ASD
APOLLO SYSTEMS DEPARTMENT

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TIR 741-MED-5009

FROM	TO
V. J. Marks	J. A. Rummel, Ph.D./DB6

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SUBJECT: User's Instructions for the Whole-Body Algorithm

The Whole-Body Algorithm is a mathematical model that can simulate the response of certain major body regulatory systems to diverse but specific stresses related to the space flight environment. These stresses include environmental (e.g., changes in cabin temperature and atmospheric composition - increased carbon dioxide concentration and hypoxia), experimental (e.g., bicycle ergometry - supine and erect, lower body negative pressure, and head-up tilt-table or passive standing), and long term adaptation (such as hypokinesis).

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Attachment
/db

6/25/75

CONCURRENCES

Counterpart:

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DISTRIBUTION

NASA/JSC:

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JM6/Technical Library(1979 distribution)

GE/TSSD:

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Central Product File

ASD 4028

PROGRAM DESCRIPTION GUIDE

A. IDENTIFICATION

Program Name - Whole-Body Algorithm

Programmer's Name - D. Grounds, D. Fitzjerrell, J. Leonard, V. Marks

Programmer Contact - V. J. Marks, GE/TSSD, Houston

Date of Issue - June 19, 1975

B. GENERAL DESCRIPTION

The Whole-Body Algorithm is a mathematical model that can simulate the response of certain major body regulatory systems to diverse but specific stresses related to the space flight environment. These stresses include environmental (e.g., changes in cabin temperature and atmospheric composition - increased carbon dioxide concentration and hypoxia), experimental (e.g., bicycle ergometry - supine and erect, lower body negative pressure, and head-up tilt-table or passive standing), and long term adaptation (such as hypokinesis).

The design of the whole-body algorithm provides for the simulation of both long and short term stresses. The long term simulation is accomplished by a circulatory, fluid and electrolyte subsystems model which then initializes a set of three short term models representing the cardiovascular, respiratory, and thermoregulatory systems. These three short term models, which are designed to simulate the responses to acute changes in environmental and short term experiment stresses, operate in parallel fashion interchanging information as often as every half second of simulation time. This approach simulates with equal facility those adaptive changes which require days, weeks, or even months of simulation time, as well as those experimental stresses in which significant changes might occur in a matter of seconds.

C. USAGE AND RESTRICTIONS

Machine, Operating System, and Compiler Required - Univac 1110 Demand, EXEC 8, Fortran

Peripheral Equipment Required - Electronic Data Terminal and Tape Unit

Approximate Memory Required - 18500_{10}

D. PARTICULAR DESCRIPTION

Equations Used and Derivations

The individual subsystem models (cardiovascular, respiratory, thermoregulatory, and circulatory fluid and electrolyte control) were developed or modified from existing models to be capable of simulating the stresses of interest on the Univac 1110 Demand System. These models and the various modifications have been described in detail in the literature in previous TIR's and, therefore, will not be repeated here. The Guyton model with modifications by White is documented in TIR's - 741-MED-3042, 4017, and 4021 is capable of simulating

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intermediate and long term changes in circulatory, fluid and electrolyte control. The respiratory subsystem is represented by Grodins' model with modifications by Gallagher in TIR's - 741-MED-3047, 4016, 4018, and 5001. The Stolwijk thermoregulatory subsystem model with modifications by GE is described in TIR's - 741-MED-3013, 4011, and 4014. The cardiovascular subsystem is represented by a model developed under this contract by Croston for bicycle ergometry exercise with modifications by Fitzjerrell and Croston for LBNP, tilt and tilt (supine) ergometry and is documented in TIR's - 741-MED-2010, 3053, 3054, and 4008.

Definition and Value of Terms Used

Circulatory - See Appendix A for definitions and Appendix F, page 72 for input/output index and initial value

Cardiovascular - See Appendix B for definitions, input/output index and initial value

Thermoregulatory - See Appendix C for definitions, input/output index and initial value

Respiratory - See Appendix D for definitions, input/output index and initial value

Detailed Description

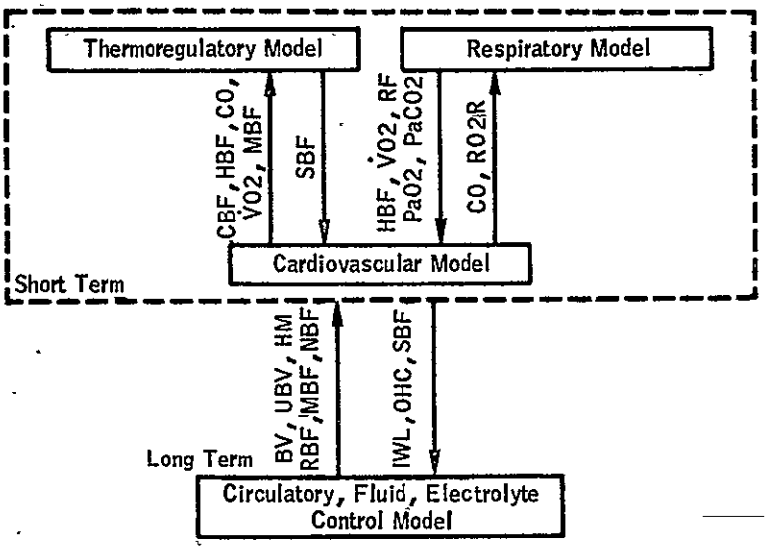
Most of the model's variables are indexed and their initial values may be changed at run time by reference to this index. The output may also be modified by use of this index. The mathematical model is summarized by a functional block diagram as shown in Figure 1.

E. DESCRIPTION OF INPUT

A Univac 1110 file (GE) contains the source and relocatables of all subroutines, the executable program, and initial data files. Since GE. is not protected, the user should copy GE. into another file, then make required modifications to this other file.

The user inputs data from a remote electronic data terminal via responding to questions asked by the program. Options are available so a user can execute long and/or short term stresses as required. (See Appendix E for examples of input).

A graphic remote terminal can obtain plots of output data by requesting the program to build an output file. This file is then plotted in a separate run. Refer to TIR 741-MED-5011 for user instructions.



CBF = Trunk Core Blood Flow
HBF = Head Blood Flow
MBF = Muscle Blood Flow
SBF = Skin Blood Flow
RBF = Renal Blood Flow
$\dot{C}O$ = Cardiac Output
$\dot{V}O2$ = Oxygen Uptake
RF = Respiratory Frequency
PaO2 = Arterial Oxygen Partial Press.
PaCO2 = Arterial CO2 Partial Press.
RO2R = Resting Oxygen Requirement
BV = Total Blood Volume
UBV = Total Unstressed Blood Vol.
IWL = Insensible Water Loss
OHC = Oxy-Hemoglobin Concentration
HM = Hematocrit
NBF = Non-muscle Blood Flow

FIGURE 1. - BLOCK DIAGRAM OF WHOLE-BODY ALGORITHM INTERFACES

The long term data is written to unit 7 and the short term data is written to unit 14, 15, 16, 18, ... N depending on the number of separate short term runs being made. This data is dynamically stored, but could be saved on tape if required by assignment of a tape unit to the appropriate output unit.

Control Cards - (Begin in card column 1)

@COPY GE., TPF$.	Copy program into work file.
@ASG,T 14, 8C,TAPENO	Save short term output for plotting
@XQT	Execute program

F. DESCRIPTION OF OUTPUT

See Appendix F for example of input/output.

G. INTERNAL CHECKS AND EXITS

Input data is checked for invalid input, allowing the user to resubmit if wrong.

H. INDEPENDENT SUBROUTINES

See Appendix F for listing of all subroutines

I. SYSTEM SUBROUTINES

No special system subroutines required.

J. COMPLETION OR FINAL CHECKOUT DATE

6/3/75

APPENDIX A
DEFINITION OF TERMS
FOR
LONG TERM MODEL

The following list includes all variables used in the long term model. Independent variables (never calculated by the program) are indicated by *. Units used are: volume in liters, mass in grams, time in minutes, chemical units in milliequivalents, pressure in millimeters of mercury, and control factors as ratio to normal.

AAR- afferent arteriolar resistance

AGK*- constant concerned with effect of renin on angiotensin formation

AH- antidiuretic hormone secretion rate

AHC- antidiuretic hormone concentration

AHK*- constant used in calculating antidiuretic hormone concentration

AHM- antidiuretic hormone multiplier

AHY- adapted effect of right atrial pressure on antidiuretic hormone secretion rate

AHZ- basic effect of right atrial pressure on antidiuretic hormone secretion rate

AH8- effect of autonomic stimulation on antidiuretic hormone secretion rate

ALO*- maximum aortic arterial oxygen saturation

AM- aldosterone multiplier

AMC- aldosterone concentration

AMM- muscle vascular constriction caused by local tissue control, ratio to resting state

AMP- effect of arterial pressure on rate of aldosterone secretion

AMR- effect of sodium to potassium ratio on rate of aldosterone secretion

AMT*- time constant of aldosterone accumulation and destruction

AM1- rate of aldosterone secretion

ANC- angiotensin concentration

ANM- angiotensin multiplier effect on vascular resistance, ratio to normal

ANP- effect of renal blood flow on angiotensin formation

ANR- effect of glomerular filtration and sodium concentration on renin formation with consequent effect on angiotensin formation

ANT*- time constant of angiotensin accumulation and destruction

ANU- non-renal effect of angiotensin

ANV*- total body systemic unstressed volume diminished by bed rest fluid shift factor

ANW- partial effect of renin on angiotensin formation

ANY*- constant used to calculate angiotensin effect on venous volume

ANZ*- constant used to calculate angiotensin effect on venous resistance

AN1 - rate of angiotensin formation

AOM- autonomic effect on tissue oxygen utilization

APD- afferent arteriolar pressure drop

ARF*- intensity of sympathetic effects on renal function

ARM- vasoconstrictor effect of all types of autoregulation

AR1- vasoconstrictor effect of rapid autoregulation

AR2- vasoconstrictor effect of intermediate autoregulation

AR3- vasoconstrictor effect of long-term autoregulation

AU- overall activity of autonomic system

AUB- effect of baroreceptors on autoregulation

AUC- effect of chemoreceptors on autonomic stimulation

AUH- autonomic stimulation of heart

AUJ- basic overall autonomic stimulation

AUK*- time constant of baroreceptor adaptation

AUL*- switch that turns on bed rest induced cardioacceleration effect.

AUM- sympathetic vasoconstrictor effect on arteries

AUN- effect of CNS ischemic reflex on autoregulation

AUO- fractional departure of overall activity of autonomic system from normal

AUP- autonomic stimulation of peripheral circulatory sensitivity

AUQ*- sensitivity of sympathetic control of peripheral circulation

AUR- autonomic stimulation for heart rate

AUS*- sensitivity of sympathetic control of heart rate

AUV*- amount of fluid shifted during bed rest from unstressed to stressed blood volume.

AUX*- sensitivity of baroreceptors

AUY*- sensitivity of sympathetic control of veins

AUZ*- overall sensitivity of autonomic control

AU4- degree of adjustment of baroreceptor response

AU6- adapted baroreceptor response

AU8- rate of adaptation of baroreceptors

AVE- effect of autonomic stimulation on venous resistance

A1B- sensitivity parameter for baroreceptor drive

A1K*- time constant of rapid autoregulation

A2K*- time constant of intermediate autoregulation

A3K*- time constant of long-term autoregulation

A4K*- time constant for muscle local vascular response to metabolic activity

BFM- muscle blood flow

BFN- blood flow in non-muscle, non-renal tissues

CCD- concentration gradient across cell membrane

CFC*- capillary filtration coefficient

CHY- concentration of hyaluronic acid in tissue fluids

CKE- extracellular potassium concentration

CKI- intracellular potassium concentration

CNA- extracellular sodium concentration

CNB- difference between extracellular sodium concentration and set point used to calculate antidiuretic hormone secretion rate

CNR*- reference sodium concentration used in determining effect of sodium on antidiuretic hormone secretion rate

CNE- sodium concentration abnormality causing third factor effect

CNX* constant used in calculation of renal excretion rate of sodium

CNY*- constant used in calculation of renal excretion rate of sodium

CNZ*- sensitivity of antidiuretic hormone production rate to extracellular sodium concentration

CN2* constant used in calculation of venous resistance

CN3- dummy variable used in calculation of the effect of capillary pressure on venous resistance

CN7*- constant used in calculation of venous resistance

CPF*- sensitivity of rate of transfer of fluid across pulmonary capillaries to pressure gradient

CPG- concentration of protein in tissue gel

CPI- concentration of protein in free interstitial fluid

CPK*- rate constant used in determining loss of plasma protein through systemic capillaries

CPN- concentration of protein in pulmonary fluids

CPP- plasma protein concentration

CPR*- reference plasma protein concentration governing protein production by liver

CV*- venous capacitance

DAS- rate of volume increase of systemic arteries

DAU- autonomic stimulation drive

DFP- rate of increase in pulmonary free fluid

DHM- rate of cardiac deterioration caused by hypoxia

DLA- rate of volume increase in pulmonary veins and left atrium

DLP- rate of formation of plasma protein by liver

DLZ- undamped plasma protein concentration differential causing protein production by liver

DOB- rate of oxygen delivery to non-muscle cells

DPA- rate of increase in pulmonary volume

DPC- rate of loss of plasma proteins through systemic capillaries

DPI- rate of change of protein in free interstitial fluid

DPL- rate of systemic lymphatic return of protein

DPO*- rate of loss of plasma protein

DRA- rate of increase in right atrial volume

DVS- rate of increase in venous vascular volume

EXC* exercise activity, ratio to normal at rest

EXE- exercise effect on autonomic stimulation

EX1*- constant concerned with effect of muscle cell P_{O_2} on autonomic stimulation during exercise

FIS*- fistula parameter

GBL*- Goldblatt hypertension parameter

GFN- glomerular filtration rate of undamaged kidney

GFR- glomerular filtration rate

GF1- value of GFN on previous iteration

GF2*- constant used in calculation of glomerular filtration rate

GF3- degree of autoregulatory feedback at macular densa

GF4*- constant controlling the feedback loop for GF3

GLP- glomerular pressure

GPD- rate of increase of protein in gel

GPR- total protein in gel

HKM*- constant used in calculation of portion of blood viscosity caused by red blood cells

HM- hematocrit

HMD- cardiac depressant effect of hypoxia

HMK*- constant used in calculation of portion of blood viscosity caused by red blood cells

HPL- hypertrophy effect on left ventricle

HPR- hypertrophy effect on right ventricle

HR- heart rate

HSL*- basic left ventricular strenght

HSR*- basic right ventricular strength

HYL*- quantity of hyaluronic acid in tissues

I- integration step size

IFP- interstitial fluid protein

II- variable integration step size utilized on stable asymptote

I2*- normal increment on time

I3*- maximum time increment for stable asymptote

KCD- rate of change of intracellular potassium concentration

KE- total extracellular fluid potassium

KED- rate of change of extracellular potassium concentration

KI- total intracellular potassium concentration

KID* rate of potassium intake

KIE- excess potassium concentration causing change in intracellular potassium level

KIR- total expected level of potassium in the intracellular fluid under equilibrium conditions

KOD- rate of renal loss of potassium

LPK*- rate constant for plasma protein production by liver

LVM- effect of aortic pressure on left ventricular output

MMO- rate of oxygen utilization by muscle cells

MO2- rate of oxygen utilization by non-muscle cells

NAE- total extracellular sodium

NED- rate of change of sodium in extracellular fluids

NID*- rate of sodium intake

NOD- rate of renal excretion of sodium

NOZ- effect of urinary output, aldosterone, and sodium level on renal excretion rate for sodium

OMM*- muscle oxygen utilization at rest

OSA- aortic oxygen saturation

OSV- non-muscle venous oxygen saturation

OVA- oxygen volume in aortic blood

OVS- muscle venous oxygen saturation

O2A*- sensitivity of the effect of autonomic stimulation on metabolism

O2M*- basic oxygen utilization in non-muscle body tissues

PA- aortic pressure

PAM- effect of arterial pressure in distending arteries, ratio to normal

PAR- renal arterial pressure

PA1- effective pressure drive on autonomic system

PA2- effective arterial pressure on left ventricle

PC- capillary pressure

PCD- net pressure gradient across capillary membrane

PCE*- capillary pressure exponent

PCP- pulmonary capillary pressure

PDO- difference between muscle venous oxygen P_{O_2} and normal venous oxygen P_{O_2}

PFI- rate of transfer of fluid across pulmonary capillaries

PFL- renal filtration pressure

PGC- colloid osmotic pressure of tissue gel

PGH- absorbency effect of gel caused by recoil of gel reticulum

PGL- pressure gradient in lungs

PGP- colloid osmotic pressure of tissue gel caused by entrapped protein

PGR- colloid osmotic pressure of interstitial gel caused by Donnan equilibrium

PGS- pressure difference between arteries and veins

PGV- venous pressure gradient

PGX- activity factor for protein in the interstitial fluid

PIF- interstitial fluid pressure

PK1*- constant used in calculating muscle cell P_{O_2} from total volume of oxygen in muscle cells

PK2*- constant used in calculating muscle cell P_{O_2} from total volume of oxygen in muscle cells

PK3*- constant used in calculating rate of oxygen transport to muscle cells

PLA- left atrial pressure

PLD- pressure gradient to cause lymphatic flow

PLF- pulmonary lymphatic flow

PMC- mean circulatory pressure

PMO- muscle cell P_{O_2}

PMP- mean pulmonary pressure

PMS- mean systemic pressure

PM1- effective muscle cell P_{O_2}

PM3*- minimum value allowed for PM1

PM4*- constant used in calculating rate of oxygen transport to muscle cells

PM5*- constant used in calculating rate of oxygen transport to muscle cells

POA- rate of change of intermediate autoregulation vasoconstrictor effect

POB- rate of change of rapid autoregulation vasoconstrictor effect

POC- rate of change of long-term autoregulation vasoconstrictor effect

POD- non-muscle venous P_{O_2} minus normal value

POE- sensitivity control for oxygen feedback control loop

POK*- sensitivity of rapid system of autoregulation

POM*- sensitivity of oxygen feedback control loop

PON*- sensitivity of intermediate autoregulation

POQ- effective non-muscle cell P_{O_2}

POR*- reference value of capillary P_{O_2} in non-muscle tissue

POS- pulmonary interstitial fluid colloid osmotic pressure

POT- non-muscle cell P_{O_2}

POV- non-muscle venous P_{O_2}

POY*- sensitivity of red cell production

POZ*- sensitivity of long-term autoregulation

PO1*- constant used in determining oxygen deficit factor causing red cell production

PO2- oxygen deficit factor causing red cell production

PPA- pulmonary arterial pressure

PPC- plasma colloid osmotic pressure

PPD- rate of change of protein in pulmonary fluids

PPI- pulmonary interstitial fluid pressure

PPN- rate of pulmonary capillary protein loss

PPO- pulmonary lymph protein flow

PPR- total protein in pulmonary fluids

PP1- variable used to empirically relate pulmonary arterial pressure and pulmonary arterial resistance

PP2- effective pulmonary arterial pressure

PRA- right atrial pressure

PRM- pressure caused by compression of interstitial fluid gel reticulum

PRP- total plasma protein

PRI- effective right atrial pressure

PTC- interstitial fluid colloid osmotic pressure

PTS- solid tissue pressure

PTT- total tissue pressure

PVG- venous pressure gradient

PVO- muscle venous P_{O_2}

PVS- average venous pressure

P1O- tissue P_{O_2} effective in oxygen utilization

P2O- muscle cell P_{O_2} effective in depressing rate of metabolism

QAO- blood flow in the systemic arterial system

QLN- basic left ventricular output

QLO- output of left ventricle (cardiac output)

QOM- total volume of oxygen in muscle cells

QO2- non-muscle total cellular oxygen

QPO- rate of blood flow into pulmonary veins and left atrium

QRF*- feedback effect of left ventricular function on right ventricular function

QRN- basic right ventricular output

QRO- actual right ventricular output

QVO - rate of blood flow from veins into right atrium

RAM*- basic vascular resistance of muscles

RAR*- basic resistance of non-muscular and non-renal arteries

RBF- renal blood flow

RCD- rate of change of red cell mass

RC1- red cell production rate

RC2- red cell destruction rate

RDO- resistance of diffusion of oxygen from capillaries to cells

REK*- fraction of normal renal function

RFN- renal blood flow if kidney is not damaged

RKC*- rate constant for red cell destruction

RMO- rate of oxygen utilization by tissues

RPA- pulmonary arterial resistance

RPT- pulmonary vascular resistance

RPV- pulmonary venous resistance

RR- renal resistance

RSM- vascular resistance in muscle

RSN- vascular resistance in non-muscle, non-renal tissues

RTP- total peripheral resistance

RVG- resistance from veins to right atrium

RVM- depressing effect of pulmonary arterial pressure on right ventricle

RVS- venous resistance

SR*- intensity factor for stress relaxation

SRK*- time constant for stress relaxation

STA*- overriding value of overall activity of autonomic system AU

STH- effect of tissue hypoxia on salt and water intake

SVO- stroke volume output

T- total time elapsed

TRR- tubular reabsorption rate

TVD- rate of drinking

TVZ- combined effect of tissue ischemia and central nervous stimulation on thirst and drinking

T1- total time elapsed on previous step

U*- damping factor for QPO

VAE- excess volume in systemic arteries that causes stretch of arterial walls

VAS- volume in systemic arteries

VB- blood volume

VBD- volume correction factor added to systemic circulation to allow for updating blood volume

VEC- extracellular fluid volume

VG- volume of interstitial fluid gel

VGD- rate of change of tissue gel volume

VIB- blood viscosity, ratio to that of water

VIC- cell volume

VID- rate of fluid transfer between interstitial fluid and cells

VIE- portion of blood viscosity caused by red blood cells

VIF- volume of free interstitial fluid

VIM- blood viscosity, ratio to normal

VLA- volume in left atrium

VLE- excess volume in left atrium causing stretch of left atrium and pulmonary veins

VP- plasma volume

VPA- volume in pulmonary arteries

VPD- rate of change of plasma volume

VPE- excess volume in right atrium causing stretching of the right atrium

VPF- pulmonary free fluid volume

VRA right atrial volume

VRC- volume of red blood cells

VRE- excess volume in right atrium causing stretching of the right atrium

VTC- rate of fluid transfer across systemic capillary membrances

VTD- rate of volume change in total interstitial fluid

VTL- rate of systemic lymph flow

VTS- total interstitial fluid volume

VTW- total body water

VUD- rate of urinary output

VVE- excess venous vascular volume before stress relaxation correction

VVR- volume of blood in veins at zero venous pressure

VVS- venous vascular volume

VV6- rate of change of vascular stress relaxation effect

VV7- increased vascular volume caused by stress relaxation

VV8- excess volume of blood in the systemic veins after stress relaxation correction

VV9*- reference venous vascular volume

V2D*- resistance factor which converts pressure drop to rate of change of tissue gel volume

X*- damping factor for QVO

Y*- damping factor for DAU

Z*- damping factor for AH, DAU, DFP, DLP, DPC, DPL, GFN, GPD, KCD, NOD, POA, POB, PPD, TVD, VID, VTC, VTL, VUD, VV6 (1.0)

Z1*- damping factor for VPD

Z3*- damping factor for VP

Z4*- time constant used to calculate non-muscle cell total cellular oxygen

Z5*- time constant used to calculate volume of oxygen in muscle cells

Z6*- damping factor for OVS

Z7*- damping factor for OSV

Z8*- time constant of autonomic response

Z10*- constant used to calculate effect of tissue hypoxia on salt and water intake

Z11*- constant used to calculate effect of tissue hypoxia on salt and water intake

Z12*- constant that converts exercise activity to autonomic stimulation

Z13*- constant used in calculating heart hypertrophy

The following is a list of all variables recently added to the long term model.

A* - sensitivity of suppressive effect of angiotensin on renin secretion

AKA* - damping factor involved in angiotensin production

AMS - short-term muscle autoregulatory effect (This was formerly called AMM.)

AM2 - intermediate-term muscle autoregulatory effect

ANAR* - sensitivity of angiotensin effect on afferent arteriolar resistance in the kidney

ANCN* - normal angiotensin concentration in plasma

ANER* - sensitivity of angiotensin effect on efferent arteriolar resistance in the kidney

ANGS - fractional suppression of renin secretion influenced by angiotensin concentration

ANGT* - time constant for attainment of angiotensin suppression of renin

ANK - angiotensin effect on tubular reabsorption

ANMM* - maximum effect of angiotensin

ANSS - steady-state fractional renin suppression caused by angiotensin

ANTC* - exponential parameter used to obtain angiotensin dose-response curve

AN2 - angiotensin II amount

AN3 - parameter used to obtain angiotensin dose-response curve

ATH* - sensitivity of angiotensin effect on thirst and salt intake

AUAB - autonomic response of aortic baroreceptors

AUCB - autonomic response of carotid baroreceptors

AUH1 - initial response of pressure effect on contractility

AUH2 - adapted response of contractility due to pressure

AUH3 - extent of adaptation of contractility response due to pressure

A5K* - time constant for intermediate-term muscle autoregulation

B* - sensitivity of suppressive effect of renal tubular sodium flow on renin secretion

CAA* - time constant for angiotensin destruction

CAB* - sensitivity of total baroreceptor effect on aortic baroreceptors

CAIV* - angiotensin infusion rate

CAS* - rate constant for angiotensin production from renin

CCB* - sensitivity of total baroreceptor effect on carotid baroreceptors

CRA* - time constant for renin destruction

DESC* - delay in renal response used during salt loading

GP1* - sensitivity of angiotensin effect on renal tubular reabsorption

KO* - controlled value for potassium excretion

NAO* - controlled value for sodium excretion

POF - sensitivity control for intermediate-term muscle autoregulatory loop

POU* - sensitivity of intermediate-term muscle autoregulation

RC - plasma renin concentration

RNA* - controlled intake rate of sodium

RNK* - damping factor involved in renin production

RNS - rate of renin secretion per gram of kidney

RSR - total rate of renin secretion for 300 grams of kidney

RT - total renin amount in plasma

RTR* - controlled infusion rate of water

SRL* - time constant for intermediate vascular stress relaxation

SRM* - time constant for long term vascular stress relaxation

SR1* - intensity factor for intermediate vascular stress relaxation

SR2* - intensity factor for long term vascular stress relaxation

UOC* - delay time constant for kidney during salt loading

VASO - unstressed volume of arterial compartment

VIL* - controlled insensible water loss rate

VINT* - controlled intake rate for water

VLAO - unstressed volume of pulmonary venous and left atrial compartment

VOB* - controlled urinary output rate

VOT - total body systemic unstressed volume

VOT1 - initial arterial pressure effect on whole-body unstressed volume

VOT2 - adapted arterial pressure effect on whole-body unstressed volume

VOT3 - extent of adaptation of arterial pressure effect on whole-body unstressed volume

VPAO - unstressed volume of pulmonary arterial compartment

VRAO - unstressed volume of right atrial compartment

VUGF - urinary flow due to filtration

VVSO - unstressed volume of venous compartment

V61 - rate of change of intermediate stress-relaxation effect

V62 - rate of change of long term stress-relaxation effect

V71 - increased vascular volume caused by intermediate stress relaxation

V72 - increased vascular volume caused by long term stress relaxation

X6* - weighting factor for short term vascular stress relaxation

X7* - weighting factor for intermediate-term vascular stress relaxation

X8* - weighting factor for long term vascular stress relaxation

APPENDIX B

INDEX OF VARIABLES AND INITIAL VALUES FOR CARDIOVASCULAR MODEL

TABLE 1

DEFINITIONS

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
1	X(1)	Stressed Vol., RT. Atrium	101.0	ml
2	X(2)	" " , RT. Ventricle	246.7	"
3	X(3)	" " , Left Atrium	43.3	"
4	X(4)	" " , Left Ventricle	244.6	"
5	X(5)	" " , Pulmonary Arteries	8.4	"
6	X(6)	" " , " Arterioles	11.7	"
7	X(7)	" " , " Venules	30.5	"
8	X(8)	" " , Aortic Arch	19.0	"
9	X(9)	Inertance Integral	0.0	-
10	X(10)	Integral of Aortic Arch Pressure/Beat	0.0	mmHg-sec
11	X(11)	Inertance Integral	0.0	-
12	X(12)	Stressed Vol., Thoracic Aorta	14.9	ml
13	X(13)	Integral of Carotid Pressure/Beat	0.0	mmHg-sec
14	X(14)	Stressed Vol., Abdominal Aorta	15.3	ml
15	X(15)	" " , Common Iliac Arteries	14.8	"
16	X(16)	" " , Legs Small Arteries	59.4	"
17	X(17)	" " , Legs Arterioles	4.0	"
18	X(18)	" " , Legs Venules	118.2	"
19	X(19)	" " , Legs Small Veins	200.0	"
20	X(20)	" " , Femoral Veins	42.0	"
21	X(21)	Total Vol., Abdominal Vena Cava	385.2	"
22	X(22)	Total Vol., Thoracic Vena Cava	274.4	"
23	X(23)	Total Vol., Superior Vena Cava	37.9	"
24	X(24)	Stressed Vol., Lower Carotid Arteries	8.75	"
25	X(25)	" " , Upper Carotid Arteries	29.0	"
26	X(26)	" " , Head Small Veins	74.8	"
27	X(27)	" " , Jugular Veins	3.6	"
28	X(28)	" " , Superior Mesenteric Veins	230.1	"
29	X(29)	Stressed Vol., Upper Thoracic Aorta	15.0	"
30	X(30)	Stressed Vol., Portal Veins	109.5	"
31	X(31)	" " , Renal Arteries	16.2	"
32	X(32)	" " , Renal Veins	47.3	"
33	X(33)	Integral of Left Vent. Flow/Beat	0.0	-
34	X(34)	Inertance Integral	0.0	-
35	X(35)	" "	0.0	-
36	X(36)	" "	0.0	-
37	X(37)	Integral of Upper Thoracic Aortic Pressure	0.0	mmHg-sec.
38	X(38)	Not Used	-	-
39	X(39)	"	-	-
40	X(40)	"	-	-

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
41	X(41)			
42	X(42)			
43	X(43)			
44	X(44)			
45	X(45)			
46	X(46)			
47	X(47)			
48	X(48)			
49	X(49)			
50	X(50)			
51 - 100				
101	QRA	Flow from RT. Atrium	Computed	ml/sec
102	QRV	" " RT. Ventricle	Variable	"
103	QLA	" " Left Atrium	"	"
104	QLV	" " " Ventricle	"	"
105	QPA	" " Pulmonary Arteries	"	"
106	QPC	" " Pulmonary Arterioles	"	"
107	QPV	" " " Venules	"	"
108	QAA	" " Aortic Arch	"	"
109		Not Used		
110		" "		
111	QUTA	Flow From Upper Thoracic Aorta	Computed	ml/sec
112	QLTA	Flow from Lower Thoracic Aorta	Variable	"
113		Not Used		
114	QLABA	Flow from Abdominal Aorta	"	"
115	QCILL	Flow from Common Iliac Arteries	"	"
116	QLGSA	" " Leg Small Arteries	"	"
117		Not Used		
118	QLGCAP	Flow from Leg Arterioles	"	"
119	QLGVE	" " Leg Venules	"	"
120	QLGSV	" " Leg Small Veins	"	"
121	QFEV	" " Femoral Veins	"	"
122	QABVC	" " Abdominal Vena Cava	"	"
123	QTHVC	" " Thoracic " "	"	"
124	QSPVC	" " Superior Vena Cava	"	"
125	QLOC	Flow to Lower Carotid Arteries	"	"
126	QUPC	" " Upper " "	"	"
127	QHCAP	" from Upper Carotid Arteries	"	"
128	QHSV	" from Head Small Veins	"	"
129	QJV	" from Jugular Veins	"	"
130	QCØR	Coronary Blood Flow	"	"

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
131	QCSMA	Flow to Superior Mesenteric Veins	Computed	ml/sec
132		Not Used	Variable	"
133	QCSMV	Flow from Superior Mesenteric Veins	"	"
134	QPØV	" " Portal Veins	"	"
135		Not Used	"	"
136	QRENA	Flow to Renal Arteries	"	"
137	QRALE	Flow from Renal Arteries	"	"
138	QRENV	" " Renal Vein	"	"
139	QRET	Flow to RT. Atrium	"	"
140	QD(1)	Long Term Flow Change in Renal Arteries	"	"
141		" " " " " Superior Mesenteric arteries	"	"
142		" " " " " Leg Arteries	"	"
143		Not Used		
144		Not Used		
145		Not Used		
146		Not Used		
147		Not Used		
148		Not Used		
149	QD(10)	Not Used		
150	QSKB	Flow Through Skeleton, Bone Marrow, and Fat	Computed Variable	ml/sec "
151	CRA	Compliance, Right Atrium	"	ml/mmHg
152	CRV	" , Right Ventricle	"	"
153	CLA	" , Left Atrium	"	"
154	CLV	" , Left Ventricle	"	"
155	CPA	" , Pulmonary Arteries	1.2	ml/mmHg
156	CPC	" " Arterioles	1.7	"
157	CPV	" " Venules	5.3	"
158	CAA	" , Aortic Arch	0.25	
159		Not Used		
160		Not Used		
161	CUTA	Upper Thoracic Aorta	0.2	
162	CLTA	Lower Thoracic Aorta	0.2	
163		Not Used		
164	CLABA	Abdominal Aorta	0.21	
165	CCILL	Compliance, Common Iliac Arteries	0.2	"
166	CLGSA	" , Leg Small Arteries	0.8	"
167	CLGAR	" , Leg Arterioles	0.3	"
168	CLGVE	" , Leg Venules	3.956	"
169	CLGSV	" , Leg Small Veins	3.14	"
170	CFEV	" , Leg Femoral Veins	0.6	"
171		Temporary Storage		
172		" "		
173		" "		
174	CLØC	Compliance, Lower Carotid Arteries	0.12	"
175	CUPC	" , Upper " "	0.3996	"
176	CHSV	" , Head Small Veins	5.3	"
177	CJV	" , Jugular Veins	0.9058	"
178	CCSMV	" , Superior Mesenteric Veins	9.59	"
179		Not Used		"
180	CPØV	" , Portal Veins	6.047	"

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
181	CRENA	Compliance, Renal Arteries	0.2224	"
182	CRENV	" , Renal Veins	2.517	"
183	CD(1)	Not Used		
184		"		
185		"		
186		"		
187		"		
188		"		
189		"		
190		"		
191		"		
192		"		
193		"		
194		"		
195		"		
196		"		
197		"		
198		"		
199		"		
200	CD(18)	"		

CALCULATED VARIABLES FOR EACH VOLUME COMPARTMENT

ELEMENT NO.	PRESSURE (mm Hg)			PRESSURE DUE TO GRAVITY		EXTERNAL PRESSURE		VOLUME COMPARTMENT
201	PRA	321	V(1)	421	PG(1)	455	PEXT(1)	RT. Atrium
202	PRV	322	V(2)	422	PG(2)	456	PEXT(2)	RT. Ventricle
203	PLA	323	V(3)	423	PG(3)	457	PEXT(3)	Left Atrium
204	PLV	324	V(4)	424	PG(4)	458	PEXT(4)	Left Ventricle
205	PPA	325	V(5)	425	PG(5)	459	PEXT(5)	Pulmonary Arteries
206	PPC	326	V(6)	426	PG(6)	460	PEXT(6)	Pulmonary Arterioles
207	PPV	327	V(7)	427	PG(7)	461	PEXT(7)	Pulmonary Veins
208	PAA	328	V(8)	428	PG(8)	462	PEXT(8)	Aortic Arch
209	Temporary Storage			429	PG(9)	463	PEXT(9)	
210	"	"		430	PG(10)	464	PEXT(10)	
211	PUTA	"		431	PG(11)	465	PEXT(11)	Upper Thor.Aorta
212	PLTA	332	V(12)	432	PG(12)	466	PEXT(12)	Lower Thor.Aorta
213	Temporary Storage			433	PG(13)	467	PEXT(13)	
214	PLABA	334	V(14)	434	PG(14)	468	PEXT(14)	Abdominal Aorta
215	PCILL	335	V(15)	435	PG(15)	469	PEXT(15)	Common Iliac Artery
216	PLGSA	336	V(16)	436	PG(16)	470	PEXT(16)	Leg Small Arteries
217	PLGAR	337	V(17)	437	PG(17)	471	PEXT(17)	Leg Arterioles
218	PLGVE	338	V(18)	438	PG(18)	472	PEXT(18)	Leg Veins
219	PLGSV	339	V(19)	439	PG(19)	473	PEXT(19)	Leg Small Veins
220	PFEV	340	V(20)	440	PG(20)	474	PEXT(20)	Femoral Veins
221	PABVC	341	V(21)	441	PG(21)	475	PEXT(21)	Abdominal Vena Cava
222	PTHVC	342	V(22)	442	PG(22)	476	PEXT(22)	Thoracic Vena Cava
223	PSPVC	343	V(23)	443	PG(23)	477	PEXT(23)	Superior Vena Cava
224	PLØC	344	V(24)	444	PG(24)	478	PEXT(24)	Lower Carotid Arteries
225	PUPC	345	V(25)	445	PG(25)	479	PEXT(25)	Upper Carotid Arteries
226	PHSV	346	V(26)	446	PG(26)	480	PEXT(26)	Head Small Veins
227	PJV	347	V(27)	447	PG(27)	481	PEXT(27)	Jugular Veins
228	PCSMV	348	V(28)	448	PG(28)	482	PEXT(28)	Superior Mesenteric Veins
229	Not Used	349	Not Used	449	Not Used	483	Not Used	
230	PPØV	350	V(30)	450	PG(30)	484	PEXT(30)	Portal Veins

CALCULATED VARIABLES FOR EACH VOLUME COMPARTMENT

ELEMENT NO.	PRESSURE (mm Hg)	TOTAL VOLUME (ml)	PRESSURE DUE TO GRAVITY	EXTERNAL PRESSURE	VOLUME COMPARTMENT
231	PRENA	351 V(31),	451 PG(31)	485 PEXT(31)	Renal Arteries
232	PRENV	352 V(32)	452 PG(32)	486 PEXT(32)	Renal Veins
233	PD(1) Mean Upper Thoracic Aortic Pressure				
234	Not Used		453 - 454 Not Used		
235	Not Used	353 - 368 Not Used			
236	" "	369 - V(49) Blood Volume Command = 5062.4 ml			
237	" "	370 - V(50) Total Blood Volume = 5062.4 ml			
238	" "				
239	" "				
240	" "				
241	" "				
242	" "				
243	" "				
244	" "				
245	" "				
246	" "				
247	" "				
248	" "				
249	PM Mean Arterial Pressure			90.0	mmHg
250	PMC Mean Carotid Arterial Pressure			90.0	mmHg

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
251	RRA	RT. Atrium Valve Resistance	0.007508	mmHg/ml/sec
252	RRV	RT. Ventricle Valve Resistance	0.007508	"
253	RMV	Left Atrium Valve	0.007508	"
254	RAV	Left Ventricle Valve	0.004	"
255	RPA	Pulmonary Arterioles	0.01502	"
256	RPC	Pulmonary Capillaries	0.05255	"
257	RPV	Pulmonary Venules	0.01502	"
258		Not Used		
259		Not Used		
260	RUTA	Upper Thoracic Aorta	0.012	
261	RLTA	Lower Thoracic Aorta	0.04	"
262		Not Used	0.0	
263	RLABA	Abdominal Aorta	0.034	"
264	RCILL	Common Iliac Arteries	0.034	"
265	RLGSA	Leg Small Arteries	0.03003	"
266	RLGAR	Leg Arterioles	4.505	"
267	RLGCAP	Leg Capillaries	0.4505	"
268	RLGVE	Leg Venules	0.07508	"
269	RLGSV	Leg Small Veins	0.07508	"
270	RFEV	Femoral Veins	0.02102	"

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
271	RABVC	Abdominal Vena Cava	0.007380	mmHg/ml/sec
272	RTHVC	Thoracic Vena Cava	0.007508	"
273	RSPVC	Superior Vena Cava	0.01502	"
274	RLØC	Lower Carotid Arteries	0.1	"
275	RUPC	Upper Carotid Arteries	0.03378	"
276	RHCAP	Head Capillaries	3.431	"
277	RHSV	Head Small Veins	0.3754	"
278	RJV	Jugular Veins	0.004302	"
279	RCØR	Coronary	15.390	"
280	RCSMA	Superior Mesenteric Arteries	2.35	"
281		Not Used		"
282	RCSMV	Superior Mesenteric Veins	0.2252	"
283	RPOV	Portal Veins	0.5255	"
284		Not Used		"
285	RRENA	Renal Arteries	0.01502	"
286	RRALE	Renal Arterioles	0.45045	"
287	RREFF	Efferent Arterioles	2.744	"
288	RRENV	Renal Veins	0.6494	"
289	RD(1)	Not Used		
290		" "		
291		Not Used		
292		" "		
293		" "		
294		" "		
295		" "		
296		" "		
297		" "		
298		" "		
299	RD(11)	" "		
300	RSKB	Skeleton and Fat	5.150	"
301	FLPA	Inertance, Pulmonary Arteries	0.0007508	$mmHg/ml/sec^2$
302	FLAA	" , Aortic Arch	0.002	"
303		Not Used		
304		" "		
305	FLUTA	Inertance, Upper Thoracic Aorta	0.004	
306	FLLTA	Inertance, Thoracic Aorta	0.004	"
307		Not Used		
308	FLLABA	Inertance, Abdominal Aorta	0.004	"
309		Not Used		"
310 - 320		Not Used		

UNSTRESSED VOLUMES

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
371	VU(1)	Rt. Atrium	30.0	ml
372	VU(2)	Rt. Ventricle	0.0	"
373	VU(3)	Left Atrium	30.0	"
374	VU(4)	Left Ventricle	0.0	"
375	VU(5)	Pulmonary Arteries	85.0	"
376	VU(6)	Pulmonary Arterioles	15.0	"
377	VU(7)	Pulmonary Veins	400.0	"
378	VU(8)	Aortic Arch	61.6	
379	VU(9)	Not Used		
380	VU(10)	" "		
381	VU(11)	" "		
382	VU(12)	Thoracic Aorta	90.5	
383	VU(13)	Not Used		
384	VU(14)	Abdominal Aorta	43.5	
385	VU(15)	Common Iliac Arteries	5.194	"
386	VU(16)	Leg Small Arteries	30.0	"
387	VU(17)	Leg Arterioles	30.0	"
388	VU(18)	Leg Venules	162.0	"
389	VU(19)	Leg Small Veins	188.0	"
390	VU(20)	Femoral Veins	40.0	"
391	VU(21)	Not Used		
392	VU(22)	" "		
393	VU(23)	" "		
394	VU(24)	Lower Carotid Arteries	50.0	"
395	VU(25)	Upper Carotid Arteries	50.0	"
396	VU(26)	Head Small Veins	509.0	"
397	VU(27)	Jugular Veins	28.0	"
398	VU(28)	Superior Mesenteric Veins	562.0	"
399	VU(29)	Not Used		"
400	VU(30)	Portal Veins	375.0	"
401	VU(31)	Renal Arteries	50.0	"
402	VU(32)	Renal Veins	150.0	"
403 - 420		Not Used		
487	E(1)	Right Atrial Elastance	Computed Variable	mmHg/ml
488	E(2)	Right Ventricle Elastance	" "	"
489	E(3)	Left Atrial Elastance	" "	"
490	E(4)	Left Ventricle Elastance	" "	"
491	PRN	Pressure Set Point	88.0	mmHg
492	ABIAS	Abdominal Vena Cava Compliance Curve Bias	2.55	-
493	TBIAS	Thoracic Vena Cava Compliance Curve Bias	3.6	-
494	TTHAZ	Tilt Down Time	9999.	-
495	TMODEL	Tilt Exp. Select	0.	
496	SPACE(1)	Not Used		
497	SPACE(2)	Press. at Exit Valves in Legs(lg)	2.5	mmHg
498	SPACE(3)	Effective Circulating Blood Volume	Computed Variable	ml
499	SPACE(4)	PTIS-Tissue Press. in Legs	2.0	mmHg
500	SPACE(5)	PGBIAS-Long Term Tissue Press.Bias	0.	mmHg

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
501	Z(1)	Length of Vascular Segment	0.0	cm
502	Z(2)	"	0.0	"
503	Z(3)	"	0.0	"
504	Z(4)	"	0.0	"
505	Z(5)	"	0.0	"
506	Z(6)	"	0.0	"
507	Z(7)	"	0.0	"
508	Z(8)	"	-7.0	"
509	Z(9)	"	0.0	"
510	Z(10)	"	0.0	"
511	Z(11)	"	0.0	"
512	Z(12)	"	10.0	"
513	Z(13)	"	10.0	"
514	Z(14)	"	16.0	"
515	Z(15)	"	6.0	"
516	Z(16)	"	16.0	"
517	Z(17)	"	0.0	"
518	Z(18)	"	0.0	"
519	Z(19)	"	16.0	"
520	Z(20)	"	14.0	"
521	Z(21)	"	14.0	"
522	Z(22)	"	2.0	"
523	Z(23)	"	-7.0	"
524	Z(24)	"	-14.0	"
525	Z(25)	"	0.0	"
526	Z(26)	"	0.0	"
527	Z(27)	"	-14.0	"
528	Z(28)	"	0.0	"
529	Z(29)	"	0.0	"
530	Z(30)	"	0.0	"
531	Z(31)	"	0.0	"
532	Z(32)	"	0.0	"
533	Z(33)	"	0.0	"
534	Z(34)	"	0.0	"
535	Z(35)	"	0.0	"
536	Z(36)	"	0.0	"
537	Z(37)	"	0.0	"
538	Z(38)	"	0.0	"
539	Z(39)	"	0.0	"
540	Z(40)	"	0.0	"
541	WK(1)	Time(Sec), LBNP Steps or Work	Protocol Section	
542	WK(2)	" "	"	
543	WK(3)	" "	"	
544	WK(4)	" "	"	
545	WK(5)	" "	"	
546	WK(6)	" "	"	
547	WK(7)	" "	"	
548	WK(8)	" "	"	
549	WK(9)	" "	"	
550	WK(10)	" "	"	

ELEMENT NO.	MNEMONIC	DEFINITION	CONSTANT OR INITIAL VALUE	UNITS
551	WK(11)	Time(Sec), LBNP or Work Steps	Protocol Section	
552	WK(12)	" "	"	
553	WK(13)	" "	"	
554	WK(14)	" "	"	
555	WK(15)	" "	"	
556	WK(16)	" "	"	
557	WK(17)	" "	"	
558	WK(18)	" "	"	
559	WK(19)	" "	"	
560	WK(20)	Finish Time	"	Sec.
561	HR	Heart Rate	Calculated	Beats/Min
562	SV	Stroke Volume	"	Liters
563	CO	Cardiac Output	"	Liters/Min
564	RT	Total Peripheral Resistance	"	mmHg/L/Min
565	PEX	Exercise Boolean (Floating)	0.0	
566	W	Work Rate	0.0	KPM/Min
567	PSYS	Systolic Blood Pressure	Calculated	mmHg
568	PDYS	Diastolic Blood Pressure	"	"
569	FREQ	Respiratory Frequency	"	Beats/Min
570	VO2DOT	Oxygen Uptake	"	Liters O_2/Min
571	AVD	Arterio-Venous O_2 Difference	"	Liters O_2 / Liters Blood
572	PIAB	Intra-Abdominal Pressure	"	mmHg
573	PITH	Intra-Thoracic Pressure	"	"
574	PMP	Leg Muscle Pump During Exercise	"	
575	THETA	Body Angle Relative to Horizontal		Degrees
576	SF	Constriction Strength Factor	0.48	-
577	TTOT	Heart Period	0.833	Sec.
578	TAS	Period of Systole	0.19	Sec.
579	TVS	Period of Diastole	0.36	Sec.
580	C1	Gain Constant	46.0	-
581	C2	Gain Constant	10.0	-
582	GNEW	Gain Constant	-0.015	-
583	PEXIN	Pressure Set Point	88.0	mmHg
584		Not Used	-	-
585 - 599		Not Used	-	-
600	VLEG	Total Leg Blood Volume	Calculated	ml

APPENDIX C

INDEX OF VARIABLES AND INITIAL VALUES FOR THERMOREGULATORY MODEL

THERMOREGULATORY - COMMON LOCATIONS

Location	Variable Name	Description	Constant or Initial Value	Units
1	QBASAL	Basal Metabolic Rate	283.	Btu/hr
2	UEFF	Efficiency of work performed	22.	%
3	TCAB	Temp. Cabin	75.	^{o}F
4	TW	Temp. Wall	75.	^{o}F
5	TDEWC	Dew Point Temp.	52.	^{o}F
6	VCAB	Ventilation Vel.	20.	Ft/sec
7	VEFF	Ventilation Eff.	100.	%
8	PCAB	Cabin Pressure	14.7	Psia
9	G	Gravity (Normal to earth)	1.	Nondimen-sional
10	CLOV	Clothing (effective thickness)	.1	
11	EUG	Emmissivity Clothing	.99	Nondimen-sional
12	CPG	c_p air	.22	Btu/lb ^{o}F
13	DT	Integration step size	.05	Min
14	PRINT1	Print interval	1.	Min
15	SET1	Run time	240.	Min
16	XIPOS	Position index	1.	1.=standing 2.=sitting 3.=supine
17-26	ACE(10)	Area for convective exchange		ft^2
27-36	ARE(10)	Area for radiative exchange		ft^2
37-77	C(41)	Weight-specific heat		$Btu/^{o}F$
78	CLO	Clothing effective thickness/conductivity		
79	DTIME	Integration Step	.00083	Hour

THERMOREGULATORY - COMMON LOCATIONS (Cont'd)

Location	Variable Name	Description	Constant or Initial Value	Units
80-89	EMAX(10)	Maximum evaporative loss		Btu/hr
90	PRINT	Print Step	0.	Hr
91	PRNOW	Print Step counter	0.	Hr
92	QEVAP	Evaporative heat loss	0.	Btu/hr
93	QLCG	Heat loss to LCG (Not used)	0.	Btu/hr
94-103	QRAD(10)	Radiative heat loss	0.	Btu/hr
104-108	QRSEN1-QRSEN6	Sensible heat loss from lungs	0.	Btu/hr
109-118	QSEN(10)	Skin sensible heat loss	0.	Btu/hr
119	QSHIV	Heat production-shivering	0.	Btu/hr
120	QSTOR	Heat stored	0.	Btu
121	RM	Metabolic rate	360.	Btu/hr
122	SETT	Run time		hr
123	SQUG	Sum. of losses from clothing		Btu/hr
124	STORAT	Rate of heat storage	0.	Btu/hr
125-167	T(43)	Temperature of body compartments		^{o}F
168	TIME	Time		Hr
169-209	TSET(41)	Point temperatures		^{o}F
210-219	TUG(10)	Temp. clothing surface		^{o}F
221	V	Useful work performed		Btu/hr
222	VPDEW	Vapor pressure @ cabin temp.		Psia
223	WORK	Heat produced by work		Btu/hr

APPENDIX D

INDEX OF VARIABLES AND INITIAL VALUES FOR RESPIRATORY MODEL

Card No.	Symbol (Col. 26-37)	Normal Initial Value (Col. 6-20)	Description
1	FA(CO2)	.0527	Alveolar gas fractions (dry), volumetric fraction of gas, dimensionaless
2	FA(O2)	.1514	
3	FA(N2)	.7959	
4	CB(CO2)	.6397	Concentration of gas in brain, liters (STPD)/liter brain.
5	CB(O2)	.0011	
6	CB(N2)	.0097	
7	CT(CO2)	.6132	Concentration of gas in tissue compartment. Liters (STPD)/liter tissue
8			
9			
10	Q	6.0000	Cardiac output blood flow, liters/min.
11	QB	.7370	Cerebral blood flow, liters/min.
12	PCSF(CO2)	47.8529	Partial pressure of gas in cerebrospinal fluid compartment, mmHg.
13	PCSF(O2)	36.0047	
14	PCSF(N2)	567.4731	
15	TMAX	30.0000	Length of computer run, min.
16	CENT SENS PT	0.0000	Central Sensitivity Partition. Weighting of the H+ concentration in CSF with that of venous blood in the brain. With C(16)=0, zero weight is given to venous blood at level of the brain and a weight of one is given to H+ concentration in CSF.

Card No.	Symbol	Normal Initial Value	Description
17	HB	.2000	Blood oxygen capacity, liters (STPD)/liter blood
18	R1	.1000	Time constants for cardiac output response (R1) and cerebral blood flow response (R2) for changes in blood chemical composition.
19	R2	.1000	
20	CNT SENS COF	1.1380	Controller sensitivity weightlings, i.e.,
21	CRTD BDY SCF		$V_I = 1.138C_{CSF(H^+)} + 1.1540$ $C_{a(H^+)}$ $(t-\tau_{ao})$ + TERM-$V_{I(N)}$ where τ_{ao} = Blood transport delay from lung to carotid body, V_I defined in C(37), and TERM = function of $F_{A(O2)}$.
22	KL	3.0000	Volumes of lung (alveoli), brain, and tissue compartments, liters.
23	KB	1.0000	
24	KT	39.0000	
25	MRB (CO2)	.0500	Metabolic rates by brain, liters (STPD)/min.
26	MRB (O2)	.0500	
27	D (CO2)	81.9900	Diffusion coefficient for gas across "blood-brain", liters $(10)^{-7}$ (STPD)/min per mmHg.
28	D (O2)	4.3610	
29	D (N2)	2.5240	
30	B	760.0000	Barometric pressure, mmHg.
31	FI (CO2)	.1000	Volumetric fraction of gas (dry inspired), dimensionless
32	FI (O2)	.1100	
33	FI (N2)	.7900	
34	KCSF	.1000	Volume of cerebrospinal fluid, liters
35	T	.0000	Initial time.
36	H	.0078125	Size of computer time step, min.

Card No.	Symbol	Normal Initial Value	Description
37	VI(N)	87.5500	Constant that is involved in the controller equation (See C(21)). Determines the normal level of Alveolar ventilation so that $P_{A(CO2)} \approx 40.0$ at rest, breathing air at sea level. When the controller sensitivity weightings are changed VI(N) should be altered accordingly.
38	VI (SS)	5.3900	Value used for normal resting alveolar ventilation. This is not used in the program if VI (N) is known.
39	PRINT AL TIM	0.50000	Output printed in these time increments. However, there is an over-riding statement that permits no increments greater than 0.5 min.
40	UNKNOWN	0.0000	Importance related to C (39), but doesn't seem to be of any real significance.
41	BHCO3 Blood	.5470	Standard bicarbonate content, liters CO_2 (STPD)/liter X, $37^{\circ}C$ where
42	BHCO3 Brain	.5850	
43	BHCO3 Tissue	.5850	
44	BHCO3 CSF	.5850	X = Blood, brain, tissue, CSF.
45	RMT(CO2)	.1820	Metabolic rates by tissue, liters (STPD)/min.
46	RMT(O2)	.2150	
47	DJ1	.0000	Used in performing Dejours experiment (Not utilized in present runs). Brief description of Dejours work relating O_2 and CO_2 threshold effects is given in Grödins' paper.
48	DJ2	.0000	

49th Card:

1-6	F6.2	WORK2	(work load)
7-9			Blank
10-15	F6.2	DURAT*	(run time for work load)

*if DURAT is less than TMAX (card 15) another work load card is read when print time exceeds DURAT.

APPENDIX E

EXAMPLE SIMULATION
ON
WHOLE-BODY ALGORITHM

```
>@XQT

  WHOLE-BODY ALGORITHM          061975 AT 080842
  REFER TO GE-AGS USER GUIDE TIR 741-MED-5009

     ◆◆◆ LONG TERM EXPERIMENT SIMULATION ◆◆◆


 WANT OUTPUT FILE (A4) Y,N...
>N
    397DATA RECORDS INPUT.
 INPUT NO.AND NAME FOR EXPERIMENT (I4,15A4)...
>       BED REST
 OUTPUT WANTED OR SAME,STOP (6A4)...
>VB  PBF BFN BFM HR
 INPUT WANTED CHGED.(A4,2X,F10.4) DONE= NO MORE CHGES...
 SYMB  VALUE...
>DONE
 TIME STEP (A4,1X,F6.0,F6.0)...
 UNIT PRINT TIME (UNIT=DAYS,HOUR,MINS,SECS,STEP)...
>DAYS 1.     1.
 EXEC PARAM.(A4) (MORE,RUN)...
>RUN
 INPUT 1.IF WANT TO CALL SHORT TERM MODELS
>1.
     0      BED REST

 DAY HR MN SE       VB          PBF         BFN         BFM         HR
   0  0  0  0     5.0624      1.1886      2.9884      2.1786     72.8625
   1  0  2  2     5.0620      1.1881      2.9866      2.1769     72.8531


     ◆◆◆ SHORT TERM EXPERIMENT SIMULATION ◆◆◆


 ENTER EXPERIMENT CODE: LBNP=1., TILT=2., TERG=3., THERMAL=4.,
                        RESPIRATORY=5.
>2.
    THE STORED PROTOCOL IS:
    TILT ANGLE    DURATION     RECOVERY
    (DEG)         (MIN)        (MIN)
      0.            1.
      70.0          2.0          2.0

 DO YOU WISH TO CHANGE PROTOCOL? (Y/N)
>N
 THE PRINT INTERVAL IS CURRENTLY  .50MINS
 IF YOU WISH TO CHANGE, ENTER NEW INTERVAL; OTHERWISE RETURN
>
 DO YOU WISH TO CHANGE INITIAL DATA?
>Y
 TO CHANGE INPUT ENTER MODEL NO. (CVS=1,THERM=2,RESP=3),INDEX,&VALUE
 (I1,1X,I4,F12.5)
>1    1 101.
>
 DO YOU WISH TO MODIFY THE OUTPUT LIST? (Y/N)
>Y
 ENTER LINE NO.,POSITION,INDEX,&NAME; CR WHEN COMPLETE
 (I1,1X,I1,1X,I4,1X,A6)
```

```
                CVI THERM   RESP
        LINE      1     2     3
    POSITION    2-9   1-9   1-9
       INDEX 1-600 1-223 1-1270
* * **** ******
1 8  575   TILT

DO YOU WISH TO CREATE AN OUTPUT FILE?
N
```

CARDIOVASCULAR MODEL

EECG	HR	CO	SV	VO2DOT	SYST	DIAS	TILT	LEGV
599	561	563	562	570	567	568	575	600
*****	*****	*****	*****	*****	*****	*****	*****	*****

THERMOREGULATORY MODEL

TSKN	TSBF	DEVAP	WORK	STORAT	SKTOR	SKHIV	TSKIN	SWEG
125	0	92	223	124	120	119	165	123
*****	*****	*****	*****	*****	*****	*****	*****	*****

RESPIRATORY MODEL

VI	VE	PA O2	PA CO2	CA H+	CSF H+	TVNT	AVO2D	FREQ
1265	1264	1200	1206	1256	1033	0	0	0
*****	*****	*****	*****	*****	*****	*****	*****	*****

.500	63.301	6.923	.109	.312	129.294	66.779	.000	563.492
98.589	8.584	48.393	52.088	-98.852	9.284	.000	98.360	385.547
5.715	5.644	106.237	37.983	43.784	37.642	7.233	45.157	11.845
1.000	63.250	6.930	.110	.309	128.828	66.350	.000	562.961
98.589	8.583	51.143	92.599	-61.868	9.267	.000	98.360	386.324
5.708	5.641	105.111	37.930	43.790	37.630	7.227	46.237	11.841
1.500	75.061	6.395	.085	.371	127.920	74.957	70.000	916.461
98.589	8.587	53.999	128.985	-29.139	9.455	.000	98.361	387.125
5.420	5.352	105.054	37.812	43.799	37.371	6.911	57.219	11.502
2.000	74.948	6.454	.086	.369	128.638	74.998	70.000	917.767
98.584	8.549	53.840	126.965	-30.944	9.839	.000	98.338	387.069
5.782	5.635	101.620	38.136	43.810	37.674	7.260	56.570	11.834
2.500	74.945	6.447	.086	.370	128.480	74.947	70.000	917.617
98.577	8.501	53.879	127.468	-30.494	10.225	.000	98.335	387.083
5.798	5.655	99.236	38.062	43.821	37.678	7.281	56.756	11.857
3.000	74.949	6.448	.086	.370	128.459	74.926	56.000	917.559
98.571	8.459	53.945	128.304	-29.751	10.614	.000	98.334	387.110
5.808	5.662	98.163	38.044	43.833	37.675	7.290	56.887	11.865
3.500	62.333	7.046	.113	.307	129.779	65.774	.000	557.202
98.569	8.439	49.293	66.775	-85.335	10.740	.000	98.356	385.817
6.080	5.918	96.347	38.139	43.844	37.899	7.579	44.443	12.156
4.000	62.855	7.109	.113	.316	131.136	66.931	.000	558.061
98.572	8.457	50.240	81.084	-72.260	10.725	.000	98.363	386.104
5.700	5.616	100.522	37.966	43.857	37.556	7.208	45.363	11.812
4.500	62.578	7.070	.113	.312	130.492	66.317	.000	557.443
98.575	8.478	49.795	74.957	-77.835	10.708	.000	98.363	385.996
5.768	5.682	102.195	37.912	43.867	37.605	7.282	45.107	11.888
5.000	62.698	7.091	.113	.312	130.836	66.491	.000	557.639
98.577	8.498	49.852	75.870	-77.011	10.682	.000	98.363	386.030
5.746	5.664	103.024	37.881	43.876	37.578	7.260	44.966	11.867

```
 OUTPUT WANTED OR SAME,STOP (6A4)...
>SAME
 INPUT WANTED CHGED.(A4,2X,F10.4) DONE= NO MORE CHGES...
 SYMB  VALUE...
>AUV   .3
 AUV        .3000
 SYMB  VALUE...
>AUL   1.
 AUL        1.0000
 SYMB  VALUE...
>DONE
 TIME STEP (A4,1X,F6.0,F6.0)...
 UNIT PRINT TIME (UNIT=DAYS,HOUR,MINS,SECS,STEP)...
>DAYS 1.    28.
 EXEC PARAM.(A4) (MORE,RUN)...
>RUN
 INPUT 1.IF WANT TO CALL SHORT TERM MODELS
>1.
    0      BED.REST

 DAY HR MN SE       VB          RBF        BFN        BFM         HR
 AT   1 DAY, 0 HR, 2 MIN, 2 SEC ... AUV  FROM      .0000 TO      .3000
 AT   1 DAY, 0 HR, 2 MIN, 2 SEC ... AUL  FROM      .0000 TO     1.0000
   2  0  0 42    4.7252     1.1233     2.8082     2.0516     73.3171
   3  0  1 16    4.7329     1.1217     2.8259     2.0575     73.5882
   4  0  0 16    4.7330     1.1242     2.8295     2.0598     74.0819
   5  0  2 25    4.7279     1.1209     2.8257     2.0563     74.4550
   6  0  1 15    4.7266     1.1221     2.8263     2.0575     74.9098
   7  0  0 44    4.7233     1.1205     2.8260     2.0566     75.3021
   8  0  0 32    4.7174     1.1159     2.8166     2.0501     75.6288
   9  0  3 38    4.7174     1.1186     2.8227     2.0543     76.1032
  10  0  1 45    4.7158     1.1190     2.8243     2.0557     76.5304
  11  0  0 22    4.7121     1.1173     2.8181     2.0518     76.9103
  12  0  1 36    4.7089     1.1158     2.8178     2.0509     77.2974
  13  0  0 40    4.7073     1.1162     2.8195     2.0523     77.7241
  14  0  0  9    4.7036     1.1145     2.8133     2.0484     78.1038
  15  0  2 12    4.7005     1.1131     2.8130     2.0476     78.4910
  16  0  0  1    4.6963     1.1105     2.8079     2.0439     78.8531
  17  0  2 12    4.6953     1.1119     2.8085     2.0451     79.2977
  18  0  0 45    4.6911     1.1093     2.8065     2.0433     79.6580
  19  0  0  9    4.6895     1.1097     2.8066     2.0431     80.0815
  20  0  0 43    4.6880     1.1102     2.8083     2.0444     80.5087
  21  0  1 31    4.6844     1.1086     2.8021     2.0406     80.8887
    0      BED REST

 DAY HR MN SE       VB          RBF        BFN        BFM         HR
  22  0  0 38    4.6803     1.1060     2.8002     2.0389     81.2492
  23  0  0 32    4.6787     1.1065     2.8004     2.0387     81.6730
  24  0  1 25    4.6773     1.1070     2.8021     2.0400     82.1003
  25  0  2 33    4.6737     1.1055     2.7959     2.0362     82.4804
  26  0  1 54    4.6696     1.1029     2.7941     2.0345     82.8411
  27  0  2  1    4.6681     1.1033     2.7942     2.0343     83.2649
  28  0  1 10    4.6640     1.1009     2.7893     2.0307     83.6276
  29  0  1 35    4.6599     1.0983     2.7837     2.0270     83.9869
```

```
    ◆◆◆ SHORT TERM EXPERIMENT SIMULATION ◆◆◆

ENTER EXPERIMENT CODE: LBNP=1., TILT=2., TERG=3., THERMAL=4.,
                       RESPIRATORY=5.
3.
  THE STORED PROTOCOL IS:
  EXERCISE        DURATION
  (WATTS)          (MIN)
      .0             2.000
    100.0            5.000
      .0             5.000
  END TIME=  12.0

DO YOU WISH TO CHANGE PROTOCOL? (Y/N)
Y
ENTER NEW PROTOCOL 2F12.6 (CR WHEN COMPLETE)
 EXERCISE      DURATION
 (WATTS)       (MIN)
0.             2.
>200.          5.

 THE PRINT INTERVAL IS CURRENTLY  .50MINS
 IF YOU WISH TO CHANGE, ENTER NEW INTERVAL; OTHERWISE RETURN

 DO YOU WISH TO CHANGE INITIAL DATA?
>N
 DO YOU WISH TO MODIFY THE OUTPUT LIST? (Y N)
 N
 DO YOU WISH TO CREATE AN OUTPUT FILE?
 N


          CARDIOVASCULAR MODEL
   SECT       HR       CO       SV   VO2DOT     SYST     DIAS     TILT     LEGV
    599      561      563      562      570      567      568      575      600
  ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆
          THERMOREGULATORY MODEL
   T(1)     TSBF    DEVAP     WORK   STORAT    QSTOR    QSHIV    T(41)    SDUG
    125        0       92      223      124      120      119      165      123
  ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆
          RESPIRATORY MODEL
     VI       VE    PA O2    PA CO2    CA H+   CSF H+     TVNT     AVO2D     FREQ
   1265     1264     1200     1206     1256     1033        0         0        0
  ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆    ◆◆◆◆◆

    .500  74.615   6.368    .086    .313 121.303  69.367    .000 124.741
  98.591   8.593  48.598  55.441 -95.759   9.289    .000  98.358 385.602
   5.698   5.594 104.448  38.225  43.781  37.630   7.194  44.533  11.786

   1.000  72.403   6.540    .090    .335 123.896  68.545    .000  14.880
  98.588   8.576  56.027 154.832  -5.882   9.317    .000  98.356 387.687
   6.025   5.965 104.460  37.844  43.781  37.914   7.580  45.321  12.209

   1.500 100.776   6.110    .061    .372 120.044  81.343  90.000 563.461
  98.590   8.587  53.783 126.242 -31.587   9.512    .000  98.416 387.047
   5.535   5.488 105.763  37.654  43.784  37.486   7.049  58.157  11.663

   2.000 101.353   6.023    .059    .377 119.917  82.072  90.000 540.869
  98.589   8.585  54.454 134.814 -23.833   9.879    .000  98.348 387.193
   5.676   5.542 103.543  38.025  43.783  37.609   7.152  58.637  11.726
```

```
CHANGE IN METABOLIC RATES      MPCO2=       .2816      MRO2=       .3200

CHANGE IN METABOLIC RATES      MPCO2=      1.1290      MRO2=      1.2830


 2.500 173.482  11.319    .065   1.312 107.670  67.937  90.000 447.841
98.500   8.050 115.870 917.109 679.576  14.029    .000  97.966 404.662
23.105  23.098 119.011  32.337  43.762  34.475  26.179 118.764  23.461
CHANGE IN METABOLIC RATES      MRCO2=      1.6329      MPO2=      1.8555


 3.000 200.000  12.931    .065   1.899 109.048  67.872  90.000 498.331
98.400   7.482 159.5431473.2311179.347  22.617    .000  98.007 417.341
32.468  31.731 106.155  32.646  43.686  34.588  36.071 147.607  26.648
CHANGE IN METABOLIC RATES      MRCO2=      2.0931      MPO2=      2.1959


 3.500 200.000  13.824    .069   2.239 115.387  69.947  90.000 512.824
98.278   6.894 184.5041791.0181464.881  33.670    .000  97.953 424.633
39.364  38.517 104.519  32.627  43.575  34.572  43.613 159.749  28.612
CHANGE IN METABOLIC RATES      MPCO2=      2.5161      MRO2=      2.3983


 4.000 200.000  14.939    .075   2.446 123.774  72.101  90.000 518.359
98.149   6.370 199.3551979.9481634.409  45.608    .000  97.825 429.184
47.224  46.395 106.806  32.556  43.443  34.543  52.205 158.431  30.467
CHANGE IN METABOLIC RATES      MPCO2=      2.8114      MRO2=      2.4580


 4.500 200.000  15.127    .076   2.507 128.675  75.317  90.000 524.776
98.027   5.930 204.1632040.8021688.480  58.362    .000  97.918 431.158
54.659  54.048 110.786  32.333  43.298  34.055  60.538 153.940  31.981
CHANGE IN METABOLIC RATES      MRCO2=      3.0439      MRO2=      2.5058


 5.000 200.000  15.398    .077   2.555 132.541  76.619  90.000 534.708
97.919   5.602 207.5212083.1361725.803  70.433    .000  97.882 432.813
60.199  59.857 114.227  32.032  43.140  33.846  66.810 157.220  32.974
CHANGE IN METABOLIC RATES      MRCO2=      3.2259      MRO2=      2.5439


 5.500 200.000  15.675    .078   2.593 134.524  77.330  90.000 530.463
97.835   5.364 210.3862119.1321757.247  83.924    .000  97.968 434.499
64.374  64.174 115.340  32.630  42.975  33.977  71.501 152.866  33.640
CHANGE IN METABOLIC RATES      MRCO2=      3.3681      MRO2=      2.5743


 6.000 200.000  16.059    .080   2.624 137.846  77.953  90.000 539.742
97.758   5.168 212.6092146.9021781.232  96.615    .000  98.034 436.061
67.513  67.457 116.182  33.029  42.811  34.348  75.075 154.216  34.114
CHANGE IN METABOLIC RATES      MRCO2=      3.4076      MPO2=      2.5986


 6.500 200.000  16.293    .081   2.648 139.427  78.593  90.000 534.729
97.703   5.040 214.3942169.0781800.118 110.034    .000  98.036 437.566
67.627  67.638 115.892  34.321  42.656  34.896  75.261 149.961  34.142
CHANGE IN METABOLIC RATES      MRCO2=      3.4386      MRO2=      2.6178


 7.000 200.000  16.737    .084   2.668 142.416  78.566  90.000 543.990
97.655   4.932 215.8372186.7851814.793 121.173    .000  98.141 439.155
 1.991   1.285 108.570  41.833  42.521  35.660   2.763 148.238   4.810
OUTPUT WANTED OR SAME,STOP (6A4)...
:STOP
```

APPENDIX F

PROGRAM LISTING

LISTING OF WHOLE BODY ALGORITHM

```
C
  SEG MAIN
  IN GUYTON
  IN PPPPPP
  IN TTYIOB
  IN SEGII
  IN    TOSHOR
  SEG GWORK*,(MAIN)
  IN GUYYY
  SEG NEWIO2*,(GWORK)
  IN TTYOUT
  SEG NEWIO*,GWORK
  IN TTYIN
  SEG OLDIO*,GWORK
  IN PUTIN
  IN PUTOUT
  SEG STM*,(MAIN)
  IN    TERG
  IN    EXEC
  IN    CVS
  IN    ALGO
  IN    BLKDAT
  IN    TRDAT
  IN NDAT
  IN    STATE
  IN    DELAYC
  IN    XIOD
  IN    Z
  IN    R
  IN    RINTR
  IN    TRINT
  SEG XERC*,(STM)
  IN    CONTRL
  IN    XIO
  SEG GROD*,(STM)
  IN    GRODIN
  SEG THERR*,(STM)
  IN    THERM
   *    LIBRARIES
  LIB   LEC*UR*
  LIB   MSC*LOCALIB*
  END
C
C       PROGRAM GUYTON
C       CIRCULATORY DYNAMICS - CIRCE
C               CIRCE1
        REAL NAE,NED,NID,NOD,I1,LPK,KID,MO2,NOZ,KCZ,HPL,HPR,I2,I3,MMO
        REAL LVM,I,IFP,KE,KOD,KIR,KI,LPD,KEI
        REAL KCD,KED,KN1,KN3,NAO,KIE,KO
        COMMON/TOSHOR/TTSHOR(20),FFSHOR(20)
        DATA FFSHOR(3)/.19908/
        DATA FFSHOR(2)/22.83/
        COMMON/ARRAY/T,I,VBD,VVS,VPA,VAS,VLA,VRA,VAE,PA,PAM,LVM,
       *             VRE,PRA,QRN,VPE,PPA,PPI,CPA,RPA,RVM,VLE,PLA,QLN,PLI,
       *             AIB,RPV,RPT,PGL,QPO,QS ,VVE,VVB,PVS,PGV,RVG,QVO,AVE
        COMMON/ARRAY/CN2,CN3,RVS,PGS,RTP,QAO,QRO,QLO,DVS,DPA,DAS,DLA,DRA,
       *             PAI,AUC,AUB,AUN,AU6,AU2,AU8,DAU,AUJ,AU ,AUO,AUH,VV4,
```

```
      LISTING OF WHOLE BODY ALGORITHM

     *              AU9,AUM,AU4,VIF,PO1,PTT,PTS,PIF,CPI,PTC,CPP,PPC,PVG
      COMMON/ARRAY/PC ,PCD,VTC,PLD,VTL,VTD,VPD,DPL,CPI,DPC,DPI,LPD,DLP,
     *              DPP,CHY,PRM,PGR,CPG,PGP,GFI,PGX,PGC,PGH,PG2,VGD,VG ,
     *              EPH,G50,GP2,GPD,AAR,RR ,RFN,APD,GLP,PFL,GFR,TRR,VUD
      COMMON/ARRAY/REK,NOD,NED,NAE,VEC,CKE,KOD,KEI,KIR,KIE,KCD,KED,CKI,
     *              CNA,CCD,VID,KE ,KI ,VIC,I1 ,VTY,Z  ,VTZ,VUZ,TVZ,PPZ,
     *              DFZ,X  ,I2 ,PRI,VTS,VP ,PRP,IFP,GPR,KN3,KN1,AMR,AMP
      COMMON/ARRAY/AM1,AMC,G51,AM3,AM5,AM ,CNE,AGK,ANP,AN1,ANC,G52,G53,
     *              AN5,ANM,VB ,HM1,HM ,B1 ,VIE,VIB,VIM,RC2,PO2,RKC,RC1,
     *              RCD,VRC,RSN,OVA,BFN,DOB,AOM,P10,OSV,POT,POD,POB,AR1
      COMMON/ARRAY/AR2,POC,AR3,ARM,CNB,GFN,AH7,AH8,AH ,AHC,AH1,AH2,AH4,
     *              AHM,CNY,CNX,VV1,VV2,VV5,VV6,VV7,TVD,VTW,HSR,HSL,NID,
     *              SR ,VVR,RAR,CV ,CN7,AUX,AUK,AUZ,Y  ,CFC,CPK,PCE,CPR
      COMMON/ARRAY/LPK,DPO,HYL,KID,AMT,ANT,POK,PON,A1K,A2K,A3K,CNR,CNZ,
     *              AHK,SRK,V9 ,V2D,Z1 ,Z2 ,Z3 ,Z4 ,Z5 ,Z6 ,Z7 ,Z8 ,HMK,
     *              HKM,POV,POZ,RDO,QO2,RBF,MO2,POA,POY,ANU,POR,GF2,HMD
      COMMON/ARRAY/DHM,POQ,I3 ,U  ,VPI,T1 ,GF3,GF4,AUP,AUV,RV1,AUY,OUT,
     *              DSP,AHZ,AHY,OSA,PPI,CPN,POS,PLF,PPO,PPN,PPD,PFI,DFP,
     *              VPF,PPR,PMC,PMS,PMP,HR ,CPF,PCP,DA1,DLZ,DPY,DPZ,GPZ
      COMMON/ARRAY/NOZ,KCZ,VIZ,HPR,HPL,STH,AL0,EXC,O2M,PA2,PP2,SVO,AUL,
     *              VV9,O2A,Q1 ,EXE,ARF,QRF,RSM,BFM,RAM,OVS,PVO,RMO,QOM,
     *              PMO,P20,MMO,PDO,POE,AMM,A4K,POM,OMM,PM1,PM3,PM4,EX1
      COMMON/ARRAY/Q2 ,Q3 ,PM5,PK1,Z9 ,Z10,Z11,Z12,Z13,Z14,Z15,Z16,PK2,
     *              PK3,FIS,STA,PAR,GBL,ANY,ANZ,ANX,ANV,ANW,ANR,AUQ,AUR,
     *              AUS,A378,H1 ,A2 ,A3 ,AUCB,AUAB,CCB,CAB,
     1AUH1,AUH2,AUH3,VOT1,VOT2,VOT3,VOT,RTR,VIL,VASO,VRAO,
     2VLAO,VVSO,VPAO,RNS,RSR,ANGS,B,RT,CRA,RNK,RC,CAIV,CAS,AN2,
     3AKA,ANCN,ANMM,AN3,ANTC,ANGSS,ANGT,A,ANAR,ANER,ANK,DESC,VUGF,
     4UOC,GP1,VOB,RNA,V61,SR1,V71,SRL,V62,SR2,V72,X6,X7,X8,
     5ATH,AMS,POF,POU,AM2,A5K,NAO,KO,CAA,SRM,VINT,VUS,
     6DUMMY(51),TITLE(500),DUMNY(40)
      COMMON/NUMERO/K,NO(20),NTIMEC,UNITS,NZ,NTIMEP,NN,MAXNO,NTIME
      COMMON/STORE/NG1,NG2,NG3,NG4,NG5,NG6,NG7,NG8,NG9,DT,TLP,TNP,ND,
     *              TM,TMM,NFIRST,ZZ(15),OLY(9),OBY(9),YMIN(10),YMAX(10),
     *              N,PT(18),BETA(10),NGRAPH(10),GRAPH(10),HEAD(19),NOEXP
     *              ,DTMAX
      COMMON/TAPE/TOTAL,IBGUY
      COMMON/DEMAND/ITAPEO,ITME,IEXECN,ICONVI,TNOUT,XX1
      DATA INOOO/'N   '/,IYOOO/'Y   '/,ISPOL/'RUN '/
C
C       WRITE(6,724)
C  724 FORMAT('1GUYTON MODEL FROM WHITE'/
C     1 ' REFER TO GE-ASG USER GUIDE ',
C     2 'TIR 741-MED-4004')
CC  SEE IF CONVERSATIONAL INPUT.
C    19 WRITE(6,20)
C    20 FORMAT('0CONVERSATIONAL INPUT (A4) Y,N...')
C       READ(5,21,ERR=19) ICONVI
    21  FORMAT(A4)
        IBGUY=13
C       IF(ICONVI .EQ. INOOO) GO TO 25
C       IF(ICONVI .NE. IYOOO .AND. ICONVI .NE. ISPOL) GO TO 19
CC  SEE IF TO OUTPUT TAPE.
CC
C    30 IF(ICONVI .EQ. IYOOO .OR. ICONVI .EQ. ISPOL) GO TO 40
CC  HERE IF NOT CONVERSATIONAL MODE.
C       WRITE(6,32)
```

LISTING OF WHOLE BODY ALGORITHM

```
C    32 FORMAT('0ADD DATA FILE...')
C       CALL PUTIN
C       GO TO 38
CC   HERE IF IN CONVERSATIONAL MODE.
C    40 WRITE(6,721)
C   721 FORMAT(' ADD DATA FILE(@ADD TTYDAT)...')
       ICONVI=IYOOO
       ITAPEO=INOOO
       CALL ERTRAN(9,MD,MT)
       WRITE (6,10) MD,MT
    10 FORMAT (/'    WHOLE-BODY ALGORITHM',10X,A6,' AT ',A6/
      * '    REFER TO GE-AGS USER GUIDE TIR 741-MED-5009'//
      &  5X,'*** LONG TERM EXPERIMENT SIMULATION ***'/)
    25 WRITE(6,26)
    26 FORMAT('0WANT OUTPUT FILE (A4) Y,N...')
       READ(5,21,ERR=25) ITAPEO
       IF(ITAPEO.NE.IYOOO.AND.ITAPEO.NE.INOOO) GO TO 25
       CALL ERTRAN(6,'@ADD .TTYDAT . ')
       CALL PUTIN
       IF(ITAPEO .EQ. INOOO) GO TO 31
       REWIND 7
       TNOUT = 500.
       WRITE(7) TNOUT,T,T,T
       XXI = T
       TNOUT = 0.
    31 CALL TTYIN
       ITME = 1
       CALL TTYOUT
C
    38 IF(I .GT. 0.5) I=0.5
   100 IF(ICONVI .EQ. IYOOO .OR. ICONVI .EQ. ISPOL) GO TO 50
       CALL PUTOUT
       GO TO 102
C   HERE IF CONVERSATIONAL MODE.
    50 IEXECN = 0
       ITME = 0
       CALL TTYOUT
       IF(IEXECN .EQ. 0) GO TO 102
C   HERE WHEN FINISHED ALL TIME STEPS INPUT.
       TTSHOR(1) = VB
       TTSHOR(2) = V71+V72
       TTSHOR(3)=RBF
       TTSHOR(4)=BFN
       TTSHOR(5)=BFM
       TTSHOR(6)=HM
       TTSHOR(7)=OSA
       TTSHOR(8)=T
       IF(AUL.LE.0.0)TTSHOR(8)=0.
       IF(DUMMY(50) .LT. 1.) GO TO 888
       CALL TERG
   888 CALL TTYIN
       ITME = 2
       CALL TTYOUT
   102 CALL GUYYY
       GO TO 100
       END
       SUBROUTINE PUTIN
```

LISTING OF WHOLE BODY ALGORITHM

```
C
      COMMON/ARRAY/A(500),TITLE(500),COL(20),ALPHA(20)
      COMMON/NUMERO/K,NO(20),NTIMEC,UNITS,NZ,NTIMEP,NN,MAXNO,NTIME
      COMMON/STORE/NG1,NG2,NG3,NG4,NG5,NG6,NG7,NG8,NG9,DT,TLP,TNP,ND,
     *             TM,TMM,NFIRST,ZZ(15),OLY(9),OBY(9),YMIN(10),YMAX(10),
     *             N,PT(18),BETA(10),NGRAPH(10),GRAPH(10),HEAD(19),NOEXP
     *             ,DTMAX
      COMMON/DEMAND/ITAPEO,ITME,IEXECN,ICONVI,TNOUT,XXI
      DATA INOOO/'N   '/
      DATA ALL/'ALL '/,BLANK/'    '/,SAME/'SAME'/
      DO 1 J=1,500
      A(J)=0.
    1 TITLE(J)=BLANK
      NZ=0
      NTIMEP=1
      NN=1
      MAXNO=1
      MIXX = 1
    2 READ(5,100) VALUE,NUMBRO,SYMBOL
  100 FORMAT       (E13.6,2X,I5,2X,A4)
      IF(MAXNO.LT.NUMBRO) MAXNO=NUMBRO
      IF(NUMBRO.EQ.0) GO TO 3
      A(NUMBRO)=VALUE
      TITLE(NUMBRO)=SYMBOL
      MIXX = MIXX + 1
      GO TO 2
    3 DSP=A(286)
      WRITE(6,731) MIXX
  731 FORMAT('0',I6,'DATA RECORDS INPUT.')
  579 WRITE(6,580)
  580 FORMAT(' INPUT NO.AND NAME FOR EXPERIMENT (I4,15A4)...')
      READ(5,101,ERR=579) NOEXP,(HEAD(J),J=1,15)
  101 FORMAT(I4,15A4)
C   GET OUT IF CONVERSATIONAL MODE.
      IF(ICONVI .NE. INOOO) GO TO 31
      IF(DSP) 37,38,37
   37 NFIRST=0.
      CONTINUE
C     IF(N-10) 201,38,201
   38 READ(5,200) (ALPHA(J),J=1,20)
  200 FORMAT       (20A4)
  201 IF(ALPHA(1).EQ.SAME) GO TO 32
      IF(ALPHA(1).NE.ALL) GO TO 4
      READ(5,300) NTIMEC,UNITS
      WRITE(6,102) NOEXP,(HEAD(J),J=1,18)
      WRITE(6,71) UNITS,(TITLE(J),A(J),J=1,MAXNO)
      GO TO 31
    4 DO 5 K=1,20
      IF(ALPHA(K).EQ.BLANK) GO TO 6
    5 CONTINUE
      K=21
    6 K=K-1
      DO 10 J=1,K
      L=1
    7 IF(ALPHA(J).EQ.TITLE(L)) GO TO 9
      L=L+1
      IF(L.LT.MAXNO+1) GO TO 7
```

LISTING OF WHOLE BODY ALGORITHM

```
C       WRITE(2,530) ALPHA(J)
C 530 FORMAT(/' THE VARIABLE ',A4,'IS NOT AVAILABLE TO THE PRINTER.'/
C     *         ' CHOOSE ANOTHER ONE TO TAKE ITS PLACE.'/
C     *         ' ABC ')
C       READ(2,531) ALPHA(J)
C 531 FORMAT(A4)
C       L=1
C       GO TO 7
      9 COL(J)=A(L)
        NO(J)=L
     10 CONTINUE
        GO TO 34
     32 DO 33 J=1,K
        ALPHA(J)=BETA(J)
        NO(J)=NGRAPH(J)
     33 COL(J)=GRAPH(J)
     34 READ(5,300) NTIMEC,UNITS
    300 FORMAT(I6,A4)
        WRITE(6,102) NOEXP,(HEAD(J),J=1,18)
    102 FORMAT(1H1,2X,'EXP ',I4/' ',18A4///)
        IF(ITAPEO .EQ. INOOO) GO TO 13
        CALL NTRAN(7,1,400,A,J)
   1234 IF (J.LT.0) GO TO 1234
     13 IF(K.GT.10) GO TO 70
        WRITE(6,21) UNITS, (ALPHA(J),J=1,K)
     21 FORMAT('0 ',A4,10(6X,A4,1X))
        WRITE(6,22) (COL(J),J=1,K)
     22 FORMAT(' ',5X,'0',2X,F10.4,9(1X,F10.4))
        GO TO 31
     70 WRITE(6,71) UNITS,(ALPHA(J),COL(J),J=1,K)
     71 FORMAT(60X,2HO ,A4//5(4X,A4,' = 'F10.4,4X))
     31 RETURN
        END
        SUBROUTINE PUTOUT
C
        COMMON/ARRAY/A(500),TITLE(500),COL(20),ALPHA(20)
        COMMON/NUMERO/K,NO(20),
       *              NTIMEC,UNITS,NZ,NTIMEP,NN,MAXNO,NTIME
        COMMON/STORE/NG1,NG2,NG3,NG4,NG5,NG6,NG7,NG8,NG9,DT,TLP,TNP,ND,
       *            TM,TMM,NFIRST,ZZ(15),OLY(9),OBY(9),YMIN(10),YMAX(10),
       *            N,PT(18),BETA(10),NGRAPH(10),GRAPH(10),HEAD(19),NOEXP
       *            ,DTMAX
        COMMON/TAPE/TOTAL
        COMMON/DEMAND/ITAPEO,ITME,IEXECN,ICONVI,TNOUT,XX1
        DATA INOOO/'N   '/
        DATA SECS/'SECS'/,TMIN/'MINS'/,HOUR/'HOUR'/,DAYS/'DAYS'/
        DATA ALL/'ALL '/,BLANK/'    '/
C       EQUIVALENCE(A(1),T)
        T=A(1)
      1 IF(UNITS.EQ.SECS) GO TO 2
        IF(UNITS.EQ.TMIN) GO TO 3
        IF(UNITS.EQ.HOUR) GO TO 4
        IF(UNITS.EQ.DAYS) GO TO 5
C       WRITE(2,501) UNITS
C 501 FORMAT(/' YOU CANNOT ASK FOR TIME UNITS OF ',A4,'.'/
C     *       44H TYPE @SECS@,@MINS@,@HOUR@, OR @DAYS@ BELOW /
C     *        ' UNIT')
```

LISTING OF WHOLE BODY ALGORITHM

```
C       READ(2,500) UNITS
C       GO TO 1
      2 NTIME=T*60.
        IF(NTIME.LT.NTIMEP) GO TO 65
        IF(NTIME.LT.(NZ+1)*60) GO TO 6
        NZ=NZ+1
        GROSSU=TMIN
        GO TO 6
      3 NTIME=T
        IF(NTIME.LT.NTIMEP) GO TO 65
        IF(NTIME.LT.(NZ+1)*60) GO TO 6
        NZ=NZ+1
        GROSSU=HOUR
        GO TO 6
      4 NTIME=T/60.
        IF(NTIME.LT.NTIMEP) GO TO 65
        IF(NTIME.LT.(NZ+1)*24) GO TO 6
        NZ=NZ+1
        GROSSU=DAYS
        GO TO 6
      5 NTIME=T/1440.
        IF(NTIME.LT.NTIMEP) GO TO 65
      6 IF(ALPHA(1).NE.ALL) GO TO 7
        WRITE(6,71) NTIME,UNITS,(TITLE(J),A(J),J=1,MAXNO)
        GO TO 51
      7 DO 20 I = 1,K
        II = NO(I)
        COL(I) = A(II)
     20 CONTINUE
        IF(ITAPEO .EQ. IN000) GO TO 34
        CALL NTRAN(7,1,400,A,J)
   1234 IF (J.LT.0) GO TO 1234
     34 IF(K-10) 75,75,70
     75 WRITE(6,31) NTIME,(COL(J),J=1,K)
     31 FORMAT(' ',I6,2X,F10.4,9(1X,F10.4))
        GO TO 51
     70 WRITE(6,71) NTIME,UNITS,(ALPHA(J),COL(J),J=1,K)
     71 FORMAT(///56X,I5,1X,A4//5(4X,A4,' = 'F10.4,4X))
   51   NTIMEP=NTIME+1
        IF(NZ.LT.NN) GO TO 53
        WRITE(6,52) NZ,GROSSU
     52 FORMAT(I4,1X,A4)
        NN=NZ+1
     53 IF(NTIME.LT.NTIMEC) GO TO 65
     54 READ(5,400) NTIMEC,CUNITS,SYMBOL,CVALUE
    400 FORMAT(I6,A4,A4,E13.6)
        IF(SYMBOL.EQ.CUNITS) GO TO 66
        IF(CUNITS.NE.BLANK) GO TO 59
C       I=.5
        IF(A(2).GT..5) A(2)=.5
C       DT=DTMAX/5.
C       TNP=T+DT
    450 DO 55 MN=1,MAXNO
        IF(SYMBOL.EQ.TITLE(MN)) GO TO 57
     55 CONTINUE
C       WRITE(2,56) SYMBOL
C    56 FORMAT(/' I DO NOT RECALL ',A4,'BEING READ IN WITH THE '/
```

LISTING OF WHOLE BODY ALGORITHM

```
C     *        ' INITIALIZING DECK.  TRY AGAIN TO CHANGE ITS VALUE '/
C     *        ' BY TYPING BELOW AS FOLLOWS,'/
C     *        ' ABC = XXX.XXX')
C      READ(2,500) SYMBOL,CVALUE
C 500 FORMAT(A4,1X,F8.3)
C      GO TO 450
   57 WRITE(6,58) NTIME,UNITS,SYMBOL,A(MN),CVALUE
   58 FORMAT(' ','AT'I5,1X,A4,
     1  1X,A4,' CHANGED FROM ',F10.3,' TO ',F10.3)
      A(MN)=CVALUE
      GO TO 54
   59 IF(K .GT. 10) GO TO 82
      WRITE(6,86) CUNITS,(ALPHA(J),J=1,K)
   86 FORMAT('0 ',A4,10(6X,A4,1X))
   82 IF(UNITS.EQ.CUNITS) GO TO 65
      IF(K .LE. 10) GO TO 83
      WRITE(6,60) UNITS,CUNITS
   60 FORMAT('  OUTPUT HAS BEEN CHANGED FROM 'A4,' TO ',
     *  A4,'.' )
   83 UNITS=CUNITS
      IF(UNITS.EQ.SECS) GO TO 61
      IF(UNITS.EQ.TMIN) GO TO 62
      IF(UNITS.EQ.HOUR) GO TO 63
      NTIMEP=T/1440.+1.
      NZ=T/1440.*7.
      GO TO 64
   61 NTIMEP=T*60.+1.
      NZ=T
      GO TO 64
   62 NTIMEP=T+1.
      NZ=T/60.
      GO TO 64
   63 NTIMEP=T/60.+1.
      NZ=T/1440.
   64 NN=NZ+1
   65 RETURN
   66 IF(ITAPEO .EQ. INOOO) GO TO 35
      CALL NTRAN(7,9)
   35 STOP
      END
      SUBROUTINE TTYIN
      COMMON/ARRAY/A(500),TITLE(500),COL(20),ALPHA(20)
      COMMON/NUMERO/K,NO(20),
     1  NTIMEC,UNITS,NZ,NTIMEP,NN,MAXNO,NTIME
      COMMON/TTYIOB/VCHGS(200,2),JTSTEP(100,5),PLOTPT,PLOTTM
      COMMON/PPPPPP/PLOTBF(101,6),RUNSTP,IEXECI,IPLTPT
     1  ,TLOTBF(101),KSTOPP
      COMMON/DEMAND/ITAPEO,ITME,IEXECN,ICONVI,TNOUT,XX1
      DATA STOP/'STOP'/,IPLL/'PLOT'/
      DATA BLANK/'    '/,DONE/'DONE'/
      DATA IISTEP/'STEP'/,INOOO/'N   '/
      DATA SAMEE/'SAME'/
      DATA JMORE/'MORE'/,JRUN/'RUN '/
      DIMENSION ITSYM(4), ALPHA2(6)
      DATA ITSYM/'SECS','MINS','HOUR','DAYS'/
      DIMENSION TDELTA(4)
      DATA TDELTA/.01666667,1.,60.,1440./
```

```
      LISTING OF WHOLE BODY ALGORITHM

        DATA ZRO/'0    '/,PLSSS/'+    '/,EXPPP/'E    '/
        TDELTA(1) = 1. / 60.
        RUNSTP = 0.
        PLOTTM = A(1)
        IPLTPT = 1
C
C
        MAXNO = 500
C
C  READ INPUT VARIABLES WANTED.
    20  WRITE(6,21)
    21  FORMAT(' OUTPUT WANTED OR SAME,STOP (6A4)...')
        READ(5,22,ERR=20) (ALPHA2(J),J=1,6)
    22  FORMAT(6A4)
        IF(ALPHA2(1) .NE. STOP) GO TO 100
        IF(A(500) .LE. 0.) GO TO 501
C   OUTPUT FILE OF FINAL DATA....
        DO 520 I = 1,500
        IF(I .EQ. 1 .OR. I .EQ. 278 .OR. I .EQ.500)A(I) = 0.
        IF(I .EQ. 500)GO TO 512
        IF(A(I) .EQ. 0. .AND. TITLE(I).EQ.BLANK)GO TO 520
   512  WRITE(8,510) A(I),I,TITLE(I)
   510  FORMAT(E13.6,2X,I5,2X,A4)
        BACKSPACE 8
        READ(8,511) (ALPHA(J),J=1,13)
   511  FORMAT(13A1)
        IF(ALPHA(12) .NE. BLANK) GO TO 524
C   HERE IF 0 DATA.
        ALPHA(12) = ZRO
        ALPHA(13) = ZRO
   524  IF(ALPHA(11) .EQ. PLSSS) ALPHA(11) = BLANK
        BACKSPACE 8
        WRITE(8,513) (ALPHA(J),J=2,10),EXPPP,
       1   (ALPHA(J),J=11,13),I,TITLE(I)
   513  FORMAT(13A1,2X,I5,2X,A4)
   520  CONTINUE
        I = 0
        WRITE(8,522) I
   522  FORMAT(15X,I5)
        END FILE 8
        WRITE(6,533)
   533  FORMAT(' STEADY STATE FILE CLOSED.')
   501  IF(ITAPEO .EQ. INOOO) STOP
        END FILE 7
   107  WRITE(6,101)
   101  FORMAT(' OUTPUT FILE CLOSED. NORMAL EXIT.')
        STOP
   100  IF(ALPHA2(1) .EQ. SAMEE .AND. ITME .NE. 1) GO TO 160
        K = 0
        DO 25 J = 1,6
        IF(ALPHA2(J) .EQ. BLANK) GO TO 27
        K = J
    25  CONTINUE
    27  IF(K .EQ. 0 ) GO TO 20
        IF(K .GT. 6) K = 6
        DO 35 I = 1,K
        DO 34 J = 1,MAXNO
```

LISTING OF WHOLE BODY ALGORITHM

```
      J1 = J
      IF(ALPHA2(I) .EQ. TITLE(J)) GO TO 31
   34 CONTINUE
C  HERE IF AN OUTPUT SYMBOL BAD.
      WRITE(6,29) ALPHA2(I)
   29 FORMAT(' SYMBOL ',A4,' WRONG. TRY AGAIN.')
      GO TO 20
C  HERE IF A GOOD SYMBOL.
   31 NO(I) = J1
      ALPHA(I) = ALPHA2(I)
   35 CONTINUE
C
C
C
  160 ISTEP = 1
      IVC = 1
C
C  START OF INPUT FOR A TIME STEP.
C
C  READ ANY CHGS.WANTED.
   39 IIVC = 0
      IF(ICONVI .EQ. JRUN) GO TO 301
      WRITE(6,40)
   40 FORMAT(' INPUT WANTED CHGED.(A4,2X,F10.4)',
     1 ' DONE= NO MORE CHGES...')
   42 WRITE(6,41)
   41 FORMAT(' SYMB   VALUE...')
  301 READ(5,43,ERR=42) SYMBOL,CVALUE
   43 FORMAT(A4,2X,F10.4)
      IF(SYMBOL .EQ. DONE) GO TO 50
      IF(SYMBOL .EQ. BLANK) GO TO 42
      DO 45 I = 1,MAXNO
      II = I
      IF(SYMBOL .EQ. TITLE(I)) GO TO 46
   45 CONTINUE
C  HERE WHEN A SYMBOL NOT RECOGNIZED.
      WRITE(6,49)
   49 FORMAT(' SYMBOL NOT RECOGNIZED. TRY AGAIN.')
  303 IF(ICONVI .EQ. JRUN) GO TO 301
      GO TO 42
C
   46 VCHGS(IVC,1) = II
      VCHGS(IVC,2) = CVALUE
      IF(ICONVI .EQ. JRUN) GO TO 302
      WRITE(6,150) SYMBOL,CVALUE
  150 FORMAT(' ',A4,2X,F10.4)
  302 IF(IVC .LT. 200) GO TO 47
      WRITE(6,48)
   48 FORMAT(' BUFFER FOR CHGS.FULL.')
      GO TO 50
   47 IVC =IVC + 1
      IIVC = IIVC + 1
      GO TO 303
C
C
C  READ TIME STEP CARD.
   50 IF(ICONVI .EQ. JRUN) GO TO 304
```

LISTING OF WHOLE BODY ALGORITHM

```
  313 WRITE(6,55)
   55 FORMAT(' TIME STEP (A4,1X,F6.0,F6.0)...'/
     1 ' UNIT PRINT TIME (UNIT=DAYS,HOUR,MINS,SECS,STEP)...')
  304 READ(5,56,ERR=50) IUNITS,XP,XZ
   56 FORMAT(A4,1X,2F6.0)
      I = XZ
      I2 = XP
      IF(IUNITS .NE. IISTEP) GO TO 200
C    WILL CALCULATE AND OUTPUT RUN STEP.
      CALL TIMPRT(PLOTTM,ID1,IH1,IM1,IS1)
      TT = PLOTTM + RUNSTP
      CALL TIMPRT(TT,ID2,IH2,IM2,IS2)
      CALL TIMPRT(RUNSTP,ID3,IH3,IM3,IS3)
      WRITE(6,108) ID1,IH1,IM1,IS1,ID2,IH2,IM2,
     1 IS2,ID3,IH3,IM3,IS3
  108 FORMAT(' RUNSTEP ',7('.'),' BEGIN',
     1 13X,7('.'),' END',8X,7('.'),' INTERVAL'/
     2 ' ',I3,'DAY',I3,'HR',I3,'MN',I3,'SE',
     3 2(3X,I3,'DAY',I3,'HR',I3,'MN',I3,'SE'))
  200 DO 58 II = 1,4
      ITSY = II
      IF(IUNITS .EQ. ITSYM(II)) GO TO 62
   58 CONTINUE
C    HERE WHEN ERROR IN TIME UNIT.
      GO TO 313
C
   62 IF(I .LE. 0) GO TO 50
      IF(I2 .LE. 0) GO TO 50
      JTSTEP(ISTEP,1) = I
      JTSTEP(ISTEP,2) = ITSY
      JTSTEP(ISTEP,3) = IIVC
      JTSTEP(ISTEP,5) = I2
C  RUNSTEP = MINS FOR RUN STEP.
      RUNSTP = RUNSTP + (FLOAT(I)*TDELTA(ITSY))
      PLOTPT = RUNSTP / 100.
C
C
C  READ EXEC PARAMETER.
      IF(ICONVI .EQ. JRUN) GO TO 73
   69 WRITE(6,70)
   70 FORMAT(' EXEC PARAM.(A4) (MORE,RUN)...')
   73 READ(5,72,ERR=69) IEXECI
   72 FORMAT(A4)
      IF(IEXECI .EQ. JMORE) GO TO 80
      IF(IEXECI .EQ. JRUN) GO TO 80
      IF(IEXECI .EQ. IPLL) GO TO 80
      WRITE(6,75)
   75 FORMAT(' DO NOT RECOGNIZE EXEC PAR. TRY AGAIN.')
      GO TO 73
C
   80 JTSTEP(ISTEP,4) = IEXECI
      IF(IEXECI .EQ. JMORE) GO TO 900
  631 WRITE(6,629)
  629 FORMAT(' INPUT 1.IF WANT TO CALL SHORT TERM MODELS')
      READ(5,630,ERR=631) A(499)
  630 FORMAT(F12.0)
      GO TO 90
```

LISTING OF WHOLE BODY ALGORITHM

```
C
  900 ISTEP = ISTEP + 1
      IF(ISTEP .LE. 100) GO TO 39
C
      WRITE(6,85)
   85 FORMAT(' BUFFER FULL FOR TIME STEPS.')
      JTSTEP(50,4) = JRUN
   90 RETURN
      END
      SUBROUTINE TTYOUT
      COMMON/ARRAY/A(500),TITLE(500),COL(20),ALPHA(20)
      COMMON/NUMERO/K,NO(20),
     1  NTIMEC,UNITS,NZ,NTIMEP,NN,MAXNO,NTIME
      COMMON/TTYIOB/VCHGS(200,2),JTSTEP(100,5),PLOTPT,PLOTTM
      COMMON/DEMAND/ITAPEO,ITME,IEXECN,ICONVI,TNOUT,XX1
      COMMON/PPPPPP/PLOTBF(101,6),RUNSTP,IEXECI,IPLTPT
     1  ,TLOTBF(101),KSTOPP
      COMMON/STORE/JUNK(118),HEAD(19),NOEXP
      COMMON/SEG11/TIMEC,TIMEP,ISTEP,IVC,ITSY
      DATA IN000/'N   '/
      DATA JMORE/'MORE'/,JRUN/'RUN '/
      DATA IPLL/'PLOT'/
      DIMENSION TDELTA(4)
      DATA TDELTA/.01666667,1.,60.,1440./
C
C
      KSTOPP = 0
      TDELTA(1) = 1./60.
      T = A(1)
C  SEE IF TIME TO BUFFER VARIABLES TO PLOT.
      IF(T .GE. TIMEC .AND. JTSTEP(ISTEP,4)
     1  .EQ. JRUN) GO TO 71
      IF(T .GE. TIMEC .AND. JTSTEP(ISTEP,4)
     1  .EQ. IPLL) GO TO 71
      IF(PLOTTM .GT. T) GO TO 80
   71 IF(IPLTPT .GT. 101) IPLTPT = 101
      IF(ITAPEO .EQ. IN000) GO TO 72
      WRITE(7) (A(I),I=1,500)
      TNOUT = TNOUT + 1.
   72 TLOTBF(IPLTPT) = T
      DO 81 I = 1,K
      J = NO(I)
      PLOTBF(IPLTPT,I) = A(J)
   81 CONTINUE
      IPLTPT = IPLTPT + 1
      PLOTTM = PLOTTM + PLOTPT
      IF(IEXECI .NE. IPLL) GO TO 80
C  SEE IF THIS ROUTINE CALLED JUST AFTER INPUTTING.
   80 IF(ITME .EQ. 0) GO TO 100
      ISTEP = 1
      IVC = 1
      IF(IEXECI .EQ. IPLL) GO TO 200
      WRITE(6,361) NOEXP,(HEAD(J),J=1,15)
      WRITE(6,211) (ALPHA(J),J=1,K)
      IPAG = 2
      GO TO 200
C
```

LISTING OF WHOLE BODY ALGORITHM

```
C  HERE AFTER A LOOP THROU MODEL.
  100 IF(IEXECI .EQ. IPLL) GO TO 35
C     SEE IF TIME TO PRINT.
      IF(T .LT. TIMEP) RETURN
C
C  OUTPUT VARIABLES.
C
C   COMPUTE TIME.
      CALL TIMPRT(T,ID1,IH1,IM1,IS1)
C  BUILD OUTPUT IN COL(5).
   11 DO 15 I = 1,K
      J = NO(I)
      COL(I) = A(J)
   15 CONTINUE
C
      ASSIGN 17 TO LBACKK
      GO TO 310
   17 WRITE(6,18) ID1,IH1,IM1,IS1,(COL(J),J=1,K)
   18 FORMAT(' ',4I3,5F10.4,F9.3)
C
C
C  COMPUTE NEXT TIME TO PRINT.
   30 I = (T / TDELTA(ITSY)) + JTSTEP(ISTEP,5)
      TIMEP = I * TDELTA(ITSY)
C
C  SEE IF END OF TIME STEP.
   35 IF(T .LT. TIMEC) RETURN
C
C
C  HERE WHEN FINISHED A TIME STEP.
      IF(JTSTEP(ISTEP,4) .EQ. JMORE) GO TO 50
C
C  HERE WHEN FINISHED RUN STEP.
      KSTOPP = 1
      IF(IEXECI .EQ. IPLL) GO TO 360
C  GO TO ROUTINE TO PLOT.
  360 CONTINUE
C
C
C  HERE WHEN NEED TO GO BACK TO TTYIN TO GET NEW TIME STEPS.
      IEXECN = 1
      RETURN
C
C
C  HERE WHEN NEXT TIME STEP IS IN JTSTEP(50,4), AND
C  CHGS.FOR SAME IN VCHGS(200,2). EXEC PARAM.IS MORE.
   50 ISTEP = ISTEP + 1
C
C  COMPUTE TIME.
  200 CALL TIMPRT(T,ID1,IH1,IM1,IS1)
C  SEE IF ANY CHGS.ASSOCIATED WITH THIS TIME STEP.
  201 IF(JTSTEP(ISTEP,3) .EQ. 0) GO TO 210
      IF(A(2) .GT. .5) A(2) = .5
      II = VCHGS(IVC,1)
      IF(IEXECI .EQ. IPLL) GO TO 408
      ASSIGN 205 TO LBACKK
      GO TO 310
```

```
      LISTING OF WHOLE BODY ALGORITHM

  205 WRITE(6,206) IDI,IHI,IMI,ISI,TITLE(II),A(II),VCHGS(IVC,2)
  206 FORMAT(' AT ',I3,' DAY,',I2,' HR,',I2,
     1  ' MIN,',I2,' SEC',
     2  ' ... ',A4,' FROM',F10.4,' TO',F10.4)
  408 A(II) = VCHGS(IVC,2)
      IVC = IVC + 1
      JTSTEP(ISTEP,3) = JTSTEP(ISTEP,3) - 1
      GO TO 201
C
C
C
C  PUT MAX.TIME FOR TIME STEP IN TIMEC.
  210 ITSY = JTSTEP(ISTEP,2)
      I = (T/TDELTA(ITSY)) + JTSTEP(ISTEP,1)
      TIMEC = I * TDELTA(ITSY)
      IF(IEXECI .EQ. IPLL) GO TO 35
C
C  OUTPUT IF THIS 1ST TIME TTYOUT CALLED.
      IF(ITME .EQ. 1) GO TO 11
C
C  PUT NEXT TIME TO PRINT IN TIMEP.
      GO TO 30
C
C  ROUTINE TO ASK FOR HARD COPY EVERY 25 LINES,ERASE PAGE,OUT HEADING.
  310 IF(IPLTPT .EQ. JRUN) GO TO 332
      IPAG = IPAG + 1
      IF(IPAG .LT. 25) GO TO 332
      WRITE(6,361) NOEXP,(HEAD(J),J=1,15)
  361 FORMAT(' ',I4,2X,15A4)
      WRITE(6,211) (ALPHA(J),J=1,K)
  211 FORMAT('0DAY HR MN SE',6(6X,A4))
      IPAG = 2
  332 GO TO LBACKK(17,205,360)
      END
      SUBROUTINE GUYYY
C
C     PROGRAM GUYTON
C     CIRCULATORY DYNAMICS - CIRCE
C           CIRCE1
      REAL NAE,NED,NID,NOD,I1,LPK,KID,MO2,NOZ,KCZ,HPL,HPR,I2,I3,MMO
      REAL LVM,I,IFP,KE,KOD,KIR,KI,LPD,KE1
      REAL KCD,KED,KN1,KN3,NAO,KIE,KO
      DIMENSION FUN1(14),FUN2(14),FUN3(14),FUN4(14),FUN6(14),FUN7(14)
      COMMON/TOSHOR/TTSHOR(20),FFSHOR(20)
      COMMON/ARRAY/T,I,VBD,VVS,VPA,VAS,VLA,VRA,VAE,PA,PAM,LVM,
     *             VRE,PRA,QRN,VPE,PPA,PP1,CPA,RPA,RVM,VLE,PLA,QLN,PLI,
     *             AIB,RPV,RPT,PGL,QPO,Q5 ,VVE,VV8,PVS,PGV,RVG,QVO,AVE
      COMMON/ARRAY/CN2,CN3,RVS,PGS,RTP,QAO,QRO,QLO,DVS,DPA,DAS,DLA,DRA,
     *             PAI,AUC,AUB,AUN,AU6,AU2,AU8,DAU,AUJ,AU ,AUO,AUH,VV4,
     *             AU9,AUM,AU4,VIF,PO1,PTT,PTS,PIF,CPI,PTC,CPP,PPC,PVG
      COMMON/ARRAY/PC ,PCD,VTC,PLD,VTL,VTD,VPD,DPL,CPI,DPC,DPI,LPD,DLP,
     *             DPP,CHY,PRM,PGR,CPG,PGP,GF1,PGX,PGC,PGH,PG2,VGD,VG ,
     *             EPH,G50,GP2,GPD,AAR,RR ,RFN,APD,GLP,PFL,GFR,TRR,VUD
      COMMON/ARRAY/REK,NOD,NED,NAE,VEC,CKE,KOD,KE1,KIR,KIE,KCD,KED,CKI,
     *             CNA,CCD,VID,KE ,KI ,VIC,I1 ,VTY,Z  ,VTZ,VUZ,TVZ,PPZ,
     *             DFZ,X  ,I2 ,PRI,VTS,VP ,PRP,IFP,GPR,KN3,KN1,AMR,AMP
      COMMON/ARRAY/AM1,AMC,G51,AM3,AM5,AM ,CNE,AGK,ANP,AN1,ANC,G52,G53,
```

LISTING OF WHOLE BODY ALGORITHM

```
*              ANS,ANM,VB ,HM1,HM ,B1 ,VIE,VIB,VIM,RC2,PO2,RKC,RC1,
*              RCD,VRC,RSN,OVA,BFN,DOB,AOM,P10,OSV,POT,POD,POB,AR1
 COMMON/ARRAY/AR2,POC,AR3,ARM,CNB,GFN,AH7,AH8,AH ,AHC,AH1,AH2,AH4,
*              AHM,CNY,CNX,VV1,VV2,VV5,VV6,VV7,TVD,VTW,HSR,HSL,NID,
*              SR ,VVR,RAR,CV ,CN7,AUX,AUK,AUZ,Y  ,CFC,CPK,PCE,CPR
 COMMON/ARRAY/LPK,DPO,HYL,KID,AMT,ANT,POK,PON,A1K,A2K,A3K,CNR,CNZ,
*              AHK,SRK,V9 ,V2D,Z1 ,Z2 ,Z3 ,Z4 ,Z5 ,Z6 ,Z7 ,Z8 ,HMK,
*              HKM,POV,POZ,RDO,QO2,RBF,MO2,POA,POY,ANU,POR,GF2,HMD
 COMMON/ARRAY/DHM,POQ,I3 ,U  ,VP1,T1 ,GF3,GF4,AUP,AUV,RV1,AUY,OUT,
*              DSP,AHZ,AHY,OSA,PP1,CPN,POS,PLF,PPO,PPN,PPD,PF1,DFP,
*              VPF,PPR,PMC,PMS,PMP,HR ,CPF,PCP,DA1,DLZ,DPY,DPZ,GPZ
 COMMON/ARRAY/NOZ,KCZ,VIZ,HPR,HPL,STH,ALO,EXC,O2M,PA2,PP2,SVO,AUL,
*              VV9,O2A,Q1 ,EXE,ARF,QRF,RSM,BFM,RAM,OVS,PVO,RMO,QOM,
*              PMO,P2O,MMO,PDO,POE,AMM,A4K,POM,OMM,PM1,PM3,PM4,EX1
 COMMON/ARRAY/Q2 ,Q3 ,PMS,PK1,Z9 ,Z10,Z11,Z12,Z13,Z14,Z15,Z16,PK2,
*              PK3,FIS,STA,PAR,GBL,ANY,ANZ,ANX,ANV,ANW,ANR,AUQ,AUR,
*              AUS,A378,H1 ,A2 ,A3 ,AUCB,AUAB,CCB,CAB,
1AUH1,AUH2,AUH3,VOT1,VOT2,VOT3,VOT,RTR,VIL,VASO,VRAO,
2VLAO,VVSO,VPAO,RNS,RSR,ANGS,B,RT,CRA,RNK,RC,CAIV,CAS,AN2,
3AKA,ANCN,ANMM,AN3,ANTC,ANGSS,ANGT,A,ANAR,ANER,ANK,DESC,VUGF,
4UOC,GP1,VOB,RNA,V61,SR1,V71,SRL,V62,SR2,V72,X6,X7,X8,
5ATH,AMS,POF,POU,AM2,A5K,NAO,KO,CAA,SRM,VINT,VUS,
6DUMMY(51),TITLE(500),DUMNY(40)
 COMMON/NUMERO/K,NO(20),NTIMEC,UNITS,NZ,NTIMEP,NN,MAXNO,NTIME
 COMMON/STORE/NG1,NG2,NG3,NG4,NG5,NG6,NG7,NG8,NG9,DT,TLP,TNP,ND,
*              TM,TMM,NFIRST,ZZ(15),OLY(9),OBY(9),YMIN(10),YMAX(10),
*              N,PT(18),BETA(10),NGRAPH(10),GRAPH(10),HEAD(19),NOEXP
*              ,DTMAX
 COMMON/TAPE/TOTAL
 DATA FUN1(1),FUN1(2),FUN1(3),FUN1(4),FUN1(5),FUN1(6),FUN1(7),
*FUN1(8),FUN1(9),FUN1(10),FUN1(11),FUN1(12)/
1 0.,1.,60.,1.,125.,1.,160.,1.,240.,1.,300.,0./
 DATA FUN2(1),FUN2(2),FUN2(3),FUN2(4),FUN2(5),FUN2(6),FUN2(7),
*FUN2(8),FUN2(9),FUN2(10),FUN2(11),FUN2(12),FUN2(13),FUN2(14)/
*-100.,0.0,-6.,0.0,-3.,.75,-1.,2.6,2.,9.8,8.,13.5,1000.,13.5/
 DATA FUN3(1),FUN3(2),FUN3(3),FUN3(4),FUN3(5),FUN3(6),FUN3(7),
*FUN3(8),FUN3(9),FUN3(10),FUN3(11),FUN3(12),FUN3(13),FUN3(14)/
*0.0,1.06,20.,.97,24.,.93,30.,.8,38.,.46,45.,0.,45.,0./
 DATA FUN4(1),FUN4(2),FUN4(3),FUN4(4),FUN4(5),FUN4(6),FUN4(7),
*FUN4(8),FUN4(9),FUN4(10),FUN4(11),FUN4(12),FUN4(13),FUN4(14)/
*-100.,0.,-4.,0.,-1.,3.6,3.,9.4,6.,11.6,10.,13.5,1000.,13.5/
 DATA FUN6(1),FUN6(2),FUN6(3),FUN6(4),FUN6(5),FUN6(6),FUN6(7),
*FUN6(8),FUN6(9),FUN6(10),FUN6(11),FUN6(12),FUN6(13),FUN6(14)/
*-100.,10000.,0.,70.,.4,9.3,.8,3.3,1.2,1.3,1.6,.43,100.,0./
 DATA FUN7(1),FUN7(2),FUN7(3),FUN7(4),FUN7(5),FUN7(6),FUN7(7),
*FUN7(8),FUN7(9),FUN7(10),FUN7(11),FUN7(12),FUN7(13),FUN7(14)/
*0.,7.,30.,6.25,60.,3.,100.,1.,160.,.15,400.,.05,400.,.05/
 DIMENSION FUN8(14),FUN9(14),FUN10(14),FUN11(14),FUN12(14)
 DATA FUN8/0.,0.01,53.,50.,68.,42.,83.,25.,100.,0.71,125.,
1 0.,300.,0./
 DATA FUN9/0.,.06,75.,.05,100.,0.,125.,-.1,150.,-.32,175.,-.35,
1 300.,-.35/
 DATA FUN10/0.,0.,75.,0.,100.,0.,125.,-.04,150.,-.12,
1 200.,-.23,300.,-.23/
 DATA FUN11/0.,1.36,60.,1.2,100.,1.,140.,.8,
1 180.,.65,250.,.5,300.,.48/
 DATA FUN12/0.,3.87,50.,3.91,75.,4.12,100.,4.25,125.,
```

```
      LISTING OF WHOLE BODY ALGORITHM

      1 4,9,150.,5,11,300.,5,23/
       COMMON/DEMAND/ITAPEO,ITME,IEXECN,ICONVI,TNOUT,XX1
       DATA INOOO/'N   '/,IYOOO/'Y   '/,ISPOL/'RUN '/
C
  102 T=T+I2
C
C  SUBROUTINE HEMO
C
C    CIRCULATORY DYNAMICS BLOCK
C   HEMODYNAMICS
C
       VBD=VP+VRC-VVS-VAS-VLA-VPA-VRA
       VVS=VVS+DVS*I2+VBD*.3986
       VPA=VPA+DPA*I2+VBD*.155
       VAS=VAS+DAS*I2+VBD*.261
       VLA=VLA+DLA*I2+VBD*.128
       VRA=VRA+DRA*I2+VBD*.0574
       VASO = .116 * ANV
       VAE = VAS - VASO
       PA=VAE/.00355
       IF(PA.LT.0.) PA=.0001
       PAM=100./PA
       PA2=PA/AUH
       CALL FUNCTN(PA2,LVM,FUN1)
       VRAO = .0235 * ANV
       VRE = VRA - VRAO
       PRA=VRE/.005
       CALL FUNCTN(PRA,QRN,FUN2)
       VPAO = .072 * ANV
       VPE = VPA - VPAO
       PPA=VPE/.0048
       PP1=.026*PPA
       IF(PP1.LT.0.) PP1=10.**(-12)
       RPA=PP1**(-.5)
       PP2=PPA/AUH
       IF(PP2.LE.0.) PP2=.0001
       CALL FUNCTN(PP2,RVM,FUN3)
       VLAO = .0941 * ANV
       VLE = VLA - VLAO
       PLA=VLE/.01
       CALL FUNCTN(PLA,QLN,FUN4)
       RPV=1./(PLA+20.)/.0357
       RPT=RPV+RPA
       PGL=PPA-PLA
       QPO=PGL/RPT
       ANU=ANM
       IF (ANU.LT..6)ANU=.6
       VVE = VVS -.694*ANV-(ANU-1.)*ANV
       VVSO = .694*ANV+(ANU-1.)*ANV+VVT
       VV8 = VVS-VVSO
       IF(VV8.LT..0001)VV8=.0001
       PVS=VV8/CV
       VUS = VASO+VRAO+VPAO+VLAO+VVSO
       PRI=PRA
       IF (PRA.LT.0.)PRI=0.
       RVG=2.738/PVS
       QVO=(PVS-PRI)/RVG
```

LISTING OF WHOLE BODY ALGORITHM

```
      CN3=CN3+(((PC-17.)*CN7+17.)*CN2-CN3)*.1
      AVE=(AUM-1.)*AUY+1.
      RVS=AVE*(1./CN3)*VIM*((ANU-1.)*ANZ+1.)
      PGS=PA-PVS
      RSN=RAR*ARM*ANU*AUM*PAM*VIM+RVS*1.79
      BFN=PGS/RSN
      RSM=ANU*VIM*PAM*AUM*AMM*RAM
      BFM=PGS/RSM
      DSBF=(FFSHOR(2)-22.83)*0.007962
      QAO=BFN+BFM+RBF+DSBF+(PA-PRA)*FIS
      QLO=LVM*QLN*AUH*HSL*HMD*HPL
      QRO=QRN*((1.-QRF)*AUH*RVM*HSR*HMD*HPR+QRF*QLO/QLN)
      QPO=QLO+(QPO-QLO)/U
      QVO=QRO+(QVO-QRO)/X
      DVS=QAO-QVO
      DPA=QRO-QPO
      DAS=QLO-QAO
      DLA=QPO-QLO
      DRA=QVO-QRO
C
C  SUBROUTINE AUTO
C
C     AUTONOMIC CONTROL BLOCK
C
  120 EXE=(8.-P20)*EX1+(EXC-1.)*Z12
      POQ=POT
      IF (POQ.GT.8.)POQ=8.
      IF (POQ.LT.4.)POQ=4.
      PA1=PA*POQ/8.-EXE
      AUC=0.
      IF(PA1.LT.80.)AUC=.03*(80.-PA1)
      IF(PA1.LT.40.)AUC=1.2
      CALL FUNCTN(PA1,AUCB,FUN9)
      CALL FUNCTN(PA1,AUAB,FUN10)
      A1B = 1.+CCB*AUCB+CAB*AUAB
  124 AUN=0
      IF(PA1.LT.50.)AUN=.2*(50.-PA1)
      IF(PA1.LT.20.)AUN=6.0
      AU6=A1B-AU4
      AU8=AUK*(AU6-1.)
      DAU=DAU+(AUC+AU6+AUN-DAU)/Z/Y
      AUJ=AUJ+(DAU-AUJ)*12*6./Z8
      IF(AUJ.LT.0.)AUJ=0.
      IF(AUJ-1.)126,127,127
  126 AU=AUJ**AUZ
      GO TO 128
  127 AU=(AUJ-1.)*AUZ+1.
  128 IF(STA.GT..00001)AU=STA
      AUO=AU-1.
      AUP=AUO*AUQ+1.
      CALL FUNCTN(PA1,AUH1,FUN11)
      AUH2 = AUH1-AUH3
      AUH = AUH+(AUH2-AUH)*12*6./Z8
      IF(STA .GT. .00001)AUH=STA
      AUR=AUO*AUS+1.
      CALL FUNCTN(PA1,VOT1,FUN12)
      VOT2 = VOT1 - VOT3
```

LISTING OF WHOLE BODY ALGORITHM

```
      VOT = VOT+(VOT2-VOT)*12*6./Z8
      IF(STA .GT. .00001) VOT = 4.25
      ANV = VOT - AUV
      AUM=.15+.85*AUP
C
C
      IF(I3.LE.I2)GO TO 168
      IF(ABS(DAU-AUJ).GT.DAI) RETURN
  110 IF (ABS(QAO-QLO).GT..2)RETURN
      IF (ABS(QAO-QPO).GT..2)RETURN
      IF (ABS(QAO-QRO).GT..4)RETURN
C
C  SUBROUTINE HORMON
C
C*****************************************************************************
C
C     ALDOSTERONE CONTROL BLOCK
C
C*****************************************************************************
  168 AMR=CKE/CNA/A3-A2
      IF(AMR.LT.0.)AMR=0.
      CALL FUNCTN (PA,AMP,FUN7)
      AMI=AMI+(ANM*AMP*AMR-AMI)/Z
      AMC=AMC+(AMI-AMC)*(1.-EXP(-I/AMT))
      AM=20.039-19.8*EXP(-.039*AMC)
C*****************************************************************************
C
C     ANGIOTENSIN CONTROL BLOCK
C
C*****************************************************************************
      CNE=152.-CNA
      IF(CNE.LT.1.)CNE=1%
      CALL FUNCTN(PAR,RNS,FUN8)
      RSR = 300.*REK*RNS*(1.-ANGS-B*(GFR*CNA-17.75))
      IF(RSR .LT. 0.) RSR=0.
      RT = RT+(RSR-CRA*RT)*(1.-EXP(-I/RNK))
      RC = RT/VP
      AN1 = CAIV +CAS*RC
      AN2=AN2+(AN1-CAA*AN2)*(1.-EXP(-I/AKA))
      ANC = AN2/VP/ANCN
      ANM = ANMM-AN3*EXP(-ANC/ANTC)
      IF(ANM .LT. .5)ANM=.5
      ANSS = A*(ANC-1.)
      ANGS = ANGS+(ANSS-ANGS)*I/ANGT
C
C  SUBROUTINE BLOOD
C
C     RED CELLS AND VISCOSITY BLOCK
C-----------------------------------------------------------------------------
C     BLOOD VISCOSITY
C-----------------------------------------------------------------------------
 170  VB=VP+VRC
      HM=100.*VRC/VB
      VIE=HM/(HMK-HM)/HKM
      VIB=VIE+1.5
      VIM=.3333*VIB
C-----------------------------------------------------------------------------
```

LISTING OF WHOLE BODY ALGORITHM

```
C     RED BLOOD CELLS
C-----------------------------------------------------------------------
      RC2=RKC*VRC
      PO2=PO1-POT
      IF(PO2.LT..2375)PO2=.2375
      RC1=POY*PO2
      RCD=RC1-RC2
      VRC=VRC+RCD*I
C
C SUBROUTINE MUSCLE
C
C     MUSCLE BLOOD FLOW CONTROL AND PO2 BLOCK
C
  180 OSA=AL0-VPF*.5
      OVA=OSA*HM*5.
C     INPUT FROM SHORT TERM
      OVA=OVA*FFSHOR(3)/0.19908
      OVS=OVS+((BFM*OVA-RM0)/HM/5./BFM-OVS)/Z6
      PV0=57.14*OVS
      RM0=(PV0-PM0)*PM5/(PM1**PK3-PM4)
      Q0M=Q0M+(RM0-MM0)*(1.-EXP(-I/Z5))
      PM0=PK2/(PK1-Q0M)
      PM1=PM0
      IF(PM1.LT.PM3)PM1=PM3
      P20=PM0
      IF(P20.GT.8.)P20=8.
      A0M=(AUP-1.)*02A+1.
      MM0=A0M*0MM*EXC*(1.-(8.0001-P20)**3./512.)
      PD0=PV0-40.
      P0E=P0M*PD0+1.
      IF(P0E.LT..005)P0E=.005
      AMS=AMS+(P0E-AMS)*(1.-EXP(-I/A4K))
      POF = 1. + POU+PD0
      AM2 = AM2+(POF-AM2)*I/A5K
      AMM = AMS*AM2
C
C  SUBROUTINE AUTORG
C
C     NON-MUSCLE OXYGEN DELIVERY BLOCK
C     AND NON-MUSCLE LOCAL BLOOD FLOW CONTROL BLOCK
C-----------------------------------------------------------------------
C     AUTOREGULATION,RAPID
C-----------------------------------------------------------------------
      OSV=OSV+((BFN*OVA-DOB)/HM/5./BFN-OSV)/Z7
      POV=OSV*57.14
      RDO=POT**3.
      IF(RDO.LT.50.)RDO=50.
      DOB=(POV-POT)*2896.5/RDO
      M02=A0M*02M*(1.-(8.0001-P10)**3./512.)
      Q02=Q02+(DOB-M02)*(1.-EXP(-I/Z4))
      POT=Q02*.00333
      P10=POT
      IF(POT.GT.8.)P10=8.
      POD=POV-POR
      POB=POB+(POK*POD+1.-POB)/Z
      IF(POB.LT..2)POB=.2
      AR1=AR1+(POB-AR1)*(1.-EXP(-I/A1K))
```

LISTING OF WHOLE BODY ALGORITHM

```
      ARM=AR1*AR2*AR3
C-----------------------------------------------------------------------
C     AUTOREGULATION, INTERMEDIATE
C-----------------------------------------------------------------------
      POA=POA+(PON*POD+1.-POA)/Z
      IF (POA.LT..5)POA=.5
      AR2=AR2+(POA-AR2)*(1.-EXP(-I/A2K))
C-----------------------------------------------------------------------
C     AUTOREGULATION, LONG-TERM
C-----------------------------------------------------------------------
      IF(POD)194,192,192
  192 POC=POZ*POD+1.
      GO TO 196
  194 POC=POZ*POD*.33+1.
  196 IF (POC.LT..3)POC=.3
      AR3=AR3+(POC-AR3)*I/A3K
C
C  SUBROUTINE ADH
C
C     ANTIDIURETIC HORMONE
C
      CNB=CNA-CNR
      AHZ=.2*PRA
      AHY=AHY+(AHZ-AHY)*.0007*I
      AH8=AUP-1.
      IF(AH8.LT.0.)AH8=0.
      IF(CNB.LT.0.)CNB=0.
      AH=AH+(CNZ*CNB+AH8-AHZ+AHY-AH)/Z
      IF(AH.LT.0.)AH=0.
      AHC=AHC+(.3333*AH-AHC)*(1.-EXP(-I/AHK))
      AHM=6.*(1.-EXP(-0.1808*AHC))
      IF(AHM.LT..3)AHM=.3
C
C  SUBROUTINE MISC1
C
C*********************************************************************
C
C     VASCULAR STRESS RELAXATION BLOCK
C
C*********************************************************************
      VV6=VV6+(SR*(VVE-V9  )-VV7-VV6)/Z
      VV7=VV7+VV6*(1.-EXP(-I/SRK))
      V61 = V61+(SR1*(VVE-V9)-V61-V71)/Z
      V71 = V71+V61*(1.-EXP(-I/SRL))
      V62 = SR2*(VVE-V9)-V72
      V72 = V72+V62*I/SRM
      VVT = X6*VV7+X7*V71+X8*V72
C*********************************************************************
C
C     THIRST AND DRINKING BLOCK
C*********************************************************************
C
      TVZ=(.01*AHM-.009)*STH
      TVD=TVD+(TVZ-TVD)/Z
      IF(TVD.LT.0.)TVD=0.
      IF(VINT .GT. .00001) TVD=VINT
      VTW=VIC+VEC
```

LISTING OF WHOLE BODY ALGORITHM

```
C*****************************************************************************
C
C     AUTONOMIC CONTROL BLOCK
C     ADAPTATION OF BARORECEPTORS
C
C*****************************************************************************
       AU4=AU4+AUB*I
       AUH3 = AUH3+(AUH2-1.)*I*AUK
       VOT3 = VOT3+(VOT2-4.25)*I*AUK
C
C  SUBROUTINE HEART
C
C     HEART HYPERTROPHY OR DETERIORATION BLOCK
C
C-----------------------------------------------------------------------------
C     HEART VICIOUS CYCLE
C-----------------------------------------------------------------------------
       DHM=(POT-6.)*.0025
       HMD=HMD+DHM*I
       IF (HMD.GT.1.)HMD=1.
C-----------------------------------------------------------------------------
C     MEAN CIRCULATORY PRESSURES
C-----------------------------------------------------------------------------
       PMC=(VAE+VVE+VRE+VPE+VLE)/.11
       PMS=(VAE+VVE+VRE)/.09375
       PMP=(VPE+VLE)/.01625
C*****************************************************************************
C
C     HEART RATE AND STROKE VOLUME BLOCK AND TOTAL PERIPHERAL RESISTANCE
C
C*****************************************************************************
       HR=(32.+H1 *AUR+PRA*2.)*((HMD-1.)*.5+1.)
       IF(AUL.GT.0.0001)GO TO 210
       GO TO 220
  210 HR=HR+(0.4/1440.)*T
  220 CONTINUE
       RTP=(PA-PRA)/QAO
       SVO=QLO/HR
C
C  SUBROUTINE CAPMBD
C
C     CAPILLARY MEMBRANE DYNAMICS BLOCK
C
  130  PTT=(VTS/12.)**2.
       VIF=VTS-VG
       CALL FUNCTN (VIF,PTS,FUN6)
       PIF=PTT-PTS
       CPI=IFP/VIF
       PTC=.25*CPI
       CPP=PRP/VP
       PPC=.4*CPP
       PVG=RVS*1.79*BFN
       PC=PVG+PVS
       PCD=PC+PTC-PPC-PIF
       VTC=VTC+(CFC*PCD-VTC)/Z
       PLD=7.8+PIF-PTT
       VTL=VTL+(.004*PLD-VTL)/Z
```

```
      LISTING OF WHOLE BODY ALGORITHM

       IF(VTL.LT.0.)VTL=0.
       VTD=VTC-VTL-VID
       VTS=VTS+VTD*I
C      INPUT FROM SHORT TERM
       VIL=FFSHOR(1)/1000./60.
       VPD=VPD+(TVD-VTC+VTL-VUD-DFP-VPD+RTR-VIL)/Z1
       VP = VP + VPD*I/Z3
C
       I=I*1.2+T-T1
       I1=ABS(VP1/VPD/I)
       IF(I1.LT.I) I=I1
       IF(I3+T-T1.LT.I) I=I3+T-T1
       T=I+T1
       T1=T
C
C
  200 CONTINUE
C
C  SUBROUTINE PULMON
C
C    PULMONARY DYNAMICS AND FLUIDS BLOCK
C
C
       PCP=.45*PPA+.55*PLA
       PPI=2.-.150/VPF
       CPN=PPR/VPF
       POS=CPN*.4
       PLF=(PPI+11.)**.0003
       PPO=PLF*CPN
       PPN=(CPP-CPN)**.000225
       PPD=PPD+(PPN-PPO-PPD)/Z
       IF(PPR+PPD*I-.025.LT.0.)PPD=(.025-PPR)/I
       PFI=(PCP-PPI+POS-PPC)*CPF
       DFP=DFP+(PFI-PLF-DFP)/Z
       IF(VPF+DFP*I-.001.LT.0.)DFP=(.001-VPF)/I
       VPF=VPF+DFP*I
       PPR=PPR+PPD*I
C
C  SUBROUTINE MISC2
C
C*****************************************************************************
C
C    HEART HYPERTROPHY OR DETERIORATION BLOCK
C
C*****************************************************************************
       HPL=HPL+(((PA/100./HSL)**Z13)-HPL)*I/57600.
       HPR=HPR+(((PPA/15./HSR)**Z13)-HPR)*I/57600.
C*****************************************************************************
C
C    TISSUE EFFECT ON THIRST AND SALT INTAKE
C
C*****************************************************************************
       STH=(Z10-POT)*Z11*(1.+ATH*(ANG-1.))
       IF(STH.LT.1.)STH=1.
       IF(STH.GT.8.)STH=8.
C
C  SUBROUTINE PROTEN
```

```
      LISTING OF WHOLE BODY ALGORITHM

C
C     TISSUE FLUIDS,PRESSURES AND GEL BLOCK
C
C-----------------------------------------------------------------------
C     PLASMA AND TISSUE FLUID PROTEIN
C-----------------------------------------------------------------------
  135 DPL=DPL+(VTL*CPI-DPL)/Z
      IF (PC.LT.0.)PC=0.
      DPC=DPC+(CPK*(CPP-CPI)*PC**PCE-DPC)/Z
      DPI=DPC-DPL
      DLZ=LPK*(CPR-CPP)
      IF(CPP.GT.CPR)DLZ=4.*DLZ
      DLP=DLP+(DLZ-DLP)/Z
      PRP=PRP+(DLP-DPO+DPL-DPC-PPD)*I
C-----------------------------------------------------------------------
C     GEL PROTEIN DYNAMICS
C-----------------------------------------------------------------------
  141 PGX=CHY**2*.01332*CPG+CPG
      GPD=GPD+(.0005*(CPI-PGX)*VG-GPD)/Z
      GPR=GPR+GPD*I
      IFP=IFP+(DPI-GPD)*I
C
C  SUBROUTINE KIDNEY
C
C     KIDNEY DYNAMICS AND EXCRETION BLOCK
C
  142 GF3=((GFN/.125-1.)*GF4)+1.
      IF(GF3.GT.15.)GF3=15.
      IF(GF3.LT..4)GF3=.4
      AAR=31.67*VIM*(AUM*ARF+1.-ARF)*GF3*(1.+ANAR*(ANM-1.))
      RR=AAR+51.66*VIM*(1.+ANER*(ANM-1.))
      PAR=PA-GBL
      RFN=PAR/RR
      RBF=REK*RFN
  150 APD=AAR*RFN
      ANK = ANM
      IF(ANK .LT. 1.) ANK=1.
      GLP=PAR-APD
      PFL=GLP-PPC-18.
      GF1=GFN
      GFN=GFN+(PFL*.00781-GFN)*GF2/Z
      IF (ABS(GFN-GF1).GT..002)GO TO 142
      GFR=GFN*REK
      IF(DESC .GT. 0.) GO TO 151
      VUGF = .2*GFR
      GO TO 152
  151 VUGF = VUGF+(.2*GFR-VUGF)*I/UOC
  152 VUD = VUGF/(1.+GPI*(ANK-1.))-.025*REK+.001*REK/AM/AHM
      IF(VUD.LT..0002)VUD=.0002
      IF(VOB .GT. .00001) VUD=VOB
C-----------------------------------------------------------------------
C     KIDNEY SALT OUTPUT AND SALT INTAKE
C     (SEE ALSO ELECTROLYTES AND CELL WATER BLOCK)
C-----------------------------------------------------------------------
      NOZ=1000.*VUD/AM/(CNE/CNX+CNY)
      NOD=NOD+(NOZ-NOD)/Z
      IF(NAO .GT. .00001) NOD=NAO
```

LISTING OF WHOLE BODY ALGORITHM

```
      NED=NID*STH-NOD+RNA
      NAE=NAE+NED*I
C
C  SUBROUTINE IONS
C
C    ELECTROLYTES AND CELL WATER BLOCK
C
 160  VEC=VTS+VP+VPF
      CKE=KE/VEC
      KOD=(.00042*CKE+.00014*AM*CKE)*REK
      IF(KO .GT. .00001) KOD = KO
      KIR=2850.+140.*CKE
      KIE=KIR-KI
      KCD=KCD+(KIE*.013-KCD)/Z
      KI=KI+KCD*I
      KED=KID-KCD-KOD
      KE=KE+KED*I
      CKI=KI/VIC
      CNA=NAE/VEC
      CCD=CKI-CNA
      VID=VID+(.01*CCD-VID)/Z
      VIC=VIC+VID*I
C
C  SUBROUTINE GELFLD
C
C    GEL FLUID DYNAMICS
 140  CHY=HYL/VG
      PRM=-5.9*CHY+24.2
      PGR=.4*CHY
      CPG=GPR/VG
      PGP=.25*PGX
      PGC=PGP+PGR
      VIF=VTS-VG
      CALL FUNCTN (VIF,PTS,FUN6)
      PIF=PTT-PTS
      CPI=IFP/VIF
      PTC=.25*CPI
      PGH=PIF+PTS+PRM
      VGD=V2D*(PIF+PGC-PTC-PGH)
      VG=VG+VGD
      IF(VG.LT.0.)VG=0.
      IF(.012.LT.ABS(VGD)) GO TO 140
C
      RETURN
      END
      SUBROUTINE FUNCTN(TH,POL,TAB)
      DIMENSION TAB(14)
      N=14
      DO 110 I=1,N,2
      IF(TAB(I)-TH) 110,120,110
  110 CONTINUE
      GO TO 140
  120 POL=TAB(I+1)
  130 RETURN
  140 NN=N-2
      DO 150 I=1,NN,2
  150 IF(TAB(I) .LT. TH .AND. TAB(I+2) .GT. TH) GO TO 160
```

LISTING OF WHOLE BODY ALGORITHM

```
      WRITE(6,100) TH
  100 FORMAT(5X,' ***** CURVE LIMITS EXCEEDED ***** ',G12.6//)
      IF(TH .LT. TAB(1)) POL=TAB(2)
      IF(TH .GT. TAB(N-1)) POL=TAB(N)
      GO TO 130
  160 POL=TAB(I+1)+(TAB(I+3)-TAB(I+1))*((TH-TAB(I))/(TAB(I+2)-TAB(I)))
      GO TO 130
      END
      SUBROUTINE TIMPRT(T,ID1,IH1,IM1,IS1)
C   THIS ROUTINE COMPUTES TIME* FOR PRINTOUT.
C    INPUT T (TIME IN MINS.).
C    OUTPUT ID1=DAYS,IH1=HOURS,IM1=MINS,IS1=SECS.
      ID1 = T / 1440.
      X1 = T - (FLOAT(ID1) * 1440.)
      IH1 = X1 / 60.
      X1 = X1 - (FLOAT(IH1) * 60.)
      IM1 = X1
      IS1 = (X1 - FLOAT(IM1)) * 60.
      RETURN
      END
 .000000E 00       1   T
 .357812E 01       2   I
-.144677E-02       3   VBD
 .330394E 01       4   VVS
 .395230E 00       5   VPA
 .852647E 00       6   VAS
 .408509E 00       7   VLA
 .102029E 00       8   VRA
 .359649E 00       9   VAE
 .101310E 03      10   PA
 .987073E 00      11   PAM
 .100000E 01      12   LVM
 .215391E-02      13   VRE
 .430782E 00      14   PRA
 .603388E 01      15   QRN
 .889803E-01      16   VPE
 .185376E 02      17   PPA
 .481977E 00      18
 .144041E 01      20   RPA
 .976582E 00      21   RVM
 .858596E-02      22   VLE
 .858596E 00      23   PLA
 .629496E 01      24   QLN
 .104769E 01      26   AIB
 .134291E 01      27   RPV
 .278332E 01      28   RPT
 .176790E 02      29   PGL
 .634867E 01      30   QPO
 .358856E 00      32   VVE
 .362421E 00      33
 .439298E 01      34   PVS
 .623268E 00      36   RVG
 .634399E 01      37   QVO
 .100000E 01      38   AVE
 .212000E-01      39   CN2
 .369239E 00      40   CN3
 .274497E 01      41   RVS
```

LISTING OF WHOLE BODY ALGORITHM

.969166E 02	42	
.158676E 02	43	RTP
.635754E 01	44	Q_{AO}
.634253E 01	45	QRO
.634764E 01	46	QLO
.135502E-01	47	DVS
-.614053E-02	48	DPA
-.989771E-02	49	DAS
.102752E-02	50	DLA
.146049E-02	51	DRA
.920524E 02	52	
.000000E 00	53	AUC
.998959E 00	54	AUB
.000000E 00	55	AUN
.100021E 01	56	
.105515E-06	58	AU8
.100021E 01	59	DAU
.100002E 01	60	AUJ
.100002E 01	61	AU
.225902E-04	62	AUO
.100002E 01	63	AUH
.100002E 01	66	AUM
.474746E-01	67	AU4
.567533E 00	68	VIF
.825000E 01	69	POI
.102622E 01	70	PTT
.678701E 01	71	PTS
-.576079E 01	72	PIF
.150990E 02	73	CPI
.377474E 01	74	PTC
.701201E 02	75	CPP
.280481E 02	76	PPC
.146837E 02	77	PVG
.190767E 02	78	PC
.562868E 00	79	PCD
.394008E-02	80	VTC
.101399E 01	81	PLO
.405595E-02	82	VTL
-.223195E-04	83	VTD
.372645E-03	84	VPD
.612362E-01	85	DPL
.611175E-01	87	DPC
-.118688E-03	88	DPI
.699353E-02	90	DLP
.491859E 01	92	CHY
-.481966E 01	93	PRM
.196743E 01	94	PGR
.114196E 02	95	CPG
.377489E 01	96	PGP
.125728E 00	97	
.150996E 02	98	PGX
.574232E 01	99	PGC
-.379344E 01	100	PGH
.460327E-05	102	VGD
.115887E 02	103	VG
-.971664E-05	107	GPD
.329719E 02	108	

LISTING OF WHOLE BODY ALGORITHM

.852318E-02	109	RR
.118864E 01	110	
.391916E 02	111	APD
.621180E 02	112	GLP
.160700E 02	113	PFL
.125717E 00	114	GFR
.124014E 00	115	TRR
.102299E-02	116	VUD
.100000E 01	117	REK
.102394E 00	118	NOD
.215082E-03	119	NED
.215678E 04	120	NAE
.151870E 02	121	VEC
.499899E 01	122	CKE
.279973E-02	123	KOD
.354986E 04	125	KIR
-.602417E-01	126	KIE
-.783142E-03	127	KCD
.783415E-03	128	KED
.142026E 03	129	CKI
.142015E 03	130	CNA
.107574E-01	131	CCD
.107574E-03	132	VID
.759223E 02	133	KE
.354992E 04	134	KI
.249952E 02	135	VIC
.749980E 01	136	I1
.100000E 01	138	Z
.103143E-02	141	TVZ
.100000E 02	144	X
.300000E-02	145	I2
.430782E 00	146	
.121562E 02	147	VTS
.301740E 01	148	VP
.211495E 03	149	PRP
.856915E 01	150	IFP
.132338E 03	151	GPR
.100038E 01	154	AMR
.981447E 00	155	AMP
.100342E 01	156	AMI
.100293E 01	157	AMC
.100042E 01	161	AM
.996620E 01	162	CNE
.200000E 00	163	AGK
.998409E 00	164	ANP
.821862E 02	165	ANI
.105187E 01	166	ANC
.102221E 01	170	ANM
.506236E 01	171	VB
.404173E 02	173	HM
.152841E 01	175	VIE
.302841E 01	176	VIB
.100937E 01	177	VIM
.118672E-04	178	RC2
.255755E 00	179	PO2
.580000E-05	180	RKC
.118670E-04	181	RC1

LISTING OF WHOLE BODY ALGORITHM

-.172349E-09	182	RCD
.204607E 01	183	VRC
.324305E 02	184	RSN
.200835E 03	185	OVA
.298844E 01	186	BFN
.180002E 03	187	DOB
.100000E 01	188	AOM
.799425E 01	189	PIO
.695551E 00	190	OSV
.799425E 01	191	POT
-.256223E 00	192	
.984627E 00	193	POB
.984617E 00	194	AR1
.923011E 00	195	AR2
.974634E 00	196	
.974623E 00	197	AR3
.885731E 00	198	ARM
.303380E 01	199	
.125717E 00	200	GFN
.225902E-04	202	
.303509E 01	203	AH
.100899E 01	204	AHC
.100052E 01	208	AHM
.600000E 01	209	CNY
.250000E 01	210	CNX
-.136513E-03	214	VV6
-.194732E-02	215	VV7
.103143E-02	216	TVD
.401798E 02	217	VTW
.100000E 01	218	HSR
.100000E 01	219	HSL
.100000E 00	220	NID
.500000E 00	221	SR
-.356600E-02	222	VVR
.305200E 02	223	RAR
.825000E-01	224	CV
.200000E 00	225	CN7
.300000E 01	226	AUX
.500000E-03	227	AUK
.100000E 01	228	AUZ
.100000E 01	229	Y
.700000E-02	230	CFC
.160000E-06	231	CPK
.300000E 01	232	PCE
.850000E 02	233	CPR
.470000E-03	234	LPK
.700000E-02	235	DPO
.570000E 02	236	HYL
.280000E-02	237	KID
.600000E 02	238	AHT
.150000E 02	239	ANT
.600000E-01	240	POK
.300000E 00	241	PON
.100000E 01	242	A1K
.200000E 02	243	A2K
.115200E 05	244	A3K
.139000E 03	245	CNR

LISTING OF WHOLE BODY ALGORITHM

.100000E 01	246	CNZ
.700000E 01	247	AHK
.330000E 02	248	SRK
.363000E 00	249	V9
.200000E-01	250	V2D
.100000E 01	251	Z1
.100000E 01	253	Z3
.100000E 02	254	Z4
.100000E 02	255	Z5
.500000E 01	256	Z6
.500000E 01	257	Z7
.100000E 01	258	Z8
.900000E 02	259	HMK
.533330E 00	260	HKM
.397438E 02	261	POV
.300000E 00	262	POZ
.510896E 03	263	
.240067E 04	264	Q02
.118864E 01	265	RBF
.180001E 03	266	MO2
.923133E 00	267	POA
.464000E-04	268	POY
.102200E 01	269	ANU
.400000E 02	270	POR
.500000E-01	271	GF2
.100000E 01	272	HMD
.498562E-02	273	DHM
.799425E 01	274	
.100000E 02	275	I3
.400000E 01	276	U
.100000E-01	277	VPI
.000000E 00	278	TI
.102913E 01	279	
.500000E 01	280	GF4
.100002E 01	281	AUP
.000000E 00	282	AUV
.250000E 00	284	AUY
.300000E 01	285	OUT
.000000E 00	286	DSP
.861563E-01	287	AHZ
.874292E-01	288	AHY
.993805E 00	289	OSA
-.101065E 02	290	
.272707E 02	291	CPN
.109083E 02	292	POS
.268060E-03	293	PLF
.731018E-02	294	PPO
.964112E-02	295	PPN
.233093E-02	296	PPD
.534252E-03	297	PFI
.266192E-03	298	DFP
.133425E-01	299	VPF
.346227E 00	300	PPR
.743841E 01	301	PMC
.768703E 01	302	PMS
.600408E 01	303	PMP
.728625E 02	304	HR

LISTING OF WHOLE BODY ALGORITHM

.300000E-03	305	CPF
.881413E 01	306	PCP
.100000E 01	307	DAI
.699353E-02	308	DLZ
.102394E 00	312	NOZ
.114206E 01	315	HPR
.100835E 01	316	HPL
.102609E 01	317	STH
.100000E 01	318	ALO
.230000E 01	319	EXC
.180000E 03	320	O2M
.101308E 03	321	
.185373E 02	322	
.871181E-01	323	SVO
.000000E 00	324	AUL
.362420E 00	325	VV9
.150000E 00	326	O2A
.918430E 01	328	EXE
.150000E 01	329	ARF
.600000E 00	330	QRF
.444862E 02	331	RSM
.217858E 01	332	BFM
.963000E 02	333	RAM
.689997E 00	334	OVS
.394264E 02	335	PVO
.133674E 03	336	RMO
.235391E 04	337	QOM
.547599E 01	338	PMO
.547599E 01	339	P2O
.133666E 03	340	MMO
-.573559E 00	341	PDO
.954115E 00	342	
.453905E 00	343	AMM
.100000E 01	344	A4K
.800000E-01	345	POM
.600000E 02	346	OMM
.547599E 01	347	PMI
.100000E-02	348	PM3
-.100000E 01	349	PM4
.300000E 01	350	EXI
.122000E 03	353	PM5
.250000E 04	354	PKI
.825000E 01	356	ZIO
.400000E 01	357	ZII
.124000E 01	358	ZI2
.625000E 00	359	ZI3
.800000E 03	363	PK2
.200000E 01	364	PK3
.000000E 00	365	FIS
.000000E 00	366	STA
.101310E 03	367	PAR
.000000E 00	368	GBL
-.200000E 00	369	ANY
.200000E 00	370	ANZ
.424998E 01	372	ANV
.000000E 00	373	ANW
.100000E 01	375	AUQ

LISTING OF WHOLE BODY ALGORITHM

.100002E 01	376	AUR
.100000E 01	377	AUS
.400000E 02	379	H1
.900000E 01	380	A2
.352000E-02	381	A3
.158951E-01	382	AUCB
.000000E 00	383	AUAB
.300000E 01	384	CCB
.300000E 01	385	CAB
.103974E 01	386	AUH1
.100018E 01	387	AUH2
.395622E-01	388	AUH3
.420867E 01	389	VOT1
.424982E 01	390	VOT2
-.411447E-01	391	VOT3
.424998E 01	392	VOT
.000000E 00	393	RTR
.000000E 00	394	VIL
.492998E 00	395	VASO
.998746E-01	396	VRAO
.399923E 00	397	VLAO
.294152E 01	398	VVSO
.306250E 00	399	VPAO
.670249E 00	400	RNS
.196270E 03	401	RSR
.774790E-02	402	ANGS
.150000E 00	403	B
.300482E 04	404	RT
.655000E-01	405	CRA
.300000E 02	406	RNK
.996196E 03	407	RC
.000000E 00	408	CAIV
.825000E-01	409	CAS
.821741E 02	410	AN2
.100000E 02	411	AKA
.259000E 02	412	ANCN
.250000E 01	413	ANMM
.193000E 01	414	AN3
.394000E 01	415	ANTC
.000000E 00	416	ANSS
.360000E 03	417	ANGT
.150000E 00	418	A
.100000E 00	419	ANAR
.100000E 00	420	ANER
.102221E 01	421	ANK
.000000E 00	422	DESC
.251434E-01	423	VUGF
.960000E 03	424	UOC
.215000E 00	425	GP1
.000000E 00	426	VOB
.000000E 00	427	RNA
-.652765E-04	428	V61
.250000E 00	429	SR1
-.971276E-03	430	V71
.360000E 03	431	SRL
-.120782E-03	432	V62
.422000E 00	433	SR2

LISTING OF WHOLE BODY ALGORITHM

```
-.162803E-02     434  V72
 .800000E 00     435  X6
 .400000E 00     436  X7
 .100000E 01     437  X8
 .580000E-01     438  ATH
 .954103E 00     439  AMS
 .476441E 00     440  POF
 .500000E-01     441  POU
 .475740E 00     442  AM2
 .100000E 04     443  ASK
 .000000E 00     444  NAO
 .000000E 00     445  KO
 .100000E 01     446  CAA
 .201600E 05     447  SRM
 .000000E 00     448  VINT
 .424057E 01     449  VUS
 .000000E 00     500
                   0
      SUBROUTINE TERG
C***   GE CARDIOVASCULAR LBNP MODEL 10/23/73
      COMMON/STATE/X(50),XDOT(50)
     2/STATE/QRA,QRV,QLA,QLV,QPA,QPC,QPV,QAA,QARC,QLAA,QUTA,QLTA,QUABA,
     3QLABA,QCILL,QLGSA,QLGAR,QLGCAP,QLGVE,QLGSV,QFEV,QABVC,QTHVC,QSPVC,
     4QLOC,QUPC,QHCAP,QHSV,QJV,QCOR,QCSMA,QIMA,QCSMV,QPOV,QIMV,
     5QRENA,QRALE,QRENV,QRET,QD(10),QSKB
     6/STATE/CRA,CRV,CLA,CLV,CPA,CPC,CPV,CAA,CARC,CLAA,CUTA,CLTA,CUABA,
     7CLABA,CCILL,CLGSA,CLGAR,CLGVE,CLGSV,CFEV,CABVC,CTHVC,CSPVC,
     8CLOC,CUPC,CHSV,CJV,CCSMV,CIMV,CPOV,
     9CRENA,CRENV,CD(18)
     A/STATE/PRA,PRV,PLA,PLV,PPA,PPC,PPV,PAA,PARC,PLAA,PUTA,PLTA,PUABA,
     BPLABA,PCILL,PLGSA,PLGAR,PLGVE,PLGSV,PFEV,PABVC,PTHVC,PSPVC,
     CPLOC,PUPC,PHSV,PJV,PCSMV,PIMV,PPOV,
     DPRENA,PRENV,PD(16),PM,PMC
      COMMON/STATE/
     ERRA,RRV,RMV,RAV,RPA,PPC,RPV,RARC,RLAA,RUTA,RLTA,RUABA,
     FRLABA,RCILL,RLGSA,RLGAR,RLGCAP,RLGVE,RLGSV,RFEV,RABVC,
     GRTHVC,RSPVC,RLOC,RUPC,RHCAP,RHSV,RJV,RCOR,RCSMA,RIMA,RCSMV,
     HRPOV,RIMV,RRENA,RRALE,RREFF,RRENV,RD(11),RSKB
     I/STATE/FLPA,FLAA,FLARC,FLLAA,FLUTA,FLLTA,FLUABA,
     JFLLABA,FLCILL,FLCSMA,FLIMA,FLRENA,FLDM(8)
     K/STATE/V(50),VU(50),PG(34),PEXT(32),E(4)
     *,PRN,ABIAS,TBIAS,TTHAZ,TMODEL,SPACE,BSLG,ECBV,PTIS,PGBIAS
     L,Z(40),WK(20),HR,SV,CO,RT,PEX,W,PSYS,PDYS,FREQ
     M,VO2DOT,AVD,PIAB,PITH,PMP,THETA,SF
     N,TTOT,TAS,TVS,C1,C2,GNEW,PEXIN,TR
     *,DUMMY(13),T,DPRT,VLEG
      COMMON/TOSHOR/GUYIN(20),OUTGUY(20)
      CALL XIO
      V(49)=1000.*GUYIN(1)
      DVO=1000.*GUYIN(2)
      VUTOT=VU(18)+VU(19)+VU(20)
      BVSN=VUTOT+DVO
      DPCT=BVSN/VUTOT
      VU(18)=DPCT*VU(18)
      VU(19)=DPCT*VU(19)
      VU(20)=DPCT*VU(20)
      BSLG=5062.-V(49)
```

LISTING OF WHOLE BODY ALGORITHM

```
      CALL CONTRL
      CALL CVS
    1 CALL ALGO(T)
      IF (T.GT.TTHAZ) THETA=0.
      IF (T.LT.WK(20)) GO TO 1
      CALL EXEC
      RETURN
      END
      SUBROUTINE EXEC
      COMMON/R/XDS,XMH,CXT
      COMMON/STATE/X(597),T
      COMMON/TRINT/TRIN(10),TROUT(10),TRTIME
      TMXER=T/60.
    9 IF(CXT.LT.TMXER)CALL GRODIN
      IF(CXT.LT.TMXER)GO TO 9
   10 IF(TRTIME.LT.TMXER) CALL THERM
      IF(TRTIME.LT.TMXER) GO TO 10
      RETURN
      END
      SUBROUTINE CVS
C               GE CARDIOVASCULAR LBNP MODEL
C                                 CONTROLLED SYSTEM
      COMMON/RINTR/RIN(10),ROUT(10)
      COMMON/TRINT/TRIN(10),TROUT(10),TRTIME
      COMMON/STATE/X(50),XDOT(50)
     2/STATE/QRA,QRV,QLA,QLV,QPA,QPC,QPV,QAA,QARC,QLAA,QUTA,QLTA,QUABA,
     3QLABA,QCILL,QLGSA,QLGAR,QLGCAP,QLGVE,QLGSV,QFEV,QABVC,QTHVC,QSPVC,
     4QLOC,QUPC,QHCAP,QHSV,QJV,QCOR,QCSMA,QIMA,QCSMV,QPOV,QIMV,
     5QRENA,QRALE,QRENV,QRET,QD(10),QSKB
     6/STATE/CRA,CRV,CLA,CLV,CPA,CPC,CPV,CAA,CARC,CLAA,CUTA,CLTA,CUABA,
     7CLABA,CCILL,CLGSA,CLGAR,CLGVE,CLGSV,CFEV,CABVC,CTHVC,CSPVC,
     8CLOC,CUPC,CHSV,CJV,CCSMV,CIMV,CPOV,
     9CRENA,CRENV,CD(18)
     A/STATE/PRA,PRV,PLA,PLV,PPA,PPC,PPV,PAA,PARC,PLAA,PUTA,PLTA,PUABA,
     BPLABA,PCILL,PLGSA,PLGAR,PLGVE,PLGSV,PFEV,PABVC,PTHVC,PSPVC,
     CPLOC,PUPC,PHSV,PJV,PCSMV,PIMV,PPOV,
     DPRENA,PRENV,PD(16),PM,PMC
      COMMON/STATE/
     ERRA,RRV,RMV,RAV,RPA,RPC,RPV,RARC,RLAA,RUTA,RLTA,RUABA,
     FRLABA,RCILL,RLGSA,RLGAR,RLGCAP,RLGVE,RLGSV,RFEV,RABVC,
     GRTHVC,RSPVC,RLOC,RUPC,RHCAP,RHSV,RJV,RCOR,RCSMA,RIMA,RCSMV,
     HRPOV,RIMV,RRENA,RRALE,RREFF,RRENV,RD(11),RSKB
     I/STATE/FLPA,FLAA,FLARC,FLLAA,FLUTA,FLLTA,FLUABA,
     JFLLABA,FLCILL,FLCSMA,FLIMA,FLRENA,FLDM(8)
     K/STATE/V(50),VU(50),PG(34),PEXT(32),E(4)
     *,PRN,ABIAS,TBIAS,TTHAZ,TMODEL,SPACE,BSLG,ECBV,PTIS,PGBIAS
     L,Z(40),WK(20),HR,SV,CO,RT,PEX,W,PSYS,PDYS,FREQ
     M,VO2DOT,AVD,PIAB,PITH,PMP,THETA,SF
     N,TTOT,TAS,TVS,C1,C2,GNEW,PEXIN,TR
     *,DUMMY(13),T,DPRT,VLEG
      DIMENSION PRS(1),CMP(32),R50(50),FINR(12)
      EQUIVALENCE (PRS,PRA),(CMP(1),CRA),(R50(1),RRA),(FINR(1),FLPA)
     & ,(PD(3),TT),(PD(4),TSVE),(PD(5),TRSP),(PD(6),TMP)
     & ,(PD(7),TPS),(PD(8),P2)
C               T IS ELAPSED TIME
C               TT IS A CLOCK FOR ONE BEAT
      TT=T-TSVE
```

LISTING OF WHOLE BODY ALGORITHM

```
      IF (TT-TTOT) 1002,1001,1001
 1001 TSVE=T
C****
      DPMD=1700.+4600./3.*(VO2DOT-.5)
      DPER=DPMD-PD(10)
      IF(DPER.LT.-50.)PD(11)=PD(11)-.001
      IF(DPER.GT.50.)PD(11)=PD(11)+.001
      IF(VO2DOT.LT..5)PD(11)=0.
      CO=X(33)/TTOT*.06
      X(33)=0.0
      PM=X(10)/TTOT
      X(10)=0.0
      PMC=X(13)/TTOT
      X(13)=0.0
      PD(1)=X(34)/TTOT
      X(34)=0.0
      SV=TTOT/60.*CO
      RT=PD(1)/CO
      DIFF=-V(50)+V(49)
      X(18)=X(18)+DIFF*0.6
      X(19)=X(19)+DIFF*0.4
      PSYS=SYS
      PDYS=DYS
      CALL XIO
      PD(10)=0.
  110 CALL CONTRL
      TEMP=TEMP+0.2
      IF (TEMP-T) 110,111,111
  111 CONTINUE
      CALL EXEC
      SYS=0.0
      DYS=1000.
      TTOT=60./HR
      TAS=0.10+0.09*TTOT
      TVS=0.16+0.20*TTOT
      IF (T.LT.61. .OR. T.GT.63.) GO TO 20
      DO 10 I=1,32
   10 PG(I)=SIN(THETA/57.2958)*Z(I)*1.05*980./1332.
      TILT=THETA
   20 CONTINUE
      IF (TMODEL.GT.0.) GO TO 26
      DO 25 I=1,18,2
      IF (WK(I).LT.0.) GO TO 30
      IF (T.GT.WK(I)) PLBNP=-WK(I+1)
   25 CONTINUE
      GO TO 30
   26 IF (ABS(THETA).GT.1.E-5) TILTD=1.
      IF (ABS(THETA).GT.1.E-5) GO TO 30
      IF (TILTD.GT.2.) GO TO 30
      DO 28 I=1,32
   28 PG(I)=0.
      TILTD=3.
   30 CONTINUE
      VLEG=0.
      DO 201 I=15,20
      VLEG=VLEG+V(I)
  201 IF (TMODEL.LT.1.5) PEXT(I)=-PLBNP
```

LISTING OF WHOLE BODY ALGORITHM

```
      VLEG=VLEG-VU(18)-VU(19)-VU(20)
      IF(T.GT.WK(3).OR.BSLG.LT.1.)GO TO 301
      IF(PGBIAS.LT.2.)PGBIAS=2.
      DVL=554.-VLEG-BSLG
      IF(DVL.LT.-120.)PGBIAS=PGBIAS+.2
      IF(DVL.GT.5.)PGBIAS=PGBIAS-.1
      IF(DVL.GT.-120..AND.DVL.LT.-5.)PGBIAS=PGBIAS+.05
  301 CONTINUE
      TEMPV=0.
      DO 16 I=1,32
   16 TEMPV=TEMPV+VU(I)
      ECBV=V(50)-VLEG-TEMPV+VU(18)+VU(19)+VU(20)
     & +VU(15)+VU(16)+VU(17)
 1002 CONTINUE
      IF(TT-TAS)1,2,2
    1 SAS=SIN(3.1416*TT/TAS)
      E(1)=0.05+0.05*SAS*SF
      E(3)=0.12+0.14*SAS*SF
      RSPVC=(20.+SAS*40.)/1332.
      RTHVC=(10.+SAS*20.)/1332.
      GO TO 3
    2 E(1)=0.05
      E(3)=0.12
      RSPVC=.015015
      RTHVC=.0075075
    3 TV=TT-0.1
      IF(TV.LT.0.0)TV=0.0
      IF(TV-TVS)4,5,5
    4 SVS=SIN(3.1416*TV/TVS)
      E(2)=0.0175+.39*SF*SVS
      E(4)=0.02+1.50*SF*SVS
      GO TO 6
    5 E(2)=0.0175
      E(4)=0.02
    6 CONTINUE
      DO 11 I=1,4
   11 CMP(I)=1./E(I)
      IF(X(4).LT.0.0)X(4)=0.0
C                COMPUTE VOLUMES
      V(50)=0.0
      DO 55 I=1,32
      V(I)=VU(I)+X(I)
   55 V(50)=V(50)+V(I)
      V(50)=V(50)-V(9)-V(11)-V(13)-V(10)-VU(18)-VU(19)-VU(20)
      IF (THETA.GT.45.AND.T.GT.60.) PITH=-2.5
C                RESPIRATORY PUMPS
      IF (PEX.EQ.0.0) GO TO 115
      IF(T.LE.60.0 .OR. THETA.LT.45.)GO TO 115
      TRSP=TRSP+T-TPS
      IF(TRSP.GT.TR)TRSP=0.0
      TI=TRSP/TR
      PITH=-2.67-19.704*TI+56.409*TI**2-53.479*TI**3+16.602*TI**4
      DEPTH=(VO2DOT-1.)/2.
      IF(DEPTH.LT.0.)DEPTH=0.
      IF(DEPTH.GT.1.5)DEPTH=1.5
      PITH=PITH-DEPTH
      PIAB=-PITH/2.
```

LISTING OF WHOLE BODY ALGORITHM

```
  115 CONTINUE
      DO 71 I=1,12
   71 PEXT(I)=PITH
      PEXT(22)=PITH
      PEXT(23)=PITH
      DO 72 I=28,32
   72 PEXT(I)=PIAB
      PEXT(14)=PIAB
      PEXT(21)=PIAB
C                MUSCLE  PUMP
      IF(TMODEL.LT.2.)GO TO 45
      TMP=TMP+T-TPS
      TPS=T
      IF (TMP.GE.1.) TMP=0.
      SMP=SIN(2.*3.1416*TMP)
      PMP=40.*SMP
      IF(THETA.LT.15.)PMP=10.*SMP
      IF (SMP.LT.0.) PMP=0.
      IF (PEX.LT.1.) PMP=0.
      DO 44 I=16,19
   44 PEXT(I)=PMP
   45 CONTINUE
C                COMPUTE PRESSURES
      P1=P2
      P2=PLV
      DO 12 I=1,7
   12 PRS(I)=X(I)/CMP(I)+PEXT(I)
      DPDT=(PLV-P1)/(2.*.002)
      IF(DPDT.GT.PD(10))PD(10)=DPDT
      DO 13 I=15,17
   13 PRS(I)=X(I)/CMP(I)+PEXT(I)
      DO 15 I=18,20
      PRS(I)=X(I)/VU(I)*2.+PEXT(I)+PTIS+PGBIAS-2.
   15 IF(X(I).GT.VU(I))PRS(I)=
     &  (X(I)-VU(I))/CMP(I)+PEXT(I)+PTIS+PGBIAS
      DO 14 I=24,32
   14 PRS(I)=X(I)/CMP(I)+PEXT(I)
      PAA=X(8)/CAA+PITH
      PUTA=X(29)/CUTA+PITH
      PLTA=X(12)/CLTA+PITH
      IF(PUTA.GT.SYS)SYS=PUTA
      IF(PUTA.LT.DYS)DYS=PUTA
      PLABA=PIAB-11.826+0.002265*V(14)+0.0097734*V(14)*V(14)
      PLABA=X(14)/CLABA+PIAB
C**** ABDOMINAL VENA CAVA
      PABVC=-5.4996+0.082408*V(21)-0.00033598*V(21)*V(21)
     ,+0.00000045026*V(21)*V(21)*V(21)
      IF (X(21).GT.200. .AND. X(21).LT.350.)
     , PABVC=.34/150.*(X(21)-200.)+1.15
C**** THORACIC VENA CAVA
      PTHVC=-5.5006+0.1154*V(22)-0.00065873*V(22)*V(22)
     ,+0.000001236*V(22)*V(22)*V(22)
      IF (X(22).GT.150. .AND. X(22).LT.250.)
     , PTHVC=.3/100. * (X(22)-150.) + 1.16
      PSPVC=-3.4999+0.92409*X(23)-0.042246*X(23)*X(23)
     ,+0.00063485*X(23)*X(23)*X(23)
      PTHVC=PTHVC+PEXT(22)+TBIAS
```

LISTING OF WHOLE BODY ALGORITHM

```
      PABVC=PABVC+PEXT(21)+ABIAS
      PSPVC=PSPVC+PEXT(23)
      QRA=(PRA-PRV)/RRA
C               HEART MODEL
      IF(PRA.LT.PRV)QRA=0.0
      QRV=X(09)/FLPA
      IF(QRV.LT.0.0)QRV=0.0
      XDOT(09)=PRV-PPA-RRV*QRV
      IF(XDOT(09).LT.0.0.AND.QRV.EQ.0.0)XDOT(09)=0.0
      QLA=(PLA-PLV)/RMV
      IF(PLA.LT.PLV)QLA=0.0
      QLV=X(11)/FLAA
      IF(QLV.LT.0.0)QLV=0.0
      XDOT(11)=PLV-PAA+PG(8)-RAV*QLV
      IF(XDOT(11).LT.0.0.AND.QLV.EQ.0.0)XDOT(11)=0.0
C               PULMONARY CIRCULATION
      QPA=(PPA-PPC)/RPA
      QPC=(PPC-PPV)/RPC
      QPV=(PPV-PLA)/RPV
C               ARTERIAL MODEL
      QAA=(PAA-PUTA+PG(12))/RUTA
      QUTA=(PUTA-PLTA+PG(13))/RLTA
      QLTA=(PLTA-PLABA+PG(14))/RLABA
      QLABA=(PLABA-PCILL+PG(15))/RCILL
C               LEGS
      QCILL=(PCILL+PG(16)-PLGSA)/RLGSA
      QLGSA=(PLGSA-PLGAR)/RLGAR
      QLGCAP=(PLGAR-PLGVE)/RLGCAP
      RLGVE=.05
      IF(QLGVE.LT.0.0)RLGVE=67.567567
      QLGVE=(PLGVE-PLGSV)/RLGVE
      RLGSV=.05
      IF(QLGSV.LT.0.0)RLGSV=67.567567
      QLGSV=(PLGSV-PG(19)-PFEV)/RLGSV
C               VENOUS MODEL
      RFEV=.021
      IF(QFEV.LT.0.0)RFEV=67.567567
      QFEV=(PFEV-PG(20)-PABVC)/RFEV
      QABVC=(PABVC-PG(21)-PTHVC)/RABVC
      QTHVC=(PTHVC-PG(22)-PRA)/RTHVC
      QSPVC=(PSPVC-PG(23)-PRA)/RSPVC
C               HEAD+ARMS
      QLOC=(PAA+PG(24)-PLOC)/RLOC
      QUPC=(PLOC-PUPC)/RUPC
      QBRAIN=RIN(3)*1000./60.
      QARM=17.25
      QHCAP=QBRAIN+QARM
C      QHCAP=(PUPC-PHSV)/RHCAP
      QHSV=(PHSV-PJV)/RHSV
      RJV=.004301
      IF(QJV.LT.0.0)RJV=67.567567
      QJV=(PJV-PG(27)-PSPVC)/RJV
C               CORONARY CIRCULATION
      QCOR=(PAA-PRA)/RCOR
C               CONTINUITY FOR VENOUS RETURN
      QRET=QSPVC+QTHVC+QCOR
C               HEPATIC-SPLANCHNIC CIRCULATION
```

LISTING OF WHOLE BODY ALGORITHM

```
      QCSMA=(PLTA-PCSMV)/RCSMA
      QCSMV=(PCSMV-PPOV)/RCSMV
      QPOV=(PPOV-PTHVC)/RPOV
C                RENAL CIRCULATION
      QRENA=(PLABA-PRENA)/RRENA
      QRALE=(PRENA-PRENV)/(RRALE+RREFF)
      QRENV=(PRENV-PABVC)/RRENV
C                SKELTON,BONE MARROW,AND OTHER
      QSKB=(PLABA-PABVC)/RSKB
      QSKIN=TRIN(1)*.1327
C                STATE VARIABLE DERIVATIVES
      XDOT(1)=QRET-QRA
      XDOT(2)=QRA-QRV
      XDOT(3)=QPV-QLA
      XDOT(4)=QLA-QLV
      XDOT(5)=QRV-QPA
      XDOT(6)=QPA-QPC
      XDOT(7)=QPC-QPV
      XDOT(8)=QLV-QAA-QCOR-QLOC
      XDOT(10)=PAA
      XDOT(12)=QUTA-QLTA-QCSMA
      XDOT(14)=QLTA-QLABA-QRENA-QSKB-QSKIN
      XDOT(15)=QLABA-QCILL
      XDOT(16)=QCILL-QLGSA
      XDOT(17)=QLGSA-QLGCAP
      XDOT(18)=QLGCAP-QLGVE
      XDOT(19)=QLGVE-QLGSV
      XDOT(20)=QLGSV-QFEV
      XDOT(21)=QFEV-QABVC+QRENV+QSKB+QSKIN
      XDOT(22)=QABVC+QPOV-QTHVC
      XDOT(23)=QJV-QSPVC
      XDOT(24)=QLOC-QUPC
      XDOT(25)=QUPC-QHCAP
      XDOT(26)=QHCAP-QHSV
      XDOT(27)=QHSV-QJV
      XDOT(28)=QCSMA-QCSMV
      XDOT(29)=QAA-QUTA
      XDOT(30)=QCSMV-QPOV
      XDOT(31)=QRENA-QRALE
      XDOT(32)=QRALE-QRENV
      XDOT(33)=QLV
      XDOT(13)=PLOC
      XDOT(34)=PUTA
      RETURN
      END
      SUBROUTINE CONTRL
      COMMON/STATE/X(50),XDOT(50)
     2/STATE/QRA,QRV,QLA,QLV,QPA,QPC,QPV,QAA,QARC,QLAA,QUTA,QLTA,QUABA,
     3QLABA,QCILL,QLGSA,QLGAR,QLGCAP,QLGVE,QLGSV,QFEV,QABVC,QTHVC,QSPVC,
     4QLOC,QUPC,QHCAP,QHSV,QJV,QCOR,QCSMA,QIMA,QCSMV,QPOV,QIMV,
     5QRENA,QRALE,QRENV,QRET,QD(10),QSKB
     6/STATE/CRA,CRV,CLA,CLV,CPA,CPC,CPV,CAA,CARC,CLAA,CUTA,CLTA,CUABA,
     7CLABA,CCILL,CLGSA,CLGAR,CLGVE,CLGSV,CFEV,CABVC,CTHVC,CSPVC,
     8CLOC,CUPC,CHSV,CJV,CCSMV,CIMV,CPOV,
     9CRENA,CRENV,CD(18)
     A/STATE/PRA,PRV,PLA,PLV,PPA,PPC,PPV,PAA,PARC,PLAA,PUTA,PLTA,PUABA,
     BPLABA,PCILL,PLGSA,PLGAR,PLGVE,PLGSV,PFEV,PABVC,PTHVC,PSPVC,
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      LISTING OF WHOLE BODY ALGORITHM

      CPLOC,PUPC,PHSV,PJV,PCSMV,PIMV,PPOV,
      DPRENA,PRENV,PD(16),PM,PMC
       COMMON/STATE/
      ERRA,RRV,RMV,RAV,RPA,RPC,RPV,RARC,RLAA,RUTA,RLTA,RUABA,
      FRLABA,RCILL,RLGSA,RLGAR,RLGCAP,RLGVE,RLGSV,RFEV,RABVC,
      GRTHVC,RSPVC,RLOC,RUPC,RHCAP,RHSV,RJV,RCOR,RCSMA,RIMA,RCSMV,
      HRPOV,RIMV,RRENA,RRALE,RREFF,RRENV,RD(11),RSKB
      I/STATE/FLPA,FLAA,FLARC,FLLAA,FLUTA,FLLTA,FLUABA,
      JFLLABA,FLCILL,FLCSMA,FLIMA,FLRENA,FLDM(8)
      K/STATE/V(50),VU(50),PG(34),PEXT(32),E(4)
      *,PRN,ABIAS,TBIAS,TTHAZ,TMODEL,SPACE,BSLG,ECBV,PTIS,PGBIAS
      L,Z(40),WK(20),HR,SV,CO,RT,PEX,W,PSYS,PDYS,FREQ
      M,VO2DOT,AVD,PIAB,PITH,PMP,THETA,SF
      N,TTOT,TAS,TVS,C1,C2,GNEW,PEXIN,TR
      *,DUMMY(13),T,DPRT,VLEG
CC      CVS-RESP. INTERFACE
C      BLOCK DATA FOR INTERFACE IN & OUT
       COMMON/RINTR/RIN(10),ROUT(10)
       COMMON/TRINT/TRIN(10),TROUT(10),TRTIME
       COMMON/TOSHOR/GUYIN(20),OUTGUY(20)
C      INPUT FROM GUYTON MODEL
       QD(1)=2.2313-0.05833*21.109/19.811*GUYIN(3)*1000./60.
       QD(2)=2.6752-0.06613*25.332/49.807*GUYIN(4)*1000./60.
       QD(3)=1.8958-0.06923*12.939/36.31*GUYIN(5)*1000./60.
       QD(4)=GUYIN(8)/1440./56.
C      INPUT FROM RESP.
       VO2DOT=RIN(1)
       FREQ=RIN(2)
       QBRAIN=RIN(3)*1000./60.
       PCO2=RIN(4)
       PO2=RIN(5)
       DPCO2=PCO2-38.
       DPO2=PO2-107.9482
       IF(PO2.GT.80.)DPO2=0.
       IF(PCO2.LT.30.)DPCO2=-8.
C      OUTPUT TO RESP.
       ROUT(1)=CO
       ROUT(3)=RESTO2
C      INPUT FROM T/R
C      QSKIN=TRIN(1).1327
       DCT=TRIN(2)
C      OUTPUT TO T/R
       TROUT(1)=QFEV+17.27
       TROUT(2)=QBRAIN
       TROUT(3)=CO
       TROUT(4)=VO2DOT
       TROUT(5)=QCOR+QPOV+QRENV
C      CVS MODEL
       REAL  NUM9DI,NUM9D
       EQUIVALENCE
      2 (ACCMET,X(41)),(XN4,X(43)),(DA,X(44)),(DL,X(45)),
      3(XN3,X(49)),(PD(2),FLAG),(PD(9),DTS),(PD(12),DMS)
       COMMON/DELAYC/ AVDTS(50),VO2TS(50),SAVE(10),F1(15),F2(15),F3(15)
      & ,F4(15),F5(45),F6(15),ANF,TDN,FNS,RESTO2,AUNC,AUNS,AUNSH
       IF(T.GT.1.0)GO TO 400
       DO 401 I=1,15
  401 F6(I)=1.0
```

LISTING OF WHOLE BODY ALGORITHM

```
      DO 402 I=1,45
  402 F5(I)=.405
  400 CONTINUE
C           SAVE OLD XDOT(41-49)
      DO 10 I=40,49
   10 SAVE(I-39)=XDOT(I)
C                                        W= WORK RATE KG-M/MIN
      DO 25 I=1,17,2
      IF(T-WK(I)) 26,25,25
   25 W=WK(I+1)
   26 IF(W) 27,27,28
   27 PEX=0.0
      GO TO 29
   28 PEX=1.0
   29 CONTINUE
      IF(X(48).LE.0.)GO TO 501
      DO2=SQRT(0.16855*(X(48)+3.726)**2-2.34)
C                                        OXYGEN REQUIREMENT FUNCTION VO2WDT
  501 IF(X(48).LE.0.0)DO2=0.0
      VO2WDT=.000485081S*W/.25
      PSW=-1.5+DO2
      DT1=DO2
      DT2=(2.*DO2-1.275)/1.15
      DT3=DA+DL
      DTIN=SWIN(PSW,DT1,DT2)
      DT=FCNSW(PEX,DT3,DT3,DTIN)
C                                        ALACTIC OXYGEN DEBT DA
      DA1H=.15*(DT-1.5)+1.5
      DA1=SWIN(PSW,DO2,DA1H)
      DA0=FCNSW(PEX,0.0,0.0,DA1)
      T8=FCNSW(PEX,0.0,300.,2.)
      XDOT(44)=(DA0-DA)/T8
C                                        LACTIC OXYGEN DEBT DL
      DL1H=.85*(DT-1.5)
      DL1=SWIN(PSW,0.0,DL1H)
      DL0=FCNSW(PEX,0.0,0.0,DL1)
      T7=FCNSW(PEX,0.0,300.,10.)
      XDOT(45)=(DL0-DL)/T8
C                                        ARTERIAL-VENOUS OXYGEN DIFFERENCE AVD
      NUM9DI=.038*DO2
      CALL DELAY(0.05,NUM9DI,AVDTS,NUM9D,1)
      AVD=VO2DOT/CO
      XDOT(46)=(NUM9D-X(46))/5.
      IF(PEX.EQ.0.0)FLAG=0.0
      IF(FLAG.EQ.1.0)GO TO 60
      IF(PEX)60,60,61
   61 ANF=1.0
      TDN=T+20.
      FLAG=1.0
   60 IF(T.GT.TDN)ANF=0.0
      TAN=FCNSW(ANF,3.,36.,3.)
      XDOT(49)=(11.00*ANF-XN3)/TAN
      XDOT(43)=(5.5*PEX-XN4)/6.
      DMMX=2.0
      DM=DO2*25./22.
      IF(PEX.GT.0.0)DTS=DT
      IF(PEX.GT.0.0)DMS=DM
```

LISTING OF WHOLE BODY ALGORITHM

```
      IF(PEX.LT.1.)DM=DMS/DTS*DT
      CHEMON=DO2/0.8
      IF(CHEMON.GT.0.5)CHEMON=0.5
      FN=2.*XN4+XN3
      IF(FN.GT.11.)FN=11.
      IF(PEX.GT.0.)FNS=FN
      IF(PEX.LT.1.)FN=FNS/DTS*DT
      SUM=0.
      DO 44 I=1,14
      F4(I)=F4(I+1)
   44 SUM=F4(I)+SUM
      F4(15)=PMC
      PMCF=(SUM+PMC)/15.
      IF(T.LT.WK(3).OR.TMODEL.LT.2.)
     & AUNS=((88.5-PMCF)*.03+1.)*1.
      IF(T.LT.WK(3).OR.TMODEL.LT.2.)
     & AUNSH=((87.15-PMCF)*.055+1.)*1.
      IF(T.LT.WK(3).OR.TMODEL.LT.2.)
     & AUNC=1.+(0.03448*DPCO2-0.010*DPO2)
      IF(AUNC.LT.1.0)AUNC=1.0
      SUM=0.
      DO 94 I=1,14
      F6(I)=F6(I+1)
   94 SUM=F6(I)+SUM
      F6(15)=AUNC
      AUNC=(SUM+AUNC)/15.
      IF(T.LT.10.)AUNS=1.08
      IF(T.LT.10.)AUNSH=1.08
      IF(T.LT.10.)AUNC=1.0
      IF(T.LT.10.)DPO2=0.
C                CONTROLLED RESISTANCES
C     LEGS
      RMET=150.-ACCMET*50.
      IF(RMET.LT.15.)RMET=15.
      RDM=450.-450.*DM/DMMX
      IF(RDM.LT.15.)RDM=15.
      RLGCAP=(RMET+RDM)/1332./((1.+3.5*(AUNC-1.))-.03*DPO2)
      RLGARM=RMET+RDM
      RLGARN=-FN*5400./11.
      RLGAR=(RLGARM+RLGARN+5400.)/1332./((1.+3.5*(AUNC-1.))-.03*DPO2)
      RLGAR=RLGAR*QD(3)
C     OTHER BRANCHES
      RHCAP=3570./1332.
      RCOR=(20500.-9395.*DM/DMMX)/1332.
      RSKB=(5540.*AUNS*(1.+(AUNC-1.))+6000.*DL/AUNS*(1.+(AUNC-1.)))/
     & 1332.
      RRALE=(3600.*AUNS*(1.+(AUNC-1.))+1600.*DL/AUNS*(1.+(AUNC-1.)))/
     & 1332.
      RRALE=RRALE*QD(1)
      RDMR=DM/DMMX
      IF(RDMR.GT.1.)RDMR=1.
      RCSMA=(2600.*AUNS*AUNS+1070./AUNS/AUNS*(FN/11./2.+RDMR/2.))/
     & 1332.
      RCSMA=RCSMA*QD(2)
      SUM=0.
      DO 92 I=1,14
      F1(I)=F1(I+1)
```

LISTING OF WHOLE BODY ALGORITHM

```
   92 SUM=F1(I)+SUM
      F1(15)=CO
      COT=(SUM+CO)/15.
      IF(COT.GT.25.)COT=25.
      RPA=.0175-.0075/21. * COT
      RPC=.0595-.0245/21. * COT
      RPV=RPA
      RREFF=0.
      IF(AUNC.LT.1.03.AND.T.LE.TTHAZ+10.)GO TO 70
      SFU=(AUNSH-.08)*.405+1.5*(AUNC-1.)+.0055*DP02
      SUM=0.
      DO 93 I=1,44
      F5(I)=F5(I+1)
   93 SUM=F5(I)+SUM
      F5(45)=SFU
      SF=(SUM+SFU)/45.
      GO TO 71
   70 SF=(AUNSH-.08)*.405+1.5*(AUNC-1.)+.0055*DP02
   71 IF(T.LT.WK(3).OR.TMODEL.LT.2.) GO TO 610
      SF=.67+.374*(X(40)-.9)
      IF(SF.GT.1.135)SF=1.135+.86*(X(40)-2.143)
      XDOT(40)=(V02DOT-X(40))/T7
      IF(SF.LT.0.67)SF=.67
      IF(SF.GT.3.)SF=3.
      IF (PEX.LT.1. .AND. THETA.LT.45.) SF=.48
      IF(THETA.GT.15..AND.T.LT.60.)SF=.48
      SF=SF+PD(11)
  610 CONTINUE
C                                        PRESSURE REFERENCE FUNCTION PR
      IF(PEX.GT.0.)QD(4)=0.
      PRN=AUNS*58.+C1*D02+C2*ACCMET+2*(AUNC-1.)*58.+.5*DCT*58.
     8 +26.6*PEX*COS(THETA/57.2958)+QD(4)*58.*AUNS
      EN=PRN-PM/2.-PMC/2.+XN3+3.*XN4+FN/2.-.55*PEXT(15)
      SUM=0.
      DO 91 I=1,14
      F2(I)=F2(I+1)
   91 SUM=F2(I)+SUM
      F2(15)=EN
      ER=(SUM+EN)/15.
      DDP=.533-.005*ER
      IF(DDP.LT.0.0)DDP=0.0
      TOT=0.300+DDP
      HR=60./TOT
C               CONTROLLED COMPLIANCES
      ERC=(PRN-PMC)*.7
      SUM=0.
      DO 90 I=1,14
      F3(I)=F3(I+1)
   90 SUM=F3(I)+SUM
      F3(15)=ERC
      ERC=(SUM+ERC)/15.
      IF(ERC.LT.0.0)GO TO 7
      IF(ERC.GT.80.)ERC=80.
      CLGVE=3.956*(1.0-.0083*ERC)
      CLGSV=3.1435*(1.0-.0083*ERC)
    7 CONTINUE
C               RESPIRATION
```

LISTING OF WHOLE BODY ALGORITHM

```
      RESTO2=.313
      IF (THETA.GT.15. .AND. T.GT.60.) RESTO2=.37
C      FREQ=VO2DOT*8.24+5.28
      IF(FREQ.GT.30.)FREQ=30.
      TR=60./FREQ
      XDOT(41)=(VO2DOT-0.38)*.4/300.
      IF(PEX.EQ.0.0)XDOT(41)=-1./300.
      IF(ACCMET.LE.0.0.AND.PEX.EQ.0.0)XDOT(41)=0.0
C                                        OXYGEN DEFICIT FUNCTION DO2
      CALL DELAY(0.0,5,VO2DOT,VO2TS,VO2DD,1)
      XDOT(48)=(-VO2DD+PEX*VO2WDT+0.33)/60.
      IF(DO2.LE.0.0.AND.PEX.EQ.0.0)XDOT(48)=0.0
      DO 31 I=40,49
   31 X(I)=X(I)+0.1*(XDOT(I)+SAVE(I-39))
      RETURN
      END
      SUBROUTINE XIO
      COMMON/STATE/X(600)
      COMMON/XIOD/N(27),NW(27),INIT,A(9,6),PT,EXC,XNC(3),XRD(3),NPASS,
     &IONE
      COMMON /TRM/XTRA(223)
      COMMON/TRINT/TRIN(10),TROUT(10),TRTIME
      COMMON/TAPE/TOTAL,IB
      COMMON/Z/XRARA(1263)
      DIMENSION XIOP(18),XNUM(27)
      DATA KY,NWTL/1HY,6H  TILT/
      DATA IBLK/'      '/
      T=X(598)
      IF (INIT.GT.0) GO TO 200
      INIT=1
      WRITE(6,5)
    5 FORMAT(///5X,'*** SHORT TERM EXPERIMENT SIMULATION ***',///
     &' ENTER EXPERIMENT CODE; LBNP=1., TILT=2., TERG=3., THERMAL=4.,',/
     & 22X,' RESPIRATORY=5.')
  442 READ (5,6) EXC
    6 FORMAT (F5.0)
      IEXC=EXC
      IF(IEXC.GE.1.AND.IEXC.LE.5)GO TO 444
      WRITE(6,443)
  443 FORMAT(' ERROR WHEN READING EXPERIMENNT CODE TRY AGAIN')
      GO TO 442
  444 IF(IEXC.EQ.3)GO TO 400
      X(516)=33.0
      X(519)=33.0
      X(543)=60.
      X(544)=-8.
      X(545)=70.
      X(546)=-16.
      X(547)=90.
      X(548)=-30.
      X(549)=120.
      X(550)=-40.
      X(551)=180.
      X(552)=-50.
      X(553)=240.
      X(554)=0.0
      X(555)=300.
```

LISTING OF WHOLE BODY ALGORITHM

```
      X(560)=301.
      X(575)=0.0
  400 CONTINUE
      WRITE(6,999)
  999 FORMAT(3X,'THE STORED PROTOCOL IS:')
      GO TO(11,12,13,14,15),IEXC
   11 X(495)=0.
      WRITE(6,998)
      DO 1000 I=1,14,2
      XDUR=(X(542+I)-X(542+I-2))/60.
 1000 WRITE(6,888)X(541+I),XDUR
  998 FORMAT(1X,'LBNP LEVEL',5X,'DURATION',/1X'(MM HG)',
     &8X,'(MIN)')
  888 FORMAT(3X,F6.1,9X,F8.3)
      ENDT=X(560)/60.
      WRITE(6,887)ENDT
  887 FORMAT(3X,'END TIME=',F6.1)
    9 WRITE (  6,8)
    8 FORMAT('0DO YOU WISH TO CHANGE PROTOCOL? (Y/N)')
      READ (  5,20) K
   20 FORMAT(1A1)
      IF (K.NE.KY) GO TO 60
      WRITE(6,997)
  997 FORMAT(' ENTER NEW PROTOCOL 2F12.6 (CR WHEN COMPLETE)',
     $/2X,'LBNP LEVEL',3X,'DURATION',/2X,,'(MM HG)',6X,'(MIN)')
  966 XXZ=1.
      DO 990 I=1,10
      IF(XXZ.EQ.0)GO TO 990
      INDX=542+(I-1)*2
  996 READ(5,995,ERR=996)X(INDX),XXZ
  995 FORMAT(2F12.6)
      IF(IEXC.EQ.3)X(INDX)=X(INDX)*6.12
      IF(XXZ.EQ.0)GO TO 990
      X(INDX+1)=X(INDX-1)+XXZ*60.
      IF(IEXC.EQ.3)GO TO 965
      IF(X(INDX).LE.0..AND.XXZ.GE.0.)GO TO 990
      GO TO 964
  965 IF(X(INDX).GE.0..AND.XXZ.GE.0.)GO TO 990
  964 CONTINUE
      WRITE(6,994)
  994 FORMAT('0ERROR IN PROTOCOL VALUE TRY AGAIN')
      GO TO 996
  990 CONTINUE
      X(560)=X(INDX-1)+1.
      GO TO 60
   12 X(495)=1.
      WRITE(6,799)
  799 FORMAT(3X,'TILT ANGLE',3X,'DURATION',4X,'RECOVERY',/3X,'(DEG)',8X
     &,2('(MIN)',7X))
      X(575)=70.
      X(494)=180.
      TDT=(X(494)-60.)/60.
      ENDT=(X(560)-X(494)-1.)/60.
      WRITE(6,797)X(575),TDT,ENDT
  797 FORMAT(5X,'0.',11X,'1.',/3X,F6.1,6X,F6.1,6X,F6.1)
      WRITE (6,8)
      READ (5,20) K
```

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```
      IF (K.NE.KY) GO TO 60
      WRITE(6,796)
  796 FORMAT(' ENTER TILT ANGLE,DURATION AND RECOVERY(3F5.0)',/,
     &' DEGS MINS MINS')
  795 READ(5,794)X(575),TDT,ENDT
  794 FORMAT(3F5.0)
      IF(ENDT.LT.0.)GO TO 703
      IF(TDT.GE.0.)GO TO 793
  703 WRITE(6,792)
  792 FORMAT(' ERROR READING TILT DURATION TRY AGAIN')
      GO TO 795
  793 X(494)=(TDT+1.)*60.
      X(560)=X(494)+ENDT*60.+1.
      GO TO 60
   13 X(495)=3.
      WRITE(6,969)
  969 FORMAT(3X,'EXERCISE',7X,'DURATION',/3X,'(WATTS)',9X,'(MIN)')
      DO 1001 I=1,15,2
      INDX=541+I
      XDUR=(X(INDX+1)-X(INDX-1))/60.
      WATTS=X(INDX)/6.12
      IF(X(INDX+1).LT.0.)GO TO 1001
      WRITE(6,888)WATTS,XDUR
 1001 CONTINUE
      ENDT=X(560)/60.
      WRITE(6,887)ENDT
      WRITE(6,8)
      READ(5,20)K
      IF (K.NE.KY) GO TO 60
      WRITE(6,968)
  968 FORMAT(' ENTER NEW PROTOCOL 2F12.6 (CR WHEN COMPLETE)',
     $/2X,'EXERCISE',5X,'DURATION',/2X,,'(WATTS)',6X,'(MIN)')
      GO TO 966
   15 X(495)=1.
      XDUR=5.
      XNC(3)=XRARA(33)
      XNC(2)=XRARA(32)
      XNC(1)=XRARA(31)
      WRITE(6,1888)(XNC(I),I=3,1,-1),XDUR
 1888 FORMAT(3X,' ATMOSPHERIC COMPOSITION (GAS FRACTIONS)',/4X,
     &'N2',4X,'O2',3X,'CO2',/1X,3('***** '),/1X,3(F5.4,1X),
     &'  FOR',F5.2,' MINS')
      WRITE(6,8)
      READ (  5,20) K
      IF (K.NE.KY) GO TO 885
      WRITE(6,884)
  884 FORMAT(3X,'ENTER NEW GAS FRACTIONS (SUM=1.0)',/4X,
     &'N2',4X,'O2',3X,'CO2',2X,'MINS',/,1X,4('***** '))
  786 READ(5,883)(XNC(I),I=3,1,-1),XDUR
  883 FORMAT(4F6.0)
      DO 882 I=1,3
  882 CSUM=CSUM+XNC(I)
      IF(ABS(CSUM-1.).GT..0001)GO TO 881
  880 IF(XDUR)881,881,889
  881 WRITE(6,878)CSUM
  878 FORMAT(3X,'SUM=',F9.4,'ERROR IN NEW PROTOCOL, TRY AGAIN')
      GO TO 786
```

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```
 885 CONTINUE
 889 X(542)=0.
     X(543)=XDUR*60.
     X(560)=X(543)+1.
     GO TO 60
  14 X(495)=1.
     XNC(1)=XTRA(3)
     XNC(2)=XTRA(5)
     XNC(3)=5.
     WRITE(6,801)(XNC(I),I=1,3)
 801 FORMAT(3X,'CABIN TEMP',2X,'DEWPOINT',4X,'DURATION',/3X,
    &2('(DEG-F)',5X),'(MIN)',/3X,3(F7.2,5X),//3X,'DO YOU ',
    &'WISH TO CHANGE PROTOCOL VALUE?')
     READ ( 5,20) K
     IF (K.NE.KY) GO TO 60
     WRITE(6,804)
 804 FORMAT(3X,'ENTER NEW VALUES FOR CABIN TEMP,DEWPT,&DURATION',
    &'(3F5.0)',/2X,'(DEG-F) (MINS)',/1X,3('**** '))
 807 READ(5,805)(XNC(I),I=1,3)
 805 FORMAT(3F5.2)
     IF(XNC(3).GT.0.)GO TO 803
     WRITE(6,994)
     GO TO 807
 803 X(560)=XNC(3)*60.+1.
  60 PRTI=X(599)/60.
     WRITE(6,451)PRTI
 451 FORMAT('0THE PRINT INTERVAL IS CURRENTLY'F5.2,'MINS',/,' IF YOU'
    &' WISH TO CHANGE, ENTER NEW INTERVAL; OTHERWISE RETURN')
 452 READ(5,6,ERR=452)PRTI
     IF(PRTI.LE.0)GO TO 450
     X(599)=PRTI*60.
 401 WRITE (6,70)
  70 FORMAT('0DO YOU WISH TO MODIFY THE OUTPUT LIST? (Y/N)')
     READ (5,20) K
     IF (K.NE.KY) GO TO 460
     WRITE(6,80)
  80 FORMAT('0ENTER LINE NO.,POSITION,INDEX,&NAME; CR WHEN COMPLETE'/
    &' (I1,1X,I1,1X,I4,1X,A6)',//15X,' CVS THERM   RESP',/8X,
    &' LINE     1',5X,'2',6X,'3',/4X,
    &' POSITION   2-9   1-9    1-9',/7X,
    &' INDEX 1-600 1-223 1-1270',/1X,
    &'* * **** ******')
     GO TO 90
  85 WRITE (6,86)
  86 FORMAT (' *READ ERROR*')
  90 READ (5,100,ERR=85) LINE,IPOS,NDX,NAME
 100 FORMAT(I1,1X,I1,1X,I4,1X,A6)
     IF (LINE.EQ.0) GO TO 460
     IF(IPOS.GT.9.OR.IPOS.LT.1)GO TO 105
     IF(LINE.GT.3.OR.LINE.LT.0)GO TO 105
     IF(NDX.LT.1)GO TO 105
     GO TO (102,103,104),LINE
 102 IF(IPOS.EQ.1)GO TO 105
     IF(NDX.GT.600)GO TO 105
     N(IPOS-1)=NDX
     NW(IPOS-1)=NAME
     GO TO 90
```

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```
103 IF(NDX.GT.223)GO TO 105
    N(IPOS+9)=NDX
    NW(IPOS+9)=NAME
    GO TO 90
104 IF(NDX.GT.1270)GO TO 105
    N(IPOS+18)=NDX
    NW(IPOS+18)=NAME
    GO TO 90
105 GO TO 85
450 WRITE(6,402)
402 FORMAT('0DO YOU WISH TO CHANGE INITIAL DATA?')
    READ(5,20)KYY
    IF(KYY.NE.KY)GO TO 401
    WRITE(6,403)
403 FORMAT('0TO CHANGE INPUT ENTER MODEL NO. (CVS=1,THERM=2',
   &',RESP=3),INDEX,&VALUE      (I1,1X,I4,F12.5)')
    GO TO 410
406 WRITE(6,411)
411 FORMAT(' READ ERROR,TRY AGAIN')
410 CONTINUE
404 READ(5,405,ERR=406)MMOD,NDX,VALU
405 FORMAT(I1,1X,I4,F12.5)
    IF(MMOD.EQ.0)GO TO 401
    IF(MMOD.GT.3.OR.MMOD.LT.0)GO TO 406
    IF(NDX.LE.0)GO TO 406
    GO TO (407,408,409),MMOD
407 IF(NDX.GT.600)GO TO 406
    X(NDX)=VALU
    GO TO 404
408 IF(NDX.GT.223)GO TO 406
    XTRA(NDX)=VALU
    INIT=3
    GO TO 404
409 IF(NDX.GT.1270)GO TO 406
    XRARA(NDX)=VALU
    GO TO 404
460 WRITE(6,461)
461 FORMAT(' DO YOU WISH TO CREATE AN OUTPUT FILE?')
    READ(5,20)K
    IF(K.NE.KY)GO TO 200
    INIT=2
555  CONTINUE
    IB=IB+1
    IF(IB.EQ.17)GO TO 555
200 CONTINUE
    IF (T.GT.0.001) GO TO 215
    IF (N(7).NE.469) GO TO 210
    IF (X(495).LT.0.5) GO TO 210
    NW(7)=NWTL
    N(7)=575
210 WRITE (6,205) (NW(I),I=1,8),(N(I),I=1,8)
205 FORMAT(///'           CARDIOVASCULAR MODEL',/
   $           '   SECS',8(2X,A6)/'    599',8I8/'  *****',
   *  8('   *****'))
    WRITE(6,206)(NW(I),I=10,18),(N(I),I=10,18)
    WRITE(6,207)(NW(I),I=19,27),(N(I),I=19,27)
206 FORMAT(1X,'           THERMOREGULATORY MODEL',/
```

```
      LISTING OF WHOLE BODY ALGORITHM

     &      1X,A6,8(2X,A6)/,17,8I8/1X,' *****',8(' *****'))
  207 FORMAT(1X,'           RESPIRATORY MODEL',/
     &      1X,A6,8(2X,A6)/,17,8I8/1X,' *****',8(' *****'))
  215 DO 220 I=1,9
      K=N(I)
      A(I,5)=X(K)
  220 A(I,6)=(A(I,1)+A(I,2)+A(I,3)+A(I,4)+A(I,5))/5.0
      DO 221 I=10,18
      K=N(I)
      XIOP(I-9)=XTRA(K)
  221 IF(N(11).EQ.0)XIOP(2)=TRIN(1)
      DO222 I=19,27
      K=N(I)
      XIOP(I-9)=XRARA(K)
  222 IF(I.GE.25.AND.K.EQ.0)XIOP(I-9)=XRD(I-24)
      X(570)=A(9,6)
      IF (N(7).EQ.575 .AND. T.LT.61.) A(7,6)=0.
C      WRITE(6,300)T,(A(I,5),I=1,8)
      IF (T.GT.1. .AND. IONE.LT.1) GO TO 427
      IF ((T-PT).LT.1.1 .OR. AMOD(T,ABS(X(599))).GT.1.) GO TO 310
      LP=T
      PT=LP
      PTI=PT/60.
      WRITE(6,301)
  301 FORMAT(1H )
      WRITE(6,300)PTI,(A(I,6),I=1,8)
  300 FORMAT (9F8.3)
      WRITE(6,300)(XIOP(I),I=1,9)
      WRITE(6,300)(XIOP(I),I=10,18)
      IF(INIT.NE.2)GO TO 430
      NPASS=NPASS+1
      IF(IONE.GT.0)GO TO 429
  427 PTI=0.
      IONE=1
      DO 428 I=1,27
  428 XNUM(I)=N(I)
      XNUM(1)=27.
      REWIND 1B
      WRITE(1B)(XNUM(I),I=1,27)
  429 WRITE(1B)PTI,(A(I,6),I=1,8),(XIOP(I),I=1,18)
      NSTP=X(560)/X(599)
      IF(NSTP.EQ.NPASS)ENDFILE 1B
  430 CONTINUE
  310 DO 320 J=1,4
      DO 320 I=1,9
  320 A(I,J)=A(I,J+1)
      RETURN
      END
      SUBROUTINE ALGO(T)
C                INTEGRATION ALGORITHM
      COMMON /STATE/ X(50),XDOT(50)
      DIMENSION XDS(50)
      DO 3 I=1,34
    3 XDS(I)=XDOT(I)
      H=0.001
      IF(T.GT.11.)H=.002
      T=T+H
```

LISTING OF WHOLE BODY ALGORITHM

```
      CALL CVS
      DO 4 I=1,34
    4   X(I)=H/2.*(XDOT(I)+XDS(I))+X(I)
      RETURN
      END
      FUNCTION SWIN(X,A,B)
      IF(X) 1,2,2
    1 SWIN=A
      RETURN
    2 SWIN=B
      RETURN
      END
      FUNCTION FCNSW(X,A,B,C)
      IF(X)1,2,3
    1 FCNSW=A
      RETURN
    2 FCNSW=B
      RETURN
    3 FCNSW=C
      RETURN
      END
      SUBROUTINE DELAY(FIC,N,X,TS,XOUT,K)
C               N=NO. OF SECS. DELAY
      DIMENSION TS(100)
      ST=0.2
      M=IFIX(FLOAT(N)/ST)
      IF(K)10,10,20
   20 XOUT=TS(1)
      DO 1 I=1,M
    1 TS(I)=TS(I+1)
      TS(M)=X
      RETURN
   10 DO 2 I=1,M
    2 TS(I)=FIC
      RETURN
      END
C     BLOCK DATA SUBROUTINE BLKDAT
      BLOCK DATA
      COMMON/STATE/A(100)
      COMMON/STATE/B(50)
      COMMON/STATE/C(50)
      COMMON/STATE/D(50)
      COMMON/STATE/E(50)
      COMMON/STATE/F(20)
      COMMON/STATE/G(280)
C** STATE
      DATA A/101.,246.7,43.3,244.6,8.4,11.7,30.5,19.,0.,0.,          1- 10
     1 0.,14.9,0.,15.3,14.8,59.4,4.0,118.2,200.,42.,                 11- 20
     2 385.2,274.4,37.9,8.75,29.0,74.8,3.6,230.1,15.,109.5,          21- 30
     3 16.2,47.3,5*0.,0.0,12*0.,50*0./                               31-100
C** FLOW
      DATA B/39*0.,204.,224.,208.,211.,212.,214.,215.,231.,0.,0.,0./  101-150
C** COMP
      DATA C/4*0.,1.2,1.7,5.3,.25,2*0.,2*.2,0.,.21,.2,.8,.3,3.96,3.14,.6 151-170
     1 ,3*0.,.12,.3996,5.3,.9058,9.59,1.505,6.047,                   171-180
     2 .2224,2.517,5*0.,.3,12*0./                                    181-200
C** PRES
```

LISTING OF WHOLE BODY ALGORITHM

```
      DATA D/40*0.,0.001,7*0.,2*90./                                    201-250
C** RES
      DATA E/3*.007508,.004,.01502,.05255,.015022,2*0.,.01200,          251-260
     1 .0400,0.,.0340000,.0340,.03003,4.505,.4505,.07508,.07508,.02102, 261-270
     2.00738,.007508,.01502,.1,.03378,3.431,.3754,.004302,15.39,2.35    271-280
     3 ,34.5345,.2252,.5255,.3003,.01502,.45045,2.744,.6494,0.,0.,      281-290
     4 9*0.,5.15/                                                       291-300
C** INRT
      DATA F/.0007508,.002,2*0.,.004,.004,0.,.004,.00626,11*0./         301-320
C** MISC
      DATA G/48*0.,5000.,5000.,30.,0.,30.,0.,85.,15.,400.,61.6,2*0.,    321-380
     1 0.,90.5,0.,43.5,5.194,30.,30.,162.,188.,40.,                     381-390
     2 3*0.,50.,50.,509.,28.,562.,0.0,375.,                             391-400
     3 50.,150.,18*0.,                                                  401-420
     * 34*0.,32*0.,4*0.,88.,2.55,3.60,9999.,0.,                        421-495
     * 0.,0.0,0.,2.,0.,7*0.,-7.,2*0.,                                  496-510
     4 0.,10.,10.,16.,6.,16.,2*0.,16.,14.,                              511-520
     5 14.,2.,-7.,-14.,0.,0.,-14.,13*0.,                                521-540
     * 0.,0.,120.,612.,420.,0.,720.,0.,11*-1.,721.,
     6 72.,.09,6.7,5*0.,8.3,0.,                                         561-570
     7 .0550,0.,-1.5,0.,90.,.48,.833,.19,.36,46.,                       571-580
     8 10.,-.015,88.,14*0.,0.00,30.,0./                                 581-600
      COMMON/XIOD/N(27),NW(27),INIT
      DATA INIT/0/
      DATA NW/'    HR','    CO','    SV','VO2DOT',
     *    '  SYST','  DIAS','  LBNP','  LEGV','      ',
     *    '  T(1)','  TSBF',' QEVAP','  WORK','STORAT',
     *    ' QSTOR',' QSHIV',' T(41)','  SQUG',
     *    '    VI','    VE',' PA O2','PA CO2',' CA H+',
     *    'CSF H+','  TVNT',' AVO2D','  FREQ'/
      DATA N/561,563,562,570,567,568,469,600,570,
     &125,0,92,223,124,120,119,165,123,
     & 1265,1264,1200,1206,1256,1033,3*0/
      COMMON/RINTR/RIN(10),ROUT(10)
      DATA RIN(2)/12.8/
      END
C   BLOCK DATA SUBROUTINE TRDAT
      BLOCK DATA
      COMMON/TRINT/TRIN(10),TROUT(10),PTIM
      COMMON /TRM/QBASAL,UEFF,TCAB,TW,TDEWC,VCAB,VEFF,PCAB,G,
     $        CLOV,EUG,CPG,DT,PRINTI,SETI,XIPOS,
     &        ACE(10),ARE(10),C(41),CLO,DTIME,EMAX(10),PRINT,PRNOW,
     &        QEVAP,QLCG,QRAD(10),QRSEN1,QRSEN2,QRSEN3,QRSEN5,QRSEN6,
     &        QSEN(10),QSHIV,QSTOR,RM,SETT,SQUG,STORAT,T(43),
     &        TIME,TSET(41),TUG(10),TUGAV,U,VPDEW,WORK,
     &        ICOND,IPOS,MCASES,NIO,IOPUT(20)
      DATA QBASAL,UEFF,TCAB,TW,TDEWC,VCAB,VEFF,PCAB
     &          ,G,CLOV,EUG,CPG,DT,PRINTI,SETI,XIPOS,IPOS,MCASES/
     &283.,22.,75.,75.,52.,20.,100.,14.7,1.,.1,.99,.22,.05,1.,240.,
     &1.,1,0/
      DATA T/98.59,94.17,93.14,92.24,98.61,98.18,90.66,88.22,95.60,95.77
     &,93.01,92.02,95.60,95.77,93.01,92.02,96.60,97.00,92.88,92.04
     &,96.60,97.00,92.88,92.04,91.01,90.57,89.89,89.13,91.01,90.57
     &,89.89,89.13,88.43,88.32,87.96,87.47,88.43,88.32,87.96,87.47
     &,98.36,90.24,97.48/
      DATA QSTOR/9.15/
      DATA TUG/92.24,86.87,90.06,90.06,90.14,90.14,89.13
```

LISTING OF WHOLE BODY ALGORITHM

```
     &,89.13,87.47,87.47 /
      DATA TROUT/33.25,12.5,7.0,.31,51.25,5*0./
      DATA IOPUT/125,166,92,223,124,120,119,165,12*0/
      DATA TSET/98.53,95.13,94.66,94.24, 98.40,97.30,94.15,92.52,
     *          95.95,93.42,92.46,91.85, 95.95,93.42,92.46,91.85,
     *          96.46,95.54,95.56,93.38, 96.46,95.54,95.56,93.38,
     *          95.74,95.68,95.54,95.40, 95.74,95.68,95.54,95.40,
     *          95.25,95.05,95.20,95.07, 95.25,95.05,95.20,95.07,
     *          98.4/
      DATA C/4.89 ,0.727,0.485,0.529, 26.59,35.57,9.36,2.67,
     *       1.56,3.35,0.635,0.474, 1.56,3.35,0.635,0.474,
     *       4.67,10.10,1.58,1.19 , 4.67,10.10,1.58,1.19,
     *       0.154,0.066,0.099,0.187, 0.154,0.066,0.099,0.187,
     *       0.254,0.0660,0.143,0.243, 0.254,0.0660,0.143,0.243,
     *       4.96/
      END
C     BLOCK DATA SUBROUTINE NDAT
      BLOCK DATA
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
      COMMON/R/ XDS,XMH,CXT,WORK,DUM1,DUM2,DUM3,WORK2,RMTB,RMTB2,TIMEOF
     1  ,RMLIN,ITTY
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      DATA/C/.05269,.15144,.79587,.63977,.00114,.00974,.61323,
     &.00145,.00974,6.0,.73723,47.85777,36.01092,567.44715,40.,0.,
     $.2,.1,.1,1.138,1.154,3.,1.0,39.,.05,.05,81.99,4.361,2.524,
     &760.,.0004,.2096,.79,.1,0.,.0078125,87.55,5.39,.25,0./
      DATA/BC/.547,.585,.585,.585/
       DATA/RMT/.182,.215/
      DATA ITTY/'TTY '/
      END
      SUBROUTINE GRODIN
      COMMON/XIOD/IARA(55),RARA(56),XNC(3)
      COMMON/STATE/XXZZ(600)
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/RINTR/ROUT(10),CIN(10)
      COMMON/TOSHOR/GUYIN(20),OUTGUY(20)
C     C(40)
C  ALVEOLAR VOL GAS FUNCTIONS
C       1   FA(CO2)
C       2   FA( O2)
C       3   FA(N2)
C
C  GAS CONCENTRATIONS IN BRAIN.
C       4   CB(CO2)
C       5   CB(O2)
C       6   CB(N2)
C
C  GAS CONCENTRATIONS IN TISSUE.
C       7   CT(CO2)
```

LISTING OF WHOLE BODY ALGORITHM

```
C       8    CT(O2)
C       9    CT(N2)
C  CARDIAC OUTPUT.
C      10    Q
C  CEREBRAL BLOOD FLOW.
C      11    QB
C  GAS TENSION IN CSF.
C      12    PCSF(CO2)
C      13    PCSF(O2)
C      14    PCSF(N2)
C
C  LENGTH OF SIMULATION RUN.
C  (THIS IS NOT USED IN TTY MODE. IN BATCH,A WORK CARD WITH 0 TIME WILL
C   ALSO STOP RUN).
C      15    TMAX
C  WEIGHTING OF H+CONC IN CSF VERSUS VENOUS BLOOD OF BRAIN.
C      16    CENTRAL SENSITIVITY PARTITION
C  BLOOD OXYGEN CAPACITY
C      17    (HB)
C  TIME CONSTANTS IN CARDIAC OUTPUT AND CEREBRAL BLOOD FLOW RESPONSES.
C      18    R1
C      19    R2
C
C  CONTROLLER EQUATION SENSITIVITY WEIGHTINGS.
C      20    CENTRAL SENSITIVITY COEFFICIENT
C      21    CAROTID BODY SENSITIVITY COEFFICIENT
C
C  VOLUMES OF LUNG,BRAIN,AND TISSUE
C      22    KL
C      23    KB
C      24    KT
C
C  BRAIN METABOLIC RATE OF CO2 PRODUCTION.
C      25    MRB(CO2)
C  BRAIN METABOLIC RATE OF O2 CONSUMPTION.
C      26    MRB(O2)
C  GAS DIFFUSION COEFF.FOR BLOOD-BRAIN BARRIER.
C      27    DCO2
C      28    DO2
C      29    DN2
C
C  BAROMETRIC PRESSURE.
C      30    B
C  VOL.FRACTION OF INSPIRED GAS.
C      31    FI(CO2)
C      32    FI(O2)
C      33    FI(N2)
C
C  VOL.OF CSF.
C      34    KCSF
C  INITIAL TIME
C      35    T
C  COMPUTER TIME STEP.
C      36    H
C  CONTROLLER EQUATION CONSTANT(MAINTAINS RESTING PA(CO2) APPROX.40).
C      37    VI(N)
C  VALUE FOR RESTING ALVEOLAR VENTILATION.
```

LISTING OF WHOLE BODY ALGORITHM

```
C      38   VI(SS)
C  OUTPUT PRINT INCREMENTS (ALSO PRINTS AT .5MIN.INCRIMENTS).
C      39   PRINT=ALL TIME
C
C      SV(18,50)
C  ARTERIAL GAS CONCENTRATIONS AT LUNG EXIT.
C       1   CA(CO2)
C       2   CA(O2)
C       3   CA(N2)
C
C  VENOUS GAS CONCENTRATIONS AT BRAIN EXIT.
C       4   CVB(CO2)
C       5   CVB(O2)
C       6   CVB(N2)
C
C  VENOUS GAS CONCENTRATIONS AT TISSUE EXIT.
C       7   CVT(CO2)
C       8   CVT(O2)
C       9   CVT(N2)
C
C  CARDIAC OUTPUT.
C      10   Q
C  CEREBRAL BLOOD FLOW.
C      11   QB
C  TISSUE BLOOD FLOW.
C      12   QT
C  ARTERIAL H+ CONCENTRATION.
C      13   CA(H+)
C  ARTERIAL O2 TENSION.
C      14   PA(O2)
C
C      15   --
C  TOTAL GAS CONCENTRATIONS AT BRAIN EXIT.
C      16   CVB(CO2) + CVB(O2) + CVB(N2)
C  TOTAL GAS CONCENTRATIONS AT TISSUE EXIT.
C      17   CVT(CO2) + CVT(O2) + CVT(N2)
C  TIME.
C      18   T
C
C      VTRAN(18)
C  ARTERIAL GAS CONCENTRATIONS AT BRAIN ENTRANCE.
C       1   CAB(CO2) = CA(CO2)(T - TAB)
C       2   CAB(O2) = CA(O2)(T - TAB)
C       3   CAB(N2) = CA(N2)(T - TAB)
C
C  VENOUS BRAIN GAS CONCENTRATION AT LUNG ENTRANCE.
C       4   CVB(CO2)(T - TVB)
C       5   CVB(O2)(T - TVB)
C       6   CVB(N2)(T - TVB)
C
C  VENOUS TISSUE GAS CONCENTRATION AT LUNG ENTRANCE.
C       7   CVT(CO2)(T - TVT)
C       8   CVT(O2)(T - TVT)
C       9   CVT(N2)(T - TVT)
C
C  ARTERIAL GAS CONCENTRATIONS AT TISSUE ENTRANCE.
C      10   CAT(CO2) = CA(CO2)(T - TAT)
```

LISTING OF WHOLE BODY ALGORITHM

```
C      11    CAT(O2) = CA(O2)(T - TAT)
C      12    CAT(N2) = CA(N2)(T - TAT)
C
C   ARTERIAL H+ CONCENTRATION AT CAROTID BODIES'SITE.
C      13    CAO(H+) = CA(H+)(T - TAO)
C   ARTERIAL O2 TENSION AT CAROTID BODIES'SITE.
C      14    PAO(O2) = PA(O2)(T - TAO)
C   ARTERIAL H+ CONCENTRATION AT BRAIN ENTRANCE.
C      15    CAB(H+) = CA(H+)(T - TAB)
C   TOTAL GAS CONCENTRATION FROM BRAIN AT LUNG ENTRANCE.
C      16    (CVB(CO2) + CVB(O2) + CVB(N2))(T - TVB)
C   TOTAL GAS CONCENTRATION FROM TISSUE AT LUNG ENTRANCE.
C      17    (CVT(CO2) + CVT(O2) + CVT(N2))(T - TVT)
C
C      D(15)
C    FOR D(15) THE SYMBOLS B=BAROMETRIC PRESSURE, 47=WATER VAPOR PRESS.,
C   K=CONVERSION FACTOR FOR ATM TO MMHG, A=SOLUBILITY COEFF.OF GASES,
C   H=COMPUTER TIME STEP, HB=BLOOD OXYGEN CAPACITY
C       1    B - 47
C       2    K ACO2
C       3    K AO2
C       4    K AN2
C       5    K AN2 (B - 47)
C       6    K AO2 (B - 47)
C       7    K AN2 (B - 47)
C       8    0.16 + 2.3(HB)
C       9    863/(B - 47)
C      10    0.62
C      11    K ACSF(CO2)
C      12    K ACSF(O2)
C      13    K ACSF(N2)
C      14    2*H
C      15    1.99*H
C      F(20)
C   COMPARTMENTAL GAS TENSIONS AND CONCENTRATIONS.
C       1    PA(O2)
C       2    K ACO2 PA(CO2)
C       3    PB(O2)
C       4    K ACO2 PB(CO2)
C       5    PT(O2)
C       6    K ACO2 PT(CO2)
C       7    PA(CO2)
C       8    PA(O2)
C       9    CA(O2)
C      10    CA(N2)
C      11    CA(CO2) + CA(O2) + CA(N2)
C      12    CVB(O2)
C      13    CVT(O2)
C
C   PRODUCT OF DIFFUSION COEFFS.AND GAS DIFFERENTIALS ACROSS BLOOD-BRAIN
C   BARRIER.
C      14    DCO2 (PB(CO2) - PCSF(CO2))
C      15    DO2 (PB(O2) - PCSF(O2))
C      16    DN2 (PB(N2) - PCSF(N2))
C
C      17    PB(O2)
C      18    PB(N2)
```

LISTING OF WHOLE BODY ALGORITHM

```
      DIMENSION  DJ(4), IDJ(2)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
      COMMON/R/ XDS,XMH,CXT,WORK,DUM1,DUM2,DUM3,WORK2,RMTB,RMTB2,TIMEOF
     1  ,RMLIN,ITTY
      DATA KKY,KYY/'YES ','Y   '/
C   ITTY =FLG FOR TTY MODE.
C      0= OUTPUT TO PRINTER (BATCH MODE).
C      'TTY '= TTY I/O AND 1ST TIME TO SUBROUTINE RC12.
C      1 = TTY I/O AND NOT 1ST TIME TO RC12.
      DATA ITTTY/'TTY '/
C      DATA FOR INITIAL CONDITIONS
      C(10)=CIN(1)
      IF (CXT.GT.0.) GO TO 60
C      WRITE (6,5)
C    5 FORMAT (/'   GRODINS: RESPIRATORY CONTROL MODEL'//)
300   CONTINUE
C      WRITE(6,483)
C  483 FORMAT('0ADD DATA...')
C   READ INDICATION OC BATCH OR TTY MODE.
C      READ(5,480) ITTY
C  480 FORMAT(A4)
C      IF(ITTY .NE. ITTTY) ITTY = 0
C      WRITE(6,90)
C   90 FORMAT (1H1,1X,37H*RESPIRATORY CHEMOSTAT -- INPUT DATA*/)
C      DATA FOR INITIAL CONDITIONS
C      DO 10 I = 1,40
C   1106 HAS PROBLEM WITH END= , SO THIS ISNT USED TO
C    DETERMINE END OF RUN(NOO CAPABILITY TO START ANOTHER
C    MODEL RUN IN SAME COMPUTER RUN).
C      READ(5,190,END=301) C(I),(XN(I,J),J=1,2)
C   10 CONTINUE
      IEXC=RARA(56)
      IF(IEXC.NE.5)GO TO 1778
      DO 1777 I=1,3
 1777 C(30+I)=XNC(I)
 1778 CONTINUE
C    ESTABLISH COMPUTER STEP INDEPENDENT OF INPUT DATA.
      C(36)=.78125E-2
C  190 FORMAT (5X,F15.0,5X,2A4)
C      DO 20 I = 1,4
C      IP40 = I + 40
C      READ    (5,190) BC(I), (XNB(I,J), J = 1,2)
C   20 CONTINUE
C      DO 30 I = 1,2
C      READ   (5,190) RMT(I), (XNB(I,J), J = 1,2)
C      IP40 = I + 44
C   30 CONTINUE
C      DO 40 I = 1,2
C      READ    (5,190) DJ(I), (XNB(I,J), J = 1,2)
C      IP40 = I + 46
C   40 CONTINUE
C
      DATA/DJ/0.,0.,0.,0./
C      INPUT FROM GUYTON MODEL - HCT TO HB
      C(17)=GUYIN(6)*GUYIN(7)**.005
```

LISTING OF WHOLE BODY ALGORITHM

```
C  OUTPUT INPUT DATA.
C      J = 1
C      DO 75 I = 1,8
C      JX = J + 4
C      WRITE(6,92) J,(C(I2),I2=J,JX)
C   92 FORMAT(' ',I2,2X,5(F9.4))
C      J = J + 5
C   75 CONTINUE
C      WRITE(6,92) J,(BC(I),I=1,4)
C      J = 45
C      WRITE(6,92) J,RMT(1),RMT(2),DJ(1),DJ(2)
C
C  IF TTY I/O MAX.TIME WILL COME FROM WORK CARD.
       C(15) = 9999999999.
C
C  FI(CO2)
       DUM1=C(31)
C  FI(O2)
       DUM2=C(32)
C  FI(N2)
       DUM3=C(33)
       WORK=0.
       WORK2=0.
C  METABOLIC RATE OF O2 CONSUMPTION IN TISSUE.
       RMTB=CIN(3)-C(26)
       RMTB2=CIN(3)-C(26)
C
       TIMEOF=0.
       XDS=0.
       XMH=10.*C(36)/0.0078125
       MMM=0
201    CONTINUE
       XDS=XDS+XMH
       IF(MMM.EQ.1)XDS=XDS+C(36)
       MMM=1
       C(35)=0.
       C(40)=0.
C
C      INITIAL GUESSES FOR ITERATIVE LOOPS
C  ARTERIAL CONCENTRATION OF CO2.
       CC(1) = 0.6
C  BRAIN CONCENTRATION OF CO2.
       CC(2) = C(4)
C  TISSUE CONCENTRATION OF CO2.
       CC(3) = C(7)
C  BRAIN CO2 TENSION.
       CPB = 50.0
C  TISSUE CO2 TENSION.
       CPT = 50.0
       IF(XDS.GT.XMH) GOTO202
C      SETS VARIOUS CONSTANTS AND AGGREGATES OF CONSTANTS
C  TMAX.
       C(15) = C(15) + .0001
C  PRINT ALL TIME.
C      C(39) = C(39) + .0001
C  FACTOR OF 1-E-7 MULTIPLYING DIFFUSION COEFFICIENTS.
       DO 200 I = 27,29
```

LISTING OF WHOLE BODY ALGORITHM

```
      C(I) = C(I) * 1.E-7
  200 CONTINUE
  202 CONTINUE
      IRK = 1
      M = 14
      N = 5
      IDJ(1) = 0
C      SOLUBILITY COEFFICIENTS.
C    A(1)= (ALPHA)CO2, A(2)= (ALPHA)O2, A(3)= (ALPHA)N2,
C    A(4)= (ALPHA)CO2, A(5)= (ALPHA)O2, A(6)= (ALPHA)N2
      A(1) = 0.51
      A(2) = 0.024
      A(3) = 0.013
      A(4) = 0.51
      A(5) = 0.024
      A(6) = 0.013
C   ATM/MMHG CONVERSION FACTOR.
      SK = 0.00132
C   CARBONIC ACID DISSOCIATION CONSTANT.
      CADK = 795.0
C   VOL(1)-VOL(10)= VOLUMES USED IN CALCULATION OF VARIABLE TIME DELAYS.
      VOL(1) = 0.015
      VOL(2) = 1.062
      VOL(3) = 0.188
      VOL(4) = 0.06
      VOL(5) = 0.188
      VOL(6) = 2.94
      VOL(7) = 0.735
      VOL(8) = 1.062
      VOL(9) = 0.008
      VOL(10)= 1.062
C
C  (METABOLIC RATE OF CO2 IN BRAIN + TISSUE.) / SAME FOR O2
      QF(6) = (C(25) + RMT(1))/(C(26) + RMT(2))
C    B=47
      D(1)=C(30)-47.
      DO 210 I = 2,4
C   PRODUCTS OF CONVERSION FACTORS AND SOLUBILITY COEFFICIENTS.
      D(I) = SK*A(I-1)
      D(I+9) = SK*A(I+2)
C
      D(I+3) = D(1)*D(I)
  210 CONTINUE
C   FACTOR USED IN ESTABLISHING CA(CO2)
      D(8) = 0.16 + 2.3*C(17)
C
      D(9) = 863.0/D(1)
C   FACTOR USED IN ESTABLISHING CB(CO2).
      D(10) = 0.62
C   MANIPULATION OF COMPUTER TIME STEP.
      D(14) = C(36)*2.0
      D(15) = D(14) - .01*C(36)
C
      CALL RC3
      CALL RC4
      CALL RC5 (CPB, F(4), C(4), BC(2))
      CALL RC21 (CHB(2), F(3), F(4), C(4), CH(2), CPH(2))
```

LISTING OF WHOLE BODY ALGORITHM

```
      CALL RC19 (CPB, CHB(2), CC(2), BC(1), F(4))
      CALL RC5 (CPT, F(6), C(7), BC(3))
      CALL RC21 (CHB(3), F(5), F(6), C(7), CH(3), CPH(3))
      CALL RC19 (CPT, CHB(3), CC(3), BC(1), F(6))
      CALL RC20
      CALL RC7
      CALL RC8
      CALL RC9
      CALL RC10
      CALL RC11
      CALL RC12
      GO TO 60
   50 CALL RC15
      CALL RC16
   60 CALL RC13
      CALL RC12
C
      IF(C(35).GE.XMH) GO TO 201
C
      IF (C(35) .GT. C(15)) GOTO80
      IF(CXT.GT.C(15)) GOTO 80
   70 CALL RC14
      UU = AMOD(C(35), D(14))
      IF (UU .LT. .0001 .OR. UU .GT. D(15))   GOTO50
      RETURN
C      GO TO 60
   80 WRITE(6,78)
   78 FORMAT('1 FINAL VALUES FOR FOLLOWING VARIABLES.')
      IF (C(37) .GT. 1.0E-5)      GO TO 250
  220 CTERM = 0.0
      IF (VTRAN(14) - 104.0)       230, 240, 240
  230 CTERM = (23.6E-9)*((104.0 - VTRAN(14))**4.9)
  240 C(37) = C(20)*(C(16)*VTRAN(15) + (1.0 - C(16))*CH(4))
     1       + C(21)*VTRAN(13) + CTERM - VI
      I = 37
      WRITE(6,192)I,C(I), (XN(I,J), J = 1,2)
  250 DO 260 I = 1,14
      WRITE(6,192)I,C(I), (XN(I,J), J = 1,2)
  260 CONTINUE
      WRITE (6,194)
      WRITE(6,830)
  830 FORMAT('0NORMAL TERMATION')
  301 CONTINUE
      STOP
C   90 FORMAT (1H1,48X,37H*RESPIRATORY CHEMOSTAT -- INPUT DATA*///)
C   92 FORMAT (42X,I3,10XF10.4,10X2A6)
C  190 FORMAT (5XF15.0,5X2A6)
  192 FORMAT(' ',I3,2X,F15.5,2X,2A4)
  194 FORMAT (1H1)
      END
      SUBROUTINE RC3
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
```

LISTING OF WHOLE BODY ALGORITHM

```
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C6969                 FORMAT(1H 7HSUB RC3)
C      SETS TIME-DEPENDENT EXPRESSIONS
C  TISSUE BLOOD FLOW.
       QF(1) = C(10) - C(11)
C  ARTERIAL O2 TENSION.
       F(1) = D(1)*C(2)
C  ARTERIAL CO2 CONCENTRATION.
       F(2) = D(5)*C(1)
C  BRAIN O2 CONCENTRATION / (CONV.FACTOR*SOLUBILITY COEFF.FOR O2)
       F(3) = C(5)/D(3)
C  (CONV.FACTOR*SOLUBILITY COEFF.FOR CO2) * BRAIN CO2 TENSION.
       F(4) = D(2)*CPB
C  TISSUE O2 CONCENTRATION / (CONV.FACTOR*SOLUBILITY COEFF.FOR O2)
       F(5) = C(8)/D(3)
C  (CONV.FACTOR*SOLUBILITY COEFF.FOR CO2) * TISSUE CO2 TENSION.
       F(6) = D(2)*CPT
C  ARTERIAL CO2 TENSION.
       F(7) = D(1)*C(1)
C  ARTERIAL O2 TENSION.
       F(8) = D(1)*C(2)
       RETURN
       END
       SUBROUTINE RC4
       DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
      1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
      2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
      3          DQ(4)
       COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
      1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
      2        IRK, LOC, ITERX, INDEX, I, J, M, N
C      ITERATES FOR CC(1), ARTERIAL CO2 CONCENTRATION
C6969                 FORMAT(1H 7HSUB RC4)
  410  CALL RC21 (CHB(1), F(1), F(2), CC(1), CH(1), CPH(1))
       X = (CC(1) - F(2))/(0.01*F(7))
       X = RCF1(X)
C   SEE EQUATION 3.1,   X= CA(CO2) .
       X = BC(1) + 0.375*(C(17) - CHB(1)) + F(2) - D(8)*(X - 0.14)
C   CC(1) = CA(CO2) .
       CALL RC6 (CC(1))
       CC(1) = CC(1) + 2.0*(X - CC(1))/3.0
C3000 FORMAT(1H ,5HCC(1),5X,E16.6)
       IF (ITERX)   420, 410, 420
  420  RETURN
       END
       SUBROUTINE RC5 (CP, FB, CCB, BHC)
       DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
      1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
      2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
      3          DQ(4)
       COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
      1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
      2        IRK, LOC, ITERX, INDEX, I, J, M, N
C      ITERATES FOR BRAIN AND TISSUE PCO2
C6969                 FORMAT(1H 7HSUB RC5)
  510  X = (CCB - FB)/(0.01*CP)
       X = RCF1(X)
```

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```
C  SEE EQUATION 4.1,  X = PB(CO2) .
      X = (-BHC + CCB + D(10)*(X - 0.14))/D(2)
C  CP = PB(CO2) .
      CALL RC6 (CP)
      CP = CP + (X - CP)/10.0
C  CEREBRAL BLOOD FLOW.
      FB = D(2)*CP
C3000 FORMAT(1H ,4HCP= ,E16.6,4HFB= E16.6,5HCCB= E16.6,5HBHC= E16.6)
      IF (ITERX)   520, 510, 520
  520 RETURN
      END
      SUBROUTINE RC6 (Y)
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C     CHECKS CONVERGENCE OF ITERATIVE PROCEDURES
C       RC4 : X=CA(CO2), Y=CC(1)  .
C       RC5 : X=PB(CO2), Y=CP  .
C      RC19 : X=CVB(CO2), Y=CVC .
C6969               FORMAT(1H 7HSUB RC6)
      ITERX = 0
      DIFF = ABS ((X - Y)/Y)
      IF (DIFF - 1.0E-5)    620, 620, 630
  620 ITERX = 1
  630 RETURN
      END
      SUBROUTINE RC7
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1        SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2        BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3        DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
      COMMON/R/ XDS,XMH,CXT,WORK,DUM1,DUM2,DUM3,WORK2,RMTB,RMTB2,TIMEOF
     1  ,RMLIN
C6969               FORMAT(1H 7HSUB RC7)
C     FILLS SV ARRAY WITH INITIAL CONDITIONS
      CALL RC16
      IF(XDS.GT.XMH) GOTO2
      DO 725 I = 1,17
      DO 720 J = 2,50
      SV(I,J) = SV(I,1)
  720 CONTINUE
  725 CONTINUE
2     CONTINUE
      DO 730 J = 2,50
      SV(18,J) = SV(18,J - 1) - D(14)
  730 CONTINUE
C3000 FORMAT(1H ,12H18SV S D(14),6(3X,E16.6)/1H ,6(3X,E16.6)/1H ,7(3X,E1
C     C6.6))
      RETURN
      END
```

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```
      SUBROUTINE RC8
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
C     CALCULATES TRANSPORT TIMES
C      EQUATIONS 8.10 THRU 8.14  .
C6969              FORMAT(1H 7HSUB RC8)
      DO 870 I = 1,5
      DT = C(35) - SV(18,1)
      ND = 1
      GO TO (810,812,814,816,810), I
  810 NC = 11
      NB = 10
      GO TO 820
  812 NC = 10
      NB = 11
      GO TO 820
  814 NC = 10
      NB = 12
      GO TO 820
  816 NC = 12
      NB = 10
      QA = QF(1)
      GO TO 822
  820 QA = C(NC)
  822 DO 860 J = 1,2
      GO TO (834,824), J
  824 NC = NB
      ND = K + 1
      IF (K)              826, 826, 832
  826 IF (NC - 12)        830, 828, 830
  828 QA = SV(NC,1) - (SV(NC,1) - QF(1))*DT/(C(35) - SV(18,1))
      GO TO 834
  830 QA = SV(NC,1) - (SV(NC,1) - C(NC))*DT/(C(35) - SV(18,1))
      GO TO 834
  832 QA = SV(NC,ND) - (SV(NC,K) - SV(NC,ND))*DT/D(14)
  834 IJ = 2*I + J - 2
      AB = VOL(IJ)
      AA = DT*(QA + SV(NC,ND))/2.0
      DO 838 K = ND,49
      IF (AA - AB)        836, 836, 840
  836 AA = AA + C(36)*(SV(NC,K) + SV(NC,K+1))
  838 CONTINUE
      WRITE (6,890) I
  840 DA = AA - AB
      K = K - 1
      IF (K)             842, 842, 846
  842 DV = SV(NC,1) - QA
      IF (DV)             850, 844, 850
  844 DT = DA/QA
      GO TO 860
  846 DV = SV(NC,K+1) - SV(NC,K)
      IF (DV)             850, 848, 850
```

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```
  848 DT = DA/SV(NC,K)
      GO TO 860
  850 DT = (SV(NC,K+1) - SQRT (SV(NC,K+1)**2 - DV*DA/C(36)))/(DV/D(14))
  860 CONTINUE
      TAU(I) = C(35) - SV(18,K + 1) - DT
  870 CONTINUE
      RETURN
  890 FORMAT (5X27HSV ARRAY EXCEEDED ON CYCLE I2)
      END
      SUBROUTINE RC9
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C     SETS VALUES IN VTRAN ARRAY
C6969               FORMAT(1H 7HSUB RC9)
      DO 960 I = 1,5
      TA = TAU(I) - (C(35) - SV(18,1))
      LOC = TA/D(14)
      IF (LOC - 49)     904, 904, 902
  902 WRITE (6,990) I,LOC
      LOC = 49
  904 XLOC = LOC
      TB = XLOC*D(14)
      DT = TA - TB
      GO TO (910,920,930,940,950), I
  910 DO 914 J = 1,3
C  LUNG TO BRAIN CO2,O2,N2 TIME DELAYED ARTERIAL CONCENTRATIONS.
      VTRAN(J) = RCF3(J)
  914 CONTINUE
C  LUNG TO BRAIN H+ TIME DELAYED ARTERIAL CONCENTRATION.
      VTRAN(15) = RCF3(13)
      GO TO 960
  920 DO 924 J = 4,6
C  BRAIN TO LUNG CO2,O2,N2 TIME DELAYED VENOUS CONCENTRATIONS.
      VTRAN(J) = RCF3(J)
  924 CONTINUE
C  BRAIN TO LUNG COMBINED CO2,O2,N2 TIME DELAYED VENOUS CONCENTRATIONS.
      VTRAN(16) = RCF3(16)
      GO TO 960
  930 DO 934 J = 7,9
C  TISSUE TO LUNG CO2,O2,N2 TIME DELAYED VENOUS CONCENTRATIONS.
      VTRAN(J) = RCF3(J)
  934 CONTINUE
C  TISSUE TO LUNG COMBINED CO2,O2,N2 TIME DELAYED VENOUS CONCENTRATIONS.
      VTRAN(17) = RCF3(17)
      GO TO 960
  940 DO 944 J = 1,3
C  LUNG TO TISSUE CO2,O2,N2 TIME DELAYED ARTERIAL CONCENTRATIONS.
      VTRAN(J+9) = RCF3(J)
  944 CONTINUE
      GO TO 960
C  LUNG TO CAROTID SITE H+ TIME DELAYED ARTERIAL CONCENTRATION.
  950 VTRAN(13) = RCF3(13)
```

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```
C  LUNG TO CAROTID SITE O2 TIME DELAYED ARTERIAL TENSION.
      VTRAN(14) = RCF3(14)
  960 CONTINUE
C     NAMELIST/DONM/VTRAN
      RETURN
  990 FORMAT (5X27HSV ARRAY EXCEEDED ON CYCLE I2,12H WITH LOC = I4)
      END
      SUBROUTINE RC10
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
C6969              FORMAT(1H 8HSUB RC10)
C     COMPUTES EMPIRICAL FUNCTIONS FOR ACRDIAC OUTPUT AND BRAIN BLOOD
C     FLOW DIFFERENTIAL EQUATIONS
C   F(8) > PA(O2) .
      IF (F(8) - 104.0)          1008, 1020, 1020
C   (DELTA)Q(O2) , EQUATION 7.3 .
 1008 DQ(1) = ((-1.0033E-5*F(8) + 2.9241E-3)*F(8) - 0.2885)*F(8) +9.6651
C   (DELTA)QB(O2) , EQUATION 7.9 .
      DQ(2) = (((7.6559E-8*F(8) - 2.324E-5)*F(8) + 2.6032E-3)*F(8)
     1       - 0.1323)*F(8) + 2.785
      IF (DQ(1))                 1012, 1016, 1016
 1012 DQ(1) = 0.0
 1016 IF (DQ(2))                 1024, 1028, 1028
 1020 DQ(1) = 0.0
 1024 DQ(2) = 0.0
C     F(7) = PA(CO2) .
 1028 IF (F(7) - 60.0)           1032, 1032, 1036
C
C     IF.PCO2 GT 60 DQ(3) STAYS AT ITS VALUE AT 60 - - OLD ROUTINE SETS
C     THE VALUE OF DQ(3) EQUAL TO 0
 1032 IF (F(7) - 40.0)           2036, 1040, 1040
 2036 DQ(3)=0.
      GOTO1044
C   (DELTA)Q(CO2) , REPLACES EQUATION 7.6 .
1036  DQ(3)=6.0
C
      GO TO 1044
C   (DELTA)Q(CO2) , EQUATION 7.5 .
 1040 DQ(3) = 0.3*(F(7) - 40.0)
 1044 IF (F(7) - 38.0)           1048, 1052, 1052
C   (DELTA)QB(CO2) , EQUATION 7.11 .
 1048 DQ(4) = (8.0163E-4*F(7) - 3.1073E-2)*F(7) + 2.3232E-2
      RETURN
 1052 IF (F(7) - 44.0)           1056, 1056, 1060
 1056 DQ(4) = 0.0
      RETURN
C   (DELTA)QB(CO2) , EQUATION 7.13 .
 1060 DQ(4) = (((-2.1748E-7*F(7) + 9.3918E-5)*F(7) - 1.2947E-2)*F(7)
     1       + 0.7607)*F(7) - 15.58
C     NAMELIST/DG/DQ,F
      RETURN
      END
```

LISTING OF WHOLE BODY ALGORITHM

```
      SUBROUTINE RC11
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1         SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2           BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3           DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C     CALCULATES DIFFERENTIAL EQUATIONS
C6969                FORMAT(1H 8HSUB RC11)
      CALL RC17
C  EQUATION 10.1 .
      DC(1) = (VI*C(31) - VE*C(1) + D(9)*(C(11)*VTRAN(4) + QF(1)
     1         *VTRAN(7) - C(10)*CC(1)))/C(22)
C  EQUATION 10.2 .
      DC(2) = (VI*C(32) - VE*C(2) + D(9)*(C(11)*VTRAN(5) + QF(1)
     1         *VTRAN(8) - C(10)*F(9)))/C(22)
C  EQUATION 10.3 .
      DC(3) = (VI*C(33) - VE*C(3) + D(9)*(C(11)*VTRAN(6) + QF(1)
     1         *VTRAN(9) - C(10)*F(10)))/C(22)
C  EQUATION 10.4 .
      DC(4) = (C(25) + C(11)*(VTRAN(1) - CC(2)) - F(14))/C(23)
C  EQUATION 10.5 .
      DC(5) = (-C(26) + C(11)*(VTRAN(2) - F(12)) - F(15))/C(23)
C  EQUATION 10.6 .
      DC(6) = (C(11)*(VTRAN(3) - C(6)) - F(16))/C(23)
C  EQUATION 10.7 .
      DC(7) = (RMT(1) + QF(1)*(VTRAN(10) - CC(3)))/C(24)
C  EQUATION 10.8 .
      DC(8) = (-RMT(2) + QF(1)*(VTRAN(11) - F(13)))/C(24)
C  EQUATION 10.9 .
      DC(9) = QF(1)*(VTRAN(12) - C(9))/C(24)
C  EQUATION 7.1 .
      DC(10) = (-C(10) + 6.0 + DQ(1) + DQ(3))/C(18)
C  DEPENDANCE OF CARDIAC OUTPUT ON TISSUE
C  UTILIZATION OF OXYGEN.
C
      XAB=5.5 *(RMT(2)-.215)+6.-C(10)
      IF((RMT(2).GT..215).AND.(XAB.GT.0.))DC(10)=DC(10)+XAB/.010
C
C
C  EQUATION 7.7 .
      DC(11) = (-C(11) + 0.75 + DQ(2) + DQ(4))/C(19)
C  EQUATION 1.10 .
      DC(12) = F(14)/(C(34)*D(11))
C  EQUATION 1.11 .
      DC(13) = F(15)/(C(34)*D(12))
C  EQUATION 1.12 .
      DC(14) = F(16)/(C(34)*D(13))
C     NAMELIST/AB/DC
      RETURN
      END
      SUBROUTINE RC12
      COMMON/XIOD/IARA(55),RARA(56),XNC(3),TVNT,AVO2DF,FREQ
      COMMON/STATE/XXZZ(600)
      COMMON/RINTR/ROUT(10),CIN(10)
      COMMON/TOSHOR/GUYIN(20),OUTGUY(20)
```

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      LISTING OF WHOLE BODY ALGORITHM

       DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
      1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
      2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
      3          DQ(4)
       COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
      1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
      2        IRK, LOC, ITERX, INDEX, I, J, M, N
       COMMON/R/ XDS,XMH,CXT,WORK,DUM1,DUM2,DUM3,WORK2,RMTB,RMTB2,TIMEOF
      1  ,RMLIN,ITTY,ITTYOT,ITTYIN,WRKTTY(50,3),LEXEC,MARKER,NWREST
      2  ,RMTM,TCT,DURAT,TIMEON,RMTK,TKT
       DATA IRUN/'RUN '/,ISTOP/'STOP'/,MORE/'MORE'/
       DATA IBACK/'BACK'/
C       DIMENSION WRKTTY(50,3)
C6969                 FORMAT(1H BHSUB RC12)
C      OUTPUT -- PUNCHED CARDS AND PRINTED
       CXT=C(35)+XDS-10.
       IF(CXT.LE.0.)CXT=+0.
C   DEAD SPACE VOLUME
       DSVOL=0.140+0.002*VE
C   RESPIRATORY FREQUENCY.
       FREQ=((1.+(.726*VE)/DSVOL)**.5-1.)/.363
C   DEAD SPACE VENTILATION
       DEADVT=1.+.098*VE
C      C(31)=(DEADVT*C(1)+VE*DUM1)/(DEADVT+VE)
C      C(32)=(DEADVT*C(2)+VE*DUM2)/(DEADVT+VE)
C      C(33)=(DEADVT*C(3)+VE*DUM3)/(DEADVT+VE)
C   MINUTE VOLUME.
       TVNT=DEADVT+(VE+VI)/2.
C   HEART RATE.
       HRATE=43.8*(RMT(2)+C(26))+54.5
C
C
       IF(CXT .LT. TIMEOF) GO TO 203
C
C   HERE IF NEED TO READ A NEW WORK LOAD CARD.
C          BRANCH IF IN BATCH MODE.
       IF(ITTY .EQ. 0) GO TO 500
C
C
       ITST=RARA(56)
       IF(ITST.EQ.4)WRKTTY(1,2)=(XXZZ(560)-1.)/60.
C    HERE IF TTY MODE.................
       IF(ITTY .EQ. 1) GO TO 550
C   HERE IF TTY MODE, AND 1ST TIME THIS ROUTINE CALLED.
       ITTY = 1
C      WRITE(6,505)
C  505 FORMAT('0INPUT WORK CARDS...'/)
C      1 ' WORK= WORK LOAD(WATTS)...'/
C      2 ' MINS= TIME FOR WORK LOAD...'/
C      3 ' PRINT= TIME INCRIMENT(MINS)FOR PRINTOUT...'/
C      4 ' EXEC...'/
C      5 '  MORE= INPUT MORE BEFORE EXEC...'/
C      6 '  RUN = EXEC.WITH ABOVE,THEN CAN INPUT AGAIN...'/
C      7 '  STOP= EXEC.WITH ABOVE THEN STOP...'/
C      8 '  BACK= ERASE PREVIOUS WORK RECORD...')
  504  ITTYIN = 0
       ITTYOT = 1
```

LISTING OF WHOLE BODY ALGORITHM

```
      PRINT=XXZZ(599)/60.
      IF(ITST.NE.3)GO TO 701
      DO 747 I=1,18,2
      INDX=I+541
      IF(XXZZ(INDX+1).LE.0.)GO TO 747
      IF(RARA(56).GT.4..AND.ITTYIN.GE.1.)GO TO 747
      IF(XXZZ(INDX).LT.0.)GO TO 747
      ITTYIN=ITTYIN+1
      WRKTTY(ITTYIN,1)=XXZZ(INDX)/6.12
      WRKTTY(ITTYIN,2)=(XXZZ(INDX+1)-XXZZ(INDX-1))/60.
      WRKTTY(ITTYIN,3)=PRINT
  747 CONTINUE
      GO TO 702
  701 ITTYIN=1
      WRKTTY(ITTYIN,2)=(XXZZ(560)-1.)/60.
      WRKTTY(ITTYIN,3)=PRINT
      WRKTTY(ITTYIN,1)=0.
  702 CONTINUE
      LEXEC=IRUN
C     DO 9999 I=1,ITTYIN
C9999 WRITE(6,748)I,(WRKTTY(I,J),J=1,3)
C 748 FORMAT( 3X,' WORK CARDS',/,I3,3X,3(F10.5))
C
C  HERE IF 1ST TIME THIS ROUTINE CALLED.
C SEE IF MORE WORK CARDS IN BUFFER(WRKTTY(50,3))
  550 IF(ITTYOT .LE. ITTYIN) GO TO 551
C  HERE IF EXAUSTED WORK CARD BUFFER (WRKTTY(50,3)).
      IF(LEXEC .EQ. IRUN) GO TO 504
C  FORCE END OF COMPUTER RUN WHEN LEXEC= 'STOP'.
      C(15) = 0.
      GO TO 1210
C
  551 WORK2 = WRKTTY(ITTYOT,1)
      DURAT = WRKTTY(ITTYOT,2)
      C(39) = WRKTTY(ITTYOT,3)
      ITTYOT = ITTYOT + 1
      GO TO 606
C
C
C
  203 IF(MARKER.EQ.0) GOTO101
  1   WORK=WORK2
      MARKER=1
C  SYSTEM RESPONSES: TIME CONSTANTS FOR WORK LOAD LEVELS(INCREASING).
      IF(WORK.LE.0.)GOTO2
      IF(WORK.GE.50.) TKT=2.3/(2.**WORK/200.)
      IF(WORK.LT.50)TKT=4.6
      TIMEIN=CXT-TIMEON
      IF(WORK.LE.50.)TCT=1.6632
      IF(WORK.GT.50..AND.WORK.LE.100.)TCT=2.2864-.6232*WORK/50.
      IF(WORK.GT.100..AND.TIMEIN.LE.2.)TCT=1.04
      IF(WORK.GT.100..AND.TIMEIN.GT.2.)TCT=.45
C  TISSUE O2 METABOLIC RATE.
      IF(TIMEIN.LE.2.)RMT(2)
     & =SSO2W(WORK)-(SSO2W(WORK)-RMTB2)*EXP(-TCT*TIMEIN)
      IF(TIMEIN.LE.2.)RMTK=RMT(2)
      IF(TIMEIN.GT.2.)RMT(2)
```

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      LISTING OF WHOLE BODY ALGORITHM

     & =SSO2W(WORK)-(SSO2W(WORK)-RMTK)*EXP(-TCT*(TIMEIN-2.))
      VTIME=1.1-1.1*EXP(-TKT*(CXT-TIMEON)/1.92)
C   TERM USED IN VI THAT IS A COMPONENT OF TRANSIENT RESPONSE RELATED
C   TO WORK LOAD.
      RMLIN =SSO2W(WORK)-(SSO2W(WORK)-RMTB2)*(1.-VTIME)
      IF(VTIME.GE.1.) RMLIN=SSO2W(WORK)
C   TISSUE CO2 METABOLIC RATE.
      RMT(1)=.88*RMT(2)
      IF(TVNT.GT.37.) RMT(1)=(TVNT+40.77)*RMT(2)/88.5
      IF(C(35).LT.C(40)) GOTO2
      WRITE (6,333) RMT(1),RMT(2)
333   FORMAT(  '0',1X,25HCHANGE IN METABOLIC RATES,5X,7HMRCO2= ,F10.4,
     1  5X,6HMRO2= ,F10.4,/)
C
C
   2  CONTINUE
      IF (WORK.LE.0.0 .AND. NWREST.LT.1) RMT(2)=CIN(3)-C(26)
      AVO2DM=(F(9)*C(10)-F(13)*(C(10)-C(11))-F(12)*C(11))*1000.
      AVO2DF=AVO2DM/C(10)
C     OUTPUT INTERFACE FROM RESPIRATORY
      OUTGUY(3)=CHB(1)
      ROUT(1)=AVO2DM/1000.
      IF (WORK.GT.0.) ROUT(1)=RMT(2)*C(26)
      ROUT(2)=FREQ
      ROUT(3)=C(11)
      ROUT(4)=F(7)
      ROUT(5)=F(1)
C     U = AMOD(C(35), 0.5)
C     IF (U .LT. 1.0E-5 .OR. U .GT. .4999)        GO TO 1210
      IF(C(35).LT.C(40))GOTO1230
      C(40)=C(40)+C(39)
C  ARTERIAL N2 TENSION.
 1210 PAN2 = D(1)*C(3)
C  TISSUE O2 TENSION.
      PTO2 = C(8)/D(3)
C  TISSUE N2 TENSION.
      PTN2 = C(9)/D(4)
C  CEREBROSPINAL FLUID PH , EQUATION 6.2 .
      PHCSF = 9. - RCF1(CH(4))
C  VENOUS BRAIN H+ CONCENTRATION , EQUATION 4.7 .
      HVB   = CADK*F(4)/(CC(2) - F(4))
C  VENOUS BRAIN PH , EQUATION 4.6 .
      PHVB  = 9. - RCF1(HVB)
C  VENOUS TISSUE H+ CONCENTRATION , EQUATION 5.7 .
      HVT   = CADK*F(6)/(CC(3) - F(6))
C  VENOUS TISSUE PH , EQUATION 5.6 .
      PHVT  = 9. - RCF1(HVT)
C  RESPIRATORY QUOTIENT (ALVEOLAR).
      RQ = ((C(11)*VTRAN(4) + QF(1)*VTRAN(7))/C(10) - CC(1))/
     1       (F(9) - (C(11)*VTRAN(5) + QF(1)*VTRAN(8))/C(10))
      QF(5) = QF(6) - RQ
C
C.
C  HERE WHEN READY TO PRINT.
C          SEE IF TTY MODE.
      IF(ITTY .EQ. 0) GO TO 610
C
```

LISTING OF WHOLE BODY ALGORITHM

```
C  HERE IF TTY OUTPUT.
C      WRITE (6,700) CXT,CC(1),CC(2),CC(3),F(9),F(12),F(13),
C     &  VTRAN(13),CH(4),F(7),CPB,CPT,F(1),F(17),PTO2,VI,VE,
C     &  FREQ,TVNT,C(11),AVO2DF,RMT(2),C(10)
C 700 FORMAT(/F9.4,9X,6F9.4/8F9.4/8F9.4/)
      RETURN
  610 IF (N .NE. 4)      GO TO 1220
      N = 0
      WRITE (6,1805)
 1220 N = N + 1
C
      WRITE (6,1810) CXT, RQ, QF(5)
C
      WRITE (6,1815)   (C(I), I = 1,3), (DC(I), I = 1,3), F(7), F(1),
     1       PAN2
      WRITE (6,1820)   CC(1), F(9), F(10), F(7), F(1), PAN2, CH(1),
     1       CPH(1), CHB(1)
      WRITE (6,1825)   (C(I), I = 4,6), (DC(I), I = 4,6), CPB, F(17),
     1       F(18), CH(2), CPH(2)
      WRITE (6,1830)   (C(I), I = 7,9), (DC(I), I = 7,9), CPT, PTO2,
     1       PTN2, CH(3), CPH(3)
      WRITE (6,1835)   (DC(I), I = 12,14), (C(I), I = 12,14), CH(4),
     1       PHCSF
      WRITE (6,1840)   CC(2), F(12), C(6), CPB, F(17), F(18), HVB,
     1       PHVB, CHB(2)
      WRITE (6,1845)   CC(3), F(13), C(9), CPT, PTO2, PTN2, HVT,
     1       PHVT, CHB(3)
      WRITE (6,1850)   (TAU(I), I = 1,5), VI, VE, C(10), C(11), DC(10),
     1       DC(11)
      WRITE (6,1855) FREQ,TVNT,DEADVT,HRATE,AVO2DF,DSVOL
 1230 RETURN
 1290 FORMAT (5H XXXX5X7F10.4)
 1292 FORMAT (8F10.4)
 1805 FORMAT (1H1)
 1810 FORMAT (1H06X4HTIMEF10.4,74X6HALV RQF10.4,3X7HRQ DIFF,F8.4/
     1       16X3HCO28X2HO28X2HN27X21HD E R I V A T I V E S9X4HPCO26X
     2       3HPO27X3HPN27X4H(H+)7X2HPH5X4HHBO2)
 1815 FORMAT (3X8HALVEOLAR9F10.4)
 1820 FORMAT (3X8HARTERIAL3F10.4,30X,5F10.4,F8.4)
 1825 FORMAT (6X5HBRAIN11F10.4)
 1830 FORMAT (5X6HTISSUE11F10.4)
 1835 FORMAT (8X3HCSF30X8F10.4)
 1840 FORMAT (4X7HV BRAIN3F10.4,30X,5F10.4,F8.4)
 1845 FORMAT (3X8HV TISSUE3F10.4,30X,5F10.4,F8.4)
 1850 FORMAT (5X18HTRANSPORT TIMES --4X2HAB8X2HVB8X2HVT8X2HAT8X2HAC2X
     1   2H**4X2HVI8X2HVE8X1HQ9X2HFB7X11HDERIVATIVES/21X,10F10.4,F8.4)
 1855 FORMAT(3X,9HRESP FREQ,F8.4,2X,13HMINUTE VOLUME,F8.4,
     1   2X,8HD S VENT,F8.4,2X,10HHEART RATE,F8.4,
     2   2X,7HAVO2DF,F8.4,2X,5HDSVOL,F8.4)
C    BATCH MODE WORK CARD READ...
C
C      WILL USE WORK CARD WITH TIME=0 AS INDICATION
C      OF END OF RUN BECAUSE 1106 HAS PROBLEM
C      WITH END= ON READ.
  500  READ(5,300,END=2) WORK2,DURAT
  300  FORMAT(F6.2,3X,F6.2)
C
```

LISTING OF WHOLE BODY ALGORITHM

```
      IF(DURAT .GT. 0.) GO TO 606
C  HERE IF READ INDICATION OF END OF RUN IN BATCH MODE.
      C(15) = 0.
      GO TO 1210
C
  606 CONTINUE
C 606 WRITE (6,305) WORK2,DURAT,CXT
C 305 FORMAT('0',43('*')/
C     1 ' WORK LOAD CHG.(',F6.2,'WATTS FOR',
C     2 F8.2,'MINS) AT',F9.4,'MINS')
  607 TIMEOF=DURAT+CXT
      TIMEON=CXT
C  SYSTEM RESPONSES; TIME CONSTANTS FOR WORK LOADS AND TISSUE O2
C  METABOLIC RATE.
      IF(WORK2.GE.WORK)RMTB2=RMT(2)
C  DECREASING WORK LOADS.
      IF(WORK2.LT.WORK) RMTM=RMT(2)
      IF(WORK2.LT.WORK)RMTB=SSO2W(WORK2)
      IF((WORK2.LT.WORK).AND.(WORK.GE.50.))   TCT=2.3/(2.*WORK/200.)
      IF((WORK2.LT.WORK).AND.(WORK.LT.50.))TCT=4.6
      IF(WORK2.GE.WORK) GOTO1
  101 WORK=WORK2
      MARKER=0
      NWREST=2
C  TISSUE O2 METABOLIC RATE.
      RMT(2)=RMTB-(RMTB-RMTM)*EXP(-TCT*(CXT-TIMEON)*.50)
      VTIME=1.1-1.1*EXP(-TCT*(CXT-TIMEON)/3.84)
C  TERM USED IN VI THAT IS A COMPONENT OF TRANSIENT RESPONSE RELATED
C  TO WORK LOAD.
      RMLIN =RMTB-(RMTB-RMTM)*(1.-VTIME)
      IF(VTIME.GE.1.) RMLIN=RMTB
C  TISSUE CO2 METABOLIC RATE.
      RMT(1)=.88*RMT(2)
      IF(TVNT.GT.37.) RMT(1)=(TVNT+40.77)*RMT(2)/88.5
      IF(C(35).LT.C(40)) GOTO2
      WRITE (6,333) RMT(1),RMT(2)
      GOTO2
      END
      SUBROUTINE RC13
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2         BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
C6969              FORMAT(1H 8HSUB RC13)
C     SOLVES M DIFFERENTIAL EQUATIONS BY FOURTH-ORDER RUNGE-KUTTA AND
C     ADAMS-MOUTLON PREDICTOR-CORRECTOR METHODS
C     NAMELIST/DBG/C,DC,SC
      IF (IRK - 4)      1304, 1356, 1356
 1304 DO 1352 INDEX = 1,4
      DO 1308 I = 1,M
      RK(I,INDEX) = DC(I)
 1308 CONTINUE
      GO TO (1312, 1320, 1328, 1340), INDEX
 1312 DO 1316 I = 1,M
```

LISTING OF WHOLE BODY ALGORITHM

```
      SC(I,IRK+1) = C(I)
      SC(I,IRK) = DC(I)
 1316 CONTINUE
      TI = C(35)
 1320 C(35) = TI + C(36)/2.0
      DO 1324 I = 1,M
      C(I) = SC(I,IRK+1) + C(36)*RK(I,INDEX)/2.0
 1324 CONTINUE
      GO TO 1336
 1328 C(35) = TI + C(36)
      DO 1332 I = 1,M
      C(I) = SC(I,IRK+1) + C(36)*RK(I,INDEX)
 1332 CONTINUE
 1336 CALL RC14
      GO TO 1352
 1340 DO 1344 I = 1,M
      C(I) = SC(I,IRK+1) + C(36)*(RK(I,1) + 2.0*RK(I,2) + 2.0*RK(I,3)
     1        + RK(I,4))/6.0
 1344 CONTINUE
      IRK = IRK + 1
 1352 CONTINUE
      RETURN
 1356 DO 1360 I = 1,M
      SC(I,5) = C(I)
      SC(I,4) = DC(I)
      C(I) = SC(I,5) + C(36)*(55.0*SC(I,4) - 59.0*SC(I,3) + 37.0*SC(I,2)
     1        - 9.0*SC(I,1))/24.0
 1360 CONTINUE
      C(35) = C(35) + C(36)
      NC35=C(35)/C(36) + .1
      C(35)=C(36)*NC35
 1364 CALL RC14
      DO 1368 I = 1,M
      SC(I,1) = C(I)
      C(I) = SC(I,5) + C(36)*(9.0*DC(I) + 19.0*SC(I,4) - 5.0*SC(I,3)
     1        + SC(I,2))/24.0
 1368 CONTINUE
      DO 1372 I = 1,M
      IF  (ABS  (C(I) - SC(I,1)) - 1.0E-3)  1372, 1372, 1364
 1372 CONTINUE
      DO 1376 I = 1,M
      DO 1376 J = 1,3
      SC(I,J) = SC(I,J+1)
 1376 CONTINUE
      RETURN
      END
      SUBROUTINE RC14
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C     CALLS OTHER SUBROUTINES IN A BLOCK
C6969               FORMAT(1H 8HSUB RC14)
      CALL RC3
```

LISTING OF WHOLE BODY ALGORITHM

```
      CALL RC8
      CALL RC9
      CALL RC4
      CALL RC5 (CPB, F(4), C(4), BC(2))
      CALL RC21 (CHB(2), F(3), F(4), C(4), CH(2), CPH(2))
      CALL RC19 (CPB, CHB(2), CC(2), BC(1), F(4))
      CALL RC5 (CPT, F(6), C(7), BC(3))
      CALL RC21 (CHB(3), F(5), F(6), C(7), CH(3), CPH(3))
      CALL RC19 (CPT, CHB(3), CC(3), BC(1), F(6))
      CALL RC10
      CALL RC20
      CALL RC11
      RETURN
      END
      SUBROUTINE RC15
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
C6969              FORMAT(1H 8HSUB RC15)
C     NAMELIST/SCH/SV
C     SHIFTS VALUES IN SV ARRAY
      DO 1530 I = 1,18
      DO 1520 J = 1,49
      JM = 51 - J
      JMM = JM - 1
      SV(I,JM) = SV(I,JMM)
 1520 CONTINUE
 1530 CONTINUE
      RETURN
      END
      SUBROUTINE RC16
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
      COMMON/R/ XDS,XMH,CXT,WORK,DUM1,DUM2,DUM3,WORK2,RMTB,RMTB2,TIMEOF
     1  ,RMLIN
C6969              FORMAT(1H 8HSUB RC16)
C     SETS VALUES FOR SV ARRAY
C  ARTERIAL CO2 CONCENTRATION.
      SV(1,1) = CC(1)
C  ARTERIAL O2 CONCENTRATION.
      SV(2,1) = F(9)
C  BRAIN VENOUS CO2 CONCENTRATION.
      SV(4,1) = CC(2)
C  ARTERIAL N2 CONCENTRATION.
      SV(3,1) = F(10)
C  BRAIN VENOUS O2 CONCENTRATION
      SV(5,1) = F(12)
C  BRAIN VENOUS N2 CONCENTRATION.
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      SV(6,1) = C(6)
C  TISSUE VENOUS CO2 CONCENTRATION.
      SV(7,1) = CC(3)
C  TISSUE VENOUS O2 CONCENTRATION.
      SV(8,1) = F(13)
C  TISSUE VENOUS N2 CONCENTRATION.
      SV(9,1) = C(9)
C  CARDIAC OUTPUT.
      SV(10,1) = C(10)
C  CEREBRAL BLOOD FLOW.
      SV(11,1) = C(11)
C  TISSUE BLOOD FLOW.
      SV(12,1) = QF(1)
C  ARTERIAL H+ CONCENTRATION.
      SV(13,1) = CH(1)
C  ARTERIAL O2 TENSION.
      SV(14,1) = F(1)
C  INITIAL TIME.
      SV(15,1) = 0.0
C  TOTAL GAS CONCENTRATIONS AT BRAIN EXIT.
      SV(16,1) = SV(4,1) + SV(5,1) + SV(6,1)
C  TOTAL GAS CONCENTRATIONS AT TISSUE EXIT.
      SV(17,1) = SV(7,1) + SV(8,1) + SV(9,1)
C  SIMULATED TIME.
      SV(18,1) = C(35)
      RETURN
      END
      SUBROUTINE RC17
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
      COMMON/R/ XDS,XMH,CXT,WORK,DUM1,DUM2,DUM3,WORK2,RMTB,RMTB2,TIMEOF
     1  ,RMLIN
C     NAMELIST/BAD/CH(4),CADK,D(11),C(12),BC(4),C(37),C(38),VTRAN(14),
C    1TERM,VI,C(20),C(16),VTRAN(15),C(21),VTRAN(13),C(37),D(9),C(11),
C    2VTRAN(16),QF(1),VTRAN(17),C(10),F(11),
C6969               FORMAT(1H 8HSUB RC17)
C     CALCULATES VENTILATION
C  CFS H+ CONCENTRATION , EQUATION 6.1 .
      CH(4)  = CADK*D(11)*C(12)/BC(4)
      IF (C(37) .GT. 1.0E-5)      GO TO 1708
 1704 VI = C(38)
      GO TO 1730
 1708 TERM = 0.0
C  DECISION ON ARTERIAL O2 TENSION AT CAROTID BODIES SITE.
      IF (VTRAN(14) - 104.0)      1710, 1720, 1720
 1710 TERM = (23.6E-9)*((104.0 - VTRAN(14))**4.9)
C  CONTROLLER EQUATION AS A FUNCTION OF HUMORAL TERMS.
 1720 VI = C(20)*(C(16)*VTRAN(15) + (1.0 - C(16))*CH(4))
     1      + C(21)*VTRAN(13) + TERM - C(37)
      IF(WORK .LE. 0.0) GO TO 1730
C  INCLUSION OF NEURAL COMPONENT AS A FUNCTION OF WORK LOAD.
      SVNT2=SSVENT(SSO2W(WORK))  -VI
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      IF((SVNT2.GT.0.).AND.(SVNT2.LE.15.))    VI=VI+SVNT2
      IF(SVNT2.GT.15.)  VI=VI+15.
C
C  DESCRIPTION OF TRANSIENT VENTILATION RESPONSE.
      SVNT =SSVENT(RMLIN ) -VI
      IF(SVNT.GT.0.5)    VI=VI+0.75*SVNT
C
C  EXPIRED VENTILATION RATE, EQUATION 11.1 .
 1730 VE = VI + D(9)*(C(11)*VTRAN(16) + QF(1)*VTRAN(17) - C(10)*F(11))
      IF (VI .LT. 0.0 .OR. VE .LT. 0.0)      GO TO 1740
      RETURN
 1740 VI = 0.0
      VE = 0.0
      RETURN
      END
      SUBROUTINE RC19 (CPA, CVHBA, CVC, BHCA, FC)
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
C     NAMELIST/DM2/CPA,CVHBA,CVC,BHCA,FC
C6969               FORMAT(1H 8HSUB RC19)
C     ITERATES FOR VENOUS BRAIN AND VENOUS TISSUE CO2 CONCENTRATION
C  TERM USED IN EQUATION 4.2 .
 1910 X = (CVC - FC)/(0.01*CPA)
C  LOGARITHM SUBROUTINE.
      X = RCF1(X)
C  EQUATION 4.2 .
      X = BHCA + 0.375*(C(17) - CVHBA) - D(8)*(X - 0.14) + FC
      CALL RC6 (CVC)
      CVC = CVC + 2.0*(X - CVC)/3.0
      IF (ITERX)         1920, 1910, 1920
 1920 CONTINUE
      RETURN
      END
      SUBROUTINE RC20
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1       TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2       IRK, LOC, ITERX, INDEX, I, J, M, N
C     NAMELIST/NMF/F
C6969               FORMAT(1H 8HSUB RC20)
C     SETS TIME DEPENDENT EXPRESSIONS
C  ARTERIAL OXYGEN CONCENTRATION INCLUDING EFFECTS OF HEMOGLOBIN.
      F(9) = D(6)*C(2) + CHB(1)
C  ARTERIAL NITROGEN CONCENTRATION.
      F(10) = D(7)*C(3)
C  TOTAL ARTERIAL GAS CONCENTRATION AT LUNG EXIT.
      F(11) = CC(1) + F(9) + F(10)
C  VENOUS BRAIN OXYGEN CONCENTRATION INCLUDING EFFECTS OF HEMOGLOBIN.
      F(12) = C(5) + CHB(2)
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C  VENOUS TISSUE OXYGEN CONCENTRATION INCLUDING EFFECTS OF HEMOGLOBIN.
      F(13) = C(8) + CHB(3)
C  OXYGEN TENSION IN BRAIN.
      F(17) = C(5)/D(3)
C  NITROGEN TENSION IN BRAIN.
      F(18) = C(6)/D(4)
C  PRODUCT OF DIFFUSION COEFFS.AND DIFFERENTIAL BRAIN - CSF GAS TENSIONS
      F(14) = C(27)*(CPB - C(12))
      F(15) = C(28)*(F(17) - C(13))
      F(16) = C(29)*(F(18) - C(14))
C
      RETURN
      END
      SUBROUTINE RC21 (CHBA, FA, FD, CCA, CHA, CPHA)
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C6969              FORMAT(1H 8HSUB RC21)
C     NAMELIST/PB/CHBA,FA,FD,CCA,CHA,CPHA
C     COMPUTES H+ ION, PH, AND OXYHEMOGLOBIN
C  ARTERIAL H+ CONCENTRATION.
      CHA = CADK*FD/(CCA - FD)
C  ARTERIAL PH.
      CPHA = 9.0 - RCF1(CHA)
C  DEVELOPMENT OF EXPRESSION USED IN CALCULATION OF ARTERIAL
C  OXYHEMOGLOBIN SATURATION.
      X = RCF2(CPHA)
      X = -X * FA
      X = (1.0 - EXP (X))**2
      X=ABS(X)
C
C  ARTERIAL OXYHEMOGLOBIN CONCENTRATION.
      CHBA = X*C(17)
      RETURN
      END
      FUNCTION RCF1(W)
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C     LOGARITHM TO BASE 10
      RCF1    = 0.43429448 * ALOG(W)
      RETURN
      END
      FUNCTION RCF2(Z)
      DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1          SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2          BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3          DQ(4)
      COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
```

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     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C      OXYHEMOGLOBIN = PH EMPIRICAL FUNCTION
C        EQUATION 3.4 .
       RCF2     = (((0.0066815*Z) - 0.10098)*Z + 0.44921)*Z - 0.454
       RETURN
       END
       FUNCTION RCF3(KK)
       DIMENSION C(40), XN(40,2), SV(18,50), VTRAN(18), RK(14,4),
     1           SC(14,5), DC(14), A(6), D(15), F(20), VOL(10), RMT(2),
     2           BC(4), QF(6), TAU(5), CC(3), CHB(3), CH(4), CPH(3),
     3           DQ(4)
       COMMON/Z/ C, XN, SV, VTRAN, RK, SC, DC, A, D, F, VOL, RMT, BC, QF,
     1        TAU, CC, CHB, CH, CPH, DQ, VE, VI, CPB, CPT, CADK, X, DT,
     2        IRK, LOC, ITERX, INDEX, I, J, M, N
C      VTRAN FUNCTION
C  VARIABLES WITH TIME DELAYS USED IN EQUATIONS 8.1-8.1 .
       RCF3 = SV(KK,LOC) + (SV(KK,LOC + 1) - SV(KK,LOC))*DT/D(14)
       RETURN
       END
       FUNCTION  SSVENT(X)
C  CALCULATION OF STEADY-STATE VENTILATION RATE AS A FUNCTION OF TISSUE
C  OXYGEN METABOLIC RATE.
       IF(X.LE..215) SSVENT=5.398
       IF((X.GT..215).AND.(X.LT.2.))SSVENT=25.*X
       IF(X.GE.2.)SSVENT=50.+50.*(X-2.)
C
       RETURN
       END
       FUNCTION SSO2W(X)
C  CALCULATION OF STEADY-STATE OXYGEN REQUIREMENTS FOR VARIOUS LEVELS
C  OF WORK LOAD (X=WATTS).
       COMMON/RINTR/ROUT(10),CIN(10)
       VO2RDT=CIN(3)
       SSO2W=VO2RDT-.0500+(.0004850815*6.12*X)/.25
       RETURN
       END
       SUBROUTINE THERM
C      STOLWIJK METABOLIC MAN TRANSIENT MODEL
       COMMON /TRM/QBASAL,UEFF,TCAB,TW,TDEWC,VCAB,VEFF,PCAB,G,
     $        CLOV,EUG,CPG,DT,PRINTI,SETI,XIPOS,
     &        ACE(10),ARE(10),C(41),CLO,DTIME,EMAX(10),PRINT,PRNOW,
     &        QEVAP,QLCG,QRAD(10),QRSEN1,QRSEN2,QRSEN3,QRSEN5,QRSEN6,
     &        QSEN(10),QSHIV,QSTOR,RM,SETT,SQUG,STORAT,T(43),
     &        TIME,TSET(41),TUG(10),TUGAV,U,VPDEW,WORK,
     &        ICOND,IPOS,MCASES,NIO,IOPUT(20)
        COMMON/XIOD/IRARA(55),A(9,6),PT,EXC,XNC(3)
        COMMON/TRINT/TRIN(10),TROUT(10),PTIM
        COMMON/TOSHOR/GUYIN(20),OUTGUY(20)
        COMMON/TRDX/BF(40),QCOND(40),QCONV(40),QMET(40),TRCO
        DIMENSION PCA(10),XXTR(20)
        DIMENSION XNEW(223)
        EQUIVALENCE (QBASAL,XNEW(1))
        DATA PCA/.07,.3602,.06705,.06705,.1587,.1587,.025,.025,2*.0343/
        DATA KY/1HY/
C
C  DEFINITION OF BODY SEGMENT TEMPERATURE SUBSCRIPTS
```

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```
C   T(1)  = HEAD CORE          T(2)  = HEAD MUSCLE      T(3)  = HEAD FAT
C   T(4)  = HEAD SKIN          T(5)  = TRUNK CORE       T(6)  = TRUNK MUSC
C   T(7)  = TRUNK FAT          T(8)  = TRUNK SKIN       T(9)  = RIGHT ARM
C   T(10) = RIGHT ARM MUSCLE   T(11) = RIGHT ARM FAT    T(12) = RIGHT ARM
C   T(13) = LEFT ARM CORE      T(14) = LEFT ARM MUSCLE  T(15) = LEFT ARM F
C   T(16) = LEFT ARM SKIN      T(17) = RIGHT LEG CORE   T(18) = RIGHT LEG
C   T(19) = RIGHT LEG FAT      T(20) = RIGHT LEG SKIN   T(21) = LEFT LEG C
C   T(22) = LEFT LEG MUSCLE    T(23) = LEFT LEG FAT     T(24) = LEFT LEG S
C   T(25) = RIGHT HAND CORE    T(26) = RIGHT HAND MUSCLET(27) = RIGHT HAND
C   T(28) = RIGHT HAND SKIN    T(29) = LEFT HAND CORE   T(30) = LEFT HAND
C   T(31) = LEFT HAND FAT      T(32) = LEFT HAND SKIN   T(33) = RIGHT FOOT
C   T(34) = RIGHT FOOT MUSCLE  T(35) = RIGHT FOOT FAT   T(36) = RIGHT FOOT
C   T(37) = LEFT FOOT CORE     T(38) = LEFT FOOT MUSCLE T(39) = LEFT FOOT
C   T(40) = LEFT JOOT SKIN     T(41) = CENTRAL BLOOD    T(42) = AVERAGE SK
C   T(43) = AVERAGE MUSCLE
C
C       WRITE(6,442)(TROUT(I),I=1,5)
C442   FORMAT(1H ,5F10.4)
       IF(QBASAL.LT.0.01) QBASAL=293.
       IF(PTIM.GT..16)GO TO 321
       TROUT(1)=33.25
       TROUT(2)=12.5
       TROUT(3)=7.0
       TROUT(4)=.313
       TROUT(5)=51.25
  321   CONTINUE
       RM=TROUT(4)*4.825*60.*3.97
       IF(QBASAL.GT.RM) RM=QBASAL
C      WRITE(6,443)RM
C443   FORMAT(1H ,'RM=  ',F10.4)
C      U=UEFF/100.*(RM-QBASAL)
       IF(RM.GT.360.)GO TO 34
       U=0.
       GO TO 33
   34  U=UEFF/100.*(RM-360.)
   33  WORK=RM-QBASAL-U
C      WORK=RM-QBASAL-U
       IF (MCASES.GT.0) GO TO 260
C      WRITE(6,544)
C 544 FORMAT(1H ,'THERMOREGULATORY MODEL'/// ' DO YOU WISH TO'
C     &' SEE INITIAL DATA (Y/N)')
C      READ(5,545)LY
   545 FORMAT(A1)
    20 IF(IRARA(55).EQ.3)GO TO 330
  1330 MCASES=1
       IEXC=EXC
       IF(IEXC.NE.4)GO TO 1776
       TCAB=XNC(1)
       IDEWC=XNC(2)
  1776 CONTINUE
   330 IPOS=XIPOS
       IF(IPOS.GT.3.OR.IPOS.LT.1)GO TO 332
       GO TO (333,334,335),IPOS
   333 AC=19.5
       AR=15.5
       GO TO 336
   334 AC=15.5
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```
      AR=11.5
      GO TO 336
  335 AC=12.5
      AR=9.5
      GO TO 336
  332 WRITE(6,337)
  337 FORMAT(1H ,'ERROR IN AREA SPECIFICATION')
  336 CONTINUE
      DTIME=DT/60.
      SETX=SETI/60.
      SETT=SETX
      PRINT=PRINTI/60.
      PRNOW=PRINT
      ICOND=0
  140 DO 160 I=1,10
      ACE(I)=PCA(I)*AC
      ARE(I)=PCA(I)*AR
  160 CONTINUE
      TIME=0.
      VPDEW=VPT(TDEWC)
      CLO=.88*CLOV
  180 CONTINUE
      IF(MCASES.EQ.0)GO TO 260
C*****************************************************************
C     MAIN LOOP FOR SHIRTSLEEVE CASE
C*****************************************************************
  220 CONTINUE
  567 CONTINUE
      PTIM=TIME*60.
      DO 655 I1=1,NIO
      NGER=IOPUT(I1)
  655 XXTR(I1)=XNEW(NGER)
C     WRITE(6,444)PTIM,TRIN(2),(XXTR(IX),IX=1,NIO)
C     WRITE(6,444)(TROUT(I),I=1,10)
  444 FORMAT(1H ,10F7.2)
C 240 FORMAT(F8.1,9X,11F9.2)
      IF (MCASES.GT.0) RETURN
  260 OLDSTR = STORAT
C---------------------------------------------------------------
C
      CALL SHRT
C
C---------------------------------------------------------------
C     OUTPUT FROM THERM TO GUYTON
      OUTGUY(1)=QEVAP*454./1040.
      OUTGUY(2)=TRIN(1)
      TIME=TIME+DTIME
      PTIM=TIME*60.
  280 IF (TIME.GE.SETT.AND.MCASES.EQ.0) GO TO 300
      IF(MCASES.EQ.0) GO TO 260
      IF (PRNOW.GT.TIME) RETURN
      PRNOW=PRNOW+PRINT
      GO TO 220
  300 PTIM=TIME*60.
      PRNOW=PRNOW+PRINT
      IF(MCASES.EQ.0)GO TO 568
      RETURN
```

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```
 568  CONTINUE
C     WRITE(6,222)(QCONV(I1),I1=1,40),(BF(I2),I2=1,40),TRCO
C     WRITE(6,222)(XNEW(I1),I1=125,167),(XNEW(I2),I2=210,219),QSTOR
C 222 FORMAT(1H ,10F7.2)
      WRITE(6,225)
  225 FORMAT(' THERMOREGULATORY STEADY STATE')
      MCASES=1
      GO TO 20
      END
      SUBROUTINE MANT
      COMMON /TRM/QBASAL,UEFF,TCAB,TW,TDEWC,VCAB,VEFF,PCAB,G,
     $        CLOV,EUG,CPG,DT,PRINTI,SETI,XIPOS,
     &        ACE(10),ARE(10),C(41),CLO,DTIME,EMAX(10),PRINT,PRNOW,
     &        QEVAP,QLCG,QRAD(10),QRSEN1,QRSEN2,QRSEN3,QRSEN5,QRSEN6,
     &        QSEN(10),QSHIV,QSTOR,RM,SETT,SQUG,STORAT,T(43),
     &        TIME,TSET(41),TUG(10),TUGAV,U,VPDEW,WORK,
     &        ICOND,IPOS,MCASES,NIO,IOPUT(20)
      COMMON/TRINT/TSBF,DDEGF,TRIN(8),TROUT(10),TRTIME
      COMMON/TRDX/BF(40),QCOND(40),QCONV(40),QMET(40),TRCO
C     DIMENSION   QCONV(40),QCOND(40),BF(40),QMET(40),ERROR(40),WARM(41)
C    *           ,COLD(41),QDIF(10),QLAT(10)
      DIMENSION ERROR(40),WARM(41),COLD(41),QDIF(10),QLAT(10)
      DIMENSION   FACTOR(40),QSWT(10),WTAREA(10)
      DIMENSION BFB(40),QB(40),WORKM(10),CHILM(10),SKINV(10),SKINC(10),
     *          SKINS(10),SKINR(10),RESTM(10)
      DATA CSW,SSW,PSW,CDIL,SDIL,PDIL,CCON,SCON,PCON,CCHIL,SCHIL,PCHIL
     *  /705.0,64.0,0.0,166.,10.9,0.0,40.,10.,0.0,0.0,0.0,0.0,25.7/
      DATA BFB/99.3,0.265,0.287,3.18, 463.0,13.2,2.65,4.63,
     *         0.925,1.26,0.221,0.550,0.925,1.26,0.221,0.550,
     *          2.97,3.79,0.575,3.15, 2.97,3.79,0.575,3.15,
     *         0.111,0.265,0.0442,2.21, 0.111, .265, .0442,2.21,
     *         0.177, .0221, .055, 3.31,  .177, .0221, .055, 3.31/
C     DATA QB/.172,.00134,.00148,.00108,.610,.0672,.0286,.00537,
C    *.0047,.0064,.00114,.000875,.0047,.0064,.00114,.000875,
C    *.015,.0192,.00289,.00215,.015,.0192,.00289,.00215,
C    *.00054,.00134,.000202,.000336,.00054,.00134,.000202,.000336,
C    *.000875,.000135,.000268,.000470,.000875,.000135,.000268,
C    *.000470/
      DATA QB/.1652,.0027,.0017,.0018,.5955,.1015,.0246,.007,
     &.0035,.0086,.0015,.00115,.0035,.0086,.0015,.00115,
     $.0005,.00025,.00025,.0005,.0005,.00025,.00025,.0005,
     $.00765,.00183,.0026,.002,.00765,.00183,.0026,.002,
     $.0012,.00035,.00065,.001,.0012,.00035,.00065,.001/
      DATA WORKM/0.0,0.3,0.04,0.04,0.3,0.3,0.005,0.005,0.005,0.005/
C      DATA RESTM/.02,.663,.055,.055,.145,.145,4*.004/
C      DATA RESTM/.01,.55,.05,.05,.15,.15,4*.01/
      DATA CHILM/0.02,0.85,0.025,0.025,0.035,0.035,4*0.0/
      DATA RESTM/0.0132,0.721,0.03,0.03,0.0982,0.0982,.002,.002,.0023,
     &.0023/
      DATA SKINV/0.132,0.322,0.0475,0.0475,0.115,0.115,0.061,0.061,
     *          0.05,0.05/
      DATA SKINC/0.05,0.15,0.025,0.025,0.025,0.025,0.175,0.175,0.175,
     *          0.175/
      DATA SKINS/0.081,0.482,2*0.077,2*0.1095,2*0.0155,2*0.0175/
      DATA SKINR/.21,.42,.05,.05,.1,.1,.02,.02,.015,.015/
      DATA FACTOR/3.04,25.14,30.43,0.0,3.02,10.48,43.67,0.0,
     *           1.32,9.82,28.89,0.0,1.32,9.82,28.89,0.0,
```

```
      LISTING OF WHOLE BODY ALGORITHM

     *             9.93,13.68,70.57,0.0,9.93,13.68,70.57,0.0,
     *             6.07,10.64,10.92,0.0,6.07,10.64,10.92,0.0,
     *             15.44,19.52,15.55,0.0,15.44,19.52,15.55,0.0/
C*****************************************************************
C
C  SWEAT,SHIVER,CONSTRICTION,DILATION CALCULATIONS
C
C*****************************************************************
      DO 80 I=1,40
      ERROR(I)=T(I)-TSET(I)
      WARM(I)=0.0
      COLD(I)=0.0
      IF (ERROR(I)) 20,40,60
   20 COLD(I)=-ERROR(I)
   40 GO TO 80
   60 WARM(I)=ERROR(I)
   80 CONTINUE
C
      TAVSK=T(42)
C
C       INTEGRATE PEIPHERAL AFFERENTS
C
      WARMS = 0.0
      COLDS = 0.0
      DO 90 I=1,10
      K = 4*I
      WARMS = WARMS + WARM(K)*SKINR(I)
      COLDS = COLDS + COLD(K)*SKINR(I)
   90 CONTINUE
C
C       DETEMINE EFFERENT OUTFLOW
C
      SWEAT=CSW*ERROR(1)+SSW*(WARMS-COLDS)+PSW*WARM(1)*WARMS
      DILAT=CDIL*ERROR(1)+SDIL*(WARMS-COLDS)+PDIL*WARM(1)*WARMS
      STRIC=-CCON*ERROR(1)-SCON*(WARMS-COLDS)+PCON*COLD(1)*COLDS
C     QSHIV=(24.6*ERROR(1)+.756*(WARMS-COLDS))*.308*(WARMS-COLDS)
      TC=(T(1)-32.)*5./9.
      TAVG=(TAVSK-32.)*5./9.
      TC=TC-(.1-(((37.0-TC)*1.7)**2.)/10.)
      RMX=22221.-614.2*(TC)+TAVG*(-1933.2+53.66*(TC))
     &+TAVG**2*(46.45-1.289*(TC))
C    CONVERTS METABOLIC RATE FROM CAL/SEC TO BTU/HR
      RMX=RMX*3.6*3.97
      QSHIV=RMX-QBASAL
C
C       ENSURE EFFERENT COMMANDS ARE POSITIVE
C
      IF(SWEAT) 91,92,92
   91 SWEAT= 0.0
   92 IF(DILAT) 93,94,94
   93 DILAT = 0.0
   94 IF(STRIC) 95,96,96
   95 STRIC = 0.0
   96 IF(QSHIV) 97,98,98
   97 QSHIV = 0.0
   98 IF(ERROR(1)) 110,110,99
   99 QSHIV=0.0
```

LISTING OF WHOLE BODY ALGORITHM

```
  110 CONTINUE
C*****************************************************************
C
C  CALCULATION OF RESPIRATORY EVAPORATIVE LOSS
C
C*****************************************************************
      VPIN = VPDEW
      HUMIN = 0.622*VPIN/(PCAB-VPIN)
      TEXP = 86.9 + 0.066*TCAB + 57.4*HUMIN
      VPEXP = VPT(TEXP)
      HUMEXP = 0.622*0.8*VPEXP/(PCAB-0.8*VPEXP)
      VRESP = (0.0415*PCAB*144.*30.)/(1544.*(TCAB+460.))
     *        *(1.0 - 0.33*(14.7 - PCAB))*RM
      QR = VRESP*(HUMEXP-HUMIN)*1040.
C     WRITE(6,555)VRESP,HUMEXP,HUMIN,TEXP,VPEXP,VPIN
C 555 FORMAT( 6F10.4)
      QLAT1 = 0.3860*QR
      QLAT2 = 0.0860*QR
      QLAT3 = 0.0287*QR
      QLAT5 = 0.2380*QR
      QLAT6 = 0.2630*QR
C*****************************************************************
C
C  CALCULATION OF SWEAT EVAPORATIVE LOSS
C
C*****************************************************************
      QSWEAT = 0.0
      DO 100 I=1,10
      J=4*I
      QSWT(I) = SKINS(I)*(SWEAT*2.**(ERROR(J)/18.0) )*1.0
      IF(QSWT(I) .LT. 0.0) QSWT(I) = 0.0
      QSWEAT = QSWEAT + QSWT(I)
      WTAREA(I) = QSWT(I)/EMAX(I)
      IF(WTAREA(I) .GT. 1.00) WTAREA(I) = 1.000
  100 CONTINUE
C*****************************************************************
C
C     CALCULATION OF SKIN DIFFUSION EVAPORATIVE LOSS
C
C*****************************************************************
      QD = 0.0
      DO 120 I=1,10
      QDIF(I) = 2.8*ACE(I)*(VPT(TUG(I))-VPDEW)
     *          *((VCAB/PCAB)**0.15)*(1.0 - WTAREA(I))
      IF(QDIF(I) .GT. 0.06*EMAX(I)) QDIF(I) = 0.06*EMAX(I)
      QD = QD + QDIF(I)
  120 CONTINUE
C*****************************************************************
C
C     CALCULATION OF TOTAL EVAPORATIVE LOSSES
C
C*****************************************************************
      DO 130 I=1,10
      QLAT(I) = QDIF(I) + QSWT(I)
      IF(QLAT(I) .GT. EMAX(I)) QLAT(I) = EMAX(I)
  130 CONTINUE
C     WRITE(6,987)QEVAP,QR,QD,QSWEAT
```

LISTING OF WHOLE BODY ALGORITHM

```
C 987 FORMAT( 4F10.4)
      QEVAP = QR + QD + QSWEAT
C*****************************************************************
C  BLOOD FLOW CALCULATIONS
C*****************************************************************
      WERG=WORK-77.
      IF(WERG)7,7,8
  7   WERG=0.
      WORKR=WORK
      GO TO 9
  8   WORKR=77.
  9   CONTINUE
      TBMBF=24.537
      BFW=TROUT(1)*3.6/3.785*8.322-TBMBF
      IF(TROUT(4).LT..4)GO TO 775
      BFR=239.
      BFW=BFW-BFR
      GO TO 776
 775  BFR=BFW
      BFW=0.
 776  CONTINUE
      IF(BFR.LE.0.0)BFR=0.0
      DO 200 I=1,10
      N=4*I-3
      BF(N)=BFB(N)
      QMET(N)=QB(N)*QBASAL
      QMET(N+1)=QB(N+1)*QBASAL+WORKM(I)*WORK+CHILM(I)*QSHIV
      BF(N+1)=BFB(N+1)+RESTM(I)*BFR+WORKM(I)*BFW
      QMET(N+2)=QB(N+2)*QBASAL
      BF(N+2)=BFB(N+2)
      QMET(N+3)=QB(N+3)*QBASAL
      BF(N+3)=((BFB(N+3)+SKINV(I)*DILAT)/(1.0+SKINC(I)*STRIC))
C     &*EXP(ERROR(N+3)/18.0)
 200  CONTINUE
      BF(1)=TROUT(2)*3.6/3.785*8.322
      BF(5)=TROUT(5)*3.6/3.785*8.322
      TCBF=0.
      TFBF=0.
      TMBF=0.
      TSBF=0.
      DO 676 KL=1,10
      KL1=KL*4-3
      TCBF=BF(KL1)+TCBF
      TMBF=TMBF+BF(KL1+1)
      TFBF=TFBF+BF(KL1+2)
      TSBF=TSBF+BF(KL1+3)
 676  CONTINUE
      TRCO=TCBF+TFBF+TMBF+TSBF
      COTR=TRCO
      TRCO=TRCO/3.6*3.785/8.327
C     WRITE(6,655)TRCO,TMBF,TSBF,BF(1)
C655  FORMAT(1H ,4F10.4)
C-----------------------------------------------------------------
C  CHECK FOR NEGATIVE BLOOD FLOW
C-----------------------------------------------------------------
      DO 220 I=1,40
 220  IF(BF(I).LT.0.0)BF(I)=0.0
```

LISTING OF WHOLE BODY ALGORITHM

```
C-----------------------------------------------------------------------
C      QCONV(I)=CONVECTION FROM BLOOD TO EACH NODE
C      QCOND(I)=CONDUCTION BETWEEN ADJACENT NODES
C-----------------------------------------------------------------------
      HEF1=1.
      HEF2=1.
      HEF3=.3
      DO 244 I=1,40
      QCOND(I)=FACTOR(I)*(T(I)-T(I+1))
  244 CONTINUE
      DO 240 I=1,24
      QCONV(I)=BF(I)*(T(41)-T(I))
  240 CONTINUE
      TVAN=0.
      TVLN=0.
      TVHN=0.
      TVFN=0.
      TBFA=0.
      TBFL=0.
      TBFH=0.
      TBFF=0.
      DO 1070 I=1,8
      TBFA=TBFA+BF(I+8)
      TBFL=TBFL+BF(I+16)
      TBFH=TBFH+BF(I+24)
      TBFF=TBFF+BF(I+32)
      TVAN=TVAN+BF(I+8)*T(I+8)
      TVLN=TVLN+BF(I+16)*T(I+16)
      TVHN=TVHN+BF(I+24)*T(I+24)
 1070 TVFN=TVFN+BF(I+32)*T(I+32)
      TVA=TVAN/TBFA
      TVL=TVLN/TBFL
      TVH=TVHN/TBFH
      TVF=TVFN/TBFF
      CCT=COTR*(T(41)-T(5))*HEF3
      CCA=TBFA*(TVA-T(9))*HEF1
      CCH=TBFH*(TVH-T(9)+T(41)-T(9))*HEF2
      CCL=TBFL*(TVL-T(17))*HEF1
      CCF=TBFF*(TVF-T(17)+T(41)-T(17))*HEF2
      QCONV(5)=QCONV(5)+CCT
      QCONV(9)=QCONV(9)+CCA*.5+CCH*.5
      QCONV(13)=QCONV(9)
      QCONV(17)=QCONV(17)+CCL*.5+CCF*.5
      QCONV(21)=QCONV(17)
      DO 1071 I=25,32
      QCONV(I)=BF(I)*(T(9)-T(I))
 1071 CONTINUE
      DO 1072 I=33,40
      QCONV(I)=BF(I)*(T(17)-T(I))
 1072 CONTINUE
C***********************************************************************
C  TEMPERATURE CALCULATIONS
C***********************************************************************
C-----------------------------------------------------------------------
C  CALCULATE TEMP OF HEAD CORE,T(1), AND TRUNK CORE,T(5).
C-----------------------------------------------------------------------
      T(1)=T(1)+DTIME/C(1)*(QMET(1)-QLAT1+QCONV(1)-QCOND(1)-QRSEN1)
```

LISTING OF WHOLE BODY ALGORITHM

```
      T(5)=T(5)+DTIME/C(5)*(QMET(5)-QLAT5+QCONV(5)-QCOND(5)-QRSEN5)
      IF(TCAB.LT.74..OR.TCAB.GT.76.)DDEGF=T(5)-98.7
C-----------------------------------------------------------------
C  CALCULATE TEMPERATURES OF REMAINING CORES --ARM(9+13),LEG(17+21),
C                    HAND(25+29),AND FOOT(33+37)
C-----------------------------------------------------------------
      DO 260 I=9,37,4
      T(I)=T(I)+DTIME/C(I)*(QMET(I)+QCONV(I)-QCOND(I))
C     IF(I.GT.21)WRITE(6,9876)I,QMET(I),QCONV(I),QCOND(I)
C9876 FORMAT( I4,8X,3F10.4)
  260 CONTINUE
C-----------------------------------------------------------------
C  CALCULATE THE TEMPERATURES OF THE MUSCLE --HEAD(2),TRUNK(6),ARM(10+
C                14),LEG(18+22),HAND(26+30),FOOT(34+38)
C-----------------------------------------------------------------
      T(2)=T(2)+DTIME/C(2)*(QCOND(1)+QMET(2)-QLAT2+QCONV(2)-QCOND(2)-
     .     QRSEN2)
      T(6)=T(6)+DTIME/C(6)*(QCOND(5)+QMET(6)-QLAT6+QCONV(6)-QCOND(6)-
     .     QRSEN6)
      DO 280 I=10,38,4
      T(I)=T(I)+DTIME/C(I)*(QCOND(I-1)+QMET(I)+QCONV(I)-QCOND(I))
  280 CONTINUE
C-----------------------------------------------------------------
C  CALCULATE TEMPERATURES OF THE FAT LAYER --HEAD(3),TRUNK(7),ARM(11+15)
C            LEG(19+23),HAND(27+31),FOOT(35+39)
C-----------------------------------------------------------------
      T(3)=T(3)+DTIME/C(3)*(QCOND(2)+QMET(3)-QLAT3+QCONV(3)-QCOND(3)-
     .     QRSEN3)
      DO 300 I=7,39,4
      T(I)=T(I)+DTIME/C(I)*(QCOND(I-1)+QMET(I)+QCONV(I)-QCOND(I))
  300 CONTINUE
C-----------------------------------------------------------------
C  CALCULATE TEMPERATURES OF THE SKIN --HEAD(4),TRUNK(8),ARM(12+16),
C            LEG(20+24),HAND(28+32),FOOT(36+40)
C-----------------------------------------------------------------
      DO 320 I=4,40,4
      J=I/4
      T(I)=T(I)+DTIME/C(I)*(QCOND(I-1)+QMET(I)-QLAT(J)+QCONV(I)
     .     -QSEN(J)-QRAD(J)-QLCG)
  320 CONTINUE
C-----------------------------------------------------------------
C  CALCULATE TEMP OF CENTRAL BLOOD --(41)
C-----------------------------------------------------------------
      SQCONV = 0.0
      DO 340 I=1,40
      SQCONV=SQCONV-QCONV(I)
  340 CONTINUE
      TCC=CCA+CCL+CCH+CCF+CCT
      SQCONV=SQCONV-TCC
C     IPT=PTIM/2.
C     IF(((PTIM/2.)-IPT).GT.0.001)GO TO 665
C     WRITE(6,664)SQCONV,TCC,CCA,CCL,CCH,CCF
C 664 FORMAT( 6F10.4)
C 665 CONTINUE
      T(41)=T(41)+DTIME/C(41)*SQCONV
C-----------------------------------------------------------------
C     CALCULATE AVERAGE SKIN TEMPERATURE(42) BASED ON PERCENTAGE OF
```

LISTING OF WHOLE BODY ALGORITHM

```
C  TOTAL SKIN AREA FOR EACH SKIN NODE * THAT NODES TEMPERATURE
C-------------------------------------------------------------------
      T(42)=0.07*T(4)+0.3602*T(8)+0.06705*T(12)+0.06705*T(16)+0.1587*
     .       T(20)+0.1587*T(24)+0.025*T(28)+0.025*T(32)+0.0343*T(36)+
     .       0.0343*T(40)
      T(43)=0.02325*T(2)+0.549*T(6)+0.0527*T(10)+0.0527*T(14)+0.1592*
     .       T(18)+0.1592*T(22)+0.00115*T(26)+0.00115*T(30)+0.00115*
     .       T(34)+0.00115*T(38)
      TBF=0.0
      DO 360 I=1,40
  360 TBF=TBF+BF(I)
C     PULSE=5.926*TBF/60.0
      RETURN
      END
      SUBROUTINE SHRT
      COMMON /TRM/QBASAL,UEFF,TCAB,TW,TDEWC,VCAB,VEFF,PCAB,G,
     $       CLOV,EUG,CPG,DT,PRINTI,SETI,XIPOS,
     &       ACE(10),ARE(10),C(41),CLO,DTIME,EMAX(10),PRINT,PRNOW,
     &       QEVAP,QLCG,QRAD(10),QRSEN1,QRSEN2,QRSEN3,QRSEN5,QRSEN6,
     &       QSEN(10),QSHIV,QSTOR,RM,SETT,SQUG,STORAT,T(43),
     &       TIME,TSET(41),TUG(10),TUGAV,U,VPDEW,WORK,
     &       ICOND,IPOS,MCASES,NIO,IOPUT(20)
      DIMENSION H(10)
      DATA H/.033,.026,2*.036,2*.033,2*.04,2*.036/
      TWR=TW+460.
      SQUGA=0.0
      SQUGW=0.0
      SQW=0.0
      TAVSKN=(0.446*T(8)+0.0826*T(12)+0.0826*T(16)+0.1945*T(20)+0.1945*
     &T(24))/.9902
C*****************************************************************
C
C  CALCULATION OF Q-RADIATED(QRAD) AND Q-SENSIBLE(QSEN)
C
C*****************************************************************
      DO 60 I=1,10
      J=4*I
      TUGR=TUG(I)+460.
      HC=H(I)*ACE(I)*SQRT(PCAB*VCAB)
      IF(G.LE.0.0)GO TO 10
      HC1=0.06*ACE(I)*(PCAB**2*G*ABS(TUG(I)-TCAB))**.25
      IF(HC1.GT.HC)HC=HC1
10    HR=0.1713E-8*ARE(I)*EUG*(TUGR**3+TUGR**2*TWR+TUGR*TWR**2+
     $TWR**3)
      IF(I.LT.2.OR.I.GT.6)GO TO 20
      IF(CLO.LT.0.01)GO TO 20
      TUG(I)=(HR*TW+HC*TCAB+ACE(I)/CLO*T(J))/(HR+HC+ACE(I)/CLO)
      GO TO 40
   20 TUG(I)=T(J)
   40 QUGW=HR*(TUG(I)-TW)
      QUGA=HC*(TUG(I)-TCAB)
      SQUGW=SQUGW+QUGW
      SQUGA=SQUGA+QUGA
      QSEN(I)=QUGA
      QRAD(I)=QUGW
   60 CONTINUE
C*****************************************************************
```

LISTING OF WHOLE BODY ALGORITHM

```
C
C    CALCULATION OF RESPIRATORY SENSIBLE
C
C*****************************************************************
      QRSEN1=0.5*0.0418*PCAB*144.0/(48.3*(TCAB+459.69))*RM*CPG*((0.385*T
     *(1)+0.086*T(2)+0.0287*T(3)+0.238*T(5)+0.2615*T(6))-TCAB)
     &*(1.-.33*(14.7-PCAB))
C     WRITE(6,888)QRSEN1,PCAB,TCAB,RM,CPG,T(1),T(5)
C888  FORMAT( 7F10.4)
C     QRSEN1=0.
      QRSEN2 = 0.172 * QRSEN1
      QRSEN3 = 0.0574 * QRSEN1
      QRSEN6 = 0.523 * QRSEN1
      QRSEN5 = 0.476 * QRSEN1
      QRSEN1=0.771*QRSEN1
C
C
      SQUG = SQUGA + SQUGW + SQW + QRSEN1 + QRSEN5 + QRSEN2 + QRSEN3 +
     *QRSEN6
      TUGAV=0.3317*TUG(2)+0.104*(TUG(3)+TUG(4))+0.23015*(TUG(5)+TUG(6))
C*****************************************************************
C
C     CALCULATE MAXIMUM EVAPORATION RATE
C
C*****************************************************************
      DO 80 I=1,10
      J=4*I
      VPTUG=VPT(TUG(I))
      HE=0.126*ACE(I)*(TCAB+460.)**1.04*VEFF/100.**SQRT(VCAB/PCAB)
      IF(G.LE.0.0)GO TO 65
      HE1=1.32*ACE(I)*(TCAB+460.)/PCAB*(PCAB*G*(ABS(.005*PCAB*(TUG(I)-
     *TCAB))+1.02*(VPT(TUG(I))-VPDEW)))**.25
      IF(HE1 .GT. HE) HE=HE1
 65   IF(I .LT. 2 .OR. I .GT. 6) GO TO 70
      IF(CLO .LT. .01) GO TO 70
      HECL=22.36*ACE(I)*(T(J)+460.)**0.81/(CLO*PCAB)
      EMAX(I)=HE*HECL/(HE+HECL)*(VPT(T(J))-VPDEW)
      GO TO 75
   70 EMAX(I)=HE*(VPT(T(J))-VPDEW)
   75 IF(EMAX(I) .LT. 0.0) EMAX(I)=0.0
   80 CONTINUE
C-----------------------------------------------------------------
C
      CALL MANT
C
C-----------------------------------------------------------------
      QSTOR=0.
      DO 100 I=1,41
      QSTOR=QSTOR+C(I)*(T(I)-TSET(I))
  100 CONTINUE
      STORAT=RM-(SQUGA+SQUGW+SQW+QEVAP+QRSEN1+QRSEN2+QRSEN3+QRSEN6+
     1     QRSEN5)-U+QSHIV
C     SCABC = QRSEN1 + QRSEN5 + QRSEN2 + QRSEN3 + QRSEN6 + SQUGA
C     SCAB1=SQUGA+SQUGW
      RETURN
      END
      FUNCTION VPT(T)
```

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```
C    FUNCTION TO CALCULATE VAPOR PRESSURE AT TEMP=T
       X=647.27-(T+460.)/1.8
       TEMP=X*1.8/(T+460.)*(3.244+5.868E-3*X+1.170E-8*X**3)
      & /(1.+2.188E-3*X)
       VPT=3207./10.**TEMP
       RETURN
       END
```

END ONSITE PRINTOUT ON JUNE 18, 1975 AT 16:19:35
DB6-G03432*TPFS(0).XXX(0)