WOOD BURNING SIMULATOR

BY SCANADA CONSULTANTS LIMITED

User's Manual

TABLE 1: Main program sections

MODULE	STARTING AT LINE:
- FRICTION FACTORS AND ELA's OF THE SYSTEM	4000
- INITIAL TEMPERATURE PROFILES FOR FLUE AND GAS FLOW NETWORK	4500
- MASS FLOW SUBROUTINE	5000
- CALCULATION OF PRESSURE PARAMETERS	6000
- SPECIFICATION OF ELEMENTAL PROPERTIES OF THE FLUE & FIREBOX	8000
- FLUE TRANSIENT HEAT TRANSFER ROUTINE	9000
- PARAMETER ANALYSIS AT LIGHTING OF FIRE	11000
- TEMPERATURE UPDATE ROUTINE	12000
- FLUE FILM HT. TRANSFER COEFFICIENT AND FRICTION FACTORS	12500
- OUTPUT ROUTINE TO PRINT TEMPERATURES OF FLUE ELEMENTS	13000
- FLOW NETWORK PAPAMETER ROUTINE	14000
- PHYSICAL CHARACTERISTICS OF THE SYSTEM	15000
- GUIDE TO IDENTIFY NETWORK POINTS	16000
- SUMMARY TABLE OUTPUT	17000
- LINE SUMMARY OUTPUT FOR EACH CALCULATION INTERVAL	18000
- HEADINGS FOR LINE SUMMARY	18500
- FLUE TEMPERATURE PROFILE OUTPUT	19750
- ON-LINE GRAPHICS ROUTINE	20000
- DYNAMIC MODEL OF THE HOUSE ENVELOPE	22000
- INITIALIZE THE WOOD BURNING ROUTINE	25000
- DYNAMIC THERMAL MODEL OF WOOD BURNING	27000
- RADIATION ALGORITHMS	30000

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4) Heat Transfer, J.P. Holman, McGraw-Hill Book Company, New York, 1981, Fifth Edition.

5) Investigation of the Fire Hazards of Fireplace Inserts in Factory-Built and Masonry Fireplaces, Underwriters Laboratories for U.S Department of Commerce, National Bureau of Standards, 1981.

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7) Fire Safety of Wood Burning Appliances, Part 1: State of the Art Review and Fire Tests, Volume 1, Peacock and Ruiz, Centre for Fire Research, National Bureau of Standards, 1980.

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APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

airtightness
- the degree to which unintentional openings in the building envelope have been avoided

backdrafting
- a condition where all flow in the flue is downwards and all of the stack gases as well as the outside air flowing down the flue flow out the dilution device

chimney
- a primarily vertical shaft enclosing at least one flue

combustion air
- the air drawn or forced into the combustion chamber of a heating appliance for combustion of the fuel

combustion air intake
- in the context of fireplaces, a fire resistant plenum or duct, designed to direct combustion air either directly into the fire chamber or in the vicinity of the fireplace

combustion products
- the mixture of suspended particles and gases resulting from the complete and incomplete chemical reactions that take place during combustion of fuel in the presence of air

dilution air
- ambient or room air admitted to a venting system at the dilution device

dilution device
- a device for admitting room air to a venting system to mix with the stack gases for the purpose of controlling the draft at the heating appliance exit
- also referred to as a draft regulator or draft control device
- includes barometric dampers and draft hoods (draft diverters)

draft
- the difference between the pressure at a specific point in an appliance or venting device and the pressure of the ambient air at the same elevation outside the appliance or venting device

excess air
- that portion of the combustion air which is in excess of the amount required for complete (stoichiometric) combustion

fire chamber (firebox)
- the section of a fireplace in which fuel is burned including the entire volume bounded by the hearth, chamber walls or screens and the chamber ceiling

firebrick
- refractory brick manufactured from clay that is highly resistant to heat without deforming

fireplace
- a built-in device for burning solid fuels having the major portion of one or more essentially vertical sides open or capable of being opened for refuelling and intended to permit visual observation of the flames while the fuel is burning.

fireplace, factory-built
- a fire chamber and its chimney, consisting entirely of factory-made parts designed for assembly without requiring field construction

fireplace insert
- any solid-fuel fired heat producing appliance intended for installation within, or partially within the fuel burning space of a masonry fireplace and which substantially closes off the fireplace opening

fireplace, masonry
- a fireplace constructed of masonry units such as brick, stone, firebrick, or reinforced concrete provided with a suitable chimney

flue
- an enclosed conduit for conveying flue gases out of a building
- often referred to as a vent in the context of gas heating

flue gases
- the mixture of stack gases and dilution air

flue pipe
- the conduit connecting the flue collar of a heating appliance to a chimney

glass
- any transparent or translucent material employed in the construction of a heat producing appliance or intended as an accessory or component of an accessory for such an appliance

outdoor aired appliance
- an appliance wherein all combustion air is taken directly from outdoors.

passive ventilation duct
- a vertical or near vertical duct passing through the top storey ceiling and intended to provide ventilation of the interior of the building by exhausting interior air under the influence of buoyancy- and wind-induced pressures without the use of fans
- also referred to as "dummy chimney"

spillage
- flow of stack gases out of the dilution device caused by a condition where flow in the flue is upwards but not of sufficient magnitude to remove all of the stack gases

smoke chamber
- that part of the system that connects the fireplace to the chimney and allows channeling of the flue gases to occur

stack gases
- the mixture of combustion products and excess air in its state as it leaves the heating appliance but before the introduction of dilution air

vent connector
- that part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device

APPENDIX B

PROGRAM LISTING

```
6       REM       MODEL TO SIMULATE WOOD BURNING
7       REM       DEVELOPED BY SCANADA CONSULTANTS LIMITED
8       '                   FOR CANADA MORTGAGE AND HOUSING CORPORATION
9       '      CONCEPTION & CODING: M.C. SWINTON
11       DIM TRING(10,10),TRF(10,10),ARING(10,10),VOLRING(10,10),MRING(10,
           10),MMRING(10,10),OMRING(10)
12       DIM DIAM(10),DRAD(10),NPL(10),RRING(10,10),URING(10,10),HCRING(10
           ,10),HEATIN(10),HCOMB(10,10),MASCOMB(10,10)
13       DIM NCOEF%(10),INCOEF%(10,10),RFRACTS(10),FRWDS(6),FRWS(6),F(6,6)
14       DIM TS(5),MS(5),CPS(5),EXPOSR(5),RAD(5),ARWALL(6),EMISS(6),TRANSM
           ISS(6),MASSWALL(10,15),CPWALL(10,15),RSI(10,15),TWALL(10,15),EL
           EMTHK(10)
15      '
20       DIM TN(20),TI(5,15),TF(5,15),RO(20),KE(20),HT(20),FPAR(10),AR(20)
           ,PAR(20),PB(20),ELA(10),VQ(20),FPDI2(5),CHDI2(5),FPHC(5),CHHC(5
           ),PRISE(5),PRUUN(5),DHF(15),DIA(5,15)
25       DIM FLENME$(60), OOW(20)
27       DIM CPWENV(5),ARD(5),HD$(13),ANDNO%(4),PATTRN%(4)
30       DIM MF(20),VF(20),VL(20),DI(20),U(5,15),A(5,15),M(5,15),EH(20),HC
           (5,15),OO(20),FM(20),FF(20),TW(5),DI2(5,15),CHM$(9),RISE(5),FPL
           N(5),ELTL(15),ELTS(15),ELTO(15),DENL(15),DENS(15),DENO(15),THCL
           (15),THCS(15),THCO(15),ELHT(20)
31       DIM EXTCONV(6),ELEM(4),WDENS(4),CPW(4),RVAL(4),TOTCONDOUT(6),CPLO
           G(10,10)
32       DIM N$(300),GTOUT(20),GPOUT(20),YNEW(5),YOLD(5),LT(5),Y$(3),TIT$(
           5),TTI$(10),PTI$(11),FTI$(10),TISET$(10)
33       DIM BOX%(6),TRI%(6),CIR%(6),DIAMND%(6)
        REM   $INCLUDE: 'WOODCOM.BAS'
96       ON ERROR GOTO 29000
97       CPWENV(1)=.7 :
          CPWENV(2)= -.5 :
          CPWENV(3) = -.7 :
          CPWENV(4) = -.3 :
          CPWENV(5)=0.
98       FOR I% = 2 TO 5 :
             ARD(I%)=AR(I%) :
         NEXT
99       INDCOMB%=1
100      MASTER%=1234
101      SETUP% = 0
103      PT=100:
          BOX%(0)=8:
          BOX%(1)=9:
          BOX%(2)=31744:
          BOX%(3)=17476:
          BOX%(4)=124:
          BOX%(5)=0
104      TRI%(0)=8:
          TRI%(1)=9:
          TRI%(2)=5128:
          TRI%(3)=16674:
          TRI%(4)=255:
          TRI%(5)=0
```

```
105     CIR%(0)=8:
         CIR%(1)=9:
         CIR%(2)=0:
         CIR%(3)=-13192:
         CIR%(4)=-13108:
         CIR%(5)=120
106     DIAMND%(0)=8:
         DIAMND%(1)=9:
         DIAMND%(2)=14352:
         DIAMND%(3)=-388:
         DIAMND%(4)=14460:
         DIAMND%(5)=16
107     OPEN OU$ FOR OUTPUT AS #2 :
         OPEN PW$ FOR OUTPUT AS #4
108     PRINT #2, CHR$(15)
109     WIDTH #2,255 :
         CLS
110     IF PRFLAG2%=5678
           THEN GOSUB 18500:
                IF FL1%=0
                   THEN GOSUB 32613 :
                         GOTO 3000
                   ELSE GOTO 3000
120     PRFLAG2%=0
125     '
130     REM:  SCANADA CONSULTANTS LIMITED  DYNAMIC WOOD BURNING ANALYSIS
          PROGRAM
140     REM:  DEVELOPED BY  M.C. SWINTON     1985, 1986, 1987
150     REM:                M.D. MONETTE     1985
155     REM                 R.P. SINHA       1986, 1987
156     REM:                C.J. McLARNON    1987
         157
170     CLS:
         PRINT:
         PRINT" EXECUTION OF THE WOOD BURNING SIMULATOR  PROGRAM"
180                PRINT" ----------------------------------------------
          "
190     T=TIMER :
        [ WHILE TIMER < T+1 :
        [ WEND
320     MFIPOT=0!
340     K1=(NELBOWS%*.9)+1.4
350     UI = 5*1.8 :
        UF = 5 *1.8
360     MU = .0000184
370     CPAIR = 1035
380     GC = 9.8
390     PIE=3.141593
400     TA = 273.15
410     GF = 0
420     XD = 0
440     RISET=ABS(CHBOT-HT(5))
441     ELAENV= 1.157 * ((353.6/(T1+TA)) ^ .5) * C * ((10) ^ (N - .5))
```

```
442     KEINT=(NELINT*1)+2.69+1
443     ELAINT=ARINT*1.64/SQR(KEINT)
444     VCL=((LNPP*ELAENV)+(VCLINT*ELAINT))/(ELAENV+ELAINT)
445     ELAENV=ELAENV+ELAINT
446     CC=ELAENV/((10^(N-.5))*1.157*(353.6/(T1+TA))^.5)
448     HT(8)=VCL :
        HT(9)=VCL
470      PRINT #2, "MODEL OF THE TRANSIENT PERFORMANCE OF A WOODBURNING D
          EVICE AND A CHIMNEY IN NON-DESIGN FLOW CONDITIONS"
480     PRINT #2, "============================================================
          ============================"
490     PRINT #2, :
         PRINT #2, "PROGRAM DEVELOPED BY: SCANADA CONSULTANTS LIMITED"
500     PRINT #2, "                    FOR:CANADA MORTGAGE AND HOUSING CORPO
          RATION"
510     PRINT #2, "                    DATE:1984,1986 "
520     PRINT #2, "============================================================
          ============================"
530     PRINT #2, :
         PRINT #2,
540     REM
550     REM
1000    REM=========================================================
          =======
1010    REM
1020    REM     SUBROUTINE GUIDE:
1030    REM        4000-FRICTION FACTORS AND ELA's OF THE SYSTEM
1040    REM        4500-INITIAL TEMPERATURE PROFILES FOR FLUE AND GAS FLO
          W NETWORK
1050    REM        5000-MASS FLOW SUBROUTINE
1060    REM        6000-CALCULATION OF PRESSURE PARAMETERS
1080    REM        8000-SPECIFICATION OF ELEMENTAL PROPERTIES OF THE FLUE
           & FIREBOX
1090    REM        9000-FLUE TRANSIENT HEAT TRANSFER ROUTINE
1105    REM        10500-MATH MODULE
1110    REM        11000-PARAMETER ANALYSIS AT LIGHTING OF FIRE
1120    REM        12000-TEMPERATURE UPDATE ROUTINE
1130    REM        12500-FLUE FILM HT. TRANSFER COEFFICIENT AND FRICTION
          FACTORS
1140    REM        13000-OUTPUT ROUTINE TO PRINT TEMPERATURES OF FLUE ELE
          MENTS
1150    REM        14000-FLOW NETWORK PAPRMETER ROUTINE
1160    REM        15000-PHYSICAL CHARACTERISITCS OF THE SYSTEM
1170    REM        16000-GUIDE TO IDENTIFY NETWORK POINTS
1180   REM         17000-SUMMARY TABLE OUTPUT
1190   REM         18000-LINE SUMMARY OUTPUT FOR EACH CALCULATION INTERVA
          L
1200   REM         18500-HEADINGS FOR LINE SUMMARY
1240   REM         19750-FLUE TEMPERATURE PROFILE OUTPUT
1245    REM        20000-ON-LINE GRAPHICS ROUTINE
1250   REM         22000-DYNAMIC MODEL OF THE HOUSE ENVELOPE
1252   REM         25000-INITIALIZE THE WOOD BURNING ROUTINE
1254   REM         27000-DYNAMIC THERMAL MODEL OF WOOD BURNING
```

```
1260   REM=================================================================
       =======
1270   REM
1500   REM=================================================================
       =======
1510   REM
1520   REM  : BOUNDARY CONDITIONS AND INITIAL CONDITIONS TO START THE I
       TERATIONS
1530   REM
1540   REM=================================================================
       =======
1550   REM
1560   REM :-------------BOUNDARY CONDITIONS----------------
1570   REM
1580   IF THETAW = 0
          THEN PVC=1:
               GOTO 1590
1583   IF THETAW < 0
          THEN SN = -1
          ELSE SN = 1
1585   PVC = SN * (PTC-PHC*(COS(THETAW*PIE/180!)^2))/(SIN(THETAW*PIE/180
       !)^2)
1590   VH = VWINDT * COS(THETAW*PIE/180!)
1600   VV = VWINDT * SIN(THETAW*PIE/180!)
1610   FOR I%=1 TO NFPSEGS%:    No. of Flue Pipe Segments
          DHF(I%)=FPLN(I%):  Lngth of each segment = FLUE PIPE LENGTH
       NEXT I%:
       REM:DHF=SQR((RISE*RISE)+(RUUN*RUUN))
1620   NE%=5:
       HF=CHBOT:
       PELHT=HF+3*HF/(NE%-NFPSEGS%)
1630   HH=ABS(HT(19)-HT(15))
1640   REM:NE% = 10
1644   FOR Y%=1 TO NE%
1645      IF Y% > NFPSEGS%
             THEN GOTO 1647
1646      DIA(1,Y%)= (2*SQR(AR(5)/PIE)) :
          GOTO 1648
1647      DIA(1,Y%)= (2*SQR(AR(2)/PIE))
1648      DI2(1,Y%)=(DIA(1,Y%)*PIE):
       NEXT Y%
1649   REM:AR(2)=PIE*(DIA(1,NE%)^2)/4:AR(3)=AR(2):AR(4)=PIE*(DIA(1,1)^2)
       /4:AR(5)=AR(4)
1650   REM:DF=2*SQR((AR(2)/PIE)):
1660   FOR ZZ%=1 TO NE%:
          ELHT(ZZ%)=PELHT-HF/(NE%-NFPSEGS%):
          PELHT=ELHT(ZZ%):
       NEXT ZZ%
1670   REM
1680   REM : -----------HOUSE AIRTIGHTNESS CHARACTERISTICS-----------
1690   REM :
1700   REM
1710   REM : ---------------PHYSICAL DATA IS READ IN-------------
```

```
1720   REM
1730    GOSUB 4000
1732  REM      INITIATION OF WOOD BURNING CHARACTERISTICS
1734   GOSUB 25000
1740    IF Z$ = "N"
          THEN  GOTO 1760
1750    GOSUB 15000
1760   REM
1770   REM : ---------INITIAL TEMPERATURE PROFILES ARE READ IN---------
         ---
1780   REM
1790    GOSUB 4500
1800   REM
1820   REM   :                                          F2 - FULL FIRING RATE
         IN  BTU/HR
1830   REM
1840   F$ = "NOT"
1850   FW=0
1870   REM
1880   REM :-----------COMPETING FANS & FIREPLACE CHIMNEY FLOWS--------
         -----
1890   REM
1900   FANM = (QF * RO(9)) / 1000
1910   FIRM = (FP * RO(9)) / 1000
1920   MCOMP = FANM + FIRM
1930   REM
2000  REM================================================================
         =======
2010  REM
2020  REM : INITIAL CONDITIONS FOR THE ITERATIVE PROCESS
2030  REM
2040  REM================================================================
         =======
2050  REM
2060    GOSUB 8000
2070    GOSUB 9510
2080   Q6 = .022
2090   Q9 = .001
2120   Q1 = .026:
       ER1 = 2
2130   X3 = .01 :
       ER3 = 2
2140   SCS = SCS - SEC:
       SCSCHRG=SCS
2145   THS=T9
2150   Z1 = Z2 - 1
2170    GOSUB 18500
2185   IF FL1%=1
          THEN LOCATE 12,32:
               COLOR 15,0:
               PRINT "  CALCULATING  ":
               LOCATE 12,32:
               COLOR 31,0:
```

```
                PRINT "!":
                LOCATE 12,46:
                PRINT "!":
                LOCATE 14,32:
                COLOR 15,0:
                PRINT "  PLEASE WAIT":

          ELSE 3000
2190    THCOMBT=0
2191    TRAD1= 0
3000    REM=============================================================
          =======
3010    REM
3020    REM  :    S T A R T   O F   E X E C U T I O N   L O O P
3030    REM
3040    REM=============================================================
          =======
3050    REM
3055     S=0
3060      S=S+1
3065     SCS = SCS + SEC
3070     BRAND$="N":
         IF BRAND$="Y"
            THEN SCSCHRG = SCSCHRG + SEC
3071     IF BRAND$ = "Y" AND SCSCHRG > 450
            THEN GOSUB 25000:
                 SCSCHRG=0
3072     IF S > 25000
            THEN S = 31
3075     IF FL1%=1
            THEN 3100
            ELSE 3080
3080     REM: CLS
3090    REM:LOCATE 1,1 : PRINT USING"TIME = #####.#   (s)    TIME STEP = #.
          ### (s)";SCS;SEC
3100     Z1 = Z1 + 1
3110      IF SCS >  = FS AND F$ = "NOT"
            THEN F$ = "ON":
                 TRING(2,NWE%)=300.:
                 TRING(1,NWE%)=300:
                 TRING(3,NWE%)=300:
                 TRADFL=TRING(2,NWE%):
                 Z1 = 0:
                  GOSUB 19500
3120     REM
3130     REM :----------5000- CALCULATION OF MASS FLOWS USING "CONTINUITY
           ", PRESSURES USING BERNOULLI +
3140     REM
3180     ITER=0
3210      GOSUB 5000
3220      GOSUB 6000
3230     REM
3240     REM  :--------CONVERGENCE ROUTINES---------
```

```
3250   REM
3260    ITER=ITER+1
3270   C1 = PB(5) + PB(10)
3280   IF ABS(C1) > 1E+11
          THEN Q9=.002:
                X3 = .003 :
                ER3=.16 :
                Q6=.02 :
                Q1=.026 :
                ER1=.2 :
                GOTO 3210
3290    IF  ABS (C1) < .001
          THEN GOTO 3390
3300   IF ITER > 100
          THEN PRINT #2,"*** ITERATION CONVERGENCE PROBLEMS -- ERROR FUN
            CTIONS = ";C1,C2" (Pa)":
                GOTO 3520
3310   Q2 = Q6:
       ER2 = C1
3320   IF ER1 = ER2
          THEN Q9=.002:
                X3 = .003 :
                ER3=.16 :
                Q6=.02 :
                Q1=.026 :
                ER1=.2 :
                GOTO 3210
3330   REM : Q6 = Q6 * (PT(12) / PT(6))
3340   Q6 = (Q2 * ER1 - Q1 * ER2) / (ER1 - ER2)
3350   REM : Q6 = (Q6 + 1.2 * Q2) / 2.2
3355   IF FL1%=1
          THEN 3370
          ELSE 3360
3360  REM:  PRINT USING"##. FLUEFLOW (Kg/S) AND ERRFUNCTION (PA) = #.##
         ##  ###.###";ITER,Q2,ER2
3370    Q1 = Q2:
       ER1 = ER2
3380    GOTO 3210
3390   C2 = PB(9) - PB(10)
3400   IF ABS(C2) > 1E+11
          THEN Q9=.002:
                X3 = .003 :
                ER3=.16 :
                Q6=.02 :
                Q1=.026 :
                ER1=.2 :
                GOTO 3210
3410    IF  ABS (C2) < .001
          THEN GOTO 3520
3420   ER4 = C2:
       X4 = Q9
3430   IF ER3 = ER4
          THEN Q9=.002:
```

```
                X3 = .003 :
                ER3=.16 :
                Q6=.02 :
                Q1=.026 :
                ER1=.2 :
                GOTO 3210
3440    Q9 = (X4 * ER3 - X3 * ER4) / (ER3 - ER4)
3445    IF FL1%=1
           THEN 3460
           ELSE 3450
3450  REM PRINT USING"##. FIBX INLET FLOW (Kg/S) AND ERRFUNCTION (PA) =
           #.####   ###.###";ITER,X4,ER4
3460    X3 = X4:
        ER3 = ER4
3470    REM
3480     GOTO 3210
3490    REM
3500    REM :---------END OF CONVERGENCE ROUTINE--------
3510    REM
3520    REM
3530    REM :----------OUTPUT OF CALCULATION RESULTS--------------
3540   REM
3545    GOSUB 18000
3550    IF SCS >= ST
           THEN GOSUB 3750 :
                 GOTO 3669
3640    GOSUB 27000
3650    GOSUB 9000
3655    GOSUB 29600
3656    GOSUB 31622
3660    ABORT$=INKEY$:
         IF ABORT$="A" OR ABORT$="a"
           THEN GOTO 3669
3662    GOTO 3060
3663    REM
3664    REM=================================================================
          =======
3665    REM   :   E N D    O F    E X E C U T I O N    L O O P
3666    REM=================================================================
          =======
3667   REM
3669    BEEP:
        SCSFLAG%=1:
        IF FL1%=1
           THEN GOSUB 3675
           ELSE 3670
3670    IF FL1%<>1
           THEN GO TO 3671
           ELSE CLOSE #2:
                CLOSE #4:
                CLS:
                LOCATE 20,60:
                COLOR 19,0:
```

```
                PRINT"Please Standby":
                COLOR 7:
                CHAIN FLUEIN$ :
               REM ,30000,ALL
3671    CLOSE #2:
        CLOSE #4:
         INPUT"PRESS RETURN TO END"; A$ :
        F$="NOT":
        CLS:
        LOCATE 20,60:
        COLOR 19,0:
        PRINT"Please Standby":
        COLOR 7:
        CHAIN FLUEIN$ :
       REM ,30000,ALL
3672    END
3673   REM     -----   PRINTOUT CONTROL SUBROUTINES  -----
3674   REM  SCREEN GRAPHICS PRINT OPTION
3675    LOCATE 1,13:
        PRINT "Press 'P' for PRINT, 'S' for SAVE"
3676    LOCATE 2,13:
        IF SCS>=ST
           THEN PRINT "'E' for EXIT                "
           ELSE PRINT "'E' for EXIT or 'C' to CONTINUE"
3677    JUNK$=INKEY$:
        IF JUNK$=""
           THEN 3677
3678    IF JUNK$="E" OR JUNK$="e"
           THEN 3696
           ELSE 3679
3679    IF JUNK$="P" OR JUNK$="p"
           THEN JUNK$="P" :
                 GOTO 3690
           ELSE 3680
3680    IF JUNK$="S" OR JUNK$="s"
           THEN 3690
           ELSE 3681
3681    IF JUNK$="C" OR JUNK$="c"
           THEN 3682
           ELSE 3677
3682    LOCATE 1,13:                                  "
        PRINT "
3683    LOCATE 2,13:                                  "
        PRINT "
3684    GOTO 3662
3690    LOCATE 1,13:                                      \";TITLE$
        PRINT USING"\
3692    LOCATE 2,13:                                    \";DATE$
        PRINT USING"DATE: \
3693    IF JUNK$="P"
           THEN CALL PRTSC  :
                 GOTO 3696 :
               REM:  ASM=-51973.8
```

```
3694    CHK$=".":
         LOCDOT=INSTR(DOC$,CHK$):
         FAULT$=LEFT$(DOC$,LOCDOT-1) :
          REM:  PRTSCR%=VARPTR(ASM)
3695    DEF SEG=&HB800 :
         BSAVE DRIVE$+FAULT$+".PIC",0,16384 :
         DEF SEG :
                  REM:  CALL ABSOLUTE(PRTSCR%)
3696    CLS:
        SCREEN 0,0:
        RETURN
3750   REM:  FINAL SYSTEM PRINTOUTS
3754    GOSUB 15000
3756    GOSUB 13000
3758    GOSUB 14000
3760    GOSUB 17000
3762    RETURN
4000    REM================================================================
          =======
4010    REM:
4020    REM:              FRICTION FACTORS AND ELA's OF THE SYSTEM
4030    REM:
4040    REM================================================================
          =======
4050    REM:
4060    REM: ---------K FACTOR NORMAL FLOW VALUES-----------
4070    REM:
4080    FOR X% = 1 TO 19
4090        READ KE(X%)
4100    NEXT X%
4110     DATA  0,1.,0,3.2 ,0.5,0,0,0,0,0,4.0,0,0,0,3.0,0,0,2.5,0
4120    IF KE(4)< K1
           THEN KE(4)= K1
4125    KE(2)=FCAPL
4130    REM
4140    REM:
4150    REM:
4160    ADR = AR(11) * APRD / 100
4170    REM :
4180    REM :  E Q U I V A L E N T   L E A K A G E   A R E A S
4190    REM :
4200    REM :    1 - CHIMNEY ELA
4210    REM :    2 - DILUTION PORT ELA (DESIGN FLOWS)
4220    REM :    3 - DILUTION PORT ELA (REVERSE FLOW)
4230    REM :    4 - FIREBOX INLET ELA
4240    REM :    5 - FIREBOX OUTLET ELA
4250    REM
4260    ELA(1) = ARD(4) * ((2.68 / (KE(4) + KE(5) + KE(2))) ^ .5)
4270    ELA(2) = (AR(11) * ((2.68 / KE(11)) ^ .5))
4280    ELA(3) = (ADR    * ((2.68 / KE(11)) ^ .5))
4285    IF INTAKE$="Y"
           THEN KE15=KE(15)+NELINTAK *.45
           ELSE KE15=KE(15)
```

```
4290    ELA(4) = AR(15) * ((2.68 / KE15) ^ .5)
4300    ELA(5) = AR(18) * ((2.68 / KE(18)) ^ .5)
4305    IF GLASSDR$ = "Y"
           THEN ELA4GD=ELA(4):
                ELA2GD=ELA(2)
4310     RETURN
4500    REM=============================================================
          =======
4510    REM:
4520    REM:              INITIAL TEMPERATURE PROFILES FOR FLUE
4530    REM:                    AND GAS FLOW NETWORK
4540    REM:
4550    REM=============================================================
          =======
4560    REM:
4570    REM:
4580    REM: -------------READ IN FLUE LINER INITIAL TEMPERATURES-------
          -------
4590    REM
4600    REM:
4610    REM:------------CHIMNEY STRUCTURE & SURROUNDINGS TEMPERATURES----
          ----
4620    REM:
4640    FOR X% = 1 TO NE%
4650       TI(5,X%) = T1:
           IF X%<(NFPSEGS%+1)
              THEN TI(5,X%)=T9:
                   GOTO 4662
4660       IF ELHT(X%)>(XPT+HF/(2*(NE%-NFPSEGS%))) AND X%<NE%
              THEN TI(5,X%)=T9
4662       IF SCSFLAG%=1
              THEN GOTO 4680
4664       IF ELHT(X%)<(XPT+HF/(2*(NE%-NFPSEGS%))) OR  X%=NE%
              THEN GOTO 4680
4670       TI(4,X%) = TI(5,X%):
           IF TI(3,X%) < TI(4,X%)
              THEN TI(3,X%)=TI(4,X%):
                   TI(2,X%)=TI(3,X%)
4680    NEXT X%
4690    FOR X% = 1 TO NE%
4700       IF X%<(NFPSEGS%+1)
              THEN EH(X%)=RISE(X%):
                   GOTO 4720:
                 REM IF X<3 THEN EH(X)=RISE/2
4710        EH(X%)=(HF/(NE%-NFPSEGS%))
4720    NEXT X%
4730    REM :
4740    REM : --------COMPUTE DENSITY TERMS FOR GAS FLOW NETWORK POINTS(
          19)------
4750    REM
4760    FOR X% = 1 TO 19
4770       RO(X%) = 353.6 / (TN(X%) + TA)
4780    NEXT
```

```
4790    RETURN
5000    REM=================================================================
          =======
5010    REM
5020    REM  :          MASS FLOW  SUBROUTINE
5030    REM
5040    REM=================================================================
          =======
5050    REM
5060    REM :-----------CALCULATION OF MASS PARAMETERS--------------
5070    REM
5080    MF(6) = Q6
5090    MF(19) = Q9 + MTFUEL
5100    FOR X% = 1 TO 5
5110       MF(X%) = MF(6)
5120    NEXT
5130    REM
5140    FOR X% = 10 TO 12
5150       MF(X%) = MF(6) - MF(19)
5160    NEXT
5170    REM
5180    FOR X% = 13 TO 14
5185       IF INTAKE$ = "Y" AND SCS > CDT
              THEN MF(X%)=0 :
                      GOTO 5200
5190       MF(X%) = MF(19) - TMASCOMB
5200    NEXT
5210    MF(15)=MF(19)-TMASCOMB
5220    REM
5230    FOR X% = 16 TO 18
5240       MF(X%) = MF(19)
5250    NEXT
5260    REM
5270    FOR X% = 7 TO 9
5280       MF(X%) = MF(10) + MF(13) + MCOMP
5290    NEXT
5300    REM
5310    FOR X% = 1 TO 19
5320       VF(X%) = MF(X%) / RO(X%)
5330    NEXT
5340    REM
5350    REM
5360    REM:------VELOCITIES--------
5370    REM
5380    FOR X% = 1 TO 19
5390       IF AR(X%) < .0004
             THEN VL(X%) = 0 :
                      GOTO 5410
5400       VL(X%) = VF(X%) / AR(X%)
5405       IF X%>1 AND X% < 6
             THEN VL(X%)=VF(X%)/ARD(X%)
5410    NEXT X%
5420    IF VF(11) < 0
```

```
          THEN VL(11) = VF(11) / ADR
5430    RETURN
6000    REM=================================================================
          =======
6010    REM
6020    REM  :                CALCULATION OF PRESSURE PARAMETERS
6030    REM
6040    REM=================================================================
          =======
6050    REM
6060    REM :----LOOP #1:   FLUE PIPE - VENT OR CHIMNEY - CAP - OUTDOORS
          - ENVELOPE - INDOORS DOWN TO DILUTION DEVICE------
6070    REM
6080    ELA(1) = ARD(2) * ((2.68 / (KE(4) + KE(5) + KE(2))) ^ .5)
6090    TT = ((353.6 * GC * (HF +RISET)) / GF) - TA
6095    TFLUE = TT
6100    PB(1) = (353.6 * GC * (((HF + RISET + ABS(HT(6)-HT(5)) -  ABS (VC
          L )) / (TN(9) + TA)) + ( ABS (VCL) / (TN(1) + TA)) - ((HF + RIS
          ET) / (TT + TA)) - (ABS(HT(6)-HT(5)) / (TN(6) + TA))))
6105   'CLS: PRINT HF,CHBOT,HT(5),RISET,HT(6),VCL,TN(9),
6106   'PRINT TT,,GC,GF,TN(6),TN(1),PB(1):
6107   'FOR Y% = 1 TO NE%:PRINT EH(Y%):NEXT Y%
6108   'FOR ZZ% = 1 TO 1000:NEXT ZZ%
6110    SN = 1:
          IF VV < 0
            THEN SN = 0 - 1
6120    PB(2) = (((PHC+CPWENV(LEAKDIST)) * .5 * RO(1) * (VH ^ 2)) + (SN *
            PVC * .5 * RO(1) * ( ABS (VV) ^ 2)))
6130    SN = 1:
          IF MF(8) < 0
            THEN SN= 0 - 1
6140    PB(3) = 0 - SN * ((( ABS (MF(8)) / RO(8)) /CC) ^ (1 / N))
6150    VAC = ((VF(4) * KE(4)) + (VF(5) * KE(5)) + (VF(2) * KE(2))) / (KE
          (4) + KE(5) + KE(2))
6160    SN = 1:
          IF VAC < 0
            THEN SN = 0 - 1
6170    PB(4) = 0 - SN * ((473.8 / (TT + TA)) * (( ABS (VAC) / ELA(1)) ^
          2))
6180    PB(5) = PB(1) + PB(2) + PB(3) + PB(4)
6190    REM
6200    REM :---LOOP #2:  OUTSIDE FIREBOX -FIREBOX INLET - UP THROUGH FI
          REBOX - OUT TO MIXING AREA IN DILUTION DEVICE-------
6210    REM
6220    TEF = (1 / ((FRACOMB / (TN(16) + TA)) + ((1-FRACOMB) / (TN(17) +
          TA)))) - TA
6222    COLWT=HH/(TN(9) + TA)
6223    IF INTAKE$ = "Y" AND SCS > CDT
            THEN COLWT=(HT(16)-VCL)*(1/(TN(1)+TA) - 1/(TN(9)+TA))+COLWT
6230    PB(6) = (353.6 * GC * (COLWT - ((HH +(HT(19)-HT(18))) / (TEF + TA
          )) + ((HT(19)-HT(18)) / (TN(19) + TA))))
6240    SN = 1
6250     IF VF(15) < 0
```

```
          THEN SN = 0 - 1
6255    IF GLASSDR$ = "Y" AND SCS > CDT
          THEN ELA(4) = ELA4GD:
               ELA(2)=ELA2GD:
               ELA(3)=ELA(2)
6260    IF GLASSDR$="Y" AND SCS <= CDT
          THEN ELA(2)=  0.162 :
                ELA(3) = ELA(2) :
                ELA(4)=.3
6280    PB(7) = 0 - SN * (473.8 * ((ABS (VF(15)) / ELA(4)) ^ 2) / (TN(15)
          + TA))
6290    PB(8) = 0 - SN * (473.8 * ((ABS (VF(18)) / ELA(5)) ^ 2) / (TN(18)
          + TA))
6295    IF INTAKE$="N"
          THEN PB3=0
          ELSE PB3=-PB(3)
6300    PB(9) = PB(6) + PB(7) + PB(8)
6310    REM
6320    REM :--------CLOSING LOOPS #1 & #2  THROUGH THE DILUTION DEVICE-
          -------
6330    REM
6340    SN = 1:
        II = 2
6350     IF VF(11) < 0
           THEN SN = 0 - 1:
                II = 3:
                GOTO 6360
6360    PB(10) = 0 - SN * (473.8 * (( ABS (VF(11)) / ELA(II)) ^ 2) / (TN(
          11) + TA))
6410    RETURN
8000    REM=================================================================
          =======
8010    REM
8020    REM:     SPECIFICATION OF ELEMENTAL PROPERTIES OF THE FLUE & THE
          FIREBOX
8030    REM
8040    REM=================================================================
          =======
8050    REM
8060    FOR Y% = 1 TO NE%
8070       U(1,Y%) = UI
8080       U(2,Y%)=THCL(Y%)
8090       U(3,Y%)=THCS(Y%)
8100       U(4,Y%)=THCO(Y%)
8110       REM
8120       REM:----------ALL  "M"  "HC" "A" TO BE SPECIFIED HERE-----
             ------
8130       REM
8140       FOR J%=1 TO 4
8145            IF DI2(J%,Y%)=0
                   THEN A(J%,Y%)=A(J%-1,Y%) :
                        GOTO 8170
8150            IF Y%<(NFPSEGS%+1)
```

```
                THEN A(J%,Y%)=DHF(Y%)*DI2(J%,Y%):
                     GOTO 8170
8160           A(J%,Y%)=HF*DI2(J%,Y%)/(NE%-NFPSEGS%)
8170       NEXT J%
8180       REM:A(1,Y%)=A(2,Y%)*.98
8190        HC(1,Y%) = CPAIR
8200        REM
8210        M(2,Y%)=DENL(Y%)*A(2,Y%)*ELTL(Y%)
8220        M(3,Y%)=DENS(Y%)*A(3,Y%)*ELTS(Y%)
8230        M(4,Y%)=DENO(Y%)*A(4,Y%)*ELTO(Y%)
8240    NEXT Y%
8250    REM
8260    REM: -----------SPECIFICATION OF FLUEPIPE PROPERTIES-----------
          -
8270    REM
8280    FOR Y% = 1 TO NFPSEGS%
8290       REM:U(2,Y%) = 8.3:DEFINED IN LINE 8080
8300       REM:IF M(2,Y%)=0 THEN M(2,Y%) = 7900! * A(2,Y%) * .0005:U(2
             ,Y%)=8.3:HC(2,Y%)=500!:FPI$="U"
8305        IF M(3,Y%)=0
              THEN M(3,Y%) = M(3,NE%):
                   U(3,Y%)=U(3,NE%):
                   HC(3,Y%)=HC(3,NE%):
                   FPI$="U"
8306        IF M(4,Y%)=0
              THEN M(4,Y%) = M(4,NE%):
                   U(4,Y%)=U(4,NE%):
                   HC(4,Y%)=HC(4,NE%):
                   FPI$="U"
8310       REM:HC(2,Y%)= 500!:DEFINED IN FLUEIN
8320    NEXT Y%
8330    REM
8340    REM:----------------CHECK OF TIME CONSTANTS-------------------
8350    REM
8355    GOTO 8460
8360     CLS :
         PRINT "OUTFLOW TIME CONSTANTS OF CHIMNEY ELEMENTS FROM LINER TO
          SURROUNDINGS:":
        PRINT
8370    FOR J% = 2 TO 4
8380       TZ = (M(J%,NE%) * HC(J%,NE%)) / (U(J%,NE%) * A(J%,NE%)):
          REM:NOTE NE% WAS ORIGINALLY 5,THE VALUE OF 5 WAS ARBITRARY-
             MCS.
8390         PRINT USING"FROM POINT ##  TO POINT ## :  ######.";J%,J%+1
              ,TZ
8400    NEXT J%
8410     PRINT :
         PRINT "INFLOW TIME CONSTANTS OF CHIMNEY ELEMENTS FROM LINER TO
         SURROUNDINGS:":
        PRINT
8420    FOR J% = 2 TO 4
8430       TZ = (M(J%,NE%) * HC(J%,NE%)) / (U(J% - 1,NE%) * A(J% - 1,N
             E%)):
```

```
          REM SAME COMMENT ABOUT NE% AS LINE 8380
8440        PRINT USING"FROM POINT ##  TO POINT ## :  ######.";J%-1,J%
              ,TZ
8450      NEXT J%
8455    T=TIMER:
        WHILE TIMER < T+3 :
        WEND
8460    REM
8470    REM :-------------FIREBOX PHYSICAL PROPERTIES---------------
8480    REM
8530     RETURN
9000    REM================================================================
          =======
9010    REM
9020    REM :  TRANSIENT HEAT TRANSFER MODEL OF THE FLUE
9030    REM :  PARAMETERIZED TEMPERATURE ALGORITHMS ARE CALLED IN SUBROU
          TINE 12000
9040    REM
9050    REM================================================================
          =======
9060    REM
9070    KK = 0
9080    UF = 0
9090    REM
9100    REM
9110     FOR Y% = 1 TO NE%
9120        REM :----MASS OF THE FLUE GAS ELEMENT = VOLUME OF ELEMENT
              X  DENSITY AT INITIAL TEMPERATURE-----
9130        IF Y%<(NFPSEGS%+1)
              THEN M(1,Y%) = ((ARD(5) * DHF(Y%)) * (353.6 / (TI(1,Y%)
                + TA)))
9131       REM:ORIGINAL LINE:IF Y%<3 THEN M(1,Y%) = ((AR(5) * (DHF/2))
             * (353.6 / (TI(1,Y%) + TA)))
9140        IF Y%>NFPSEGS%
              THEN M(1,Y%)=((ARD(5)*(HF/(NE%-NFPSEGS%)))*(353.6/(TI(1,
                Y%)+TA)))
9150        REM
9160        REM :--SUBROUTINE 12500 CALCULATES THE HEAT TRANSFER COEFF
              ICIENTS NEEDED FOR THE FOLLOWING WORK & FRICTION FACTORS
              FOR THE PRESSURE LOSS ROUTINE--------
9170        REM
9180         GOSUB 12500
9190         IF Y% = 1
               THEN TB = TN(5)
9200         IF Y% = 1
               THEN  GOTO 9220
9210        TB = TI(1,(Y% - 1))
9220         IF MF(5) > 0
               THEN  GOTO 9250
9230         IF Y% = NE%
               THEN TB = TN(1):
                    GOTO 9250
9240        TB = TI(1,(Y% + 1))
```

```
9250        INDT = 1    CONTROL INICATOR FOR THE PARAMTERIZED THERMAL MODEL
9260        ITW = M(1,Y%) /  ABS (MF(5))
9270        OTW = (M(1,Y%) * HC(1,Y%) / (U(1,Y%) * A(1,Y%)))
9280        D1TM = TB - TI(1,Y%)
9290        D2TM = TI(1,Y%) - TI(2,Y%)
9300         GOSUB 12020
9310        TF(1,Y%) = TI(1,Y%) + DTM
9320      FOR J% = 2 TO 4
9330          INDT = 2
9340          ITW = (M(J%,Y%) * HC(J%,Y%) / (U(J% - 1,Y%) * A(J% -
                1,Y%)))
9350          OTW = (M(J%,Y%) * HC(J%,Y%) / (U(J%,Y%) * A(J%,Y%)))
9360          D1TM = TI(J% - 1,Y%) - TI(J%,Y%)
9370          D2TM = TI(J%,Y%) - TI(J% + 1,Y%)
9380           GOSUB 12020
9390          TF(J%,Y%) = TI(J%,Y%) + DTM
9395          IF FPI$="U"
                 THEN GOTO 9400
                 ELSE GOTO 9410
9400           IF Y% <(NFPSEGS%+1) AND J% > 2
                 THEN TF(J%,Y%) = TN(9)
9410      NEXT J%
9420    NEXT Y%
9430    FOR Y% = 1 TO NE%
9440       FOR J% = 1 TO 4
9450          TI(J%,Y%) = TF(J%,Y%)
9460       NEXT J%
9470    NEXT Y%
9480    KE(4) = KK / NE%
9490    UF = UF / NE%
9500    REM
9510    REM :----CALCULATE NEW COLUMN WEIGHT OF THE FLUE GAS BASED ON TH
          E NEW FLUE TEMPERATURES------
9520    REM
9530    GF = 0!
9540    FOR Y% = 1 TO NE%
9550       RW = 353.6 / (TI(1,Y%) + TA)
9560       GF = GF + (RW * GC * EH(Y%))
9570    NEXT Y%
9580    REM
9590    REM
9600    TN(4) = TI(1,1)
9610     IF MF(5) < 0
           THEN TN(5) = TN(4)
9620    TN(3) = TI(1,NE%)
9630    TN(2) = TN(3)
9640    REM
9650    REM :---------NEW DENSITIES----------
9660    REM
9670    FOR X% = 1 TO 19
9680       RO(X%) = 353.6 / (TN(X%) + TA)
9690    NEXT X%
9692    REM:------------ NEW FLOW AREAS ACCOUNTING FOR DISPLACEMENT THICKN
          ESS ------
```

```
9694    ARD(2)=PIE*(DIA(1,NE%)^2)/4:
        ARD(3)=ARD(2):
        ARD(4)=PIE*(DIA(1,1)^2)/4:
        ARD(5)=ARD(4)
9700     RETURN
11000   REM=============================================================
          ======
11010   REM
11020   REM :     P A R A M E T E R   A N A L Y S I S
11030   REM               AT LIGHTING OF THE WOOD PILE
11040   REM
11050   REM=============================================================
          ======
11060   IF FL1%=1
           THEN 11550
           ELSE 11070
11070   PRINT #2, :
         PRINT #2,
11080   PRINT #2, "S Y S T E M   P A R A M E T E R S"
11090   PRINT #2, "==================================":
         PRINT #2,
11100   REM
11110   PAR(1) =   INT (100 * (((QF + FP) / (1000 *CC)) ^ (1 / N)) + .5)
          / 100
11120   SN = 1:
         IF VV < 0
           THEN SN = 0 - 1
11130   PAR(2) = 0 +  INT (100 * (((PHC+CPWENV(LEAKDIST)) * .5 * RO(1) *
          (VH ^ 2)) - (SN * PVC * .5 * RO(1) * ( ABS (VV) ^ 2))) + .5) /
          100
11140   PAR(3) = PAR(2) - PAR(1)
11150   PAR(4) =  INT (100 * (353.6* GC * (((HF -  ABS (VCL )) / (TN(9) +
           TA)) + ( ABS (VCL ) / (TN(1) + TA)) - (HF / (TT + TA)))) + .5)
           / 100
11160   PAR(5) =  INT (100 * (PAR(4) + PAR(3)) + .5) / 100
11170   L1A = AR(15) * (2.68 / KE(15)) ^ .5
11180   L2A = AR(18) * (2.68 / KE(18)) ^ .5
11190   IF L1A <.01
           THEN L1A=1000000!
11200   PAR(6) =  INT (1000 * (1 / ((1 / L1A) + (1 / L2A))) + .5) / 1000
11210   L1A = ARD(4) * (2.68 / (KE(4) + KE(2) + KE(5))) ^ .5
11220   PAR(7) =  INT (1000 * L1A + .5) / 1000
11230   L1A = ADR * (2.68 / KE(11))^ .5
11240   PAR(8) =  INT (1000 * L1A + .5) / 1000
11250   L1A = 1.157 * (RO(1) ^ .5) *CC * ((10) ^ (N - .5))
11260   PAR(9) =  INT (1000 * L1A + .5) / 1000
11300   PAR(10) =  INT (10 * (M(2,NFPSEGS%+1)*HC(2,NFPSEGS%+1) / (U(1,NFP
          SEGS%+1) * A(1,NFPSEGS%+1))) + .5) / 10
11350   HD$(1)="ENVELOPE ADVERSE PRESS.(FANS & FIREPLACE)  (PA):"
11360   HD$(2)="WIND INDUCED DRIVING PRESSURE              (PA):"
11370   HD$(3)="NET BOUNDARY DRIVING PRESSURE              (PA):"
11380   HD$(4)="CHIMNEY/HOUSE BUOYANCY PRESSURE AT STANDBY (PA):"
11390   HD$(5)="NET DRIVING PRESSURE PARAMETER (AT STANDBY)(PA):"
```

```
11400  HD$(6)="FIREBOX EQUIVALENT LEAKAGE AREA OF FLOW     (m2):"
11410  HD$(7)="CHIMNEY EQUIVALENT LEAKAGE AREA OF FLOW     (m2):"
11420  HD$(8)="E.L.A.  OF CHIMNEY CONNECTION               (m2):"
11425  IF FB$="F"
          THEN HD$(8)="E.L.A.  OF UPPER OPENING OR OF DOORS        (m2):"
11430  HD$(9)="ENVELOPE EQUIVALENT LEAKAGE AREA AT 10 PA  (m2):"
11470  HD$(10)="CHIMNEY LINER HEAT TRANSFER TIME CONSTANT   (S):"
11472  FOR X% = 1 TO 10
11473      IF X% = 6
              THEN PRINT #2,
11476      PRINT #2,HD$(X%);"  ";PAR(X%)
11478  NEXT X%
11480  PRINT #2, :
        PRINT #2,
11490  PRINT #2, "FLUE LOCATION:  ";:
       IF CHIMT$="I"
          THEN PRINT #2, "INTERIOR"
          ELSE PRINT #2, "EXTERIOR"
11500  PRINT #2, "CHIMNEY FLOW DIRECTION AT STANDBY: ";
11510   IF VL(4) < 0
          THEN  PRINT #2, "REVERSED  ("; INT (100 * VL(4) + .5) / 100;"
            M/S)":
                GOTO 11530
11520  PRINT #2, " UPWARD   ("; INT (100 * VL(4) + .5) / 100;" M/S)"
11530  PRINT #2,
11540   GOSUB 18570
11550   RETURN
12000  REM================================================================
        ======
12010  REM
12020  REM :          T E M P E R A T U R E    U P D A T E
12030  REM :            ---PARAMETERIZED ALGORITHMS---
12040  REM
12050  REM================================================================
        ======                                              INDT = 9250
12060  REM                                                        9330
12070   IF INDT = 1 AND SEC > .9 * ABS (ITW)                    12070
          THEN SEC = .9 * ABS (ITW)                             12080
12080   IF INDT = 2 AND SEC > .3 * ABS (ITW)                    12140
          THEN SEC = .3 * ABS (ITW)                             12150
12090   IF D1TM = 0
          THEN  GOTO 12130
12100  TR = (D2TM / OTW) * (ITW / D1TM)
12110  DTM = D1TM * (1 - TR) * (SEC / ITW)
12120   GOTO 12180
12130   IF D2TM = 0
          THEN DTM = 0:
               GOTO 12180
12140   IF INDT = 1 AND SEC > .9 * ABS (OTW)
          THEN SEC = .9 * ABS (OTW)
12150   IF INDT = 2 AND SEC > .3 * ABS (OTW)
          THEN SEC = .3 * ABS (OTW)
12160  TR = (D1TM / ITW) * (OTW / D2TM)
```

```
12170  DTM = D2TM * (TR - 1) * (SEC / OTW)
12180   RETURN
12190   RETURN
12500  REM================================================================
         ======
12510  REM
12520  REM : FLUE FILM HEAT TRANSFER COEFFICIENT & FRICTION FACTORS
12530  REM :           AS A FUNCTION OF REYNOLDS NUMBER
12540  REM
12550  REM================================================================
         ======
12560  REM
12570  IF Y%<(NFPSEGS%+1)
          THEN V = (DHF(Y%)) / (M(1,Y%) /  ABS (MF(5)))
12580  IF Y%>=(NFPSEGS%+1)
          THEN V = (HF/(NE%-NFPSEGS%)) / (M(1,Y%) /  ABS (MF(5)))
12590  RE = (353.6 / (TI(1,Y%) + TA)) * V * DIA(1,Y%) / MU
12600  U(1,Y%) = 1.8*(.0238 / DIA(1,Y%)) * (.021 * (.78 ^ .5) * RE ^ .8)
12610  FF(Y%) = ((NELBOWS%*.9)+0)+(38700! / RE) ^ 1.24
12620  IF (TI(1,Y%) - TI(2,Y%)) < 15
          THEN FF(Y%) = K1
12630  IF FF(Y%) <K1
          THEN FF(Y%)=K1
12640   IF U(1,Y%) < UI
          THEN U(1,Y%)= UI
12650  KK = KK + FF(Y%)
12660  UF = UF + U(1,Y%)
12661 REM: DB=DIA(1,Y%)*61.8/(RE^(7/8))
12662  DIA(1,Y%)=(DI2(1,Y%)/PIE)*(1-.096):
       IF Y%<(NFPSEGS%+1)
          THEN A(1,Y%)=(PIE*DIA(1,Y%))*DHF(Y%)
          ELSE A(1,Y%)=(PIE*DIA(1,Y%))*HF/(NE%-NFPSEGS%)
12670   RETURN
12680  REM
12690  REM================================================================
         ======
12700  REM
12710  REM :              E N D   O F   C A L C U L A T I O N S
12720  REM
12730  REM================================================================
         ======
13000  REM================================================================
         ======
13010  REM
13020  REM :         O U T P U T   R O U T I N E S    B E G I N
13030  REM : ROUTINE TO PRINT OUT TEMPERATURES OF THE FLUE ELEMENTS
13040  REM
13050  REM================================================================
         ======
13060  REM
13070  D$ =  CHR$ (4):
       REM  : CTRLD VALUE
13110  PRINT #2, :
```

```
        PRINT #2, :
        PRINT #2, USING"TIME = ######.# SECONDS";SCS
13120   PRINT #2, "==============================":
        PRINT #2,
13130   PRINT #2, :
        PRINT #2, "TEMPERATURES OF THE FLUE GAS, LINER, AND STRUCTURE":
        PRINT #2, "-----------------------------------------------------
         ---":
        PRINT #2,
13140   PRINT #2, TAB( 23);
13150   FOR X% = 1 TO 9
13155       IF X% > NE%
              THEN GOTO 13210
13160       PRINT #2, "    F";X%;
13170   NEXT
13180   FOR X% = 10 TO NE%
13190       PRINT #2, "   F";X%;
13200   NEXT
13210   PRINT #2, ""
13220   PRINT #2,
13230   PRINT #2, "FLUE GAS TEMP (C)";
13240   PRINT #2, TAB(22);
13250   FOR X% = 1 TO NE%
13260       PRINT #2, USING "   ###.#";TI(1,X%);
13270   NEXT X%
13280   PRINT #2, ""
13290   PRINT #2, "INNER LINER    (C)";
13300   PRINT #2, TAB(22)
13310   FOR X% = 1 TO NE%
13320       PRINT #2, USING"   ###.#";TI(2,X%);
13330   NEXT X%
13340   PRINT #2, ""
13350   IF IND10 = 1
           THEN GOTO 13540
13360   PRINT #2, "INSUL OR STRUCT (C)";
13370   PRINT #2, TAB(22)
13380   FOR X% = 1 TO NE%
13390       PRINT #2, USING"    ##.#";TI(3,X%);
13400   NEXT X%
13410   PRINT #2, ""
13420   PRINT #2, "OUTER STRUCTURE(C)";
13430   PRINT #2, TAB(22)
13440   FOR X% = 1 TO NE%
13450       PRINT #2, USING"    ##.#";TI(4,X%);
13460   NEXT X%
13470   PRINT #2, ""
13480   PRINT #2, "SURROUNDING (DEG C)";
13490   PRINT #2, TAB(22)
13500   FOR X% = 1 TO NE%
13510       PRINT #2, USING"    ##.#";TI(5,X%);
13520   NEXT X%
13530   PRINT #2, ""
13540    RETURN
```

```
14000  REM=================================================================
         ======
14010  REM
14020  REM : FLOW NETWORK PARAMETER OUTPUT
14030  REM
14040  REM=================================================================
         ======
14050  REM
14060  PRINT #2, :
       PRINT #2, "THE MASSFLOW SYSTEM PARAMETERS"
14070  PRINT #2, "------------------------------"
14080   GOSUB 16020:
        PRINT #2, :
        PRINT #2, TAB( 23);
14090 ┌ FOR X% = 1 TO 19
14100 │    PRINT #2, USING"        ##";X%;
14110 └ NEXT
14120  PRINT #2, "":
        PRINT #2,
14130  PRINT #2,
14140  PRINT #2, "TEMPERATURE (DEG C)";
14150  PRINT #2, TAB(23)
14160 ┌ FOR X% = 1 TO 19
14170 │    PRINT #2, USING"  ####.# ";TN(X%);
14180 └ NEXT X%
14190  PRINT #2, ""
14200  PRINT #2, "DENSITY (KG/M3)     ";
14210  PRINT #2, TAB(23)
14220 ┌ FOR X% = 1 TO 19
14230 │    PRINT #2, USING"     ##.##";RO(X%);
14240 └ NEXT X%
14250  PRINT #2, ""
14260  PRINT #2, :
        PRINT #2, "MASS FLOW (KG/S)       ";
14270  PRINT #2, TAB(23)
14280 ┌ FOR X% = 1 TO 19
14290 │    PRINT #2, USING"     #.###";MF(X%);
14300 └ NEXT X%
14310  PRINT #2, ""
14320  PRINT #2, "VOLUME FLOW (M3/S) ";
14330  PRINT #2, TAB(23)
14340 ┌ FOR X% = 1 TO 19
14350 │    PRINT #2, USING"     #.###";VF(X%);
14360 └ NEXT X%
14370  PRINT #2,
14380  PRINT #2, "FLOW VELOCITY (M/S)";
14390  PRINT #2, TAB(23)
14400 ┌ FOR X% = 1 TO 19
14410 │    PRINT #2, USING"  ###.## ";VL(X%);
14420 └ NEXT X%
14430  PRINT #2, ""
14440  PRINT #2, :
        PRINT #2,
```

```
14450  PRINT #2, "PRESSURE PARAMETERS OF THE FLOW SYSTEMS"
14460  PRINT #2, "-----------------------------------"
14470  PRINT #2, "          NET BUOYANCY      WIND EFFECT     ENVELOPE LO
         SS    FRICTION LOSS    NET DRIVING     FIBX BUOYANCY      INLET
          DROP      OUTLET DROP      NET FIREBOX      DILUTION PORT"
14480  FOR X% = 1 TO 10
14490     PRINT #2, USING"          ###.###";PB(X%);
14500  NEXT X%
14510  PRINT #2, ""
14520 REM:CLS
14530   RETURN
14540  REM
15000  REM================================================================
         ======
15010  REM
15020  REM  :  PRINTOUT OF PHYSICAL CONSTANTS OF ALL SYSTEMS
15030  REM
15040  REM================================================================
         ======
15050  REM
15060  WIDTH #2,255
15070  PRINT #2, "PHYSICAL CHARACTERISTICS OF THE SYSTEM"
15080  PRINT #2, "----------------------------------------":
        PRINT #2,
15090   GOSUB 16000
15100  PRINT #2,  TAB( 23);
15110  FOR X% = 1 TO 19
15120     PRINT #2, USING"       ##";X%;
15130  NEXT
15140  PRINT #2, "":
        PRINT #2,
15150  PRINT #2, "DISTANCE->DATUM (M)";
15160  PRINT #2,  TAB(23);
15170  FOR X% = 1 TO 19
15180     PRINT #2, USING"    ##.##";ABS(HT(X%));
15190  NEXT X%
15200  PRINT #2, ""
15210  PRINT #2, "AREA OF OPENING (m2)";
15220  PRINT #2,  TAB(23);
15230  FOR X% = 1 TO 19
15240     PRINT #2, USING"     #.###";AR(X%);
15250  NEXT X%
15260  PRINT #2, ""
15270  PRINT #2, "K FACTOR NORMAL";
15280  PRINT #2,  TAB(23);
15290  FOR X% = 1 TO 19
15300     PRINT #2, USING"      #.#";KE(X%);
15310  NEXT X%
15320  PRINT #2, ""
15330   RETURN
16000  REM================================================================
         ======
16010  REM
```

```
16020  REM : GUIDE TO IDENTIFY NETWORK POINTS
16030  REM
16040  REM=================================================================
         ======
16050  REM
16060  PRINT #2,  TAB( 31)
16070  PRINT #2, "<-----------------C H I M N E Y----------------->";
16080  PRINT #2, " <--------E N V E L O P E------>";
16090  PRINT #2, "<--DILUTION OPENING->";
16100  PRINT #2, " <---------------------F I R E B O X-----------------
         ----->"
16110   RETURN
16120  REM
17000  REM=================================================================
         ======
17010  REM
17020  REM :      SUMMARY TABLE OUTPUT
17030  REM
17040  REM=================================================================
         ======
17050  REM
17060  FOR X% = 1 TO 19
17070      FM(X%) = ( INT (1000 * MF(X%)+ .5)) / 1000
17080      TN(X%) = ( INT (10 * TN(X%) +  .5)) / 10
17090      VQ(X%) = ( INT (10 * VF(X%) * 1000)) / 10
17100  NEXT X%
17110   PRINT #2, CHR$(18)
17120   PRINT #2, :
         PRINT #2,
17130   PRINT #2, "S U M M A R Y   T A B L E"
17140   PRINT #2, "-------------------------"
17150   PRINT #2,
17160   PRINT #2, USING"OUTDOOR TEMPERATURE      =      ## C";T1
17170   PRINT #2, USING"INDOOR  TEMPERATURE      =      ## C";T9
17180   PRINT #2,
17230   PRINT #2, :
         PRINT #2,
17240   PRINT #2,"WIND SPEED & PRESSURE          SPEED      PRESSURE COEFFI
          CIENTS"
17250   PRINT #2,"COEFFICIENTS:                  (M/S)       CHIM TOP     IN
          SIDE HOUSE"
17260   PRINT #2,"---------------------           -----      --------     --
          ----------"
17270   PRINT #2, USING"HORIZONTAL COMPONENT              ##          #.##
              #.##";VH;PHC;CPWENV(LEAKDIST)
17280   PRINT #2, USING"VERT. COMPONENT (+VE UP)          ##          #.# ";VV
          ;PVC
17290   PRINT #2, :
         PRINT #2,
17300   PRINT #2, "FLOW RATES:                                L/S       KG/S"
17310   PRINT #2, "-----------                               ---       ----"
17320  REM E1 =  INT(((MF(16)/(353.6/TA)) - ((286 * FW * 3.413) / 3.6E+0
         9))/ (2.625* FW * 3.413 / 3.6E+09))
```

```
17330 REM E2 =  INT(((MF(6)/(353.6/TA)) - ((286 * FW * 3.413) / 3.6E+09
      )) / (2.625* FW * 3.413 / 3.6E+09))
17340 REM IF E1>1000 THEN E1=0 : E2=0
17350  PRINT #2,
17370  PRINT #2, USING"FIREBOX OUTLET FLOW            ##.#       #.###";VQ
       (18);FM(18)
17380  PRINT #2, USING"DILUTION AIR FLOW             ###.#       #.###";VQ
       (10);FM(10)
17390  PRINT #2, USING"CHIMNEY INLET FLOW            ##.#       #.###";VQ
       (5);FM(5)
17400  PRINT #2,
17410  PRINT #2, USING"EXHAUST FAN FLOW              ##.#       #.#";QF;F
       ANM
17420  PRINT #2, USING"FLOW FROM COMPETING CHIMNEYS  ##.#       #.#";FP;F
       IRM
17430  PRINT #2, USING"NET ADDITIONAL ENVELOPE FLOW  ##.#    ###.# (AT O
       UTDOOR TEMPERATURE)";VQ(8);FM(8)
17440  PRINT #2, USING"INDUCED PRESSURE DROP ACROSS THE ENVELOPE = ##.#
       Pa";PB(3)
17450  PRINT #2, :
        PRINT #2, :
        PRINT #2, "TEMPERATURES:"
17460  PRINT #2, "---------------":
        PRINT #2,
17470  PRINT #2, USING"AIR TEMPERATURE ABOVE FLAME= ####.  C";TN(16)
17480  PRINT #2, USING"FIREBOX EXIT  TEMPERATURE  =  ###.# C";TN(17)
17490  PRINT #2, USING"CHIM GAS T. AFTER DILUTION =  ###.# C";TN(6)
17500  TT = 0:
       TQ = 0
17510  FOR Y% = 1 TO NE%
17520     TT = TT + TI(1,Y%)
17530     TQ = TQ + TI(2,Y%)
17540  NEXT Y%
17545  TT=TT/NE%:
       TQ=TQ/NE%
17550  PRINT #2, USING"MEAN FLUE GAS TEMPERATURE =   ###.# C";TT
17560  PRINT #2, USING"MEAN FLUE LINER TEMPERATURE=  ###.# C";TQ
17570  PRINT #2, :
        PRINT #2, :
        PRINT #2,
17580  PRINT #2, "THERMAL PROPERTIES OF FIREBOX & CHIMNEY"
17590  PRINT #2, "--------------------------------------":
        PRINT #2,
17640  PRINT #2,
17650  PRINT #2, "AT THE BASE OF THE CHIMNEY:                              FLU
        E GAS       LINER          SLEEVE      STRUCTURE"
17660  PRINT #2, "-------------------------                              ---
        -----       -----          ------      ---------"
17670  PRINT #2, "HEAT TRANSFER COEFF. 'U' (W/(m2.C))        ";:
       PRINT #2, USING"   #######.###";UF;U(2,NFPSEGS%+1);U(3,NFPSEGS%+1
        );U(4,NFPSEGS%+1)
17680  PRINT #2, "ELEMENTAL SURFACE AREA 'A' (m2)            ";:
       PRINT #2, USING"    ######.###";A(1,NFPSEGS%+1);A(2,NFPSEGS%+1);A
        (3,NFPSEGS%+1);A(4,NFPSEGS%+1)
```

```
17690  PRINT #2, "ELEMENTAL MASS 'M' (KG)                              ";:
       PRINT #2, USING"   #######.###";M(1,NFPSEGS%+1);M(2,NFPSEGS%+1);M
         (3,NFPSEGS%+1);M(4,NFPSEGS%+1)
17700  PRINT #2, "HEAT CAPACITY OF MATERIALS 'CP'  (W.S/KG.C)";:
       PRINT #2, USING"   #######.#  ";HC(1,NFPSEGS%+1);HC(2,NFPSEGS%+1)
         ;HC(3,NFPSEGS%+1);HC(4,NFPSEGS%+1)
17710  PRINT #2, "HEAT TRANSFER TIME CONSTANTS-OUT (S)       ";
17720  FOR J% = 1 TO 4
17725     IF J%=1
             THEN TW(J%) = (M(J%,NFPSEGS%+1) * HC(J%,NFPSEGS%+1)) / (
               UF * A(J%,NFPSEGS%+1)):
                  GOTO 17740
17730     TW(J%) = (M(J%,NFPSEGS%+1) * HC(J%,NFPSEGS%+1)) / (U(J%,NFP
            SEGS%+1) * A(J%,NFPSEGS%+1))
17740     PRINT #2, USING"   #######.#  ";TW(J%);
17750  NEXT J%
17760  PRINT #2,
17770  PRINT #2, "HEAT TRANSFER TIME CONSTANTS-IN  (S)       ";
17780  PRINT #2,       "                ";
17790  FOR J% = 2 TO 4
17800     TW(J%) = (M(J%,NFPSEGS%+1) * HC(J%,NFPSEGS%+1)) / (U(J% - 1
            ,NFPSEGS%+1) * A(J% - 1,NFPSEGS%+1))
17810     PRINT #2, USING"   #######.#  ";TW (J%);
17820  NEXT J%
17830  PRINT #2, :
        PRINT #2, :
        PRINT #2,
17840  PRINT #2,"ENVELOPE CHARACTERISTICS:        WITHOUT     WITH"
17850  PRINT #2,"-------------------------        AIR INTAKE  AIR INTAKE
         (IF ANY)"
17855  PRINT #2,"                                 ----------  ----------"
17860  PRINT #2, USING"FLOW COEFFICIENT (M3/(S.PA^N) = #.####      #.###
         #";C;CC
17870  PRINT #2, USING"FLOW EXPONENT    (--)          = #.###      #.###
         ";N;N
17880  PRINT #2, USING"LOCATION OF VCL BELOW CHIM TOP= #.##       #.##(
         m)";ABS(LNPP);ABS (VCL )
17890  PRINT #2,:
        PRINT #2, :
        PRINT #2,
17895  PRINT #2,"FRESH AIR INTAKE TO THE FIREBOX"
17900  PRINT #2,"------------------------------" :
       PRINT #2,
17905  IF INTAKE$ = "N"
          THEN PRINT #2,"----- NONE -----" :
               GOTO 17912
17910  PRINT #2,USING"THE INTAKE ELA (m2)  =  #.#####";ELA(4)
17912  PRINT#2,:
       PRINT #2,"ELA OF THE FIREDOOR"
17913  PRINT #2,"------------------" :
       PRINT #2,
17914  IF GLASSDR$ = "N"
          THEN PRINT #2,"----- NONE -----" :
```

```
                GOTO 17999
17915   IF INTAKE$="Y"
           THEN ELAGD = ELA(2)
           ELSE ELAGD=ELA(4)+ELA(2)
17920   PRINT #2,USING"THE FIREDOOR ELA (m2) = #.####";ELAGD
17999    RETURN
18000   REM================================================================
          ======
18010   REM
18020   REM :          LINE SUMMARY OUTPUT FOR EACH CALCULATION INTERVAL
18030   REM
18040   REM================================================================
          ======
18050   REM
18070   REM
18080   OO(1) = SCS
18090   OO(2) = FW/1000
18100   OO(3) = VF(18) * 1000
18110   OO(4) = VF(10) * 1000
18120   OO(5) = VF(5) * 1000
18130   OO(6) = VF(8) * 1000
18140   OO(7) = PB(3)
18150   OO(8) = TMF
18160   OO(9) = TN(17)
18170   OO(10) = TN(6)
18180   TT = 0:
        TQ = 0
18190   FOR Y% = 1 TO NE%
18200      TT = TT + TI(1,Y%)
18210      TQ = TQ + TI(2,Y%)
18220   NEXT Y%
18230   TT = TT / NE%
18240   TQ = TQ / NE%
18250   OO(11) = TT
18260   OO(12) = TI(1,NE%)
18270   OO(13) = TQ
18280   FE = 100 * (TWDRAD+TOTFLRAD)/(THCOMBT+.00001)
18290   IF ABS(FE) > 100
           THEN FE=100
18300   OO(14) = FE
18310   OO(15) = UF
18320   OO(16) = KE(4)
18322 GOSUB 19300   'ASSIGN THE ARRAY OOW FOR PR2 FILE
18325   IF FL1%=1
           THEN GOSUB 20000
18326   IF SCS>=ST
           THEN GOTO 18328
18327   IF Z1<Z2 AND S>30
           THEN GOTO 18460
18328   Z1=0
18330    IF P$ = "D"
           THEN  GOTO 18400
18340   PRINT #2, USING"          #####.#";SCS  ;
```

```
18350  FOR X% = 1 TO 10
18360     PRINT #2, USING"          ###.###";PB(X%);
18370  NEXT X%
18380  PRINT #2, " "
18390   GOTO 18460
18400  FOR X% = 1 TO 16
18420     PRINT #2, USING"    #######.#";OO(X%);
18430  NEXT X%
18440  PRINT #2, ""
18442  REM: IND10=1 : GOSUB 13230 : IND10=0
18450  FOR X% = 1 TO 16
18452       PRINT #4, USING"    #######.#";OOW(X%);
18454  NEXT X%
18456   PRINT #4, ""
18460   RETURN
18500  REM=================================================================
         ======
18510  REM
18520  REM :       HEADINGS FOR LINE SUMMARY
18530  REM
18540  REM=================================================================
         ======
18550  REM
18560   PRINT #2,  CHR$ (15)
18570  PRINT #2, :
        PRINT #2, :
        PRINT #2, :
        PRINT #2,:
       PRINT #2,"C A S E:  ";
18580  PRINT #2,"  WOOD BURNING - ";
18600  PRINT #2, TITLE$;:
       PRINT #2,"                          DATE: ";DATE$
18610  PRINT #2, "=========================================================
         ==================== ":
        PRINT #2, :
        PRINT #2,
18620   IF P$ = "P"
          THEN GOTO 18670
18630  PRINT #2, "         TIME       BURN RATE     FIREBOX      DILUTION
          CHIMNEY      INC. ENVEL  ENVELOPE     FIREBOX      FIREBOX      MI
         XING       MEAN FLUE   GAS EXIT     MEAN FLUE   INSTANT.     FLUE
         FILM      FLUE FRICTION"
18640  PRINT #2, "         (SECS)       (kW)        FLOW(L/S)    FLOW(L/S)
          FLOW(L/S)   FLOW(L/S)   PRES DROP   WALL TEMP   EXIT TEMP   TE
         MP(C)      GAS TEMP    TEMP (C)    LINER TEMP  EFFICIENCY  HT TR
         ANS CF   FACTOR"
18650  PRINT #2, " "
18660   GOTO 18680
18670  PRINT #2, "                TIME       NET BUOYANCY    WIND EFFECT
          ENVELOPE LOSS  FRICTION LOSS   NET DRIVING   FIREBOX BUOY.   IN
         LET DROP   OUTLET DROP    NET FIREBOX      DILUTION "
18675 REM
18680  PRINT #4,  CHR$ (15)
```

```
18690  PRINT #4, :
        PRINT #4, :
        PRINT #4, :
        PRINT #4,:
       PRINT #4,"C A S E:  ";
18700  PRINT #4,"  WOOD BURNING - ";
18710  PRINT #4, TITLE$;:
       PRINT #4,"                    DATE: ";DATE$
18720  PRINT #4, "=============================================================
         ==================== ":
        PRINT #2, :
        PRINT #2,
18730  PRINT #4, "        TIME      BURN RATE                    WALL    TEMP
         ERATURES                      MID   WALL                  BACK  WALL
                 RAD HEAT TO     FLAME       HEAT-AIR          FLUE     FLA
         ME RAD.  WOOD RAD. "
18740  PRINT #4, "          (s)       (kW)          FRONT       BACK
           SIDE         FLOOR         BACK     SIDE           BACK       SI
         DE     HOUSE (Whr)     TEMP (C)    TRANSFER    ENERGY(Wh)      (
         Wh)       (Wh)      "
18750  PRINT #4, " "
18760  RETURN
18770  REM
19300 REM ASSIGN VALUES FOR .PR2 FILE
19310  OOW(1) = SCS
19320  OOW(2) = FW/1000!
19325  OOW(3) = TWALL(5,1)
19330  OOW(4) = TWALL(2,1)
19340  OOW(5) = TWALL(1,1)
19350  OOW(6) = TWALL(4,1)
19360  OOW(7) = TWALL(2,4)
19370  OOW(8) = TWALL(1,4)
19380  OOW(9) = TWALL(2,10)
19390  OOW(10) = TWALL(1,10)
19400  OOW(11) = TOTRAD(5)/3600!
19410  OOW(12) = TRADFL
19420  OOW(13) = SOURCEQ/3600!
19430  OOW(14) = TQFLUE/3600!
19440  OOW(15) = TOTFLRAD/3600!
19450  OOW(16) = TWDRAD/3600!
19455 'OOW(17) = TWALL(1,1)
19460  RETURN
19500  REM=============================================================
         ======
19510  REM
19520  REM :   LIGHTING THE WOOD PILE
19530  REM
19540  REM=============================================================
         ======
19550  REM
19580  PRINT #2, :
        PRINT #2, "******* THE WOOD PILE WILL BE LIT AT ";( INT (100 * S
         CS + .5) / 100);" SECONDS *******"
```

```
19590  IF FL1%=1
          THEN 19600
          ELSE GOSUB 11000
19600   RETURN
19610  REM
20000 REM=============================================================
        ======
20010 REM
20020 REM: GRAPH PLOTTER ROUTINE
20030 REM
20040 REM=============================================================
        ======
20050 REM
20070  IF AXIS=0
          THEN 20080
          ELSE 21300
20080  CLS
20090  SCREEN 2
20100  KEY OFF
20102  N$(0) = "BR2H2U6E2R3F2G4E4D6G2L3BR7"
20104  N$(1) = "BR1R2U9G2E2D9R2BR5"
20106  N$(2) = "BU9R6D4L6D5R6BR3"
20108  N$(3) = "BU9R6D4L4R4D5L6BR9"
20110  N$(4) = "BU9BR4G4R6L2U4D9BR5"
20112  N$(5) = "R6U5L6U4R6BD9BR3"
20114  N$(6) = "U5D5R6U5L6U4R6BD9BR3"
20116  N$(7) = "BU9R6D2G4D3BR7"
20118  N$(8) = "U9R6D4L4R4D5L6BR9"
20120  N$(9) = "BU5U4R6D4L6R6D5L6BR9"
20122  N$(10) = N$(1) + N$(0)
20124  N$(15) = N$(1) + N$(5)
20126  N$(20) = N$(2) + N$(0)
20128  N$(30) = N$(3) + N$(0)
20130  N$(40) = N$(4) + N$(0)
20132  N$(50) = N$(5) + N$(0).
20134  N$(60) = N$(6) + N$(0)
20136  N$(120) = N$(1) + N$(2)+N$(0)
20138  N$(180) = N$(1) + N$(8)+N$(0)
20140  N$(240) = N$(2) + N$(4)+N$(0)
20142  N$(300) = N$(3) + N$(0)+N$(0)
20180  LT(1)=&HFFFF
20182  PATTRN%(1)=32767
20184  ANDNO%(2)=96:
       PATTRN%(2)=771
20186  ANDNO%(3)=128:
       PATTRN%(3)=511
20188  ANDNO%(4)=192:
       PATTRN%(4)=63
20190  PTI$(1)="CHIM/HOUSE BUOYANCY"
20192  PTI$(2)="FLUE FRICTION LOSS"
20194  PTI$(3)="FIREBOX BUOYANCY"
20196  PTI$(4)="FIREBOX OUTLET LOSS"
20198  PTI$(5)="ENVELOPE LOSS"
```

```
20200  PTI$(6)="NET DRIVING PRESS."
20202  PTI$(7)="FIREBOX INLET LOSS"
20204  PTI$(8)="NET FIREBOX DRIVE "
20206  PTI$(9)="DILUTION PORT LOSS"
20208  PTI$(10)="WIND EFFECT"
20210  PTI$(11)="DRAFT INDUCER"
20212  TTI$(1)="FIBX. STACK GAS TEMP."
20214  TTI$(2)="DILUTION MIXING TEMP."
20216  TTI$(3)="MEAN FLUE GAS TEMP."
20218  TTI$(4)="FLUE EXIT GAS TEMP."
20220  TTI$(5)="MEAN FLUE LINER TEMP."
20222  TTI$(6)="FIREBOX WALL TEMP."
20224  TTI$(7)="ROOM TEMP. x 10    "
20226  FTI$(1)="FIREBOX FLOW"
20228  FTI$(2)="DILUTION FLOW"
20230  FTI$(3)="CHIMNEY FLOW"
20232  FTI$(4)="NET ENVELOPE FLOW"
21000  AXIS=1
21002  TIT$(0) = "TEMPERATURE vs. TIME"
21004  TIT$(1) = "PRESSURE vs. TIME"
21006  TIT$(2) = "FLOW RATE vs. TIME"
21008  A$ = TIT$(FL2% )
21010  LOCATE 25, (80 - LEN(A$)) * .5
21012  PRINT A$
21014  IF ST>300   TOTAL CALCULATION INTERVALS
          THEN B$=" TIME (MIN.)"
          ELSE B$ = "TIME (SECS)"
21016  LOCATE 23, INT(80 - LEN(B$)) * .5
21018  PRINT B$
21020  PSET(90,15)
21022  DRAW "D148 R465"
21024  IF FL2%=1 OR FL2%=2
          THEN 21026
          ELSE 21028
21026  LINE (90,115)-(550,115),,,257
21028  PSET (110,163)
21030  IF FL2%=1
          THEN 21032
          ELSE 21044
21032  FOR X%= 1 TO 9
21034      A=163-16*X%
21036      PSET (90,A)
21038      DRAW "L8"
21040  NEXT
21042  GOTO 21054
21044  FOR X% = 1 TO 12
21046        A% = 163 - 12 * X%
21048        PSET(90,A%)
21050        DRAW "L8"
21052  NEXT
21054  PSET(90,115)
21056  IF ST<=70
          THEN  YY% =6:
```

```
                A% = 76:
                NSCAL% =10:
                J%=6:
               SCAL=76:
               XSCAL=7.6:
               ANDFACT%=16
21058  IF ST<=310 AND ST>70
       THEN  YY% = 5 :
                A% = 92 :
                NSCAL% = 60 :
                J%=10:
               SCAL=46:
               XSCAL=1.53:
               ANDFACT%=4
21060  IF ST>310
       THEN  YY%=4 :
                A%=115:
                NSCAL%=5 :
                J%=8:
               SCAL=57:
               XSCAL=.38:
               ANDFACT%=1
21062  FOR X% = 1 TO J%
21064        B% = 90 + SCAL * X%
21066        PSET(B%,163)
21068        DRAW "D2"
21070  NEXT
21072  VAR% = 0
21074  FOR X% = 0 TO YY%
21076        B% = 87 + A% * X%
21078        B$ = STR$(B%)
21080        DRAW "BM" + B$ + ",174"
21082        DRAW "S 3;" + N$(VAR%)
21084        VAR% = VAR% + NSCAL%
21086  NEXT
21088  T$ = Y$(FL2%)
21090  Y$(0) = "TEMPERATURE C"
21092  Y$(1) = "PRESSURE  Pa "
21094  Y$(2) = " FLOW  L-S    "
21096  FOR X% = 1 TO 13
21098        LOCATE X% + 3,3
21100        PRINT MID$(T$,X%,1)
21102  NEXT
21104  YTEMP$= "  0 50100150200250300"
21106  YFLO$ = "-50-25  0 25 50 75100"
21108  YPRS$ = "-15-10 -5  0  5 10 15 20 25 30"
21110  IF FL2%  = 0
       THEN  YNUMS$ = YTEMP$:
               YSCAL=.48
21112  IF FL2%  = 1
       THEN  YNUMS$ = YPRS$:
               YSCAL=3.2
21114  IF FL2%  = 2
```

```
          THEN  YNUMS$ = YFLO$:
                YSCAL=.96
21116  IF FL2%=1
          THEN 21118
          ELSE 21134
21118  PP%=1:
       P%=21
21120 FOR X%= 1 TO 10
21122     LOCATE P%,8
21124     PRINT MID$(YNUMS$,PP%,3)
21126     P%=P%-2
21128     PP%=PP%+3
21130 NEXT
21132  GOTO 21150
21134  PP% = 1
21136  P% = 21
21138 FOR X% = 1 TO 7
21140       LOCATE P%,8
21142       PRINT MID$(YNUMS$,PP%,3)
21144       P% = P% - 3
21146       PP% = PP% + 3
21148 NEXT
21150  T$ = Y$(FL2%)
21152  Y$(0) = "TEMPERATURE C"
21154  Y$(1) = "PRESSURE  Pa "
21156  Y$(2) = " FLOW  L-S   "
21158 FOR X% = 1 TO 13
21160       LOCATE X% + 4,3
21162       PRINT MID$(T$,X%,1)
21164 NEXT
21166  IF FL2%=0
          THEN 21168
          ELSE 21176
21168  TISET$(1)=TTI$(TMP1%)
21170  TISET$(2)=TTI$(TMP2%)
21172  TISET$(3)=TTI$(TMP3%)
21174  TISET$(4)=TTI$(TMP4%)
21176  IF FL2%=1
          THEN 21178
          ELSE 21186
21178  TISET$(1)=PTI$(P1%)
21180  TISET$(2)=PTI$(P2%)
21182  TISET$(3)=PTI$(P3%)
21184  TISET$(4)=PTI$(P4%)
21186  IF FL2%=2
          THEN 21188
          ELSE 21194
21188 FOR X%=1 TO 4
21190     TISET$(X%)=FTI$(X%)
21192 NEXT
21194 FOR X%=1 TO 4
21196     LOCATE X%,56:
          PRINT TISET$(X%)
```

```
21198 └NEXT
21199  PUT (405,2),BOX%:
        PUT (405,10),TRI%:
        PUT (405,16),CIR%:
        PUT (405,25),DIAMND%
21200  LINE (384,8*1-4)-(430,8*1-4)
21202 ┌FOR X%=2 TO 4
21204 │    ┌FOR XX%=384 TO 430
21206 │    │     IF XX% AND ANDNO%(X%)/32
      │    │        THEN 21208
      │    │        ELSE PSET (XX%,8*X%-4)
21208 │    └NEXT XX%:
      └NEXT X%
21300 REM
21302 REM      PLOTTING BEGINS
21304 REM
21305  XNEW=SCS
21346  IF SCS < 0 OR SCS >1200
          THEN 21940
21348  GTOUT(1)=OO(9)
21350  GTOUT(2)=OO(10)
21352  GTOUT(3)=OO(11)
21354  GTOUT(4)=OO(12)
21356  GTOUT(5)=OO(13)
21358  GTOUT(6)=OO(8)
21360  GTOUT(7)=T9*10!
21362  GPOUT(1)=PB(1)
21364  GPOUT(2)=PB(4)
21366  GPOUT(3)=PB(6)
21368  GPOUT(4)=PB(8)
21370  GPOUT(5)=PB(3)
21372  GPOUT(6)=PB(5)
21374  GPOUT(7)=PB(7)
21376  GPOUT(8)=PB(9)
21378  GPOUT(9)=PB(10)
21380  GPOUT(10)=PB(2)
21382  GPOUT(11)=PB(11)
21850  IF FL2%=0
          THEN YNEW(1)=GTOUT(TMP1%):
               YNEW(2)=GTOUT(TMP2%):
               YNEW(3)=GTOUT(TMP3%):
               YNEW(4)=GTOUT(TMP4%):
               YST=163
21860  IF FL2%=1
          THEN YNEW(1)=GPOUT(P1%):
               YNEW(2)=GPOUT(P2%):
               YNEW(3)=GPOUT(P3%):
               YNEW(4)=GPOUT(P4%):
               YST=115
21870  IF FL2%=2
          THEN YNEW(1)=OO(3):
               YNEW(2)=OO(4):
               YNEW(3)=OO(5):
```

```
                YNEW(4)=OO(6):
                YST=115
21875       PSET ((XNEW*XSCAL)+90,YST-INT(YNEW(1)*YSCAL))
21877    PT1=XNEW*XSCAL+90
21880   FOR OP% = 1 TO 4
21882   |    IF ABS((XNEW-XOLD)*XSCAL)>16 OR ABS((YNEW(OP%)-YOLD(OP%))*Y
        |      SCAL)>16
        |       THEN LINE (XOLD*XSCAL+90,YST-INT(YOLD(OP%)*YSCAL))-(PT1,
        |         YST-INT(YNEW(OP%)*YSCAL)),,,PATTRN%(OP%):
        |            GOTO 21900
21884   |    LINE (XOLD*XSCAL+90,YST-INT(YOLD(OP%)*YSCAL))-(PT1,YST-INT(
        |      YNEW(OP%)*YSCAL))
21886   |    IF OP%=1
        |       THEN 21900
21887   |    IF PT1 > PT-5 AND PT1 < PT+5 AND PT1 <> PT
        |       THEN GOTO 21909
21888   |    IF (SCS*10) AND (ANDNO%(OP%)/ANDFACT%)
        |       THEN PRESET ((XOLD*XSCAL)+90,YST-INT(YOLD(OP%)*YSCAL))
21900   |    IF PT1 < PT
        |       THEN GOTO 21909
21901   |    PT=PT+50
21902   |    YT1 = YST-2-INT(YNEW(1)*YSCAL):
        |     YT2 = YST-2-INT(YNEW(2)*YSCAL):
        |     YT3 = YST-4-INT(YNEW(3)*YSCAL):
        |     YT4 = YST-3-INT(YNEW(4)*YSCAL)
21903   |    IF YT1 > 0 AND YT1 < 200 AND PT1 < 630
        |       THEN PUT (PT1,YT1),BOX%
21904   |    IF YT2 > 0 AND YT2 < 200 AND PT1 < 630
        |       THEN PUT (PT1,YT2),TRI%
21905   |    IF YT3 > 0 AND YT3 < 200 AND PT1 < 630
        |       THEN PUT (PT1,YT3),CIR%
21906   |    IF YT4 > 0 AND YT4 < 200 AND PT1 < 630
        |       THEN PUT (PT1,YT4),DIAMND%
21909   |    YOLD!(OP%) = YNEW!(OP%)
21910   NEXT
21920    XOLD! = XNEW!
21930    XNEW=SCS
21940    LOCATE 1,13:
         PRINT USING"TIME  =  #####.#  s";SCS
21950    RETURN
25000   '     INITIATION OF WOOD BURNING CHARACTERISTICS
25020    CRAD=5.672E-08
25030   '     PROPERTIES OF HARDWOODS & SOFTWOODS (KINDLING)
25100    RHARD  = 6
25110    RSOFT  = 7
25120    BRATE=0.0003:
         '.000225
25125   REM:  TBRLIMIT=0.003
25130   '
25140   '   PROPERTIES OF MATERIALS SURROUNDING THE FIRE, & EXPOSURE TO F
          IRE AS FRACTION
25150   '    #1  - INDOOR ROOM CHARACTERISTICS
25160   '    #2  - BACK WALL
```

```
25170 '    #3  - SIDE WALLS
25180 '    #4  - FLOOR (ASHES OR BARE LIKE BACK WALL)
25190  MS(1) = 500 :
        CPS(1) = 1000 :
        EXPOSR(1) = .35
25200  MS(2) = MOHE*.3 :
        CPS(2) = HCHE :
        EXPOSR(2) = .3
25210  MS(3) = MOHE*.7 :
        CPS(3) = HCHE :
        EXPOSR(3) = .3
25220  MS(4) = 25  :
        CPS(4) = 1600 :
        EXPOSR(4) = .05
25230 '     KEY CONDITIONS RELATING TO AIR FLOW IN THE FIREBOX AREA
25240  STOICHAIR = 13.8
25280 ' ASSUME THAT ONLY 30% OF AIR FLOW INTO FIREBOX IS AVAILABLE FOR
        COMBUSTION
25290  FRACOMB = .3   :
      REM SEE LINE 27198
25310 '      PORTION OF RELEASED COMBUSTION ENERGY TO ITSELF, AIR, ADJAC
       ENT WOOD
25315  UNBURND =15
25320  PWR=.2
25330  PAW=.08
25340 '
25530 '    ELEMENT VOLUMES, SURFACE AREAS, MASSES, HEAT CAPACITIES, TIME
       CONSTANTS, COMBUSTION ENERGY
25540 '    NOTE:   HARD WOOD PIECES ARE ONE SIXTH OF A LOG
25550  TMASS=0:
      FOR I%=1 TO NT%:
          OMRING(I%)=0:
      NEXT I%
25560 FOR I% = 1 TO NT%
25570     FOR J% = 1 TO NWE%
25580         J1%=J%-1
25590         IF I% > NPS%
                 THEN GOTO 25700
25600        '  SOFTWOOD  MASS, CONDUCTANCE & SENSIBLE HEAT CAPACI
                TY
25610         RRING(I%,J%)=RRING(I%,J1%)+DRAD(I%)
25620         ARING(I%,J%)=LENGTH*2*PIE*RRING(I%,J%)/NPL(I%)
25630         IF NPL(I%) > 1
                 THEN ARING(I%,J%)=ARING(I%,J%)+2*RRING(I%,J%)*LENG
                   TH
25640         VOLRING(I%,J%)=LENGTH*PIE*(RRING(I%,J%)^2 - RRING(I%,
                J1%)^2)/NPL(I%)
25650         MRING(I%,J%)=VOLRING(I%,J%)*ROWSOFT:
              IF J%=NWE%
                 THEN MRING(I%,J%)=MRING(I%,J%)+MRINGO(I%)
                 ELSE MRING(I%,J%)=MRING(I%,J%)+(MRINGL(I%)-MRINGO(
                   I%))/4
25655         OMRING(I%)=OMRING(I%)+MRING(I%,J%)
```

```
25660 |   |     TMASS=TMASS+MRING(I%,J%)
25670 |   |     URING(I%,J%)=1/(DRAD(I%)*RSOFT+.000001)
25680 |   |     HCRING(I%,J%)=HCSOFT
25690 |   |     GOTO 25800
25700 |   |   '  HARDWOOD MASS, CONDUCTANCE & SENSIBLE HEAT CAPACIT
                 Y
25710 |   |     RRING(I%,J%)=RRING(I%,J1%)+DRAD(I%)
25720 |   |     ARING(I%,J%)=LENGTH*2*PIE*RRING(I%,J%)/NPL(I%)
25730 |   |     IF NPL(I%) > 1
                    THEN ARING(I%,J%)=ARING(I%,J%)+2*RRING(I%,J%)*LENG
                      TH
25740 |   |     VOLRING(I%,J%)=LENGTH*PIE*(RRING(I%,J%)^2 - RRING(I%,
                  J1%)^2)/NPL(I%)
25750 |   |     MRING(I%,J%)=VOLRING(I%,J%)*ROWHARD:
              |   IF J%=NWE%
                    THEN MRING(I%,J%)=MRING(I%,J%)+MRINGO(I%)
                    ELSE MRING(I%,J%)=MRING(I%,J%)+(MRINGL(I%)-MRINGO(
                      I%))/4
25755 |   |     OMRING(I%)=OMRING(I%)+MRING(I%,J%)
25760 |   |     MMRING(I%,J%)=MRING(I%,J%)*.1
25770 |   |     TMASS=TMASS+MRING(I%,J%)
25780 |   |     URING(I%,J%)=1/(DRAD(I%)*RHARD)
25790 |   |     HCRING(I%,J%)=HCHARD
25800 |   |   NEXT J%
25810 | NEXT I%
26260 '
26270 ' INITIALIZATION OF TEMPERATURES
26280 '
26290 | FOR I% = 1 TO NT%
26295 |   |   IF F$="ON" AND BRAND$="Y"
              |     THEN TORN(I%)=TRING(I%,ORN%(I%))
26300 |   | FOR J% = 1 TO NWE%
26305 |   |   |   IF F$="ON" AND BRAND$="Y" AND J%=NWE%
              |   |     THEN TRING(I%,NWE%)=20+((MRINGO(I%)*CPLOG(I%,ORN%(
              |   |       I%))*(TORN(I%)-20))/((MRINGO(I%)*CPLOG(I%,ORN%(I
              |   |       %)))+((MRING(I%,NWE%)-MRINGO(I%))*HCRING(I%,NWE%
              |   |       )))):
              |   |         GOSUB 26500:
              |   |         GOTO 26320
26310 |   |   |   TRING(I%,J%)=20
26320 |   |   NEXT J%
26330 | NEXT I%
26340   IF F$="ON" AND BRAND$="N"
          THEN TRING(2,NWE%)=300:
               TRING(1,NWE%)=300:
               TRING(3,NWE%)=300
26350   IF F$="ON" AND TRING(2,NWE%)<204
          THEN TRING(2,NWE%)=300
26360 FOR II%=1 TO 4
26370 |   TS(II%)=T9
26380 NEXT
26385   IF FL1%=1
          THEN GOTO 26490
```

```
26390 '      SETTING UP BEFORE THE TIME STEP
26400  KEY OFF
26480 '
26490  RETURN
26500 'LPRINT MRINGO(I%);CPLOG(I%,ORN%(I%));TORN(I%);TRING(I%,NWE%);MRI
        NG(I%,NWE%);MRINGL(I%);HCRING(I%,NWE%);J%;ORN%(I%)
26510 'LPRINT
26515  RETURN
27000 REM      ENERGY UPDATE IN THE WOODBURNING MODULE
27010 '           ESTABLISH THE BURN RATE OF EACH ELEMENT
27020 ' AND CORRESPONDING ENERGY PRODUCED BY COMBUSTION
27030 '
27040 '         FINDING CANDIDATE WOOD MASS ( WITH TEMP ABOVE 204 C)
27050 '
27052  TSTEP=SEC
27060  TMASCOMB = 0
27065  TMCP=0
27070 FOR I% = 1 TO NT%
27071     MRINGL(I%)=0.
27072    FOR J% = NWE% TO 1 STEP -1
27073        MRINGL(I%)=MRINGL(I%)+MRING(I%,J%) :
             CPLOG(I%,J%)=HCRING(I%,J%)*(0.908+0.0046*TRING(I%,J%)
               )
27074    NEXT J%
27080    FOR J% = NWE% TO 1 STEP -1
27090        MASCOMB(I%,J%)  = 0
27095        IF INDCOMB%=0
                THEN 27150
27100        IF TRING(I%,J%) < 204
                THEN GOTO 27150
27110        IF MRING(I%,J%) < = 0
                THEN GOTO 27150
27115        IF MRINGL(I%) <= (UNBURND*OMRING(I%)/100)
                THEN 27150
27120        IF J% < NWE% AND MRING(I%,J%+1) > 0
                THEN GOTO 27150
27130        MASCOMB(I%,J%) =  MRING(I%,J%)
27140        TMASCOMB  = TMASCOMB   + MRING(I%,J%)
27150    NEXT J%
27160 NEXT I%
27170 '
27180 '         ACTUAL RATE OF COMBUSTION AS LIMITED BY AIR SUPPLY IN PI
        LE
27190 '
27194  TROOM = T9
27195  IF INTAKE$ = "Y" AND SCS > CDT
          THEN TINTAKE=TN(1)
          ELSE TINTAKE = TROOM
27196  MFAIR = MF(15)
27198  IF INTAKE$ = "Y" AND SCS > CDT
          THEN FRACOMB = .30
          ELSE FRACOMB = .30
27200 'MAXWD=TSTEP*MFAIR*FRACOMB/STOICHAIR
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27210 'MRATE= MAXWD/(TMASCOMB+1E-09)
27220 'IF MRATE > 1 THEN MRATE = 1
27230 '
27240 ' ACTUAL RATE OF COMBUSTION FOR EACH ELEMENT
27250  TMASSL=0
27260  TMASCOMB=0
27270  HCOMBT=0
27275  TBSURF =0
27280 FOR I% = 1 TO NT%
27290     FOR J% = NWE% TO 1 STEP -1
27300        IF MASCOMB(I%,J%) = 0
                THEN HCOMB(I%,J%)=0 :
                     GOTO 27390
27305        TBRATE=BRATE*ABS(VF(16))*1000*FRACOMB :
             REM   IF TBRATE > TBRLIMIT THEN TBRATE = TBRLIMIT
27310        MASCOMB(I%,J%)=TBRATE*TSTEP*ARING(I%,J%)
27315        TBSURF = TBSURF +ARING(I%,J%)
27320       REM: MASCOMB(I%,J%)= MASCOMB(I%,J%)*MRATE
27330        IF (MRING(I%,J%)-MASCOMB(I%,J%)) < 0
                THEN MASCOMB(I%,J%) = MRING(I%,J%) :
                     MRING(I%,J%)=0 :
                     GOTO 27350
27340        MRING(I%,J%)=MRING(I%,J%)-MASCOMB(I%,J%)
27350        TMASCOMB=TMASCOMB+MASCOMB(I%,J%)
27142        TMCP=TMCP + MASCOMB(I%,J%) * CPLOG(I%,J%)
27360        IF I% <= NPS%
                THEN HCOMB(I%,J%) = MASCOMB(I%,J%)* HEATSOFT
                ELSE HCOMB(I%,J%) = MASCOMB(I%,J%)* HEATHARD
27370        HCOMBT=HCOMBT+HCOMB(I%,J%)
27380        THCOMBT=THCOMBT+HCOMB(I%,J%)
27390        TMASSL=TMASSL+MRING(I%,J%)
27400     NEXT J%
27410 NEXT I%
27420  TMASSB=TMASS-TMASSL
27430 '       SHIFTING THE LAST PORTION OF WOOD MASS TO THE NEXT ELEMENT
27440 FOR I% =1 TO NT%
27450     FOR J% = NWE% TO 1 STEP -1
27455        IF TRING(I%,J%) > 700 AND MRING(I%,J%+1) <= 0
                THEN GOTO 27470
27460        IF (.4*MRING(I%,J%)*CPLOG(I%,J%))/(URING(I%,J%)*ARING
               (I%,J%)) > TSTEP
                THEN GOTO 27540
27470        IF MRING(I%,J%) = 0
                THEN GOTO 27540
27475        IF J% = 1 AND MRING(I%,J%) <= OMRING(I%)
                THEN GOTO 27540
27480        I1%=I% :
              J1% = J%-1 :
              IF J% = 1 AND I% < NT%
                THEN I1%=I%+1 :
                     J1% = NWE%
27490        IF MRING(I%,J%+1) > 0 AND J% = 1
                THEN CLS:
```

```
                    PRINT USING"LOG  ##  IS TOO SMALL FOR THE TIM
                      E STEP";I%:
                    END
27495           INDCOMB%=1
27500           IF I% = NT% AND J% = 1
                   THEN I1%=I1%-1:
                        IF MRING(I1%,1)<=0
                           THEN GOTO 27500:
                                'INDCOMB%=0:GOTO 27590
27510           MTEMP=0
27512           IF J% = 1 AND MRING(I%,J%) > OMRING(I%)
                   THEN MTEMP = OMRING(I%) :
                         MRING(I%,J%)=MRING(I%,J%)-OMRING(I%)
27515           TRING(I1%,J1%)=-TA+(((TRING(I%,J%)+TA)*MRING(I%,J%))
                  + ((TRING(I1%,J1%)+TA)*MRING(I1%,J1%)))/(MRING(I%,J
                  %)+MRING(I1%,J1%))
27520           MRING(I1%,J1%)=MRING(I1%,J1%)+MRING(I%,J%)
27530           MRING(I%,J%)=MTEMP
27540       NEXT J%
27550   NEXT I%
27560   '           UPDATE HEAT INPUT & NEW TEMPERATURES OF THE LOG ELEMEN
          TS
27570   '
27580   '           SUM UP THE HEAT BACK INTO EACH LOG & HEAT INTO THE AIR
27590    HEATAIR=0
27600   FOR I% = 1 TO NT%
27610       HEATIN(I%)=0
27620   NEXT I%
27630   FOR I% = 1 TO NT%
27640       FOR J% = NWE% TO 1 STEP -1
27650           IF HCOMB(I%,J%)=0
                   THEN GOTO 27710
27660           HEATIN(I%)=HEATIN(I%)+HCOMB(I%,J%)*PWR
27670           FOR II% = 1 TO NCOEF%(I%)
27680               HEATIN(INCOEF%(I%,II%))=HEATIN(INCOEF%(I%,II%))
                      +((HCOMB(I%,J%)*PAW))
27690           NEXT II%
27700           HEATAIR  = HEATAIR + HCOMB(I%,J%)*(1-PWR-(NCOEF%(I%)*
                  PAW)) + (MASCOMB(I%,J%)*CPLOG(I%,J%)*(TRING(I%,J%)-
                  TINTAKE))
27710       NEXT J%
27720   NEXT I%
27730   REM LOCATE 16,1:FOR I% = 1 TO NT% : PRINT HEATIN(I%),:NEXT:PRINT
          HEATAIR
27740   '           UPDATE OF LOG TEMPERATURES
27750   FOR I% = 1 TO NT%
27760       FOR J% = NWE% TO 1 STEP -1
27770           TRF(I%,J%)=TRING(I%,J%)
27780           IF J% < NWE% AND MRING(I%,J%+1) > 0
                   THEN JP1%=J%+1
                   ELSE JP1%=J%
27790           IF MRING(I%,J%) <= 0
                   THEN TRF(I%,J%) = TFLAME :
```

```
                    GOTO 27840
27800           IF MRING(I%,J%) > 0 AND HEATIN(I%) > 0
                   THEN HIN=HEATIN(I%) :
                         HEATIN(I%) = 0 :
                        GOTO 27830
27810           HIN=TSTEP*ARING(I%,J%)*URING(I%,J%)*(TRING(I%,JP1%)-T
                  RING(I%,J%))
27820           TRF(I%,JP1%)=TRF(I%,JP1%)- (HIN/(MRING(I%,J%)*CPLOG(I
                  %,J%)))
27830           TRF(I%,J%) = TRF(I%,J%) + (HIN/(MRING(I%,J%)*CPLOG(I%
                  ,J%)))
27840       NEXT J%
27850   NEXT I%
27860   FOR I% = 1 TO NT%
27870       FOR J% = 1 TO NWE%
27880           IF TRF(I%,J%) > 9999
                   THEN TRF(I%,J%) = 9999
27890           TRING(I%,J%)=TRF(I%,J%)
27900       NEXT J% :
        NEXT I%
27905   GOSUB 30000:
        GOTO 28130
27910   '
27920   '      RADIATION HEAT TRANSFER
28130   '           NET HEAT GIVEN OFF TO THE AIR STREAM
28140    MT1AIR=(TSTEP*MFAIR*FRACOMB)+TMASCOMB
28150    MT2AIR=TSTEP*MFAIR + TMASCOMB
28160    TRISE1 = QFLUE/(TSTEP*MFAIR*FRACOMB*CPAIR + TMCP)
28165    SURFCONV=0:
        FOR SURFACE% = 1 TO 6 :
            SURFCONV = SURFCONV + QCONV(SURFACE%) :
        NEXT SURFACE%
28170    TRISE2 = (QFLUE+SURFCONV)/(TSTEP*MFAIR*CPAIR + TMCP)
28180    TFLAME = TINTAKE + TRISE1
28186    T9=TROOM:
        'T9=TS(1)
28190    TSTACK = TINTAKE + TRISE2
28192    TN(16)=TFLAME :
          TN(17)=TSTACK:
          TN(18)=TN(17)
28194   REM : TMF=(TWALL(1,1)+TWALL(2,1)+TWALL(3,1)+TWALL(4,1)+TWALL(6,1)
          )/5
28195    TMF=TWALL(2,1)
28200    REM
28202    REM
28204     IF MF(6) = 0
            THEN  GOTO 28212
28206    TN(6) = ((MF(18) *CPAIR* (TN(18) + TA)) + (MF(11) *CPAIR* (TN(11)
            + TA))) / (MF(6)*CPAIR)
28208     IF MF(10) < 0
            THEN TN(6) = TN(18) + TA
28210     IF MF(10) < 0 AND MF(6) < .0000001
            THEN TN(6) = ((MF(18) * (TN(18) + TA)) + ( ABS (MF(5)) * (TN(5
              ) + TA))) / (MF(18) +  ABS (MF(5)))
```

```
28212   IF MF(18) < 0
          THEN TN(6) = (TN(5) + TA)
28214  TN(6) = TN(6) - TA
28216  TN(19) = TN(6):
       TN(12) = TN(6)
28218   IF MF(5) > 0
          THEN TN(5) = TN(6)
28220  TN(11) = T9
28222   IF MF(11) < 0
          THEN TN(11) = TN(6)
28224   IF MF(17) < 0
          THEN TN(18) = TN(6)
28300  FW=HCOMBT/TSTEP
28500  RETURN
28600 REM  VERY LITTLE WOOD LEFT TO BURN - SKIP CALCULATION
28610 REM   NOT USED
28630  RETURN
29000 REM *** USER ERROR HANDLING ROUTINES ***
29100 REM:  ERROR HANDLING ROUTINES
29110  SCREEN 0:
        COLOR 7
29120  IF ERR=27 OR ERR=24
          THEN LOCATE 20,40:
               PRINT"CHECK PRINTER":
               RESUME
29130  IF ERR=61
          THEN LOCATE 10,40:
               PRINT"DISK IS FULL - USE ANOTHER DISKETTE":
               LOCATE 20,1:
               PRINT SPACE$(79):
               PRINT SPACE$(79):
               RESUME 4750
29140  IF ERR=5 AND ERL=21020
          THEN GOTO 35000
29500  ON ERROR GOTO 0
29600 '           PRINT OUT OF FINAL ENERGY STATE AT END OF TIME STEP
29610 'IF FL1%=1 THEN GOTO 29760
29750 '
29800  RETURN
30000 'SUBROUTINE TO CALCULATE ENERGY BALANCE OF FIREBOX ENCLOSURE
30021 '              1-LEFT SIDE
30022 '              2-BACK SIDE
30023 '              3-RIGHT SIDE
30024 '              4-FLOOR OF FIREBOX
30025 '              5-ROOM SURROUNDINGS
30026 '              6-TOP OF FIREPLACE OR TOP OF WOODSTOVE
30030  IF FL1%<>1 AND SETUP% = 0
          THEN CLS :
                DISPLAY% = 3:
               NDISPLAY% = 1
30500 '
30510 'PROPERTIES OF WOOD
30530 FOR I%= 1 TO NT%
```

```
30540       FOR J% = NWE% TO 1 STEP -1
30545          IF SETUP% = 0
                  THEN EMISSW(I%)=.8:
                       TFLAME2=300.:
                       J%=1
30546          IF MRING(I%,J%)=<0
                  THEN GOTO 30570
30550          IF MRING(I%,J%)>0 AND TRING(I%,J%)=<204
                  THEN J%=1
30555          IF MRING(I%,J%)>0 AND TRING(I%,J%)>204
                  THEN TBSURF=TBSURF+ARING(I%,J%):
                       J%=1
30570       NEXT J%
30580    NEXT I%
30590    SETUP% = 1
30940    '
31040    'PERFORM ENERGY BALANCE ON ENCLOSURE
31050    QWTO5=0:
         QFTO5=0:
         QSTO5=0:
         QTRAN=0
31060    FOR I% = 1 TO NT%
31070       FOR J% = NWE% TO 1 STEP - 1
31075          IF J% < NWE% AND MRING(I%,J%+1) > 0.
                  THEN J%=1 :
                        GOTO 31177
31080          IF MRING(I%,J%)=<0
                  THEN GOTO 31177
31090          ORN%(I%)=J%:
               MRINGO(I%)=MRING(I%,J%):
               BOUNDFND=0:
               GUESS1=0
31100          '
31120          ' SUM ALL RADIATION THAT FALLS ON EACH SURFACE FROM W
                 OOD
31125          '
31130          WOODRAD(I%) = 1E-34
31140          FOR SURFACE% = 1 TO 6
31145             IF MRING(I%,J%)<=0
                     THEN GOTO 31170
31150             QRADW(I%,SURFACE%) = TSTEP*EMISS(SURFACE%)*EMIS
                    SW(I%)*RFRACTS(I%)*SBCONST*((TRING(I%,J%)+273
                    .15)^4-(TWALL(SURFACE%,1)+273.15)^4)*ARING(I%
                    ,J%)*FRWDS(SURFACE%)
31160             WOODRAD(I%) = WOODRAD(I%)+QRADW(I%,SURFACE%)
31165             IF GLASSDR$ = "Y" AND SURFACE%=5
                     THEN QWTO5 =QWTO5 +TSTEP *TRANSMISS(5)*SBCON
                       ST*ARING(I%,J%)*RFRACT(I%)*FRWDS(5)*((EMIS
                       SW(I%)*((TRING(I%,J%)+273.15)^4))-((TWALL(
                       5,11)+273.15)^4)):
                         'TRANSMISSION EQUATION
31170          NEXT SURFACE%
31172          '
```

```
31174          DT1RAD = WOODRAD(I%)/(MRING(I%,J%)*CPLOG(I%,J%)):
                IF ABS(DT1RAD) > 10
                  THEN DT1RAD = 10 * DT1RAD/ABS(DT1RAD)
31175          TRING(I%,J%)=TRING(I%,J%)-DT1RAD
31176         ' CHECK TO SEE IF COMBUSTION HAS OCCURED-SOLVE THE ST
                EADY STATE FLAME TEMPERATURE
31177       NEXT J%
31778    NEXT I%
31179    IF HEATAIR<=0
            THEN FLAMERAD=0:
                 QFLUE=0:
                 GOTO 31290
31180    TRADFL=1200:
        'TFLAME2
31181    ARFLAME =HEATAIR *.007/(TSTEP*3600):
         FLAMERAD=1E-34
31182    FOR SURFACE% = 1 TO 6
31184       QRADFL(SURFACE%)=TSTEP*EMISS(SURFACE%)*SBCONST*((TRADFL+273
              .15)^4-(TWALL(SURFACE%,1)+273.15)^4)*ARFLAME*FRWS(SURFACE
              %)
31185       IF GLASSDR$ = "Y" AND SURFACE% = 5
               THEN QFTO5 =TSTEP *TRANSMISS(5)*SBCONST*ARFLAME*FRWS(5)*
                 (((TRADFL+273.15)^4)-(TWALL(5,11)+273.15)^4):
                   'TRANSMISSION EQUATION
31186       FLAMERAD = FLAMERAD + QRADFL(SURFACE%)
31188    NEXT SURFACE%
31190    QFLUE = HEATAIR - FLAMERAD :
        REM TSTEP*MFAIR*FRACOMB*CPAIR*(TRADFL-TINTAKE)
31195    GOTO 31290 :
         REM JUMP OVER THE FLAME TEMP CALC
31200    QBALANCE=HEATAIR-FLAMERAD-QFLUE
31205    IF ETRAP = 0
            THEN GOTO 31216
            ELSE GOTO 31210
31210    CLS:
         PRINT" HEATAIR;FLAMERAD;QFLUE;QBALANCE;QBALANCEO"
31211    CLS:
         PRINT HEATAIR;FLAMERAD;QFLUE;QBALANCE;QBALANCEO
31212    PRINT"LB;RB;TRADFL;BOUNDFND":
         PRINT LB;RB;TRADFL;BOUNDFND
31213    PRINT "MRING":
         FOR XXX%=1 TO NT%:
             RR%=ORN%(XXX%):
              PRINT MRING(XXX%,RR%):
         NEXT XXX%
31214    PRINT "ARING":
         FOR XXX%=1 TO NT%:
             RR%=ORN%(XXX%):
              PRINT ARING(XXX%,RR%):
         NEXT XXX%
31215    FOR SURFACE%= 1 TO 6:
             PRINT QRADS(SURFACE%):
```

```
      LNEXT SURFACE%
31216 ' USE THE BISECTION METHOD TO SOLVE FOR STEADY STATE FLAME TEMEPR
        ATURE
31217 '
31220  IF ABS(QBALANCE)<1
          THEN GOTO 31290
31221  IF GUESS1=0
          THEN QBALANCEO=QBALANCE:
               GUESS1=1
31222  IF BOUNDFND=1
          THEN GOTO 31230
31223 '
31224 ' FIND THE LEFT AND RIGHT BOUNDS ON EITHER SIDE OF THE SOLUTION
31225 '
31226  IF QBALANCE*QBALANCEO >0 AND QBALANCE > 0
          THEN LB=TRADFL:
               TRADFL=TRADFL*2:
               RB=TRADFL:
               GOTO 31260
31227  IF QBALANCE*QBALANCEO >0 AND QBALANCE < 0
          THEN RB=TRADFL:
               TRADFL=TRADFL/2:
               LB=TRADFL:
               GOTO 31260
31228  BOUNDFND = 1
31229 '
31230 ' IF THE BOUNDS ARE FOUND KEEP BISECTING UNTIL ROOT IS FOUND
31231 '
31235  IF QBALANCE*QBALANCEO>0 AND QBALANCE >0
          THEN LB=TRADFL:
               TRADFL=(LB+RB)/2:
               GOTO 31260
31240  IF QBALANCE*QBALANCEO>0 AND QBALANCE <0
          THEN RB=TRADFL:
               TRADFL=(LB+RB)/2:
               GOTO 31260
31245  IF QBALANCEO>0
          THEN RB=TRADFL:
               TRADFL=(LB+RB)/2:
               GOTO 31260
31246  IF QBALANCEO<0
          THEN LB=TRADFL:
               TRADFL=(LB+RB)/2:
               GOTO 31260
31260  QBALANCEO=QBALANCE:
       GOTO 31181
31280  TFLAME2=TRADFL
31290 '
31312 '
31313 'QFLUET=QFLUET+QFLUE:' SUM THE ENERGY TRANSFERRED TO THE FLUE FOR
        THE TIMESTEP
31314 '
31315 ' SUM THE RADIATION FROM THE WOODPILE THAT FALLS ON EACH SURFACE
        FOR THAT TIME STEP
```

```
31316 '
31320 FOR SURFACE% = 1 TO 6:
          FLWDRAD(SURFACE%)=0:
          FOR I%= 1 TO NT%:
              FLWDRAD(SURFACE%)=FLWDRAD(SURFACE%)+QRADW(I%,SURFACE%
                )+QRADFL(SURFACE%):
              QRADW(I%,SURFACE%)=0:
              QRADFL(SURFACE%)=0:
          NEXT I%:
      NEXT SURFACE%
31321 '
31330 'SUM NET RE-RADIATION FROM SURFACE TO ALL OTHER SURFACES
31331 '
31340 FOR SURFACE% = 1 TO 6
31350     QRADS(SURFACE%)=0
31360     FOR SURFACEI% = 1 TO 6
31370         QRADS(SURFACE%) = QRADS(SURFACE%)+TSTEP*EMISS(SURFACE
                %)*EMISS(SURFACEI%)*SBCONST*((((TWALL(SURFACE%,1)+2
                73.15)^4)-(TWALL(SURFACEI%,1)+273.15)^4))*ARWALL(SU
                RFACE%)*F(SURFACE%,SURFACEI%):
              'IF NO GLASS DOOR SURFACE 5 DOES NOT RADIATE TO FIREB
                OX
31372         IF SURFACE% = 5 AND GLASSDR$ = "N"
                  THEN QRADS(SURFACE%) = QRADS(SURFACE%)-TSTEP*EMISS
                    (SURFACE%)*EMISS(SURFACEI%)*SBCONST*((((TWALL(SU
                    RFACEI%,1)+273.15)^4)-(TWALL(5,11)+273.15)^4))*A
                    RWALL(SURFACEI%)*F(SURFACEI%,SURFACE%)
31375         IF GLASSDR$ = "Y" AND SURFACE% = 5
                  THEN QSTO5 =QSTO5 +TSTEP *TRANSMISS(5)*SBCONST*((E
                    MISS(SURFACEI%)*((TWALL(SURFACEI%,1)+273.15)^4))
                    -(TWALL(5,11)+273.15)^4)*ARWALL(SURFACEI%)*F(SUR
                    FACEI%,SURFACE%):
                      'TRANSMISSION EQUATION
31380     NEXT SURFACEI%
31390     TOTQRAD(SURFACE%) = FLWDRAD(SURFACE%)-QRADS(SURFACE%)
31391 NEXT SURFACE%
31392 ' CHECK TO SEE IF THE INSIDE SURFACE IS OPEN, HAS GLASS DOORS, OR
      HAS A LINER-USE APPROPRIATE ALGORITHMS
31395 FOR SURFACE% = 1 TO 6
31396     QCONV(SURFACE%)=0:
          QCONVOUT(SURFACE%)=0:
          QCONDOUT(SURFACE%)=0
31400     QIN=TOTQRAD(SURFACE%)
31405     FOR SECTION% = 1 TO 10
31410         HCONVI=8.33:
              QCONVL=0:
              QCONVEXT=0:
              QOUTRAD=0:
              QINRAD=0
31412         IF SURFACE% =5
                  THEN GOSUB 31500:
                       GOTO 31445
31414         QOUT= TSTEP* (ARWALL(SURFACE%)*2/(RSI(SURFACE%,SECTIO
                N%)+RSI(SURFACE%,SECTION%+1)))*((TWALL(SURFACE%,SEC
                TION%))-(TWALL(SURFACE%,SECTION%+1))):
```

```
                'QCOND IS THE CONDUCTIVE HEAT LOSS TO NEXT ELEMENT IN
                   WALL
31415              IF SECTION% = 1
                   THEN QCONVL = TSTEP* HCONVI*ARWALL(SURFACE%)*(TWAL
                     L(SURFACE%,1)-((2*TINTAKE+TN(6))/3)):
                        QCONV(SURFACE%)=QCONVL
31416              IF SECTION% = 1 AND SURFACE% = 6
                   THEN QCONVL=TSTEP*HCONVI*ARWALL(SURFACE%)*(TWALL(S
                     URFACE%,1)-TSTACK):
                        QCONV(SURFACE%)=QCONVL:
                        GOTO 31440
31417              IF FTYPE$="W" AND SECTION% = 4
                   THEN GOSUB 31490:
                        QTEMPRAD=QOUTRAD
31418              IF FTYPE$="W" AND SECTION% = 6
                   THEN QINRAD=QTEMPRAD
31419              IF FTYPE$="F" AND SECTION% = 3
                   THEN GOSUB 31490:
                        QTEMPRAD=QOUTRAD:
                       ' QOUTRAD IS ASSIGNED FOR FACTORY BUILT FIREP
                          LACES
31420              IF FTYPE$="F" AND SECTION% = 5
                   THEN QINRAD= QTEMPRAD
31421              IF SECTION% >1 AND SECTION% <10
                   THEN GOTO 31440
31435              IF SECTION% = 10
                   THEN QOUT=0:
                        QOUTRAD=TSTEP*EMISS(SURFACE%)*ARWALL(SURFACE%
                          )*((TWALL(SURFACE%,10)^4)-(TWALL(SURFACE%,1
                          1)^4)):
                        QCONDOUT(SURFACE%)=QOUTRAD
31437              IF SECTION% = 10
                   THEN QCONVEXT = TSTEP* (HCONV)*ARWALL(SURFACE%)*(T
                     WALL(SURFACE%,10)-TWALL(SURFACE%,11)):
                        QCONVOUT(SURFACE%)=QCONVEXT
31440              QWRISE(SURFACE%,SECTION%) =QIN+QINRAD-QOUT-QOUTRAD-QC
                     ONVL-QCONVEXT
31445              TRISE = QWRISE(SURFACE%,SECTION%)/(MASSWALL(SURFACE%,
                     SECTION%)*CPWALL(SURFACE%,SECTION%))
31450              TWALL(SURFACE%,SECTION%)=TWALL(SURFACE%,SECTION%)+TRI
                     SE
31455              QIN=QOUT
31460           NEXT SECTION%
31465        NEXT SURFACE%
31470        GOTO 31600
31480        '
31490        QOUTRAD= TSTEP*ARWALL(SURFACE%)*EMISS(SURFACE%)*.85*SBCONST*((TWA
               LL(SURFACE%,SECTION%)^4)-TWALL(SURFACE%,SECTION%+2)^4):
             RETURN
31500        IF GLASSDR$="N"
                THEN QWRISE(5,1)=0:
                     QCONDOUT(5)=QIN:
                     GOTO 31540
```

```
31501  IF SECTION% >1
          THEN QWRISE(SURFACE%,SECTION%)=0:
               GOTO 31540
31505  QOUT = TSTEP*EMISS(5)*ARWALL(5)*SBCONST*(((TWALL(5,1)+273.15)^4)-
         (TWALL(5,11)+273.15)^4)
31510  QCONV(5) = TSTEP* HCONVI*ARWALL(5)*(TWALL(5,1)-((2*TINTAKE+TN(6))
         /3)):
       QCONVL=QCONV(5)
31520  QCONVOUT(5)=TSTEP*HCONV*ARWALL(5)*(TWALL(5,1)-TWALL(5,11)):
       QCONVEXT=QCONVOUT(5)
31530  QTRAN = (QWTO5+QFTO5+QSTO5)
31534  QWRISE(5,1) = (QIN-QTRAN)-QOUT-QCONVL-QCONVEXT
31535  QCONDOUT(5) = QOUT + QTRAN
31540  RETURN
31545 'QOUT = TRANSMISS(SURFACE%)*((WDRAD(SURFACE%)-(TSTEP*SBCONST*EMIS
         S(SURFACE%)*((TAIR+273.15)^4)))):'IF SURFACE% IS GLASS QCOND(SU
         RFACE%) IS RADIATION
31590 '
31592 ' CUMULATIVE ENERGY DISTRIBUTION THROUGHOUT WOOD PILE AND SURROUN
         DINGS
31594 '
31600  SOURCEQ=SOURCEQ+HEATAIR
31602  TQFLUE=TQFLUE +QFLUE
31604  TOTFLRAD=TOTFLRAD+FLAMERAD
31605 FOR I%=1 TO NT%:
          TWDRAD=TWDRAD+WOODRAD(I%):
      NEXT I%
31606 FOR SURFACE% = 1 TO 6
31607     CUMWDRAD(SURFACE%)=CUMWDRAD(SURFACE%)+FLWDRAD(SURFACE%)
31608     SURFRAD(SURFACE%)=SURFRAD(SURFACE%)-QRADS(SURFACE%)
31609     TOTRAD(SURFACE%)=SURFRAD(SURFACE%)+CUMWDRAD(SURFACE%)
31610     TOTCONV(SURFACE%)=TOTCONV(SURFACE%)+QCONV(SURFACE%)
31611     NETRAD(SURFACE%)=TOTRAD(SURFACE%)-TOTCONV(SURFACE%)
31613    FOR SECTION% = 1 TO 10
31614        TOTSTOR(SURFACE%,SECTION%)=TOTSTOR(SURFACE%,SECTION%)
             +QWRISE(SURFACE%,SECTION%)
31615    NEXT SECTION%
31617     TOTCONDOUT(SURFACE%)=TOTCONDOUT(SURFACE%)+QCONDOUT(SURFACE%
            )
31618     EXTCONV(SURFACE%)=EXTCONV(SURFACE%)+QCONVOUT(SURFACE%)
31619 NEXT SURFACE%
31620  RETURN
31621 '
31622 'CHECK WHICH SCREEN DISPLAY IS REQUESTED-SKIP IF GRAPHICS DISPLAY
         IS ON
31623 '
31624   IF FL1%=1
        THEN GOTO 31655
31625   KB$=INKEY$:
      WHILE INKEY$<>"":
      WEND
31626   IF KB$ =""
        THEN KB$ = " "
```

```
31627   IF KB$="a" OR KB$="A"
          THEN GOTO 3669
31628   IF KB$="e" OR KB$="E"
          THEN NDISPLAY%= 2:
               KB$=" ":
               GOTO 31648
31629   IF KB$="t" OR KB$="T"
          THEN NDISPLAY%= 1:
               KB$=" ":
               GOTO 31648
31630   IF KB$="s" OR KB$="S"
          THEN NDISPLAY%= 3:
               KB$=" ":
               GOTO 31648
31631   IF KB$="x" OR KB$="X"
          THEN ETRAP = 1:
               CLS:
               GOTO 31655
31632   IF KB$="c" OR KB$="C"
          THEN ETRAP = 0:

31647  GOTO 31649
31648  IF NDISPLAY%<>DISPLAY%
          THEN DISPLAY% = NDISPLAY%:
               CLS
31649  IF DISPLAY% = 1
          THEN GOSUB 31860
31650  IF DISPLAY% = 2
          THEN GOSUB 32123
31651  IF DISPLAY% = 3
          THEN GOSUB 32613
31655  RETURN
31669 '
31770 'OUTPUT TABLE PRESENTATION
31771 '
31860 'SCREEN SETUP FOR DISPLAY 1-PRINTOUT OF TEMPERATURE MATRIX OF FIR
        EPLACE/WOODSTOVE
31861 '
31870  LOCATE 1,1:
       PRINT "     TEMPERATURE PROFILES FOR EACH WALL OF THE FIREPLACE E
         NCLOSURE"
31880  LOCATE 2,17:
       PRINT"RADIANT TEMPERATURES FROM WOOD"
31890  LOCATE 3,1:
       FOR I%=1 TO NT%:
           PRINT USING"  ###  ";I%;:
       NEXT I%
31900  LOCATE 4,1:
       FOR I%= 1% TO NT%:
           J%=ORN%(I%):
           PRINT USING"#####.#";TRING(I%,J%);:
       NEXT I%
31905  LOCATE 5,30:
```

```
       PRINT USING"#####.#";TRADFL
31906 'J%= ORN%(I):FLAMET=TRADFL:IF TRING(I,J%)=<9 THEN FLAMET=0
31907 'PRINT USING"#####.#";TRADFL
31908 'NEXT I
31910  LOCATE 6,1:
       PRINT"FIREBOX SURFACE----------------------------------------
         ---->SURROUNDINGS"
31920  LOCATE 7,30:
       PRINT"SIDE WALLS "
31930  LOCATE 10,30:
       PRINT"BACK WALL "
31940  LOCATE 13,30:
       PRINT"FLOOR "
31950  LOCATE 16,30:
       PRINT"FRONT FACE"
31960  LOCATE 19,30:
       PRINT"TOP OF FIREBOX":
      'OR ANY OTHER SURROUNDING TO INVESTIGATE
31970 FOR SECTION% = 1 TO 11
31980     FOR SURFACE% = 1 TO 6
31990         IF SURFACE% = 3
               THEN GOTO 32030
32000         IF SURFACE% > 3
               THEN XS%=5+3*(SURFACE%-1)
               ELSE XS%=5+3*SURFACE%
32010        LOCATE XS%,(SECTION%-1)*7+2:
           PRINT USING "  ###  ";SECTION%;
32020        LOCATE XS%+1,(SECTION%-1)*7+1:
            PRINT USING "  ###.#";TWALL(SURFACE%,SECTION%);
32030     NEXT SURFACE%
32040 NEXT SECTION%
32070  LOCATE 23,1:
       PRINT"PRESS E FOR ENERGY BALANCE,S FOR SUMMARY-->";:
       PRINT KB$:
       LOCATE 23,55:
       PRINT USING"ELAPSED TIME(s) #####";SCS
32080  RETURN
32081 '
32123 ' SCREEN SETUP UP FOR DISPLAY 2-ENERGY BALANCE FOR WOOD PILE AND
        SURROUNDING SURFACES
32124 '
32125  LOCATE 1,1:
       PRINT"CUMULATIVE ENERGY DISTRIBUTION FOR FIREPLACE/WOODSTOVE SYST
         EM(Wh)"
32130  LOCATE 2,1:
       PRINT USING "HEATAIR=######.##";SOURCEQ/3600
32140  LOCATE 2,20:
       PRINT USING"FLUE=#####.## ";TQFLUE/3600
32144  LOCATE 2,35:
       PRINT USING"FLAME RAD=######.##";TOTFLRAD/3600
32146  LOCATE 2,55:
       PRINT USING"WOOD RAD=#######.##";TWDRAD/3600
32147 '
```

```
32148 'ENERGY DISTRIBUTION FOR EACH SURFACE AND ELEMENT OF WALL
32149 '
32150  LOCATE 3,1:
       PRINT"ENERGY BALANCE FOR EACH SURFACE"
32160  LOCATE 5,1:
       PRINT"TOTAL RAD"
32170  LOCATE 6,1:
       PRINT"SURF. RAD"
32180  LOCATE 7,1:
       PRINT"TOTAL RAD"
32190  LOCATE 8,1:
       PRINT"SURF CONV"
32200  LOCATE 9,1:
       PRINT"NET ENRGY"
32210  LOCATE 11,1:
       PRINT "FIREBOX":
       LOCATE 20,1:
       PRINT "EXTERIOR"
32220  LOCATE 10,1:
       PRINT"TOTAL ENERGY STORED IN EACH ELEMENT OF ENCLOSURE"
32230  LOCATE 21,1:
       PRINT"RADIAT'N"
32240  LOCATE 22,1:
       PRINT"CONVECT'N"
32250 FOR SURFACE% = 1 TO 6
32260     LOCATE 4,SURFACE%*10:
          PRINT USING" #######    ";SURFACE%
32270     LOCATE 5,SURFACE%*10:
          PRINT USING" ######.## ";CUMWDRAD(SURFACE%)/3600
32280     LOCATE 6,SURFACE%*10:
          PRINT USING" ######.## ";SURFRAD(SURFACE%)/3600
32300     LOCATE 7,SURFACE%*10:
          PRINT USING" ######.## ";TOTRAD(SURFACE%)/3600
32350     LOCATE 8,SURFACE%*10:
          PRINT USING" ######.## ";-TOTCONV(SURFACE%)/3600
32400     LOCATE 9,SURFACE%*10:
          PRINT USING" ######.## ";NETRAD(SURFACE%)/3600
32420     FOR SECTION% = 1 TO 10
32470        LOCATE SECTION%+10,SURFACE%*10:
             PRINT USING" ######.## ";TOTSTOR(SURFACE%,SECTION%)/3
               600
32490     NEXT SECTION%
32530      LOCATE 21,SURFACE%*10:
           PRINT USING" ######.## ";TOTCONDOUT(SURFACE%)/3600
32580      LOCATE 22,SURFACE%*10:
           PRINT USING" ######.## ";EXTCONV(SURFACE%)/3600
32590 NEXT SURFACE%
32600  LOCATE 23,1:
       PRINT"PRESS T FOR WALL TEMP, S FOR SUMMARY-->";:
       PRINT KB$:
       LOCATE 23,55:
       PRINT USING"ELAPSED TIME(s) #####";SCS
32610  RETURN
```

```
32612 '
32613 'SCREEN SETUP FOR DISPLAY 3-TEMPERATURE DISTRIBUTION IN LOGS
32614 '
32615 '
32617  LOCATE 1,1:
       PRINT"TIME   HEAT    AIR TEMP IN    WOOD ELEMENT TEMP-->"
32618  PRINT"         COMB  THROAT CHIMN"
32619  PRINT" (s)     (kW)    (C)   (C)       (C).....                "
32620  PRINT
32621  LOCATE 4,28 :
      ┌ FOR I% = 1 TO NT% :
      │    PRINT USING"  ## ";I%;:
      └NEXT
32622  PRINT:
       PRINT
32625  LOCATE 6,1
32630  PRINT USING"#####.#";SCS;
32640  PRINT USING" #### ";HCOMBT/(1000*TSTEP);
32650  PRINT USING"  #### ";TN(6);
32660  PRINT USING" #### ";TFLUE;
32670 ┌ FOR J% = NWE% TO 1 STEP -1
32680 │    LOCATE 11-J%,28
32690 │   ┌FOR I% = 1 TO NT%
32695 │   │    IF MRING(I%,J%) <= 0
      │   │       THEN PRINT "      ";:
      │   │            GOTO 32710
32700 │   │    PRINT USING"#### ";TRING(I%,J%);
32710 │   └NEXT
32720 │    PRINT
32730 └NEXT J%
32740  LOCATE 11,1 :
        PRINT USING"OPENING TEMP        =  ###.# (C)";TWALL(5,1)
32750  LOCATE 12,1 :
        PRINT USING"BACK WALL TEMP      =  ###.# (C)";TWALL(2,1)
32760  LOCATE 13,1 :
        PRINT USING"SIDE WALLS TEMP     =  ###.# (C)";TWALL(1,1)
32765  LOCATE 14,1 :
        PRINT USING"FLAME AREA          =    #.#### (m2)";ARFLAME
32770 'LOCATE 14,1 : PRINT USING"FLOOR OR ASHES TEMP=  ###.# (C)";TWALL
        (4,1)
32780  LOCATE 16,1:
       PRINT USING"TOTAL ENERGY RELEASED= ##.### kWh";THCOMBT/3600000!
32790  LOCATE 17,1:
       PRINT USING"HEAT TRANSF. TO HOUSE= ##.### kWh";CUMWDRAD(5)/360000
        0!
32795  LOCATE 18,1:
       PRINT USING"EFFICIENCY           =  ###.# %  ";FE
32800  LOCATE 19,1:
       PRINT USING"MASS OF WOOD BURNED  = ##.### kg      ###.#%";TMASSB;
        (TMASSB*100/TMASS)
32810  LOCATE 20,1:
       PRINT USING"MASS OF WOOD LEFT    = ##.### kg      ###.#%";TMASSL;
        (TMASSL*100/TMASS)
```

```
32820  LOCATE 21,1:
       PRINT USING"TOTAL ORIGINAL MASS  = ##.### kg       100.0%";TMASS
32830  IF TMASCOMB > 0 AND TMASSL > 0
          THEN TLB =  (TMASSL/(60*(TMASCOMB+1E-08)/TSTEP))
          ELSE TLB=0
32840  LOCATE 22,1:
       PRINT USING"ELAPSED TIME          = ####.# min     ESTIMATED TIME
         LEFT TO BURN = ##### min  ";SCS/60;TLB
32845  LOCATE 23,1:
       PRINT"PRESS E FOR ENERGY BALANCE,T FOR WALL TEMP-->";:
       PRINT KB$:
       LOCATE 23,55:
       PRINT USING"ELAPSED TIME(s) #####";SCS
32850  RETURN
35000  BEEP:
       CLS:
        LOCATE 5,5:
       PRINT "You have chosen 'GRAPH' output and the 'WINSTAL2.DAT' file
         "
35010  LOCATE 7,5:
       PRINT"indicates that your computer is capable of 640x200"
35015  LOCATE 9,5:
       PRINT"resolution graphics, but this is not the case for"
35017  LOCATE 11,5:
       PRINT"the present configuration"
35020  LOCATE 14,5:
       PRINT"DO YOU WISH TO -"
35030  LOCATE 16,1:
       PRINT"1. RETURN to the main menu to SAVE the current input data,
         then EXIT to DOS "
35040  LOCATE 18,1:
       PRINT"2. RUN the WINSTAL2 program to correct 'WINSTAL2.DAT'"
35050  LOCATE 22,10:
       INPUT "Your choice  1,'2 or [3]";A%
35055  IF A%=1
          THEN GOTO 3671
35060  IF A%=2
          THEN RUN "WINSTAL2"
35070  FL1%=0:
        GD$="T":
       CLS:
      RESUME 18325    'SET UP FOR TABLES
```

APPENDIX C

VARIABLE LIST AND LINE NUMBER REFERENCES

VARIABLE LIST FOR PROGRAM: WOODSIMA.BAS

DATE: 04-08-1987
TIME: 15:57:20

THE PROGRAM HAS 1380 LINES OF CODE

	VARIABLE	REFERENCED ON LINE No. ...
1	A	30 50 8150 8160 8210 8220 8230 8380 8430 9270 9340 9350 11300 12662 17680 17725 17730 17800 21034 21036 21046 21048 21056 21058 21060 21076 35050 35055 35060
2	A$	21008 21010 21012
3	ABORT$	3660
4	ADR	60 4160 4280 5420 11230
5	ANDFACT	21056 21058 21060 21888
6	ANDNO	27 20184 20186 20188 21206 21888
7	APRD	80 4160
8	AR	20 40 98 1646 1647 4160 4270 4290 4300 5390 5400 11170 11180 15240
9	ARD	27 98 4260 5405 6080 9130 9140 9694 11210
10	ARING	11 35 25620 25630 25720 25730 27310 27315 27460 27810 30555 31150 31214
11	ARINT	93 443
12	ARINTAKE	94
13	ARWALL	14 36 30080 30082 30084 30086 30100 31370 31395 31400 31405 31406 31420 31523 31540 31550
14	AUFF	90
15	AXIS	20070 21000
16	B	21064 21066 21076 21078
17	B$	21014 21016 21018 21078 21080
18	BOUNDFND	31090 31212 31222 31228
19	BOX	33 103 21210 21903
20	BRATE	37 25120 27305
21	BSAVE	3695
22	BWH	36 30080
23	BWL	36 30080
24	C	90 441 17860
25	C1	70 3270 3280 3290 3300 3310
26	C2	70 3300 3390 3400 3410 3420
27	CC	93 446 6140 11110 11250 17860
28	CDT	94
29	CHBOT	80 440 1620
30	CHDENL	92
31	CHDENO	92
32	CHDENS	92
33	CHDI2	20 40
34	CHELTL	92
35	CHELTO	92
36	CHELTS	92

87 ER2 60 3310 3320 3340 3370
88 ER3 60 2130 3280 3320 3400 3430 3440 3460
89 ER4 60 3420 3430 3440 3460
90 ERROR 96
ETRAP 31205 31631 31632
91 EXPOSR 14 37 25190 25200 25210 25220
92 EXTCONV 31 31618 32580
93 F 13 35 31370
94 F$ 60 1840 3110 26340
95 F1 80
96 F2 80
97 FANM 60 1900 1920 17410
98 FAULT$ 3694 3695
99 FB$ 70 11425
100 FBANGLE 36
101 FCAPL 94 4125
102 FE 18280 18290 18300 19400 32795
103 FF 30 50 12610 12620 12630 12650
104 FICV 80
105 FIRM 60 1910 1920 17420
106 FL1 75 110 2185 3075 3670 11060 18325 19590 26385 30073 31624 35070
107 FL2 75 21008 21024 21030 21088 21110 21112 21114 21116 21150 21166 21176 21186 21850 21860
21870

FLAMERAD 31179 31181 31184 31200 31211 31604
108 FLENME$ 25 93
109 FLUEIN$ 93 3671
110 FM 30 50 17070 17370 17380 17390 17430
111 FP 90 1910 11110 17420
112 FPAR 20 40
113 FPDENL 91
114 FPDENO 91
115 FPDENS 91
116 FPDI2 20 40
117 FPELTL 91
118 FPELTO 91
119 FPELTS 91
120 FPHC 20 40
121 FPI$ 8305 8306 9395
122 FPLN 30 50 1610
123 FPTHCL 91
124 FPTHCO 91
125 FPTHCS 91
126 FRACOMB 37 25290 27305 28140 31190
127 FRWDS 13 94 31150
128 FRWS 13 35 31183
129 FS 90 3110
130 FTI$ 32 20226 20228 20230 20232 21190
131 FTYPE$ 36 30075 30076 30077 31405 31406 31420
132 FW 60 1850 18090 28300
133 FWL 36 30080
134 GC 60 380 6090 6100 6230 9560 11150
135 GD$ 70 35070
136 GDCP 36 30100

```
137  GDDENS        36  30100
138  GDTHK         36  30100
139  GE            60
140  GF            60    410   6090   9530   9560
141  GLASSDR$      36  30100  31394  31395  31400  31522  31523  31524  31525
142  GPOUT         32  21362  21364  21366  21368  21370  21372  21374  21376  21378  21380  21382  21860
143  GTOUT         32  21348  21350  21352  21354  21356  21358  21360  21850
     GUESS1     31090  31221
144  HB800       3695
145  HC            30     50   8190   8305   8306   8380   8430   9270   9340   9350  11300  17700  17725  17730  17800
146  HCHARD        93  25790
147  HCHE          90  25200  25210
148  HCOMB         12     35  27300  27360  27370  27380  27650  27660  27680  27700
149  HCOMBT     27270  27370  28300  32640
     HCONV      30470  31400  31406  31420  31523  31550
150  HCRING        12     35  25680  25790  27460  27820  27830  31174
151  HCSOFT        37  25680
152  HD$           27  11350  11360  11370  11380  11390  11400  11410  11420  11425  11430  11470  11476
153  HDRTHK        36
154  HEATAIR    27590  27700  31179  31200  31211  31600
155  HEATHARD      37  27360
156  HEATIN        12     35  27610  27660  27680  27800
157  HEATSOFT      37  27360
158  HF            60   1620   1660   4660   4664   4710   6090   6100   8160   9140  11150  12580  12662
159  HFFFF      20180
160  HH            60   1630   6222   6230
161  HIN        27800  27810  27820  27830
162  HINT          94
163  HT            20     40    440    448   1630   6100   6223   6230  15180
164  HTWTAR        93   4270   4280
165  HTWTC         93  28206
166  HTWTEF        93  28206
167  I             98   1610  25560  25590  25610  25620  25630  25640  25650  25655  25660  25670  25680  25710  2572
                25730  25740  25750  25755  25760  25770  25780  25790  25810  26290  26310

168  I1         27480  27500  27510  27520
169  ICHTYPE       93
170  ICOEF         13     35
171  II          6340   6350   6360  26360  26370  27670  27680  27690
172  INCOEF        13     35  27680
173  IND10      13350
174  INDCOMB       99  27095  27495
175  INDT        9250   9330  12070  12080  12140  12150
176  INSTR       3694
177  INTAKE$       94   4285   5185   6223   6295  17905  27195
178  ITER        3180   3260   3300
179  ITW         9260   9340  12070  12080  12100  12110  12160
180  J           8140   8150   8160   8170   8370   8380   8390   8400   8420   8430   8440   8450   9320   9340   93
                9360   9370   9390   9400   9410   9440   9450   9460  17720  17725  17730

181  J1         25580  25610  25640  25710  25740  27480  27510  27520
182  JP1        27780  27810  27820
183  JUNK$       3677   3678   3679   3680   3681   3693
184  K1            60    340   4120  12620  12630
```

	NETRAD	31611	32400													
223	NFPSEGS	90	1610	1620	1645	1660	4650	4660	4664	4700	4710	8150	8160	8280	9130	9140
		9400	11300	12570	12580	12662	17670	17680	17690	17700	17725	17730				
224	NPH	37														
225	NPL	12	35	25620	25630	25640	25720	25730	25740							
226	NPS	37	25590													
227	NSCAL	21056	21058	21060	21084											
228	NT	37	25560	26290	27070	27280	27440	27480	27500	27600	27630	27750	27860			
		30530	31060	31213	31214	31320	31605	31890	31900	32621	32690					
229	NWE	37	3110	25570	26300	26340	27080	27120	27290	27360	27450	27480	27640	27760	27780	27870
		30540	31070	31075	32670											
230	OMRING	25655	25755	27115	27480											
231	OO	30	50	18080	18090	18100	18110	18120	18130	18140	18150	18160	18170	18250	18260	18270
		18300	18310	18320	18420	21348	21350	21352	21354	21356	21358	21870				
232	OOW	25	18452	19310	19320	19330	19340	19350	19360	19370	19380	19390	19400	19410	19420	19430
		19440	19450													
233	OP	21880	21882	21884	21886	21888	21909									
	ORN	31090	31213	31214	31900											
234	OTW	9270	9350	12100	12140	12150	12160	12170								
235	OU$	93	107													
236	OUTPUT	107														
237	P	21118	21122	21126	21136	21140	21144									
238	P$	70	18330	18620												
239	P1	75	21178	21860												
240	P2	75	21180	21860												
241	P3	75	21182	21860												
242	P4	75	21184	21860												
243	PAR	20	40	11110	11130	11140	11150	11160	11200	11220	11240	11260	11300	11476		
244	PATTRN	27	20182	20184	20186	20188	21882									
245	PAW	37	25330	27680	27700											
246	PB	20	40	3270	3390	6100	6120	6140	6170	6180	6230	6280	6290	6295	6300	6360
		14490	17440	18140	18360	21362	21364	21366	21368	21370	21372	21374				
247	PB3	6295														
248	PCODE	50														
249	PELHT	60	1620	1660												
250	PHC	60	1585	6120	11130	17270										
251	PIE	60	390	1585	1590	1600	1646	1647	1648	9694	12662	25620	25640	25720	25740	
252	PP	21118	21124	21128	21134	21142	21146									
253	PRCOND$	90														
254	PRFF$	90														
255	PRFLAG	70														
256	PRFLAG2	70	110	120												
257	PRISE	20														
258	PRREG$	90														
259	PRTSC	3693														
260	PRUUN	20														
261	PT	103	21887	21900	21901											
262	PT1	21877	21882	21884	21887	21900	21903	21904	21905	21906						
263	PTC	90	1585													
264	PTI$	32	20190	20192	20194	20196	20198	20200	20202	20204	20206	20208	20210	21178	21180	2118

337	TMASSB	27420	32800													
338	TMASSL	27250	27390	27420	32810	32830										
339	TMF	90	18150	28195												
340	TMONOFF	75														
341	TMP1	75	21168	21850												
342	TMP2	75	21170	21850												
343	TMP3	75	21172	21850												
344	TMP4	75	21174	21850												
345	TN	20	40	4770	6100	6220	6222	6223	6230	6280	6290	6360	9190	9230	9400	9600
		9610	9620	9630	9680	11150	14170	17080	17470	17480	17490	18160				
		28206	28208	28210	28212	28214	28216	28218	28220	28222	28224	30104	32650			
346	TOTCONDOUT	31	31617	32530												
	TOTCONV	31610	31611	32350												
347	TOTFLRAD	18280	19440	31604	32144											
	TOTQRAD	31390	31430													
	TOTRAD	31609	31611	32300												
	TOTSTOR	31614	32470													
	TOUT	30480														
348	TQ	17500	17530	17545	17560	18180	18210	18240	18270							
349	TQFLUE	19430	31602	32140												
350	TR	12100	12110	12160	12170											
351	TRAD1	2191														
352	TRADFL	3110	19410	31180	31183	31190	31212	31226	31227	31235	31240	31245	31246	31280	31905	
353	TRANSMISS	14	36	31522												
354	TRF	11	35	27770	27790	27820	27830	27880	27890							
355	TRI	33	104	21210	21904											
356	TRING	11	35	3110	26310	26340	27100	27455	27510	27700	27770	27810	27890	30550	30555	31150
		31175	31900	32700												
	TRISE	31440	31470													
357	TRISE1	28160	28180													
358	TRISE2	28170	28190													
359	TROOM	27194	27195	28186												
360	TS	14	37	26370												
361	TSSGE	80														
362	TSTACK	37	28190	28192	30104	31420										
363	TSTEP	37	27052	27310	27460	27810	28140	28150	28300	31150	31183	31190	31370	31395	31400	31405
		31406	31420	31522	31523	31540	31550	32640	32830							
364	TT	6090	6095	6100	6170	11150	17500	17520	17545	17550	18180	18200	18230	18250		
365	TT$	70														
366	TTI$	32	20212	20214	20216	20218	20220	20222	20224	21168	21170	21172	21174			
367	TW	30	50	17725	17730	17740	17800	17810								
368	TWALL	14	36	19330	19340	19350	19360	19370	19380	19390	28195					
		30102	30104	31150	31183	31370	31395	31400	31405	31406	31420	31470	31523	31525	31540	31550
		31560	31940	31970	32000	32030	32060	32740	32750	32760	32770					
369	TWDRAD	18280	19450	31605	32146											
370	TZ	8380	8390	8430	8440											
371	U	30	50	8070	8080	8090	8100	8305	8306	8380	8430	9270	9340	9350	11300	12600
		12640	12660	17670	17730	17800										
372	U1A	70														
373	U2A	70														
374	U2AR	60														
375	UF	80	350	9080	9490	12660	17670	17725	18310							

421	YT1	21902	21903				
422	YT2	21902	21904				
423	YT3	21902	21905				
424	YT4	21902	21906				
425	YTEMP$	21104	21110				
426	YY	21056	21058	21060	21074		
427	Z$	70	1740				
428	Z1	60	2150	3100	3110	18327	18328
429	Z2	60	2150	18327			
430	ZZ	1660					

APPENDIX D.1

SAMPLE DETAILED SUMMARY OUTPUT

MODEL OF THE TRANSIENT PERFORMANCE OF A WOODBURNING DEVICE AND A CHIMNEY IN NON-DESIGN FLOW CONDITIONS

PROGRAM DEVELOPED BY: SCANADA CONSULTANTS LIMITED
FOR:CANADA MORTGAGE AND HOUSING CORPORATION
DATE:1984,1986

C A S E: WOOD BURNING - DEFAULT FILE FOR FIREPLACE DATE: 07-15-1987

TIME (SECS)	BURN RATE (kW)	FIREBOX FLOW(L/S)	DILUTION FLOW(L/S)	CHIMNEY FLOW(L/S)	INC. ENVEL FLOW(L/S)	ENVELOPE PRES DROP	FIREBOX WALL TEMP	FIREBOX EXIT TEMP	MIXING TEMP(C)	MEAN FLUE GAS TEMP	GAS EXIT TEMP (C)	MEAN FLUE LINER TEMP	INSTANT. EFFICIENCY	FLUE FILM HT TRANS CF	FLUE FRICTION FACTOR
0.0	0.0	18.8	59.2	78.2	74.2	-3.4	20.0	18.0	19.0	15.2	14.0	20.0	0.0	9.0	3.2
0.5	0.0	18.3	55.4	73.7	70.0	-3.2	16.0	19.0	19.8	16.4	14.3	20.0	100.0	9.2	2.3
1.0	0.0	18.4	56.2	74.5	70.8	-3.2	16.0	18.7	19.7	17.0	14.6	20.0	100.0	10.5	2.3

******* THE WOOD PILE WILL BE LIT AT 1.41 SECONDS *******

S Y S T E M P A R A M E T E R S

ENVELOPE ADVERSE PRESS.(FANS & FIREPLACE) (PA): 0
WIND INDUCED DRIVING PRESSURE (PA): 11.19
NET BOUNDARY DRIVING PRESSURE (PA): 11.19
CHIMNEY/HOUSE BUOYANCY PRESSURE AT STANDBY (PA): 1.08
NET DRIVING PRESSURE PARAMETER (AT STANDBY)(PA): 12.27

FIREBOX EQUIVALENT LEAKAGE AREA OF FLOW (m2): .041
CHIMNEY EQUIVALENT LEAKAGE AREA OF FLOW (m2): .043
E.L.A. OF UPPER OPENING OR OF DOORS (m2): .133
ENVELOPE EQUIVALENT LEAKAGE AREA AT 10 PA (m2): .066
CHIMNEY LINER HEAT TRANSFER TIME CONSTANT (S): 2159.4

FLUE LOCATION: EXTERIOR
CHIMNEY FLOW DIRECTION AT STANDBY: UPWARD (1.52 M/S)

C A S E: WOOD BURNING - DEFAULT FILE FOR FIREPLACE DATE: 07-15-1987

TIME (SECS)	BURN RATE (kW)	FIREBOX FLOW(L/S)	DILUTION FLOW(L/S)	CHIMNEY FLOW(L/S)	INC. ENVEL FLOW(L/S)	ENVELOPE PRES DROP	FIREBOX WALL TEMP	FIREBOX EXIT TEMP	MIXING TEMP(C)	MEAN FLUE GAS TEMP	GAS EXIT TEMP (C)	MEAN FLUE LINER TEMP	INSTANT. EFFICIENCY	FLUE FILM HT TRANS CF	FLUE FRICTION FACTOR
1.4	0.0	18.6	56.7	75.3	71.5	-3.3	16.0	18.8	19.7	17.5	14.8	20.0	100.0	10.6	2.3
1.9	3.4	40.8	40.0	78.3	71.5	-3.3	16.0	64.4	31.0	20.0	15.3	20.0	28.8	10.7	2.3
2.3	9.5	45.7	37.0	82.1	70.6	-3.2	16.0	82.9	49.5	25.6	16.0	20.0	27.2	10.7	2.3
2.7	11.5	47.6	36.7	84.2	71.1	-3.2	16.0	90.0	55.3	30.7	16.6	20.0	26.9	10.6	2.4
3.1	12.3	48.5	37.9	86.6	72.6	-3.3	16.0	93.1	57.4	34.2	17.2	20.0	26.7	10.7	2.4
3.5	12.7	49.2	40.2	89.6	75.2	-3.5	16.0	94.4	57.7	36.7	18.0	20.0	26.7	10.9	2.4
3.8	12.9	49.6	41.8	91.5	76.9	-3.6	16.1	95.0	57.0	38.8	19.4	20.0	26.6	11.2	2.5
4.2	13.0	49.9	44.0	94.2	79.2	-3.8	16.1	95.4	56.6	40.5	21.6	20.0	26.6	11.4	2.4
4.6	13.1	50.3	46.0	96.5	81.4	-3.9	16.1	95.5	55.8	42.0	24.3	20.0	26.6	11.7	2.4
4.9	13.2	50.6	47.6	98.3	83.1	-4.0	16.1	95.7	55.2	43.1	27.2	20.0	26.6	11.9	2.4
5.2	13.3	50.7	48.4	99.2	83.9	-4.1	16.1	95.8	54.7	44.0	30.1	20.0	26.6	12.1	2.4
5.6	13.3	50.9	49.2	100.2	84.9	-4.1	16.1	95.9	54.5	44.8	32.6	20.0	26.6	12.2	2.4
5.9	13.4	51.0	49.8	100.9	85.5	-4.2	16.1	96.0	54.3	45.3	34.8	20.0	26.6	12.3	2.4
6.2	13.4	51.1	50.2	101.3	86.0	-4.2	16.1	96.1	54.1	45.6	36.4	20.0	26.6	12.4	2.4
6.6	13.4	51.1	50.1	101.2	85.9	-4.2	16.2	96.1	54.0	45.9	37.6	20.0	26.6	12.4	2.4
6.9	13.4	51.1	50.2	101.4	86.0	-4.2	16.2	96.2	54.1	46.0	38.5	20.0	26.6	12.4	2.4
7.2	13.4	51.1	50.3	101.5	86.1	-4.2	16.2	96.2	54.1	46.1	39.1	20.1	26.6	12.4	2.4
7.5	13.5	51.2	50.4	101.6	86.1	-4.2	16.2	96.3	54.1	46.2	39.5	20.1	26.6	12.5	2.4
7.9	13.5	51.2	50.4	101.6	86.2	-4.2	16.2	96.4	54.1	46.2	39.7	20.1	26.6	12.5	2.4
8.2	13.5	51.2	50.4	101.6	86.2	-4.2	16.2	96.4	54.1	46.3	39.8	20.1	26.6	12.5	2.4
8.5	13.5	51.2	50.4	101.6	86.2	-4.2	16.2	96.5	54.1	46.3	39.9	20.1	26.6	12.5	2.4
8.9	13.5	51.2	50.4	101.6	86.2	-4.2	16.2	96.5	54.1	46.3	39.9	20.1	26.6	12.5	2.4
9.2	13.5	51.2	50.4	101.6	86.2	-4.2	16.2	96.6	54.2	46.3	40.0	20.1	26.6	12.5	2.4
9.5	13.5	51.2	50.4	101.7	86.2	-4.2	16.2	96.7	54.2	46.3	40.0	20.1	26.6	12.5	2.4
9.8	13.5	51.3	50.4	101.7	86.2	-4.2	16.3	96.7	54.2	46.3	40.0	20.1	26.6	12.5	2.4
10.2	13.5	51.3	50.4	101.7	86.2	-4.2	16.3	96.8	54.3	46.4	40.0	20.1	26.6	12.5	2.4
10.5	13.5	51.3	50.4	101.7	86.2	-4.2	16.3	96.8	54.3	46.4	40.0	20.1	26.7	12.5	2.4
13.8	13.5	51.4	50.5	101.9	86.3	-4.2	16.4	97.5	54.6	46.6	40.1	20.1	26.8	12.5	2.4
17.0	13.6	51.6	50.5	102.1	86.4	-4.2	16.5	98.3	55.0	46.9	40.3	20.2	26.9	12.5	2.4
20.3	13.7	51.8	50.6	102.4	86.5	-4.3	16.6	99.1	55.3	47.2	40.6	20.2	27.1	12.5	2.4
23.5	13.7	52.0	50.6	102.7	86.6	-4.3	16.7	100.0	55.7	47.5	40.8	20.3	27.2	12.5	2.4
26.8	13.8	52.2	50.7	102.9	86.8	-4.3	16.8	100.9	56.1	47.8	41.0	20.3	27.4	12.5	2.4
30.0	13.9	52.4	50.8	103.2	86.9	-4.3	16.9	101.8	56.5	48.1	41.3	20.4	27.5	12.5	2.4
33.2	13.9	52.7	50.9	103.5	87.1	-4.3	17.1	102.8	57.0	48.5	41.6	20.4	27.7	12.6	2.4
36.5	14.0	52.9	50.9	103.9	87.2	-4.3	17.2	103.8	57.5	48.8	41.9	20.5	27.9	12.6	2.4
39.7	14.1	53.2	51.0	104.2	87.3	-4.3	17.3	104.9	57.9	49.2	42.2	20.5	28.1	12.6	2.4
42.8	23.9	59.1	51.7	110.9	89.3	-4.4	17.4	132.7	71.2	57.8	44.9	20.6	27.8	12.8	2.4
45.8	24.2	59.9	53.2	113.1	90.9	-4.6	17.6	135.7	71.6	59.7	50.0	20.6	27.5	13.0	2.4
48.7	36.1	64.9	51.2	115.9	89.3	-4.4	17.7	165.7	86.3	64.6	50.7	20.7	27.3	12.9	2.4
50.1	38.0	66.5	54.0	120.6	92.3	-4.7	17.9	172.9	88.8	70.3	52.8	20.7	27.0	13.1	2.3

PHYSICAL CHARACTERISTICS OF THE SYSTEM

	<----------C H I M N E Y---------->						<---E N V E L O P E--->			<--DILUTION OPENING->		<----------F I R E B O X---------->						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
DISTANCE->DATUM (M)	0.00	0.00	0.00	6.37	6.37	6.48	0.00	2.80	2.80	6.48	6.48	6.48	6.48	6.80	6.80	6.80	6.37	6.37	6.48
AREA OF OPENING (m2)	0.000	0.046	0.046	0.060	0.060	0.000	0.000	0.000	0.000	0.000	0.162	0.000	0.000	0.000	0.290	1.000	1.000	0.046	0.000
K FACTOR NORMAL	0.0	0.7	0.0	2.3	0.5	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	3.0	0.0	0.0	2.5	0.0

TIME = 50.1 SECONDS

TEMPERATURES OF THE FLUE GAS, LINER, AND STRUCTURE

	F 1	F 2	F 3	F 4	F 5
FLUE GAS TEMP (C)	84.8	81.2	71.6	61.2	52.8
INNER LINER (C)	20.9	20.9	20.7	20.6	20.5
INSUL OR STRUCT (C)	20.1	20.1	20.1	20.1	20.0
OUTER STRUCTURE(C)	20.0	20.0	20.0	20.0	20.0
SURROUNDING (DEG C)	20.0	20.0	5.0	5.0	5.0

THE MASSFLOW SYSTEM PARAMETERS

	<----------C H I M N E Y---------->						<---E N V E L O P E--->			<--DILUTION OPENING->		<----------F I R E B O X---------->						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
TEMPERATURE (DEG C)	5.0	52.8	52.8	84.8	88.8	88.8	-5.0	5.0	20.0	20.0	20.0	88.8	20.0	20.0	20.0	429.4	172.9	172.9	88.8
DENSITY (KG/M3)	1.27	1.08	1.08	0.99	0.98	0.98	1.27	1.27	1.21	1.21	1.21	0.98	1.21	1.21	1.21	0.50	0.79	0.79	0.98
MASS FLOW (KG/S)	0.118	0.118	0.118	0.118	0.118	0.118	0.117	0.117	0.117	0.065	0.065	0.065	0.052	0.052	0.052	0.053	0.053	0.053	0.053
VOLUME FLOW (M3/S)	0.093	0.109	0.109	0.119	0.121	0.121	0.092	0.092	0.097	0.054	0.054	0.067	0.043	0.043	0.043	0.105	0.067	0.067	0.054
FLOW VELOCITY (M/S)	0.00	2.88	2.88	2.43	2.46	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.15	0.10	0.07	1.44	0.00

PRESSURE PARAMETERS OF THE FLOW SYSTEMS

NET BUOYANCY	WIND EFFECT	ENVELOPE LOSS	FRICTION LOSS	NET DRIVING	FIBX BUOYANCY	INLET DROP	OUTLET DROP	NET FIREBOX	DILUTION PORT
11.761	11.187	-4.652	-18.053	0.243	1.861	-0.040	-2.063	-0.243	-0.243

S U M M A R Y T A B L E

OUTDOOR TEMPERATURE = 5 C
INDOOR TEMPERATURE = 20 C

WIND SPEED & PRESSURE COEFFICIENTS:	SPEED (M/S)	PRESSURE COEFFICIENTS CHIM TOP	INSIDE HOUSE
HORIZONTAL COMPONENT	4	1.10	0.00
VERT. COMPONENT (+VE UP)	0	1.0	

FLOW RATES:	L/S	KG/S	
FIREBOX OUTLET FLOW	66.5	0.053	
DILUTION AIR FLOW	53.9	0.065	
CHIMNEY INLET FLOW	%120.6	0.118	
EXHAUST FAN FLOW	0.0	0.0	
FLOW FROM COMPETING CHIMNEYS	0.0	0.0	
NET ADDITIONAL ENVELOPE FLOW	92.2	0.1	(AT OUTDOOR TEMPERATURE)

INDUCED PRESSURE DROP ACROSS THE ENVELOPE = -4.7 Pa

TEMPERATURES:

AIR TEMPERATURE ABOVE FLAME= 429. C
FIREBOX EXIT TEMPERATURE = 172.9 C
CHIM GAS T. AFTER DILUTION = 88.8 C
MEAN FLUE GAS TEMPERATURE = 70.3 C
MEAN FLUE LINER TEMPERATURE= 20.7 C

THERMAL PROPERTIES OF FIREBOX & CHIMNEY

AT THE BASE OF THE CHIMNEY:	FLUE GAS	LINER	SLEEVE	STRUCTURE
HEAT TRANSFER COEFF. 'U' (W/(m2.C))	13.109	90.000	4.100	10.220
ELEMENTAL SURFACE AREA 'A' (m2)	1.330	1.891	2.061	2.912
ELEMENTAL MASS 'M' (KG)	0.098	37.230	40.580	573.294
HEAT CAPACITY OF MATERIALS 'CP' (W.S/KG.C)	1035.0	829.0	829.0	800.0
HEAT TRANSFER TIME CONSTANTS-OUT (S)	5.8	181.4	3981.2	15412.9
HEAT TRANSFER TIME CONSTANTS-IN (S)		1751.5	197.7	54277.5

ENVELOPE CHARACTERISTICS:	WITHOUT AIR INTAKE	WITH AIR INTAKE (IF ANY)
FLOW COEFFICIENT (M3/(S.PA^N) =	0.0305	0.0305
FLOW EXPONENT (--) =	0.720	0.720
LOCATION OF VCL BELOW CHIM TOP=	2.80	2.80(m)

FRESH AIR INTAKE TO THE FIREBOX

----- NONE -----

APPENDIX D.2

SAMPLE PRESSURE PARAMETER SUMMARY OUTPUT

MODEL OF THE TRANSIENT PERFORMANCE OF A WOODBURNING DEVICE AND A CHIMNEY IN NON-DESIGN FLOW CONDITIONS

PROGRAM DEVELOPED BY: SCANADA CONSULTANTS LIMITED
FOR:CANADA MORTGAGE AND HOUSING CORPORATION
DATE:1984,1986

C A S E: WOOD BURNING - DEFAULT FILE FOR FIREPLACE DATE: 07-15-1987

TIME	NET BUOYANCY	WIND EFFECT	ENVELOPE LOSS	FRICTION LOSS	NET DRIVING	FIREBOX BUOY.	INLET DROP	OUTLET DROP	NET FIREBOX	DILUTION
0.0	0.277	11.187	-3.437	-7.736	0.292	-0.030	-0.008	-0.254	-0.292	-0.292
0.5	0.407	11.187	-3.170	-8.168	0.256	-0.011	-0.007	-0.238	-0.256	-0.256
1.0	0.629	11.187	-3.221	-8.332	0.263	-0.014	-0.007	-0.241	-0.262	-0.263

******* THE WOOD PILE WILL BE LIT AT 1.41 SECONDS *******

S Y S T E M P A R A M E T E R S

ENVELOPE ADVERSE PRESS.(FANS & FIREPLACE)	(PA):	0
WIND INDUCED DRIVING PRESSURE	(PA):	11.19
NET BOUNDARY DRIVING PRESSURE	(PA):	11.19
CHIMNEY/HOUSE BUOYANCY PRESSURE AT STANDBY	(PA):	1.08
NET DRIVING PRESSURE PARAMETER (AT STANDBY)	(PA):	12.27
FIREBOX EQUIVALENT LEAKAGE AREA OF FLOW	(m2):	.041
CHIMNEY EQUIVALENT LEAKAGE AREA OF FLOW	(m2):	.043
E.L.A. OF UPPER OPENING OR OF DOORS	(m2):	.133
ENVELOPE EQUIVALENT LEAKAGE AREA AT 10 PA	(m2):	.066
CHIMNEY LINER HEAT TRANSFER TIME CONSTANT	(S):	2159.4

FLUE LOCATION: EXTERIOR
CHIMNEY FLOW DIRECTION AT STANDBY: UPWARD (1.52 M/S)

C A S E: WOOD BURNING - DEFAULT FILE FOR FIREPLACE DATE: 07-15-1987

TIME	NET BUOYANCY	WIND EFFECT	ENVELOPE LOSS	FRICTION LOSS	NET DRIVING	FIREBOX BUOY.	INLET DROP	OUTLET DROP	NET FIREBOX	DILUTION
1.4	0.833	11.187	-3.267	-8.486	0.268	-0.013	-0.008	-0.247	-0.268	-0.268
1.9	1.180	11.187	-3.268	-8.965	0.134	0.921	-0.027	-1.027	-0.133	-0.133
2.3	1.681	11.187	-3.209	-9.545	0.114	1.136	-0.030	-1.219	-0.114	-0.114
2.7	2.256	11.187	-3.238	-10.093	0.112	1.216	-0.031	-1.298	-0.113	-0.112
3.1	3.009	11.187	-3.337	-10.739	0.120	1.250	-0.032	-1.337	-0.120	-0.120
3.5	3.795	11.187	-3.500	-11.347	0.135	1.266	-0.033	-1.368	-0.135	-0.135
3.8	4.547	11.187	-3.613	-11.975	0.146	1.275	-0.033	-1.388	-0.146	-0.146
4.2	5.232	11.187	-3.766	-12.492	0.161	1.280	-0.034	-1.408	-0.161	-0.161
4.6	5.819	11.187	-3.907	-12.924	0.176	1.285	-0.034	-1.426	-0.176	-0.176
4.9	6.305	11.187	-4.023	-13.280	0.188	1.288	-0.034	-1.442	-0.189	-0.189
5.2	6.687	11.187	-4.080	-13.599	0.195	1.291	-0.035	-1.451	-0.195	-0.195
5.6	6.975	11.187	-4.142	-13.818	0.202	1.293	-0.035	-1.459	-0.202	-0.202
5.9	7.181	11.187	-4.186	-13.976	0.206	1.294	-0.035	-1.466	-0.207	-0.206
6.2	7.325	11.187	-4.217	-14.086	0.210	1.295	-0.035	-1.470	-0.210	-0.210
6.6	7.420	11.187	-4.210	-14.188	0.209	1.296	-0.035	-1.471	-0.209	-0.209
6.9	7.480	11.187	-4.218	-14.239	0.210	1.297	-0.035	-1.471	-0.209	-0.210
7.2	7.516	11.187	-4.225	-14.267	0.211	1.297	-0.035	-1.473	-0.211	-0.211
7.5	7.538	11.187	-4.230	-14.284	0.211	1.298	-0.035	-1.473	-0.210	-0.211
7.9	7.550	11.187	-4.232	-14.293	0.212	1.298	-0.035	-1.474	-0.211	-0.212
8.2	7.556	11.187	-4.233	-14.299	0.212	1.299	-0.035	-1.475	-0.212	-0.212
8.5	7.560	11.187	-4.233	-14.302	0.212	1.300	-0.035	-1.476	-0.211	-0.212
8.9	7.562	11.187	-4.233	-14.304	0.212	1.300	-0.035	-1.476	-0.211	-0.212
9.2	7.563	11.187	-4.233	-14.305	0.212	1.301	-0.035	-1.476	-0.211	-0.212
9.5	7.565	11.187	-4.233	-14.307	0.212	1.301	-0.035	-1.477	-0.211	-0.212
9.8	7.568	11.187	-4.233	-14.310	0.212	1.302	-0.035	-1.477	-0.211	-0.212
10.2	7.570	11.187	-4.233	-14.312	0.212	1.302	-0.035	-1.479	-0.211	-0.211
10.5	7.574	11.187	-4.234	-14.316	0.211	1.303	-0.035	-1.479	-0.211	-0.211
13.8	7.621	11.187	-4.240	-14.356	0.212	1.309	-0.035	-1.485	-0.211	-0.212
17.0	7.675	11.187	-4.247	-14.403	0.213	1.316	-0.035	-1.493	-0.212	-0.212
20.3	7.734	11.187	-4.256	-14.453	0.212	1.323	-0.035	-1.501	-0.213	-0.213
23.5	7.796	11.187	-4.264	-14.506	0.213	1.331	-0.036	-1.508	-0.213	-0.213
26.8	7.861	11.187	-4.273	-14.561	0.214	1.339	-0.036	-1.517	-0.214	-0.214
30.0	7.929	11.187	-4.282	-14.619	0.215	1.347	-0.036	-1.526	-0.214	-0.215
33.2	8.000	11.187	-4.292	-14.680	0.215	1.356	-0.036	-1.535	-0.215	-0.215
36.5	8.074	11.187	-4.302	-14.744	0.215	1.366	-0.036	-1.545	-0.216	-0.216
39.7	8.151	11.187	-4.312	-14.808	0.218	1.375	-0.036	-1.556	-0.217	-0.217
42.8	9.587	11.187	-4.443	-16.108	0.223	1.604	-0.039	-1.788	-0.223	-0.223
45.8	10.177	11.187	-4.558	-16.570	0.236	1.626	-0.039	-1.823	-0.236	-0.236
48.7	10.550	11.187	-4.443	-17.075	0.218	1.817	-0.040	-1.997	-0.219	-0.218

APPENDIX D.3

SAMPLE SECONDARY OUTPUT
(.PR2 FILE)

C A S E: WOOD BURNING - DEFAULT FILE FOR FIREPLACE DATE: 07-15-1987

TIME (s)	BURN RATE (kW)	TEMPERATURES FRONT	WALL BACK	SIDE	FLOOR	MID WALL BACK	SIDE	BACK WALL BACK	SIDE	RAD HEAT TO HOUSE (Whr)	FLAME TEMP (C)	HEAT-AIR TRANSFER	FLUE ENERGY(Wh)	FLAME RAD. (Wh)	WOOD RAD. (Wh)
0.0	0.0	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	0.0	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	-0.0	0.0	0.0	0.0	0.0	0.0
1.0	0.0	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	-0.0	0.0	0.0	0.0	0.0	0.0

C A S E: WOOD BURNING - DEFAULT FILE FOR FIREPLACE DATE: 07-15-1987

TIME (s)	BURN RATE (kW)	TEMPERATURES FRONT	WALL BACK	SIDE	FLOOR	MID WALL BACK	SIDE	BACK WALL BACK	SIDE	RAD HEAT TO HOUSE (Whr)	FLAME TEMP (C)	HEAT-AIR TRANSFER	FLUE ENERGY(Wh)	FLAME RAD. (Wh)	WOOD RAD. (Wh)
1.4	0.0	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	-0.0	300.0	0.0	0.0	0.0	0.0
1.9	3.4	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	0.0	1200.0	0.2	0.1	0.1	0.0
2.3	9.5	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	0.0	1200.0	0.9	0.5	0.4	0.0
2.7	11.5	20.0	16.0	16.0	20.0	13.0	13.0	6.0	6.0	0.0	1200.0	1.7	1.0	0.7	0.0
3.1	12.3	20.0	16.0	16.0	20.1	13.0	13.0	6.0	6.0	0.1	1200.0	2.5	1.4	1.1	0.0
3.5	12.7	20.0	16.0	16.0	20.1	13.0	13.0	5.9	5.9	0.1	1200.0	3.3	1.9	1.5	0.1
3.8	12.9	20.0	16.1	16.0	20.1	13.0	13.0	5.9	5.9	0.1	1200.0	4.1	2.3	1.8	0.1
4.2	13.0	20.0	16.1	16.0	20.1	13.0	13.0	5.9	5.9	0.2	1200.0	4.9	2.7	2.2	0.1
4.6	13.1	20.0	16.1	16.0	20.2	13.0	13.0	5.9	5.9	0.2	1200.0	5.7	3.2	2.5	0.1
4.9	13.2	20.0	16.1	16.1	20.2	13.0	13.0	5.9	5.9	0.2	1200.0	6.4	3.6	2.8	0.1
5.2	13.3	20.0	16.1	16.1	20.2	13.0	13.0	5.9	5.9	0.2	1200.0	7.2	4.0	3.2	0.1
5.6	13.3	20.0	16.1	16.1	20.2	13.0	13.0	5.9	5.9	0.3	1200.0	7.9	4.4	3.5	0.1
5.9	13.4	20.0	16.1	16.1	20.2	13.0	13.0	5.9	5.9	0.3	1200.0	8.6	4.8	3.8	0.1
6.2	13.4	20.0	16.1	16.1	20.3	13.0	13.0	5.9	5.9	0.3	1200.0	9.4	5.2	4.1	0.1
6.6	13.4	20.0	16.2	16.1	20.3	13.0	13.0	5.9	5.9	0.3	1200.0	10.1	5.6	4.4	0.2
6.9	13.4	20.0	16.2	16.1	20.3	13.0	13.0	5.9	5.9	0.3	1200.0	10.8	6.0	4.8	0.2
7.2	13.4	20.0	16.2	16.1	20.3	13.0	13.0	5.9	5.9	0.4	1200.0	11.5	6.4	5.1	0.2
7.5	13.5	20.0	16.2	16.1	20.3	13.0	13.0	5.9	5.9	0.4	1200.0	12.2	6.8	5.4	0.2
7.9	13.5	20.0	16.2	16.1	20.4	13.0	13.0	5.9	5.9	0.4	1200.0	13.0	7.2	5.7	0.2
8.2	13.5	20.0	16.2	16.1	20.4	13.0	13.0	5.9	5.9	0.4	1200.0	13.7	7.7	6.0	0.2
8.5	13.5	20.0	16.2	16.1	20.4	13.0	13.0	5.9	5.9	0.5	1200.0	14.4	8.1	6.3	0.2
8.9	13.5	20.0	16.2	16.1	20.4	13.0	13.0	5.9	5.9	0.5	1200.0	15.1	8.5	6.7	0.2
9.2	13.5	20.0	16.2	16.1	20.4	13.0	13.0	5.9	5.9	0.5	1200.0	15.8	8.9	7.0	0.2
9.5	13.5	20.0	16.2	16.1	20.5	13.0	13.0	5.9	5.9	0.5	1200.0	16.6	9.3	7.3	0.3
9.8	13.5	20.0	16.3	16.1	20.5	13.0	13.0	5.9	5.9	0.6	1200.0	17.3	9.7	7.6	0.3
10.2	13.5	20.0	16.3	16.1	20.5	13.0	13.0	5.9	5.9	0.6	1200.0	18.0	10.1	7.9	0.3
10.5	13.5	20.0	16.3	16.1	20.5	13.0	13.0	5.9	5.9	0.6	1200.0	18.7	10.5	8.2	0.3
13.8	13.5	20.0	16.4	16.2	20.7	13.0	13.0	5.8	5.8	0.8	1200.0	26.0	14.5	11.5	0.4
17.0	13.6	20.0	16.5	16.3	20.9	13.0	13.0	5.8	5.8	1.1	1200.0	33.3	18.6	14.7	0.6
20.3	13.7	20.0	16.6	16.3	21.1	13.0	13.0	5.8	5.8	1.3	1200.0	40.7	22.8	17.9	0.7
23.5	13.7	20.0	16.7	16.4	21.3	13.0	13.0	5.7	5.7	1.6	1200.0	48.2	27.0	21.2	0.9
26.8	13.8	20.0	16.8	16.4	21.5	13.0	13.0	5.7	5.7	1.9	1200.0	55.8	31.2	24.6	1.1
30.0	13.9	20.0	16.9	16.5	21.8	13.0	13.0	5.7	5.7	2.1	1200.0	63.4	35.5	27.9	1.3
33.2	13.9	20.0	17.1	16.5	22.0	13.0	13.0	5.7	5.7	2.4	1200.0	71.2	39.8	31.4	1.5
36.5	14.0	20.0	17.2	16.6	22.2	13.0	13.0	5.6	5.6	2.7	1200.0	79.0	44.2	34.8	1.8
39.7	14.1	20.0	17.3	16.7	22.4	13.0	13.0	5.6	5.6	2.9	1200.0	87.0	48.6	38.3	2.1
42.8	23.9	20.0	17.4	16.7	22.7	13.0	13.0	5.6	5.6	3.3	1200.0	97.0	54.3	42.7	2.4
45.8	24.2	20.0	17.6	16.8	23.0	13.0	13.0	5.6	5.6	3.7	1200.0	107.7	60.2	47.4	2.7
48.7	36.1	20.0	17.7	16.9	23.4	13.0	13.0	5.5	5.5	4.1	1200.0	119.1	66.6	52.5	3.1
50.1	38.0	20.0	17.9	17.0	23.6	13.0	13.0	5.5	5.5	4.3	1200.0	126.2	70.6	55.6	3.3

APPENDIX E

DEFINITION OF OUTPUT HEADINGS

DETAILED SUMMARY

Time (s)
- the simulation time expressed in seconds

Burn rate(kW)
- total instantaneous heat release rate of the woodpile

Firebox flow (L/s)
- the volumetric flow rate of air and combustion gases through the firebox

Dilution flow (L/s)
- the volumetric flow of air through the dilution device. Under normal operating conditions it is positive, but under spillage conditions the dilution flow is negative.

Chimney flow (L/s)
- the volumetric flow of combustion gases and dilution air up the chimney. When that quantity is positive, the flue gases are flowing upwards. When it is negative, backdrafting is indicated.

Incremental envelope flow (L/s)
- the total volumetric flow of air leakage through the envelope

Envelope pressure drop (Pa)
- the resulting house depressurization due to the incremental envelope flow

Firebox Wall Temperature
- the average temperature of the first element of the fireplace liner on the back wall

Firebox exit temperature (°C)
- the temperature of the exhausting combustion gas (i.e. stack gas temperature) just before the gas has mixed with the dilution air

Mixing temperature (°C)
- the temperature of the flue gas after mixing with the dilution air from the dilution port. When there is spillage occurring and positive flue flow, the mixing temperature is the same as the firebox exit temperature. When there is no spillage, then the mixing temperature is generally lower than the firebox exit temperature.

Mean flue gas temperature (°C)
- the temperature of the flue gas that would result in the same total gas column weight as the sum of the actual column

weights of all the vertical elements of flue gas (i.e. the mean flue gas temperature corresponds to the true mean density of the flue gas)

Gas exit temperatures (°C)
- the temperature of the flue gas in the last element at the top of the flue

Mean flue liner temperature (°C)
- the arithmetic mean of the liner temperatures all the way up the flue (including flue pipe or vent connector elements)

Efficiency (%)
- the quantity of heat transferred from the woodpile to the air that falls on surrounding surfaces divided by the total heat generated by the woodpile (i.e it is that quantity of heat that does not go up the flue). When there is no fire, this quantity is automatically set to 100%.

Flue film heat loss coefficient ($W/m^2°C$)
- the heat loss coefficient through the boundary layer separating the main stream of the flue gas and the liner surface of the flue. It is the average of all the heat transfer coefficients from the base of the chimney to the top.

Flue pipe and flue friction factor (non-dimensional)
- the sum of all friction factors including entrance losses, elbows, length friction losses and exit losses at the chimney top

SYSTEM PARAMETERS AT THE TIME WHEN THE FIRE IS LIT

Envelope adverse pressure (fans and furnace) (Pa)
- the total induced pressure drop across the envelope of the house due to exhaust fan and furnace operation

Wind induced driving pressure (Pa)
- the net driving pressure resulting from all wind effects including vertical and horizontal wind components acting at the chimney top and the horizontal wind component acting on the envelope of the house

Net boundary driving pressure (Pa)
- the summation of the envelope adverse pressure and the wind induced driving pressure

Chimney house buoyancy pressure at standby (Pa)
- the net buoyancy in the chimney minus the net buoyancy of the house air at standby. (The net buoyancy of the house air is the buoyancy of the column of house air measured from the dilution device to the envelope's vertical centre of leakage.)

Net driving pressure parameter (Pa)
- the summation of all driving and resisting pressures in the flue/house/outdoor chimney loop

Firebox equivalent leakage area of flow (m^2)
- the effective sharp-edged orifice area of the flow paths in the firebox including the entrance and exit openings of the firebox.

Chimney equivalent leakage area of flow (m^2)
- the effective sharp-edged orifice area of the flow paths in the chimney and flue pipe, including all elbows, entrance and exit losses

ELA of reverse flow of the dilution port (m)
- the effective sharp-edged orifice area of the dilution port when the flow is reversing through it. This is used in the calculation of spillage flow rates when the flow is spilling or backdrafting.

Envelope equivalent leakage area at 10 Pa
- the ELA of the house as determined by a CGSB standard test in accordance with CAN/CGSB - 149.10-M, "Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method".

Chimney liner heat transfer time constant (s)
- the mass of the chimney liner divided by the coefficient of heat transfer into that chimney liner from the flue gas

PHYSICAL CHARACTERISTICS OF THE SYSTEM

Note: The physical characteristics of the system are specified for 19 points in the flue, envelope and fireplace flow systems. These 19 points are shown in Figure E.1 of the accompanying diagram.

Distance (datum) (m)
- distance between each calculation point and the top of the flue or chimney

Area of opening (m^2)
- the actual area of the various openings in the flow system

K factor (normal)
- friction factor for normal flow in each element of the mass flow system. Elements 3 and 4 in the mass flow network are the flue and flue pipe. The friction factors shown for points 3 and 4 are the values calculated on the final time step of the run.

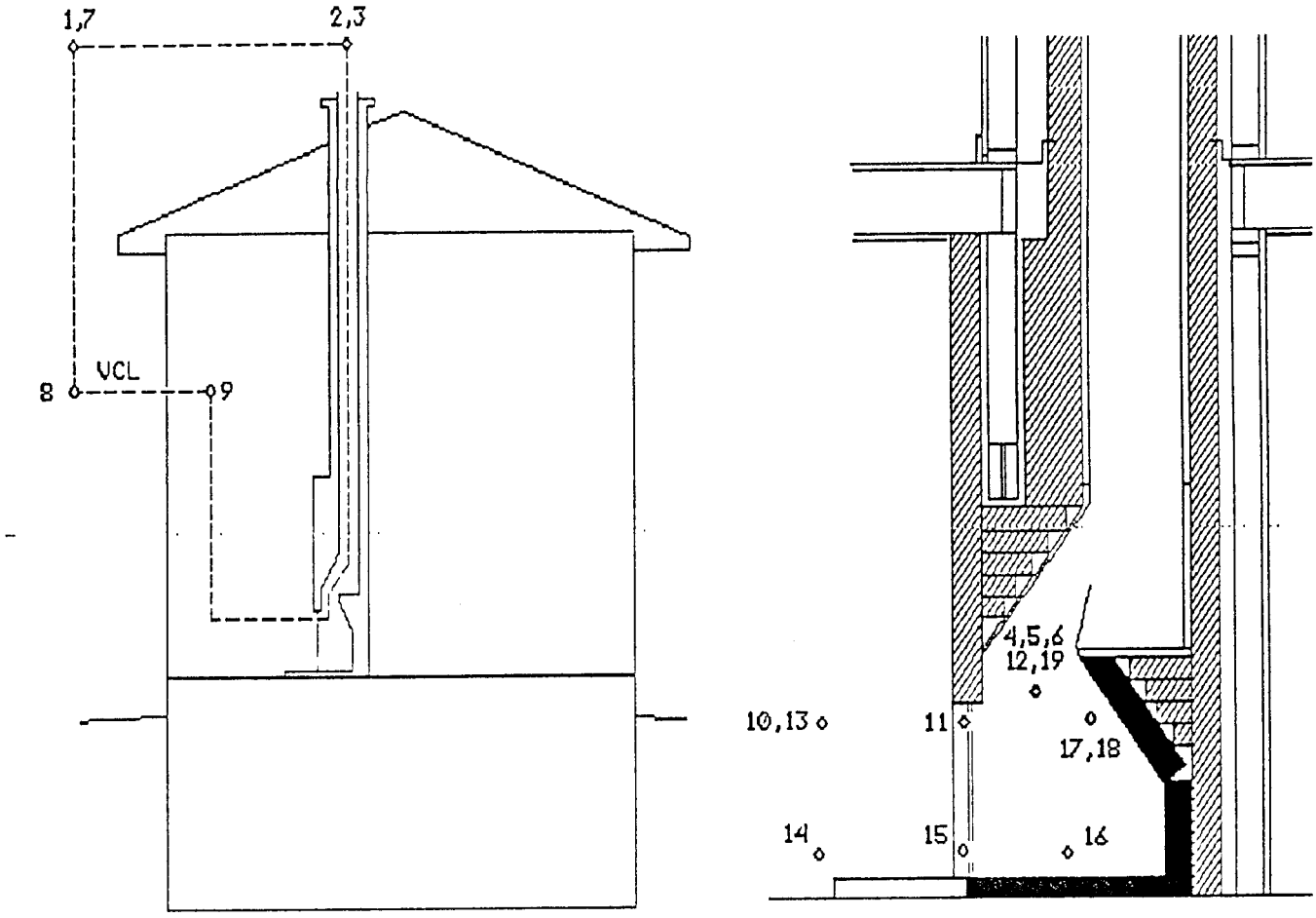


FIGURE E.1: Calculation points

TEMPERATURES OF THE FLUE GAS, LINER AND STRUCTURE

(Note: There are 10 or more elements up the flue pipe and flue depending on the number of flue pipe segments chosen. The flue pipe segments are indicated by "FP" and the flue segments are indicated by "F" in the table.)

Flue gas temperature (°C)
- the temperature of the centre core of the flue gas in each element of the flue

Inner liner temperature (°C)
- the temperature of the inner-most mass element of the chimney assembly

Insulation or structure temperature (°C)
- the temperature of the next mass element in the chimney assembly

Outer structure temperature (°C)
- the temperature of the outer-most mass element in the chimney assembly

Surrounding temperature (°C)
- the temperature of the interior or exterior air surrounding the flue pipe or chimney elements

MASS FLOW SYSTEMS PARAMETERS

(Note: The properties and mass flow results in the mass flow pressure parameter model are reported in this category for all 19 calculation points in the mass flow network - see Figure E.1.)

Temperature (°C)
- the temperature of the air or the combustion gas for each calculation point

Density (kg/m^3)
- the density of the air or the combustion gas at each calculation point

Mass flow (kg/s)
- the mass flow rate through the openings at each calculation point

Volume flow (m^3/s)
- the volumetric flow rate that corresponds to the mass flow rate at each point. It is calculated by dividing the mass flow by the density

Flow velocity (m/s)
- the air or gas velocity at each point. It is calculated by dividing the volumetric flow by the effective cross sectional area of the opening. The quantity is reported to be zero in areas where the opening is a plenum; i.e. for outdoor elements or points within the house.

PRESSURE PARAMETERS OF THE FLOW SYSTEMS

Net buoyancy (Pa)
- the net buoyancy of the chimney minus the net buoyancy of the air inside the house envelope. (The net buoyancy of the house air is the buoyancy of the column of house air measured from the dilution device to the envelope's vertical centre of leakage.)

Wind effect (Pa)
- the summation of all driving and retarding wind effects in the system

Envelope loss (Pa)
- the friction loss of the air being drawn through the envelope. This is the house depressurization at the vertical centre of leakage.

Friction loss (Pa)
- the friction loss in the flue pipe and chimney. It is the pressure drop at all the elements going up the chimney including entrance, elbow, length and exit losses.

Net driving pressure (Pa)
- the net increase in pressure across the operating draft inducer within the venting device

Firebox buoyancy (Pa)
- the total buoyancy of the column of gas in the firebox

Inlet drop (Pa)
- the friction pressure drop at the inlet opening of the firebox

Outlet drop (Pa)
- the friction pressure drop at the exhaust port of the firebox. This is the controlling opening on firebox flow in the firebox. Most of the firebox loss is in the outlet drop.

Net firebox pressure (Pa)
- the summation of firebox buoyancy rise minus the inlet and outlet drops. This number should be negative for proper operation of the system. If the resulting net firebox pressure is positive then this means that the firebox is a better chimney than the chimney itself and this will result in spilled gases.

Pressure across the dilution port (Pa)
- same as the net driving pressure in the firebox and also of opposing sign to the net driving pressure of the chimney. These differing signs are simply due to sign conventions

used in the model, but these three numbers are the same magnitude. The pressure across the dilution port determines, along with the ELA of the dilution port, the flow rate through the dilution port.

SUMMARY TABLE

Outdoor temperature (°C)
- the temperature of outdoor air. A ventilated attic is assumed to be at the outdoor temperature.

Indoor temperature (°C)
- the mean temperature in the house including all upstairs rooms and the basement.

Full firing rate (W)
- the woodpile capacity at steady state operation

Efficiency (%)
- the quantity of heat transferred from the woodpile to the air that falls on surrounding surfaces divided by the total heat generated by the woodpile (i.e it is that quantity of heat that does not go up the flue). When there is no fire, this quantity is automatically set to 100%.

Wind speed and pressure coefficients
- The wind speed horizontal and vertical components (m/s) as reported. Also reported are the wind pressure coefficients (non-dimensional) used with the respective wind speeds to determine the driving and/or reversing pressures due to wind.

Flow rates
- These are presented in volumetric (L/s) and mass flow (kg/s) quantities. They are:
  - The firebox outlet flow is the flow rate of combustion products and excess air at the exit of the firebox.
  - The dilution flow into the hood is the flow rate into the draft hood or barometric damper.
  - The chimney inlet flow is the summation of the firebox outlet flow and the dilution flow.
  - The exhaust fan flow is the summation of all exhaust fan flow rates (specified by the user).
  - Flow from competing chimneys is the net flow rate of the furnace chimney or other chimneys at steady state operation.
    These are kept constant for a run of the program.
  - The net additional envelope flow is the increase in air flow through the envelope due to the flue flow, the exhaust fan flow and the fireplace flow. The outdoor temperature is used to normalize the numbers.
  - The induced pressure drop across the envelope is the pressure drop due to friction losses which result from the incremental envelope flow.

Temperatures (°C)

- The air temperature above the flame is the predicted temperature rise of the combustion air that passes through the woodpile just before it mixes with convection air passing over the firebox wall surfaces.
- The firebox exit temperature is the temperature of the flue gas at the top of the firebox after it has mixed with air that passed over the firebox wall surfaces.
- The flue gas temperature after dilution is the temperature after mixing of the firebox stack gas and the dilution air.
- The mean flue gas temperature is the temperature of the flue gas that would result in the same total gas column weight as the sum of the actual column weights of all the vertical elements of flue gas (i.e. the mean flue gas temperature corresponds to the true mean density of the flue gas).
- The mean flue liner temperature is the arithmetic mean of the liner temperatures all the way up the flue (including flue pipe or vent connector elements)

THERMAL CHARACTERISTICS OF THE CHIMNEY

This data specifies the various properties of the structure of the flue and chimney. These are modelled as a series of cylindrical elements joined end-to-end. Each element is further subdivided, for the purpose of modelling outward heat flow, into a series of concentric cylindrical elements. The properties described below are related to each of these concentric cylindrical elements and the radial heat flow into each from the next inward element and out of each to the next outward element.

Heat Transfer Coefficient ($W/m^2.C$)
- the heat transfer coefficient of the materials of which each element is composed

Elemental surface area (m^2)
- the surface area normal to the radial heat flow

Elemental mass (kg)
- the mass of each element

Heat capacity of the material (J/kg.C)
- the specific heat of the material of which each element is composed

Heat transfer time constant (OUT) (s)
- the mass of an element divided by the coefficient of heat transfer to the next outward element multiplied by the area through which heat transfer occurs (normally equal to the elemental surface area)

Heat transfer time constant (IN) (s)
- the mass of an element divided by the coefficient of heat transfer from the next inward element multiplied by the area through which heat transfer occurs (normally equal to the elemental surface area)

ENVELOPE CHARACTERISTICS

Three envelope characteristics are given:

Flow coefficient ($m^3/s\ Pa^n$) and **Flow exponent**
- These characteristics of the envelope are determined by a CGSB Airtightness Test. These numbers are shown for the envelope both without an air intake and with an air intake, if any.

Location of the vertical centre of leakage
- below the chimney top is also given with respect to the envelope without an air intake and with an air intake. The overall effect of the air intake in terms of increased ELA and lowering of the vertical centre of leakage can be observed in this tabular output. (See the Glossary of Terms for definition of vertical centre of leakage.)

Combustion Air Intakes to the Envelope and Firebox
- this is the area of the combustion air intakes, if any to the house and firebox.

PRESSURE PARAMETER SUMMARY

The pressure parameter summary is simply a printout of the **PRESSURE PARAMETERS OF THE FLOW SYSTEMS**, discussed above, at specified print intervals. It replaces the **DETAILED SUMMARY** printout. The description of the headings were discussed above.

SECONDARY OUTPUT (.PR2) FILE

This secondary output file contains information on temperature gradients through the firebox walls and surrounding structure as well as cumulative data on the energy released during the wood burning process.

Wall surface temperatures
- this is the temperature of the first node in the firebox wall.

Mid wall temperatures
- this is the temperature of the fourth node in the firebox wall or surrounding enclosure

Back wall temperatures
- this is the temperature of the last or exterior node of the firebox wall or surrounding enclosure

Radiant heat to house
- this is the cumulative energy that is released through the front opening of the fireplace

Flame temperature
- a fixed value for the temperature of the flame set at 1200°C

Heat-Air transfer
- the cumulative fraction of combustion energy that is transferred to the flame

Flue energy
- the cumulative net residual energy that leaves the flame and is lost up the flue

Flame radiation
- the cumulative radiant energy from the flame that falls on the firebox wall surfaces

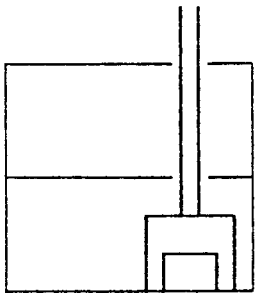
Wood radiation
- the cumulative radiant energy released by the wood that falls on the firebox wall surfaces

APPENDIX F

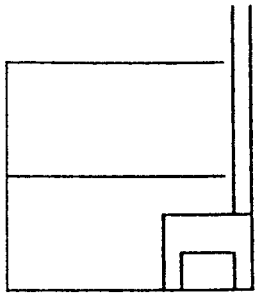
INPUT DATA FORMS

FIREPLACE OR WOOD STOVE AND CHIMNEY LOCATION SELECTION

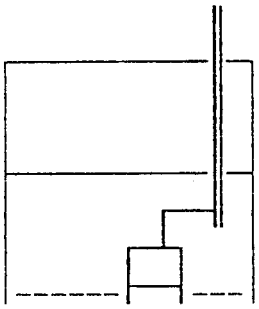
#1-Fireplace With Interior Chimney



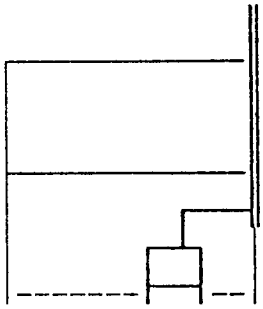
#2-Fireplace With Exterior Chimney



#3-Woodstove With Interior Chimney

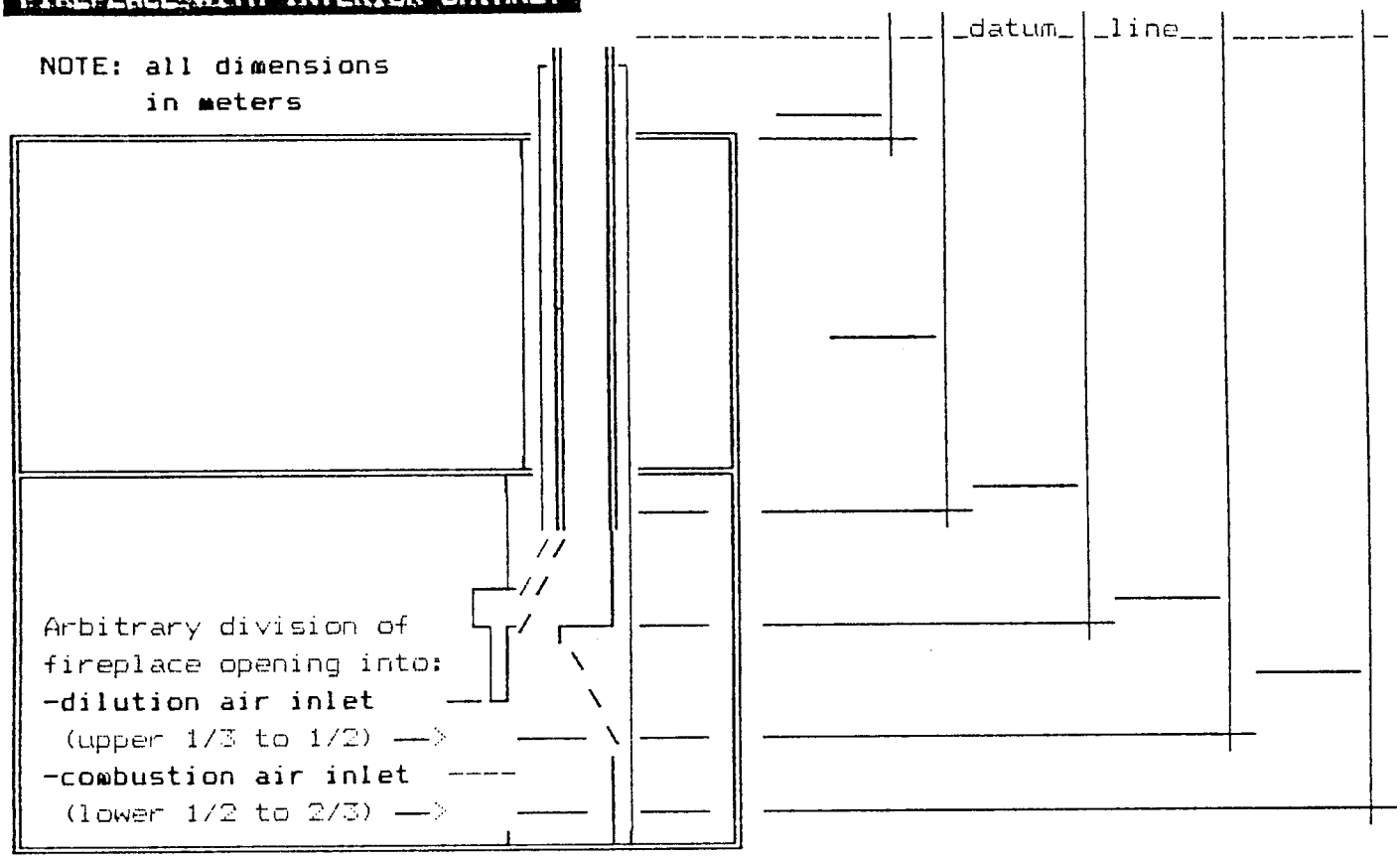


#4-Woodstove With Exterior Chimney

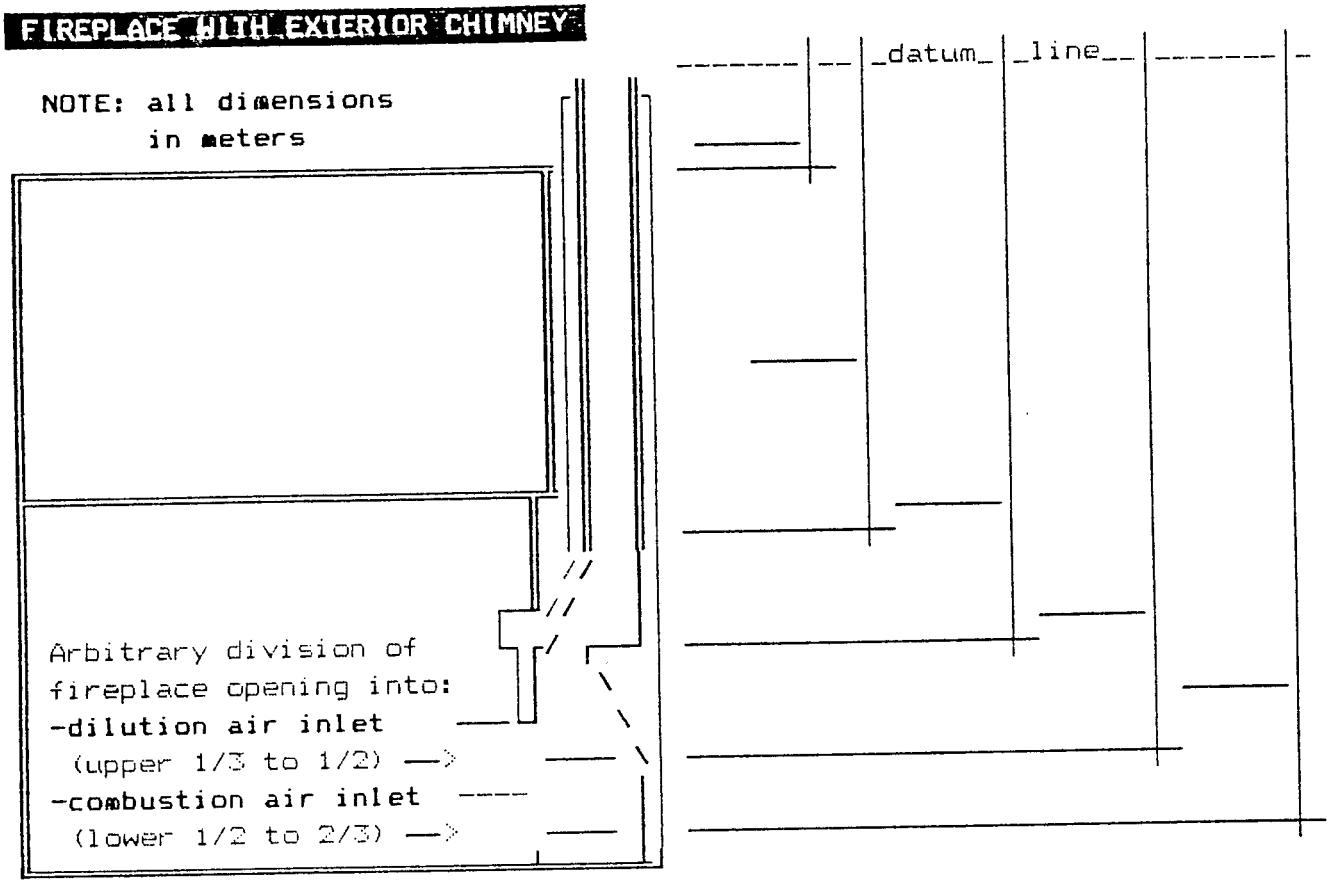


ENTER YOUR SELECTION #(1,2,3 or 4): _

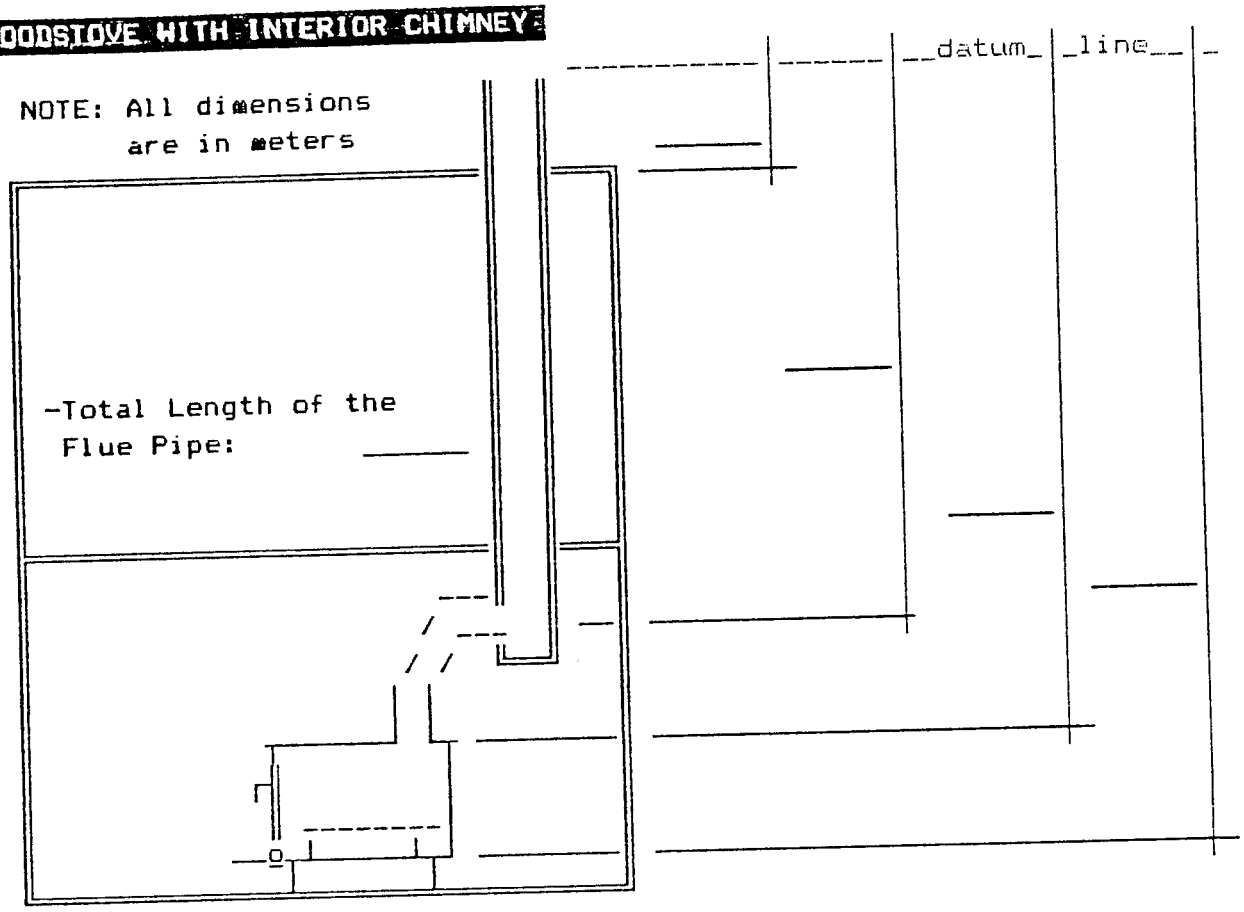
FIREPLACE WITH INTERIOR CHIMNEY



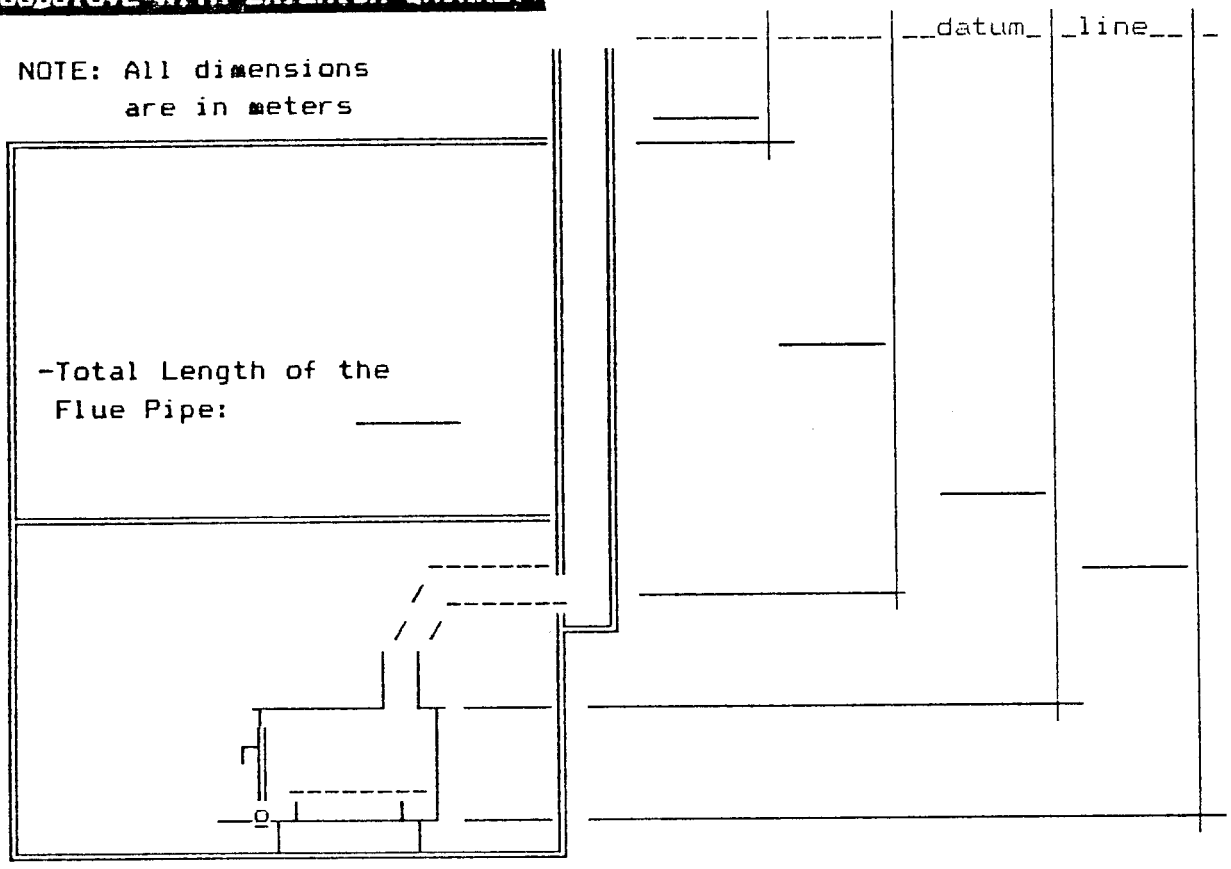
FIREPLACE WITH EXTERIOR CHIMNEY



WOODSTOVE WITH INTERIOR CHIMNEY

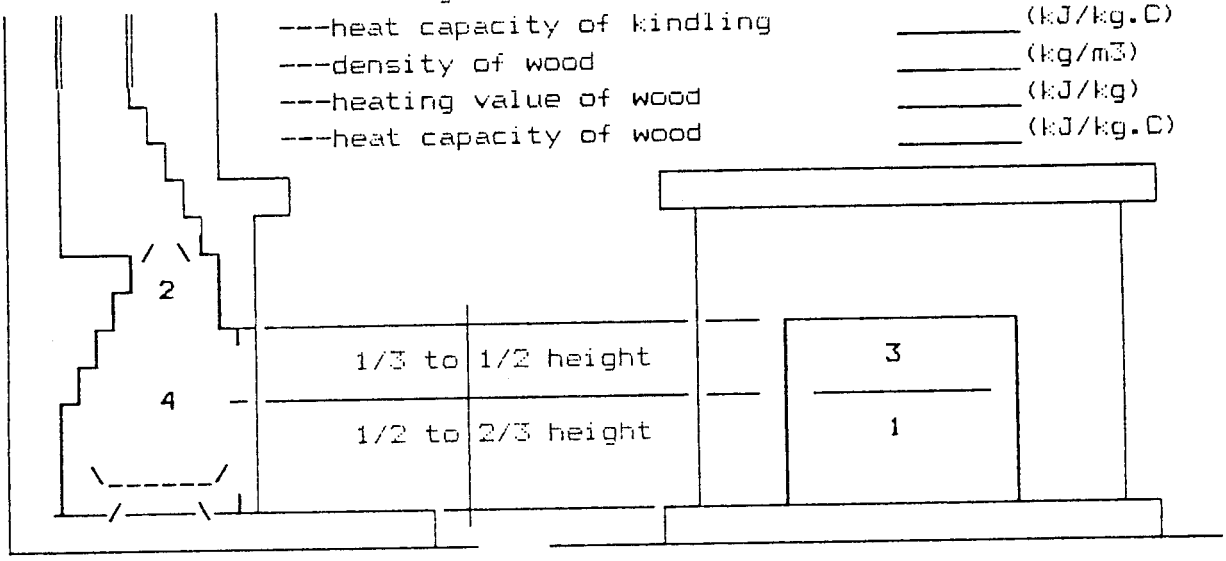


WOODSTOVE WITH EXTERIOR CHIMNEY



FIREPLACE AND WOOD CHARACTERISTICS

FIREPLACE: -1-Combustion air inlet _____ (m2)
-2-opening at firebox exit _____ (m2)
-3-dilution opening _____ (m2)
-4-firebox volume _____ (m3)
WOOD: ---density of kindling _____ (kg/m3)
---heating value of kindling _____ (kJ/kg)
---heat capacity of kindling _____ (kJ/kg.C)
---density of wood _____ (kg/m3)
---heating value of wood _____ (kJ/kg)
---heat capacity of wood _____ (kJ/kg.C)



FIREPLACE SECTION

FIREPLACE ELEVATION

FIREPLACE TYPE SELECTION

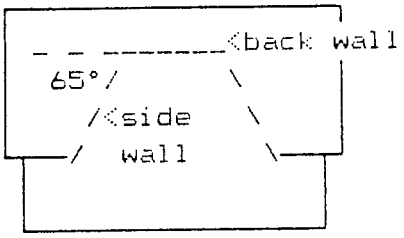
Fireplace type; (F,M,L)

-F factory built metal unit,
-M masonry,
-L masonry with metal firebox liner _

Fireplace doors; (Y,N) _

Angle of side walls:

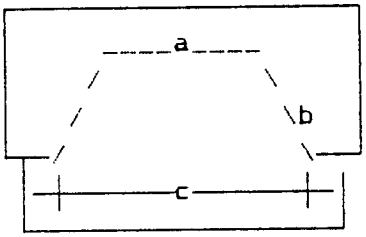
-angle between firebox side and back walls (45° to 90°) ___(°)



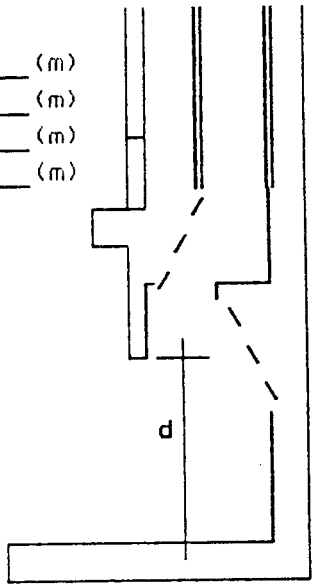
TOP VIEW SECTION THROUGH FIREBOX

Firebox wall dimensions:

a-back wall length _____(m)
b-side wall length _____(m)
c-opening width _____(m)
d-wall height _____(m)

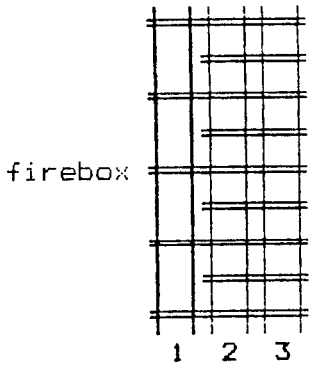


TOP VIEW SECTION THROUGH FIREBOX



SIDE SECTION THROUGH FIREBOX

MASONRY FIREPLACE CHARACTERISTICS



1-fireclay masonry liner
2-inner half of masonry enclosure
3-outer half of masonry enclosure

Element Thickness

1-fireclay brick liner _____ (m)
2-inner half of enclosure _____ (m)
3-outer half of enclosure _____ (m)

Densities

1-fireclay brick liner _____ (kg/m3)
2-inner half of enclosure _____ (kg/m3)
3-outer half of enclosure _____ (kg/m3)

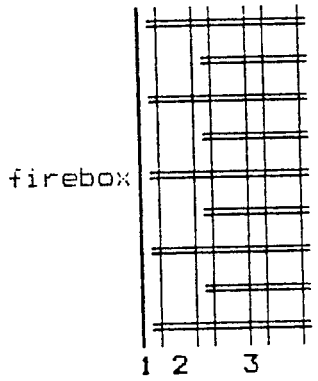
Heat Capacities

1-fireclay brick liner _____ (W.s/kg.C)
2-inner half of enclosure _____ (W.s/kg.C)
3-outer half of enclosure _____ (W.s/kg.C)

Resistivity

1-fireclay brick liner _____ (m2.C/w)
2-inner half of enclosure _____ (m2.C/w)
3-outer half of enclosure _____ (m2.C/w)

MASONRY FIREPLACE WITH METAL FIREBOX LINER CHARACTERISTICS



1-metal liner
2-masonry liner (fireclay or other masonry unit)
3-masonry enclosure (or other element)

Element Thickness

1-metal liner _____ (m)
2-masonry liner _____ (m)
3-enclosure _____ (m)

Densities

1-metal liner _____ (kg/m3)
2-masonry liner _____ (kg/m3)
3-enclosure _____ (kg/m3)

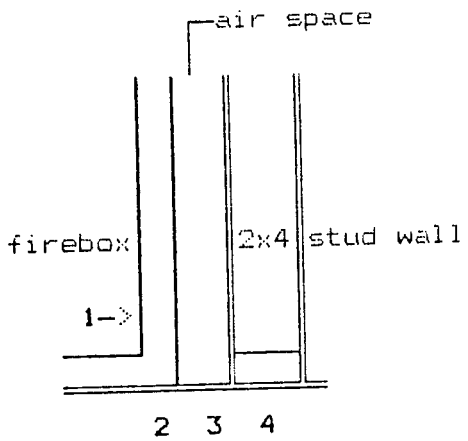
Heat Capacities

1-metal liner _____ (W.s/kg.C)
2-masonry liner _____ (W.s/kg.C)
3-enclosure _____ (W.s/kg.C)

Resistivity

1-metal liner _____ (m2.C/w)
2-masonry liner _____ (m2.C/w)
3-enclosure _____ (m2.C/w)

FACTORY BUILT FIREPLACE CHARACTERISTICS



1-inner liner
2-air or insulation
3-air space
4-enclosure (2x4 stud wall shown, any others can be used)

Is node point 2, Air or Insulation?(A/I) A

Element Thickness

1-inner metal liner	_____	(m)
2-air or insulation	_____	(m)
3-air space	_____	(m)
4-enclosure	_____	(m)

Densities

1-inner metal liner	_____	(kg/m3)
2-air or insulation	_____	(kg/m3)
3-air space	_____	(kg/m3)
4-enclosure	_____	(kg/m3)

Heat Capacities

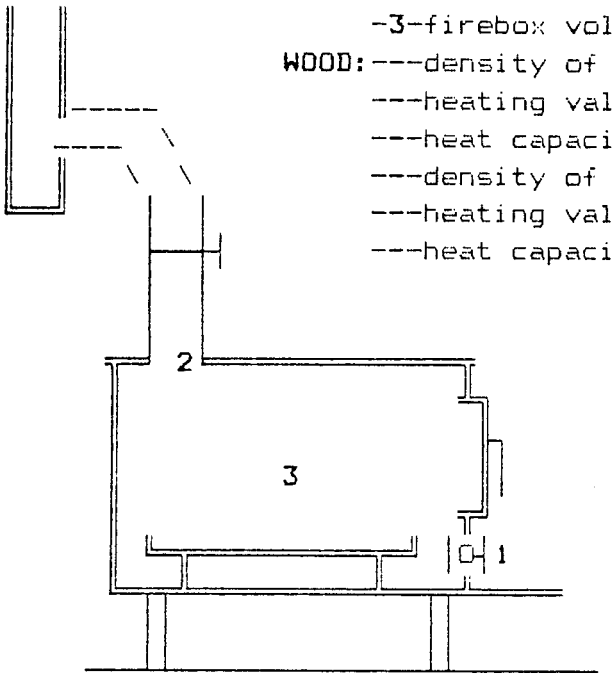
1-inner metal liner	_____	(W.s/kg.C)
2-air or insulation	_____	(W.s/kg.C)
3-air space	_____	(W.s/kg.C)
4-enclosure	_____	(W.s/kg.C)

Resistivity per meter

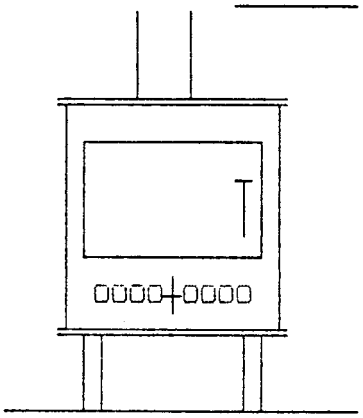
1-inner metal liner	_____	(m2.C/w)
2-air or insulation	_____	(m2.C/w)
3-air space	_____	(m2.C/w)
4-enclosure	_____	(m2.C/w)

WOODSTOVE AND WOOD CHARACTERISTICS

WOODSTOVE:	-1-combustion air inlet	_____ (m2)
	-2-opening at firebox exit	_____ (m2)
	---flue connection leakage area	_____ (m2)
	-3-firebox volume	_____ (m3)
WOOD:	---density of kindling	_____ (kg/m3)
	---heating value of kindling	_____ (kJ/kg) C)
	---heat capacity of kindling	_____ (kJ/kg.C)
	---density of wood	_____ (kg/m3)
	---heating value of wood	_____ (kJ/kg)
	---heat capacity of wood	_____ (kJ/kg.C)



WOODSTOVE SECTION (Side)



WOODSTOVE ELEVATION (front)

WOODSTOVE CHARACTERISTICS

Element 1:
unlined cast iron or steel plate outer shell

Woodstove Areas

- top _____(m2) - back _____(m2)
- sides _____(m2) - floor _____(m2)

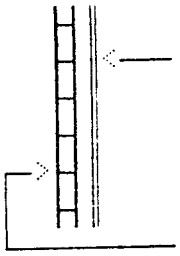
Is There a fireclay liner? (Y/N) _

Element Thickness

1-outer shell _____(m)
2-inside liner (if any) _____(m)

Densities

1-outer shell _____(kg/m3)
2-inside liner (if any) _____(kg/m3)



Element 1:
cast iron or steel plate outer shell

Element 2:
inside fireclay liner

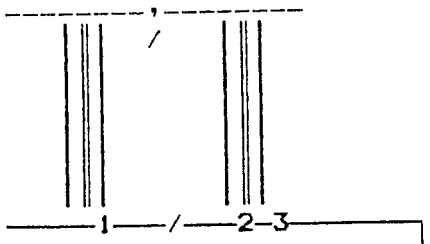
Heat Capacities

1-outer shell _____(W.s/kg.C)
2-inside liner (if any) _____(W.s/kg.C)

Resistivity

1-outer shell _____(m2.C/w)
2-inside liner (if any) _____(m2.C/w)

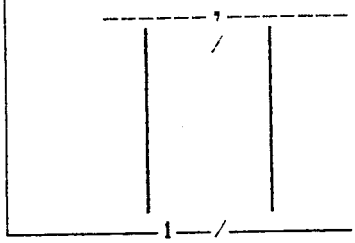
FLUE PIPE / VENT CONNECTOR



Insulated Flue Pipe

NODAL POINTS*

1-inner metal liner
2-insulation/air
3-outer metal casing



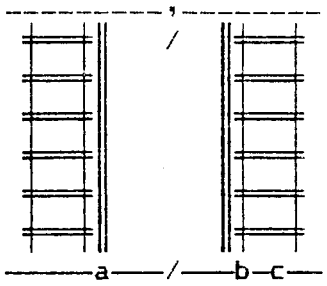
Single walled Flue Pipe*

Open Area of the Flue Pipe	_____ (m2)
Circumference or Perimeter	
1-inner metal liner	_____ (m)
2-insulation	_____ (m)
3-outer metal casing	_____ (m)
Element Thickness	
1-inner metal liner	_____ (m)
2-insulation	_____ (m)
3-outer metal casing	_____ (m)
Densities	
1-inner metal liner	_____ (kg/m3)
2-insulation	_____ (kg/m3)
3-outer metal casing	_____ (kg/m3)
Heat Capacities	
1-inner metal liner	_____ (W.s/kg.C)
2-insulation	_____ (W.s/kg.C)
3-outer metal casing	_____ (W.s/kg.C)
Heat Loss Factors Between:	
-points 1 and 2	_____ (W/m2.C)
-points 2 and 3	_____ (W/m2.C)
-points 3 and surrounding	_____ (W/m2.C)

*For single walled flue pipe enter "0" for all entries of nodal points 2 & 3.

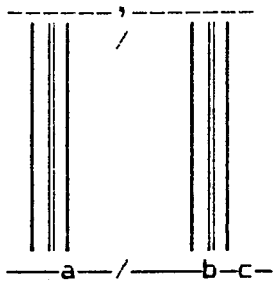
CHIMNEY TYPES

STUDY THE FOUR CHIMNEY SECTIONS BELOW AND SELECT THE TYPE THAT BEST DESCRIBES THE CHIMNEY YOU WANT TO MODEL



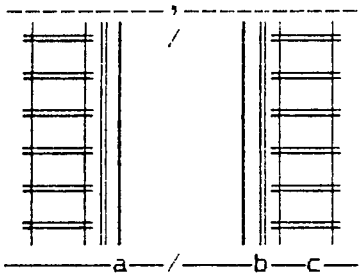
#1 MASONRY

a-clay flue liner
b-air space
c-masonry enclosure



#2 A-VENT

a-inner metal liner
b-insulated cavity
c-outer metal casing

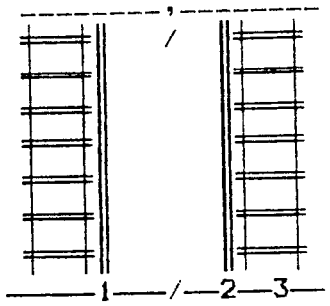


 # 3 MASONRY WITH METAL FLUE LINER

a-metal flue liner
b-clay flue liner
c-masonry enclosure

ENTER YOUR SELECTED CHIMNEY TYPE #_

MASONRY CHIMNEY CHARACTERISTICS

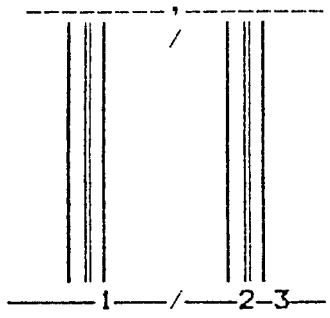


NODAL POINTS

1-inner half of clay liner
2-outer half of clay liner
3-masonry enclosure
(brick or other
masonry products)

Open Area of the Flue	_____ (m2)
Circumference or Perimeter	
1-inner half of liner	_____ (m)
2-outer half of liner	_____ (m)
3-masonry enclosure	_____ (m)
Element Thickness	
1-inner half of liner	_____ (m)
2-outer half of liner	_____ (m)
3-masonry enclosure	_____ (m)
Densities	
1-inner half of liner	_____ (kg/m3)
2-outer half of liner	_____ (kg/m3)
3-masonry enclosure	_____ (kg/m3)
Heat Capacities	
1-inner half of liner	_____ (W.s/kg.C)
2-outer half of liner	_____ (W.s/kg.C)
3-masonry enclosure	_____ (W.s/kg.C)
Heat Loss Factors Between:	
-points 1 and 2	_____ (W/m2.C)
-points 2 and 3	_____ (W/m2.C)
-points 3 and surrounding	_____ (W/m2.C)

A-VENT CHIMNEY CHARACTERISTICS

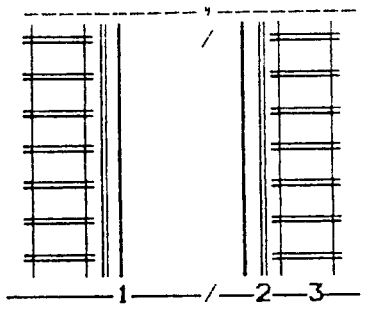


NODAL POINTS

1-inner metal liner
2-insulation
3-outer metal casing

Open Area of the Flue	_____ (m2)
Circumference or Perimeter	
1-inner metal liner	_____ (m)
2-insulation	_____ (m)
3-outer metal casing	_____ (m)
Element Thickness	
1-inner metal liner	_____ (m)
2-insulation	_____ (m)
3-outer metal casing	_____ (m)
Densities	
1-inner metal liner	_____ (kg/m3)
2-insulation	_____ (kg/m3)
3-outer metal casing	_____ (kg/m3)
Heat Capacities	
1-inner metal liner	_____ (W.s/kg.C)
2-insulation	_____ (W.s/kg.C)
3-outer metal casing	_____ (W.s/kg.C)
Heat Loss Factors Between:	
-points 1 and 2	_____ (W/m2.C)
-points 2 and 3	_____ (W/m2.C)
-points 3 and surrounding	_____ (W/m2.C)

MASONRY CHIMNEY WITH METAL FLUE LINER CHARACTERISTICS



NODAL POINTS

1-metal flue liner
2-clay flue liner
3-masonry enclosure
(brick or other
masonry products)

Open Area of the Flue	_____	(m2)
Circumference or Perimeter		
1-metal flue liner	_____	(m)
2-clay flue liner	_____	(m)
3-masonry enclosure	_____	(m)
Element Thickness		
1-metal flue liner	_____	(m)
2-clay flue liner	_____	(m)
3-masonry enclosure	_____	(m)
Densities		
1-metal flue liner	_____	(kg/m3)
2-clay flue liner	_____	(kg/m3)
3-masonry enclosure	_____	(kg/m3)
Heat Capacities		
1-metal flue liner	_____	(W.s/kg.C)
2-clay flue liner	_____	(W.s/kg.C)
3-masonry enclosure	_____	(W.s/kg.C)
Heat Loss Factors Between:		
-points 1 and 2	_____	(W/m2.C)
-points 2 and 3	_____	(W/m2.C)
-points 3 and surrounding	_____	(W/m2.C)

ENVELOPE

Airtightness Characteristics: -flow coefficient: C _____ (m3/s.Pa^n)
(as defined by standard CAN/CGSB-149.10-M86) -flow exponent: n _____ (non dimensional)

Maximum Exhaust Fan Flow Rate: _____ (L/s)

Maximum Flow Rate From Other Chimneys: _____ (L/s)

AMBIENT TEMPERATURE AND WIND SPEED

Outdoor Temperature _____ (C)

Indoor Temperature _____ (C)

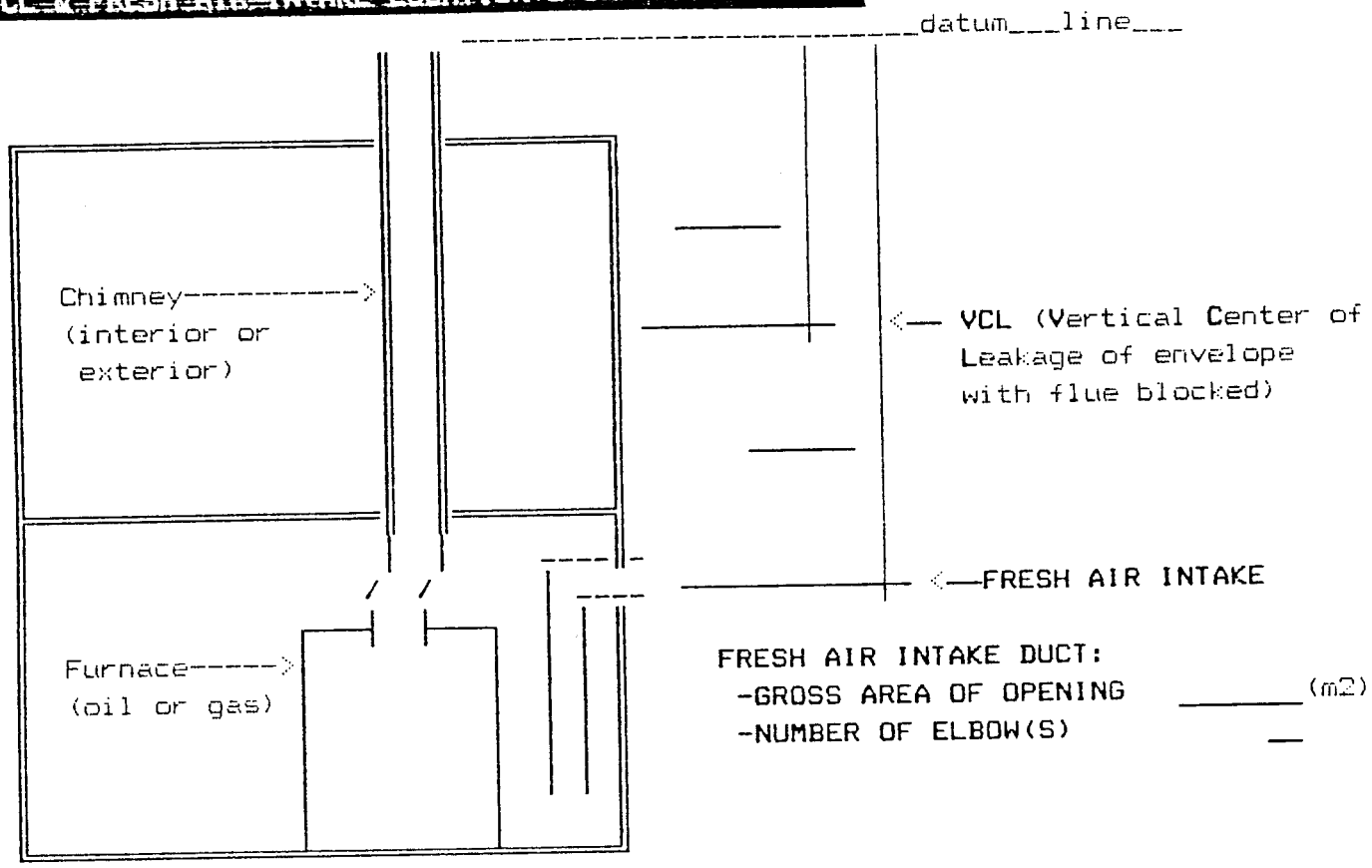
Wind Speeds: -horizontal _____ (m/s)
-vertical _____ (m/s)
(up is +)

INITIAL TEMPERATURES OF ELEMENTS

Initial Flue Temperatures: -flue gas _____ (C)
-nodal point #1 _____ (C)
-nodal point #2 _____ (C)
-nodal point #3 _____ (C)

Initial Temperatures: -walls of woodstove or fireplace _____ (C)
-gas at top of firebox _____ (C)

VCL & FRESH AIR INTAKE LOCATION & CHARACTERISTICS

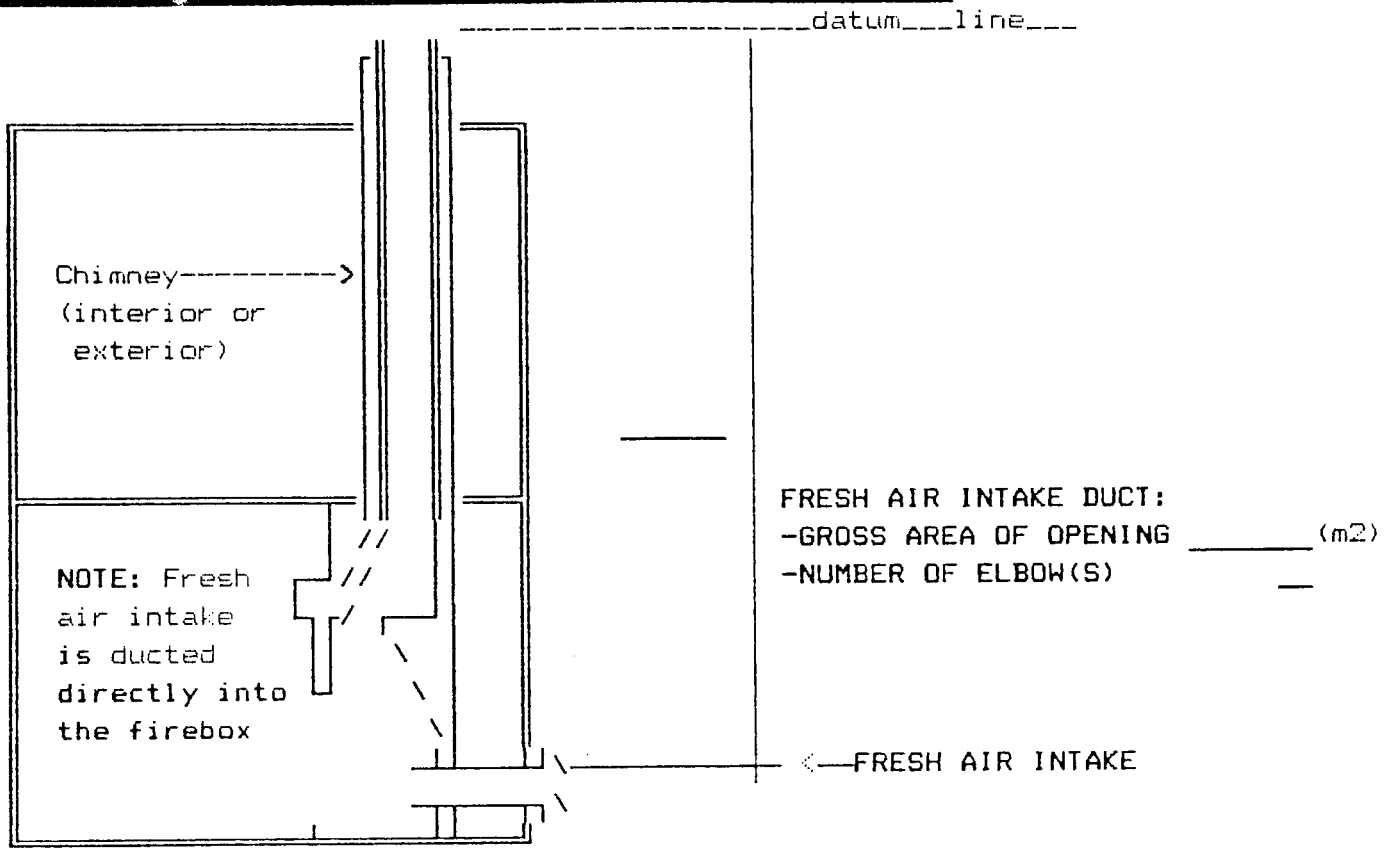


FRESH AIR INTAKE DUCT:

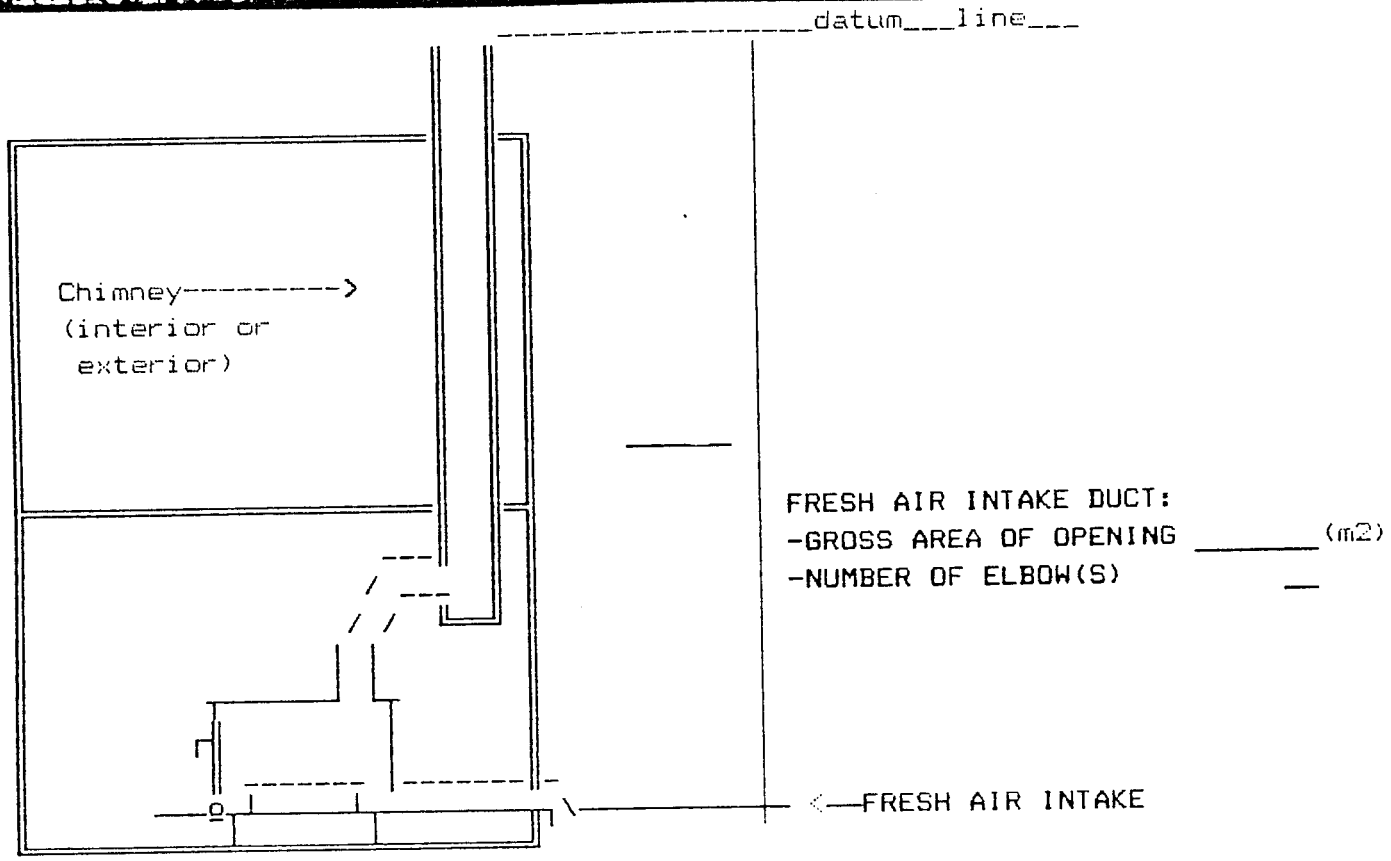
-GROSS AREA OF OPENING _____ (m2)

-NUMBER OF ELBOW(S) ___

FIREPLACE FRESH AIR INTAKE LOCATION & CHARACTERISTICS



WOODSTOVE FRESH AIR INTAKE LOCATION & CHARACTERISTICS



TIME CONTROLS

Simulation Start Time	_____ (sec)
Initial Time Step	_____ (sec)
Time at which fire is lit	_____ (sec)
Time at which fireplace/woodstove doors are closed*	_____ (sec)
Simulation Stop Time	_____ (sec)

* Time at which fireplace or woodstove doors are closed should be later than (i.e. algebraically greater than) the time at which the fire is lit, otherwise the fire will die out. A minimum delay of 120 seconds is suggested before closing doors after fire is lit. If you are modelling a fireplace with no doors, enter "0".

CALCULATIONS FOR HEAT LOSS FACTORS BETWEEN NODAL POINTS

- Calculate the thermal resistance of each intervening layer by multiplying its thickness by the resistivity of the material (press [F1] for material properties table).

- Add the thermal resistance values for all intervening layers.

- The reciprocal of the total thermal resistance is the heat loss factor.

- For heat loss factor between Nodal Point 3 and surrounding, include a thermal resistance of 0.12 m2.C/W for the air film.

PHYSICAL PROPERTIES OF MATERIALS

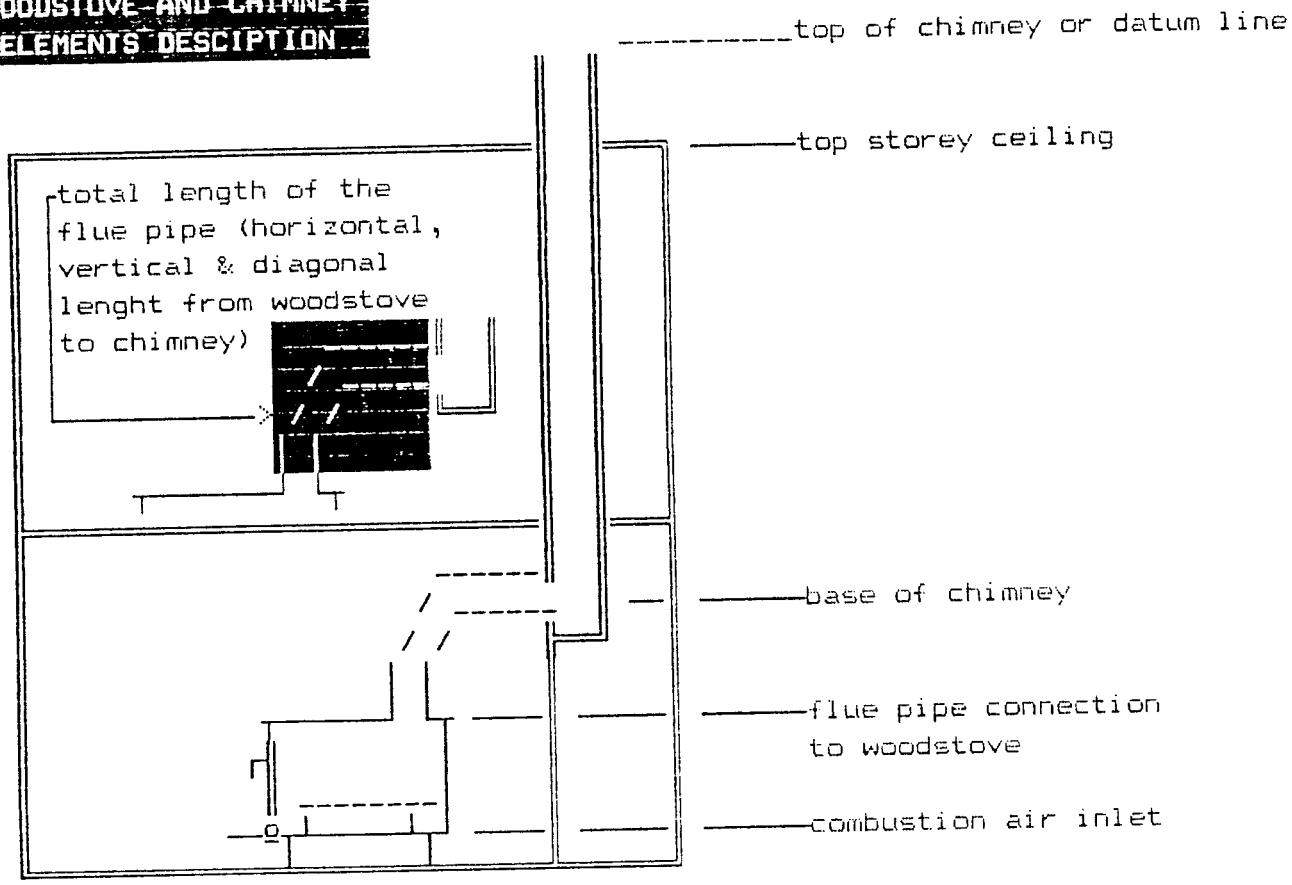
Material Description	Heat Capacity W.s/kg.°C	Density kg/m^3	Resistivity m^2.°C/W.mm
Air(@293 deg.K, 20 deg.C)*	1005	1.21	0.038
Aluminum	896	2 740.00	0.0000045
Brick, building	800	1 970.00	0.0014
Concrete (stone)	653	2 300.00	0.00108
Fireclay brick	829	1 790.00	0.001
Glass (soda lime)	750	2 470.00	0.001
Gypsum	1080	1 200.00	0.0023
Iron (cast)	500	7 210.00	0.000021
Steel (mild)	500	7 830.00	0.000022
Stone (quarried)	800	1 500.00	

*Values based on "Heat Transfer" fith edition by J.P. Holman
All other values based on "ASHRAE HANDBOOK" 1985 FUNDAMENTALS SI Edition

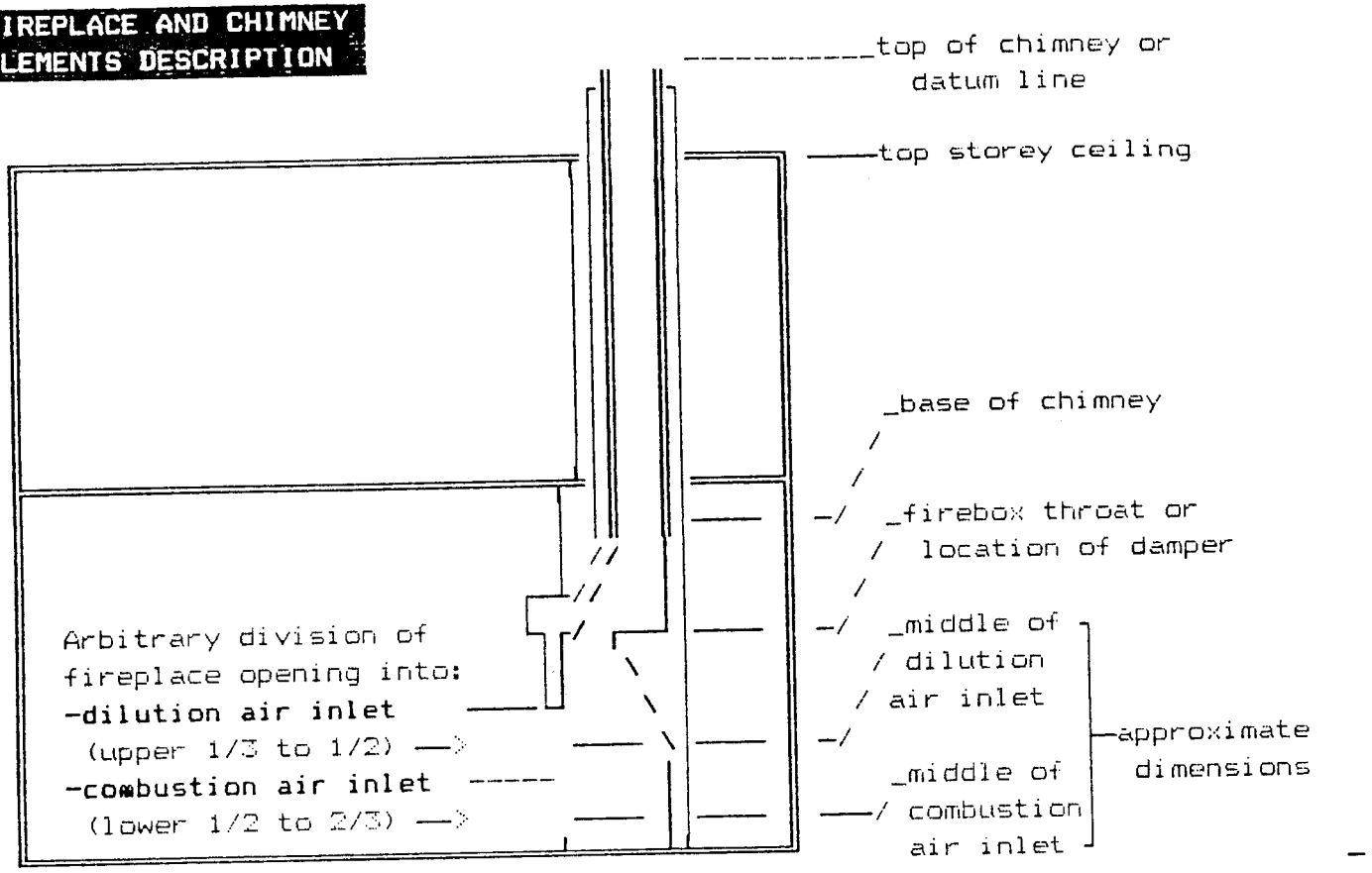
WOOD PROPERTIES

WOOD SPECIES	DENSITIES kg/m3	HEATING VALUES kJ/kg	SPECIFIC HEAT kJ/kg.°C
SOFTWOODS:			1.63
Cedar	300	22 500	
Douglas fir	490	18 755	
Balsam fir	350	18 343	
Hemlock	430	17 900	
Pine	380	20 500	
Spruce	380	18 100	
HARDWOODS:			2.4
Birch	610	17 705	
Maple	660	18 182	
Oak	610	18 525	

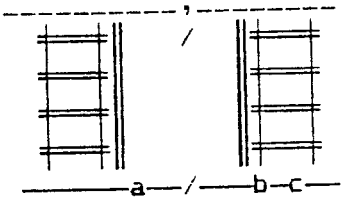
WOODSTOVE AND CHIMNEY ELEMENTS DESCIPTION



FIREPLACE AND CHIMNEY ELEMENTS DESCRIPTION

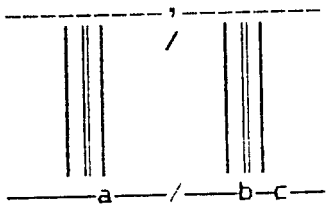


CHIMNEY TYPES: COMPONENTS AND CORRESPONDING NODAL POINT DESIGNATION



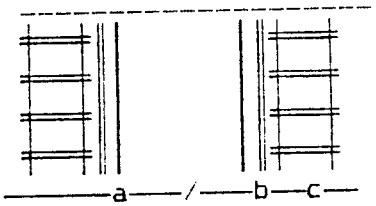
MASONRY COMPONENTS — NODAL POINT #

a-inner half of clay tile liner ---------- 1
b-outer half of clay tile liner ---------- 2
c-masonry enclosure (brick or other masonry) - 3



A-VENT COMPONENTS — NODAL POINT #

a-inner metal liner ---------- 1
b insulation ---------- 2
c-outer metal casing ---------- 3



MASONRY WITH METAL LINER COMPONENTS — NODAL POINT #

a-metal flue liner ---------- 1
b-clay tile liner ---------- 2
c-masonry enclosure (brick or other masonry) - 3

DEFAULT DWOOD.SPC FILE

```
TITLE:
CONFIGURATION OF THE WOODPILE
------------------------------
NUMBER OF KINDLING AND LARGER PIECES
5,5

LENGTH OF THE WOOD PIECES (m) AND NUMBER OF CONCENTRIC RINGS
.38,5

DIAMETER OF THE LOG FROM WHICH EACH PIECE IS DERIVED (mm)
21,35,32,41,49,130,154,179,198,228

NUMBER OF PIECES TO A ROUND LOG
1,1,1,1,1,6,6,6,6,6

FRACTION OF LOG SURFACE AREA FACING OUTSIDE (REMAINDER FACES OTHER LOGS)
.2,.33,.2,.35,.35,.5,.25,.5,.75,.75

NUMBER OF INFLUENCE INDICATORS FOR HEAT TRANSFER AMONG LOGS
3,4,3,7,7,4,6,4,3,3

INFLUENCE INDICATORS FOR LOG 1
2,4,5

INFLUENCE INDICATORS FOR LOG 2
1,3,4,5

INFLUENCE INDICATORS FOR LOG 3
2,4,5

INFLUENCE INDICATORS FOR LOG 4
1,2,3,5,6,7,8

INFLUENCE INDICATORS FOR LOG 5
1,2,3,4,6,7,8

INFLUENCE INDICATORS FOR LOG 6
4,5,7,9

INFLUENCE INDICATORS FOR LOG 7
4,5,6,8,9,10

INFLUENCE INDICATORS FOR LOG 8
4,5,7,10

INFLUENCE INDICATORS FOR LOG 9
6,7,10
```

INFLUENCE INDICATORS FOR LOG 10
7,8,9

FRACTION OF RADIATION FROM FLAME TO FIREBOX AND SURROUNDINGS
.025,.075,.025,.3,.075,.5

FRACTION OF RADIATION FROM WOOD TO FIREBOX AND SURROUNDINGS
.025,.075,.025,.5,.075,.3

FIREPLACE DOOR THICKNESS (m) AND DENSITY (kg/m3)
.009,2500

FIREPLACE DOOR HEAT CAPACITY (kJ/kg C)
750

TEMPERATURES IN THE BACK WALL (C)
16.,15.,14.,13.,12.,10., 9., 8., 7., 6.

TEMPERATURES IN THE SIDE WALLS (C)
16.,15.,14.,13.,12.,10., 9., 8., 7., 6.

TEMPERATURES IN THE TOP AND FLOOR (C)
20.,20.,20.,20.,20.,20.,20.,20.,20.,20.

SHAPE FACTORS FOR SURFACE 1 (LEFT SIDE) TO ALL OTHER SURFACES
.0,.22,.16,.18,.28,.18

SHAPE FACTORS FOR SURFACE 2 (BACK SIDE) TO ALL OTHER SURFACES
.15,.0,.15,.2,.36,.14

SHAPE FACTORS FOR SURFACE 3 (RIGHT SIDE) TO ALL OTHER SURFACES
.16,.22,.0,.18,.28,.18

SHAPE FACTORS FOR SURFACE 4 (FLOOR OF FIREBOX) TO ALL OTHER SURFACES
.16,.27,.16,.0,.25,.16

SHAPE FACTORS FOR SURFACE 5 (ROOM SURROUNDINGS) TO ALL OTHER SURFACES
0,0,0,0,0,0

SHAPE FACTORS FOR SURFACE 6 (TOP OF FIREBOX) TO ALL OTHER SURFACES
.16,.17,.16,.16,0,.35

EMISSIVITY OF EACH SURFACE
.85,.85,.85,.85,1,.85

TRANSMITTANCE OF EACH SURFACE
0,0,0,0,0,0

APPENDIX G

STANDARD DIMENSIONS OF VARIOUS TYPES OF CHIMNEYS

STANDARD B-VENT DIMENSIONS

NOMINAL SIZE	INNER LINER	OUTER CASING	AREA OF OPENING	(CIRCUMFERENCE) INNER LINER	(CIRCUMFERENCE) OUTER CASING
3"	3" 76.2 mm	4" 101.6 mm	7.1 in^2 0.0046 m^2	9.4" 0.239m	12.6" 0.319 m
4"	4" 101.6 mm	5" 127.0 mm	12.6 in^2 0.0081 m^2	12.6 0.319 m	15.7" 0.399 m
5"	5" 127.0 mm	6" 152.4 mm	19.6 in^2 0.0127 m^2	15.7" 0.399 m	18.8" 0.479 m
6"	6" 152.4 mm	7" 177.8 mm	28.3 in^2 0.0182 m^2	18.8" 0.479 m	22.0" 0.559 m
7"	7" 177.8 mm	8" 203.2 mm	38.5 in^2 0.0248 m^2	22.0" 0.559 m	25.1" 0.638 m
8"	8" 203.2 mm	9" 228.6 mm	50.3 in^2 0.0324 m^2	25.1" 0.638 m	28.3" .718 m
10"	10" 254.0mm	12" 305.0 mm	78.5 in^2 0.0507 m^2	31.4" 0.798 m	37.7" 0.958 m
12"	12" 305.0 mm	13" 330.4 mm	113.in^2 0.0731 m^2	37.7" 0.958 m	40.8" 1.038 m

STANDARD A-VENT DIMENSIONS

NOMINAL SIZE	INNER LINER ACTUAL SIZE DIAM.	MID POINT THRU INSUL. DIAM.	OUTER JACKET DIAM.	AREA OF OPENING	CIRCUMFERENCES		
					INNER LINER	INSULATION THRU CENTRE	OUTER JACKET
6"	6" 152.4 mm	7" 177.8 mm	8" 203.2 mm	28.3 in^2 0.0182 m^2	18.8" 0.479 m	22" 0.559 m	25.1" 0.638 m
7"	7" 177.8 mm	8" 203.2 mm	9" 228.6 mm	38.5 in^2 0.0248 m^2	22" 0.559 m	25.1" 0.638 m	28.3" 0.718 m
8"	8" 203.2 mm	9" 228.6 mm	10" 254.0 mm	50.3 in^2 0.0324 m^2	25.1" 0.638 m	28.3" 0.718 m	31.4" 0.798 m
10"	10" 254.0 mm	11" 279.4 mm	12" 305 mm	78.5 in^2 0.0507 m^2	31.4" .798 m	34.6" 0.878 m	37.7" 0.958 m

NFPSE6S
90 1610 1620
1645 1660 4
4650 4664
4700 10
8150 60
8280
9130 40
9400 11300
12570 80 12662
17670 80 90 00
25 30

STANDARD CLAY TILE LINER DIMENSIONS

NOMINAL SIZE	INSIDE DIMENSIONS	OUTSIDE DIMENSIONS	INSIDE AREA	INNER LINER PERIMETER	OUTER LINER PERIMETER
7" X 7" 177.8 mm X 177.8 mm	5 1/8" X 5 1/8" 130.2 mm X 130.2 mm	6 7/8" X 6 7/8" 174.6 mm X 174.6 mm	26.3 in^2 0.017 m^2	20.5" 520.7 mm	27.5" 698.5 mm
7" X 8" 177.8 mm X 203.2 mm	5 1/8" X 6 1/8" 130.2 mm X 155.6 mm	6 7/8" X 7 7/8" 174.6 mm X 200.0 mm	31.4 in^2 0.020 m^2	22.5" 571.5 mm	29.5" 749.3 mm
8" X 8" 203.2 mm X 203.2 mm	6 1/8" X 6 1/8" 155.6 mm X 155.6 mm	7 7/8" X 7 7/8" 200.0 mm X 200.0 mm	37.5 in^2 0.024 m^2	24.5" 622.3 mm	31.5" 800.1 mm
8" X 12" 203.2 mm X 304.8 mm	7 7/8" X 7 7/8" 6 1/8" 200.0 mm X 197.7 mm	10 1/8" X 61.3 in^2 155.6 mm X 257.2 mm	31.32" 0.040 m^2	32.5" 795.5 mm	 825.5 mm
12" X 12" 304.8 mm X 304.8 mm	11 7/8" X 11 7/8" 301.6 mm X 301.6 mm	9 7/8" X 9 7/8" 250.8 mm X 250.8 mm	141.0 in^2 0.091 m^2	47.5" 1206.5 mm	39.5" 1003.3 mm
12" X 16" 304.8 mm X 406.4 mm	11 7/8" X 15 7/8" 301.6 mm X 403.2 mm	9 3/8" X 13 3/8" 238.1 mm X 339.7 mm	188.5 in^2 0.122 m^2	55.5" 1409.7 mm	45.5" 1155.7 mm
16" X 16" 406.4 mm X 406.4 mm	15 7/8" X 15 7/8" 403.2 mm X 403.2 mm	13 3/8" X 13 3/8" 339.7 mm X 339.7 mm	252.0 in^2 0.163 m^2	63.5" 1612.9 mm	53.5" 1358.9 mm

APPENDIX H

TEST DATA ON FLUE CAPS

AERODYNAMIC AND FLOW CHARACTERISTICS OF FIVE FLUE CAPS*

MEASURED WIND PRESSURE COEFFICIENTS FOR A BLOCKED FLUE

WIND ANGLE	A-VENT	B-VENT	3-FINNED CAP	OPEN MASONRY	MASONRY CAP&GRILL
-45°	0.662	0.432	0.461	0.242	0.629
-30°	0.731	0.446	0.621	0.989	1.078
0°	0.728	0.503	0.580	1.626	0.958
30°	0.536	0.439	0.241	0.873	0.777
45°	0.556	0.646	0.136	0.812	0.731

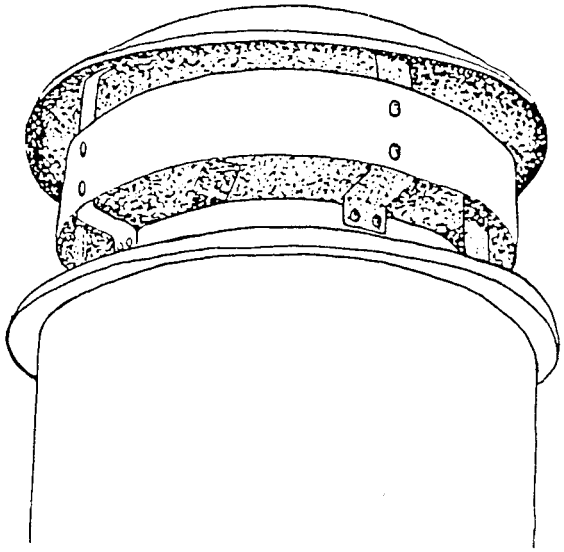
MEASURED WIND PRESSURE COEFFICIENTS FOR AN UNBLOCKED FLUE

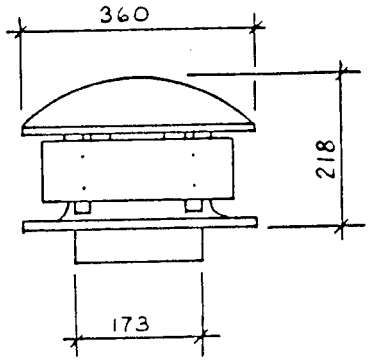
WIND ANGLE	A-VENT	B-VENT	3-FINNED CAP	OPEN MASONRY	MASONRY CAP&GRILL
-45°	0.470	0.274	0.239	0.263	0.583
-30°	0.531	0.248	0.235	0.755	0.753
0°	0.500	0.269	0.229	1.094	0.669
30°	0.395	0.218	0.166	0.837	0.759
45°	0.433	0.331	0.099	0.787	0.694

FLOW CHARACTERISTICS

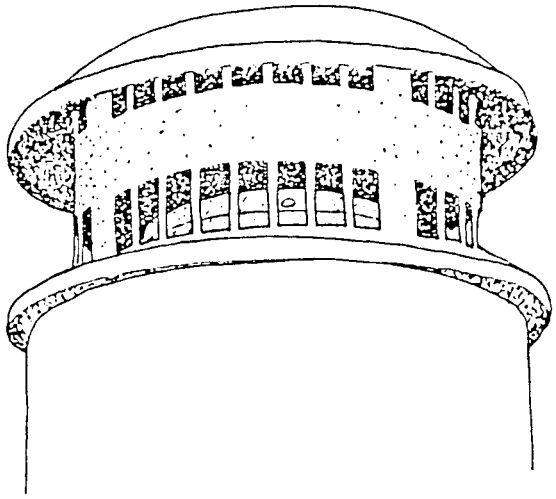
WIND ANGLE	A-VENT	B-VENT	3-FINNED CAP	OPEN MASONRY	MASONRY CAP&GRILL
FRICTION FACTOR (K)	1.1	1.4	3.6	0.7	1.0
RATIO OF CAP ELA TO CHIMNEY AREA (ELA/A)	1.6	1.4	0.9	1.9	1.6

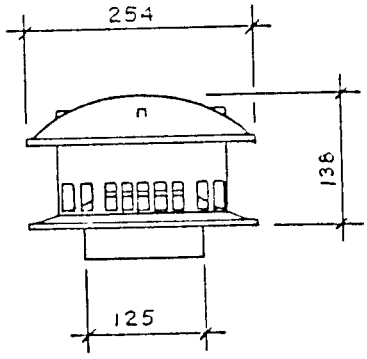
* The Influence of Termination Configuratiion on the Flow Performance of Flues
Scanada Sheltair Consortium Inc. for
Canada Mortgage and Housing Corporation
June 11, 1987



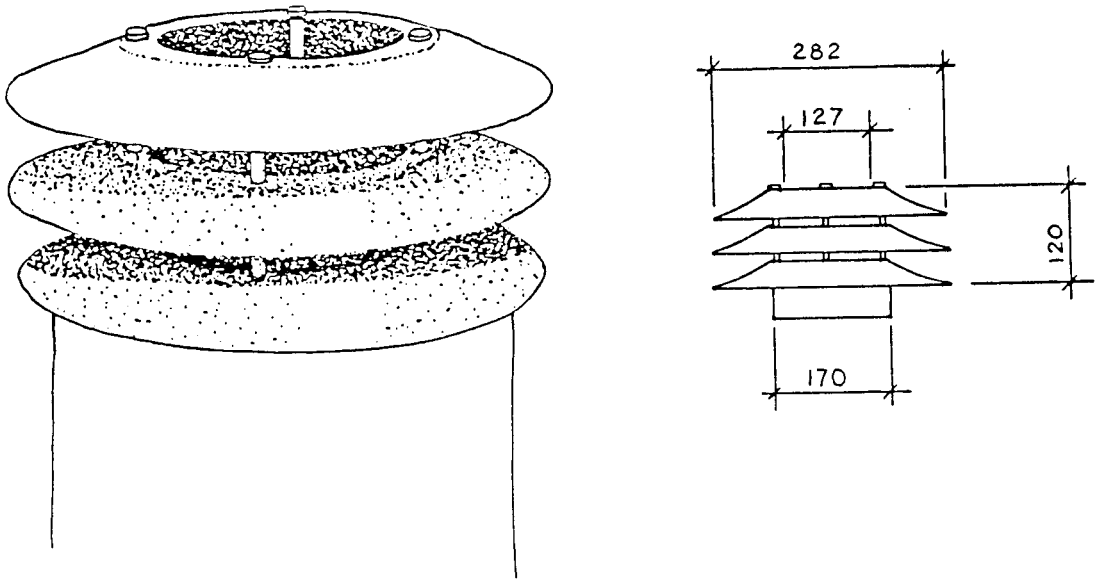


A-vent Cap

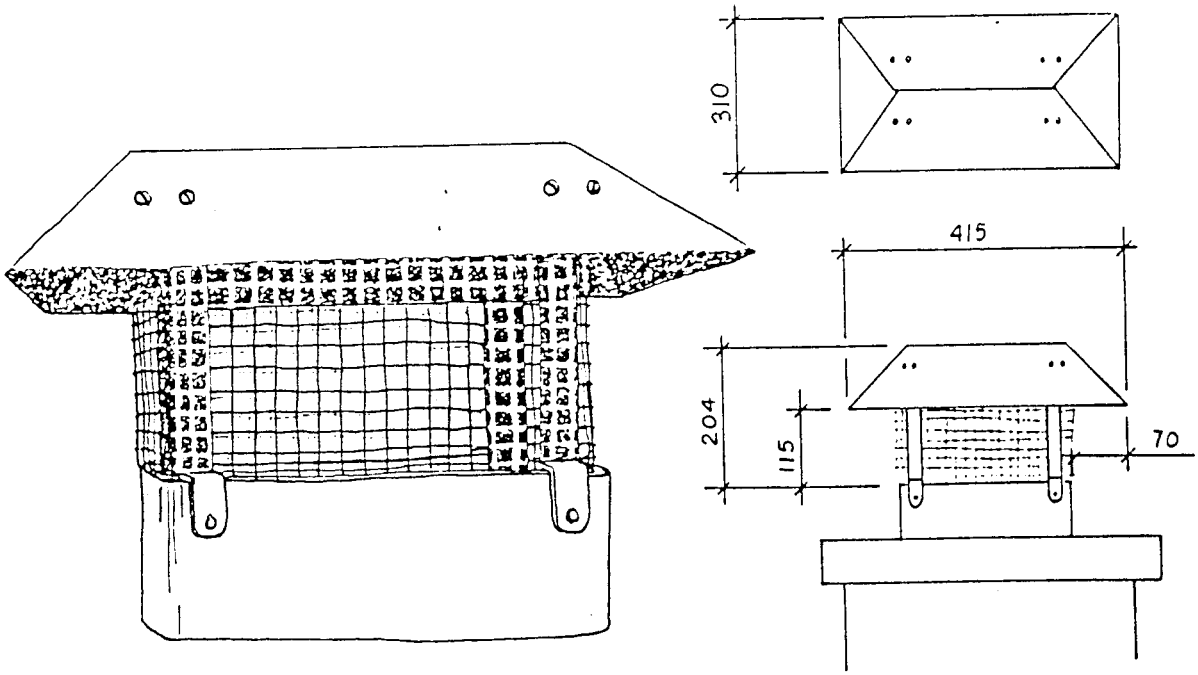




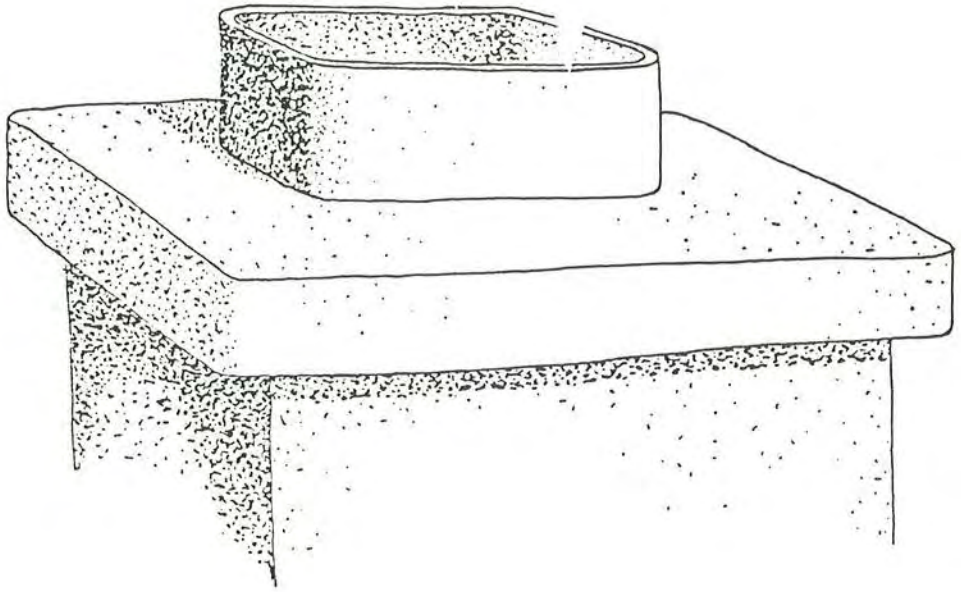
B-vent Cap

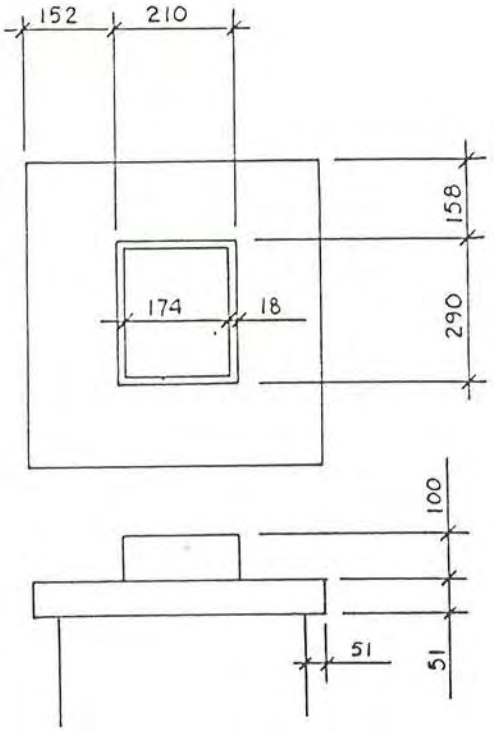


3-finned Cap



Masonry Cap and Grill





Masonry Chimney With Clay Liner