanatory notes. The curves terminate near the right side of each part of the figure at a state point for which $E_{req} = E_{max}$. This point is identified by an encircled dot. Radiative effects are less than convective effects in a cool environment, but are more than convective effects in a warm environment. For environments in which thermal equilibrium is maintained by optimum use of clothing, effects of this clothing in attenuating vapor diffusion through dry skin are indicated by rows of dots as in Figures 4 and 5.

Tables of numerical data relating to transfer of metabolic heat and moisture, the associated program listing, and explanatory notes are contained in Appendix A.

III SHELTER VENTILATION

Ventilation Process Lines

The metabolic data shown in Figure 5 suggest that the ratio of
latent to total metabolic heat transfer can be adequately represented
throughout the range of environmental conditions in which thermal equi-
librium can be maintained by a constant and a linear equation,

$$o = 0.25 \tag{18}$$

when $T \leq 82.5^\circ F$, and

$$o = 0.06T - 4.7 \tag{19}$$

when $T \geq 82.5^\circ F$. In these expressions, o is dimensionless ratio of
latent to total metabolic heat transfer and T is the environmental air
temperature (Fahrenheit). In conjunction with equations for the thermo-
dynamic properties of moist air and the following assumptions, these
relationships determine equations for families of ventilation process
lines:

- Ventilating air moves linearly through the occupied space,
  from one wall to an opposite wall.

- Metabolic heat and moisture are added gradually to air passing
  through the occupied space.

- There are no sources of heat or moisture other than metabolic
  effects. This implies that lighting loads and heat transmitted
  through walls and roof are relatively small and negligible.

31

When air temperatures are less than or equal to 82.5°F, equations for the family of ventilation process lines associated with Eq. (18) can be expressed as a function of specific enthalpy, H, and humidity ratio, W,

$$H - H_O = 4222 (W - W_O) \qquad (20)$$

or as a function of humidity ratio, W, and air temperature, T,

$$\frac{0.5508 + W}{0.5508 + W_O} = \frac{7246 - T_O}{7246 - T} \qquad (21)$$

When air temperatures are greater than or equal to 82.5°F, an equation for the family of process lines associated with Eq. (19) is

$$\frac{0.5508 + W}{0.5508 + W_O} = R_2 \left(\frac{R_3}{R_2}\right)^{0.006944} , \qquad (22)$$

where

$$R_2 = \frac{2305 + T_O}{2305 + T}$$

$$R_3 = \frac{95 - T_O}{95 - T} .$$

In Eqs. (20), (21), and (22), T_O, W_O, and H_O are properties of moist air at any state point on a particular ventilation process line, and T, W, and H are properties of moist air at any other point on the same process line. Equations (20) and (21) are not valid when air temperatures are higher than 82.5°F, and Eq. (22) is not valid for temperatures lower than 82.5°F. The equations are not valid when the air is supersaturated. The units in these equations are

- Temperature, T (°F)

32

- Humidity ratio, $W = \dfrac{\text{pounds of moisture}}{\text{pounds of dry air}}$

- Specific enthalpy, H = Btu/lb of dry air.

Equations (20), (21), and (22) determine the locus of state points (on a psychometric chart) that develop in sequence as a stream of ventilating air moves through an occupied space.

This study is particularly concerned with ventilating systems that conserve heat for tempering purposes by partial recirculation of air during cold weather. In such a system there are three salient points of interest:

(1) The state of fresh air

(2) The state of mixed air supplied to the space

(3) The state of air that is either recirculated or exhausted to atmosphere.

To identify air properties associated with each of these points, the corresponding item numbers above are used as subscripts. Then, if a space is occupied by sedentary persons in thermal equilibrium with a metabolic rate of $M = 400$ Btu/hour/person, the rate of air supply to the space must be

$$V_2 = \frac{400}{4.5\,(H_3 - H_2)}$$

$$= 88.89 \,/\, (H_3 - H_2) \tag{23}$$

where

V_2 = rate of ventilation (SCFM per person)

H_3 = specific enthalpy of air leaving the space (Btu/lb of dry air)

33

H_2 = specific enthalpy of air entering the space (Btu/lb of dry air).

The associated flow rate of fresh (outside) air is

$$V_1 = 88.89 / \left(H_3 - H_1\right) , \tag{24}$$

where

V_1 = flow rate of fresh air (SCFM/person)

H_1 = specific enthalpy of fresh air (Btu/lb of dry air).

Several ventilation process lines determined analytically by Eqs. (20), (21), and (22) are shown on Figure 7. These lines resemble process lines based on experiments performed by Pefley, Cull, and Sekins.[3] The six lines that originate at a temperature of 50°F bracket the possible range of 0 to 100 percent relative humidity. Thus, these lines represent process lines associated with the prescribed criterion for a minimum temperature of 50°F in a shelter environment.[2] Across this group of six process lines are a number of heavier lines that terminate at dots. These are isoventilation lines, based on Eq. (23), with the proviso that air is supplied to the shelter space at a temperature of 50°F. Each isoventilation line is labeled with the associated ventilating rate. A curve at the top of the chart shows the locus of points above which thermal equilibrium cannot be maintained. This line was determined from data in Figures 4 and 5 at state points where $E_{req} = E_{max}$. Effective temperature lines for 80 ET and 85 ET are also shown.

Seasonal Recirculation of Air

If a shelter ventilating system of either the supply or exhaust type is so arranged that fresh air enters an occupied space through a few openings with little or no distribution, environmental temperatures in

34
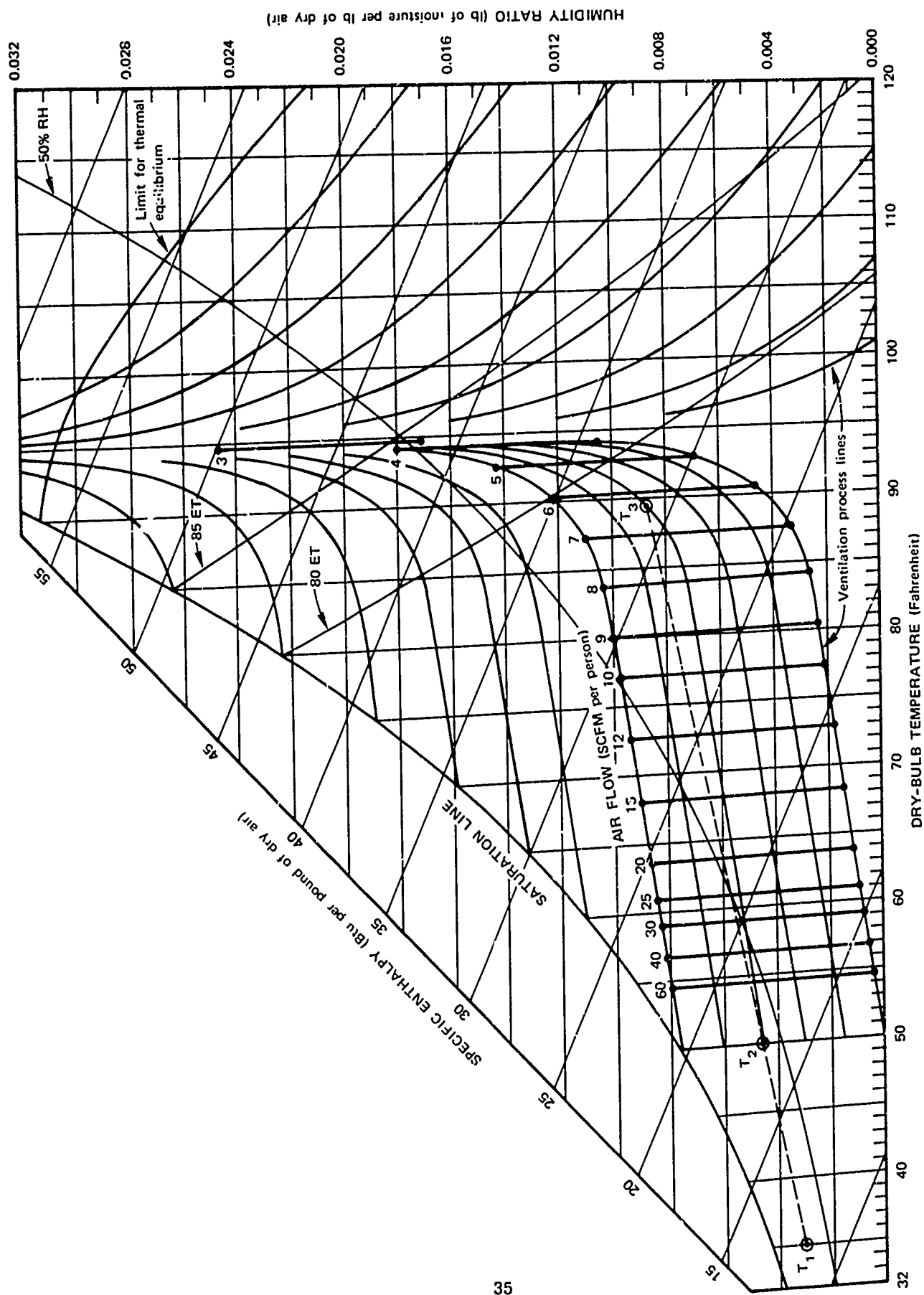
FIGURE 7   PROCESS LINES FOR VENTILATING A SPACE WITH MIXED AIR AT 50°F

35

the vicinity of these openings will not differ greatly from the outside temperature. During cold weather, temperatures may frequently be less than 50°F over a large part of the shelter space. This stressful condition could be eliminated by tempering or heating the fresh air. If heating apparatus is not provided (or is inoperable), the cold areas can be reduced or eliminated by recirculating part of the ventilating air. Partial recirculation is often used in air conditioning practice to reduce heating or cooling loads.

On Figure 7, the dashed line connecting three encircled dots at $T_1 = 35°F$, $T_2 = 50°F$, and $T_3 \approx 89°F$ illustrates the geometrical configuration associated with a recirculating system for ventilating an occupied space. The dashed line is straight because the oblique coordinates on this psychrometric chart are specific enthalphy, H, and humidity ratio, W; the lines of constant temperature are not parallel. Basic properties of moist air at the three state points are T_1, W_1, and H_1 for the fresh air; T_2, W_2, and H_2 for the mixed air; and T_3, W_3, and H_3 for the recirculated air. Points 2 and 3 must be on the same ventilation process line. In accordance with the principle of conservation of mass and energy in a mixing process, the properties of moist air at the three state points are related by the equations,

$$\frac{H_3 - H_1}{W_3 - W_1} = \frac{H_2 - H_1}{W_2 - W_1} = \frac{H_3 - H_2}{W_3 - W_2} \tag{25}$$

and the ratio of flow rates for fresh and mixed air is

$$\frac{V_1}{V_2} = \frac{H_3 - H_2}{H_3 - H_1} = \frac{W_3 - W_2}{W_3 - W_1} \quad . \tag{26}$$

Equations (18) through (26), together with precise relationships among psychrometric quantities (saturation pressure, humidity ratio, specific enthalpy, and temperature), were used as the basis for an iterative

36

computer program that determines the required flow rate for fresh air and evaluates properties of moist air at state points for fresh, mixed, and recirculated air when the input parameters are as follows:

- Flow rate of mixed air, V_2 (SCFM/person). This corresponds to the rated unit capacity of the ventilating system.

- Temperature of mixed air, T_2 ($^\circ$F).

- Temperature of fresh air, T_1 ($^\circ$F).

- Relative humidity of fresh air, ϕ_1 (%).

The program rejects combinations of input data that would lead to recirculated air having a dew point in excess of 90°F, which is just above the limit for metabolic equilibrium, or to supersaturated mixed air. If these causes for rejection occur, the program determines the minimum ventilating capacity that would satisfy these requirements.

Figure 8 is constructed with data calculated using the above program. This chart evaluates parameters associated with a recirculating system for ventilating a shelter with mixed air at a temperature $T_2 = 50^\circ$F, when the fresh air temperature, T_1, is less than or equal to 50°F. Since the prescribed minimum temperature for a shelter environment is 50°F, Figure 8 determines limiting parameters for design or operation of such systems. For example: If the unit capacity of a ventilating system is 12 SCFM per person, and the outside air temperature is 20°F, the temperature of recirculated air will be 72.6°F, the flow rate of fresh air should be 5.2 SCFM per person, and the humidity ratio of air leaving the shelter space will be higher than the humidity ratio of fresh air by about 0.004 pounds of moisture per pound of dry air.

On Figure 8, the blank area labeled "Fog" denotes conditions under which the mixed air would be supersaturated, if the fresh air were dry.

The boundaries of this fog region if the fresh air were saturated are indicated by two short dashed curves. The lower dashed curve and the adjacent solid line indicate ventilating rates below which the dew point of recirculated air would be more than 90°F and an increase in body temperatures should be expected.

Tables of numerical data relating to partial recirculation of ventilating air, the associated program listing, and explanatory notes are contained in Appendix B.
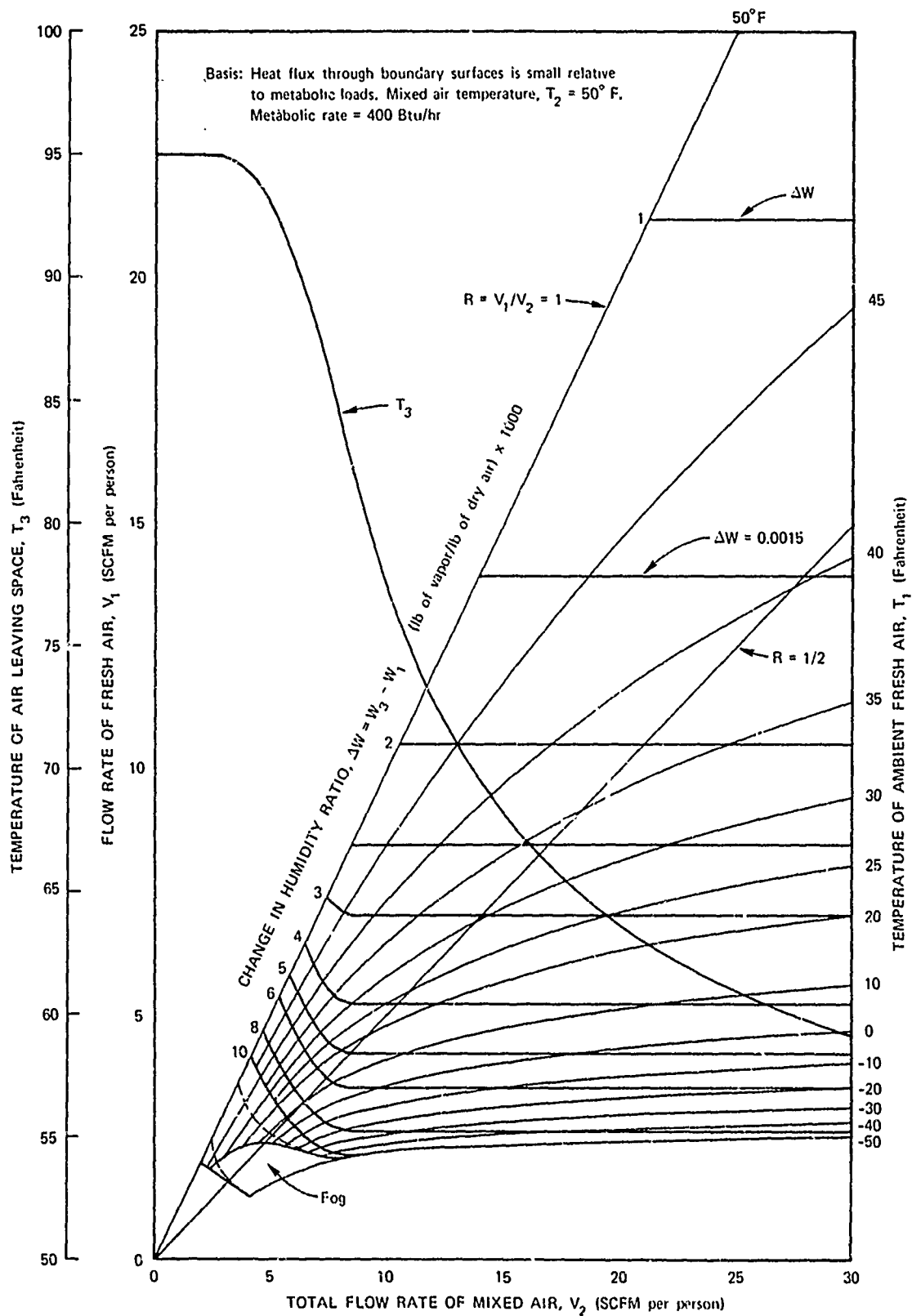
FIGURE 8   VENTILATION OF AN OCCUPIED SPACE WITH MIXED
FRESH AND RECIRCULATED AIR AT 50°F

39

IV   CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Among elements that collectively determine the condition and variabilities of the environment in a ventilated shelter are several major factors:

- Prevailing ambient conditions with respect to air temperature and humidity.

- Size, shape, and compartmentation of the space, and furnishings provided therein.

- Utilization of the space with respect to number of people and duration of occupancy.

- Metabolic responses of each person to his local macroclimate with regard to physical activity and transfer of heat and moisture.

- Lighting and other internal heat sources supplementary to metabolic effects.

- Thermal characteristics of the structure with respect to transient and steady-state heat transfer.

- Per capita and total capacities of the ventilating system.

- Configuration of the ventilating system.

If a shelter were densely populated, the transfer of metabolic heat and moisture would be modified by the proximity of one person to another. The mean radiant temperature at any point in the shelter would be determined by temperatures of skin or clothing surfaces as well as temperatures

of wall and ceiling surfaces. Also, the flow of air through the space would be diverted by obstructions (people) near the floor to clear channels near the ceiling. The effect of this diversion would be to stratify the environment. Air velocities in the living space near floor level would be lower than air velocities in the overhead space. Consequently, capabilities for heat transfer by convection and evaporation of sweat would be reduced in the living space by an increase in population density. The establishment of vertical convection currents would be necessary to transfer of heat and moisture from lower to upper levels. Thus, temperatures and humidities in the living space would be somewhat higher than in the air stream overhead. The effects of population density on comfort in a shelter environment may be either adverse or beneficial, as determined by the season of the year and by relationships between metabolic parameters.

Section II, Metabolic Parameters, examines in some detail six biophysical processes for transfer of heat and moisture from the human body to its environment, first as isolated mechanisms, and then as simultaneous processes. A salient result of this study is a set of three figures (Figures 4, 5, and 6) that provide relatively complete information regarding metabolic responses in shelters occupied by sedentary persons dressed in optimum clothing. These data are based on an air velocity of about 30 feet per minute and equality of air and wall temperatures. Computations were also made with relative air velocities of about 20, 45, and 90 feet per minute, and with wall temperatures that are not equal to air temperatures. These supplementary data are included in nine numerical tables in Appendix A. It is possible to draw some tentative conclusions from these figures and tables, as follows:

- Data in Figure 6 show that proportional effects of the six processes for metabolic heat transfer are extremely variable at temperatures higher than about 30°C (86°F), but are comparatively stable at lower temperatures. Rates of heat transfer by radiation and convection do not differ greatly.

- Data in Figure 5 show that variations in humidity have a significant effect on the partition of metabolic heat losses into sensible and latent fractions at air temperatures of about 15°C to 27°C (60°F to 80°F). At higher temperatures, humidity has virtually no effect on the sensible/total or latent/total metabolic heat ratios, but has a sharply defined effect in determining limiting conditions for thermal equilibrium.

- Data in Figure 4 show that humidity has a strong effect on the ratio of wet to total skin areas in warm or hot environments.

- Data in Figure 4 also show that differences in temperature between clothing surfaces and air remain within the range of about 3°C to 6°C (4°F to 10°F). At a temperature of 30°C (86°F), the mean skin temperature is about 4°C (7°F) higher than air temperature. At a temperature of 40°C (104°F), the mean skin temperature is about 5°C (9°F) lower than air temperature. In a hotter environment, the air temperature increases at a much higher rate than skin temperatures because the skin is cooled by evaporation. These observations suggest that population density will not have a great effect on radiant heat transfer in the critical comfort range of 30°C (86°F) to 40°C (104°F). The effect of an increase in population density may be beneficial to thermal comfort in colder and hotter environments.

• Numerical data in Tables A-4, A-5, A-6, and A-7 of Appendix A are
based on parameters that differ only with respect to relative air
velocity and the associated values of coefficients for convection
and evaporation, as shown in Table A-1. Numerical data in Tables
A-4, A-8, and A-9 are based on parameters that differ only with
respect to mean radiant temperature, as defined in Table A-1. A
comparison among data from these tables indicates that the effects
of an increase in population density on both relative air velocity
and mean radiant temperature tend to lower the air temperature at
which thermal equilibrium can be maintained without clothing and
without evaporation of sweat. At any lower temperature, the amount
of clothing required to maintain thermal equilibrium is also re-
duced by occupancy effects on either relative air velocity or mean
radiant temperature. However, population density appears to have
no significant effect on the ratio of latent to total heat trans-
fer from clothed persons. In higher temperature ranges, which are
characterized by active sweating and virtual nudity, increased
occupancy tends to increase evaporative cooling requirements at
air temperatures below 35°C (95°F), and to decrease these require-
ments at higher temperatures. The effects of changes in relative
air velocity and mean radiant temperature on the latent/total
heat ratio are shown graphically on Figure 9, which was constructed
with data from Tables A-4, A-7, and A-8 in Appendix A. This figure
also shows the effects of air velocity and radiant temperature on
the limits for thermal equilibrium at two relative humidities, 50
and 100 percent. In Table A-8, mean radiant temperatures are equal
to the temperatures of exposed skin or clothing, which implies com-
plete suppression of radiative heat transfer. In Table A-5, heat/
mass transfer coefficients are appropriate with a relative air veloc-
ity of about 20 feet/minute, which tends to be minimal for sedentary
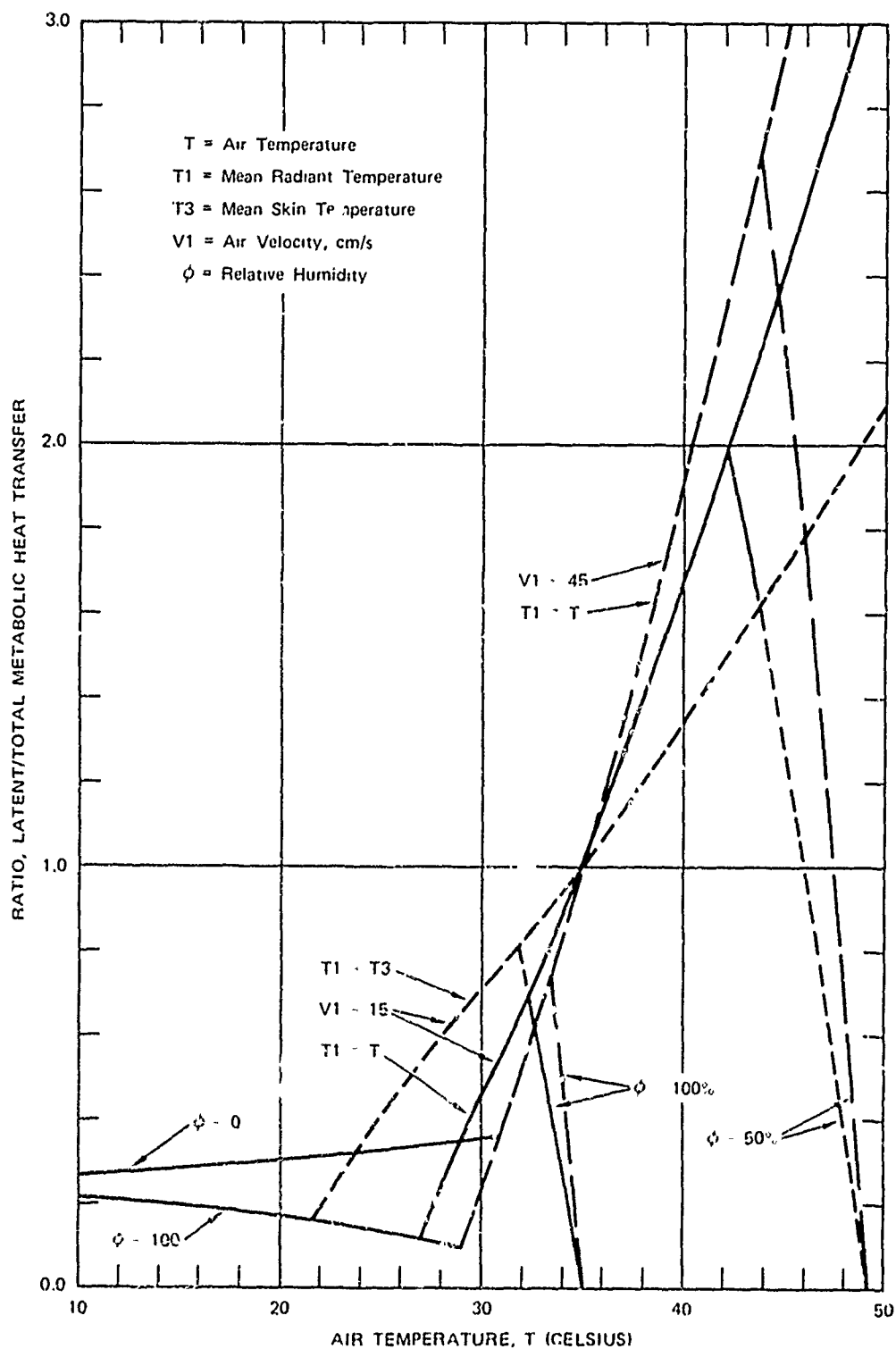
FIGURE 9   EFFECTS OF AIR VELOCITY AND MEAN RADIANT TEMPERATURE
ON METABOLIC HEAT TRANSFER

levels of physical activity. The metabolic data in Table A-9, which is based on a relative air velocity of about 30 feet per minute and a mean radiant temperature equal to the mean of environmental air and exposed skin or clothing temperatures, may be most representative for conditions likely to develop in shelters that are fully occupied by sedentary persons.

Section III, Shelter Ventilation, uses metabolic data developed in Section II (Figure 5) as the basis for a study of shelter ventilation, with special emphasis on systems that recirculate air in cold weather. The ventilation process lines on Figure 7 represent loci of conditions that would develop in sequence along the path of air moving through a shelter. For all of these lines, the direction of air movement is toward the line for $95^{\circ}F$ dry-bulb temperature from either lower or higher initial temperatures. At a temperature of $95^{\circ}F$, only evaporative cooling is effective because air, wall, and skin temperatures are equal at that model temperature. If air is supplied to an occupied space at a temperature of $50^{\circ}F$, those process lines that originate along the $50^{\circ}F$ temperature line show the band of environmental conditions that could develop along the air stream. The vertical bars across this band of process lines show the psychrometric conditions that would prevail with the designated rates of ventilation in air as it leaves the occupied space. Process lines associated with nonuniform or "varistate" environments are most realistic for ventilating systems that provide little or no air distribution.

If ventilating air enters a shelter directly from the atmosphere through a few openings, the environment near these points of entry will not differ greatly from the outside temperature. During winter weather part of the space may very cold. This objectionable situation can be avoided by one of three alternative methods, as follows:

45

- Provide reliable heating apparatus for warming the air before it enters the occupied space.

- Provide an extensive system of distribution ductwork and diffusion outlets.

- Use metabolic heat for tempering fresh air by arranging the ventilating system to recirculate part of the air that would otherwise be wasted.

Figure 8 relates paramaters associated with partial recirculation of air, including mixed and fresh air flow rates, fresh air temperatures, final air temperatures, and changes in humidity ratio. This graphic information is based on a mixed air temperature of $50^{\circ}F$, which conforms to the prescribed minimum temperature for a shelter environment.

Recommendations

The following recommendations are made with regard to environmental problems in shelters:

- Concepts for shelter ventilating systems and components should be modified as necessary to provide for partial recirculation of air during cool and cold seasons.

- An evaluation should be made of parameters for partial recirculation of air during cold weather in shelters that have relatively large heat loads associated with lighting and heat transmission through shelter boundaries.

- Studies should be continued of interrelationships among population density, metabolic heat transfer, and the thermal environment in shelters to develop a more definitive correlation of significant parameters, including structural configuration and ambient effects, as well as metabolic and physiological factors.

46

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Appendix A

NUMERICAL TABULATION OF METABOLIC PARAMETERS

Some basic results of the study of processes for transfer of metabolic heat and moisture are compared graphically in Figures 4, 5, and 6 of Section II, Metabolic Parameters. In addition to the plotted data, computations were made for other conditions in the man/environment system. These supplementary results, as well as abridged tabulations of the plotted data, are shown in Tables A-1 through A-10 at the end of this appendix. Table A-1 is a key to identification of parameters that vary among the several tables in this group. Table A-3 represents the data from which all curves in Figures 4, 5, and 6 were plotted. Table A-4 represents supplementary values for the rows of dots on the figures. The computations for these supplementary values include a factor for the effect of clothing in attenuating vapor pressure differentials that cause diffusion through dry skin. Values of input parameters that remain constant in all tables, together with associated symbols used in the computer program, are as follows:

Barometric pressure, $P8 = 1.0$ atmosphere

Body temperature, $T7 = 37^{\circ}C$.

Metabolic rate, $M = 100$ kcal/hour

Total heat loss to environment, $MO = 100$ kcal/hour

Skin surface (DuBois area), $A = 2$ m^2

Effective skin area, convection, $A1 = 1.9$ sq meters

Effective skin area, radiation, $A2 = 1.3$ sq meters

Radiation coefficient, $J1 = 4.8$ (absolute surface temperatures, $^{\circ}K$, are divided by 100)

Pulmonary ventilation, $G = 0.6$ Kg/hour of inspired dry air.

Tables A-2 through A-10 each contain eight columns of data. The first column, headed RH%, shows the three values of relative humidity ($Y2 = 0$, 50, and 100 percent) for which computations were made at each value of air temperature. Each group of computations is identified by a subheading that includes the air temperature, T $^{\circ}C$, skin temperature, $T3$ $^{\circ}C$, and

the pressure of saturated water vapor, P3 mmHg, at skin temperature.
Each of the other eight columns show two values of computed parameters
for each value of relative humidity. These two parameters are identified
by the upper and lower headings for each column. In column 2, LAHET is
the latent heat loss, L kcal/hr, and SEHET is the sensible heat loss,
S kcal/hr. In column 3, LHMIN is the minimum latent heat transfer, LO
kcal/hr, associated with respiration, L3 kcal/hr, vapor diffusion through
dry skin, L7 kcal/hr, and a spontaneous sweat, L4 kcal/hr, associated
with physical activity. For sedentary activities, L4 = 0. Also, in col-
umn 3, STORE is the rate of heat storage, X6 kcal/hr, which vanishes when
thermal equilibrium is attainable in the environment. In column 4, LREQD
is the aggregate latent heat loss, L6, required to maintain thermal equi-
librium, except that an alternative quantity is printed in place of LREQD
when clothing is worn. This alternative quantity is equal to the meta-
bolic rate minus the sensible heat loss that would occur if clothing were
not worn. The quantity RADHT is sensible heat transfer by radiation, R1,
from exposed surfaces of skin or clothing. In column 5, LHMAX is the maxi-
mum value of latent heat loss, L9, when all skin surfaces are wet, except
that the value printed for LHMAX is the same as the value for LHMIN in
column 3 when clothing is worn. The quantity, CONSK, is sensible heat
transfer by convection, C1, from exposed surfaces o: skin or clothing.
In column 6, LHRES is the latent heat transfer, L3, and CORES is the
sensible heat loss, D3, associated with respiration. In column 7, LHDSK
is the latent heat loss, L2, associated with vapor diffusion through dry
skin, and PMMHG is the partial pressure of water vapor in the environmen-
tal air in millimeters of mercury. In column 8, LHWSK is the latent heat
loss associated with evaporation of sweat, E5, at wet skin surfaces, and
CLOSR is the thermal resistance of clothing, K2, in clo units. In column
9, WETLR is a ratio, R5, relating to the proportionate area of wet skin
and is defined as the ratio of actual heat loss associated with evapora-
tion of sweat from wet skin surfaces to the maximum perspiratory heat
loss when skin surfaces are completely wet. The quantity, CLODT, is the
temperature gradient from skin to exposed surfaces of clothing.

The BASIC program used for computing and tabulating metabolic data
associated with the simultaneous effects of all heat-mass transfer proc-
esses is reproduced in Table A-10.

DATA FOR NUMERICAL TABLES OF METABOLIC PARAMETERS

TABLE NUMBER	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
SKIN TEMPERATURE, T3, AT AIR TEMPERATURE, T, (CELSIUS)									
T3=34	X								
T3=34+1.5*ATN(0.1967*(T-31))		X	X	X	X	X	X	X	X
ATTENUATION FACTOR, F3, FOR VAPOR DIFFUSION THROUGH CLOTHED SKIN AREAS									
F3=1.0	X		X	X	X	X	X	X	X
F3=1/(1+0.1*K2)		X							
F3=1/(1+0.2*K2)									
MEAN RADIANT TEMPERATURE, Ti, IN OCCUPIED SPACE (CELSIUS)									
Ti=T	X	X	X	X	X	X		X	X
Ti=T3 OR Ti=T2									
Ti=(T3+T)/2 OR Ti=(T2+T)/2							X		
CONVECTION COEFFICIENT, H1, FOR EXPOSED SKIN OR CLOTHING KCAL/(HR*SQ M*°C)	4.0	4.0	4.0	3.4	5.0	7.0	4.0	4.0	4.0
EVAPORATION COEFFICIENT, E1, FOR WET SKIN AREAS KCAL/(HR*SQ M*MMHG)	8.0	8.0	8.0	6.8	10.0	14.0	8.0	8.0	8.0
RELATIVE AIR VELOCITY, V1 CENTIMETERS/SECOND	15	15	15	10	23	45	15	15	15
FEET/MINUTE	30	30	30	20	45	90	30	30	30

T3=SKIN TEMPERATURE, T2=CLOTHING TEMPERATURE, T=AIR TEMPERATURE (CELSIUS)
K2=THERMAL RESISTANCE OF CLOTHING (CLO UNITS)

TABLE A-2

METABOLIC PARAMETERS, SET 1

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
	SEHET	STORE	RADHT	CONSK	CORES	PMMHG	CLOSR	CLODT

AIR TEMP: +10.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+35.5	+35.5	-239.5	+35.5	+8.93	+26.5	+0.0	+0.0000
	+64.5	+0.0	+26.6	+35.1	+2.80	+0.00	+3.520	+20.586
50	+31.5	+31.5	-239.6	+31.5	+8.02	+23.5	+0.0	+0.0000
	+68.5	+0.0	+28.3	+37.2	+2.93	+4.50	+3.269	+20.308
100	+27.5	+27.5	-239.7	+27.5	+7.12	+20.4	+0.0	+0.0000
	+72.5	+0.0	+30.0	+39.4	+3.05	+9.20	+3.045	+20.026

AIR TEMP: +20.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+36.0	+36.0	-102.4	+36.0	+9.48	+26.5	+0.0	+0.0000
	+64.0	+0.0	+28.6	+33.9	+1.48	+0.00	+1.722	+10.196
50	+28.3	+28.3	-102.6	+28.3	+7.64	+20.7	+0.0	+0.0000
	+71.6	+0.0	+32.1	+37.9	+1.67	+8.77	+1.455	+9.647
100	+20.7	+20.7	-102.8	+20.7	+5.80	+14.9	+0.0	+0.0000
	+79.3	+0.0	+35.5	+41.9	+1.86	+17.53	+1.239	+9.095

AIR TEMP: +25.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+36.3	+36.3	-31.5	+36.3	+9.76	+26.5	+0.0	+0.0000
	+63.7	+0.0	+29.6	+33.3	+0.81	+0.00	+0.832	+4.957
50	+25.9	+25.9	-31.7	+25.9	+7.23	+18.6	+0.0	+0.0000
	+74.1	+0.0	+34.4	+38.6	+1.05	+11.88	+0.608	+4.209
100	+15.4	+15.4	-32.0	+15.4	+4.67	+10.7	+0.0	+0.0000
	+84.6	+0.0	+39.3	+43.9	+1.28	+23.76	+0.438	+3.461

AIR TEMP: +27.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+36.4	+36.4	-2.7	+36.4	+9.88	+26.5	+0.0	+0.0000
	+63.6	+0.0	+30.0	+33.1	+0.55	+0.00	+0.477	+2.849
50	+24.7	+24.7	-2.9	+24.7	+7.01	+17.6	+0.0	+0.0000
	+75.3	+0.0	+35.5	+39.0	+0.80	+13.37	+0.285	+2.010
100	+12.9	+12.9	-3.2	+12.9	+4.10	+8.5	+0.0	+0.0000
	+87.1	+0.0	+41.1	+45.0	+1.06	+26.74	+0.143	+1.167

AIR TEMP: +29.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+36.5	+36.5	+26.4	+36.5	+10.00	+26.5	+0.0	+0.0000
	+63.4	+0.0	+30.4	+32.8	+0.28	+0.00	+0.123	+0.737
50	+26.2	+23.3	+26.2	+385.0	+6.76	+16.4	+3.0	+0.0079
	+73.8	+0.0	+35.3	+38.0	+0.56	+15.02	+0.000	+0.000
100	+25.9	+10.0	+25.9	+153.3	+3.46	+5.8	+16.6	+0.1106
	+74.1	-0.0	+35.3	+38.0	+0.84	+30.04	+0.000	+0.000

AIR TEMP: +31.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+55.8	+36.7	+55.8	+616.7	+10.12	+25.7	+20.0	+0.0330
	+44.2	-0.0	+21.4	+22.8	+0.01	+0.00	+0.000	+0.000
50	+55.5	+21.8	+55.5	+356.9	+6.46	+13.8	+35.3	+0.1006
	+44.5	+0.0	+21.4	+22.8	+0.31	+16.85	+0.000	+0.000
100	+55.2	+6.9	+55.2	+97.1	+2.74	+1.9	+50.5	+0.5359
	+44.8	+0.0	+21.4	+22.8	+0.62	+33.70	+0.000	+0.000

AIR TEMP: +35.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+115.4	+36.9	+115.4	+616.9	+10.36	+22.9	+82.1	+0.1353
	-15.4	+0.0	-7.3	-7.6	-0.52	+0.00	+0.000	+0.000
50	+115.0	+18.3	+115.0	+291.7	+5.75	+8.1	+101.2	+0.3539
	-15.0	+0.0	-7.3	-7.6	-0.16	+21.09	+0.000	+0.000
100	-33.6	-33.6	+114.7	-33.6	+1.02	+0.0	-34.6	+1.0000
	-14.7	+148.3	-7.3	-7.6	+0.20	+42.18	+0.000	+0.000

AIR TEMP: +40.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+191.5	+37.2	+191.5	+617.2	+10.67	+19.5	+161.3	+0.2660
	-91.5	-0.0	-44.7	-45.6	-1.19	+0.00	+0.000	+0.000
50	+190.6	+12.7	+191.0	+190.6	+4.58	+0.0	+186.0	+1.0000
	-91.0	+0.5	-44.7	-45.6	-0.75	+27.67	+0.000	+0.000
100	-236.3	-236.3	+190.6	-236.3	-1.74	+0.0	-234.6	+1.0000
	-90.6	+426.9	-44.7	-45.6	-0.29	+55.34	+0.000	+0.000

AIR TEMP: +52.00   SKIN: 34.00 C   39.90 MMHG

RH%	LAHET	LHMIN	LREOD	LHMAX	LHRES	LHDSK	LHWSK	WETLR
0	+381.7	+38.0	+381.7	+618.0	+11.45	+10.8	+359.4	+0.5926
	-281.7	+0.0	-142.1	-136.8	-2.79	+0.00	+0.000	+0.000
50	-169.6	-169.6	+381.0	-169.6	+0.12	+0.0	-169.7	+1.0000
	-281.0	+550.6	-142.1	-136.8	-2.08	+51.07	+0.000	+0.000

A-4

RH%	LAHET / SEHET	LHMIN / STORE	LREQD / RADHT	LHMAX / CONSK	LHRES / CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+34.9 / +65.0	+34.9 / +0.1	-370.5 / +24.7	+34.9 / +36.2	+8.41 / +4.12	+26.5 / +0.00	+0.0 / +5.353	+0.0000 / +30.896
50	+33.0 / +67.0	+33.0 / +0.0	-370.6 / +25.4	+33.0 / +37.3	+8.01 / +4.21	+25.0 / +2.29	+0.0 / +5.173	+0.0000 / +30.763
100	+31.1 / +68.9	+31.1 / +0.0	-370.7 / +26.2	+31.1 / +38.4	+7.61 / +4.29	+23.5 / +4.58	+0.0 / +5.005	+0.0000 / +30.632
AIR TEMP: +15.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+35.7 / +64.2	+35.7 / +0.0	-171.7 / +27.6	+35.7 / +34.5	+9.20 / +2.14	+26.5 / +0.00	+0.0 / +2.617	+0.0000 / +15.403
50	+30.2 / +69.8	+30.2 / +0.0	-171.9 / +30.0	+30.2 / +37.5	+7.90 / +2.29	+22.3 / +6.39	+0.0 / +2.346	+0.0000 / +15.009
100	+24.6 / +75.4	+24.6 / +0.0	-172.0 / +32.5	+24.6 / +40.4	+6.59 / +2.45	+18.0 / +12.78	+0.0 / +2.115	+0.0000 / +14.610
AIR TEMP: +23.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+36.2 / +63.8	+36.2 / +0.0	-60.1 / +29.2	+36.2 / +33.5	+9.65 / +1.08	+26.5 / +0.00	+0.0 / +1.187	+0.0000 / +7.055
50	+26.9 / +73.0	+26.9 / +0.0	-60.3 / +33.4	+26.9 / +38.3	+7.42 / +1.29	+19.5 / +10.53	+0.0 / +0.940	+0.0000 / +6.393
100	+17.7 / +82.3	+17.7 / +0.0	-60.5 / +37.7	+17.7 / +43.1	+5.16 / +1.51	+12.5 / +21.07	+0.0 / +0.749	+0.0000 / +5.730
AIR TEMP: +30.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+41.1 / +58.9	+36.6 / +0.0	+41.1 / +28.4	+616.6 / +30.4	+10.06 / +0.15	+26.3 / +0.00	+4.7 / +0.000	+0.0077 / +0.000
50	+40.8 / +59.2	+22.6 / +0.0	+40.8 / +28.4	+371.3 / +30.4	+6.62 / +0.43	+15.1 / +15.91	+19.1 / +0.000	+0.0523 / +0.000
100	+40.5 / +59.5	+8.5 / -0.0	+40.5 / +28.4	+125.9 / +30.4	+3.11 / +0.73	+3.9 / +31.83	+33.5 / +0.000	+0.2727 / +0.000
AIR TEMP: +33.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+85.5 / +14.5	+36.8 / -0.0	+85.5 / +7.2	+616.8 / +7.6	+10.24 / -0.25	+24.3 / +0.00	+50.9 / +0.000	+0.0839 / +0.000
50	+85.1 / +14.9	+20.1 / -0.0	+85.1 / +7.2	+325.9 / +7.6	+6.13 / +0.07	+11.0 / +18.87	+68.0 / +0.000	+0.2126 / +0.000
100	+34.9 / +15.2	+3.4 / +49.9	+84.8 / +7.2	+34.9 / +7.6	+1.92 / +0.41	+0.0 / +37.73	+33.0 / +0.000	+1.0000 / +0.000
AIR TEMP: +37.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+145.6 / -45.6	+37.0 / +0.0	+145.6 / -22.0	+617.0 / -22.8	+10.48 / -0.78	+21.6 / +0.00	+113.6 / +0.000	+0.1872 / +0.000
50	+145.2 / -45.2	+16.2 / +0.0	+145.2 / -22.0	+254.1 / -22.8	+5.33 / -0.40	+5.0 / +23.54	+134.9 / +0.000	+0.5423 / +0.000
100	-109.0 / -44.8	-109.0 / +253.8	+144.8 / -22.0	-109.0 / -22.8	+0.00 / +0.00	+0.0 / +47.08	-109.0 / +0.000	+1.0000 / +0.000
AIR TEMP: +45.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+269.4 / -169.4	+37.5 / +0.0	+269.4 / -83.9	+617.5 / -83.6	+10.99 / -1.85	+15.9 / +0.00	+242.5 / +0.000	+0.3998 / +0.000
50	+63.2 / -168.9	+5.7 / +205.7	+268.9 / -83.9	+63.2 / -83.6	+3.05 / -1.32	+0.0 / +35.95	+60.1 / +0.000	+1.0000 / +0.000
AIR TEMP: +50.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+349.2 / -249.2	+37.9 / +0.0	+349.2 / -125.1	+617.8 / -121.6	+11.31 / -2.52	+12.3 / +0.00	+325.6 / +0.000	+0.5368 / +0.000
50	-95.8 / -248.6	-95.8 / +444.4	+348.6 / -125.1	-95.8 / -121.6	+1.06 / -1.87	+0.0 / +46.28	-96.9 / +0.000	+1.0000 / +0.000
AIR TEMP: +60.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+514.8 / -414.8	+38.5 / +0.0	+514.8 / -213.3	+618.5 / -197.6	+12.00 / -3.87	+4.7 / +0.00	+498.0 / +0.000	+0.8211 / +0.000
AIR TEMP: +70.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+619.2 / -588.6	+39.3 / +69.4	+686.6 / -309.8	+619.2 / -273.6	+12.71 / -5.21	+0.0 / +0.00	+606.5 / +0.000	+1.0000 / +0.000
AIR TEMP: +80.00			**SKIN: 34.00 C 39.90 MMHG**					
0	+620.0 / -771.3	+40.0 / +251.3	+871.3 / -415.2	+620.0 / -349.6	+13.47 / -6.57	+0.0 / +0.00	+606.5 / +0.000	+1.0000 / +0.000

TABLE A-3

METABOLIC PARAMETERS, SET 2

RHZ	LAHET SEHET	LHMIN STØRE	LREQD RADHT	LHMAX CØNSK	LHRES CØRES	LRDSK PMMHG	LHWSK CLØSR	WETLR CLØDT
AIR TEMP: +10.00			SKIN: 32.00 C	35.67 MMHG				
0	+32.6	+32.6	-210.0	+32.6	+8.93	+23.7	+0.0	+0.0000
	+67.3	+0.0	+27.9	+36.6	+2.80	+0.00	+2.991	+18.289
50	+28.7	+28.7	-210.1	+28.7	+8.02	+20.7	+0.0	+0.C000
	+71.3	+0.0	+29.6	+38.8	+2.93	+4.60	+2.779	+18.004
100	+24.7	+24.7	-210.2	+24.7	+7.12	+17.6	+0.0	+0.0000
	+75.3	+0.0	+31.2	+41.0	+3.05	+9.20	+2.589	+17.718
AIR TEMP: +20.00			SKIN: 32.29 C	36.26 MMHG				
0	+33.6	+33.6	-77.2	+33.6	+9.48	+24.1	+0.0	+0.0000
	+66.4	+0.0	+29.7	+35.2	+1.48	+0.00	+1.334	+8.209
50	+25.9	+25.9	-77.4	+25.9	+7.64	+18.3	+0.0	+0.0000
	+74.0	+0.0	+33.2	+39.2	+1.67	+8.77	+1.116	+7.657
100	+18.3	+18.3	-77.6	+18.3	+5.80	+12.5	+0.0	+0.0000
	+81.7	+0.0	+36.2	+43.2	+1.86	+17.53	+0.938	+7.099
AIR TEMP: +25.00			SKIN: 32.70 C	37.10 MMHG				
0	+34.4	+34.4	-12.3	+34.4	+9.76	+24.7	+0.0	+0.0000
	+65.5	+0.0	+30.5	+34.3	+0.81	+0.00	+0.559	+3.430
50	+24.0	+24.0	-12.5	+24.0	+7.23	+16.8	+0.0	+0.0000
	+76.0	+0.0	+35.3	+39.6	+1.05	+11.88	+0.377	+2.680
100	+13.5	+13.5	-12.7	+13.5	+4.67	+8.9	+0.0	+0.0000
	+86.4	+0.0	+40.2	+44.9	+1.28	+23.76	+0.239	+1.927
AIR TEMP: +27.00			SKIN: 33.00 C	37.73 MMHG				
0	+35.0	+35.0	+12.1	+35.0	+9.88	+25.1	+0.0	+0.0000
	+65.0	+0.0	+30.7	+33.8	+0.55	+0.00	+0.274	+1.673
50	+23.2	+23.2	+11.9	+23.2	+7.01	+16.2	+0.0	+0.0000
	+76.8	+0.0	+36.2	+39.7	+0.80	+13.37	+0.115	+0.830
100	+11.6	+11.4	+11.6	+171.2	+4.10	+7.3	+0.2	+0.0013
	+88.4	+0.0	+41.7	+45.6	+1.06	+26.74	+0.000	+0.000
AIR TEMP: +29.00			SKIN: 33.44 C	38.67 MMHG				
0	+35.7	+35.7	+34.8	+35.7	+10.00	+25.7	+0.0	+0.0000
	+64.3	+0.0	+30.8	+33.2	-0.28	+0.00	+0.012	+0.071
50	+34.5	+22.5	+34.5	+366.2	+6.76	+15.2	+12.5	+0.0349
	+65.5	-0.0	+31.2	+33.7	+0.56	+15.02	+0.000	+0.000
100	+34.2	+9.2	+34.2	+134.6	+3.46	+4.6	+26.1	+0.1994
	+65.8	+0.0	+31.2	+33.7	+0.84	+30.04	+0.000	+0.000
AIR TEMP: +31.00			SKIN: 34.00 C	39.90 MMHG				
0	+55.8	+36.7	+55.8	+616.7	+10.12	+25.7	+20.0	+0.0330
	+44.2	-0.0	+21.4	+22.8	+0.01	+0.00	+0.000	+0.000
50	+55.5	+21.8	+55.5	+356.9	+6.46	+13.8	+35.3	-0.1006
	+44.5	+0.0	+21.4	+22.8	+0.31	+16.85	+0.000	+0.000
100	+55.2	+6.9	+55.2	+97.1	+2.74	+1.9	+50.5	+0.5359
	+44.8	+0.0	+21.4	+22.8	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00			SKIN: 35.00 C	42.18 MMHG				
0	+100.5	+38.4	+100.5	+651.5	+10.36	+25.2	+65.0	+0.1013
	-0.5	+0.C	-0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+326.3	+5.75	+10.3	+84.1	+0.2622
	-0.2	-0.0	-0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	-0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00			SKIN: 35.58 C	43.56 MMHG				
0	+167.9	+39.6	+167.9	+672.9	+10.67	+23.1	+134.1	+0.2025
	-67.9	+0.0	-33.1	-33.6	-1.19	+0.00	+0.000	+0.000
50	+167.4	+15.2	+167.4	+246.2	+4.58	+3.6	+159.2	+0.6591
	-67.4	+0.0	-33.1	-33.6	-0.75	+27.67	+0.000	+0.000
100	-180.7	-180.7	+167.0	-160.7	-1.74	+0.0	-178.9	+1.0000
	-67.0	+347.7	-33.1	-33.6	-0.29	+55.34	+0.000	+0.000
AIR TEMP: +52.00			SKIN: 36.00 C	44.57 MMHG				
0	+351.9	+41.1	+351.9	+688.9	+11.45	+15.4	+325.0	+0.4797
	-251.9	+0.0	-127.5	-121.6	-2.79	+0.00	+0.000	+0.000
50	-98.7	-98.7	+351.2	-98.7	+0.12	+0.0	-98.8	+1.0000
	-251.2	+449.8	-127.5	-121.6	-2.08	+51.07	+0.000	+0.000

A-6

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00	SKIN: 31.89 C	35.44 MMHG						
0	+32.0	+32.0	-339.4	+32.0	+8.41	+23.6	+0.0	+0.0000
	+58.0	+0.0	+25.9	+38.0	+4.12	+0.00	+4.707	+28.490
50	+30.1	+30.1	-339.4	+30.1	+8.01	+22.0	+0.0	+0.0000
	+69.9	+0.0	+26.7	+39.1	+4.21	+2.29	+4.553	+28.356
100	+28.1	+28.1	-339.5	+28.1	+7.61	+20.5	+0.0	+0.0000
	+71.8	+0.0	+27.4	+40.1	+4.29	+4.58	+4.409	+28.222
AIR TEMP: +15.00	SKIN: 32.11 C	35.88 MMHG						
0	+33.1	+33.1	-143.7	+33.1	+9.20	+23.9	+0.0	+0.0000
	+66.9	+0.0	+28.8	+35.9	+2.14	+0.00	+2.152	+13.213
50	+27.5	+27.5	-143.9	+27.5	+7.90	+19.6	+0.0	+0.0000
	+72.4	+0.0	+31.3	+38.9	+2.29	+6.39	+1.927	+12.814
100	+21.9	+21.9	-144.1	+21.9	+6.59	+15.4	+0.0	+0.0000
	+78.0	+0.0	+33.7	+41.9	+2.45	+12.78	+1.733	+12.411
AIR TEMP: +23.00	SKIN: 32.49 C	36.67 MMHG						
0	+34.0	+34.0	-37.8	+34.0	+9.65	+24.4	+0.0	+0.0000
	+65.9	+0.0	+30.2	+34.7	+1.08	+0.00	+0.861	+5.295
50	+24.8	+24.8	-38.0	+24.8	+7.42	+17.4	+0.0	+0.0000
	+75.2	+0.0	+34.5	+39.4	+1.29	+10.53	+0.661	+4.629
100	+15.5	+15.5	-38.2	+15.5	+5.16	+10.4	+0.0	+0.0000
	+84.4	+0.0	+38.7	+44.2	+1.51	+21.07	+0.504	+3.960
AIR TEMP: +30.00	SKIN: 33.71 C	39.26 MMHG						
0	+45.4	+36.2	+45.4	+606.8	+10.06	+25.7	+9.7	+0.0162
	+54.6	+0.0	+26.3	+28.2	+0.15	+0.00	+0.000	+0.000
50	+45.1	+22.1	+45.1	+361.5	+6.62	+14.5	+24.0	+0.0677
	+54.9	-0.0	+26.3	+28.2	+0.43	+15.91	+0.000	+0.000
100	+44.8	+8.1	+44.8	+116.1	+3.11	+3.3	+38.4	+0.3402
	+55.2	+0.0	+26.3	+28.2	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00	SKIN: 34.56 C	41.17 MMHG						
0	+77.1	+37.6	+77.1	+636.0	+10.24	+25.6	+41.3	+0.0660
	+22.9	-0.0	+11.3	+11.9	-0.25	+0.00	+0.000	+0.000
50	+76.8	+21.0	+76.8	+345.1	+5.13	+12.3	+58.4	+0.1722
	+23.2	-0.0	+11.3	+11.9	+0.07	+18.87	+0.000	+0.000
100	+54.2	+4.2	+76.8	+54.2	+1.92	+0.0	+52.2	+1.0000
	+23.6	+22.3	+11.3	+11.9	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00	SKIN: 35.30 C	42.89 MMHG						
0	+126.2	+39.0	+126.2	+662.4	+10.48	+24.5	+91.2	+0.1399
	-26.2	-0.0	-12.5	-12.9	-0.78	+0.00	+0.000	+0.000
50	+125.8	+18.2	+125.8	+299.5	+5.33	+7.9	+112.6	+0.3827
	-25.8	+0.0	-12.5	-12.9	-0.40	+23.54	+0.000	+0.000
100	-63.6	-63.6	+125.4	-63.6	+0.00	+0.0	-63.6	+1.0000
	-25.4	+189.1	-12.5	-12.9	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00	SKIN: 35.83 C	44.17 MMHG						
0	+242.1	+40.4	+242.1	+682.3	+10.99	+20.1	+210.9	+0.3142
	-142.1	+0.0	-70.6	-69.7	-1.85	+0.00	+0.000	+0.000
50	+127.9	+8.5	+241.5	+127.9	+3.05	+0.0	+124.9	+1.0000
	-141.5	+113.6	-70.6	-69.7	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00	SKIN: 35.96 C	44.48 MMHG						
0	+319.9	+40.9	+319.9	+687.4	+11.31	+16.8	+291.8	+0.4315
	-219.9	+0.0	-110.7	-106.7	-2.52	+0.00	+0.000	+0.000
50	-26.2	-26.2	+319.3	-26.2	+1.06	+0.0	-27.3	+1.0000
	-219.3	+345.5	-110.7	-106.7	-1.87	+46.28	+0.000	+0.000
AIR TEMP: +60.00	SKIN: 36.10 C	44.81 MMHG						
0	+483.5	+41.8	+483.5	+693.0	+12.00	+9.6	+461.9	+0.6783
	-383.5	+0.0	-198.0	-181.7	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00	SKIN: 36.16 C	44.97 MMHG						
0	+656.4	+42.6	+656.4	+696.2	+12.71	+1.8	+641.9	+0.9391
	-556.4	+0.0	-294.0	-257.2	-5.21	+0.00	+0.000	+0.000
AIR TEMP: +80.00	SKIN: 36.20 C	45.06 MMHG						
0	+698.5	+43.4	+838.5	+698.5	+13.47	+0.0	+685.0	+1.0000
	-738.5	+140.1	-399.1	-332.9	-6.57	+0.00	+0.000	+0.000

TABLE A-4

METABOLIC PARAMETERS, SET 3

RH%	LAHET SEHET	LHMIN STØRE	LREQD RADHT	LHMAX CØNSK	LHRES CØRES	LHD.SK PMMHG	LHWSK CLØSR	WETLR CLØDT
AIR TEMP: +10.00			SKIN: 32.00 C	35.67 MMHG				
0	+27.6	+32.6	-210.0	+32.6	+8.93	+18.7	+0.0	+0.0000
	+72.4	+0.0	+30.1	+39.5	+2.80	+0.00	+2.716	+17.914
50	+24.5	+28.7	-210.1	+28.7	+8.02	+16.4	+0.0	+0.0000
	+75.5	+0.0	+31.4	+41.2	+2.93	+4.60	+2.571	+17.689
100	+21.3	+24.7	-210.2	+24.7	+7.12	+14.2	+0.0	+0.0000
	+78.7	+0.0	+32.8	+42.9	+3.05	+9.20	+2.436	+17.461
AIR TEMP: +20.00			SKIN: 32.29 C	36.26 MMHG				
0	+30.9	+33.6	-77.2	+33.6	+9.48	+21.4	+0.0	+0.0000
	+69.1	+0.0	+31.0	+36.6	+1.48	+0.00	+1.250	+8.010
50	+24.2	+25.9	-77.4	+25.9	+7.64	+16.5	+0.0	+0.0000
	+75.8	+0.0	+34.0	+40.1	+1.67	+8.77	+1.071	+7.525
100	+17.2	+18.3	-77.6	+18.3	+5.80	+11.4	+0.0	+0.0000
	+82.7	+0.1	+37.2	+43.7	+1.86	+17.53	+0.916	+7.023
AIR TEMP: +25.00			SKIN: 32.70 C	37.10 MMHG				
0	+33.2	+34.4	-12.3	+34.4	+9.76	+23.4	+0.0	+0.0000
	+66.8	+0.0	+31.1	+34.9	+0.81	+0.00	+0.534	+3.337
50	+23.4	+24.0	-12.5	+24.0	+7.23	+16.2	+0.0	+0.0000
	+76.6	+0.0	+35.6	+39.9	+1.05	+11.88	+0.368	+2.635
100	+13.3	+13.5	-12.7	+13.5	+4.67	+8.7	+0.0	+0.0000
	+86.6	+0.0	+40.3	+45.0	+1.28	+23.76	+0.236	+1.912
AIR TEMP: +27.00			SKIN: 33.00 C	37.73 MMHG				
0	+34.3	+35.0	+12.1	+35.0	+9.88	+24.4	+0.0	+0.0000
	+65.7	+0.0	+31.0	+34.1	+0.55	+0.00	+0.263	+1.624
50	+23.0	+23.2	+11.9	+23.2	+7.01	+16.0	+0.0	+0.0000
	+76.9	+0.0	+36.3	+39.8	+0.80	+13.37	+0.113	+0.817
100	+11.6	+11.4	+11.6	+171.2	+4.10	+7.3	+0.2	+0.0013
	+88.4	+0.0	+41.7	+45.6	+1.06	+26.74	+0.000	+0.000
AIR TEMP: +29.00			SKIN: 33.44 C	38.67 MMHG				
0	+35.7	+35.7	+34.8	+35.7	+10.00	+25.7	+0.0	+0.0000
	+64.3	+0.0	+30.8	+33.2	+0.28	+0.00	+0.011	+0.068
50	+34.5	+22.5	+34.5	+366.2	+6.76	+15.2	+12.5	+0.0349
	+65.5	-0.0	+31.2	+33.7	+0.56	+15.02	+0.000	+0.000
100	+34.2	+9.2	+34.2	+134.6	+3.46	+4.6	+26.1	+0.1994
	+65.8	+0.0	+31.2	+33.7	+0.84	+30.04	+0.000	+0.000
AIR TEMP: +31.00			SKIN: 34.00 C	39.90 MMHG				
0	+55.8	+36.7	+55.8	+616.7	+10.12	+25.7	+20.0	+0.0330
	+44.2	-0.0	+21.4	+22.8	+0.01	+0.00	+0.000	+0.000
50	+55.5	+21.8	+55.5	+356.9	+6.46	+13.8	+35.3	+0.1006
	+44.5	+0.0	+21.4	+22.8	+0.31	+16.85	+0.000	+0.000
100	+55.2	+6.9	+55.2	+97.1	+2.74	+1.9	+50.5	+0.5359
	+44.8	+0.0	+21.4	+22.8	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00			SKIN: 35.00 C	42.18 MMHG				
0	+100.5	+38.4	+100.5	+651.5	+10.36	+25.2	+65.0	+0.1013
	-0.5	+0.0	-0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+326.3	+5.75	+10.3	+84.1	+0.2622
	-0.2	-0.0	-0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	-0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00			SKIN: 35.58 C	43.56 MMHG				
0	+167.9	+39.6	+167.9	+672.9	+10.67	+23.1	+134.1	+0.2025
	-67.9	+0.0	-33.1	-33.6	-1.19	+0.00	+0.000	+0.000
50	+167.4	+15.2	+167.4	+246.2	+4.58	+3.6	+159.2	+0.6591
	-67.4	+0.0	-33.1	-33.6	-0.75	+27.67	+0.000	+0.000
100	-180.7	-180.7	+167.0	-180.7	-1.74	+0.0	-178.9	+1.0000
	-67.0	+347.7	-33.1	-33.6	-0.29	+55.34	+0.000	+0.000
AIR TEMP: +52.00			SKIN: 36.00 C	44.57 MMHG				
0	+351.9	+41.1	+351.9	+688.9	+11.45	+15.4	+325.0	+0.4797
	-251.9	+0.0	-127.5	-121.6	-2.79	+0.00	+0.000	+0.000
50	-98.7	-98.7	+351.2	-98.7	+0.12	+0.0	-98.8	+1.0000
	-251.2	+449.8	-127.5	-121.6	-2.08	+51.07	+0.000	+0.000

RHZ	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00	SKIN: 31.89 C	35.44 MMHG						
0	+25.0	+32.0	-339.4	+32.0	+8.41	+16.5	+0.0	+0.0000
	+74.9	+0.0	+28.8	+42.1	+4.12	+0.00	+4.170	+27.982
50	+23.7	+30.1	-339.4	+30.1	+8.01	+15.7	+0.0	+0.0000
	+76.3	+0.1	+29.3	+42.8	+4.21	+2.29	+4.082	+27.889
100	+22.3	+28.1	-339.5	+28.1	+7.61	+14.7	+0.0	+0.0000
	+77.7	+0.0	+29.8	+43.6	+4.29	+4.58	+3.995	+27.792
AIR TEMP: +15.00	SKIN: 32.11 C	35.88 MMHG						
0	+29.1	+33.1	-143.7	+33.1	+9.20	+19.9	+0.0	+0.0000
	+70.8	+0.0	+30.6	+38.1	+2.14	+0.00	+1.984	+12.921
50	+24.5	+27.5	-143.9	+27.5	+7.90	+16.6	+0.0	+0.0000
	+75.5	+0.0	+32.6	+40.6	+2.29	+6.39	+1.815	+12.588
100	+19.8	+21.9	-144.1	+21.9	+6.59	+13.2	+0.0	+0.0000
	+80.2	+0.0	+34.7	+43.1	+2.45	+12.78	+1.662	+12.245
AIR TEMP: +23.00	SKIN: 32.49 C	36.67 MMHG						
0	+32.2	+34.0	-37.8	+34.0	+9.65	+22.5	+0.0	+0.0000
	+67.8	+0.0	+31.1	+35.6	+1.08	+0.00	+0.816	+5.158
50	+23.8	+24.8	-38.0	+24.8	+7.42	+16.3	+0.0	+0.0000
	+76.2	+0.0	+35.0	+40.0	+1.29	+10.53	+0.641	+4.549
100	+15.1	+15.5	-38.2	+15.5	+5.16	+9.9	+0.0	+0.0000
	+84.9	+0.0	+39.0	+44.4	+1.51	+21.07	+0.497	+3.925
AIR TEMP: +30.00	SKIN: 33.71 C	39.26 MMHG						
0	+45.4	+36.2	+45.4	+606.8	+10.06	+25.7	+9.7	+0.0162
	+54.6	+0.0	+26.3	+28.2	+0.15	+0.00	+0.000	+0.000
50	+45.1	+22.1	+45.1	+361.5	+6.62	+14.5	+24.0	+0.0677
	+54.9	-0.0	+26.3	+28.2	+0.43	+15.91	+0.000	+0.000
100	+44.8	+8.1	+44.8	+116.1	+3.11	+3.3	+38.4	+0.3402
	+55.2	+0.0	+26.3	+28.2	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00	SKIN: 34.56 C	41.17 MMHG						
0	+77.1	+37.6	+77.1	+636.0	+10.24	+25.6	+41.3	+0.0660
	+22.9	-0.0	+11.3	+11.9	-0.25	+0.00	+0.000	+0.000
50	+76.8	+21.0	+76.8	+345.1	+6.13	-12.3	+58.4	+0.1722
	+23.2	-0.0	+11.3	+11.9	+0.07	+18.87	+0.000	+0.000
100	+54.2	+4.2	+76.4	+54.2	+1.92	+0.0	+52.2	+1.0000
	+23.6	+22.3	+11.3	+11.9	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00	SKIN: 35.30 C	42.89 MMHG						
0	+126.2	+39.0	+126.2	+662.4	+10.48	+24.5	+91.2	+0.1399
	-26.2	-0.0	-12.5	-12.9	-0.78	+0.00	+0.000	+0.000
50	+125.8	+18.2	+125.8	+299.5	+5.33	+7.9	+112.6	+0.3827
	-25.8	+0.0	-12.5	-12.9	-0.40	+23.54	+0.000	+0.000
100	-63.6	-63.6	+125.4	-63.6	+0.00	+0.0	-63.6	+1.0000
	-25.4	+189.1	-12.5	-12.9	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00	SKIN: 35.83 C	44.17 MMHG						
0	+242.1	+40.4	+242.1	+682.3	+10.99	+20.1	+210.9	+0.3142
	-142.1	+0.0	-70.6	-69.7	-1.85	+0.00	+0.000	+0.000
50	+127.9	+8.5	+241.5	+127.9	+3.05	+0.0	+124.9	+1.0000
	-141.5	+113.6	-70.6	-69.7	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00	SKIN: 35.96 C	44.48 MMHG						
0	+319.9	+40.9	+319.9	+687.4	+11.31	+16.8	+291.9	+0.4316
	-219.9	+0.0	-110.7	-106.7	-2.52	+0.00	+0.000	+0.000
50	-26.2	-26.2	+319.3	-26.2	+1.06	+0.0	-27.3	+1.0000
	-219.3	+345.5	-110.7	-106.7	-1.87	+46.28	+0.000	+0.000
AIR TEMP: +60.00	SKIN: 36.10 C	44.81 MMHG						
0	+483.5	+41.8	+483.5	+693.0	+12.00	+9.6	+461.9	+0.6783
	-383.5	+0.0	-198.0	+181.7	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00	SKIN: 36.16 C	44.97 MMHG						
0	+656.4	+42.6	+656.4	+696.2	+12.71	+1.8	+641.9	+0.9391
	-556.4	+0.0	-294.0	-257.2	-5.21	+0.00	+0.000	+0.000
AIR TEMP: +80.00	SKIN: 36.20 C	45.06 MMHG						
0	+698.5	+43.4	+838.5	+698.5	+13.47	+0.0	+685.0	+1.0000
	-738.5	+140.1	-399.1	-332.9	-6.57	+0.00	+0.000	+0.000

TABLE A-5

METABOLIC PARAMETERS, SET 4

RHZ	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +10.00		SKIN: 32.00 C	35.67 MMHG					
0	+27.7	+32.6	-184.9	+32.6	+8.93	+18.7	+0.0	+0.0000
	+72.3	+0.0	+32.9	+36.6	+2.80	+0.00	+2.660	+17.523
50	+24.5	+25.7	-185.0	+28.7	+8.02	+16.5	+0.0	+0.0000
	+75.4	+0.0	+34.3	+38.2	+2.93	+4.60	+2.514	+17.278
100	+21.3	+24.7	-185.1	+24.7	+7.12	+14.2	+0.0	+0.0000
	+78.6	+0.0	+35.8	+39.8	+3.05	+9.20	+2.377	+17.026
AIR TEMP: +20.00		SKIN: 32.29 C	36.26 MMHG					
0	+31.0	+33.6	-63.2	+33.6	+9.48	+21.5	+0.0	+0.0000
	+69.0	+0.0	+33.7	+33.8	+1.48	+0.00	+1.191	+7.618
50	+24.3	+25.9	-63.4	+25.9	+7.64	+16.3	+0.0	+0.0000
	+75.7	+0.0	+37.0	+37.0	+1.67	+8.77	+1.010	+7.087
100	+17.3	+18.3	-63.6	+18.3	+5.80	+11.5	+0.0	+0.0000
	+82.7	+0.0	+40.5	+40.4	+1.36	+17.53	+0.853	+6.535
AIR TEMP: +25.00		SKIN: 32.70 C	37.10 MMHG					
0	+33.3	+34.4	-3.5	+34.4	+9.76	+23.6	+0.0	+0.0000
	+66.7	+0.0	+33.7	+32.1	+0.81	+0.00	+0.472	+2.946
50	+23.5	+24.0	-3.7	+24.0	+7.23	+16.3	+0.0	+0.0000
	+76.5	+0.0	+38.7	+36.7	+1.05	+11.88	+0.305	+2.178
100	+13.4	+13.5	-3.9	+13.5	+4.67	+8.7	+0.0	+0.0000
	+86.6	+0.0	+43.8	+41.5	+1.28	+23.76	+0.171	+1.085
AIR TEMP: +27.00		SKIN: 33.00 C	37.73 MMHG					
0	+34.5	+35.0	+19.0	+35.0	+9.88	+24.6	+0.0	+0.0000
	+65.5	+0.0	+33.6	+31.4	+0.55	+0.00	+0.201	+1.238
50	+23.1	+23.2	+18.7	+23.2	+7.01	+16.1	+0.0	+0.0000
	+76.8	+0.0	+39.4	+36.6	+0.80	+13.37	+0.049	+0.355
100	+18.5	+11.4	+18.5	+146.2	+4.10	+6.9	+7.4	+0.0523
	+81.5	+0.0	+41.7	+38.8	+1.06	+26.74	+0.000	+0.000
AIR TEMP: +29.00		SKIN: 33.44 C	38.67 MMHG					
0	+39.8	+35.7	+39.8	+509.6	+10.00	+25.5	+4.3	+0.0087
	+60.2	+0.0	+31.2	+28.7	+0.28	+0.00	+0.000	+0.000
50	+39.5	+22.5	+39.5	+312.3	+6.76	+14.8	+18.0	+0.0589
	+60.5	+0.0	+31.2	+28.7	+0.56	+15.02	+0.000	+0.000
100	+39.3	+9.2	+39.3	+114.9	+3.46	+4.1	+31.7	+0.2844
	+60.7	-0.0	+31.2	+28.7	+0.84	+30.04	+0.000	+0.000
AIR TEMP: +31.00		SKIN: 34.00 C	39.90 MMHG					
0	+59.2	+36.7	+59.2	+525.7	+10.12	+25.3	+23.8	+0.0462
	+40.8	+0.0	+21.4	+19.4	+0.01	+0.00	+0.000	+0.000
50	+58.9	+21.8	+58.9	+304.3	+6.46	+13.3	+39.1	+0.1314
	+41.1	+0.0	+21.4	+19.4	+0.31	+16.85	+0.000	+0.000
100	+58.6	+6.9	+58.6	+82.9	+2.74	+1.3	+54.6	+0.6806
	+41.4	+0.0	+21.4	+19.4	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00		SKIN: 35.00 C	42.18 MMHG					
0	+100.5	+38.4	+100.5	+555.3	+10.36	+24.7	+65.5	+0.1202
	-0.5	+0.0	-0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+278.2	+5.75	+9.7	+84.7	+0.3110
	-0.2	+0.0	-0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	-0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00		SKIN: 35.58 C	43.56 MMHG					
0	+162.8	+39.6	+162.8	+573.5	+10.67	+22.3	+129.9	+0.2308
	-62.8	-0.0	-33.1	-28.5	-1.19	+0.00	+0.000	+0.000
50	+162.4	+15.2	+162.4	+210.0	+4.58	+2.6	+155.2	+0.7559
	-62.4	+0.0	-33.1	-28.5	-0.75	+27.67	+0.000	+0.000
100	-153.9	-153.9	+161.9	-153.9	-1.74	+0.0	-152.1	+1.0000
	-61.9	+315.8	-33.1	-28.5	-0.29	+55.34	+0.000	+0.000
AIR TEMP: +52.00		SKIN: 36.00 C	44.57 MMHG					
0	+333.6	+41.1	+333.6	+587.3	+11.45	+13.8	-308.4	+0.5356
	-233.6	-0.0	-127.5	-103.4	-2.79	+0.00	+0.000	+0.000
50	-83.9	-83.9	+332.9	-83.9	+0.12	+0.0	-84.0	+1.0000
	-232.9	+416.8	-127.5	-103.4	-2.08	+51.07	+0.000	+0.000

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00		SKIN: 31.89 C	35.44 MMHG					
0	+25.1	+32.0	-303.0	+32.0	+8.41	+16.7	+0.0	+0.0000
	+74.9	+0.0	+31.6	+39.2	+4.12	+0.00	+4.116	+27.593
50	+23.7	+30.1	-303.1	+30.1	+8.01	+15.7	+0.0	+0.0000
	+76.2	+0.0	+32.2	+39.9	+4.21	+2.29	+4.026	+27.489
100	+22.3	+28.1	-303.2	+28.1	+7.61	+14.7	+0.0	+0.0000
	+77.7	+0.0	+32.8	+40.6	+4.29	+4.58	+3.939	+27.379
AIR TEMP: +15.00		SKIN: 32.11 C	35.88 MMHG					
0	+29.2	+33.1	-124.2	+33.1	+9.20	+20.0	+0.0	+0.0000
	+70.8	+0.0	+33.4	+35.3	+2.14	+0.00	+1.926	+12.528
50	+24.6	+27.5	-124.4	+27.5	+7.90	+16.7	+0.0	+0.0000
	+75.4	+0.0	+35.6	+37.5	+2.29	+6.39	+1.756	+12.165
100	+19.8	+21.9	-124.6	+21.9	+6.59	+13.2	+0.0	+0.0000
	+80.2	+0.0	+37.9	+39.8	+2.45	+12.78	+1.601	+11.789
AIR TEMP: +23.00		SKIN: 32.49 C	36.67 MMHG					
0	+32.3	+34.0	-27.0	+34.0	+9.65	+22.7	+0.0	+0.0000
	+67.6	+0.0	+33.7	+32.8	+1.08	+0.00	+0.756	+4.769
50	+23.8	+24.8	-27.2	+24.8	+7.42	+16.4	+0.0	+0.0000
	+76.1	+0.0	+38.0	+36.8	+1.29	+10.53	+0.579	+4.103
100	+15.1	+15.5	-27.4	+15.5	+5.16	+9.9	+0.0	+0.0000
	+84.9	+0.0	+42.4	+41.0	+1.51	+21.07	+0.432	+3.413
AIR TEMP: +30.00		SKIN: 33.71 C	39.26 MMHG					
0	+49.6	+36.2	+49.6	+517.3	+10.06	+25.4	+14.2	+0.0280
	+50.4	+0.0	+26.3	+24.0	+0.15	+0.00	+0.000	+0.000
50	+49.3	+22.1	+49.3	+308.3	+6.62	+14.1	+28.7	+0.0951
	+50.7	+0.0	+26.3	+24.0	+0.43	+15.91	+0.000	+0.000
100	+49.0	+8.1	+49.0	+99.2	+3.11	+2.7	+43.2	+0.4499
	+51.0	+0.0	+26.3	-4.0	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00		SKIN: 34.56 C	41.17 MMHG					
0	+78.9	+37.6	+78.9	+542.2	+10.24	+25.1	+43.5	+0.0818
	+21.1	-0.0	+11.3	+10.1	-0.25	+0.00	+0.000	+0.000
50	+78.6	+21.0	+78.6	+294.3	+6.13	+11.7	+60.7	+0.2117
	+21.4	-0.0	+11.3	+10.1	+0.07	+18.87	+0.000	+0.000
100	+46.3	+4.2	+78.2	+46.3	+1.92	+0.0	+44.4	+1.0000
	+21.8	+31.9	+11.3	+10.1	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00		SKIN: 35.30 C	42.89 MMHG					
0	+124.3	+39.0	+124.3	+564.6	+10.48	+23.9	+89.9	+0.1623
	-24.3	+0.0	-12.5	-11.0	-0.78	+0.00	+0.000	+0.000
50	+123.9	+18.2	+123.9	+255.4	+5.33	+7.1	+111.5	+0.4458
	-23.9	+0.0	-12.5	-11.0	-0.40	+23.54	+0.000	+0.000
100	-54.1	-54.1	+123.5	-54.1	+0.00	+0.0	-54.1	+1.0000
	-23.5	+177.6	-12.5	-11.0	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00		SKIN: 35.83 C	44.17 MMHG					
0	+231.6	+40.4	+231.6	+581.6	+10.99	+19.0	+201.6	+0.3534
	-131.6	+0.0	-70.6	-59.2	-1.85	+0.00	+0.000	+0.000
50	+109.	+8.5	+231.1	+109.2	+3.05	+0.0	+106.2	+1.0000
	-131.1	+121.9	-70.6	-59.2	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00		SKIN: 35.96 C	44.48 MMHG					
0	+303.9	+40.9	+303.9	+586.0	+11.31	+15.3	+277.3	+0.4825
	-203.9	+0.0	-110.7	-90.7	-2.52	+0.00	+0.000	+0.000
50	-22.1	-22.1	+303.3	-22.1	+1.06	+0.0	-23.2	+1.0000
	-203.3	+325.4	-110.7	-90.7	-1.87	+46.28	+0.000	+0.000
AIR TEMP: +60.00		SKIN: 36.10 C	44.81 MMHG					
0	+456.3	+41.8	+456.3	+590.9	+12.00	+7.3	+437.0	+0.7543
	-356.3	+0.0	-198.0	-154.4	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00		SKIN: 36.16 C	44.97 MMHG					
0	+593.7	+42.6	+617.8	+593.7	+12.71	+0.0	+581.0	+1.0000
	-517.8	+24.1	-294.0	-218.6	-5.21	.00	+0.000	+0.000
AIR TEMP: +80.00		SKIN: 36.20 C	45.06 MMHG					
0	+595.7	+43.4	+788.6	+595.7	+13.47	+0.0	+532.2	+1.0000
	-6?.6	+192.9	-399.1	-282.9	-6.57	+0.00	+0.000	+0.000

METABOLIC PARAMETERS, SET 5

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +10.00		SKIN: 32.00 C	35.67 MMHG					
0	+27.5	+32.6	-251.8	+32.6	+8.93	+18.5	+0.0	+0.0000
	+72.5	+0.0	+26.3	+43.3	+2.80	+0.00	+2.791	+18.433
50	+24.4	+28.7	-251.9	+28.7	+8.02	+16.3	+0.0	+0.0000
	+75.6	+0.0	+27.5	+45.2	+2.93	+4.60	+2.647	+18.238
100	+21.2	+24.7	-252.0	+24.7	+7.12	+14.1	+0.0	+0.0000
	+78.8	+0.0	+28.7	+47.1	+3.05	+9.20	+2.514	+18.042
AIR TEMP: +20.00		SKIN: 32.29 C	36.26 MMHG					
0	+30.8	+33.6	-100.6	+33.6	+9.48	+21.3	+0.0	+0.0000
	+69.2	+0.0	+27.3	+40.4	+1.48	+0.00	+1.330	+8.535
50	+24.0	+25.9	-100.8	+25.9	+7.64	+16.4	+0.0	+0.0000
	+75.9	+0.0	+30.0	+44.3	+1.67	+8.77	+1.152	+8.111
100	+17.1	+18.3	-100.9	+18.3	+5.80	+11.3	+0.0	+0.0000
	+82.9	+0.0	+32.7	+48.3	+1.86	+17.53	+1.000	+7.672
AIR TEMP: +25.00		SKIN: 32.70 C	37.10 MMHG					
0	+33.0	+34.4	-26.9	+34.4	+9.76	+23.2	+0.0	+0.0000
	+67.0	+0.0	+27.5	+38.7	+0.81	+0.00	+0.616	+3.861
50	+23.3	+24.0	-27.1	+24.0	+7.23	+16.0	+0.0	+0.0000
	+76.7	+0.0	+31.5	+44.2	+1.05	+11.88	+0.453	+3.249
100	+13.3	+13.5	-27.3	+13.5	+4.67	+8.6	+0.0	+0.0000
	+86.7	+0.0	+35.6	+49.8	+1.28	+23.76	+0.323	+2.617
AIR TEMP: +27.00		SKIN: 33.00 C	37.73 MMHG					
0	+34.1	+35.0	+0.7	+35.0	+9.88	+24.3	+0.0	+0.?000
	+65.8	+0.0	+27.4	+37.9	+0.55	+0.00	+0.347	+2.148
50	+22.9	+23.2	+0.5	+23.2	+7.01	+15.9	+0.0	+0.0000
	+77.1	+0.0	+32.1	+44.2	+0.80	+13.37	+0.199	+1.440
100	+11.3	+11.4	+0.2	+11.4	+4.10	+7.2	+0.0	+0.0000
	+88.6	+0.0	+36.9	+50.6	+1.06	+26.74	+0.086	+0.717
AIR TEMP: +29.00		SKIN: 33.44 C	38.67 MMHG					
0	+35.5	+35.7	+26.3	+35.7	+10.00	+25.5	+0.0	+0.0000
	-64.5	+0.0	+27.3	+36.9	+0.28	+0.00	+0.096	+0.586
50	+26.0	+22.5	+24.0	+456.1	+6.76	+15.6	+3.7	+0.0082
	+74.0	+0.0	+31.2	+42.2	+0.56	+15.02	+0.000	+0.000
100	+25.8	+9.2	+25.8	+167.4	+3.46	+5.1	+17.2	+0.1048
	+74.2	+0.0	+31.2	+42.2	+0.84	+30.04	+0.000	+0.000
AIR TEMP: +31.00		SKIN: 34.00 C	39.90 MMHG					
0	+50.1	+36.7	+50.1	+768.3	+10.12	+26.0	+13.9	+0.0184
	+49.9	+0.0	+21.4	+28.5	+0.01	+0.00	+0.000	+0.000
50	+49.8	+21.8	+49.8	+444.5	+6.46	+14.3	+29.0	+0.0663
	+50.2	-0.0	+21.4	+28.5	+0.31	+16.85	+0.000	+0.000
100	+49.5	+6.9	+49.5	+120.6	+2.74	+2.6	+44.2	+0.3747
	+50.5	+0.0	+21.4	+28.5	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00		SKIN: 35.00 C	42.18 MMHG					
0	+100.5	+38.4	+100.5	+811.8	+10.36	+25.8	+64.4	+0.0803
	-0.5	+0.0	-0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+406.5	+5.75	+11.1	+83.3	+0.2079
	-0.2	-0.0	-0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	-0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00		SKIN: 35.58 C	43.56 MMHG					
0	+176.3	+39.6	+176.3	+838.4	+10.67	+24.0	+141.6	+0.1710
	-76.3	-0.0	-33.1	-41.9	-1.19	+0.00	+0.000	+0.000
50	+175.8	+15.2	+175.8	+306.6	+4.58	+4.7	+166.5	+0.5513
	-75.8	+0.0	-33.1	-41.9	-0.75	+27.67	+0.000	+0.000
100	-225.4	-225.4	+175.4	-225.4	-1.74	+0.0	-283.7	+1.0000
	-75.4	+400.8	-33.1	-41.9	-0.29	+53.34	+0.000	+0.000
AIR TEMP: +52.00		SKIN: 36.00 C	44.57 MMHG					
0	+382.3	+41.1	+382.3	+858.3	+11.45	+17.3	+353.6	+0.4175
	-282.3	+0.0	-127.5	-152.0	-2.79	+0.00	+0.000	+0.000
50	-123.4	-123.4	+381.6	-123.4	+0.12	+0.0	-123.5	+1.0000
	-281.6	+504.9	-127.5	-152.0	-2.08	+51.07	+0.000	+0.000

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00		SKIN: 31.89 C	35.44 MMHG					
0	+25.0	+32.0	-399.9	+32.0	+8.41	+16.5	+0.0	+0.0000
	+75.0	+0.0	+25.0	+45.9	+4.12	+0.00	+4.242	+28.497
50	+23.6	+30.1	-400.0	+30.1	+8.01	+15.6	+0.0	+0.0000
	+76.4	+0.0	+25.5	+46.7	+4.21	+2.29	+4.154	+28.414
100	+22.2	+28.1	-400.1	+28.1	+7.61	+14.6	+0.0	+0.0000
	+77.8	+0.0	+26.0	+47.5	+4.29	+4.58	+4.068	+28.331
AIR TEMP: +15.00		SKIN: 32.11 C	35.88 MMHG					
0	+29.0	+33.1	-176.2	+33.1	+9.20	+19.8	+0.0	+0.0000
	+71.0	+0.0	+26.9	+42.0	+2.14	+0.00	+2.060	+13.442
50	+24.4	+27.5	-176.4	+27.5	+7.90	+16.5	+0.0	+0.0000
	+75.6	+0.0	+28.7	+44.7	+2.29	+6.39	+1.894	+13.153
100	+19.7	+21.9	-176.6	+21.9	+6.59	+13.1	+0.0	+0.0000
	+80.3	+0.0	+30.5	+47.4	+2.45	+12.78	+1.743	+12.858
AIR TEMP: +23.00		SKIN: 32.49 C	36.67 MMHG					
0	+32.0	+34.0	-55.9	+34.0	+9.65	+22.4	+0.0	+0.0000
	+67.9	+0.0	+27.4	+39.4	+1.08	+0.00	+0.897	+5.684
50	+23.6	+24.9	-56.0	+24.9	+7.42	+16.2	+0.0	+0.0000
	+76.3	+0.0	+30.9	+44.2	+1.29	+10.53	+0.725	+5.154
100	+15.0	+15.5	-56.3	+15.5	+5.16	+9.8	+0.0	+0.0000
	+85.0	+0.0	+34.4	+49.1	+1.51	+21.07	+0.582	+4.605
AIR TEMP: +30.00		SKIN: 33.71 C	39.26 MMHG					
0	+38.4	+36.2	+38.4	+756.0	+10.06	+26.0	+2.3	+0.0030
	+61.6	+0.0	+26.3	+35.2	+0.15	+0.00	+0.000	+0.000
50	+38.1	+22.1	+38.1	+450.2	+6.62	+14.9	+16.5	+0.0372
	+61.9	+0.0	+26.3	+35.2	+0.43	+15.91	+0.000	+0.000
100	+37.8	+8.1	+37.8	+144.4	+3.11	+3.9	+30.8	+0.2180
	+62.2	+0.0	+26.3	+35.2	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00		SKIN: 34.56 C	41.17 MMHG					
0	+74.1	+37.6	+74.1	+792.5	+10.24	+26.1	+37.8	+0.0484
	+25.9	-0.0	+11.3	+14.8	-0.25	+0.00	+0.000	+0.000
50	+73.8	+21.0	+73.8	+429.9	+6.13	+12.9	+54.8	+0.1292
	+26.2	-0.0	+11.3	+14.8	+0.07	+18.87	+0.000	+0.000
100	+67.2	+4.2	+73.5	+67.2	+1.92	+0.0	+65.3	+1.0000
	+26.5	+6.2	+11.3	+14.8	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00		SKIN: 35.30 C	42.89 MMHG					
0	+129.5	+39.0	+129.5	+825.4	+10.48	+25.2	+93.7	+0.1150
	-29.5	+0.0	-12.5	-16.1	-0.?8	+0.00	+0.000	+0.000
50	+129.1	+18.2	+129.1	+373.0	+5.33	+8.8	+114.9	+0.3125
	-29.1	+0.0	-12.5	-16.1	-0.40	+23.54	+0.000	+0.000
100	-79.5	-79.5	+128.7	-79.5	+0.00	+0.0	-79.5	+1.0000
	-28.7	+208.2	-12.5	-16.1	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00		SKIN: 35.83 C	44.17 MMHG					
0	+259.5	+40.4	+259.5	+850.1	+10.99	+21.4	+227.1	+0.2706
	-159.5	+0.0	-70.6	-87.1	-1.85	+0.00	+0.000	+0.000
50	+159.2	+8.5	+259.0	+159.2	+3.05	+0.0	+156.1	+1.0000
	-159.0	+99.8	-70.6	-8.1	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00		SKIN: 35.96 C	44.48 MMHG					
0	+346.6	+40.9	+346.6	+856.5	+11.31	+18.5	+316.8	+0.3748
	-246.6	+0.0	-110.7	-133.3	-2.52	+0.00	+0.000	+0.000
50	-33.0	-33.0	+346.0	-33.0	+1.06	+0.0	-34.1	+1.0000
	-246.0	+379.0	-110.7	-133.3	-1.87	+46.28	+0.000	+0.000
AIR TEMP: +60.00		SKIN: 36.10 C	44.81 MMHG					
0	+528.9	+41.8	+528.9	+863.3	+12.00	+32.1	+504.8	+0.5930
	-428.9	+0.0	-178.0	-227.1	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00		SKIN: 36.16 C	44.97 MMHG					
0	+720.7	+42.6	+720.7	+867.1	+12.71	+5.3	+702.7	+0.8224
	-620.7	+0.0	-294.0	-321.5	-5.21	+0.00	+0.000	+0.000
AIR TEMP: +80.00		SKIN: 36.20 C	45.06 MMHG					
0	+869.7	+43.4	+921.7	+869.7	+13.47	+0.0	+856.2	+1.0000
	-821.7	+52.0	-399.1	-416.1	-6.57	+0.00	+0.000	+0.000

METABOLIC PARAMETERS, SET 6

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +10.00		SKIN: 32.00 C	35.67 MMHG					
0	+27.3	+32.6	-335.4	+32.8	+8.93	+18.4	+0.0	+0.0000
	+72.6	+0.0	+21.1	+48.8	+2.80	+0.00	+2.894	+19.157
50	+24.2	+28.7	-335.5	+28.7	+8.02	+16.2	+0.0	+0.0000
	+75.8	+0.0	+22.0	+50.8	+2.93	+4.60	+2.753	+19.003
100	+21.1	+24.7	-335.6	+24.7	+7.12	+13.9	+0.0	+0.0000
	+78.9	+0.0	+22.9	+52.9	+3.05	+9.20	+2.622	+18.846
AIR TEMP: +20.00		SKIN: 32.29 C	36.26 MMHG					
0	+30.6	+33.6	-147.3	+33.6	+9.48	+21.1	+0.0	+0.0000
	+69.4	+0.1	+22.0	+45.9	+1.48	+0.00	+1.441	+9.278
50	+23.9	+25.9	-147.5	+25.9	+7.64	+16.2	+0.0	+0.0000
	+76.1	+0.0	+24.2	+50.3	+1.67	+8.77	+1.267	+8.938
100	+17.0	+18.3	-147.7	+18.3	+5.80	+11.2	+0.0	+0.0000
	+83.0	+0.0	+26.4	+54.7	+1.86	+17.53	+1.118	+8.591
AIR TEMP: +25.00		SKIN: 32.70 C	37.10 MMHG					
0	+32.8	+34.4	-56.1	+34.4	+9.76	+23.0	+0.0	+0.0000
	+67.2	+0.0	+22.3	+44.1	+0.81	+0.00	+0.732	+4.607
50	+23.1	+24.0	-56.4	+24.0	+7.23	+15.9	+0.0	+0.0000
	+76.9	+0.1	+25.5	+50.3	+1.05	+11.88	+0.573	+4.120
100	+13.2	+13.5	-56.6	+13.5	+4.67	+8.5	+0.0	+0.0000
	+86.8	+0.1	+28.8	+56.7	+1.28	+23.76	+0.446	+3.617
AIR TEMP: +27.00		SKIN: 33.00 C	37.73 MMHG					
0	+33.9	+35.0	-22.1	+35.0	+9.88	+24.0	+0.0	+0.0000
	+66.1	+0.0	+22.3	+43.3	+0.55	+0.00	+0.465	+2.892
50	+22.7	+23.2	-22.3	+23.2	+7.01	+15.7	+0.0	+0.0000
	+77.3	+0.0	+26.1	+50.4	+0.80	+13.37	+0.321	+2.328
100	+11.3	+11.4	-22.6	+11.4	+4.10	+7.2	+0.0	+0.0000
	+88.7	+0.0	+29.9	+57.7	+1.06	+26.74	+0.210	+1.748
AIR TEMP: +29.00		SKIN: 33.44 C	38.67 MMHG					
0	+35.2	+35.7	+9.5	+35.7	+10.00	+25.2	+0.0	+0.0000
	+64.8	+0.0	+22.2	+42.3	+0.28	+0.00	+0.217	+1.326
50	+22.3	+22.5	+9.2	+22.5	+6.76	+15.6	+0.0	+0.0000
	+77.7	+0.0	+26.6	+50.5	+0.56	+15.02	+0.093	+0.678
100	+9.2	+9.2	+8.9	+9.2	+3.46	+5.7	+0.0	+0.0000
	+90.8	+0.0	+31.1	+58.8	+0.84	+30.04	+0.002	+0.017
AIR TEMP: +31.00		SKIN: 34.00 C	39.90 MMHG					
0	+38.7	+36.7	+38.7	+1071.6	+10.12	+26.5	+2.1	+0.0020
	+61.3	+0.0	+21.4	+39.9	+0.01	+0.00	+0.000	+0.000
50	+38.4	+21.8	+38.4	+619.7	+6.46	+14.9	+17.0	+0.0276
	+61.6	+0.0	+21.4	+39.9	+0.31	+16.85	+0.000	+0.000
100	+38.1	+6.9	+38.1	+167.8	+2.14	+3.3	+32.0	+0.1941
	+61.9	-0.0	+21.4	+39.9	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00		SKIN: 35.00 C	42.18 MMHG					
	+100.5	+38.4	+100.5	+1132.4	+10.36	+26.5	+63.7	+0.0568
	-0.5	+0.0	-0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+566.8	+5.75	+12.0	+82.4	+0.1470
	-0.2	-0.0	-0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	-0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00		SKIN: 35.58 C	43.56 MMHG					
0	+193.0	+39.6	+193.0	+1169.5	+10.67	+25.0	+157.3	+0.1358
	-93.0	-0.0	-33.1	-58.7	-1.19	+0.00	+0.000	+0.000
50	+192.6	+15.2	+192.6	+427.4	+4.58	+6.0	+182.0	+0.4304
	-92.6	-0.0	-33.1	-58.7	-0.75	+27.67	+0.000	+0.000
100	-314.9	-314.9	+192.1	-314.9	-1.74	+0.0	-313.2	+1.0000
	-92.1	+507.1	-33.1	-58.7	-0.29	+55.34	+0.000	+0.000
AIR TEMP: +52.00		SKIN: 36.00 C	44.57 MMHG					
0	+443.1	+41.1	+443.1	+1197.0	+11.45	+19.3	+412.3	+0.3478
	-343.1	-0.0	-127.5	-212.8	-2.79	+0.00	+0.000	+0.000
50	-172.8	-172.8	+442.4	-172.8	+0.12	+0.0	-172.9	+1.0000
	-342.4	+615.1	-127.5	-212.8	-2.08	+51.07	+0.000	+0.000

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WCTLR CLODT

AIR TEMP: +0.00   SKIN: 31.89 C   35.44 MMHG

0	+24.8	+32.0	-521.1	+32.0	+8.41	+16.4	+0.0	+0.0000
	+75.1	+0.1	+19.8	+51.1	+4.12	+0.00	+4.340	+29.207
50	+23.5	+30.1	-521.2	+30.1	+8.01	+15.5	+0.0	+0.0000
	+76.4	+0.1	+20.2	+52.0	+4.21	+2.29	+4.254	+29.143
100	+22.1	+28.1	-521.3	+28.1	+7.61	+14.5	+0.0	+0.0000
	+77.9	+0.0	+20.6	+53.0	+4.29	+4.58	+4.169	+29.076

AIR TEMP: +15.00   SKIN: 32.11 C   35.88 MMHG

0	+28.8	+33.1	-241.2	+33.1	+9.20	+19.6	+0.0	+0.0000
	+71.2	+0.0	+21.6	+47.4	+2.14	+0.00	+2.167	+14.175
50	+24.2	+27.5	-241.4	+27.5	+7.90	+16.3	+0.0	+0.0000
	+75.7	+0.1	+23.0	+50.4	+2.29	+6.39	+2.004	+13.948
100	+19.5	+21.9	-241.6	+21.9	+6.59	+13.0	+0.0	+0.0000
	+80.4	+0.0	+24.5	+53.5	+2.45	+12.78	+1.855	+13.712

AIR TEMP: +23.00   SKIN: 32.49 C   36.67 MMHG

0	+31.8	+34.0	-91.9	+34.0	+9.65	+22.1	+0.0	+0.0000
	+68.2	+0.0	+22.2	+44.9	+1.08	+0.00	+1.011	+6.427
50	+23.4	+24.8	-92.1	+24.8	+7.42	+16.0	+0.0	+0.0000
	+76.5	+0.0	+25.0	+50.3	+1.29	+10.53	+0.842	+6.005
100	+14.9	+15.5	-92.3	+15.5	+5.16	+9.7	+0.0	+0.0000
	+85.1	+0.0	+27.8	+55.8	+1.51	+21.07	+0.703	+5.571

AIR TEMP: +30.00   SKIN: 33.71 C   39.26 MMHG

0	+35.9	+36.2	+24.3	+36.2	+10.06	+25.9	+0.0	+0.0000
	+64.1	+0.0	+22.2	+41.7	+0.15	+0.00	+0.099	+0.600
50	+24.0	+22.1	+24.0	+627.7	+6.62	+15.5	+1.9	+0.0030
	+76.0	+0.0	+26.3	+49.3	+0.43	+15.91	+0.000	+0.000
100	+23.7	+8.1	+23.7	+200.9	+3.11	+4.5	+16.0	+0.0810
	+76.3	+0.0	+26.3	+49.3	+0.73	+31.83	+0.000	+0.000

AIR TEMP: +33.00   SKIN: 34.56 C   41.17 MMHG

0	+68.2	+37.6	+68.2	+1105.4	+10.24	+26.6	+31.4	+0.0286
	+31.8	+0.0	+11.3	+20.8	-0.25	+0.00	+0.000	+0.000
50	+67.9	+21.0	+67.9	+599.4	+6.13	+13.6	+48.1	+0.0811
	+32.1	-0.0	+11.3	+20.8	+0.07	+18.87	+0.000	+0.000
100	+67.5	+4.2	+67.5	+93.4	+1.92	+0.7	+65.0	+0.7104
	+32.5	+0.0	+11.3	+20.8	+0.41	+37.73	+0.000	+0.000

AIR TEMP: +37.00   SKIN: 35.30 C   42.89 MMHG

0	+135.9	+39.0	+135.9	+1151.4	+10.48	+26.0	+99.4	+0.0871
	-35.9	+0.0	-12.5	-22.6	-0.73	+0.00	+0.000	+0.000
50	+135.5	+18.2	+135.5	+520.1	+5.33	+9.9	+120.3	+0.2338
	-35.5	+0.0	-12.5	-22.6	-0.40	+23.54	+0.000	+0.000
100	-111.3	-111.3	+135.1	-111.3	+0.00	+0.0	-111.3	+1.0000
	-35.1	+246.5	-12.5	-22.6	+0.00	+47.08	+0.000	+0.000

AIR TEMP: +45.00   SKIN: 35.83 C   44.17 MMHG

0	+294.3	+40.4	+294.3	+1185.8	+10.99	+22.9	+260.5	+0.2217
	-194.3	+0.0	-70.6	-121.9	-1.85	+0.00	+0.000	+0.000
50	+221.6	+8.5	+293.8	+221.6	+3.05	+0.0	+218.6	+1.0000
	-193.8	+72.2	-70.6	-121.9	-1.32	+35.95	+0.000	+0.000

AIR TEMP: +50.00   SKIN: 35.96 C   44.48 MMHG

0	+399.9	+40.9	+399.9	+1194.6	+11.31	+20.4	+368.3	+0.3112
	-299.9	+0.0	-110.7	-186.7	-2.52	+0.00	+0.000	+0.000
50	-46.7	-46.7	+399.3	-46.7	+1.06	+0.0	-47.7	+1.0000
	-299.3	+446.0	-110.7	-186.7	-1.87	+46.28	+0.000	+0.000

AIR TEMP: +60.00   SKIN: 36.10 C   44.81 MMHG

| 0 | +619.8 | +41.3 | +619.8 | +1203.8 | +12.00 | +15.0 | +592.8 | +0.4974 |
| | -519.8 | -0.0 | -198.0 | -317.9 | -3.87 | +0.00 | +0.000 | +0.000 |

AIR TEMP: +70.00   SKIN: 36.16 C   44.97 MMHG

| 0 | +849.3 | +42.6 | +849.3 | +1208.9 | +12.71 | +9.2 | +827.4 | +0.6917 |
| | -749.3 | +0.0 | -294.0 | -450.0 | -5.21 | +0.00 | +0.000 | +0.000 |

AIR TEMP: +80.00   SKIN: 36.20 C   45.06 MMHG

| 0 | +1088.2 | +43.4 | +1088.2 | +1212.2 | +13.47 | +3.2 | +1071.5 | +0.8939 |
| | -988.2 | +0.0 | -399.1 | -582.5 | -6.57 | +0.00 | +0.000 | +0.000 |

METABOLIC PARAMETERS, SET 7

RH%	LAHET SEHET	LHMIN STØRE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLØSR	WETLR CLØDT
AIR TEMP: +10.00			SKIN: 32.00 C	35.67 MMHG				
0	+28.3	+32.6	-70.0	+32.6	+8.93	+19.4	+0.0	+0.0000
	+71.7	+0.0	+0.0	+68.9	+2.80	+0.00	+2.236	+14.594
50	+25.1	+28.7	-70.1	+28.7	+8.02	+17.1	+0.0	+0.0000
	+74.9	+0.0	+0.0	+71.9	+2.93	+4.60	+2.078	+14.164
100	+21.9	+24.7	-70.3	+24.7	+7.12	+14.8	+0.0	+0.0000
	+78.1	+0.0	+0.0	+75.1	+3.05	+9.20	+1.929	+13.721
AIR TEMP: +20.00			SKIN: 32.29 C	36.26 MMHG				
0	+32.1	+33.6	+5.1	+33.6	+9.48	+22.6	+0.0	+0.0000
	+67.9	+0.0	+0.0	+66.4	+1.48	+0.00	+0.650	+4.091
50	+25.2	+25.9	+4.9	+25.9	+7.64	+17.5	+0.0	+0.0000
	+74.8	+0.0	+0.0	+73.2	+1.67	+8.77	+0.443	+3.074
100	+17.9	+18.3	+4.7	+18.3	+5.80	+12.1	+0.0	+0.0000
	+82.0	+0.0	+0.0	+80.2	+1.86	+17.53	+0.265	+2.015
AIR TEMP: +25.00			SKIN: 32.70 C	37.10 MMHG				
0	+40.7	+34.4	+40.7	+573.7	+9.76	+24.4	+6.5	+0.0116
	+59.3	-0.0	+0.0	+58.5	+0.81	+0.00	+0.000	+0.000
50	+40.4	+24.0	+40.4	+390.6	+7.23	+16.0	+17.2	+0.0449
	+59.6	+0.0	+0.0	+58.5	+1.05	+11.88	+0.000	+0.000
100	+40.2	+13.5	+40.2	+207.5	+4.67	+7.7	+27.9	+0.1375
	+59.8	-0.0	+0.0	+58.5	+1.28	+23.76	+0.000	+0.000
AIR TEMP: +27.00			SKIN: 33.00 C	37.73 MMHG				
0	+53.9	+35.0	+53.9	+583.4	+9.88	+24.2	+19.7	+0.0344
	+46.1	-0.0	+0.0	+45.6	+0.55	-0.00	+0.000	+0.000
50	+53.6	+23.2	+53.6	+377.3	+7.01	+14.8	+31.8	+0.0858
	+46.4	+0.0	+0.0	+45.6	+0.80	+13.37	+0.000	+0.000
100	+53.3	+11.4	+53.3	+171.2	+4.10	+5.4	+43.8	+0.2624
	+46.7	+0.0	+0.0	+45.6	+1.06	+26.74	+0.000	+0.000
AIR TEMP: +29.00			SKIN: 33.44 C	38.67 MMHG				
0	+66.0	+35.7	+66.0	+597.8	+10.00	+24.3	+31.7	+0.0539
	+34.0	-0.0	+0.0	+33.7	+0.28	+0.00	+0.000	+0.000
50	+65.7	+22.5	+65.7	+366.2	+6.76	+13.7	+45.2	+0.1258
	+34.3	-0.0	+0.0	+33.7	+0.56	+15.02	+0.000	+0.000
100	+65.4	+9.2	+65.4	+134.6	+3.46	+3.2	+58.8	+0.4485
	+34.6	+0.0	+0.0	+33.7	+0.84	+30.04	+0.000	+0.000
AIR TEMP: +31.00			SKIN: 34.00 C	39.90 MMHG				
0	+77.2	+36.7	+77.2	+616.7	+10.12	+24.7	+42.4	+0.0699
	+22.8	+0.0	+0.0	+22.8	+0.01	+0.00	+0.000	+0.000
50	+76.9	+21.8	+76.9	+356.9	+6.45	+12.8	+57.6	+0.1644
	+23.1	+0.0	+0.0	+22.8	+0.31	+16.85	+0.000	+0.000
100	+76.6	+6.9	+76.6	+97.1	+2.74	+0.9	+72.9	+0.7730
	+23.4	+0.0	+0.0	+22.8	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00			SKIN: 35.00 C	42.18 MMHG				
0	+100.5	+38.4	+100.5	+651.5	+10.36	+25.2	+65.0	+0.1013
	-0.5	+0.0	+0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+326.3	+5.75	+10.3	+84.1	+0.2622
	-0.2	-0.0	+0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	+0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00			SKIN: 35.58 C	43.56 MMHG				
0	+134.7	+39.6	+134.7	+672.9	+10.67	+24.6	99.5	+0.1502
	-34.7	+0.0	+0.0	-33.6	-1.19	+0.00	+0.000	+0.000
50	+134.3	+15.2	+134.3	+246.2	+4.58	+5.1	+124.6	+0.5157
	-34.3	+0.0	+0.0	-33.6	-0.75	+27.67	+0.000	+0.000
100	-180.7	-180.7	+133.8	-180.7	-1.74	+0.0	-178.9	+1.00C0
	-33.8	+314.5	+0.0	-33.6	-0.29	+53.34	+0.000	+0.000
AIR TEMP: +52.00			SKIN: 36.00 C	44.57 MMHG				
0	+224.4	+41.1	+224.4	+688.9	+11.45	+21.3	+191.7	+0.2830
	-124.4	+0.0	+0.0	121.6	-2.79	+0.00	+0.000	+0.000
50	-98.7	-98.7	+223.7	-98.7	+0.12	+0.0	-98.8	+1.0000
	-123.7	+322.4	+0.0	-121.6	-2.08	+51.07	+0.000	+0.000

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00	SKIN: 31.89 C	35.44 MMHG						
0	+25.5	+32.0	-146.5	+32.0	+8.41	+17.1	+0.0	+0.0000
	+74.4	+0.0	+0.0	+70.3	+4.12	+0.00	+3.776	+25.171
50	+24.1	+30.1	-146.6	+30.1	+8.01	+16.1	+0.0	+0.0000
	+75.9	+0.0	+0.0	+71.6	+4.21	+2.29	+3.682	+24.997
100	+22.7	+28.1	-146.6	+28.1	+7.61	+15.1	+0.0	+0.0000
	+77.3	+0.0	+0.0	+73.0	+4.29	+4.58	+3.589	+24.821
AIR TEMP: +15.00	SKIN: 32.11 C	35.88 MMHG						
0	+30.0	+33.1	-32.1	+33.1	+9.20	+20.8	+0.0	+0.0000
	+70.0	+0.0	+0.0	+67.8	+2.14	+0.00	+1.449	+9.311
50	+25.3	+27.5	-32.3	+27.5	+7.90	+17.4	+0.0	+0.0000
	+74.7	+0.0	+0.0	+72.4	+2.29	+6.39	+1.261	+8.647
100	+20.4	+21.9	-32.5	+21.9	+6.59	+13.8	+0.0	+0.0000
	+79.5	+0.0	+0.0	+77.1	+2.45	+12.78	+1.089	+7.958
AIR TEMP: +23.00	SKIN: 32.49 C	36.67 MMHG						
0	+33.6	+34.0	+26.8	+34.0	+9.65	+24.0	+0.0	+0.0000
	+66.4	+0.0	+0.0	+65.3	+1.08	+0.00	+0.169	+1.045
50	+26.6	-24.8	+26.6	+404.7	+7.42	+17.3	+1.8	+0.0046
	+73.4	+0.0	+0.0	+72.1	+1.29	+10.53	+0.000	+0.000
100	+26.3	+15.5	+26.3	+242.4	+5.16	+9.9	+11.3	+0.0476
	+73.7	-0.0	+0.0	+72.1	+1.51	+21.07	+0.000	+0.000
AIR TEMP: +30.00	SKIN: 33.71 C	39.26 MMHG						
0	+71.7	+36.2	+71.7	+606.8	+10.06	+24.5	+37.1	+0.0622
	+28.3	-0.0	+0.0	+28.8	+0.15	+0.00	+0.000	+0.000
50	+71.4	+22.1	+71.4	+361.5	+6.62	+13.3	+51.5	+0.1451
	+28.6	+0.0	+0.0	+28.2	+0.43	+15.91	+0.000	+0.000
100	+71.1	+8.1	+71.1	+116.1	+3.11	+2.1	+65.9	+0.5833
	+28.9	+0.0	+0.0	+28.2	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00	SKIN: 34.56 C	41.17 MMHG						
0	+88.4	+37.6	+88.4	+636.0	+10.24	+25.1	+53.1	+0.0848
	+11.6	-0.0	+0.0	+11.9	-0.25	+0.00	+0.000	+0.000
50	+88.1	+21.0	+88.1	+345.1	+6.13	+11.8	+70.2	+0.2070
	+11.9	-0.0	+0.0	+11.9	+0.07	+18.87	+0.000	+0.000
100	+54.2	+4.2	+87.7	+54.2	+1.92	+0.0	+52.2	+1.0000
	+12.3	+33.5	+0.0	+11.9	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00	SKIN: 35.30 C	42.89 MMHG						
0	+113.7	+39.0	+113.7	+662.4	+10.48	+25.1	+78.1	+0.1198
	-13.7	+0.0	+0.0	-12.9	-0.78	+0.00	+0.000	+0.000
50	+113.3	+18.2	+113.3	+299.5	+5.33	+8.5	+99.5	+0.3381
	-13.3	+0.0	+0.0	-12.9	-0.40	+23.54	+0.000	+0.000
100	-63.6	-63.6	+112.9	-63.6	+0.00	+0.0	-63.6	+1.0000
	-12.9	+176.5	+0.0	-12.9	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00	SKIN: 35.83 C	44.17 MMHG						
0	+171.5	+40.4	+171.5	+682.3	+10.99	+23.4	+137.2	+0.2043
	-71.5	+0.0	+0.0	-69.7	-1.85	+0.00	+0.000	+0.000
50	+127.9	+8.5	+171.0	+127.9	+3.05	+0.0	+124.9	+1.0000
	-71.0	+43.9	+0.0	-69.7	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00	SKIN: 35.96 C	44.48 MMHG						
0	+209.2	+40.9	+209.2	+687.4	+11.31	+21.9	+176.0	+0.2603
	-109.2	+0.0	+0.0	-106.7	-2.52	+0.00	+0.000	+0.000
50	-26.2	-26.2	+208.5	-26.2	+1.06	+0.0	-27.3	+1.0000
	-108.5	+234.8	+0.0	-106.7	-1.97	+46.28	+0.000	+0.000
AIR TEMP: +60.00	SKIN: 36.10 C	44.81 MMHG						
0	+285.5	+41.8	+285.5	+693.0	+12.00	+18.6	+254.9	+0.3743
	-185.5	-0.0	+0.0	-181.7	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00	SKIN: 36.16 C	44.97 MMHG						
0	+362.4	+42.6	+362.4	+696.2	+12.71	+15.3	+334.4	+0.4892
	-262.4	-0.0	+0.0	-257.2	-5.21	+0.00	+0.000	+0.000
AIR TEMP: +80.00	SKIN: 36.20 C	45.06 MMHG						
0	+439.4	+43.4	+439.4	+698.5	+13.47	+11.9	+414.1	+0.6046
	-339.4	+0.0	+0.0	-332.9	-6.57	+0.00	+0.000	+0.000

METABOLIC PARAMETERS, SET 8

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +10.00		SKIN: 32.00 C	35.67 MMHG					
0	+27.8	+32.6	-143.9	+32.6	+8.93	+18.9	+0.0	+0.0000
	+72.2	+0.0	+19.4	+50.0	+2.80	+0.00	+2.551	+16.763
50	+24.7	+28.7	-144.0	+28.7	+8.02	+16.7	+0.0	+0.0000
	+75.3	+0.0	+20.3	+52.1	+2.93	+4.60	+2.402	+16.476
100	+21.5	+24.7	-144.2	+24.7	+7.12	+14.4	+0.0	+0.0000
	+78.5	+0.0	+21.2	+54.3	+3.05	+9.20	+2.262	+16.175
AIR TEMP: +20.00		SKIN: 32.29 C	36.26 MMHG					
0	+31.3	+33.6	-37.3	+33.6	+9.48	+21.8	+0.0	+0.0000
	+68.7	+0.0	+20.3	+46.9	+1.48	+0.00	+1.053	+6.705
50	+24.5	+25.9	-37.5	+25.9	+7.64	+16.8	+0.0	+0.0000
	+75.5	+0.0	+22.3	+51.5	+1.67	+8.77	+0.866	+6.058
100	+17.4	+18.3	-37.7	+18.3	+5.80	+11.6	+0.0	+0.0000
	+82.5	+0.0	+24.5	+56.2	+1.86	+17.53	+0.705	+5.387
AIR TEMP: +25.00		SKIN: 32.70 C	37.10 MMHG					
0	+33.7	+34.4	+13.7	+34.4	+9.73	+23.9	+0.0	+0.0000
	+66.3	+0.0	+20.5	+45.0	+0.81	+0.00	+0.315	+1.954
50	+23.8	+24.0	+10.5	+24.0	+7.23	+16.5	+0.0	+0.0000
	+76.2	+0.0	+23.6	+51.6	+1.05	+11.88	+0.142	+1.009
100	+13.5	+13.5	+13.2	+13.5	+4.67	+8.9	+0.0	+0.0000
	+86.4	+0.0	+26.9	+58.3	+1.28	+23.76	+0.004	+0.032
AIR TEMP: +27.00		SKIN: 33.00 C	37.73 MMHG					
0	+34.9	+35.0	+32.7	+35.0	+9.88	+25.0	+0.0	+0.0000
	+65.1	+0.0	+20.4	+44.1	+0.55	+0.00	+0.036	+0.218
50	+32.4	+23.2	+32.4	+377.3	+7.01	+15.8	+9.6	+0.0260
	+67.6	+0.0	+21.2	+45.6	+0.80	+13.37	+0.000	+0.000
100	+32.2	+11.4	+32.2	+171.2	+4.10	+6.4	+21.7	+0.1299
	+67.8	+0.0	+21.2	+45.6	+1.06	+26.74	+0.000	+0.000
AIR TEMP: +29.00		SKIN: 33.44 C	38.67 MMHG					
0	+50.2	+35.7	+50.2	+597.8	+10.00	+25.1	+15.2	+0.0258
	+49.8	+0.0	+15.8	+33.7	+0.28	+0.00	+0.000	+0.000
50	+49.9	+22.5	+49.9	+366.2	+6.76	+14.5	+28.7	+0.0798
	+50.1	-0.0	+15.8	+33.7	+0.56	+15.02	+0.000	+0.000
100	+49.46	+9.2	+49.6	+134.6	+3.46	+3.9	+42.3	+0.3226
	+50.4	-0.0	+15.8	+33.7	+0.84	+30.04	+0.000	+0.000
AIR TEMP: +31.00		SKIN: 34.00 C	39.90 MMHG					
0	+66.4	+36.7	+66.4	+616.7	+10.12	+25.2	+31.1	+0.0513
	+33.6	-0.0	+10.8	+22.8	+0.01	+0.00	+0.000	+0.000
50	+66.1	+21.8	+66.1	+356.9	+6.46	+13.3	+46.3	+0.1323
	+33.9	+0.0	+10.8	+22.8	+0.31	+16.85	+0.000	+0.000
100	+65.8	+6.9	+65.8	+97.1	+2.74	+1.4	+61.6	+0.6536
	+34.2	+0.0	+10.8	+22.8	+0.62	+33.70	+0.000	+0.000
AIR TEMP: +35.00		SKIN: 35.00 C	42.18 MMHG					
0	+100.5	+38.4	+100.5	+651.5	+10.36	+25.2	+65.0	+0.1013
	-0.5	+0.0	-0.0	-0.0	-0.52	+0.00	+0.000	+0.000
50	+100.2	+19.8	+100.2	+326.3	+5.75	+10.3	+84.1	+0.2622
	-0.2	-0.0	-0.0	-0.0	-0.16	+21.09	+0.000	+0.000
100	+1.0	+1.0	+99.8	+1.0	+1.02	+0.0	-0.0	+1.0000
	+0.2	+98.8	-0.0	-0.0	+0.20	+42.18	+0.000	+0.000
AIR TEMP: +40.00		SKIN: 35.58 C	43.56 MMHG					
0	+151.1	+39.6	+151.1	+672.9	+10.67	+23.9	+116.6	+0.1761
	-51.1	-0.0	-16.4	-33.6	-1.19	+0.00	+0.000	+0.000
50	+150.7	+15.2	+150.7	+246.2	+4.58	+4.4	+141.7	+0.5866
	-50.7	+0.0	-16.4	-33.6	-0.75	+27.67	+0.000	+0.000
100	-180.7	-180.7	+150.2	-180.7	-1.74	+0.0	-178.9	+1.0000
	-50.2	+330.9	-16.4	-33.6	-0.29	+55.34	+0.000	+0.000
AIR TEMP: +52.00		SKIN: 36.00 C	44.57 MMHG					
0	+285.7	+41.1	+285.7	+688.9	+11.45	+18.4	+255.8	+0.3776
	-185.7	+0.0	-61.3	-121.6	-2.79	+0.00	+0.000	+0.000
50	-98.7	-98.7	+285.0	-98.7	+0.12	+0.0	-98.8	+1.0000
	-185.0	+383.7	-61.3	-121.6	-2.08	+51.07	+0.000	+0.000

RH%	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00		SKIN: 31.89 C	35.44 MMHG					
0	+25.2	+32.0	-250.9	+32.0	+8.41	+16.8	+0.0	+0.0000
	+74.8	+0.0	+18.3	+52.4	+4.12	+0.00	+4.029	+26.975
50	+23.8	+30.1	-251.0	+30.1	+8.01	+15.8	+0.0	+0.0000
	+76.2	+0.0	+18.6	+53.3	+4.21	+2.29	+3.938	+26.852
100	+22.4	+28.1	-251.0	+28.1	+7.61	+14.8	+0.0	+0.0000
	+77.5	+0.0	+18.9	+54.3	+4.29	+4.58	+3.851	+26.731
AIR TEMP: +15.00		SKIN: 32.11 C	35.88 MMHG					
0	+29.4	+33.1	-90.4	+33.1	+9.20	+20.2	+0.0	+0.0000
	+70.6	+0.0	+19.9	+48.5	+2.14	+0.00	+1.804	+11.696
50	+24.8	+27.5	-90.5	+27.5	+7.90	+16.9	+0.0	+0.0000
	+75.2	+0.0	+21.2	+51.7	+2.29	+6.39	+1.629	+11.257
100	+20.0	+21.9	-90.7	+21.9	+6.59	+13.4	+0.0	+0.0000
	+80.0	+0.0	+22.6	+54.9	+2.45	+12.78	+1.471	+10.808
AIR TEMP: +23.00		SKIN: 32.49 C	36.67 MMHG					
0	+32.6	+34.0	-6.3	+34.0	+9.65	+23.0	+0.0	+0.0000
	+67.3	+0.0	+20.4	+45.8	+1.08	+0.00	+0.606	+3.805
50	+24.1	+24.8	-6.5	+24.8	+7.42	+16.7	+0.0	+0.0000
	+75.9	+0.0	+23.1	+51.5	+1.29	+10.53	+0.423	+2.989
100	+15.3	+15.5	-6.7	+15.5	+5.16	+10.1	+0.0	+0.0000
	+84.7	+0.0	+25.8	+57.3	+1.51	+21.07	+0.272	+2.148
AIR TEMP: +30.00		SKIN: 33.71 C	39.26 MMHG					
0	+58.4	+36.2	+58.4	+606.5	+10.06	+25.1	+23.3	+0.0390
	+41.6	+0.0	+13.3	+28.2	+0.15	+0.00	+0.000	+0.000
50	+58.1	+22.1	+58.1	+361.5	+2.62	+13.9	+37.6	+0.1060
	+41.9	+0.0	+13.3	+28.2	+0.43	+15.91	+0.000	+0.000
100	+57.8	+8.1	+57.8	+116.1	+3.11	+2.7	+52.1	+0.4606
	+42.2	+0.0	+13.3	+28.2	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00		SKIN: 34.56 C	41.17 MMHG					
0	+82.7	+37.6	+82.7	+636.0	+10.24	+25.3	+47.2	+0.0754
	+17.3	-0.0	+5.7	+11.9	-0.25	+0.00	+0.000	+0.000
50	+82.4	+21.0	+82.4	+345.1	+6.13	+12.0	+64.2	+0.1895
	+17.6	-0.0	+5.7	+11.9	+0.07	+18.87	+0.000	+0.000
100	+54.2	+4.2	+82.1	+54.2	+1.92	+0.0	+52.2	+1.0000
	+17.9	+27.9	+5.7	+11.9	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00		SKIN: 35.30 C	42.89 MMHG					
0	+119.9	+39.0	+119.9	+662.4	+10.48	+24.8	+84.6	+0.1298
	-19.9	+0.0	-6.2	-12.9	-0.78	+0.00	+0.000	+0.000
50	+119.6	+18.2	+119.6	+299.5	+5.33	+8.2	+106.0	+0.3603
	-19.6	+0.0	-6.2	-12.9	-0.40	+23.54	+0.000	+0.000
100	-63.6	-63.6	+119.2	-63.6	+0.00	+0.0	-63.6	+1.0000
	-19.2	+122.8	-6.2	-12.9	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00		SKIN: 35.83 C	44.17 MMHG					
0	+206.0	+40.4	+206.0	+682.3	+10.99	+21.8	+173.2	+0.2581
	-106.0	+0.0	-34.5	-69.7	-1.85	+0.00	+0.000	+0.000
50	+127.9	+8.5	+205.5	+127.9	+3.05	+0.0	+124.9	+1.0000
	-105.5	+77.6	-34.5	-69.7	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00		SKIN: 35.96 C	44.48 MMHG					
0	+262.7	+40.9	+262.7	+687.4	+11.31	+19.4	+232.0	+0.3431
	-162.7	+0.0	-53.5	-106.7	-2.52	+0.00	+0.000	+0.000
50	-26.2	-26.2	+262.1	-26.2	+1.06	+0.0	-27.3	+1.0000
	-162.1	+288.3	-53.5	-106.7	-1.87	+46.28	+0.000	+0.000
AIR TEMP: +60.00		SKIN: 36.10 C	44.81 MMHG					
0	+379.0	+41.8	+379.0	+693.0	+12.00	+14.4	+352.6	+0.5178
	-279.0	+0.0	-93.5	-181.7	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00		SKIN: 36.16 C	44.97 MMHG					
0	+498.0	+42.6	+498.0	+696.2	+12.71	+9.1	+476.2	+0.6967
	-398.0	-0.0	-135.6	-257.2	-5.21	+0.00	+0.000	+0.000
AIR TEMP: +80.00		SKIN: 36.20 C	45.06 MMHG					
0	+619.3	+43.4	+619.3	+698.5	+13.47	+3.6	+602.2	+0.8791
	-519.3	+0.0	-179.8	-332.9	-6.57	+0.00	+0.000	+0.000

RHZ	LAHET SEHET	LHMIN STORE	LREQD RADHT	LHMAX CONSK	LHRES CORES	LHDSK PMMHG	LHWSK CLOSR	WETLR CLODT
AIR TEMP: +0.00		SKIN: 31.89 C	35.44 MMHG					
0	+21.6	+32.0	-339.4	+32.0	+8.41	+13.2	+0.0	+0.0000
	+78.4	+0.0	+30.2	+44.1	+4.12	+0.00	+3.940	+27.727
50	+20.4	+30.1	-339.4	+30.1	+8.01	+12.4	+0.0	+0.0000
	+79.6	+0.0	+30.6	+44.7	+4.21	+2.29	+3.873	+27.647
100	+19.3	+28.1	-339.5	+28.1	+7.61	+11.7	+G.0	+0.0000
	+80.7	+0.0	+31.1	+45.3	+4.29	+4.58	+3.807	+27.567
AIR TEMP: +15.00		SKIN: 32.11 C	35.88 MMHG					
0	+26.5	+33.1	-143.7	+33.1	+9.20	+17.3	+0.0	+0.0000
	+73.4	+0.0	+31.8	+39.5	+2.14	+0.00	+1.884	+12.730
50	+22.4	+27.5	-143.9	+27.5	+7.90	+14.5	+0.0	+0.0000
	+77.6	+0.0	+33.6	+41.7	+2.29	+6.39	+1.744	+12.434
100	+18.2	+21.9	-144.1	+21.9	+6.59	+11.6	+0.0	+0.0000
	+81.8	+0.0	+35.4	+43.9	+2.45	+12.78	+1.614	+12.131
AIR TEMP: +23.00		SKIN: 32.49 C	36.67 MMHG					
0	+30.7	+34.0	-37.8	+34.0	+9.65	+21.1	+0.0	+0.0000
	+69.3	+0.0	+31.8	+36.4	+1.08	+0.00	+0.782	+5.050
50	+22.9	+24.8	-38.0	+24.8	+7.42	+15.5	+0.0	+0.0000
	+77.!	+0.0	+35.4	+40.4	+1.29	+10.53	+0.625	+4.487
100	+14.6	+15.5	-35.2	+15.5	+5.16	+9.5	+0.0	+0.0000
	+85.4	+0.0	+39.2	+44.7	+1.51	+21.07	+0.490	+3.891
AIR TEMP: +30.00		SKIN: 33.71 C	39.26 MMHG					
0	+45.4	+36.2	+45.4	+606.8	+10.06	+25.7	+9.7	+0.0162
	+54.6	+0.0	+26.3	+28.2	+0.15	+0.00	+0.000	+0.000
50	+45.1	+22.1	+45.1	+361.5	+6.62	+14.5	+24.0	+0.0677
	+54.9	-0.0	+26.3	+28.2	+0.43	+15.91	+0.000	+0.000
100	+44.8	+8.1	+44.8	+116.1	+3.11	+3.3	+38.4	+0.3402
	+55.2	+0.0	+26.3	+28.2	+0.73	+31.83	+0.000	+0.000
AIR TEMP: +33.00		SKIN: 34.56 C	41.17 MMHG					
0	+77.1	+37.6	+77.1	+636.0	+10.24	+25.6	+41.3	+0.0660
	+22.9	-0.0	+11.3	+11.9	-0.25	+0.00	+0.000	+0.000
50	+76.8	+21.0	+76.8	+345.1	+6.13	+12.3	+58.4	+0.1722
	+23.2	-0.0	+11.3	+11.9	+0.07	+18.87	+0.000	+0.000
100	+54.2	+4.2	+76.4	+54.2	+1.92	0.0	+52.2	+1.0000
	+23.6	+22.3	+11.3	+11.9	+0.41	+37.73	+0.000	+0.000
AIR TEMP: +37.00		SKIN: 35.30 C	42.99 MMHG					
0	+126.2	+39.0	+126.2	+662.4	+10.48	+24.5	+91.2	+0.1399
	-26.2	-0.0	-12.5	-12.9	-0.78	+0.00	+0.000	+0.000
50	+125.8	+18.2	+125.8	+299.5	+5.33	+7.9	+112.6	+0.3827
	-25.8	+0.0	-12.5	-12.9	-0.40	+23.54	+0.000	+0.000
100	-63.6	-63.6	+125.4	-63.6	+0.00	+0.0	-63.6	+1.0000
	-25.4	+189.1	-12.5	-12.9	+0.00	+47.08	+0.000	+0.000
AIR TEMP: +45.00		SKIN: 35.83 C	44.17 MMHG					
0	+242.1	+40.4	+242.1	+682.3	+10.99	+20.1	+210.9	+0.3142
	-142.1	+0.0	-70.6	-69.7	-1.85	+0.00	+0.000	+0.000
50	+127.9	+8.5	+241.5	+127.9	+3.05	+0.0	+124.9	+1.0000
	-141.5	+113.6	-70.6	-69.7	-1.32	+35.95	+0.000	+0.000
AIR TEMP: +50.00		SKIN: 35.96 C	44.48 MMHG					
0	+319.9	+40.9	+319.9	+687.4	+11.31	+16.8	+291.8	+0.4316
	-219.9	+0.0	-110.7	-106.7	-2.52	+0.00	+0.000	+0.000
50	-26.2	-26.2	+319.3	-26.2	+1.06	+0.0	-27.3	+1.0000
	-219.3	+345.5	-110.7	-106.7	-1.87	+46.28	+0.000	+0.000
AIR TEMP: +60.00		SKIN: 36.10 C	44.81 MMHG					
0	+483.5	+41.8	+483.5	+693.0	+12.00	+9.6	+461.9	+0.6783
	-383.5	+0.0	-198.0	-181.7	-3.87	+0.00	+0.000	+0.000
AIR TEMP: +70.00		SKIN: 36.16 C	44.97 MMHG					
0	+656.4	+42.6	+656.4	+696.2	+12.71	+1.8	+641.9	+0.9391
	-556.4	+0.0	-294.0	-257.2	-5.21	+0.00	+0.000	+0.000
AIR TEMP: +80.00		SKIN: 36.20 C	45.06 MM IG					
0	+698.5	+43.4	+838.5	+698.5	+13.47	+0.0	+685.0	+1.0000
	-738.5	+140.1	-399.1	-332.9	-6.57	+0.00	+0.000	+0.000

METABOLIC HEAT TRANSFER — PROGRAM LISTING

```
100   REM: > SIM0C5 <   5/72
110   DIM A$[60],B$[38],C$[34],D$[38],E$[34]
120   A$="            METABOLIC PARAMETERS WITH OPTIMUM CLOTHING"
130   B$=" RH%    LAHET    LHMIN    LREQD    LHMAX"
140   C$="   LHRES    LHDSK    LHWSK    WETLR"
150   D$="        SFHET    STORE    RADHT    CONSK"
160   E$="   CORES    PMMHG    CLOSR    CLODT"
180   PRINT  USING "4(DDD)";TIM(3),TIM(2),TIM(1),TIM(0)
190   IMAGE " AIR TEMP:",S3D.DD,"   SKIN:",3D.DD," C ",3D.DD," MMHG"
200   IMAGE 4D,XS4D.D,XS4D.D,XS4D.D,XS4D.D,XS3D.DD,XS4D.D,XS4D.D,XSD.4D
210   IMAGE 5XS4D.D,XS4D.D,XS4D.D,XS4D.D,XS3D.DD,XS3D.DD,XSDD.3D,XSDD.3D
250   r8=1
260   T7=37
270   M=M0=100
280   A=2
290   A1=1.9
300   A2=1.3
310   J1=4.8
320   H1=4
330   H2=.35
340   E1=2*H1
350   G=.006*M
360   M1=M/A
400   PRINT ".";LIN(1);A$
410   PRINT LIN(1);B$;C$
430   PRINT D$;E$
450   DATA 10,20,25,27,29,31,35,40,52
490   DATA 99
510   T6=35.5-.03*M1
520   IF M1>50 THEN 550
530   L4=0
540   GOTO 560
550   L4=.43A*(M1-50)
560   PRINT
610   READ T
620   IF T>94 THEN 2900
630   T3=T6+1.5*ATN(.1967*(T-31))
640   T1=T0=T
650   T9=T3
660   GOSUB 2610
670   P3=P9
680   U0=28+T/10
690   U=EXP(T*(40819.+132.5*T-.0128*T↑3)*.000001)
700   U1=U0+U
710   B1=(T1+273.15)/100
720   B3=(T3+273.15)/100
730   C3=H1*A1*(T3-T)
740   R3=J1*A2*(B3↑4-B1↑4)
750   T9=T
760   GOSUB 2610
770   P1=P9
780   PRINT  USING 190;T,T3,760*P3
790   E4=L4
1010  FOR Y2=0 TO 100 STEP 50
1020  P=P1*Y2/100
1030  IF (760*P)>56 THEN 2180
1040  P9=P
1050  T9=T
1060  GOSUB 2810
1070  W=W9
```

```
1080    U2=U0+U*Y2/100
1090    T9=U2
1100    GOSUB 2610
1110    GOSUB 2810
1120    W2=W9
1130    U3=(T7+U2)/2
1140    H3=597.4-.568*U3
1150    L3=G*(W2-W)*H3
1160    D3=G*(.2403+.216*(W2+W))*(U2-T)
1170    L7=H2*A1*(P3-P)*760
1180    L8=E1*A1*(P3-P)*760
1190    S3=C3+R3+D3
1200    IF L8 <= L4 THEN 1230
1210    R4=L4/L8
1220    GOTO 1240
1230    R4=1
1240    Z2=MO-L3-L7-R4*(L8-L7)-D3
1250    Z3=C3+R3
1260    IF Z3>Z2 THEN 1610
1310    K2=D5=0
1320    R1=R3
1330    C1=C3
1340    S=S3
1350    L6=MO-S
1360    L5=L6-L3
1370    IF L5>L8 THEN 1420
1380    R5=(L5-L7)/(L8-L7)
1410    GOTO 1440
1420    R5=1
1440    L1=R5*L8-L4
1450    L2=(1-R5)*L7
1460    L=L1+L2+L3+L4
1470    LO=L3+L7+R4*(L8-L7)
1480    L9=L8+L3
1490    X6=L6-L
1500    GOTO 2010
1610    R5=R4
1620    LO=L9=L3+L7+R5*(L8-L7)
1630    L6=MO-S3
1650    N=1
1660    N1=0
1670    N2=4/N
1680    FOR K2=N1 TO N1+4*N2 STEP N2
1690    F2=1+.1*K2
1700    F3=1/(1+.1*K2)
1710    F4=1/F2
1720    L2=F3*(1-R5)*L7
1730    E4=F4*L4
1740    Z5=MO-L3-D3-E4-L2
1750    T2=T3-.18*K2*Z5/A1
1770    B2=(T2+273.15)/100
1780    B0=(T0+273.15)/100
1790    C2=H1*F2*A1*(T2-T)
1800    R2=J1*F2*A2*(B2+4-B0+4)
1810    Z4=C2+R2
1820    IF Z4<Z5 THEN 1840
1830    NEXT K2
1840    IF N2<.0005 THEN 1980
1850    N1=K2-N2
1860    N=2*N
1870    GOTO 1670
```

```
1880    D5=T3-T2
1910    C1=C2
1920    R1=R2
1930    S=C1+R1+D3
1950    L1=0
1960    L=L1+L2+L3+E4
1970    X6=M0-S-L
2010    E5=L1+E4
2020    DEF FNR(Q)=(Q/M0)*100
2030    L=FNR(L)
2040    S=FNR(S)
2050    L0=FNR(L0)
2060    L6=FNR(L6)
2070    L9=FNR(L9)
2080    L3=FNR(L3)
2090    L2=FNR(L2)
2100    E5=FNR(E5)
2110    X6=FNR(X6)
2120    R1=FNR(R1)
2130    C1=FNR(C1)
2140    D3=FNR(D3)
2160    PRINT   USING 200;Y2,L,L0,L6,L9,L3,L2,E5,R5
2170    PRINT   USING 210;S,X6,R1,C1,D3,760*P,K2,DS
2180    NEXT Y2
2190    GOTO 610
2610    IF T9<0 THEN 2710
2620    Q1=-17.5604
2630    Q2=+1.79764
2640    Q3=+3.86061
2650    Q4=-1.41654
2660    Q6=373.15/(273.15+T9)
2670    Q7=Q6-1
2680    Q8=Q7/Q6
2690    Q9=Q1*Q7+Q2*LOG(Q6)+Q8*(Q3+Q4/Q6)
2700    GOTO 2780
2710    Q1=-20.9422
2720    Q2=-3.57231
2730    Q3=+2.02115
2740    Q6=273.15/(273.15+T9)
2750    Q7=Q6-1
2760    Q8=Q7/Q6
2770    Q9=Q1*Q7+Q2*LOG(Q6)+Q3*Q8-5.11145
2780    P9=EXP(Q9)
2790    RETURN
2810    X9=.62197*P9/(P8-P9)
2820    IF T9<0 THEN 2860
2830    Q0=66-T9
2840    Q5=1+.004*P8+1/(500+Q0↑2)
2850    GOTO 2870
2860    Q5=1+(4200-15*T9+.375*T9↑2)*.000001*P8
2870    C9=(P8-P9)/(P8/Q5-P9)
2880    W9=C9*X9
2890    RETURN
2900    PRINT
2910    PRINT "      M        M1        M0        L4        T6        P8"
2920    PRINT   USING "6(XDDDD.DD)";M,M1,M0,L4,T6,P8
2930    PRINT "      A1       A2        J1        H1        E1        G"
2940    PRINT   USING "6(XDDDD.DD)";A1,A2,J1,H1,E1,G
2950    PRINT " T3=34+1.5*ATN[0.1967*(T-31)]   U0=28+T/10"
2970    PRINT " V1= ";.00925*H1↑2;"M/S ";1.82*H1↑2;"FPM"
2980    PRINT " T1=T0= T   F2=1+.1*K2   F3=1/(1+.1*K2)";LIN(1)
3000    END
```

Appendix B

TABULATED DATA RELATING TO PARTIAL RECIRCULATION OF AIR

The salient results of the study relating to partial recirculation
of ventilating air in shelters during cold weather are shown in graphic
form on Figures 7 and 8 in Section III, Shelter Ventilation. Tables B-1
through B-5 represent data used for preparation of Figure 8, as well as
some parameters that are not shown graphically. All of these tables re-
late to a recirculating system during winter operation with a minimal
mixture temperature of $50^{\circ}F$ (i.e., the temperature of air supplied to
occupied spaces is $50^{\circ}F$). The data therefore apply when the fresh or
outside air temperature is $50^{\circ}F$ or less. Each table is based on a single
value of fresh air temperature as indicated on the first tabulated line,
along with WSAT, which is the humidity ratio of saturated air at the fresh
air temperature. The first column in each table shows the two values for
relative humidity of fresh air, Y1 = 0 or 100 percent, used in the compu-
tations. In each of the other six columns there are values of two quan-
tities for each value of relative humidity, as indicated by the upper
and lower symbols at the head of each column. In column 2, SCFM2 is the
total ventilating capacity or mixed air quantity, V2, in SCFM per person,
and V2CFM is the mixed air volume corrected to actual conditions of tem-
perature and humidity. In column 3, SCFM1 is the flow rate of fresh air
in SCFM per person, and SCFM4 is the flow rate of recirculated air in
SCFM per person. In column 4, T3 (F) is the dry bulb temperature and
DOPT3 is the dew point of air that is either recirculated or exhausted
to the atmosphere. In column 5, MAIRW2 is the humidity ratio of mixed
air, and RAIRW3 is the humidity ratio of air that is either recirculated
or exhausted. In column 6, VI/V2 is the ratio of fresh to total air flow
quantities. The difference, W3 - W1, is the increase in humidity ratio
of air passing through the system, that is, the increase from outside to
exhaust conditions. In column 7, DH/DW is the slope of the mixing process
line in the coordinate system of specific enthalpy and humidity ratio.
The quantity, LBW/DAY, is the amount of water added to the ventilating
air by metabolic processes in pounds per day per person. Data relating
to partial recirculation of ventilating air in shelters, as shown in
these tables and plotted in Figure 8, were computed with the BASIC pro-
gram listed in Table B-6.

TABLE B-1

PARTIAL RECIRCULATION OF VENTILATING AIR
MIXED AIR TEMPERATURE = 50 °F
FRESH AIR TEMPERATURE = 50 °F

RH1	SCFM2 / V2CFM	SCFM1 / SCFM4	T3(F) / DPT3	MAIRW2 / RAIRW3	V1/V2 / W3-W1	DH/DW / LBW/DAY

FRESH AIR TEMP= +50.00 F, WSAT= 0.007659

RH1	SCFM2 / V2CFM	SCFM1 / SCFM4	T3(F) / DPT3	MAIRW2 / RAIRW3	V1/V2 / W3-W1	DH/DW / LBW/DAY
0	60.00	60.00	+54.58	0.000000	1.00000	4222.0
	57.83	0.00	-14.90	0.000351	0.000351	2.274
100	60.00	60.00	+54.52	0.007659	1.00000	4222.0
	58.54	0.00	+51.18	0.008009	0.000351	2.274
0	40.00	40.00	+56.87	0.000000	1.00000	4222.0
	38.55	0.00	-7.54	0.000526	0.000526	2.274
100	40.00	40.00	+56.78	0.007659	1.00000	4222.0
	39.03	0.00	+51.76	0.008185	0.000526	2.274
0	30.00	30.00	+59.16	0.000000	1.00000	4222.0
	28.91	0.00	-2.17	0.000702	0.000702	2.274
100	30.00	30.00	+59.03	0.007659	1.00000	4222.0
	29.27	0.00	+52.33	0.008360	0.000702	2.274
0	20.00	20.00	+63.73	0.000000	1.00000	4222.0
	19.28	0.00	+5.61	0.001053	0.001053	2.274
100	20.00	20.00	+63.54	0.007659	1.00000	4222.0
	19.51	0.00	+53.44	0.008711	0.001053	2.274
0	15.00	15.00	+68.29	0.000000	1.00000	4222.0
	14.46	0.00	+11.30	0.001404	0.001404	2.274
100	15.00	15.00	+68.04	0.007659	1.00000	4222.0
	14.63	0.00	+54.51	0.009062	0.001404	2.274
0	10.00	10.00	+77.40	0.000000	1.00000	4222.0
	9.64	0.00	+19.55	0.002105	0.002105	2.274
100	10.00	10.00	+77.03	0.007659	1.00000	4222.0
	9.76	0.00	+56.53	0.009754	0.002105	2.274
0	7.00	7.00	+87.58	0.000000	1.00024	3806.6
	6.75	-0.00	+29.24	0.003335	0.003335	2.521
100	7.00	7.00	+87.26	0.007659	1.00020	3856.4
	6.83	-0.00	+59.68	0.010951	0.003292	2.489
0	5.00	5.00	+92.79	0.000000	0.99962	2611.2
	4.82	0.00	+46.91	0.006811	0.006811	3.678
100	5.00	5.00	+92.66	0.007659	0.99996	2651.3
	4.88	0.00	+67.25	0.014364	0.006706	3.621
0	3.00	3.00	+94.86	0.000000	0.99993	1733.0
	2.89	0.00	+72.23	0.017099	0.017099	5.540
100	3.00	3.00	+94.95	0.007659	0.99990	1746.5
	2.93	0.00	+82.91	0.024626	0.016967	5.497
0	2.00	2.00	+95.00	0.000000	1.00024	1457.2
	1.93	-0.00	+89.33	0.030492	0.030492	6.596
100	2.00	V2 TOO LOW, BODY HEAT STORAGE				1463.8
100	2.41	2.41	+94.97	0.007659	1.00000	1563.4
	2.35	0.00	+90.01	0.031184	0.023525	6.121

TABLE B-2

PARTIAL RECIRCULATION OF VENTILATING AIR
MIXED AIR TEMPERATURE =   50 °F
FRESH AIR TEMPERATURE =   40 °F

RH1	SCFM2 V2CFM	SCFM1 SCFM4	T3(F) D3PT3	MAIRW2 RAIRW3	V1/V2 W3-W1	DH/DW LBW/DAY
FRESH AIR TEMP= +40.00 F, WSAT= 0.005213						
0	60.00	18.86	+54.58	0.000765	0.31433	4222.0
	57.90	41.14	+6.76	0.001116	0.001116	2.274
100	60.00	18.74	+54.53	0.005986	0.31231	4222.0
	58.39	41.26	+45.02	0.006337	0.001124	2.274
0	40.00	16.30	+56.96	0.000765	0.40746	4222.0
	38.60	23.70	+9.65	0.001292	0.001292	2.274
100	40.00	16.21	+56.80	0.005986	0.40519	4222.0
	38.92	23.79	+45.73	0.006512	0.001299	2.274
0	30.00	14.35	+59.14	0.000765	0.47332	4222.0
	28.95	15.65	+12.19	0.001467	0.001467	2.274
100	30.00	14.28	+59.06	0.005986	0.47597	4222.0
	29.19	15.72	+46.43	0.006698	0.001474	2.274
0	20.00	11.58	+63.71	0.000765	0.57900	4222.0
	19.30	8.42	+16.53	0.001818	0.001818	2.274
100	20.00	11.53	+63.58	0.005986	0.57670	4222.0
	19.46	8.47	+47.77	0.007039	0.001825	2.274
0	15.00	9.71	+68.27	0.000765	0.64711	4222.0
	14.47	5.29	+20.16	0.002169	0.002169	2.274
100	15.00	9.67	+68.09	0.005986	0.64496	4222.0
	14.60	5.33	+49.06	0.007390	0.002176	2.274
0	10.00	7.33	+77.36	0.000765	0.73338	4222.0
	9.65	2.67	+26.04	0.002871	0.002871	2.274
100	10.00	7.32	+77.11	0.005986	0.73153	4222.0
	9.73	2.68	+51.47	0.008091	0.002878	2.274
0	7.00	5.54	+87.55	0.000976	0.79103	3813.8
	6.76	1.46	+34.62	0.004209	0.004209	2.520
100	7.00	5.53	+87.33	0.006097	0.79013	3848.2
	6.81	1.47	+55.47	0.009390	0.004176	2.497
0	5.00	4.06	+92.76	0.001560	0.81296	2621.0
	4.83	0.94	+52.29	0.008343	0.008343	3.663
100	5.00	4.06	+92.67	0.006759	0.81285	2648.6
	4.87	0.94	+65.44	0.013471	0.008258	3.625
0	3.00	2.47	+94.85	0.003658	0.82340	1739.8
	2.91	0.53	+77.75	0.020683	0.020683	5.516
100	3.00	V2 TOO LOW, FOG IN MIXED AIR				1748.8
100	3.86	3.16	+94.30	0.007659	0.81949	2075.0
	3.77	0.70	+74.90	0.018762	0.013548	4.628
0	2.00	V2 TOO LOW, BODY HEAT STORAGE				1462.6
0	2.26	1.87	+94.98	0.005420	0.82616	1526.3
	2.20	0.39	+90.01	0.031179	0.031179	6.289
100	2.00	V2 TOO LOW, BODY HEAT STORAGE				1467.3
100	2.57	V2 TOO LOW, FOG IN MIXED AIR				1615.8
100	3.86	3.16	+94.30	0.007659	0.81949	2075.0
	3.77	0.70	+74.90	0.018762	0.013548	4.628

TABLE B-3

PARTIAL RECIRCULATION OF VENTILATING AIR
MIXED AIR TEMPERATURE = 50 °F
FRESH AIR TEMPERATURE = 20 °F

RH1	SCFM2 / V2CFM	SCFM1 / SCFM4	T3(F) / D3PT3	MAIRW2 / RAIRW3	VI/V2 / W3-WI	DH/DW LBW/DAY

FRESH AIR TEMP= +20.00 F, WSAT= 0.002152

RH1	SCFM2 / V2CFM	SCFM1 / SCFM4	T3(F) / D3PT3	MAIRW2 / RAIRW3	VI/V2 / W3-WI	DH/DW LBW/DAY
0	60.00	7.95	+54.56	0.002296	0.13256	4222.0
	58.04	52.05	+24.33	0.002647	0.002647	2.274
100	60.00	7.93	+54.54	0.004457	0.13211	4222.0
	58.24	52.07	+37.95	0.004808	0.002656	2.274
0	40.00	7.46	+56.84	0.002296	0.18647	4222.0
	38.69	32.54	+25.69	0.002823	0.002823	2.274
100	40.00	7.44	+56.81	0.004457	0.18588	4222.0
	38.83	32.56	+38.86	0.004993	0.002832	2.274
0	30.00	7.02	+59.12	0.002296	0.23408	4222.0
	29.02	22.98	+26.97	0.002998	0.002998	2.274
100	30.00	7.00	+59.08	0.004457	0.23338	4222.0
	29.12	23.00	+39.73	0.005159	0.003007	2.274
0	20.00	6.29	+63.67	0.002296	0.31433	4222.0
	19.35	13.71	+29.34	0.003349	0.003349	2.274
100	20.00	6.27	+63.62	0.004457	0.31349	4222.0
	19.41	13.73	+41.41	0.005510	0.003358	2.274
0	15.00	5.69	+68.22	0.002296	0.37936	4222.0
	14.51	9.31	+31.49	0.003700	0.003700	2.274
100	15.00	5.68	+68.14	0.004457	0.37844	4222.0
	14.56	9.32	+43.00	0.005861	0.003709	2.274
0	10.00	4.78	+77.29	0.002296	0.47832	4222.0
	9.67	5.22	+35.73	0.004402	0.004402	2.274
100	10.00	4.77	+77.18	0.004457	0.47734	4222.0
	9.71	5.23	+45.94	0.006563	0.004411	2.274
0	7.00	3.91	+87.48	0.002619	0.55829	3828.1
	6.77	3.09	+43.36	0.005942	0.005942	2.512
100	7.00	3.90	+87.38	0.004766	0.55782	3843.4
	6.80	3.10	+51.41	0.009075	0.005923	2.501
0	5.00	2.96	+92.71	0.004630	0.59271	2638.0
	4.85	2.04	+60.71	0.011370	0.011370	3.640
100	5.00	2.96	+92.67	0.006767	0.59246	2649.0
	4.97	2.04	+65.45	0.013479	0.011327	3.625
0	3.00	V2 T00 LOW, FOG IN MIXED AIR				1752.5
0	3.74	2.26	+94.41	0.007659	0.60514	2024.2
	3.65	1.48	+75.87	0.019396	0.019396	4.743
100	3.00	V2 T00 LOW, FOG IN MIXED AIR				1756.1
100	4.54	2.71	+93.46	0.007659	0.59747	2397.1
	4.43	1.93	+70.01	0.015930	0.013678	4.004
0	2.00	V2 T00 LOW, BODY HEAT STORAGE				1472.9
0	2.77	V2 T00 LOW, FOG IN MIXED AIR				1679.8
0	3.74	2.26	+94.41	0.007659	0.60514	2024.2
	3.65	1.48	+75.87	0.019396	0.019396	4.743
100	2.00	V2 T00 LOW, BODY HEAT STORAGE				1475.0
100	2.90	V2 T00 LOW, FOG IN MIXED AIR				1724.7
100	4.54	2.71	+93.46	0.007659	0.59747	2397.1
	4.43	1.83	+70.01	0.015830	0.013678	4.004

TABLE B-4

PARTIAL RECIRCULATION OF VENTILATING AIR
MIXED AIR TEMPERATURE = 50 °F
FRESH AIR TEMPERATURE = 0 °F

RH1	SCFM2 V2CFM	SCFM1 SCFM4	T3(F) D3PT3	MAIRW2 RAIRW3	V1/V2 W3-W1	DH/DW LEW/DAY
	FRESH AIR TEMP= +0.00 F, WSAT= 0.000787					
0	60.00	5.04	+54.55	0.003827	0.08399	4222.0
	58.18	54.96	+34.42	0.004178	0.004178	2.274
100	60.00	5.03	+54.54	0.004620	0.08388	4222.0
	58.26	54.97	+39.79	0.004971	0.004183	2.274
0	40.00	4.84	+56.82	0.003827	0.12090	4222.0
	38.79	35.16	+35.45	0.004353	0.004353	2.274
100	40.00	4.83	+56.81	0.004620	0.12075	4222.0
	38.84	35.17	+39.67	0.005146	0.004359	2.274
0	30.00	4.65	+59.09	0.003827	0.15496	4222.0
	29.09	25.35	+36.44	0.004529	0.004529	2.274
100	30.00	4.64	+59.08	0.004620	0.15477	4222.0
	29.13	25.36	+40.53	0.005321	0.004534	2.274
0	20.00	4.31	+63.63	0.003827	0.21572	4222.0
	19.39	15.69	+38.32	0.004880	0.004880	2.274
100	20.00	4.31	+63.61	0.004620	0.21548	4222.0
	19.42	15.69	+42.16	0.005672	0.004885	2.274
0	15.00	4.03	+68.16	0.003827	0.26934	4222.0
	14.55	10.97	+40.09	0.005231	0.005231	2.274
100	15.00	4.02	+68.14	0.004620	0.26805	4222.0
	14.56	10.98	+43.71	0.006023	0.005236	2.274
0	10.00	3.55	+77.21	0.003827	0.35489	4222.0
	9.70	6.45	+43.32	0.005932	0.005932	2.274
100	10.00	3.55	+77.17	0.004620	0.35456	4222.0
	9.71	6.45	+46.58	0.006725	0.005938	2.274
0	7.00	3.02	+87.41	0.004349	0.43157	3840.2
	6.79	3.98	+50.01	0.007662	0.007662	2.504
100	7.00	3.02	+87.38	0.005136	0.43125	3844.2
	6.80	3.98	+52.62	0.008447	0.007660	2.50
0	5.00	2.33	+92.66	0.007648	0.46692	2652.6
	4.88	2.67	+67.23	0.014354	0.014354	3.621
100	5.00	V2 TOO LOW, FOG IN MIXED AIR				2656.3
100	5.31	2.45	+92.02	0.007659	0.46242	2833.8
	5.18	2.85	+65.64	0.013572	0.012785	3.389
0	3.00	V2 TOO LOW, BODY HEAT STORAGE				1764.5
0	3.20	V2 TOO LOW, FOG IN MIXED AIR				1832.6
0	5.00	2.33	+92.66	0.007659	0.46680	2651.6
	4.88	2.67	+67.25	0.014364	0.014364	3.621
100	3.00	V2 TOO LOW, BODY HEAT STORAGE				1766.2
100	3.25	V2 TOO LOW, FOG IN MIXED AIR				1852.3
100	5.31	2.45	+92.02	0.007659	0.46242	2833.8
	5.18	2.85	+65.64	0.013572	0.012785	3.389
0	2.00	V2 TOO LOW, BODY HEAT STORAGE				1483.2
0	3.20	V2 TOO LOW, FOG IN MIXED AIR				1832.6
0	5.00	2.33	+92.66	0.007659	0.46680	2651.6
	4.88	2.67	+67.25	0.014364	0.014364	3.621
100	2.00	V2 TOO LOW, BODY HEAT STORAGE				1483.8
100	3.25	V2 TOO LOW, FOG IN MIXED AIR				1852.3
100	5.31	2.45	+92.02	0.007659	0.46242	2833.8
	5.18	2.85	+65.64	0.013572	0.012785	3.389

TABLE B-5

PARTIAL RECIRCULATION OF VENTILATING AIR
MIXED AIR TEMPERATURE = 50 °F
FRESH AIR TEMPERATURE = -20 °F

RH1	SCFM2 V2CFM	SCFM1 SCFM4	T3(F) DGPT3	MAIRW2 RAIRW3	V1/V2 W3-W1	DH/DW LBW/DAY
FRESH AIR TEMP= -20.00 F, WSAT= 0.000263						
0	60.00	3.69	+54.54	0.005358	0.06147	4222.0
	58.33	56.31	+42.31	0.005709	0.005709	2.274
100	60.00	3.69	+54.54	0.005623	0.06144	4222.0
	58.35	56.31	+43.50	0.005974	0.005711	2.274
0	40.00	3.58	+56.80	0.005358	0.08945	4222.0
	38.88	36.42	+43.11	0.005884	0.005884	2.274
100	40.00	3.58	+56.80	0.005623	0.08941	4222.0
	38.90	36.42	+44.25	0.006150	0.005887	2.274
0	30.00	3.47	+59.07	0.005358	0.11581	4222.0
	29.16	26.53	+43.87	0.006060	0.006060	2.274
100	30.00	3.47	+59.06	0.005623	0.11576	4222.0
	29.18	26.53	+44.98	0.006325	0.006062	2.274
0	20.00	3.28	+63.59	0.005358	0.16421	4222.0
	19.44	16.72	+45.33	0.006411	0.006411	2.274
100	20.00	3.28	+63.59	0.005623	0.16414	4222.0
	19.45	16.72	+46.39	0.006676	0.006413	2.274
0	15.00	3.11	+68.12	0.005358	0.20758	4222.0
	14.58	11.89	+46.72	0.006762	0.006762	2.274
100	15.00	3.11	+68.11	0.005623	0.20751	4222.0
	14.59	11.89	+47.73	0.007027	0.006764	2.274
0	10.00	2.82	+77.14	0.005358	0.28210	4222.0
	9.72	7.18	+49.32	0.007463	0.007463	2.274
100	10.00	2.82	+77.13	0.005623	0.28200	4222.0
	9.73	7.18	+50.25	0.007729	0.007466	2.274
0	7.00	2.46	+87.33	0.006066	0.35188	3851.8
	6.91	4.54	+55.41	0.009369	0.009369	2.497
100	7.00	2.46	+87.33	0.006332	0.35171	3851.9
	6.82	4.54	+56.17	0.009636	0.009373	2.493
0	5.00	V2 TOO LOW, FOG IN MIXED AIR				2667.3
0	6.02	2.23	+90.26	0.007659	0.37035	3279.1
	5.87	3.79	+62.57	0.012168	0.012168	2.931
100	5.00	V2 TOO LOW, FOG IN MIXED AIR				2671.7
100	6.15	2.26	+89.90	0.007659	0.36789	3359.3
	6.00	3.89	+62.11	0.011962	0.011699	2.859
0	3.00	V2 TOO LOW, BODY HEAT STORAGE				1776.9
0	3.57	V2 TOO LOW, FOG IN MIXED AIR				1984.6
0	6.02	2.23	+90.26	0.007659	0.37035	3279.1
	5.87	3.79	+62.59	0.012168	0.012168	2.931
100	3.00	V2 TOO LOW, BODY HEAT STORAGE				1777.2
100	3.59	V2 TOO LOW, FOG IN MIXED AIR				1992.4
100	6.15	2.26	+89.90	0.007659	0.36789	3359.3
	6.00	3.89	+62.11	0.011962	0.011699	2.859
0	2.00	V2 TOO LOW, BODY HEAT STORAGE				1493.2
0	3.57	V2 TOO LOW, FOG IN MIXED AIR				1984.6
0	6.02	2.23	+90.26	0.007659	0.37035	3279.1
	5.87	3.79	+62.59	0.012168	0.012168	2.931
100	2.00	V2 TOO LOW, BODY HEAT STORAGE				1493.2
100	3.59	V2 TOO LOW, FOG IN MIXED AIR				1992.4
100	6.15	2.26	+89.90	0.007659	0.36789	3359.3
	6.00	3.89	+62.11	0.011962	0.011699	2.359

TABLE B-6

RECIRCULATION OF AIR - PROGRAM LISTING

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100   REM: > RAVENS <    4/72
110   PRINT  USING "4(DDD)";TIM(3),TIM(2),TIM(1),TIM(C)
120   DIM A$[48],C$[60],D$[60],E$[50]
130   A$="          PARTIAL RECIRCULATION OF AIR"
140   C$=" RH1    SCFM2    SCFM1     T3(F)    MAIRW2     V1/V2    DW/DW"
150   D$="        V2CFM    SCFM4    DWPT3    RAIRW3     W3-W1    LBW/DAY"
160   IMAGE 16X,"MIXED AIR TEMP =",3D," F"
170   IMAGE " FRESH AIR TEMP=",S3D.DD," F, WSAT= ",D.6D
180   IMAGE X3D,X3D.DD,X3D.DD,XXS3D.DD,XXD.6D,XXD.5D,XX5D.D
190   IMAGE 5X3D.DD,X3D.DD,XXS3D.DD,XXD.6D,XXD.6D,XXDD.3D
200   IMAGE X3D,X3D.DD,XX,2A,10A,21A,XX5D.D
210   P8=1
220   C=.24026
230   A1=1061.09
240   A2=1061.25
250   B1=.4412
260   B2=.4362
270   B3=.5508
280   T0=82.5
290   S0=4222
300   M0=400
310   DATA 20
320   DATA 60,40,30,20,15,10,7,5,3,2
350   T2=50
360   T7=90
370   C0=C*T0
380   G0=A2+B2*T0
390   C2=C*T2
400   G2=A2+B2*T2
410   T9=(T2-32)/1.8
420   GOSUB 2610
430   GOSUB 2810
440   S2=W9
450   T9=(T7-32)/1.8
460   GOSUB 2610
470   GOSUB 2810
480   L3=W9
490   DATA 890,890
500   D=D0=D1=.01
510   E$="T1V2 T00 LOW, FOG IN MIXED AIRBODY HEAT STORAGE"
520   PRINT ".";LIN(2);A$
530   PRINT  USING 160;T2
540   PRINT LIN(1);C$;LIN(1);D$
550   PRINT
560   READ T1
570   IF T1>T2 THEN 1210
580   C1=C*T1
590   IF T1<.. THEN 620
600   G1=A2+B2*T1
610   GOTO 630
620   G1=A1+B1*T1
630   T9=(T1-32)/1.8
640   GOSUB 2610
650   GOSUB 2810
660   S1=W9
670   PRINT  USING 170;T1,S1
680   READ V2
690   IF V2>404 THEN 2910
700   IF V2>303 THEN 520
710   IF V2>202 THEN 550
```

```
720    D5=M0/(4.5*V2)
730    Y1=0
740    G0T0 760
750    Y1=100
760    W1=S1*Y1/100
770    H1=C1+G1*W1
780    W2=(W1*(S0-G1)+C2-C1)/(S0-G2)
790    IF W2>(S2+.00001) THEN 1190
800    H2=C2+G2*W2
810    W0=(W2*(S0-G2)+C0-C2)/(S0-G0)
820    H0=C0+G0*W0
830    V0=M0/(4.5*(H0-H2))
840    N=N1=1
850    IF V0>V2 THEN 910
860    H3=H2+D5
870    W3=W2+D5/S0
880    T3=(H3-A2*W3)/(C+B2*W3)
890    S=S0
900    G0T0 1000
910    H2=C2+G2*W2
920    K3=H2+D5
930    G0SUB 1510
940    IF N>3 THEN 1000
950    S=(H3-H1)/(W3-W1)
960    X2=(W1*(S-G1)+C2-C1)/(S-G2)
970    IF ABS(X2-W2)<(D1/1000) THEN 1000
980    W2=X2
990    G0T0 910
1000   V5=V2
1010   IF W3>L3 THEN 1410
1020   IF W2>(S2+.00001) AND T1<T2 THEN 1310
1040   T=459.67+T2
1050   U2=.001891*V5*T*(1+1.6079*W2)/P8
1060   D4=H3-H1
1070   V1=M0/(4.5*D4)
1080   R=V1/V5
1090   V4=V5-V1
1100   G0SUB 2260
1110   M3=4.5*V5*(W3-W2)
1120   PRINT  USING 180;Y1,V5,V1,T3,W2,R,S
1130   PRINT  USING 190;U2,V4,T5,W3,W3-W1,24*M3
1180   G0T0 1240
1190   PRINT  USING 200;Y1,-11.11,E$[1,2],E$[5,14],E$[15,30],S0
1200   IF Y1>49.9 THEN 1250
1210   READ V2
1220   IF V2<202 THEN 1210
1230   G0T0 690
1240   IF Y1<49.9 THEN 750
1250   G0T0 680
1310   N=3
1320   PRINT  USING 200;Y1,V5,E$[3,4],E$[5,14],E$[15,30],S
1330   W2=S2
1340   H2=C2+G2*W2
1350   S=(H2-H1)/(W2-W1)
1360   G0SUB 1510
1380   G0T0 1040
1410   N=2
1420   PRINT  USING 200;Y1,V2,E$[3,4],E$[5,14],E$[31],S
1430   V2=91
1440   G0SUB 1520
1460   G0T0 1020
```

```
1510    V2=T0
1520    V4=95
1530    D1=D0
1540    V1=0
1550    T3=(V2+V4)/2
1560    V1=V1+1
1570    C3=C*T3
1580    G3=A2+B2*T3
1590    G0T0 V 0F 1660,1630,1600
1600    X3=(W1*(S-G1)+C3-C1)/(S-G3)
1610    K3=C3+G3*X3
1620    G0T0 1660
1630    X3=C3+G3*L3
1640    S=(X3-H1)/(L3-W1)
1650    W2=(W1*(S-G1)+C2-C1)/(S-G2)
1660    IF V1>15 THEN 1790
1670    W0=(W2*(S0-G2)+C0-C2)/(S0-G0)
1680    R1=(95-T0)/(95-T3)
1690    R2=(2305.2+T0)/(2305.2+T3)
1700    F2=R2*(R1/R2)+.006944
1710    W3=F2*(B3+W0)-B3
1720    H3=C3+G3*W3
1730    IF ABS(H3-K3)<D1 THEN 1850
1740    IF H3>K3 THEN 1770
1750    V2=T3
1760    G0T0 1550
1770    V4=T3
1780    G0T0 1550
1790    IF D1>.011 THEN 1860
1800    D1=2*D1
1810    IF D1>D THEN 1830
1820    G0T0 1840
1830    D=D1
1840    G0T0 1540
1850    G0T0 V 0F 1940,1920,1930
1860    G0T0 V 0F 1950,1900,1870
1870    W3=X3
1880    H3=K3
1890    G0T0 1930
1900    W3=L3
1910    H3=K3
1920    H2=C2+G2*W2
1930    V5=W0/(4.5*(H3-H2))
1940    RETURN
1950    Z3=G3-G2
1960    Z4=C3-H1
1970    Z5=D5-C3+C2
1980    Z2=Z3*G3
1990    Z1=(G2*D5+Z3*Z4-Z5*C3)/Z2
2000    Z0=(G2*D5*W1+Z4*Z5)/Z2
2010    W3=(SQR(Z1+2+4*Z0)-Z1)/2
2020    H3=C3+G3*W3
2030    S=(H3-H1)/(W3-W1)
2040    W2=(W1*(S-G1)+C2-C1)/(S-G2)
2050    N=4
2060    RETURN
2260    W9=W3
2270    G0SUB 2510
2280    P3=P9
```

```
2290    T9=0
2300    GOSUB 2610
2310    IF P9>P3 THEN 2340
2320    J1=J=1
2330    GOTO 2350
2340    J1=J=-1
2350    J2=0
2360    J3=32/J1
2370    FOR T9=J2 TO J2+3*J3 STEP J3
2380    GOSUB 2610
2390    J6=J*(P9-P3)
2400    IF J6=0 THEN 2470
2410    IF J6>0 THEN 2430
2420    NEXT T9
2430    IF ABS(J3)<.005 THEN 2470
2440    J2=T9-J3
2450    J1=2*J1
2460    GOTO 2360
2470    T5=32+1.8*T9
2480    RETURN
2510    F9=P8*W9/(.62197+W9)
2520    IF T9<0 THEN 2560
2530    Q0=66-T9
2540    Q5=1+.004*P8+1/(500+Q0+2)
2550    GOTO 2570
2560    Q5=1+(4200-15*T9+.375*T9+2)*.000001*P8
2570    P9=F9/Q5
2580    RETURN
2610    IF T9<0 THEN 2710
2620    Q1=-17.5604
2630    Q2=+1.79764
2640    Q3=+3.86061
2650    Q4=-1.41654
2660    Q6=373.15/(273.15+T9)
2670    Q7=Q6-1
2680    Q8=Q7/Q6
2690    Q9=Q1*Q7+Q2*LOG(Q6)+Q8*(Q3+Q4/Q6)
2700    GOTO 2780
2710    Q1=-20.9422
2720    Q2=-3.57281
2730    Q3=+2.02115
2740    Q6=273.15/(273.15+T9)
2750    Q7=Q6-1
2760    Q8=Q7/Q6
2770    Q9=Q1*Q7+Q2*LOG(Q6)+Q3*Q8-5.11145
2780    P9=EXP(Q9)
2790    RETURN
2810    X9=.62197*P9/(P8-P9)
2820    IF T9<0 THEN 2860
2830    Q0=66-T9
2840    Q5=1+.004*P8+1/(500+Q0+2)
2850    GOTO 2870
2860    Q5=1+(4200-15*T9+.375*T9+2)*.000001*P8
2870    C9=(P8-P9)/(P8/Q5-P9)
2880    W9=C9*X9
2890    RETURN
2910    PRINT
2940    PRINT " LHR=.25  (T<82.5F<T)  LHR=.06*T-4.7"
2980    PRINT  USING "2(3D),3X,4D,2(4D.DD)";TIM(1),TIM(0),W0,D1,D
3000    END
```