THE RÔLE OF CLOTHING IN MEETING F.E.A.
ENERGY CONSERVATION GUIDELINES

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During the summer and winter of 1974, the Federal Energy Administration (F.E.A.) established temperature guidelines for winter heating and summer cooling by attempting to lower or raise the desired working condition by 5 deg F (or 3 deg C) respectively, about the optimum level 75 deg F (23.9 deg C) currently set by ASHRAE STANDARD 55-74. Their guidelines for winter indoor temperatures were 68 - 70 deg F (20 - 21.1 deg C) and for summer 78 - 80 deg F (25.6 - 26.7 deg C) or a proposed 80 - 82 deg F (26.7 - 27.8 deg C). The summer's settings should be accomplished without humidity control and reheat.

Both the Fanger comfort equation (1) and our earlier model of temperature regulation (2 and 3) can be used to deduce the options available to the heating, ventilating and air-conditioning engineer in meeting these above F.E.A. guidelines. These options are briefly summarized in Table 1. During the summer, the discomfort caused by a 6 deg F (3 deg C) rise in T_a could be balanced theoretically by a drop to low relative humidity. Radiant cooling is impractical. The same level of comfort could be maintained if the air movement were raised to the 75 fpm (0.4 m/s) level. Both these solutions may well require extensive electric energy in the form of air-conditioning equipment and fans. The same 6 deg F (3 deg C) rise in T_a could also be balanced theoretically if the normal clothing insulation were reduced to a 0.2 Clo level, which insulation level was actually worn by only 5% of males but by 43% of females during our 1974 summer survey for F.E.A. in New York. An intrinsic Clo level of 0.4 was observed to be worn by about 50% of the males and females. During both these surveys people dressed for work according to season rather than for their expectations of the indoor temperature. From the above relationships, as has already been recognized by the F.E.A., the most practical first order compromise between a need for energy conservation and maintenance of thermal comfort in the summer is the use of less insulative clothing during office work.

In the cold, more insulative clothing is the obvious answer to stay comfortable if the air temperature is lower. Alternatively, radiant heat could be used to balance discomfort from cold air but this may require considerable energy.


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The general feasibility of using various levels of clothing insulation to meet the FEA guideline temperatures in combination with various levels of humidity and air movement are indicated in the following series of charts (Fig. 1 - 5). The ordinate scales are the ASHRAE ET*. The temperature for ET* range for 80% comfort, as prescribed by ASHRAE STANDARD 55-74, is indicated by horizontal lines. The abscissa scale is always the ambient air temperature. The relationship between ET* for the indicated level of metabolic activity, and the environmental factors, described by $T_a$, Clo (intrinsic), and air movement, have been determined by our most recent two-node model of human temperature regulation. (See Appendix 1.) The original model was described in 1972 (1); the present up-dated model includes our most recent concepts in human temperature regulation and the use of intrinsic and effective clothing insulation factors (4 and 5). Each chart to follow shows how any ambient temperature can be made comfortable in the ASHRAE 72 - 78 F ET* range for 80% acceptability by proper choice of humidity, air movement or clothing.

1. EFFECT OF CLOTHING INSULATION ON AIR TEMPERATURES FOR THERMAL COMFORT AND ACCEPTABILITY AT CONSTANT RELATIVE HUMIDITY AT 40 - 60%

The Comfort Chart in Fig. 1 shows the ASHRAE standard effective temperature (ET*) calculated for various levels of intrinsic clothing insulation indicated at various ambient temperatures ($T_a = MRT$) on the abscissa. The ASHRAE STANDARD 55-74 environmental conditions involved are 1.0 - 1.2 mets of sedentary office work, a low air movement of 20 - 30 fpm (0.1 - 0.15 m/s), and an intrinsic clothing insulation of 0.6 Clo. The test conditions observed during the FEA 1975 winter survey in New York actually paralleled the ASHRAE standard conditions with the same average clothing insulation and air movement and the temperature range 72 - 78 F. The acceptable scale at 80% and 90% corresponds with the ET* values observed during this winter survey and are representative of the comfort expected for the 72 - 78 F. ET* range specified by ASHRAE STANDARD 55-74.

For the lower FEA summer guideline, the allowable range for clothing insulation for both men and women would be 0.1 - 0.5 Clo at 79 F (26.1 C), to maintain an equivalent comfortable ET* within 72 - 78 F; the optimum is 0.3 Clo. For the extended FEA guidelines of 60 - 82 F, the optimum Clo would be less than 0.3 Clo.

For the FEA winter guidelines of 68 - 70 F the optimum Clo range for an 80% acceptable would be about 0.8 - 1.2 Clo.

2. EFFECT OF RELATIVE HUMIDITY ON THERMAL ACCEPTABILITY FOR VARIOUS CLOTHING INSULATIONS

The same type comfort charts as drawn in Fig. 1 have been redrawn for relative humidities of 60 - 80% rh (tropics)(Fig. 2) and 20 - 40% rh (desert or winter)(Fig. 3).

In Fig. 2 at the higher humidity the optimum temperature occurs near 70 F (21.1 C) for 1.0 Clo; at 74.3 F (23.5 C) for 0.6 Clo; at 77.7 F (25.4 C) for 0.3 Clo. For the winter guidelines range (68 - 70 F) high humidity does not affect significantly the clothing requirement for comfort. However, for summer temperature guideline range of 78 - 80 F at 60 - 70% rh, 0.15 Clo insulation would be required for comfort in competition with the 0.3 Clo at ~50% rh. There would be no practical solution only by proper choice of clothing for comfort at 81 F at 60 - 80% rh. As will be seen later, increased air movement will improve the present example.

For the 20 - 40% rh range presented in Fig. 3, slightly more clothing (by plus 0.1 Clo) would be required by the FEA temperature 68 - 70 F range than if the humidity were 50%. At the other extreme - both the FEA summer guideline of 78 - 80 F and 80 - 82 F comfort could easily be maintained by clothing insulation in range 0.3 - 0.4 Clo.

The effect of humidity alone under ASHRAE standard conditions ( 1.1 met - 0.6 Clo - 20 to 30 fpm) is illustrated in Fig. 4. In the FEA winter zone 68 - 70 F relative humidity is an
insignificant factor over range 20 - 80% rh. For the FEA summer zone of 78 - 80 F, a change from 20% to 80% rh would cause ET* to rise from 77.5 F (25.3 C) to 81.5 F (27.5 C); for the 80 - 82 F range, the same humidity change would cause ET* to vary from 79 F (26.1 C) to 85 F (29.4 C).

3. EFFECTIVENESS OF LOW LEVELS OF AIR MOVEMENTS ON THERMAL ACCEPTABILITY IN WARMTH

Fig. 5 has been drawn using 0.3 Clo throughout since this level of clothing insulation appears so far as the most practical to make acceptable the upper FEA summer limits (78 - 80F; 80 - 82 F). In Fig. 5 three levels of air movement are illustrated while wearing 0.3 Clo. An air movement of 30 - 40 fpm (0.15 - 0.2 m/s) would easily make the lower FEA limits 78 - 80 F acceptable, but the upper limits 80 - 82 F would require almost double the air movement 60 - 70 fpm (0.3 - 0.35 m/s). In general the rise in acceptable temperature is roughly proportional to the square root of the room air movement.

In Appendix 2 and 3 various combinations of clothing for men and women that would probably result in insulation values that fall in 0.2 - 1.2 Clo range are illustrated and tabulated. The intrinsic values of the clothing insulation indicated were actually measured directly (4) at the time the photographs were taken.

CONCLUSIONS

1. The FEA winter guidelines (68 - 70 F) are best met by wearing clothing with intrinsic insulation of 1.0 - 1.2 Clo with special emphasis on the distribution of the insulation over the legs and arms.

2. The FEA summer guidelines in range 78 - 80 F without reheat which would result in high humidities can best be met with intrinsic clothing insulation of 0.3 Clo or less. In the 80 - 82 F range, the 0.3 Clo must be reduced to 0.15 Clo, if practical and acceptable, or the local air movement in the work space should be raised at least to the 40 - 50 fpm (0.2 - 0.25 m/s) level. For the above temperature ranges humidity should still be below 70% rh.

3. For general use, an analytical method has been presented how to interpret any combination of environmental temperature, humidity, air movement and clothing worn in terms of the ASHRAE ET* scale, specified by ASHRAE STANDARD 55-74.

REFERENCES


ACKNOWLEDGMENTS

The present study was partially sponsored by ASHRAE TGRP-163 and RP-144 and partially supported by the Federal Energy Administration Contract #14-01-0001-1891 (1975) and NIH Grant ES-00354.
TABLE 1

Balance of Changes in Environment and in Ambient Temperature for Baseline Thermal Comfort

<table>
<thead>
<tr>
<th>Change of:</th>
<th>Made in:</th>
<th>Is Balanced by $T_a$ Change of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 8 Torr (or -35%)</td>
<td>Ambient Vapor Pressure</td>
<td>± 2° F (1.1° C)</td>
</tr>
<tr>
<td>± 1.5 F (or ± 0.8 C)</td>
<td>Mean Radiant Temperature</td>
<td>± 2° F (1.1° C)</td>
</tr>
<tr>
<td>+ 20 fpm (+ 0.1 m/s)</td>
<td>Air Movement</td>
<td>+ 2° F (1.1° C)</td>
</tr>
<tr>
<td>± 0.15 Clo</td>
<td>Clothing (intrinsic)</td>
<td>± 2° F (1.1° C)</td>
</tr>
<tr>
<td>+ 0.5 mets</td>
<td>Activity</td>
<td>- 5.4° F (3° C)</td>
</tr>
</tbody>
</table>

Baseline Conditions: $T_a$ (= MRT) = 24° C (75° F)  
$P_a = 11$ Torr (or 50% rh)  
$v = 0.1 - 0.15$ m/s (30 fpm)  
$\text{Clo} = 0.6$ (intrinsic)  
$M = 1.1$ met (64 W/m²)
The ASHRAE standard effective temperature (ET*) for various levels of clothing insulation worn at ambient temperature $T_a$ (= MRT) with normal relative humidity and air movement. By definition, ET* always equals $T_a$ for the 0.6 Clo locus in above chart.

**Fig. 1**

**Fig. 2**

Effect of clothing insulation on thermal acceptability for high relative humidities in determining ET*.

**Fig. 3**

Effect of clothing insulation on thermal acceptability for low relative humidities in determining ET*.
Fig. 4 Effect of relative humidity on thermal acceptability for ASHRAE standard clothing and air movement in determining ET.

Fig. 5 Effect of varying air movement on thermal acceptability at high humidity under a typical tropical condition while lightweight clothing.

239
APPENDIX 1

Annotated FORTRAN Program for Calculation of ASHRAE ET*

The present program is designed to calculate the ASHRAE ET* when the following basic factors are known and evaluated:

- TA = ambient air or dry bulb temperature (°C)
- TR = the mean radiant temperature (°C)
- VEL = room air movement (m/s)
- RH = relative humidity (as fraction)
- CLO = intrinsic insulation of clothing worn (clo)
- ACT = level of activity in met units (met)
- (ACT = ACT * 58.2 in W/m² in program)
- WK = work accomplished (W/m²)

The above factors are defined by READ and DO statements.

The basic physiological terms used to describe the regulatory model are as follows. Secondary definitions will occur in the program itself.

- TSK = mean skin temperature (°C)
- TCR = internal body temperature (°C)
- SKBF = skin blood flow (liters/m²·h)
- REGSW = regulatory sweating (g/m²·h)

The following function relating saturation vapor pressure SVP in Torr to temperature T in °C is used. The function is known as the Antoine Equation.

\[ SVP(T) = \exp(18.6686 - 4030.183/(T + 235.)) \]

C STEADY STATE CHARACTERISTICS OF MODEL AT THERMAL NEUTRALITY

- TTSK = 34.0
- TTCR = 36.6
- ALPHA = 0.1
- TTBM = ALPHA * TTSK + (1. - ALPHA) * TTCR
- CSW = 200,
- CSTR = 0.5
- CDIL = 150.

C INITIAL CONDITIONS-PHYSIOLOGICAL THERMAL NEUTRALITY

- TSK = TTSK
- TCR = TTCR
- TBM = ALPHA * TSK + (1. - ALPHA) * TCR
- SKRFN = 6.3
- SKRF = SKRFN
- EV = 0.1 * ACT

240
C CLOTHING AND ENVIRONMENTAL HEAT TRANSFER FACTORS AT SEA LEVEL
C CHCA IS EFF. CHC DUE TO ACT IN STILL AIR (TREADMILL WALKING)
   CHCA=5.66*(ACT/58.2-0.85)**0.39
C CHCV IS FUNCTION OF ROOM AIR MOVEMENT (VEL)
   CHCV=8.6*VEL**0.53
   IF(CHCV-CHCA) 4,4,5
4  CHC=CHCA
   GO TO 6
5  CHC=CHCV
6  CONTINUE
C CHC VALUE FOR STILL AIR IS 3.0 AT SEA LEVEL
7  IF(CHC-3.) 8,9,9
8  CHC=3.0
9  CONTINUE
   FACL=1.+0.15*CLO
   CHR=4.7
   CTC=CHR+CHR
   TO=(CHR*TR+CHC*TA)/CTC
   CLOE=CLO-((FACL-1.)/(0.155*FACL*CTC)
   FCL=1./((1.+0.155*CLOE)
   FPCL=1./((1.+0.143*CHC*CLOE)
C TIME OF EXPOSURE SET AT ONE HOUR
   TIME=0.
   TIME=1.
C SIMULATION OF BODY TEMPERATURE REGULATION - START OF REG. LOOP
100 CONTINUE
10  CONTINUE
   CLOE=CLO-((FACL-1.)/(0.155*FACL*CTC)
   FCL=1./((1.+0.155*CTC*CLOE)
   TCR=TO+FCL*(TSK-TO)
   CHR=4.5*6**(5*(TCL-1.273.2)**3)*0.725
   CTC=CHR+CHC
   TO=(CHR*TR+CHC*TA)/CTC
   ERES=0.0025*ACT*(44.-RH*SWP(TA))
   CRES=0.0014*ACT*(34.-TA)
C HEAT FLOW EQUATION AT SKIN SURFACE
   DRY=FCL*CTC*(TSK-TO)
   ESK=EV-ERES
   HFSK=(TFR-TEK)*(5.28+1.163*SKRF)-DRY-ESK
   HFCR=ACT-(TFR-TSK)*(5.28+1.163*SKRF)-CRES-ERES-WK
C AVERFAGE MAN 70KG, 1.8 SQ.METER
   TSK=0.97+ALPHA*70.
   TCR=0.97*(1.-ALPHA)*70.
   DTSK=(HFSK*1.8)/TCSK
   DTCR=(HFCR*1.8)/TCCR
   DTIM=1./60.
   DTM=ALPHA*DSK+(1.-ALPHA)*DTCR
   TIM=TIM+DTIM
   TSK=TSK+DTSK+DTIM
   TCR=TCR+DTCR+DTIM
C DEFINITION OF REGULATORY CONTROL SIGNALS
   SKSIG=TSK-TSK
   IF(SKSIG) 10,10,15
10  COLDS=-SKSIG
   WARM=0.
   GO TO 20
15  COLDS=0.
   WARM=SKSIG
20  CRSIG=TTCR-TCCR
   IF(CRSIG) 30,30,35
30  COLDC=-CRSIG
   WARM=0.
   GO TO 40
35  WARM=CRSIG
40  CONTINUE
C CONTROL SKIN BLOOD FLOW
STRIC=CSST*C đàos
DILAT=CDIL*HARM
SKBF=(SKBFH*DILAT)/(1.+STRIC)
C RELATIVE WT. OF SKIN SHELL TO BODY CORE VARIES WITH SKBF
ALPHA=0.0415*0.351/(SKBF-0.014)
C DEFINITION OF CONTROL SIGNALS FOR SWEATING
TZH=ALPHA*TSK+(1.-ALPHA)*TCR
RYSIG=TZH-TRSH
IF(RYSIG) 50,50,55
50 COLD=-RYSIG
WARM=0,
GO TO 60
55 WARM=RYSIG
COLD=0,
60 CONTINUE
C CONTROL OF REGULATORY SWEATING
REGSACH=CSH*WARMH*EXP(WARMS/10.7)
ERSW=0.68*REGSACH
FMAX=2.14*CHC*(SVP(TSK)-SVP(TA))*Fpcl
PRSW=ERSW/EMAX
PMET=0.05*0.49*PRSW
EF=PRSH*EMAX-ERSW
EV=ERSW+ERSW+EDIF
IF(EMAX-ERSW) 70,70,75
70 IF(EMAX+EMAX) 100,110,110
110 CONTINUE
C END OF REGULATORY LOOP

At the end of exposure TIME, all the basic physiological terms listed above are now evaluated for activity and environment defined above. The state of thermal equilibrium (STORE) and the skin heat loss to the environment (HSK) now follow:

C CALCULATION OF HEAT STORAGE
STORE=ACT-VK-CRES-EV-DRY
C CALCULATION OF SKIN HEAT LOSS (HSK)
HSK=ACT-RES-CRES-VK-STORE
C CALCULATION OF ASHRAE STANDARD EFFECTIVE TEMPERATURE - SET
C DEFINITION OF ASHRAE STANDARD ENVIRONMENT
CHR=CHR
C CHCS IS CHCA VALUE FOR ACT SELECTED IN STILL AIR
CHCS=CHCA
CLOS=0.6
FACLS=1.09
CTCS=CHR+CHCS
CLOES=CLOS-(FACLS-1.)/(0.155+FACLS*CTCS)
FCLFS=1./((CLOS*FACLS)+1.)/(CLOS*FACLS)
FCLFS=1./((0.155*CTCS*CLOFS)+1.)/(0.155*CTCS*CLOFS)
C STANDARD ACTIVITY POINT
TACTS=TSK-HSK/(CTCS*FCLFS)
C AT START OF ITERATION
SET=TACTS
C DEF. OF SET IS SOLUTION OF HEAT BAL. EQ. WHEN ERROR=0.
200  ERROR=HSK-CTCS*FCLES*(TSK-SET)-PWET*2.2*CHCS*FPCLS*(SVP(TSK)
X-0.5*SVP(SET))
  IF(ERRO<210,220,220)
210  SET=SET+0.1
    GO TO 200
220  CONTINUE

For the present analysis, the following printout is useful.

WRITE(1,4000)TA,CLO,ACT,PWET,EMAX,TSK,TCR,TBM,HSK,DRY,EV,STORE,SET
4000 FORMAT(13F7.2)

END of program

The above program applies for sea level conditions and may be used to develop psychrometric tables for clothed subjects in heated, ventilated and air-conditioned environments encountered in normal engineering practice and for prediction of comfortable-acceptable environments, when basic indoor temperatures are determined by a Building Simulation Program such as the Bureau of Standards NBSLN.

For Fig. 1-5 the following common inputs were used:

    ACT  = 1.1 mets for sedentary office work
    WK   = 0.  W.m⁻²
    TIME = 1.  hour
    TA    = TR = TO  °C

Other environmental factors used are indicated on the figures themselves.
Photographs of Clothing Ensembles for FEA Summer and Winter Guideline Temperature Ranges

0.15 ~ 0.25 clo
Summer - FEA

0.4 ~ 0.5 clo
Summer - Normal

0.7 ~ 0.8 clo
Winter - Normal

0.9 ~ 1.1 clo
Winter - FEA

0.3 ~ 0.4 clo
Summer - FEA

0.4 ~ 0.6 clo
Summer - Normal

0.7 ~ 0.9 clo
Winter - Normal

1 ~ 1.1 clo
Winter - FEA
APPENDIX 3

Clothing Combinations for Protection Against Discomfort in FEA Winter and Summer Guideline Zone

FEA Winter Guideline

A. Winter zone 68 – 70 F; required 0.9-1.2 Clo.

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>(II)</th>
<th>(III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter jacket</td>
<td>0.49</td>
<td>Add winter vest to (I)</td>
<td>0.29</td>
</tr>
<tr>
<td>Winter trousers</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy long-sleeve dress shirts</td>
<td>0.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-undershirts</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underpants</td>
<td>0.05</td>
<td>or Add winter sweater to (I)</td>
<td>0.37</td>
</tr>
<tr>
<td>Knee high socks</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxford shoes</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
I_s = 1.38 \\
I_{clo \cdot N} = 1.12 \\
I_{clo \cdot i} = 0.88
\]

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>(II)</th>
<th>(III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter dress</td>
<td>0.72</td>
<td>Add Winter sweater</td>
<td>0.37</td>
</tr>
<tr>
<td>Full slip</td>
<td>0.19</td>
<td>to (I)</td>
<td></td>
</tr>
<tr>
<td>Underwear</td>
<td>0.05</td>
<td>Winter pants suits</td>
<td></td>
</tr>
<tr>
<td>Stocking</td>
<td>0.01</td>
<td>dress 0.66</td>
<td></td>
</tr>
<tr>
<td>Shoes</td>
<td>0.04</td>
<td>pants 0.44</td>
<td></td>
</tr>
</tbody>
</table>

\[
I_s = 1.01 \\
I_{clo \cdot N} = 0.83 \\
I_{clo \cdot i} = 0.65
\]

<table>
<thead>
<tr>
<th></th>
<th>(IV)</th>
<th>(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter pants suits</td>
<td>Add blouse to (III)</td>
<td>0.29</td>
</tr>
<tr>
<td>Underwear</td>
<td>0.05</td>
<td>Add Winter sweater to (IV)</td>
</tr>
<tr>
<td>Stocking</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Shoes</td>
<td>0.04</td>
<td></td>
</tr>
</tbody>
</table>

\[
I_s = 1.20 \\
I_{clo \cdot N} = 0.97 \\
I_{clo \cdot i} = 0.77
\]
PEA Summer Guideline
B. Summer zone 78 - 80 F; 80 - 82 F; required 0.15-0.45 Clo.

<table>
<thead>
<tr>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer jacket</td>
<td>0.22</td>
<td>Remove Jacket and Tie</td>
<td></td>
</tr>
<tr>
<td>Summer trousers</td>
<td>0.25</td>
<td>Remove Undershirts from (II)</td>
<td></td>
</tr>
<tr>
<td>Short sleeve shirts</td>
<td>0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with tie</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeveless undershirt</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underpants</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankle socks</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxford shoes</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| I_s = 0.82           | I_s = 0.59                          | I_s = 0.53                          | I_s = 0.34                |
| I_clo*N = 0.71       | I_clo*N = 0.54                      | I_clo*N = 0.50                      | I_clo*N = 0.38            |
| I_clo*i = 0.56       | I_clo*i = 0.43                      | I_clo*i = 0.40                      | I_clo*i = 0.30            |

<table>
<thead>
<tr>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer blouse</td>
<td>0.18</td>
<td>Summer dress</td>
<td></td>
</tr>
<tr>
<td>Summer skirts</td>
<td>0.10</td>
<td>Underwear</td>
<td></td>
</tr>
<tr>
<td>Underwear</td>
<td>0.05</td>
<td>Stocking</td>
<td></td>
</tr>
<tr>
<td>Stocking</td>
<td>0.01</td>
<td>Sandal</td>
<td></td>
</tr>
<tr>
<td>Sandal</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| I_s = 0.36           | I_s = 0.28                          | I_s = 0.52                          | I_s = 0.40                |
| I_clo*N = 0.33       | I_clo*N = 0.27                      | I_clo*N = 0.45                      | I_clo*N = 0.36            |
| I_clo*i = 0.26       | I_clo*i = 0.21                      | I_clo*i = 0.36                      | I_clo*i = 0.28            |

|                     |                                     |                                     |                           |
| Shorts              | 0.15                                |                                     |                           |
| Short sleeveless shirts | 0.15              |                                     |                           |
| Underpants          | 0.05                                |                                     |                           |
| Sandal              | 0.02                                |                                     |                           |
DISCUSSION

JOHN E. JANSSEN (Honeywell Corp., Bloomington, MN): This paper shows how clothing can be effectively used to widen the comfort range. Women do dress with a wide variation in clo value but the style for men's clothing seems more restrictive. How can we encourage the fashion designers, especially for men's clothes, to conceive acceptable styles that will yield the needed variation in clo value?

A. PHARO GAGGE: As a matter of interest to Mr. Janssen, there is an article, "Playing It Cool In Hot Weather - and Vice Versa: Tips from a Famous Scientific Laboratory," by Lydia McClean, Health Editor, in the August issue (Vol. 166,-8 1976) of Vogue magazine in which proper dress for both winter and summer FHA conditions is discussed.