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ADDENDUM/SUPPLEMENTAL INFORMATION FOR VALLEY CRSTER ISC

The attached information on three models is furnished as part of the UNAMAP (Version 4) package to enable users to update their user's guides for these three models. The coding changes mentioned in this information have already been made to the source codes included as part of the UNAMAP (Version 4) tape.

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ADDENDUM/SUPPLEMENTAL INFORMATION

TO THE

VALLEY MODEL

The computer code modifications addressed herein are the complete set of changes made to date in the Valley Model code as it appears in the Valley Model User's Guide, EPA-4/2-77-018, September 1977. All modifications have been incorporated in the Valley code as part of the UNAMAP-4 available from the National Technical Information Service.

Each item in this report is preceded by the date on which it was issued. MAIN designates the main program.

A Computer Program Modifications

Make the following modifications to Appendix B of the Valley Model User's Guide. Note that the code line sequence numbers in the Subroutine EBPLT1 code of UNAMAP are 100 larger than those in the User's Guide; the latter are cited herein as in the original source code in the User's Guide.

1. 8/78 - Insert the following line of code in MAIN:

```
      IF(TEMP.EQ.0.)TEMP=293.                                    MA021250
```

The original code caused all concentrations to be zero when conversion to standard conditions was specified.

2. 8/78 - Delete the following lines of code from Subroutine EBPLT1:

```
      P=1.E+10                                                   PL023700
      TEMP=1.E+10                                                PL023800
```

The original code caused the ambient temperature and pressure to be incorrectly assigned very large values for the analyses of the second and successive STAR decks in a single execution of the program, resulting in concentrations that are obviously in error.

3. 7/79 - Replace lines MA046200 through MA046600 in MAIN with the following lines of code:

```
      DUM3=-.5*((-H-DUM1)/SIGZ)**2                                      MA046150
      DUM4=-.5*((H-DUM1)/SIGZ)**2                                       MA046155
      IF(DUM4.LT.-40.)GO TO 68                                          MA046160
      IF(DUM3.LT.-40.)GO TO 64                                          MA046165
      DUM2=EXP(DUM3)+EXP(DUM4)                                          MA046170
      GO TO 65                                                          MA046175
   64 DUM2=EXP(DUM4)                                                    MA046180
```

This change precludes underflow diagnostics that may occur in some computer systems, but does not affect resulting concentrations.

4. 10/79 - Insert the following lines of code in MAIN:

```
      NPASS=0                                                           MA008505
      SGRID=0                                                           MA008510
      IF(GRID.EQ.SGRID.OR.NPASS.EQ.0.OR.SUM.EQ.0.0) GO TO 72            MA013840
      WRITE(6,71)                                                       MA013845
   71 FORMAT('1'///////' VALLEY DIAGNOSTIC.'/' BE AWARE THAT YOU HAVE CHMA013850
     AANGED THE VALUE OF GRID BELOW.'/' A RERUN IS REQUIRED UNLESS ALL RMA013855
     BECEPTORS OF CONCERN '/' LIE ON AN ELEVATED, FLAT PLANE.')         MA013860
   72 NPASS=1                                                           MA013865
      SGRID=GRID                                                        MA013870
```

These additions produce a warning of potential errors due to a possible oversight by the user. See page 3-2 (Section 3.1.4, first paragraph) of the Valley Model User's Guide.

5. 10/79 - Change the following line of code in MAIN to read:

```
      IF(MWT.NE.0.0) GO TO 3220                                         MA020700
```

6. 10/79 - In code line PL002500 of Subroutine EBPLT1 replace the literal data (i.e., ' VIA VALLEY VI') with 'VIA VALLEY V1 10/79'.

7. 10/79 - Insert the following line of code in EBPLT1:

```
      REAL MWT                                                          MA000790
```

8. 10/79 - Change the following code line of MAIN to read:

```
      IF(IZBRIG.EQ.0) GO TO 15                                          MA041200
```

Precludes division overflow in Subroutine BEH072.

9. 10/79 - Change the following lines of code in Subroutine EBPLT1 to read:

```
  803 FORMAT(T9,'HLIFE=',F6.2,'HRS. {etc.}                              PL011500
      IF(W.EQ.0.0) W=1.E10                                              PL013300
```

10. 10/79 - Insert the following lines of code in Subroutine EBPLT1:

```
      IF(TS(NSOR).EQ.1.E10) TS(NSOR)=0.                                 PL014750
      IF(D(NSOR).EQ.1.E10) D(NSOR)=0.                                   PL014751
      IF(VS(NSOR).EQ.1.E10) VS(NSOR)=0.                                 PL014752
      IF(VF(NSOR).EQ.1.E10) VF(NSOR)=0.                                 PL014753

      DO  11540 I=1,ISOR                                                PL016950
      IF(GT(I).EQ.1.E10) GT(I)=0.                                       PL016951
      IF(TS(I).EQ.1.E10) TS(I)=0.                                       PL016952
      IF(D(I).EQ.1.E10) D(I)=0.                                         PL016953
      IF(VS(I).EQ.1.E10) VS(I)=0.                                       PL016954
      IF(VF(I).EQ.1.E10) VF(I)=0.                                       PL016955
11540 CONTINUE                                                          PL016956
```

These changes preserve the proper values of the variables examined under two constraints: (1) more than one stability/wind (STAR) array is evaluated in a single job; and (2) the source-data records are, for convenience, input only once for the entire job. Without the recommended changes, concentrations for the second and successive STAR data sets are significantly underestimated -- only under the constraints just mentioned. The revised program code should be used to reexamine the second and successive STAR data sets evaluated in a single job with the original program code when DUPSOR, an input control parameter, was assigned a value greater than zero.

11. The following set of program changes must be made as a group.

12/80 - Delete the following lines of code from MAIN:

```
      SIGZ=SQRT((A(LL)*ABS(XP)**B(LL)+C(LL))**2 + SIGI**2)              MA040500
      IF(IZBRIG.EQ.0)GO TO 15                                           MA041200
      IF(L.LT.5) GO TO 14                                               MA041300
      H=HS+BRIG                                                         MA042000
```

12/80 - Change the following lines of code in MAIN to read:

```
     C ISOR,GT,HST,WT,VFORM,AXDIR,IUR,ISHORT,NN,MAP,RECHT,HFCTR,K,P,MWT,MA001900
     A HLIFE,ISHORT,IBID,I26,IFR                                        MA010500
   73 FORMAT(F5.1,F7.0,F6.0,5I3,2F4.0,I3,3I1)                           MA010600
     * TS(IL),VS(IL),D(IL),VF(IL),IT,1.0,XXP,DTDZ(IT),TEMP,P,I26)       MA034000
CC  SIGMA IS INCREASED FOR ALL LOW-LEVEL SRCS XCPT FOR RURAL STABLE.    MA040300
     * TS(IL),VS(IL),D(IL),VF(IL),L,WS,XXP,DTDZ(L),TEMP,P,I26)          MA041700
```

12/80 - Replace the subroutine name "BEH072" with "BEHVAL" in lines MA033900 and MA041600 of MAIN.

12/80 - Insert the following lines of code in MAIN:

```
CC  1280 - OPTIONS ADDED FOR BUOYANCY INDUCED DISPERSION VIA SUM OF     MA000070
CC  SQUARES OF PG SIGMA AND (DELTA H/3.5), AND FOR FACTOR 2.6 OR 2.4 IN MA000080
CC  STABLE PLUME RISE(FINAL) FORMULA, AND FOR SELECTIVE EXCLUSION OF    MA000090
CC  TRANSITIONAL PLUME RISE.  P AND T CHANGED FOR PPM.                  MA000091
     D IBID,I26,IFR                                                     MA001910
CC  IBID = 0 NO BUOYANCY-INDUCED DISPERSION.                            MA013710
CC       = 1 VALLEY WITH BUOYANCY-INDUCED DISPERSION.                   MA013720
CC  I26  = 0 MODEL USES 2.4 IN STABLE PLUME RISE EQ                     MA013730
CC         1 MODEL USES 2.6 IN STABLE PLUME RISE EQ                     MA013740
CC  IFR  = 0 TRANSITIONAL PLUME RISE AVAILABLE FOR ALL STABILITIES.     MA013750
CC       = 1 NO TRANSITIONAL PLUME RISE.                                MA013751
CC       = 2 TRANSITIONAL RISE AVAILABLE FOR STABLE ONLY.               MA013752
    IF(IFR.GT.0)XXP=0.                                                  MA033711
    IF(XXP.EQ.0.)BRIGUN(IL)=DUM5                                        MA034110
      IF(IBID.EQ.0)GO TO 800                                            MA040410
      SIGZ=((A(LL)*ABS(XP)**B(LL)+C(LL))**2 + SIGI**2)                  MA040420
      GO TO 9                                                           MA040430
  800 SIGZ=SQRT((A(LL)*ABS(XP)**B(LL)+C(LL))**2 + SIGI**2)              MA040440
      IF(IZBRIG.EQ.0.AND.IBID.EQ.0) GO TO 15                            MA041110
      IF(IZBRIG.EQ.0.AND.IBID.NE.0) GO TO 802                           MA041120
      IF(L.LT.5.AND.IBID.EQ.0) GO TO 14                                 MA041130
      IF(L.LT.5.AND.IBID.NE.0) GO TO 804                                MA041140
      XXP=XP/1000.                                                      MA041535
      IF(IFR.EQ.1)XXP=0.                                                MA041540
      IF(XXP.EQ.0.)BRIG=DUM5                                            MA041750
      IF(IBID.NE.0)GO TO 802                                            MA041910
      H=HS+BRIG                                                         MA041920
      GO TO 15                                                          MA041930
  804 BRIG=BRIGUN(IL)/WS                                                MA041940
  802 IF(G.GT.0.0)BRIG=G                                                MA041950
      H=HS+BRIG                                                         MA041960
      DUM=BRIG/3.5                                                      MA041970
      DUM=DUM*DUM                                                       MA041980
      SIGZ=SQRT(SIGZ+DUM)                                               MA041990
```

12/80 - Change the following lines of code in Subroutine EBPLT1 to read:

```
      DIMENSION TS(50),VS(50),D(50),VF(50),RECHT(112),KFIRI(8),NFIRI(8) PL000900
      DIMENSION VERBL (12),URBRUR(2),THREED(12),KBID(8),KCON(8),KBLK(8) PL001000
     C ISOR,GT,HST,WT,VFORM,AXDIR,IUR,ISHORT,NN,MAP,RECHT,HFCTR,K,P,MWT,PL001600
     C T27,F5.1,T93,F5.1,'          VALLEY          '/T2,'1280',        PL002500
     L T42,F5.1,T78,F5.1,/T5,8A4,T56,'0 KM',3X,F7.3,5('KM ',F7.3),'KM'/ PL005200
     M T5,8A4,T56,6(']....+....'),']'/T5,8A4,T60,F5.1,                  PL005300
     G V(68),V(54),V(77),V(49),V(61),V(69),V(55),(KFIRI(I),I=1,8),      PL014500
     G S(68),S(54),S(77),S(49),S(61),S(69),S(55),(KFIRI(I)=1,8),        PL021700
```

12/80 - Insert the following lines of code in Subroutine EBPLT1:

```
      D IBID,T26,IFR                                                    PL001610
       DATA KCON/'BRIG','GS S','TABL','E CO','NSTA','NT I','S 2.',      PL002150
      A          '6.  '/                                               PL002155
       DATA KBID/'BUOY','ANCY','-IND','UCED',' DIS','PERS','ION.',      PL002160
      A          '    '/                                               PL002165
       DATA KBLK/'    ','    ','    ','    ','    ','    ','    ',      PL002170
      A          '    '/                                               PL002175
       DATA KFIRI/'FINA','L RI','SE O','NLY',',' FOR',' ALL',' CAS',    PL002176
      A           'ES. '/                                              PL002177
       DATA NFIRI/'ONLY',' FIN','AL R','ISE ','FOR ','NONS','TABL',     PL002178
      A           'E.  '/                                              PL002179
       IF(IFR.EQ.1)GO TO 509                                            PL010214
       IF(IFR.EQ.2)GO TO 502                                            PL010215
       DO 501 I=I,8                                                     PL010216
       KFIRI(I)=KBLK(I)                                                 PL010219
  501  CONTINUE                                                         PL010222
       GO TO 509                                                        PL010225
  502  DO 503 I=1,8                                                     PL010228
       KFIRI(I)=NFIRI(I)                                                PL010231
  503  CONTINUE                                                         PL010234
  509  CONTINUE                                                         PL010237
       IF(IBID.NE.0)GO TO 500                                           PL010250
       DO 510 I=1,8                                                     PL010255
       KBID(I)=KBLK(I)                                                  PL010260
  510  CONTINUE                                                         PL010265
  500  IF(I26.NE.0)GO TO 520                                            PL010270
       DO 525 I=1,8                                                     PL010275
       KCON(I)=KBLK(I)                                                  PL010280
  525  CONTINUE                                                         PL010285
  520  CONTINUE                                                         PL010290
      * (SCALE(N1),N1=1,6),(KCON(I),I=1,8),(KBID(I),I=1,8),             PL014550
      * (SCALE(N1),N1=1,6),(KCON(I),I=1,8),(KBID(I),I=1,8),             PL021710
       DO 3805 I=1,8                                                    PL022450
       KCON(I)=KBLK(I)                                                  PL022451
       KBID(I)=KBLK(I)                                                  PL022452
       KFIRI(I)=KBLK(I)                                                 PL022453
 3805  CONTINUE                                                         PL022459
```

12/80 - Change the subroutine name "BEH072" to "BEHVAL" in Subroutine BEH072 line BE000100. This subroutine will hereafter be referred to as "BEHVAL."

12/80 - Change the following lines of code in Subroutine BEHVAL to read:

```
      1 KST,U,X,DTHDZ,T,P,I26)                                          BE000200
       DHA = PRC*(F/(U*S))**0.333333                                    BE010300
```

12/80 - Insert the following lines of code in Subroutine BEHVAL:

```
C  BEHVAL - BEH072 WITH OPTION TO PERMIT 2.4 OR 2.6 AS COEFFICIENT       BE000298
C  IN STABLE FINAL PLUME RISE EQN.  X =0 FORCES FINAL RISE, AS IN BEH072 BE000299
      PRC=2.4                                                            BE005150
      IF(I26.NE.0)PRC=2.6                                                BE005151
```

These changes permit the user to optionally designate treatment of the effects of buoyancy-induced dispersion (BID), to designate whether the program will assign the constant coefficient in the final stable plume-rise equation a value of 2.4 or 2.6, and to designate conditions for the use of transitional plume rise. See Section B below for discussion of the options. They also allow for the continued identification of the revisions made to the Valley Model computer code.

The use of the optional constants for the plume-rise formula are self-explanatory. Briggs' latest recommendation is to assign the constant a value 2.6.

Default is zero in all cases, and such default relegates the analysis to that controlled by the original Valley code. Statements are printed in the output indicating when the new options have been invoked.

12. Make the following modifications to MAIN:

12/80 - In statement MA009000 delete "OR TO PPM."

12/80 - In statement MA009300 change "CHI IS AT AMBIENT COND." to "CHI (UG/M3 ONLY) IS AT AMBIENT COND."

12/80 - In statement MA012300 change "TEMP/(MWT*P)" to "298./(MWT*1013.2)".

12/80 - Delete statements MA012400 and MA012600.

12/80 - Change the following line of code to read:

```
      ALWT=8.31E04*298./(MWT*1013.2)                                     MA021900
```

These modifications describe and assure the proper values of temperature and pressure used in the conversion from $\mu g/m^3$ to ppm. Concentrations in ppm generated by the original computer code can be in error by up to about + 15 percent in rare cases, but most often the error would be near zero.

13. 12/80 - Change the following lines of code in Main to read:

```
 3420 IF(PLHT.GT.0.0) GO TO 3430                                         MA043500
      IF(PLHT.LE.-400.0) GO TO 99                                        MA043700
      WS=WS*(400./(400.+PLHT)                                            MA043800
 3430 IF(PLHT.LT.10.0) PLHT=10.                                          MA044000
```

These changes eliminate insignificant positive errors in calculated concentrations. The largest of these errors occurred at receptors no more than 10 m below the undisturbed plume centerline elevation.

B. Text Corrections to the Valley Model User's Guide

1. 8/78 - Page 3-2, line 5: Change 293 to 298.

2. 10/79 - The discussion of lateral plume deflection on Page 2-2, last paragraph, is incomplete. A statement to further define the treatment of emissions from very low heights during stable conditions is as follows: "The height-dependent attenuation factor for concentrations on elevated terrain is not applied to contributions from any stable plume with an undisturbed height of 10 m or less above stack base."

3. 10/79 - Page 3-1, Section 3.1.1, insert the following:

   No attempt should be made to force alignment of the printed concentrations exactly on 16-point radials from map center or exactly on circles about map center. Consider, for example, the first printed concentration from center about the southwest direction. The decimal point lies 9.8 print spaces from center at a bearing of 227.5 degrees from center (using graphical techniques). With the variable GRID equal to 100 m, the distance of this receptor from center of the plot is 980 m. This receptor does not lie exactly on the southwest radial (225 degrees), nor does it lie on a circle about center that passes through, say, the first receptor to the west of center. The latter lies 8 print spaces from center, or, for this example, 800 m from center. Hence, the printed concentration decimal point represents, without relocation, the geographical position of a receptor in the real world.

4. 12/80 - Page 1-9, add the following lines to the list in Section 1.4.4:

   - BUOYANCY-INDUCED DISPERSION
   - COEFFICIENT 2.4 OR 2.6 IN FINAL STABLE PLUME-RISE EQUATION
   - TRANSITIONAL AND/OR FINAL PLUME RISE

5. 12/80 - Page 2-4, Equation 2.1, and page 2-7, Equation 2.1a:

   Change h to h_o.

6. 12/80 - Page 2-5, last line: Change

   "T/(MP)" to "298./(M·1013.2)".

7. 12/80 - Page 2-6: Delete lines 2 and 4 (i.e., definitions of T and P).

12/80 - Page 2-8, last line of Section 2.1.3: Delete "during $S \leq 4$" and insert "except that SIGI is set to zero during stable conditions in the rural mode. The vertical dispersion coefficient can be adjusted internally, at the user's discretion, for buoyancy-induced dispersion so that the net coefficient becomes

$$\sigma_z = \{(ax_p^b + d)^2 + SIGI^2 + (\Delta h/3.5)^2\}^{1/2}$$

where Δh is either the calculated or user-assigned plume rise at the receptor of concern."

9. 12/80 - Page 2-8, next to last line: Insert as a reference "1975." Also, add to list of references on page 5-1 the following paper by Briggs:

_____, 1975: Plume Rise Predictions. Lectures on Air Pollution and Environmental Impact Analysis. September 29 - October 3, 1975, Boston, Massachusetts. D. A. Haugen, Workshop Coordinator. AMS, Boston. pp59-104.

10. 12/80 - Insert the following at bottom of page 2-8:

The user may designate a value of 2.4 or 2.6 for the constant coefficient in the final plume rise equations for stable conditions. The value 2.6 is consistent with other EPA models. The user also selects one of three techniques which cause the program to invoke the use of : (1) the original code, which selects the lesser plume rise from the transitional and final rise formulae for all stabilities; or (2) only the final rise formula for all stabilities; or (3) only the final rise formula for nonstable conditions and the lesser result from both formulae for stable conditions. The second of these three techniques affords consistency with other EPA models; the third may be preferred for sources near elevated receptors.

11. 12/80 - Page 2-12, line 3: Delete "made."

12. 12/80 - Page 2-14, replace lines 8 through 12 with the following:

cloudy conditions, and can exist in both the daytime and nighttime. In rural areas the afternoon mixing height is halved in the Valley Model, and in urban areas it is averaged with the nighttime mixing height, for 40 percent of the class S = 4 occurrences. The remaining 60 percent of the neutral class (urban or rural) utilizes the mean afternoon mixing

13. 12/80 - Page 2-16, seventh line from bottom, delete the phrase "for the long-term option only,"

14. 12/80 - Page 3-9, last line, add the following:

An input value of zero (or blank) in effect defaults to infinity for the calculations, and is printed as 999.99 in the output.

15. 12/80 - Page 4-15, in @HDG card, replace the comma between X and M with a period.

December 1980

ADDENDUM/SUPPLEMENTAL INFORMATION

TO THE

USER'S MANUAL FOR SINGLE SOURCE (CRSTER) MODEL

The computer code modifications addressed herein are the complete set of changes made to date to the CRSTER code as it appears in the User's Manual for Single-Source (CRSTER) Model, EPA-450/2-77-013, July 1977. All modifications have been incorporated in the CRSTER code as part of the UNAMAP-4 available from the National Technical Information Service (NTIS).

Each item in this report is preceeded by the date on which it was issued.

A. 9/79 - Additional Options

Several options have been added to the CRSTER computer program. These options potentially make the model more useful for a variety of applications. However, please note that the inclusion of the options does not constitute a change in the recommended procedures. The options are therefore to be exercised for regulatory applications only with the concurrence of the appropriate Regional Office.

The following list identifies the options that have been added to the CRSTER program:

- transitional plume rise
- anemometer height input
- wind profile power-law exponent input
- stack downwash
- momentum plume rise

The new namelist variables associated with these options are as follows:

Variable Name	Type	Description
IPLAS	Integer	0 = Transitional plume rise not accounted for. 1 = Transitional plume rise accounted for. Default = 0 Current recommended usage: IPLAS = 0
ANHT	Real	Anemometer height. Default = 7. meters. Current recommended usage: ANHT = Actual anemometer height.

IDWN	Integer	0 = Stack downwash <u>not</u> accounted for. 1 = Stack downwash accounted for. Default = 0 Current recommended usage: IDWN = 0
P	Real	Array of dimension 6. Positions 1-6 correspond to the set of wind profile law exponents as a function of stability. Default = .1, .15, .2, .25, .3, .3 Current recommended usage: P = Default values
IMOM	Integer	0 = Momentum plume rise not accounted for. 1 = Momentum plume rise accounted for. Default = 0 Current recommended usage: IMOM = 0

The momentum plume rise option allows the momentum plume rise equations to be used for cold plume sources. This option has no effect for sources with buoyant plumes - the sources for which CRSTER was originally designed to be used. Hence, the default for this option is to omit the momentum plume rise equation. However, since it may be necessary to consider sources with non-buoyant plumes, the option which includes the momentum plume rise equations may be used for such cases.

9/79 - Program Modifications Required to Incorporate Additional Options

I. Replace the following lines of code:

MAIN CRSV

```
*Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM      CV001300
*ISC,SC1,SC3,SCN,SC24,SCAN,ANHT,P,IPLAS,IDWN,IMOM                  CV001700
```

SUBROUTINE CRS

```
 DIMENSION DTH(11),SYD(5,6),SZD(5,6),LOOP(6,2),                    CR000800
*TAPIN(171),JMAX3(4),CHI(180),HE(20,5),DDD(366)                    CR001200
*Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM      CR001900
 WS(IS)=XWS*((HP(IS)/ANHT)**P(KST))                                CR016400
 H=HE(IH,J)-FADJ                                                   CR021800
```

SUBROUTINE BLK

```
Q240(12,20),V240(12,20),T240(12,20),ANHT,P(6),IPLAS,IDWN,IMOM      BL000400
```

II. Delete the following lines of code:

SUBROUTINE CRS

```
DATA P/.1,.15,.2,.25,.3,.3/                                        CR002700
HE(IS)=HEIS                                                        CR018500
```

III. Add the following lines of code:

MAIN

```
      IF(IPLAS.EQ.1)WRITE(6,841)                                        CV009110
  841 FORMAT(1X,'GRADUAL PLUME ASCENT UP TO POINT OF FINAL ',           CV009120
     1'RISE ACCOUNTED FOR')                                             CV009130
      WRITE(6,842)ANHT                                                  CV009140
  842 FORMAT(1X,'ANEMOMETER HEIGHT IS ',F4.1,' METERS')                 CV009150
      IF(IDWN.EQ.1)WRITE(6,843)                                         CV009160
  843 FORMAT(1X,'STACK DOWNWASH ACCOUNTED FOR')                         CV009170
      IF(IMOM.EQ.1)WRITE(6,844)                                         CV009180
  844 FORMAT(1X,'MOMENTUM PLUME RISE ACCOUNTED FOR')                    CV009185
      WRITE(6,845)P                                                     CV009190
  845 FORMAT(1X,'WIND PROFILE EXPONENTS ARE: ',6(F7.3,','))             CV009195
```

SUBROUTINE CRS

```
      IF(IDWN.EQ.0) GO TO 1779                                          CR018110
C***ACCOUNT FOR STACK DOWNWASH                                          CR018115
      DUD=VS(IS)/WS(IS)                                                 CR018120
      IF(DUD.LT.1.5)HPIS=HP(IS)+2.*D(IS)*(DUD-1.5)                      CR018130
      IF(HPIS.LT.0.)HPIS=0.                                             CR018140
 1779 CONTINUE                                                          CR018150
      IF(IMOM.EQ.0)GO TO 1801                                           CR018203
C***MOMENTUM PLUME RISE ACCOUNTED FOR                                   CR018206
      DELT=TSIS-T                                                       CR018209
      IF(KST.GT.4)GO TO 1802                                            CR018212
      VFIS=0.785398*VS(IS)*D(IS)*D(IS)                                  CR018215
      DUMF=3.12139*VFIS*DELT/TSIS                                       CR018218
      IF(DUMF.GE.55.)GO TO 1783                                         CR018221
      DTMB=.0297*TSIS*VS(IS)**0.333333/D(IS)**0.666667                  CR018224
      GO TO 1784                                                        CR018227
 1783 DTMB=.00575*TSIS*VS(IS)**0.666667/D(IS)**0.333333                 CR018230
 1784 CONTINUE                                                          CR018233
      IF(DELT.GE.DTMB)GO TO 1801                                        CR018236
      HEIS=HPIS+3.*VS(IS)*D(IS)/WSIS                                    CR018239
      GO TO 1803                                                        CR018242
```

```
 1802 CONTINUE                                                          CR018245
      S=9.80616*DTHDZ/T                                                 CR018248
      DTMB=0.019582*T*VS(IS)*SQRT(S)                                    CR018251
      IF(DELT.GE.DTMB)GO TO 1801                                        CR018254
      DHA=3.*VS(IS)*D(IS)/WSIS                                          CR018257
      DELHF=1.5*(VS(IS)*VS(IS)*D(IS)*D(IS)*T/(4.*TSIS*WSIS))**0.333333/ CR018260
     *S**0.166667                                                       CR018263
      IF(DHA.LT.DELHF)DELHF=DHA                                         CR018266
      HEIS=HPIS+DELHF                                                   CR018269
 1803 CONTINUE                                                          CR018272
      DO 1804 J=1,5                                                     CR018275
      HE(IS,J)=HEIS                                                     CR018278
 1804 CONTINUE                                                          CR018281
      GO TO 1800                                                        CR018284
 1801 CONTINUE                                                          CR018287
      IF(IPLAS.EQ.1)GO TO 1781                                          CR018296
      DO 1780 J=1,5                                                     CR018410
      HE(IS,J)=HEIS                                                     CR018420
 1780 CONTINUE                                                          CR018430
      GO TO 1800                                                        CR018440
C***ACCOUNT FOR TRANSITIONAL RISE UP TO POINT OF FINAL RISE             CR018445
 1781 DO 1782 J=1,5                                                     CR018450
      RDIS=RNG(J)                                                       CR018460
      CALL BEH072(DUMHX,HEIS,DUMHMW,DUMF,DHA,DUMDSF,DUMDHX,             CR018470
     *HPIS,TSIS,DUMVS,DUMD,VFIS,KST,WSIS,RDIS,DTHDZ,T,DUMP)             CR018480
      HE(IS,J)=HEIS                                                     CR018490
 1782 CONTINUE                                                          CR018495
```

SUBROUTINE BLK

```
      DATA P/.1,.15,.2,.25,.3,.3/                                       BL001500
      DATA ANHT/7./                                                     BL001600
      DATA IPLAS/0/                                                     BL001700
      DATA IDWN/0/                                                      BL001800
      DATA IMOM/0/                                                      BL001900
```

B. Computer Program Modifications

Several program modifications are described below. Some changes are cosmetic or produce a code more compatible with a variety of computer systems. Others may affect the output of the model slightly; however, the effect is of no consequence for applications in which CRSTER is most commonly used.

Make the following program line modifications to Appendix A of the User's Manual and check your computer programs for conformance.

PREPROCESSOR PROGRAM

1. 8/78 - In line METO3040 change ' Day ',I2, to ' DAY ',F4.0,.

2. 9/79 - Remove the statement number 220 from line METO2040.

3. 9/79 - Insert the following line of code:

```
      220 CONTINUE                                                    METO2041
```

SINGLE SOURCE CRSTER MODEL PROGRAM

1. 8/78 - Insert the following line of code:

```
      IF(ELEV(I7,I8).LT.PELEV)GADJ(I8,I7)=0.0                         CV022910
```

   The addition of this line of code will reposition the receptors that are below ground elevation of the plant to plant elevation. This prevents concentration estimates from being unrealistically low for receptors at elevations lower than the plant. This line of code was inadvertantly omitted from the original program.

2. 8/78 - Delete lines CV002000 and CV002100.

3. 8/78 - Insert the following lines:

```
      IMET=1                                                          CV002710
      IPTZ=0                                                          CV002720
```

4. 8/78 - Remove statement numbers 152, 816, and 515 respectively from lines CV013200, CV016400 and CV027700, and change the NS in line CV026400 to I2.

5. 8/78 - Remove IHC(4), from line CR000800.

6. 8/78 - Remove IHC, and 6,13,18,24, from line CR002700.*

7. 8/78 - Delete lines CR008600, CR068800, CR068900, CR071300 and CR071400.

*This modification is not required if the options under Section A herein are employed.

8. 8/78 - Insert a comma after:

   TABLE' in line CR045500,
   '/' in line CR061400,
   '/' in line CR061800 and
   CO' in line CR067000.

9. 8/78 - Remove ,KSTL from lines CV027700 and CR000100.

10. 8/78 - Remove TX3(2),TX4(2), from line BL000200.

11. 9/79 - Insert the following line of code:

```
      IF(KST.GE.5) GO TO 2350                                  CR023210
```

    4/80 - Change the following line of code to read:

```
      IF(CHEK.GE.1.6.AND.KST.LT.5)GO TO 2400                   CR022400
```

    12/80 - Change the following line of code to read:

```
      IF(KST.LT.5.AND.H.GT.XMH)GO TO 2800                      CR022000
```

    The addition/modification of these lines of code prevent inappropriate limited mixing under stable conditions in the rural mode. This may have a slight affect on concentrations for stable conditions; however this has no effect on design concentrations for applications in which CRSTER is most commonly used.

12. 9/79 - Change the following lines of code to read as follows:

```
C   BEH072   (BRIGGS EFFECTIVE HEIGHT)  September 79            BE000300
C    THIS DIFFERS FROM THE OCT. 1972 VERSION IN STATEMENT 24+1:  BE000400
C     THE CONSTANT 2.6 PREVIOUSLY WAS 2.4.                      BE000500
C                                                               BE000600
       DHA  = 2.6*(F/(U*S))**0.333333                           BE010300
```

    The code in line BE010300 is the equation for plume rise for the stable case as it is currently recommended by Briggs*. The constant "2.6" represents a change from Briggs' previously recommended value of "2.4", which was used in the original CRSTER code. This change causes the plume rise under stable conditions to be somewhat greater; however, this has no effect on design concentrations for applications in which CRSTER is most commonly used.

*Briggs, Gary A., 1972: Discussion on Chimney Plumes in Neutral and Stable Surroundings. Atmos. Environ. 6, 507-510 (July 72)

13. 9/79 - Delete lines CR015700 and CR015800 and replace with the following five lines:

```
C***IF STABILITY=7,SET KST AND KSTL TO 6.                          CR015700
      IF(ISTAB(IHR).LT.7) GO TO 1631                               CR015800
      KST=6                                                        CR015810
      KSTL=6                                                       CR015820
 1631 CONTINUE                                                     CR015830
```

The replacement of these lines of code will effectively reset all stability class 7 values to 6 and calculate a concentration for the time period involved. Since CRSTER was originally designed for relatively tall stacks with hot plumes and since stability class 6 results in nearly zero ground level concentrations, CRSTER was originally coded to assign a zero for the occurrence of stability class 7. However, to maintain consistency with the RAM and MPTER models which have been designed to accommodate, in addition, low level sources for which the stable conditions of stability class 6 may produce significant concentrations, the calculation of concentrations in CRSTER for stability class 7 (extremely stable) conditions is necessary. This change, though, will have no effect on design concentrations for applications in which CRSTER is most commonly used.

14. 9/79 - Insert the following lines:

```
      DATA HV1,HVX,HV3,KV1,KVX,KV3/150*0.0,150*0/                  CR002410
      IG=51-KIG                                                    CR031610
      IG=51-KIG                                                    CR036810
      IG=51-KIG                                                    CR042210
```

15. 9/79 - In lines CR031600, CR036800 and CR042200 change <u>IG=50,2,-1</u> to <u>KIG=1,49</u>.

16. 12/80 - Change the following lines of code to read as follows:

```
C--CRSTER--UNEVEN TERRAIN MODEL--REVISED-12/80                     CV000100
*'  EMISSION UNITS: GM/SEC  ', ' AIR QUALITY UNITS: GM/M**3 12/80')  CV003800
```

These modifications allow for the continued identification of the revisions made to the CRSTER computer code.

17. 12/80 - Change the following lines of code to read as follows:

```
     *HLH(2,24),WS(20),HP(20),TS(20),TITLE(20),IDENT(5),VF(20),D(20), CR000600
     *TAPIN(123),JMAX3(4),CHI(180),HE(20,5),DDD(366)                 CR001200
 8042 IF(IMET.EQ.0)GO TO 1199                                        CR012600
      WRITE(6,1500)TAPIN,((HLH(I,J),J=1,24),I=1,2)                   CR012900
      XMH =HLH(IUR,IHR)                                              CR014500
```

12/80 - Delete lines CR011500 through CR012500

These modifications eliminate the need to restructure the mixing height arrays as read from the preprocessor file.

18. 12/80 - Delete the following line of code;

```
      IDIR=DIR/10.                                                    CR019100
```

12/80 - Add the following lines of code:

```
      IF(DIR.LT.0.0)IDIR=(DIR/10.)-0.005                              CR019110
      IF(DIR.GE.0.0)IDIR=(DIR/10.)+0.005                              CR019120
```

These modifications eliminate the possibility of calculating incorrect receptor directions due to computer hardware limitations which do not allow for the exact representation of whole numbers in decimal notation.

19. 12/80 - Insert the following lines of code:

```
      IVT3=0                                                          CR005010
      IVTV=0                                                          CR005020
```

12/80 - Change the following lines of code to read as follows:

```
8007  IVT3=IVT3+1                                                     CR035400
      IF(IVT2.NE.3)GO TO 8008                                         CR035500
      IVT3=0                                                          CR035600
      IVT1=IHR/3                                                      CR035700
```

12/80 - Delete lines CR035800 and CR035900

12/80 - Change the following lines of code to read as follows:

```
      CHIH=CHIH/3.0                                                   CR036500
8052  IVTV=IVTV+1                                                     CR040800
      IF(IVTV.NE.IVT)GO TO 8054                                       CR040900
      IVTV=0                                                          CR041000
      AVT=IVT                                                         CR041100
      IVT1=IHR/IVT                                                    CR041200
```

12/80 - Delete line CR041300.

These modifications eliminate the possibility of the 3-hour and variable hour counter being miscalculated due to computer hardware limitations which do not allow for the exact representation of whole numbers in decimal notation.

C. 8/78 - Input Form Correction

The format of the PREP INITIALIZATION CARDS form at the top of Figure C-1, PREPROCESSOR INPUT DATA CODING FORMS, page C-3, is in error and should be modified to be compatible with the format described in TABLE 4-1, PREPROCESSOR INITIALIZATION CARD FORMAT, on page 4-11 of the User's Manual.

D. 8/78 - Clarification of the Highest 50 Concentration Tables

Users should note that the highest 50 maximum daily concentration table allows only the highest of the 180 24-hour average receptor concentrations on each day to be a candidate for entry into the table. However, the highest 50 concentration tables for 1-hour, 3-hour and variable hour time periods allow all of the 180 receptor concentrations for the specified time period to be candidates for entry into their respective tables.

If one desires a high 50 maximum daily concentration table where all of the 180 receptor concentrations are candidates for entry, then the variable time option should be used. To accomplish this, the namelist variable IVT should be set equal to 24 and program line CV011600 on page A-13 should be modified to read:

```
(OR.IVT.EQ.12.OR.IVT.EQ.24)                    CV011600
```

E. 8/78 - Random Number Alternative

The preprocessor program requires a random number subroutine not supplied with the program. The subroutine calculates numbers to be used in the development of the hourly randomized wind flow vectors. However, the set of numbers in Appendix A of this Supplement should be used routinely. These numbers were used to derive the randomized wind flow vectors for the test case. They are the set used by EPA for regulatory applications. These numbers were computed by the Sperry Rand Corp. random number generator subroutine, RANDU, installed on EPA's UNIVAC 1110 computer; the random number seed used is 65549.

Each line of data in Appendix A contains the day number and 24 integers. The positions of the integers(1-24) identify the hours of that day for which the integers are to be used in the derivation of the randomized wind flow vectors. Using the numbers will require the user to effectively modify the preprocessor program such that the given integers get transferred into the integer variable IRAND in line MET01870 to properly coincide with the KHR hour of the IDY day.

F. 9/79 - Running Averages

A new subroutine has been developed for the purpose of calculating running averages. The subroutine, entitled RUN, has been written for the express use with the Single Source (CRSTER) Model. The use of the procedure is optional and allows for the selection of running 3-hour, 8-hour and/or 24-hour averaging times. For each averaging time selected the subroutine will produce a table of highest concentrations and a table of second highest concentrations for each of the 180 radial receptors defined. The second highest table values are determined using the criteria that there is one other non-overlapping value that is at least as high as the second highest value. This procedure is consistent with that stated in Issue 7B, OAQPS Guidelines for The Interpretation of Air Quality Standards, No. 1.2-008 (Revised February 1977). Also, for each averaging time selected a high-50 table will be produced. This table allows concentrations for different starting hours for the same day, direction and distance to be candidates for inclusion.

A note of caution, though, is in order for prospective users. Selection of all three averaging time options will cause an increase in the CRSTER model run time by approximately a factor of thirteen (13). Selection of one or two running averages will show proportionate increases.

Instructions for the installation and use of Subroutine RUN are given in the first 47 lines of code for the subroutine. The computer code can be found in Appendix B of this Supplement.

Appendix A

1	528776971580736851814644
2	066401304595314825698912
3	408413032862561435121351
4	002356020117965473131362
5	981469693223249230116426
6	079760262290596669256060
7	274970384876501988562659
8	352919954431386324767248
9	900803784851894758053489
10	574929880657900221739625
11	487878656914981570380053
12	238012267523225303690194
13	327384175765415018402542
14	872460684421751060970114
15	462494361164847071568734
16	031386626156645905340036
17	123871458609028623312253
18	433796327611595933943570
19	119072661583445782481520
20	371817924920746753193832
21	343415319469304228030123
22	654896162827119830914957
23	414435319308434769851114
24	031236172812317226669973
25	468959058652764055424 14
26	692280707860060495820082
27	565525145674018025002500
28	141861033880295652241522
29	169528787374759841713682
30	961742691663842765872552
31	826571960820183023035207
32	721310304800830026039656
33	697937009050706428217437
34	590200468794226119067279
35	110962138097719606980862
36	036630324966908971963681
37	274021838220839666253611
38	298254688725645587294978
39	459546595807866723917306
40	380152014558301261130995
41	934509531456837928419815
42	078610727955269981575008
43	338536750691252826946929
44	893186143585314349803320
45	460029487728619770315227
46	766421580209262080095848
47	956853942896790463688358
48	065851952598286633824670
49	777814482231015037482769
50	332032418547661181642312
51	278527696176248021959004
52	482282808068572225683760
53	044084948180388675200391
54	024357956530090100966427
55	766581035643599768885911
56	892197676070049525214088
57	524694763544250618789598
58	217698779353299905230921
59	330143041033496367143969

60	332182962881998959333374
61	933449097112500240729843
62	323798327819007763706259
63	497020131840727388723431
64	440141950835984537380281
65	044145492524615353091464
66	865015050207362466532494
67	622068244854795638845018
68	372646946090684899002112
69	343415319469304228030123
70	654896162827119830914957
71	414435319308434769851114
72	031236172812317226669973
73	468959058652766405542414
74	692280707860060495820082
75	565525145674018025002500
76	141861033880295652241522
77	169528787374759841713682
78	961742691663842765872552
79	826571960820183023035207
80	721310304800830026039656
81	697937009050706428217437
82	590200468794226119067279
83	110962138097719606980862
84	036630324966908971963681
85	274021838220839666253611
86	298254688725645587294978
87	459546595807866723917306
88	380152014558301261130995
89	934509531456837928419815
90	078610727955269081575008
91	338536760691252826946929
92	893186143585314349803320
93	460029487728619770315227
94	766421580209262080095848
95	956853942896790463688358
96	065851952598288633824670
97	777814482231015037482769
98	332032418547661181642312
99	278527696176248021959004
100	482282808068572225683760
101	044084948180388675200391
102	024357956530090100966427
103	766581035643599768885911
104	892197676070049525214088
105	524694763544250618789598
106	217698779353299905230921
107	330143041033496367143969
108	332182962881998959333374
109	933449097112500240729843
110	323798327819007763706259
111	497020131840727388723431
112	440141950835984537380281
113	044145492524615353091464
114	865015050207362466532494
115	622068244854795638845018
116	372646946090684899002112
117	343415319469304228030123
118	654896162827119830914957
119	414435319308434769851114

120	03123617281231722669973
121	46895905865276640554241 4
122	69228070786006049582008 2
123	56552514567401802500250 0
124	14186103388029565224152 2
125	16952878737475984171368 2
126	96174269166384276587255 2
127	82657196082018302303520 7
128	72131030480083002603965 6
129	69793700905070642821743 7
130	59020046879422611906727 9
131	11096213809771960698086 2
132	03663032496690897196368 1
133	27402183822083966625361 1
134	29825468872564558729497 8
135	45954659580786672391730 6
136	38015201455830126113099 5
137	93450953145683792841981 5
138	07861072795526998157500 8
139	33853676069125282694692 9
140	89318614358531434980332 0
141	46002948772861977031522 7
142	76642158020926208009584 8
143	95685394289679046368835 8
144	06585195259828863382467 0
145	77781448223101503748276 9
146	33203241854766118164231 2
147	27852769617624802195900 4
148	48228280806857222568376 0
149	04408494818038867520039 1
150	02435795653009010096642 7
151	76658103564359976888591 1
152	89219767607004952521408 8
153	52469476354425061878959 8
154	21769877935329990523092 1
155	33014304103349636714396 9
156	33218296288199895933337 4
157	93344909711250024072984 3
158	32379832781900776370625 9
159	49702013184072738872343 1
160	44014195083598453738028 1
161	04414549252461535309146 4
162	86501505020736246653249 4
163	62206824485479563884501 8
164	37264694609068489900211 2
165	34341531946930422803012 3
166	65489616282711983091495 7
167	41443531930843476985111 4
168	03123617281231722669973
169	46895905865276640554241 4
170	69228070786006049582008 2
171	56552514567401802500250 0
172	14186103388029565224152 2
173	16952878737475984171368 2
174	96174269166384276587255 2
175	82657196082018302303520 7
176	72131030480083002603965 6
177	69793700905070642821743 7
178	59020046879422611906727 9
179	11096213809771960698086 2

180	036630324966908971963681
181	274021838220839666253611
182	298254688725645587294978
183	459546595807866723917306
184	380152014558301261130995
185	934509531456837928419815
186	078610727955269981575008
187	338536760691252826946929
188	893186143585314349803320
189	460029487728619770315227
190	766421580209262080095848
191	956853942896790463688358
192	065851952598288633824670
193	777814482231015037482769
194	332032418547661181642312
195	278527696176248021959004
196	482282808068572225683760
197	044084948180388675200391
198	024357956530090100966427
199	766581035643599768885911
200	892197676070049525214088
201	524694763544250618789598
202	217698779353299905230921
203	330143041033496367143969
204	332182962881998959333374
205	933449097112500240729843
206	323798327819007763706259
207	497020131840727388723431
208	440141950835984537380281
209	044145492524615353091464
210	865015050207362466532494
211	622068244854795638845018
212	372646946090684899002112
213	343415319469304228030123
214	654896162827119830914957
215	414435319308434769851114
216	031236172812317226669973
217	468959058652766405542414
218	692280707860060495820082
219	565525145674018025002500
220	141861033880295652241522
221	169528787374759841713682
222	961742691663842765872552
223	826571960820183023035207
224	721310304800830026039656
225	697937009050706428217437
226	590200468794226119067279
227	110962138097719606980862
228	036630324966908971963681
229	274021838220839666253611
230	298254688725645587294978
231	459546595807866723917306
232	380152014558301261130995
233	934509531456837928419815
234	078610727955269981575008
235	338536760691252826946929
236	893186143585314349803320
237	460029487728619770315227
238	766421580209262080095848
239	956853942896790463688358

240	065851952598288633824670
241	777814482231015037482769
242	332032418547661181642312
243	278527696176248021959004
244	482282808068572225683760
245	044084948180388675200391
246	024357956530090100966427
247	766581035643599768885911
248	892197676070049525214088
249	524694763544250618789598
250	217698779353299905230921
251	330143041033496367143969
252	332182962881998959333374
253	933449097112500240729843
254	323798327819007763706259
255	497020131840727388723431
256	440141950835984537380281
257	044145492524615353091464
258	865015050207362466532494
259	622068244854795638845018
260	372646946090684899002112
261	343415319469304228030123
262	654896162827119830914957
263	414435319308434769851114
264	031236172812317226669973
265	468959058652766405542414
266	692280707860060495820082
267	565525145674018025002500
268	141861033880295652241522
269	169528787374759841713682
270	961742691663842765872552
271	826571960820183023035207
272	721310304800830026039656
273	697937009050706428217437
274	590200468794226119067279
275	110962138097719606980862
276	036630324966908971963681
277	274021838220839666253611
278	298254688725645587294978
279	459546595807866723917306
280	380152014558301261130995
281	934509531456837928419815
282	078610727955269981575008
283	338536760691252826946929
284	893186143585314349803320
285	460029487728619770315227
286	766421580209262080095848
287	956853942896790463688358
288	065851952598288633824670
289	777814482231015037482769
290	332032418547661181642312
291	278527696176248021959004
292	482282808068572225683760
293	044084948180388675200391
294	024357956530090100966427
295	766581035643599768885911
296	892197676070049525214088
297	524694763544250618789598
298	217698779353299905230921
299	330143041033496367143969

300	332182962881998959333374
301	933449097112500240729843
302	323798327819007763706259
303	497020131840727388723431
304	440141950835984537380281
305	044145492524615353091464
306	865015050207362466532494
307	622068244854795638845018
308	372646946090684899002112
309	343415319469304228030123
310	654896162827119830914957
311	414435319308434769851114
312	031236172812317226669973
313	468959058652766405542414
314	692280707860060495820082
315	565525145674018025002500
316	141861033880295652241522
317	169528787374759841713682
318	961742691663842765872552
319	826571960820183023035207
320	721310304800830026039656
321	697937009050706428217437
322	590200468794226119067279
323	110962138097719606980862
324	036630324966908971963681
325	274021838220839666253611
326	298254688725645587294978
327	459546595807866723917306
328	380152014558301261130995
329	934509531456837928419815
330	078610727955269981575008
331	338536760691252826946929
332	893186143585314349803320
333	460029487728619770315227
334	766421580209262080095848
335	956853942896790463688358
336	065851952598288633824670
337	777814482231015037482769
338	332032418547661181642312
339	278527696176248021959004
340	482282808068572225683760
341	044084948180388675200391
342	024357956530090100966427
343	766581035643599768885911
344	892197676070049525214088
345	524694763544250618789598
346	217698779353299905230921
347	330143041033496367143969
348	332182962881998959333374
349	933449097112500240729843
350	323798327819007763706259
351	497020131840727388723431
352	440141950835984537380281
353	044145492524615353091464
354	865015050207362466532494
355	622068244854795638845018
356	372646946090684899002112
357	343415319469304228030123
358	654896162827119830914957
359	414435319308434769851114

360	031236172812317226669973
361	468959058652766405542414
362	692280707860060495820082
363	565525145674018025002500
364	141861033880295652241522
365	169528787374759841713682
366	961742691663842765872552

Appendix B

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      SUBROUTINE RUN(A,B,C,CHI,TX1,TX2,IDAY,ISC,RNG)                    RN000100
C         9/10/79                                                       RN000200
C*** THE FUNCTION OF THIS SUBROUTINE IS TO CALCULATE AND PRINT RUNNING  RN000300
C    AVERAGES FOR 3-HOUR, 8-HOUR AND/OR 24-HOUR AVERAGING TIMES. THIS   RN000400
C    PROCEDURE WAS DEVELOPED FOR USE WITH THE SINGLE SOURCE CRSTER      RN000500
C    MODEL. TO ESTABLISH THIS SUBROUTINE, ONE NEED ONLY ADD THE         RN000600
C    FOLLOWING CALL STATEMENTS TO THE CRSTER ROUTINES INDICATED BELOW:  RN000700
C                                                                       RN000800
C     MAIN CRSV                                                         RN000900
C                                                                       RN001000
C      CALL RUN(SOURCE(1),SOURCE(2),SOURCE(3),GADJ,TX1,TX2,DAY,ISC,RNG) RN001100
C      CALL RUN(SOURCE(1),SOURCE(2),SOURCE(3),GADJ,TX1,TX2,DAY,ISC,RNG) RN001200
C         AS LINES CV018150 AND CV027750 RESPECTIVELY.                  RN001300
C                                                                       RN001400
C     SUBROUTINE CRS                                                    RN001500
C                                                                       RN001600
C      CALL RUN(TX1,TX1,TX1,CHI,TX1,TX2,DAY,ISC,RNG)                    RN001700
C      CALL RUN(TX1,TX1,TX1,CHI,TX1,TX2,DAY,ISC,RNG)                    RN001800
C         AS LINES CR013750 AND CR071050 RESPECTIVELY.                  RN001900
C                                                                       RN002000
C                                                                       RN002100
C    TO OPTION THE USE OF THE SUBROUTINE, THE FIRST OF THE TWO BLANK    RN002200
C    CARDS AT THE VERY END OF THE CRSTER INPUT DECK IS USED. ANY        RN002300
C    CHARACTER IN CC 1-4 WILL PRODUCE 3-HOUR RUNNING AVERAGES; ANY      RN002400
C    CHARACTER IN CC 5-8 WILL PRODUCE 8-HOUR RUNNING AVERAGES; ANY      RN002500
C    CHARACTER IN CC 9-12 WILL PRODUCE 24-HOUR RUNNING AVERAGES. FOR    RN002600
C    EACH AVERAGING TIME CHOSEN, A HIGHEST, SECOND HIGHEST AND HIGH-50  RN002700
C    TABLE WILL BE PRINTED.                                             RN002800
C                                                                       RN002900
C                                                                       RN003000
C    THE SECOND HIGHEST RUNNING AVERAGES CALCULATED ARE DETERMINED      RN003100
C    USING THE PROCEDURE OUTLINED UNDER ISSUE 7B IN THE OAQPS GUIDELINE RN003200
C    DOCUMENT ENTITLED "GUIDELINES FOR THE INTERPRETATION OF AIR        RN003300
C    QUALITY STANDARDS, NO. 1.2-008 (REVISED FEBRUARY 1977)".           RN003400
C                                                                       RN003500
C                                                                       RN003600
C    RESTRICTIONS                                                       RN003700
C                                                                       RN003800
C       1) IF THE SOURCE CONTRIBUTION OPTION IN CRSTER IS TURNED        RN003900
C          ON (ISC=1), THE RUNNING AVERAGE OPTION WILL DEFAULT TO "OFF".RN004000
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C                                                                       RN004100
C       2) ANY NUMBER OF DAYS OF THE YEAR MAY BE RUN FOR CRSTER IN      RN004200
C          CONJUNCTION WITH SUBROUTINE RUN BUT ALL OF THE DAYS SELECTED RN004300
C          MUST DEFINE A CONTINUOUS PERIOD OF DAYS (NO GAPS) IN ORDER   RN004400
C          FOR THE RUNNING AVERAGE RESULTS TO BE MEANINGFUL.            RN004500
C                                                                       RN004600
C                                                                       RN004700
C                                                                       RN004800
C                                                                       RN004900
C                                                                       RN005000
      DIMENSION CHI(180),TX1(6),TX2(2),RNG(5),IDAY(366)                 RN005100
      DIMENSION CONC(180),AVG3(180),AVG8(180),AVG24(180),               RN005200
     *AWK(180),IAWK(180),JAWK(180),HI503(51),IH503(51),ID503(51),       RN005300
     *HI508(51),IH508(51),ID508(51),HI5024(51),                         RN005400
     *IH5024(51),ID5024(51),JMAX1U(180),DMAXUN(180),                    RN005500
     *TOT3(180),TOT8(180),TOT24(180),                                   RN005600
     *RTAB3(180,4),RTAB8(180,9),RTAB24(180,25),                         RN005700
     *ITID3(180,4),ITID8(180,9),ITID24(180,25),                         RN005800
     *VAL3(180,3),VAL8(180,8),VAL24(180,24),IUNI(180)                   RN005900
      INTEGER*2 SAB(180,2),SUB(36,5)                                    RN006000
      DATA AA,BB,CC /'    ','    ','    '/                             RN006100
      DATA N,ID,IRA3,IRA8,IRA24 /5*0/                                   RN006200
      DATA SAB/36*1,36*2,36*3,36*4,36*5,                                RN006300
     *1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,         RN006400
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36,1,2,3,4,5,6,7,8,9,10,11,RN006500
     *12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,RN006600
     *34,35,36,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,RN006700
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36,1,2,3,4,5,6,7,8,9,10,11,RN006800
     *12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,RN006900
     *34,35,36,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,RN007000
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36/                        RN007100
      DATA SUB/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,RN007200
     *23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,RN007300
     *45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,RN007400
     *67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,RN007500
     *89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107, RN007600
     *108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,  RN007700
     *124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,  RN007800
     *140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,  RN007900
     *156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,  RN008000
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     *172,173,174,175,176,177,178,179,180/                              RN008100
      IF(ISC.EQ.1)RETURN                                                RN008200
      N=N+1                                                             RN008300
      IF(N.EQ.2)RETURN                                                  RN008400
      IF(N.GT.2)GO TO 1000                                              RN008500
      IF(A.NE.AA)IRA3=1                                                 RN008600
      IF(B.NE.BB)IRA8=1                                                 RN008700
      IF(C.NE.CC)IRA24=1                                                RN008800
      DO 1 I=1,365                                                      RN008900
    1 ID=ID+IDAY(I)*24                                                  RN009000
      RETURN                                                            RN009100
 1000 IF(IRA3.EQ.1.OR.IRA8.EQ.1.OR.IRA24.EQ.1) GO TO 2000               RN009200
      RETURN                                                            RN009300
 2000 IDD=N-3                                                           RN009400
      IF(ID.EQ.IDD) GO TO 3000                                          RN009500
C                                                                       RN009600
C                                                                       RN009700
C                                                                       RN009800
C***COMMENCE CALCULATING RUNNING AVERAGES FOR SELECTED AVERAGING TIMES. RN009900
C                                                                       RN010000
C                                                                       RN010100
C                                                                       RN010200
      DO 5 LR=1,180                                                     RN010300
      CONC(LR)=CHI(LR)                                                  RN010400
    5 CONTINUE                                                          RN010500
      ISUMR=ISUMR+1                                                     RN010600
      IF(IRA3.EQ.0)GO TO 40                                             RN010700
C                                                                       RN010800
C***CALCULATE 3-HOUR RUNNING AVERAGES.                                  RN010900
C                                                                       RN011000
      IF(ISUMR.GE.3)GO TO 20                                            RN011100
      DO 10 LR=1,180                                                    RN011200
      VAL3(LR,ISUMR+1)=CONC(LR)                                         RN011300
      TOT3(LR)=TOT3(LR)+CONC(LR)                                        RN011400
   10 CONTINUE                                                          RN011500
      GO TO 40                                                          RN011600
   20 DO 25 LR=1,180                                                    RN011700
      TOT3(LR)=TOT3(LR)-VAL3(LR,1)+CONC(LR)                             RN011800
      AVG3(LR)=TOT3(LR)/3.                                              RN011900
      DO 24 IQ=1,2                                                      RN012000
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      VAL3(LR,IQ)=VAL3(LR,IQ+1)                                         RN012100
   24 CONTINUE                                                          RN012200
      VAL3(LR,3)=CONC(LR)                                               RN012300
   25 CONTINUE                                                          RN012400
      DO 29 LR=1,180                                                    RN012500
      DO 28 IOUR=1,4                                                    RN012600
      IF(AVG3(LR).LT.RTAB3(LR,IOUR))GO TO 28                            RN012700
      IF(IOUR.EQ.4)GO TO 23                                             RN012800
      IP=4-IOUR                                                         RN012900
      DO 27 LTS=1,IP                                                    RN013000
      LS=5-LTS                                                          RN013100
      RTAB3(LR,LS)=RTAB3(LR,LS-1)                                       RN013200
      ITID3(LR,LS)=ITID3(LR,LS-1)                                       RN013300
   27 CONTINUE                                                          RN013400
   23 RTAB3(LR,IOUR)=AVG3(LR)                                           RN013500
      ITID3(LR,IOUR)=ISUMR-2                                            RN013600
      GO TO 29                                                          RN013700
   28 CONTINUE                                                          RN013800
   29 CONTINUE                                                          RN013900
      DO 45 LR=1,180                                                    RN014000
      DO 44 LT=1,50                                                     RN014100
      IF(AVG3(LR).LE.HI503(LT))GO TO 44                                 RN014200
      IF(LT.EQ.50)GO TO 47                                              RN014300
      IP=50-LT                                                          RN014400
      DO 43 LTS=1,IP                                                    RN014500
      LS=51-LTS                                                         RN014600
      HI503(LS)=HI503(LS-1)                                             RN014700
      IH503(LS)=IH503(LS-1)                                             RN014800
      ID503(LS)=ID503(LS-1)                                             RN014900
   43 CONTINUE                                                          RN015000
   47 HI503(LT)=AVG3(LR)                                                RN015100
      IH503(LT)=ISUMR-2                                                 RN015200
      ID503(LT)=LR                                                      RN015300
      GO TO 45                                                          RN015400
   44 CONTINUE                                                          RN015500
   45 CONTINUE                                                          RN015600
   40 IF(IRA8.EQ.0)GO TO 70                                             RN015700
C                                                                       RN015800
C***CALCULATE 8-HOUR RUNNING AVERAGES.                                  RN015900
C                                                                       RN016000
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      IF(ISUMR.GE.8)GO TO 50                                            RN016100
      DO 46 LR=1,180                                                    RN016200
      VAL8(LR,ISUMR+1)=CONC(LR)                                         RN016300
      TOT8(LR)=TOT8(LR)+CONC(LR)                                        RN016400
   46 CONTINUE                                                          RN016500
      GO TO 70                                                          RN016600
   50 DO 52 LR=1,180                                                    RN016700
      TOT8(LR)=TOT8(LR)-VAL8(LR,1)+CONC(LR)                             RN016800
      AVG8(LR)=TOT8(LR)/8.                                              RN016900
      DO 51 IQ=1,7                                                      RN017000
      VAL8(LR,IQ)=VAL8(LR,IQ+1)                                         RN017100
   51 CONTINUE                                                          RN017200
      VAL8(LR,8)=CONC(LR)                                               RN017300
   52 CONTINUE                                                          RN017400
      DO 60 LR=1,180                                                    RN017500
      DO 59 IOUR=1,9                                                    RN017600
      IF(AVG8(LR).LE.RTAB8(LR,IOUR))GO TO 59                            RN017700
      IF(IOUR.EQ.9)GO TO 57                                             RN017800
      IP=9-IOUR                                                         RN017900
      DO 58 LTS=1,IP                                                    RN018000
      LS=10-LTS                                                         RN018100
      RTAB8(LR,LS)=RTAB8(LR,LS-1)                                       RN018200
      ITID8(LR,LS)=ITID8(LR,LS-1)                                       RN018300
   58 CONTINUE                                                          RN018400
   57 RTAB8(LR,IOUR)=AVG8(LR)                                           RN018500
      ITID8(LR,IOUR)=ISUMR-7                                            RN018600
      GO TO 60                                                          RN018700
   59 CONTINUE                                                          RN018800
   60 CONTINUE                                                          RN018900
      DO 65 LR=1,180                                                    RN019000
      DO 64 LT=1,50                                                     RN019100
      IF(AVG8(LR).LE.HI508(LT))GO TO 64                                 RN019200
      IF(LT.EQ.50)GO TO 67                                              RN019300
      IP=50-LT                                                          RN019400
      DO 63 LTS=1,IP                                                    RN019500
      LS=51-LTS                                                         RN019600
      HI508(LS)=HI508(LS-1)                                             RN019700
      IH508(LS)=IH508(LS-1)                                             RN019800
      ID508(LS)=ID508(LS-1)                                             RN019900
   63 CONTINUE                                                          RN020000
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   67 HI508(LT)=AVG8(LR)                                                RN020100
      IH508(LT)=ISUMR-7                                                 RN020200
      ID508(LT)=LR                                                      RN020300
      GO TO 65                                                          RN020400
   64 CONTINUE                                                          RN020500
   65 CONTINUE                                                          RN020600
   70 IF(IRA24.EQ.0)GO TO 4081                                          RN020700
C                                                                       RN020800
C***CALCULATE 24-HOUR RUNNING AVERAGES.                                 RN020900
C                                                                       RN021000
      IF(ISUMR.GE.24)GO TO 71                                           RN021100
      DO 72 LR=1,180                                                    RN021200
      VAL24(LR,ISUMR+1)=CONC(LR)                                        RN021300
      TOT24(LR)=TOT24(LR)+CONC(LR)                                      RN021400
   72 CONTINUE                                                          RN021500
      GO TO 4081                                                        RN021600
   71 DO 74 LR=1,180                                                    RN021700
      TOT24(LR)=TOT24(LR)-VAL24(LR,1)+CONC(LR)                          RN021800
      AVG24(LR)=TOT24(LR)/24.                                           RN021900
      DO 73 IQ=1,23                                                     RN022000
      VAL24(LR,IQ)=VAL24(LR,IQ+1)                                       RN022100
   73 CONTINUE                                                          RN022200
      VAL24(LR,24)=CONC(LR)                                             RN022300
   74 CONTINUE                                                          RN022400
      DO 80 LR =1,180                                                   RN022500
      DO 79 IOUR=1,25                                                   RN022600
      IF(AVG24(LR).LE.RTAB24(LR,IOUR))GO TO 79                          RN022700
      IF(IOUR.EQ.25)GO TO 75                                            RN022800
      IP=25-IOUR                                                        RN022900
      DO 78 LTS=1,IP                                                    RN023000
      LS=26-LTS                                                         RN023100
      RTAB24(LR,LS)=RTAB24(LR,LS-1)                                     RN023200
      ITID24(LR,LS)=ITID24(LR,LS-1)                                     RN023300
   78 CONTINUE                                                          RN023400
   75 RTAB24(LR,IOUR)=AVG24(LR)                                         RN023500
      ITID24(LR,IOUR)=ISUMR-23                                          RN023600
      GO TO 80                                                          RN023700
   79 CONTINUE                                                          RN023800
   80 CONTINUE                                                          RN023900
      DO 85 LR=1,180                                                    RN024000
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      DO 84 LT=1,50                                                     RN024100
      IF(AVG24(LR).LE.HI5024(LT)) GO TO 84                              RN024200
      IF (LT.EQ.50)GO TO 87                                             RN024300
      IP=50-LT                                                          RN024400
      DO 83 LTS=1,IP                                                    RN024500
      LS=51-LTS                                                         RN024600
      HI5024(LS)=HI5024(LS-1)                                           RN024700
      IH5024(LS)=IH5024(LS-1)                                           RN024800
      ID5024(LS)=ID5024(LS-1)                                           RN024900
   83 CONTINUE                                                          RN025000
   87 HI5024(LT)=AVG24(LR)                                              RN025100
      IH5024(LT)=ISUMR-23                                               RN025200
      ID5024(LT)=LR                                                     RN025300
      GO TO 85                                                          RN025400
   84 CONTINUE                                                          RN025500
   85 CONTINUE                                                          RN025600
      RETURN                                                            RN025700
C                                                                       RN025800
C                                                                       RN025900
C                                                                       RN026000
C***COMMENCE WRITING OUTPUT TABLES FOR SELECTED AVERAGEING TIMES.       RN026100
C                                                                       RN026200
C                                                                       RN026300
C                                                                       RN026400
 3000 IF(IRA24.EQ.0)GO TO 9135                                          RN026500
      INM=24                                                            RN026600
 9101 CONTINUE                                                          RN026700
C                                                                       RN026800
C***TRANSFER 24-HOUR TABLES FOR PRINTING.                               RN026900
C                                                                       RN027000
      DO 9100 LR=1,180                                                  RN027100
      DO 9105 J=1,INM                                                   RN027200
      K=J+1                                                             RN027300
 9103 K=K-1                                                             RN027400
      IF(K.EQ.0)GO TO 9105                                              RN027500
      IF((ABS(ITID24(LR,K)-ITID24(LR,J+1))).LT.INM)GO TO 9103           RN027600
      RTAB24(LR,2)=RTAB24(LR,J+1)                                       RN027700
      ITID24(LR,2)=ITID24(LR,J+1)                                       RN027800
      GO TO 9100                                                        RN027900
 9105 CONTINUE                                                          RN028000
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 9100 CONTINUE                                                          RN028100
C                                                                       RN028200
C***GENERALIZED ROUTINE TO PREPARE **HIGHEST** TABLES FOR EACH          RN028300
C   AVERAGING TIME FOR PRINTING.                                        RN028400
C                                                                       RN028500
      DO 9110 LR=1,180                                                  RN028600
      AWK(LR)=RTAB24(LR,1)                                              RN028700
      IAWK(LR)=ITID24(LR,1)/24                                          RN028800
      IWK=IAWK(LR)*24                                                   RN028900
      JAWK(LR)=ITID24(LR,1)-IWK                                         RN029000
      IAWK(LR)=IAWK(LR)+1                                               RN029100
      IF(JAWK(LR).EQ.0)JAWK(LR)=24                                      RN029200
      IF(JAWK(LR).EQ.0)IAWK(LR)=IAWK(LR)-1                              RN029300
 9110 CONTINUE                                                          RN029400
      IJN=0                                                             RN029500
      DO 9106 IJER=1,36                                                 RN029600
      DO 9106 IJES=1,5                                                  RN029700
      IJN=IJN+1                                                         RN029800
      IJK=SUB(IJER,IJES)                                                RN029900
      DMAXUN(IJN)=AWK(IJK)                                              RN030000
      JMAX1U(IJN)=IAWK(IJK)                                             RN030100
      IUNI(IJN)=JAWK(IJK)                                               RN030200
 9106 CONTINUE                                                          RN030300
C                                                                       RN030400
C***GENERALIZED ROUTINE FOR PRINTING **HIGHEST** TABLES FOR EACH        RN030500
C   AVERAGING TIME.                                                     RN030600
C                                                                       RN030700
      WRITE(6,6050)TX1,TX2                                              RN030800
 6050 FORMAT(1H1,2X,'PLANT NAME: ',6A4,'  POLLUTANT: ',2A4,             RN030900
     *'  EMISSION UNITS: GM/SEC  ','  AIR QUALITY UNITS: GM/M**3'/)     RN031000
      WRITE(6,9080)INM,RNG                                              RN031100
 9080 FORMAT(1X,T17,'HIGHEST ',I2,'-HOUR RUNNING AVERAGE',              RN031200
     *' CONCENTRATIONS AT EACH RECEPTOR'//                              RN031300
     *1X,T4,'RANGE    ',4(F5.1,' KM',17X),F5.1,' KM'/                   RN031400
     *1X ,T2,'DIR'/3X,5(14X,'(DAY,ST HR)'))                             RN031500
      DO 9120 I=1,36                                                    RN031600
      IFR=I*5-4                                                         RN031700
      ITO=I*5                                                           RN031800
      WRITE(6,8040)I,(DMAXUN(J),JMAX1U(J),IUNI(J),J=IFR,ITO)            RN031900
 8040 FORMAT(1X,T3,I2,T6,5(1PE11.4,' (',I3,',',I2,')',5X))              RN032000
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 9120 CONTINUE                                                          RN032100
C                                                                       RN032200
C***GENERALIZED ROUTINE FOR PREPARING **SECOND HIGHEST** TABLES FOR     RN032300
C   EACH AVERAGING TIME FOR PRINTING.                                   RN032400
C                                                                       RN032500
      DO 9122 LR=1,180                                                  RN032600
      AWK(LR)=RTAB24(LR,2)                                              RN032700
      IAWK(LR)=ITID24(LR,2)/24                                          RN032800
      IWK=IAWK(LR)*24                                                   RN032900
      JAWK(LR)=ITID24(LR,2)-IWK                                         RN033000
      IAWK(LR)=IAWK(LR)+1                                               RN033100
      IF(JAWK(LR).EQ.0)JAWK(LR)=24                                      RN033200
      IF(JAWK(LR).EQ.0)IAWK(LR)=IAWK(LR)-1                              RN033300
 9122 CONTINUE                                                          RN033400
      IJN=0                                                             RN033500
      DO 9104 IJER=1,36                                                 RN033600
      DO 9104 IJES=1,5                                                  RN033700
      IJN=IJN+1                                                         RN033800
      IJK=SUB(IJER,IJES)                                                RN033900
      DMAXUN(IJN)=AWK(IJK)                                              RN034000
      JMAX1U(IJN)=IAWK(IJK)                                             RN034100
      IUNI(IJN)=JAWK(IJK)                                               RN034200
 9104 CONTINUE                                                          RN034300
C                                                                       RN034400
C***GENERALIZED ROUTINE FOR PRINTING **SECOND HIGHEST** TABLES FOR      RN034500
C   EACH AVERAGING TIME.                                                RN034600
C                                                                       RN034700
      WRITE(6,6050)TX1,TX2                                              RN034800
      WRITE(6,9081)INM,RNG                                              RN034900
 9081 FORMAT(1X,T17,'SECOND HIGHEST ',I2,'-HOUR RUNNING AVERAGE',       RN035000
     *' CONCENTRATIONS AT EACH RECEPTOR'//                              RN035100
     *1X,T4,'RANGE    ',4(F5.1,' KM',17X),F5.1,' KM'/                   RN035200
     *1X ,T2,'DIR'/3X,5(14X,'(DAY,ST HR)'))                             RN035300
      DO 9123 I=1,36                                                    RN035400
      IFR=I*5-4                                                         RN035500
      ITO=I*5                                                           RN035600
      WRITE(6,8040)I,(DMAXUN(J),JMAX1U(J),IUNI(J),J=IFR,ITO)            RN035700
 9123 CONTINUE                                                          RN035800
      WRITE(6,9128)                                                     RN035900
 9128 FORMAT(//////58X,'**** NOTE ****'//                               RN036000
```

```
     *22X,'THE SECOND HIGHEST RUNNING AVERAGES LISTED ON THIS PAGE',
     *' HAVE BEEN DETERMINED USING THE'/
     *21X,' PROCEDURE OUTLINED UNDER ISSUE 7B IN THE OAQPS GUIDE',
     *'LINE DOCUMENT ENTITLED GUIDELINES'/
     *22X,'FOR THE INTERPRETATION OF AIR QUALITY STANDARDS.',
     *' NO. 1.2-008 (REVISED FEBRUARY 1977).')
C
C***GENERALIZED ROUTINE FOR PREPARING **HIGH-50** TABLES FOR EACH
C   AVERAGING TIME FOR PRINTING.
C
      WRITE(6,6050)TX1,TX2
      WRITE(6,9129)INM,INM
 9129 FORMAT(49X,'MAXIMUM ',I2,'-HOUR RUNNING AVERAGE',
     *' CONCENTRATIONS'//
     *41X,'DAY      ',I2,'-HOUR RUNNING AVG    DIRECTION    ',
     *'DISTANCE  START HOUR'/)
      DO 9132 I=1,50
      KR2=IH5024(I)/24
      IWK=KR2*24
      KR7=IH5024(I)-IWK
      KR2=KR2+1
      IF(KR7.EQ.0)KR7=24
      IF(KR7.EQ.0)KR2=KR2-1
      IWK=ID5024(I)
      KR4=SAB(IWK,1)
      GR5=RNG(KR4)
      KR4=SAB(IWK,2)
C
C***GENERALIZED ROUTINE FOR PRINTING **HIGH-50** TABLES FOR EACH
C   AVERAGING TIME.
C
 9132 WRITE(6,9130)KR2,HI5024(I),KR4,GR5,KR7
 9130 FORMAT(40X,I3,1PE20.4,I14,0PF14.2,7X,I3)
 9135 IF(IRA8.EQ.0)GO TO 9160
      IRA8=0
      INM=8
C
C***TRANSFER 8-HOUR TABLE FOR PRINTING.
C
      DO 9136 I=1,50
```

```
      HI5024(I)=HI508(I)                                                RN040100
      IH5024(I)=IH508(I)                                                RN040200
      ID5024(I)=ID508(I)                                                RN040300
 9136 CONTINUE                                                          RN040400
      DO 9200 I=1,180                                                   RN040500
      DO 9200 J=1,9                                                     RN040600
      RTAB24(I,J)=RTAB8(I,J)                                            RN040700
      ITID24(I,J)=ITID8(I,J)                                            RN040800
 9200 CONTINUE                                                          RN040900
      GO TO 9101                                                        RN041000
 9160 IF(IRA3.EQ.0)GO TO 9260                                           RN041100
      IRA3=0                                                            RN041200
      INM=3                                                             RN041300
C                                                                       RN041400
C***TRANSFER 3-HOUR TABLES FOR PRINTING.                                RN041500
C                                                                       RN041600
      DO 9137 I=1,50                                                    RN041700
      HI5024(I)=HI503(I)                                                RN041800
      IH5024(I)=IH503(I)                                                RN041900
      ID5024(I)=ID503(I)                                                RN042000
 9137 CONTINUE                                                          RN042100
      DO 9230 I=1,180                                                   RN042200
      DO 9230 J=1,4                                                     RN042300
      RTAB24(I,J)=RTAB3(I,J)                                            RN042400
      ITID24(I,J)=ITID3(I,J)                                            RN042500
 9230 CONTINUE                                                          RN042600
      GO TO 9101                                                        RN042700
 9260 CONTINUE                                                          RN042800
 4081 RETURN                                                            RN042900
      END                                                               RN043000
```

December 1980

ADDENDUM/SUPPLEMENTAL INFORMATION

TO THE

INDUSTRIAL SOURCE COMPLEX (ISC) DISPERSION MODEL

The computer code modifications addressed herein are the complete set of changes made to date to the ISC code as it appears in the Industrial Source Complex (ISC) Dispersion Model User's Guide, Volume II, EPA-450/4-79-031, December 1979. All modifications have been incorporated in the ISC code as part of the UNAMAP-4 available from the National Technical Information Service (NTIS).

Each item in this report is preceded by the date on which it was issued.

A. Computer Program Modifications

Program modifications are described below. The changes correct errors in the original source code released in December 1979.

INDUSTRIAL SOURCE COMPLEX (ISCST) PROGRAM

Make the following modifications to Appendix A of the User's Guide and check your program for conformance.

1. 4/80 - Change the following lines of code in subroutine MODEL to read as follows:

```
IYR=YR                                                    S0304630
YRS=SINNUM(IYR)                                           S0304640
YRC=COSNUM(IYR)                                           S0304650
IYR=YR                                                    S0304800
YRS=SINNUM(IYR)                                           S0304810
YRC=COSNUM(IYR)                                           S0304820
```

2. 4/80 - Delete subroutine UPWIND from the ISC Short Term model program.

   Subroutine UPWIND was originally placed in the ISCST to save computer time by not calculating concentrations at polar coordinate receptors upwind of centrally located sources. However, due to an error in the subroutine, it was incorrectly applied to source/receptor combinations not covered by the original definition and as a result provided substantial but erroneous savings in computer run time. Correcting the subroutine though, has resulted in only a negligible savings in run time. Since subroutine MODEL provides an in-line upwind check for all source/receptor combinations and the computer time saved using the corrected UPWIND subroutine is negligible, the subroutine is being deleted.

3. 4/80 - Change the following line of code in subroutine MAXOT to read as follows:

```
      IY=(K-1)/NXPNTS+1                                          S0500370
```

4. 12/80 - Change the following lines of code in subroutine MODEL to read:

```
1010 IF(ISW(4).NE.1.OR.HS+ZS-GRIDZ(IJ).GT.0.0.OR.ITYPE.EQ.2)GO TO 1020  S0304930
     IF(ITYPE.GT.0)GO TO 1095                                           S0305200
     IF(VS.LE.0.0)GO TO 1095                                            S0305220
1095 IF(ISW(4).NE.1.OR.ISW(1).NE.1.OR.NVS.NE.0.OR.ITYPE.EQ.2)GO TO 1100 S0305480
```

These modifications are required to allow for the treatment of area sources as flat terrain sources as indicated in the documentation.

5. 12/80 - Insert the following line of code in subroutine MODEL:

```
     IF(I.EQ.1) JDY=JDAY                                            S0301795
```

12/80 - Delete line S0301930 from subroutine MODEL.

The modifications correct on error in the Julian Day for the selection of the meteorological card input data/no listing option.

6. 12/80 - Delete line S0306540 from subroutine MODEL.

12/80 - Insert the following line of code in subroutine MODEL:

```
     DO 1290 K=1,NVS                                                S0306515
```

These modifications are necessary to eliminate the possibility of calculating an incorrect Vertical Term when ground-level concentrations are calculated from sources with significant gravitational settling.

7. 12/80 - Change the following lines of code in subroutine MODEL to read:

```
C     TEST FOR WAKE EFFECTS - CALCULATE XPLUME.                      S0304070
 780 DHA=3.*FM*GAMJI*UBARI*SSI                                       S0304110
```

12/80 - Insert the following line of code in subroutine MODEL:

```
     IF(1.570796327*UBARS*SSI.GT.HB+HB)DHA=DHA*SIN(SS*(HB+HB)*UBARI)  S0304115
```

12/80 - Delete line S0304170 from subroutine MODEL.

The modifications are required to correct a wake effects test plume rise calculation error.

INDUSTRIAL SOURCE COMPLEX (ISCLT) PROGRAM

Make the following program line modifications to Appendix B of the User's Guide and check your program for conformance.

1. 4/80 - Change the following line of code in subroutine MODEL to read:

```
      IF (RD.GE.XMX) GO TO 1930                                  S0211230
```

This change allows sources located 100 m from a receptor to be considered for contribution to the receptor. This is compatible with the ISC Short Term Model.

2. 12/80 - Change the following line of code in subroutine MODEL to read:

```
      IF(ZP.LT.ZS.OR.TYPE.EQ.2)ZP=ZS                             S0211150
```

This modification is required to allow for the treatment of area sources as flat terrain sources as indicated in the documentation.

3. 12/80 - Change the following line of code in subroutine MODEL to read:

```
      IF(TYPE.NE.0.OR.JTYPE.EQ.0.OR.XB.GE.HB10)GO TO 1970         S0211740
```

This modification corrects a mis-coded switch used in the calculation of σ_z for stacks with wake effects and calculation distances less than 10 building heights.

4. 12/80 - Change the following line of code in subroutine OUTPT to read:

```
      IF(NOCOMB(NG).EQ.1.AND.IDSORC(NGT+1).GE.0)GO TO 260         S0301621
```

This modification is required to correct an error that allowed the print output for an individual source to be printed several times.

5. 12/80 - Change the following lines of code in subroutines OUTPT and HEADNG respectively to read:

```
      COMMON /HEAD/ MSG3(4),MSG4(8),IS,N3,I3,M3,ILN,LSTILN        S0300120
      COMMON /HEAD/ MSG3(4),MSG4(8),IS,N3,I3,M3,ILN,LSTILN        S0400110
```

B. 4/80 - Computer Underflow in the Short Term and Long Term Model Programs

An underflow interrupt condition occurs on computers whenever an arithmetic operation between two very small numbers results in a number too small to be contained in the computer's arithmetic results register. When this condition arises, computers such as the UNIVAC 1100 series and the CDC 6000 series set the underflow result to zero and continue processing. The ISC model programs were specifically designed to allow the computer to zero an underflow condition, therefore an underflow condition is not to be considered an error within the ISC programs.

However, some IBM computers abort the run when an underflow occurs. In order to circumvent this problem the user must inform the computer system that underflows are to be set to zero and program execution to continue. For example, the following FORTRAN call may be inserted at the beginning of either ISC Model program and thus preclude termination of runs due to underflows on an IBM 360 series computer:

```
CALL ERRSET (208,256,-1,1,0,208)
```

To find the appropriate solution to this problem on other computer systems, the user should contact on-site systems personnel.

C. 4/80 - Receptor Heights Versus Source Elevations

The ISC model allows each receptor to be situated at any height (z). Both the ISCST and ISCLT programs terminate, however, if the receptor elevation is above the lowest source height. In addition, if any receptor is located below the source base height, the ISC programs automatically reset the receptor height to the source base height (thus, flat terrain is assigned for that source receptor combination). This will cause a receptor to be located at different vertical points if two or more sources affect the same receptor, and are at different base elevations. To avoid this problem all sources should be located at approximately the same base elevation, thus maintaining a consistent correction among receptors that are below the plane of the sources.

The rationale for the above suggestion stems from the applicability of the ISC model primarily to very localized industrial sources and complexes, i.e., the sources are not located in radically different locations or terrain. The model can be used for widely dispersed sources, but the user's decision to assume similar source elevations should be an explicit one.

D. Text Corrections to the User's Guide

Volume I

1. 4/80 - All discussion and figures pertaining to the subroutine UPWIND are to be disregarded.

2. 12/80 - Page 3-6, Receptor Grid System Option. Delete sentence 3 and replace it with:

3. 12/80 - Page 2-24. The exponential term in Equation (2-12) should be:

$$\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]$$

Additionally, a "3" value will automatically generate a grid system using the Cartesian coordinate system and a "4" value will automatically generate the polar coordinate direction radials with user-defined starting locations and spacing distances.

4. 12/80 - Page 3-42, Table 3-4. Line 10 in the Description which pertains to ISW(2), should be changed such that the line reads:

   4= program generates polar coordinate grid direction radials

5. 4/80 - Page 3-60. Add to equation (3-1) the term "+D".

6. 4/80 - Page 3-61. To the list of variables and their definitions add:

   D=NPNTS if ISW(4) equals "1" in the first card of Card Group (2); otherwise A equals "0".

7. 12/80 - Page 4-10. Equation (4-1) should be changed to read:

$$\left.\begin{array}{l} J = 300 \\ \text{and} \\ I = \dfrac{(E-(N_x + N_y + 2\cdot N_{xy}) - K - L - M)}{(N_{se}\cdot(N_x\cdot N_y + N_{xy}))} \end{array}\right\} \quad (4\text{-}1)$$

8. 12/80 - Page 4-11, lines 9 and 11. References to "N_s" should be changed to "N_{se}".

9. 12/80 - Page 4-11. To the list of variables and their definitions add:

$$M = \begin{cases} 0 \text{ ; if ISW(4)=1 \& ISW(11)=2 or} \\ \quad \text{if ISW(7)=1 or NSEASN=1 or NGROUP=0} \\ N_x\cdot N_y + N_{xy} \text{; if ISW(4)=0 or ISW(11)}\neq 2 \text{ \&} \\ \quad \text{if ISW(7)}\neq 1 \text{ \& NGROUP}\neq 0 \text{ \& NSEASN}\neq 1 \end{cases}$$

10. 12/80 - Page 4-16. Equation (4-2) should be changed to read the same as equation (4-1).

11. 12/80 - Page 4-17, equation (4-3). Reference to "N_s" should be changed to "N_{se}".

12. 12/80 - Page 4-77. Equation (4-4) should be changed to read:

$$\left.\begin{array}{l} J = 300 \\ \text{and} \\ I = \left[\dfrac{E - (NXPNTS+NYPNTS+2*NXWYPT) - K - L - M}{NSEASN*(NXPNTS*NYPNTS+NXWYPT)}\right] \end{array}\right\} \quad (4\text{-}4)$$

13. 12/80 - Page 4-78. To the list of variables and their definitions under "Condition c" add:

$$M = \begin{cases} 0 \text{ ; if ISW(4)=1 \& ISW(11)=2 or} \\ \quad \text{if ISW(7)=1 or NSEASN=1 or NGROUP=0} \\ \text{NXPNTS*NYPNTS+NXWYPT; if ISW(4)=0 or ISW(11)}\neq 2 \text{ \&} \\ \qquad \text{if ISW(7)=1 \& NSEASN=1 \& NGROUP=0} \end{cases}$$

14. 12/80 - Page 4-79. Equation (4-5) should be changed to read the same as equation (4-4).

15. 12/80 - Page 4-80. Delete variable "L" and replace it with:

    "where L and M are the same as under Equation (4-4)".

Volume II

1. 4/80 - All discussion and figures pertaining to subroutine UPWIND are to be disregarded.

2. 4/80 - Page C-4, Figure C-1. The zero in card column 59 in the first card should be changed to a "6" such that the data value reads "860".

3. 4/80 - Page C-8, Figure C-1. The data in card columns 8 and 9 are to be transferred to columns 9 and 10 respectively with column 8 becoming blank. The change should be made for each of the 16 cards illustrated.

4. 4/80 - Page D-8, Figure D-1. The zero in card column 25 on the fourth last card should be changed to a "6" such that the data value reads ".0076794".

5. 4/80 - Page C-19, paragraph 1. Delete sentence 3 and replace it with:

   Also, because ISW(15), ISW(17), and ISW(18) equal "1" and ISW(4) equals "0", variables A,B,C, and D become 425 times 5(or 2125), 4 times 1 times 425 times 5(or 8500), 201 times 1 times 5(or 1005), and 0, respectively, according to their definitions given in equation (3-1).

6. 4/80 - Page C-19. Add to equation (C-2):

   variable version - "+D"
   numerical interpretation - "+0"

7. 12/80 - Page D-24. The numerical solution in equation (D-3) should be changed to read:

$$40000 \geq 19+19+2\cdot 1 \;+\; (2\cdot 1+0)\cdot(19\cdot 19+1)$$

$$\geq 764$$