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Produced by the NASA Center for Aerospace Information (CASI)
This model is a combined, steady-state cardiovascular and thermal model. It was originally developed for interactive use by Dr. R. F. Walters, Department of Human Physiology, School of Medicine, University of California, Davis, California. The model has been converted to batch mode simulation for the Sigma 3 computer. The purpose of the model is to compute steady-state circulatory and thermal variables in response to exercise work loads and environmental factors. During a computer simulation run, several selected variables are printed at each time step. End conditions are also printed at the completion of the run.

R. C. Croston, Ph.D.
PROGRAM DESCRIPTION

A. IDENTIFICATION

Program Name - WALTERS
Programmer - R. C. Croston, GE/MSC, Houston
Date of Issue - April 6, 1972

B. GENERAL DESCRIPTION

This model is a combined, steady-state cardiovascular and thermal model. It was originally developed for interactive use by Dr. R. F. Walters, Department of Human Physiology, School of Medicine, University of California, Davis, California. The model has been converted to batch mode simulation for the Sigma 3 computer.

C. USAGE AND RESTRICTIONS

Machine and Compiler Required - XDS Sigma 3 and ANSI FORTRAN
Peripheral Equipment Required - Card reader and line printer.
Approximate amount of memory required - 2,465 hexadecimal

D. PARTICULAR DESCRIPTION

Equations Used and Derivations - See final report of Contract NAS9-11657, Modification 2C.
Definition of Terms Used - Terms are defined in the referenced math model and in the following descriptions of input and output variables.
Detailed Description - The mathematical model is summarized here by a functional block diagram, Figure 1. The purpose of the model is to compute steady-state circulatory and thermal variables in response to exercise work loads and environmental factors. During a computer simulation run, several selected variables are printed at each time step. End conditions are also printed at the completion of the run.

E. DESCRIPTION OF INPUT

Control and Program Cards - (begin in card column 1)

;JOB
;ASSIGN SI=14 (026 Keypunch Code)
;ASSIGN F:5=3
;ASSIGN F:6=4
;FORTRAN
COMBINED STEADY-STATE CIRCULATORY AND THERMAL MODELS

FIGURE 1.
WALTERS MODEL FUNCTIONAL BLOCK DIAGRAM
(SOURCE DECK)

EOD
LOAD
$R0T 256,0
$MP
EOD
XEQ

(DATA DECK)

EOD

Program Cards - Listed at the end of this document.

Data Cards - (Card columns, format, name definitions)

Columns 1-10, 11-20, etc., 8 parameters per card for a 8P10.0 format of the following list of required input data:

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<th>Description</th>
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<td>STOP TIME FOR LENGTH OF EXPERIMENT (min)</td>
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<tr>
<td>TINC</td>
<td>10.0</td>
<td>TIME AT WHICH VARIABLES ARE INCREMENTED (min) (fixed)</td>
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</table>
MXRSP 0.315  SLOPE FACTOR FOR INCREASE IN RESP MUSCLE O_2
TS 1.0  TIME STEP FOR MODEL (in minutes) (fixed)
VLPKE 0.04  PERCENT OXYGEN UPTAKE IN VENTILATION
TAIR 20.0  AIR TEMPERATURE (°C)
RHUM 0.50  RELATIVE HUMIDITY
PATM 760.0  ATMOSPHERIC PRESSURE (mm Hg)
PO_2 160.0  PARTIAL PRESSURE OXYGEN (mm Hg)
VAIR 0.1524  WIND SPEED (m/sec)
CORST 5000.0  RESTING CARDIAC OUTPUT (ml/min)
WGT 75.0  BODY WEIGHT (Kg)
HGT 175.0  HEIGHT (cm)
TB 36.8  BODY TEMP, INITIAL (°C)
HRRST 60.0  RESTING HEART RATE (beats/min)
HRMAX 200.0  MAXIMUM HEART RATE
VMAX 20000.0  MAXIMUM VENTILATION (ml/min)
TPMAX 41.0  MAXIMUM BODY TEMPERATURE (°C)
PRINT 1.0  PRINT INTERVAL (min)

Col. 1-10, 21-30, 41-50, 61-70  8F10.0  Time to change work rate (sec)
11-20, 31-40, 51-60, 71-80  8F10.0  Work rate in KPM/min

(Seven of the above cards are required for a complete schedule.)

Time (seconds), oxygen uptake (ml/min), ventilation (ml/min), heart rate (beats/min), cardiac output (ml/min), body temperature (°C), and skin temperature (°C).

F. DESCRIPTION OF OUTPUT

The following variables are printed on the line printer. A sample printout is shown in Figure 2.
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**SUMMARY OF CONDITIONS AT TIME OF STOP**

**TIME OF STOP** 71. MIN

**ENVIRONMENT**

**TAIR** = 23°C

**HUMIDITY** = 0.6 PCT

**ATM PRESS** = 760 + 0

**AIR SPEED** = 0.2

**LEG WORK** = 33.5 MJ 02/MIN

**ARM WORK** = 13.5

**BOD STATUS**

**BODY TEMP** = 34.3°C

**SKIN TEMP** = 32.7

**VENTILATION** = 6186.2

**O2 UPTAKE** = 246.6

**CARCIC OUTPUT** = 4945.7

**HEART RATE** = 59.3

**OXYGEN DEBTS**

**CARDIC** = 0.4

**LEG** = 11.5

**ARM** = 0.0

**LEG RATE** = 2.386 ML 02/MIN

**ARM RATE** = 0.0
C. INTERNAL CHECKS AND EXITS

Exit - A normal exit gives end conditions and a stop.

H. INDEPENDENT SUBROUTINES

None

I. SYSTEM SUBROUTINES

No special subroutines.

J. COMPLETION OR FINAL CHECKOUT DATE

April 6, 1972.

K. PROGRAM LISTING
C 

WRITE (6,95) HITOT,62BR,62LG,62AR,62RSR,62COR,62SK,62IM,82TH
95 FORMAT (12,2(TOT,62LEG,ARM,RSR,COR,SKIN,IM,TH $12/2(1H ,5F9.3/))
OBR=0
OLR=0
OAR=0
OSK=0
OLG=0
V=0

BFSKIN=BFNK
BFLEG=BFLEGR
BFARM=BFARMR
BFRSR=BFRSR
BFCK=BFCKR
HLINC=0
MTINC=0
MUMINC=0
THINC=0
PATINC=0
PBINC=0
VELINC=0

HTBR=02BR+.00*825
HTLEG=02LG+.00*825
HTARM=02AR+.00*825
HTSK=02SK+.00*825
HTRS=02RSR+.00*825
PCRA=0MAX1(0.,(MRSP=V/VMAX=4.5))

02XPRE=0
IF (TB+LT+TBSW > OR+ TSKIN+LT+29.) GO TO 102
02XSP=02BR+02TH+02AR+02LG+02CR+02SK+02IM
DT=MIN1(3,(TS-TBSW))
HLS=MAX1(TB+TSW)+TS

IF (MHSW+GT+HLSMX) HLSW=HLSMX
GO TO 103

HLSW=0
DT=0
103 CONTINUE

HTTB=HTBR+HTIM+HTGTH+HTCR+HTLEG+HTARM+HTSK+HTRS

WVEX=10**8*051*(12353/(1B+273+18))*.PRES/101.3
HLSR=10**8*598*(WVEX=0W/2882/(1TAIR+273)+.60)+TS
HTNET=HTNET=HLSV
HLSK=17.1*AB+TSKU+TAIR)*TS*.8598/60.
HTST=HTNET+HLSW+HLSK
TIME=0

PAPHI=0
INCI=0
TPrH=1
JPR=6
DO 600 I=1,6
600 IFRI=1

900 FORMAT (6BA1)
C C REMOVED INTERACTIVE SECTION
C C
4000 CONTINUE
C C
C C MODEL EXECUTION
C****
C 4000 WRITE (1) PRVAL
C NRECS=NRECS+1
C**** FIRST CHECK TO SEE IF STOP, PRINT, OR OTHER HALT PRNTS REACHED
IF (ISTART+N10) GO TO 4001
C WRITE (6,114A) (PRNA(I)1),1=1,JPR)
114A FORMAT (1,13X,6(16X,4X))
WRITE (6,601)
601 FORMAT(' TIME, VR, V, HR, CA, TB',/TSKIN')
READ (5,10) PRNT
READ (5,99) W
27 FORMAT (6(8F10.0),12F12.0)
ISTART=1
+001 IF (TIME+LT,STP=) GO TO 4010
C WRITE (6,4001)
C+002 FORMAT (' STOP TIME EXCEEDED. DO YOU WISH PLT (Y/N) A')
C READ (6,990) A(1)
C IF (A(1)<=.8) GO TO 4005
C WRITE (6,4004)
C+004 FORMAT (' OR YOU WISH TO RESTART (Y/N)'),
C READ (6,990) A(1)
C IF (A(1)<=.8) GO TO 526
GO TO 10000
C C+005 REMOVED PLOTTING ROUTINE
C+010 IF (TIME=LT,PRNT) GO TO 4020
PRNT='TIME=PRNT'
C+015 ISTART=1
C IF (ISTART=LT,10) GO TO 4010
C WRITE (6,114A) (PRNA(I)1),1=1,JPR)
C+019 ISTART=1
C+020 WRITE (6,4012) (PRVL11PRV(I)1),1=1,JPR)
C CHANGED VARIABLE OUTPUT
+015 WRITE (6,4012) TIME,VR2,VR,CA,TC,TSKIN
+021 FORMAT (1H4,F8.16F9.1)
C**** TEMPORARY CONTINUE OPTION
C IPT=0
C CALL TTREAD(A,ALFA,FP,IND,IP1)
C IF (IND+1=0) GO TO 1006
C**** END OF TEMPORARY SECTION
C C+024 IPT=0
C C**** REMOVED VARIABLE INCREMATING SECTION
C C+025 IPT=0
C 4020 Ta=M*N+S
C 4025 BLEG=MK(1START+1)*.85+23*B2LEG
C 4030 CONTINUE
C**** START EXECUTION LOOP
C**** RESPIRATION RATE
+050 V=20TR/I,T,VRPTKE
C WRITE (6,111) V
+11 FORMAT (1H4,V=16F10.1)
C**** BRAIN
+278 BR=BRR*K
C MTRK = BRR * 0.004825
C**** INACTIVE MUSCLE
+282
**C***

**SKIN OXYGEN CONSUMPTION**

**4090**

**RESPIRATORY COMPARTMENT**

**C***

**CALCULATE TOTAL NON-RESP 02 CONSUMPTION**

\[ \text{D2RSP} = (\text{MR2R} + \text{D2CR} + \text{MR2R} + \text{D2CR}) \times \text{D2TP} + \text{TS} \]

**C***

**WRITE** (6,101) **O2LEG, O2ARM, O2COR, D2RSP, O2TP)

**C***

**WRITE** (6,102) **V**

**4102**

**FORMAT** (V) **V EXCEEDS MAXIMUM ALLOWABLE VENTILATION RATE NOW 8.1**

**C***

**SUM TOTAL BLOOD FLOW**

**C***

**WRITE** (6,103) **C0, D0**

**C***

**FORMAT** (1) **O2 LEG, ARM, CAR, RESP, TOT, T/1, 1, S15F10, 4)

**C***

**HEAT BALANCE PORTION OF MODEL**

**C***

**CONTINUE**

**C***

**WRITE** (6,14) **HTOT, HTBR, HTLEG, THTM, THTH, THTB**

**C***

**FORMAT** (1) **HT PROD, TOT, BR, LEG, ARM, CAR, SKIN, RESP, IM, TOT/1**

**C***

**SUM 1, 1, S15F10, 5/1, 1, S15F10, 5/1**

**C***

**CALCULATE VAPOR PRESSURE AT BODY TEMP**

\[ \text{WYEXP} = \text{WYEXP} + \text{WYEXP} \times \text{V1} + 2.82 \times (\text{TURP} + 273) + 0.61 \times \text{TS} \]

**C***

**HEAT LOSS FROM SKIN BLOOD FLOW**

**C***

**WRITE** (6,93) **TSKIN, BSKIN**

**C***

**FORMAT** (1) **TSKIN, BSKIN**

**C***

**NOTE OTHER WAYS TO CALCULATE SKIN, IS THIS BEST**

**C***

**CALCULATE HEAT LOSS THROUGH SWEATING**

**C***

**CALCULATE HEAT LOSS THROUGH SWEATING**

**C***

**IF** (TWF, TBSW) **GO TO 4150**

**C***

**IF** (MTSKIN + LT + 29.0) **GO TO 4150**

**C***

**CALCULATE HEAT LOSS THROUGH SWEATING**

**C***

**IF** (MTSKIN + G3) **DTSW = 3**

**C***

**CALCULATE HEAT LOSS THROUGH SWEATING**

**C***

**IF** (MTSKIN + G3) **DTSW = 3**