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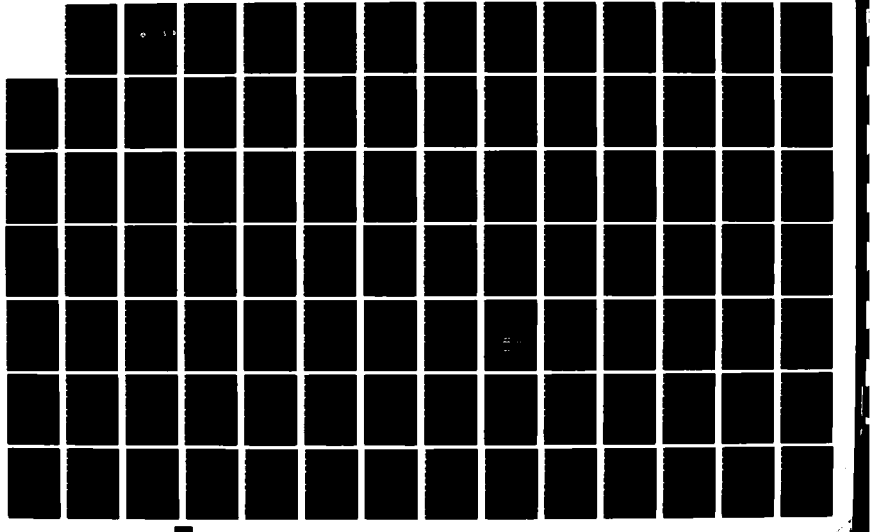

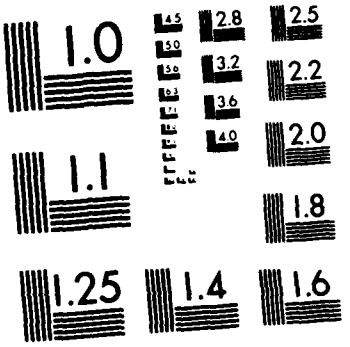

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DEVELOPMENT OF AN ATMOSPHERIC DISPERSION MODEL FOR HEAVIER-THAN-AIR GAS MIXTURES

Volume III: DEGADIS User's Manual

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FINAL REPORT
MAY 1985

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United States Coast Guard

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16. Abstract

The mathematical modeling techniques used to predict atmospheric dispersion of heavier-than-air gases discussed in Volume I ~~of this report~~ are briefly summarized; these techniques are incorporated in an interactive computer model DEGADIS. Details of ~~the~~ DEGADIS implementation are briefly discussed.

The necessary input information to simulate a heavier-than-air gas release with DEGADIS is summarized. Example simulations of a steady state and transient release are included. A list of DEGADIS self-diagnostics with suggested actions are included.

A listing of DEGADIS is included along with a partial list of program variables. Guidelines for installation of DEGADIS are presented.

17. Key Words

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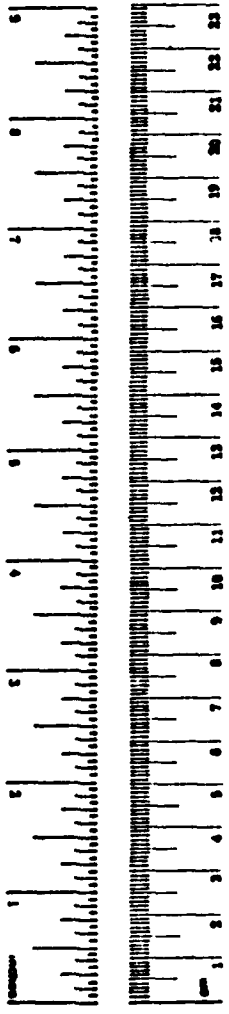
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

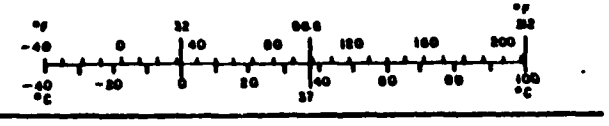
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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LIST OF SYMBOLS

b	half width of horizontally homogeneous central section of gas plume (m)
C_{p_c}	heat capacity of contaminant (J/kg K)
c_c	centerline, ground level concentration (kg/m^3)
E	plume strength (kg/s)
$E(t)$	source rate (kg/s)
H	height or depth of density intrusion or cloud (m)
H_a	ambient absolute humidity (kg water/kg bone dry air)
h	enthalpy of source blanket (J/kg)
h_0	overall heat transfer coefficient (J/m^2 s K)
k	von Karman's constant, 0.35
L	source length (m)
M_i	initial cloud mass (kg)
p	atmospheric pressure (atm)
q_1	empirical constant in heat capacity equation
R	gas source cloud radius (m)
R_m	value of R when ($\pi R^2 Q_*$) is a maximum (m)
R_{max}	maximum radius of the cloud (m)
R_p	primary source radius (m)
S_{z0}	S_z at the downwind edge of the source ($x = L/2$) (m)
S_{z0_m}	value of S_{z0} when ($\pi R^2 Q_*$) is a maximum (m)

T	temperature associated with source blanket enthalpy (K)
T_0	contaminant storage temperature (K)
T_s	surface temperature (K)
t	time (s)
u_a	ambient average velocity (m/s)
u_e	horizontal or frontal entrainment velocity (m/s)
u_*	friction velocity (m/s)
V_h	heat transfer velocity (0.0125 m/s) (m/s)
w_a	mass fraction of air
w_c	mass fraction of contaminant
w_e	vertical entrainment velocity associated with H_L (m/s)
x,y,z	Cartesian coordinates (m)
z_0	reference height in wind velocity profile specification (m)
z_R	surface roughness (m)
α	constant in power law wind profile
β	constant in σ_y correlation
Γ	gamma function
γ	ratio of $(\rho - \rho_a)/c_c$
δ	constant in σ_y correlation
λ	Monin-Obukhov length (m)
ρ	density of gas/air mixture (kg/m^3)
ρ_0	density of contaminant's saturated vapor at T_o (kg/m^3)
Ψ	logarithmic velocity profile correction function

SUMMARY

The mathematical modeling techniques used to predict atmospheric dispersion of heavier-than-air gases discussed in Volume I of this report are briefly summarized; these techniques are incorporated in an interactive computer model DEGADIS.

The necessary input information to simulate a heavier-than-air gas release is summarized. Example simulations of a steady state and transient release are included. Guidelines for installation of DEGADIS are included, and a listing of DEGADIS is included along with a partial list of program variables.

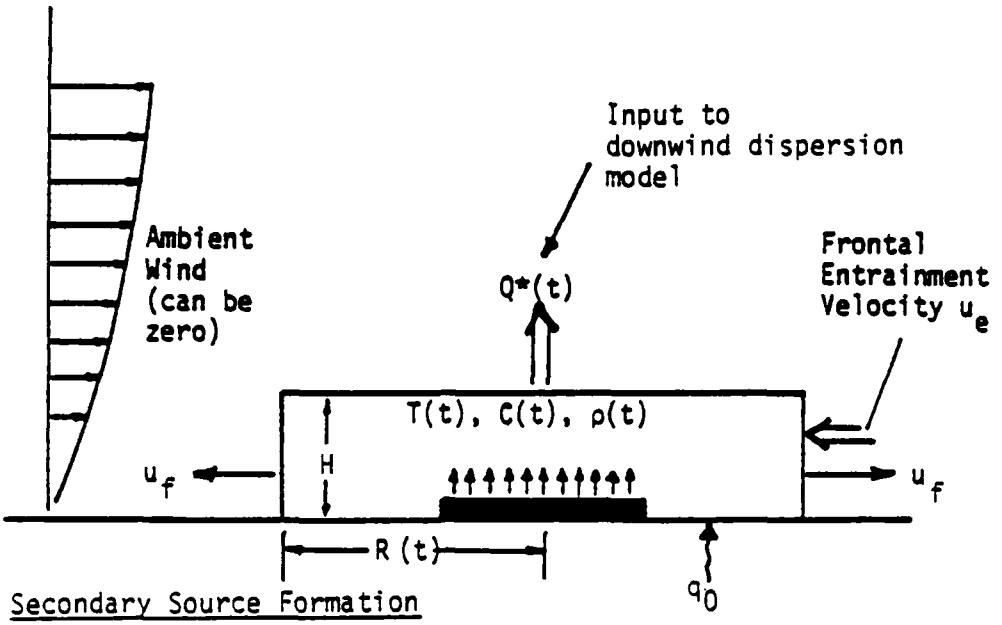
I. DEGADIS MODEL SUMMARY

The DEGADIS model methods, equations, and supporting data are described in detail in Volume I of this report. This section is intended to summarize the critical components of the model formulation and the associated limitations, and to indicate cautions and diagnostic guidelines which should be followed in its use. The suggested limitations and guidelines are based on the experience gained during the development of the model and its verification by comparison with a wide range of heavier-than-air gas dispersion tests. These limitations and precautions will almost certainly be refined through further application of the model.

I.1. Summary Description

The DEGADIS model combines the principal features of the Shell HEGADAS model (Colenbrander, 1980, and Colenbrander and Puttock, 1983) and a box model proposed by van Ulden (1983). DEGADIS incorporates some features not contained in either of the original models and substitutes methods which we believe are more appropriate for treatment of other features. The general application of the model involves formation of a "secondary" gas source, the subsequent entrainment of gas from that secondary source by the wind field, and downwind dispersion of the gas plume or cloud. Figure I.1 illustrates the general methodology; the description of the formation and development of the secondary source utilizes the box model, and the entrainment from the secondary source and subsequent downwind dispersion utilizes the similarity representations of the cloud concentration and vertical velocity profiles of the HEGADAS model. Heavier-than-air gas releases which cannnot be represented as steady, continuous releases are modeled as a series of pseudo-steady releases.

Application of the model to releases of a heavier-than-air gas in zero wind involves only the box model. The box model

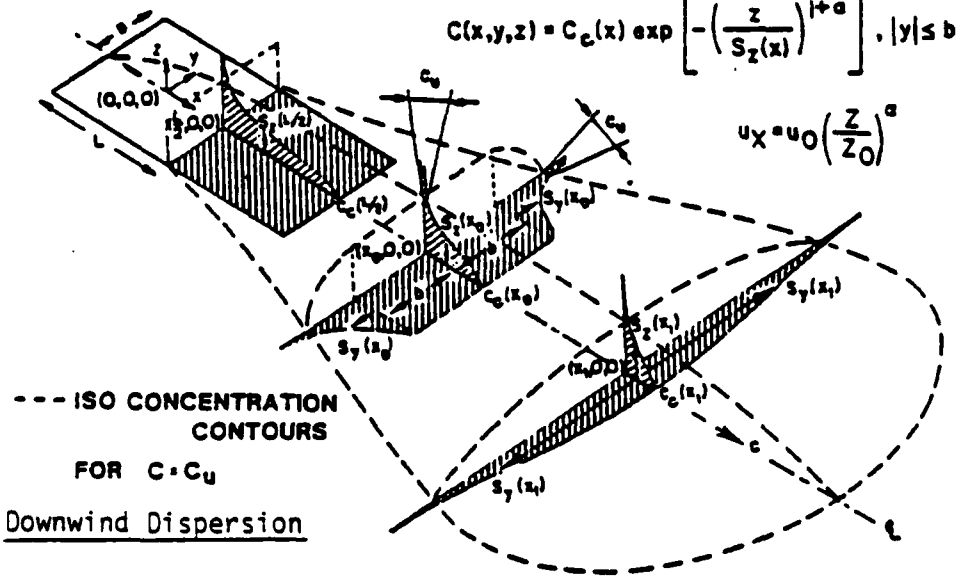


Secondary Source Formation

$$C(x,y,z) = C_c(x) \exp\left[-\left(\frac{|y|-b(x)}{S_y(x)}\right)^2 - \left(\frac{z}{S_z(x)}\right)^{1+a}\right], |y| > b$$

$$C(x,y,z) = C_c(x) \exp\left[-\left(\frac{z}{S_z(x)}\right)^{1+a}\right], |y| \le b$$

$$u_x = u_0\left(\frac{z}{z_0}\right)^a$$



Downwind Dispersion

Figure I.1. Schematic diagram of DEGADIS model.

treatment of gravity spreading and associated air entrainment is based on parameterization of the laboratory still-air experiments described in Volume II of this report. For releases in wind, the box model also describes the source development but provides for entrainment of the gas-air source cloud by the action of the wind. The rate of release relative to the wind velocity determines the important characteristics of the cloud dispersion process. For high rates of release (instantaneous being the most rapid) in low wind, the buoyancy-dominated flow processes described by the box model predominate and may essentially determine downwind distances for dilution of the gas cloud to the 1-10% gas concentration levels which characterize the lower flammability limit for light hydrocarbons. Conversely, for low rates of release in high winds, the rate of entrainment due to gravity spreading is not very important, and the downwind dispersion process is controlled primarily by the vertical dispersion produced by the action of the wind field shear in the cloud. The treatment of the large range of "intermediate" conditions (i.e. where gravity spreading and air entrainment by the secondary source importantly influence the source cloud concentration and dimensions, and consequently the "initial condition" for downwind dispersion calculation) distinguishes the DEGADIS model.

DEGADIS incorporates heat transfer and water transfer when applicable from the underlying surface to the cloud. Inclusion of these procedures in the model is optional. Effects of heat transfer on both the mean cloud buoyancy and the vertical turbulent mixing (air entrainment) are included while direct effect of water transfer is included only in the mean cloud buoyancy.

DEGADIS is written in Digital Equipment Corporation's VAX/VMS* Fortran (a superset of ANSI Fortran 77); it is

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*VAX and VMS are registered trademarks of Digital Equipment Corporation.

composed of five programs which communicate using ASCII files (see Section II). A listing of the code is included as Appendix C, and a partial list of program variables is given in Appendix E. Considerations for installation of DEGADIS are discussed in Appendices A and B. DEGADIS self-diagnostics are listed in Appendix D along with suggested actions.

I.2. Model Limitations and Cautions

DEGADIS model application should be limited to the description of atmospheric dispersion of heavier-than-air gas releases at ground level onto flat, unobstructed terrain or water. Application to releases from sources above ground level (e.g. overflow from dikes) would be expected to give conservative predictions of the downwind hazard zones, but this has not been verified.

The dispersion of a heavier-than-air gas by the action of the wind assumes the maintenance of a wind velocity profile in the gas cloud or plume whose characteristics are determined by the approach wind flow (upwind of the release). The treatment of vertical momentum transfer invokes the assumption of a logarithmic vertical velocity profile, which is in turn curve-fitted to a power law vertical velocity profile. DEGADIS also uses similarity forms for the vertical profile of gas concentration in the cloud, and the vertical profile is dependent on the power law exponent α used in the representation of the velocity profile. The vertical velocity profile, which is directly related to the air entrainment velocity into the cloud, is dependent on the factors which determine the structure of the atmospheric boundary surface layer, wind speed, surface roughness, and atmospheric stability. Consequently, the representations of the vertical velocity and concentration profiles in DEGADIS are subject to similar limitations as in other descriptions of the surface layer. Table I.1 indicates typical recommended surface roughness values. Table I.2 indicates logarithmic wind

velocity profile corrections for different atmospheric stabilities, along with typical values of the wind profile power law exponent α determined in DEGADIS.

TABLE I.1

TYPICAL VALUES OF SURFACE ROUGHNESS

Terrain	$z_{R,M}$
Mud flats, ice	10^{-5}
Calm, open sea	10^{-4}
Off-sea wind in coastal areas	10^{-3}
Cut grass (~ 3 cm)	0.007
Long grass (~ 60 cm), crops	0.04

Demonstration of the model has been primarily directed to the prediction of hazard extent defined by gas concentrations in the hydrocarbon flammable limit range (~1 to 20%). Even though the relation between peak gas concentration and time-averaged gas concentration is uncertain, there is some basis for using 2.0 as an estimate of the peak-to-time-averaged-concentration ratio for determining a flammable gas concentration zone. If this assumption is made, the predicted distance to LFL/2 would be the maximum distance at which a flammable gas concentration would be predicted. Based on the simulations of field experiments presented in Volume I, the ratio of observed distance to calculated distance for a given time-averaged concentration level (OBS/PRE) ranged from 0.82 to 1.03 for the 2.5% level nine out of ten times (i.e. 90%

TABLE I.2

REPRESENTATIVE MONIN-OBUKHOV LENGTHS AND POWER LAW EXPONENTS
FOR DIFFERENT ATMOSPHERIC STABILITIES

Pasquill Stability Category	Monin-Obukhov Length (λ) as a Function of Surface Roughness z_R(m)	Typical (*) Power Law Exponents α	Corrections to Logarithmic Profiles as Given by Businger (1973)
A	$-11.4\ z_R^{0.10}$	0.108	$\psi = 2\ln\left[\frac{1+a}{2}\right] + \ln\left[\frac{1+a^2}{2}\right] - 2\tan^{-1}(a) + \pi/2$ with $a = (1 - 15(z/\lambda))^{1/4}$
B	$-26.0\ z_R^{0.17}$	0.112	
C	$-123\ z_R^{0.30}$	0.120	
D	∞	0.142	$\psi = 0$
E	$123\ z_R^{0.30}$	0.203	$\psi = -4.7(z/\lambda)$
F	$26.0\ z_R^{0.17}$	0.253	

(*) calculated for 8 m/s at 10 m with surface roughness of 0.001 m

confidence interval); for the 5% level, (OBS/PRE) ranged from 0.73 to 0.96 for a 90% confidence interval. If for a given release scenario the calculated distance to the 2.5% average concentration level was 120 m, the distance to the 2.5% average concentration for nine out of ten realizations of the same release would be expected to range between 98 m and 124 m, which would also represent the range of the downwind extent of the flammable gas concentration zone for LNG if the peak-to-average ratio of 2.0 is assumed.

II. DEGADIS Model Inputs

As implemented under VAX/VMS, DEGADIS uses three areas of input information:

(*) VAX/VMS command procedure for execution

(*) simulation definition

(*) numerical parameters

The VAX/VMS command procedure used to execute DEGADIS can be generated in DEGADISIN. As well, DEGADISIN is the interactive input module which provides the simulation definition. An example input session is included in Section IV.2. The numerical parameters (convergence criteria, initial increments, etc.) are supplied to DEGADIS through a series of input files. Although these numerical parameters are easily changed, the user should need to change these only rarely with the exception of the time sort parameters which are explained in Section II.3.

II.1. VAX/VMS Command Procedure

The VAX/VMS command procedure generated by DEGADISIN controls the execution of images for the simulation. Image execution follows one of two paths, either for a transient release or for a steady state release. DEGADISIN will automatically generate the appropriate command procedure; but first, DEGADISIN requests a simulation name be specified. The simulation name must be a valid VAX/VMS file name without a file extension and is designated RUNNAME. DEGADIS will use this file name with standard extensions for input, interprocess communication, and output. Figures II.1 and II.2 show example VAX/VMS command procedures for the run name BURRO9S for steady state and BURRO9 transient releases, respectively. The directory which contains the executable images of DEGADIS has been assigned the system logical name SYS$DEGADIS (see Appendix A). The COPY/LOG command simply copies a file from the first argument to the second argument, and the RUN command executes

the specified image. Of course, these steps may also be carried out by issuing the commands at a terminal.

```
$COPY/LOG    SYS$DEGADIS:EXAMPLE.ER1    BURRO9S.ER1
$COPY/LOG    SYS$DEGADIS:EXAMPLE.ER2    BURRO9S.ER2
$RUN    SYS$DEGADIS:DEGADIS1
BURRO9S
$RUN    SYS$DEGADIS:SDEGADIS2
BURRO9S
$COPY/LOG    BURRO9S.SCL+BURRO9S.SR3-
BURRO9S.LIS
```

Figure II.1. Example DEGADIS command procedure on VAX/VMS for a steady state simulation named BURRO9S.

```
$COPY/LOG    SYS$DEGADIS:EXAMPLE.ER1    BURRO9.ER1
$COPY/LOG    SYS$DEGADIS:EXAMPLE.ER2    BURRO9.ER2
$COPY/LOG    SYS$DEGADIS:EXAMPLE.ER3    BURRO9.ER3
$RUN    SYS$DEGADIS:DEGADIS1
BURRO9
$RUN    SYS$DEGADIS:DEGADIS2
BURRO9
$RUN    SYS$DEGADIS:DEGADIS3
BURRO9
$COPY/LOG    BURRO9.SCL+BURRO9.SR3-
BURRO9.LIS
```

Figure II.2. Example DEGADIS command procedure on VAX/VMS for a transient simulation named BURRO9.

II.2. Simulation Definition

DEGADISIN is an interactive method of simulation definition where the user specifies information about the ambient wind field, the properties of the released gas, and some details of the release.

The ambient wind field is characterized by a known velocity u_0 at a given height z_0, a surface roughness z_R, and the Pasquill stability class. The Pasquill stability class is used to estimate values of the lateral similarity parameter coefficients δ and β (Pasquill, 1974), values of the along-wind similarity coefficients (Beals, 1971), and the Monin-Obukhov length λ used by Businger et al. (1971) in their logarithmic velocity profile function Ψ (Section I). The Monin-Obukhov length is then used to calculate the friction velocity u_*. Once these parameters have been estimated using the Pasquill stability class, the user has the option of interactively changing any of these to better describe the simulation. In addition to these specifications, the ambient temperature, pressure, and humidity must be specified.

The properties of air and the released gas are used to evaluate the mixture density as a function of temperature and composition. The desired released gas properties include the molecular weight MW_c, the storage temperature (normal boiling point for cryogenic gases) T_0, the vapor phase density at the storage temperature and ambient pressure ρ_0, and two constants q_1 and p_1 which describe the heat capacity according to the equation

$$C_{p_c}(T) = MW_c \left[3.33 \times 10^4 + q_1 \left[\frac{T^{p_1} - T_0^{p_1}}{T - T_0} \right] \right] \qquad \text{(II-1)}$$

where $C_{p_c}(T)$ is the mean heat capacity (J/kg K) at temperature T. Note that a constant heat capacity with respect to

temperature can be obtained by setting $p_1 = 1.0$ and choosing the appropriate value for q_1. Representative gas properties for liquefied natural gas (LNG) as methane and liquefied petroleum gas (LPG) as propane are included in DEGADISIN. Also included are the lower and upper flammability limits (LFL and UFL, respectively) for LNG and LPG.

The user may also choose to calculate the mixture density as a function of composition using some other method. This mixture density is entered in the program as if the release were isothermal; for each composition, the program requests the contaminant mole fraction, the contaminant concentration, and the mixture density. For ease of input, these values may be entered from a file made available to DEGADISIN.

In specifying the details of the release, the user must choose to simulate the release as transient or steady state. For both release types, the area source is assumed circular. The source radius and emission rate must be specified for a steady state release only once, while these must be specified as a function of time for transient releases (either interactively or by file). For transient releases, the user must specify the initial amount of gas present over the source in order to simulate an instantaneous release (e.g. the Thorney Island Trials).

Figure II.3 summarizes the simulation information gathered by DEGADISIN contained in the RUNNAME file with extension INP. The structure of RUNNAME.INP is illustrated in Figure III.2. At this point, RUNNAME.INP may be edited to correct any misinformation entered during the input session. Note that care must be exercised when editing RUNNAME.INP due to the fact that information contained in the file can be different depending on the answered questions (e.g. steady state versus transient simulation).

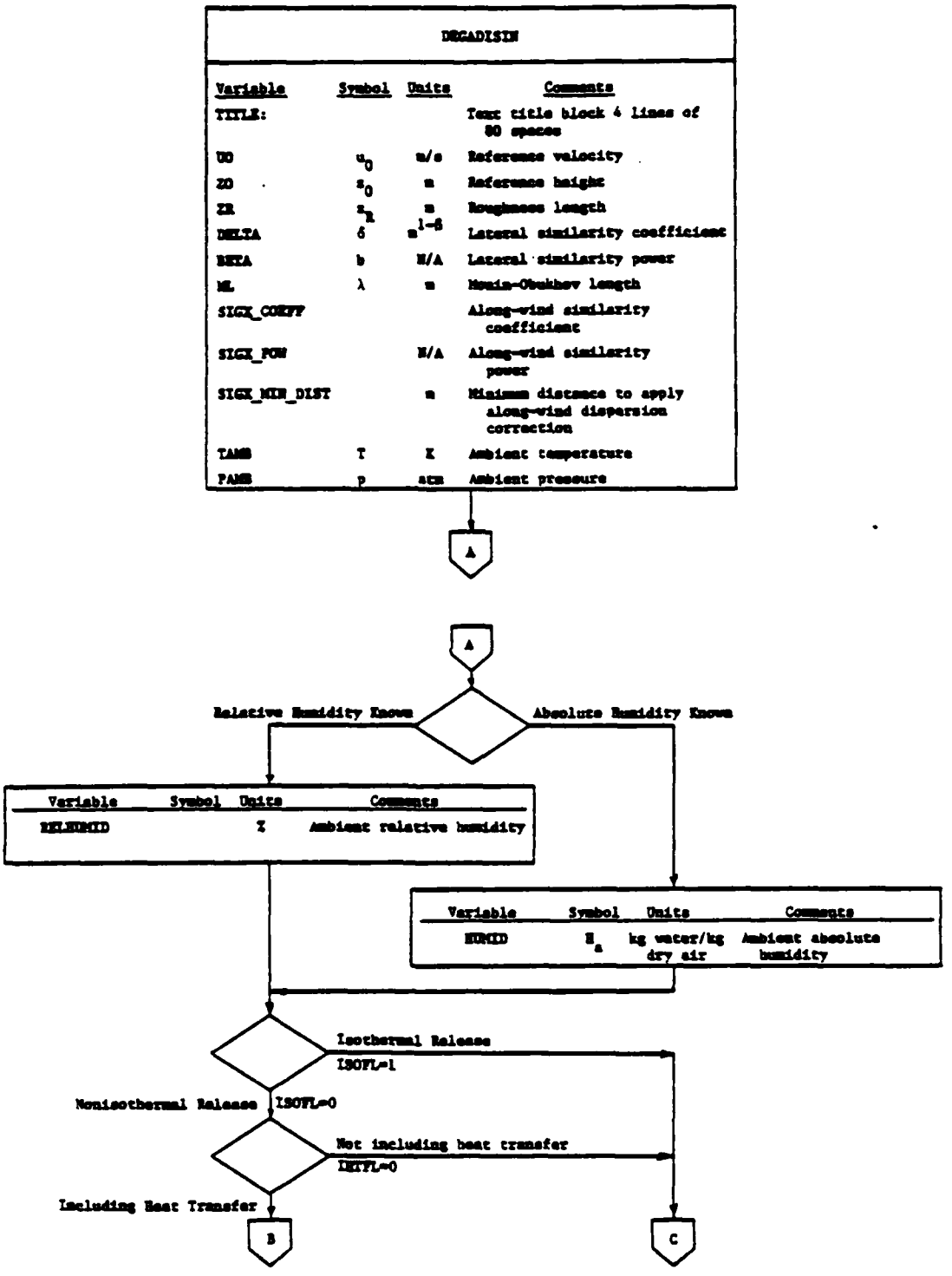


Figure II.3. Summary of simulation definition input information for DEGADIS.

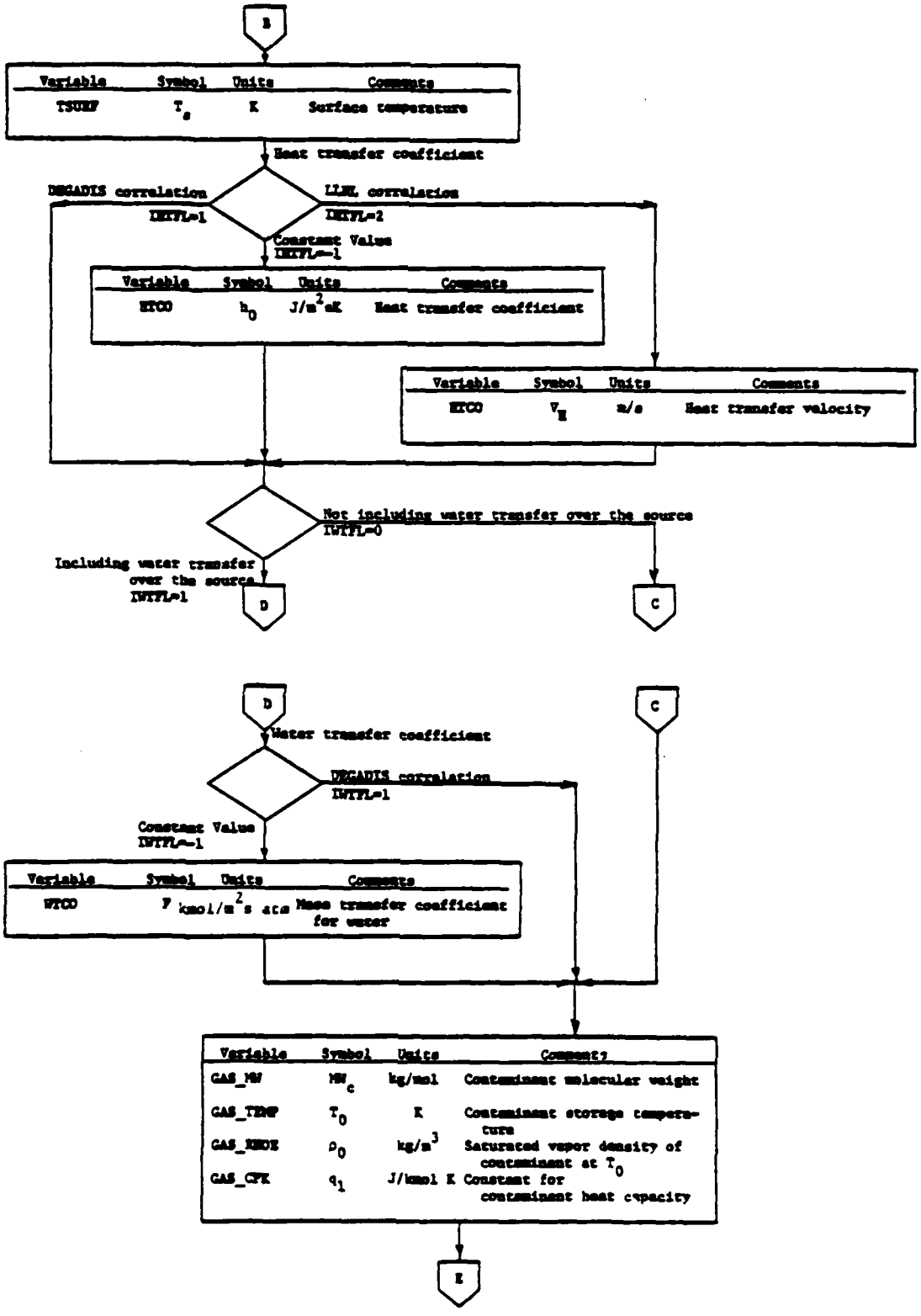


Figure II.3. (continued)

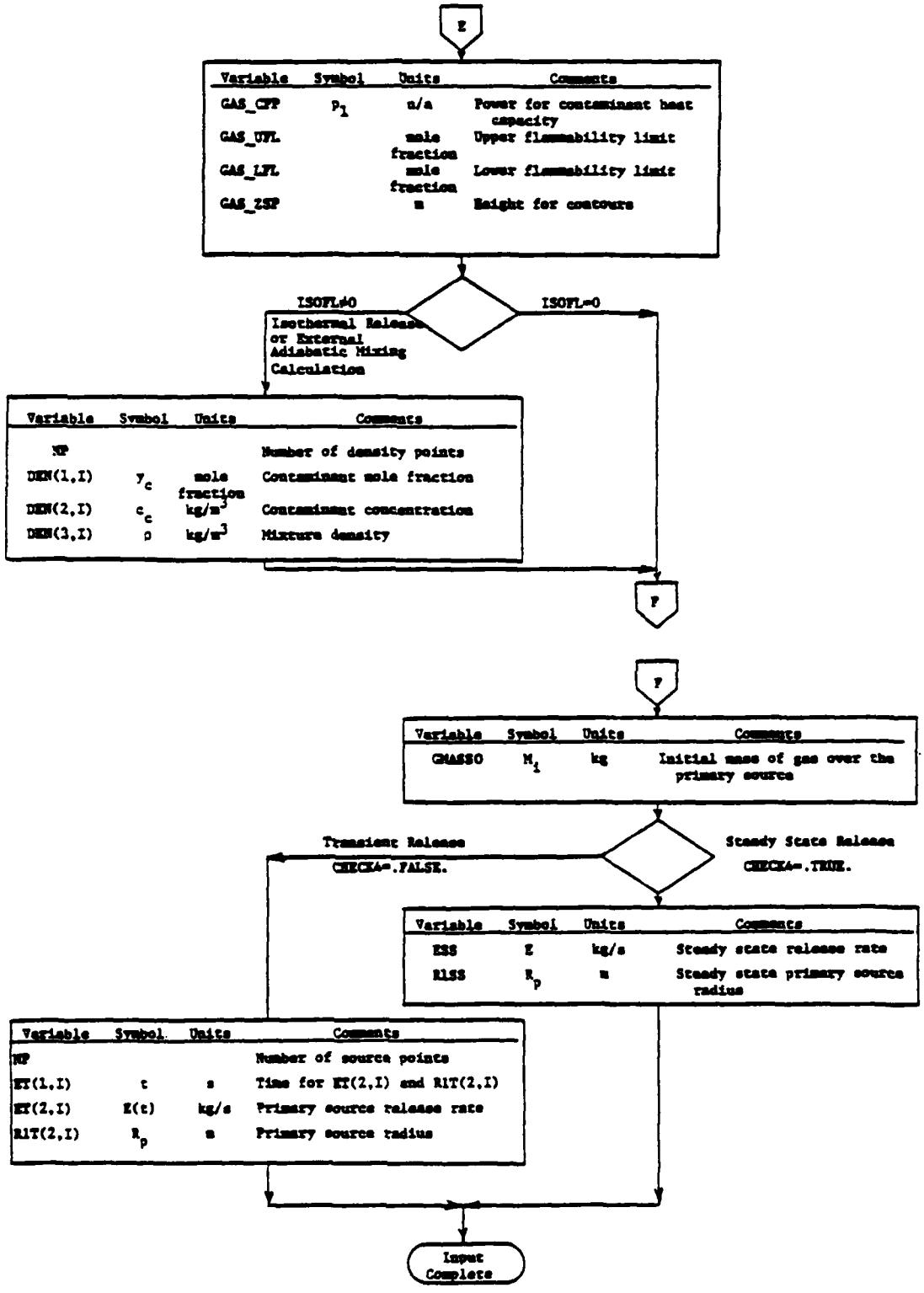


Figure II.3. (continued)

III. Model Implementation and Outputs

The model described in Section I has been implemented in VAX/VMS Fortran (a superset of Fortran 77) in the code DEGADIS. DEGADIS is comprised of five separate programs as follows:

(*) DEGADISIN is the interactive input module which defines the simulation.

(*) DEGADIS1 determines α and describes the gas source for transient and steady state releases.

(*) DEGADIS2 describes the pseudo-steady state downwind dispersion of the released gas.

(*) DEGADIS3 sorts the results of DEGADIS2 for a transient release.

(*) SDEGADIS2 describes the steady state downwind dispersion of the released gas.

As indicated in Figures II.1 and II.2, a steady state release is simulated by executing DEGADISIN, DEGADIS1, and SDEGADIS2, while a transient release is simulated by executing DEGADISIN, DEGADIS1, DEGADIS2, and DEGADIS3.

III.1 Input Module--DEGADISIN

DEGADISIN (see Section II) is the interactive input module which defines the simulation; DEGADISIN is composed of two subroutines (Figure III.1):

(*) DEGADISIN contains the program overhead and generates the command file RUNNAME.COM which can be used to control simulation execution (C-29).

(*) IOT — contains the interactive question and answer sequence which defines the simulation; IOT also creates the file RUNNAME.INP (C-55).

An example of a DEGADISIN query sequence is included in Section IV.2. As this information is gathered, it is written to the file RUNNAME.INP (see Figure III.2). Once DEGADISIN is completed, RUNNAME.INP may be edited to correct minor input mistakes. If major revisions are necessary, the recommended practice is to execute DEGADISIN again.

Once the information required by DEGADISIN has been entered properly, DEGADIS may be executed using the command procedure generated by DEGADISIN under the file name RUNNAME.COM. If DEGADIS is not to be run using this command file, the user must enter the simulation name (RUNNAME) after each of the programs are begun. As well, the user must provide copies of the numerical parameter files.

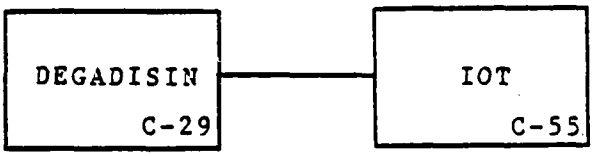


Figure III.1. DEGADISIN flow chart.

```
                        TITLE(1)
                        TITLE(2)
                        TITLE(3)
                        TITLE(4)
                        U0, Z0, ZR
                        ISTAB
                        DELTA, BETA, ML
                        SIGX_COEFF, SIGX_POW, SIGX_MIN_DIST
                        TAMB, PAMB, HUMID
                        ISOFL, TSURF
                        IHTFL, HTCO
                        IWTFL, WTCO
                        GAS_NAME
                        GAS_MW, GAS_TEMP, GAS_RHOE
                        GAS_CPK, GAS_CPP
                        GAS_UFL, GAS_LFL, GAS_ZSP
                      { NP
If (ISOFL≠0) then     { DEN((J,1),J=1,5)
(for                  { DEN((J,2),J=1,5)
external density      {   .
calculations)         {   .
NP of these           {   .
                      { DEN(J,NP),J=1,5)
                        CCLOW
                        GMASSO
                        NT
                      { ET(1,1), ET(2,1), R1T(2,1)
                      { ET(1,2), ET(2,2), R1T(2,2)
NT of these           {   .
                      {   .
                      {   .
                      { ET(1,NT), ET(2,NT), R1T(2,NT)
                        CHECK1, CHECK2,   AGAIN, CHECK3, CHECK4,
                        CHECK5
                        TINP
for steady state        ESS, SLEN, SWID
  only
```

Figure III.2. Structure for free-formatted RUNNAME.INP file.

III.2 Source Module--DEGADIS1

DEGADIS1 estimates values for the friction velocity and ambient wind profile power α and characterizes the primary gas source for the remainder of the model; DEGADIS1 is composed of the following subroutines (Figure III.3):

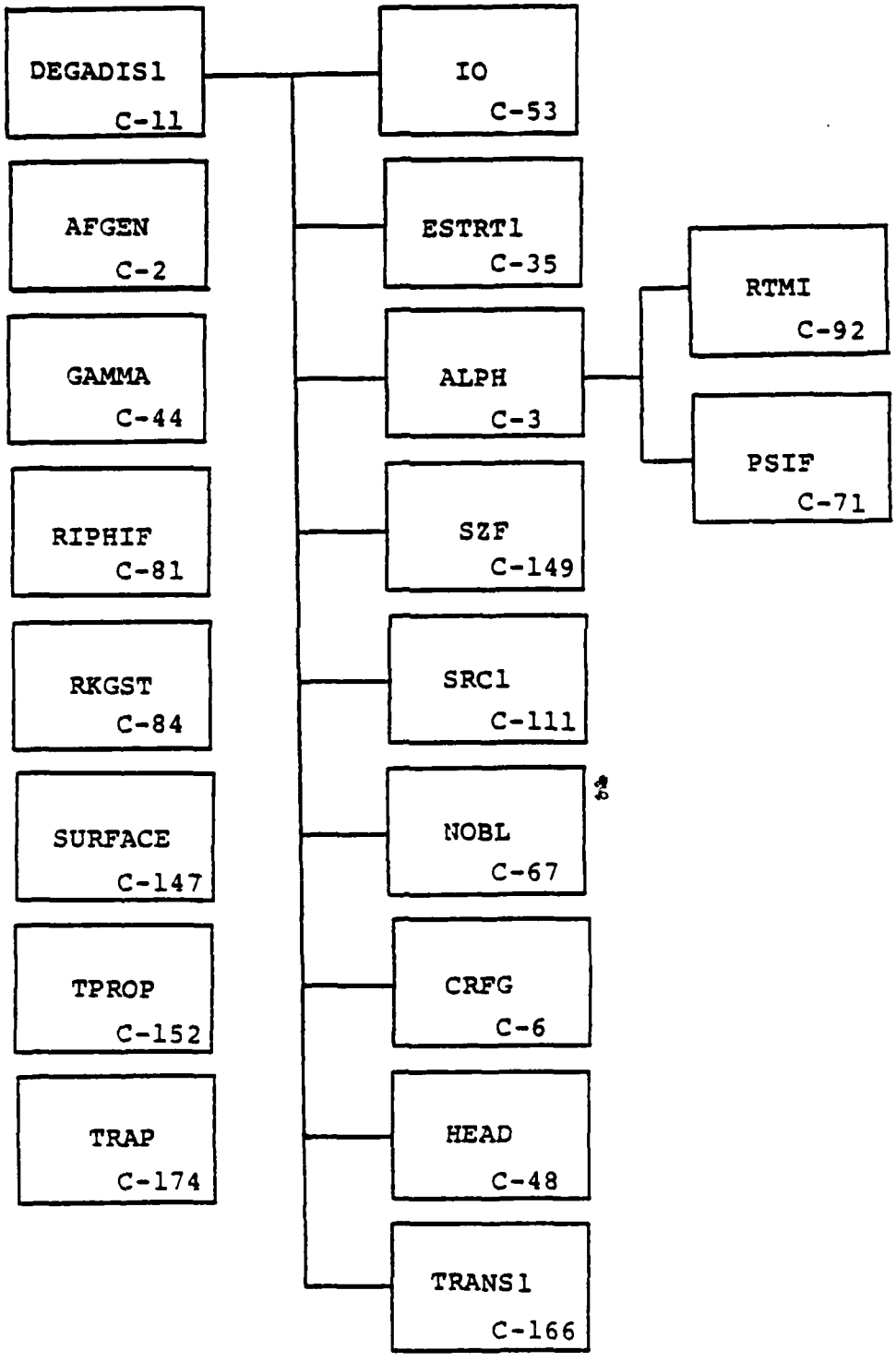


Figure III.3. DEGADIS1 flow chart.

(*) AFGEN — is a utility which linearly interpolates between a pair of points based on a list of supplied values (C-2).

(*) ALPH — estimates the ambient wind profile power α by minimizing the integral of the difference between an ambient logarithmic velocity profile and the assumed power law velocity profile (C-3).

(*) CRFG — creates a table of calculated values which will describe the secondary gas source for the downwind dispersion calculations (C-6).

(*) DEGADIS1 — contains the program overhead and sequentially calls the routines required to estimate the ambient wind profile power α and to characterize the primary gas source (C-11).

(*) ESTRT1 — recovers the numerical parameters contained in the file RUNNAME.ER1 (C-35).

(*) GAMMA — is a utility function that calculates the gamma function of the argument (i.e. $\Gamma(x)$) (C-44).

(*) HEAD — writes a formatted output heading to the file RUNNAME.SCL (C-48).

(*) IO — recovers the simulation definition contained in RUNNAME.INP (C-53).

(*) NOBL — estimates gas source behavior when no gas blanket is present (C-67).

(*) PSIF — calculates the ρ function in the logarithmic velocity profile (C-71).

(*) RIPHIF — is a series of utilities which calculates the Richardson number and the value of ϕ(Ri) (C-81).

(*) RKGST — is a utility routine which performs numerical integration of a specified system of equations using a modified fourth order Runge-Kutta method (C-84).

(*) RTMI — is a utility routine which solves the trial and error set up by ALPH (C-92).

(*) SRC1 — contains the ordinary differential equations which describe the gas blanket formed as a result of the primary gas source (C-111).

(*) SURFACE — is a utility routine which estimates heat and water transfer rates across the bottom surface of the gas layer (C-147).

(*) SZF — estimates the value of S_z if the primary source can just form a gas blanket over the source (C-149).

(*) TPROP — is a series of utility routines which estimate the thermodynamic properties of a given gas mixture (C-152).

(*) TRANS1 writes the information to continue the next simulation step to the file RUNNAME.TR2 (C-166).

(*) TRAP is a utility included for program diagnostics (C-174).

As input, DEGADIS1 requires two files:

(*) RUNNAME.ER1 contains various numerical parameters. For most simulations, a copy of the SYS$DEGADIS:EXAMPLE.ER1 file will be adequate. See Figure II.1 or II.2. A copy of SYS$DEGADIS:EXAMPLE.ER1 is included in Figure III.4.

As output, DEGADIS1 generates the following files:

(*) RUNNAME.SCD contains the calculated values which describe the secondary gas source. It is generated by SRC1 and NOBL and is then read by CRFG; it is a temporary file.

(*) RUNNAME.SCL is the listed output which describes the input information for the simulation and the calculated secondary gas source. It is written by HEAD and CRFG.

(*) RUNNAME.TR2 contains the information to continue the next simulation step.

```
!This is an example of how to set up and use the run parameter
! input files.  Comment lines start with an exclamation mark(!)
! in the first column.  The only restrictions for data input are
! as follows:
!          1) The data must be entered in the same order
!                 all of the time.
!          2) Only the number must be between columns 10 and 20.
!          3) Always include the decimal point in the number
!
! Column layout:
!2345678901234567890123456789O
!--------1---------2---------3
!        I         I
STPIN      0.01      MAIN - RKGST - INITIAL STEP SIZE
ERBND      0.0025    MAIN - RKGST - ERROR BOUND
STPMX      5.12      MAIN - RKGST - MAXIMUM STEP SIZE
WTRG        1.       MAIN - RKGST - WEIGHT FOR RG
WTTM        1.       MAIN - RKGST - WEIGHT FOR Total Mass
WTYA        1.       MAIN - RKGST - WEIGHT FOR ya
WTYC        1.       MAIN - RKGST - WEIGHT FOR yc
WTEB        1.       MAIN - RKGST - WEIGHT FOR Energy Balance
WTmB        1.       MAIN - RKGST - WEIGHT FOR Momentum Balance
WTuh        1.       MAIN - RKGST - WEIGHT FOR Ueff*Heff
XLI        0.05      ALPH - LOWER LIMIT OF SEARCH FOR ALPHA
XRI        0.40      ALPH - UPPER LIMIT OF SEARCH FOR ALPHA
EPS        0.001     ALPH - ERROR BOUND USED BY 'RTMI'
ZLOW       0.01      ALPHI - maximum BOTTOM HEIGHT FOR FIT OF ALPHA
!
STPINZ     -0.02     ALPHI - INITIAL RKGST STEP <0.
!
ERBNDZ     0.005     ALPHI - ERROR BOUND FOR RKGST
!
STPMXZ     -0.04     ALPHI - MAXIMUM STEP FOR RKGST <0.
!
!  Note that comment lines can be mixed with the numbers.
!
SRCOER     0.007     SRC10 - OUTPUT Error criteria
SRCSS       5.2      SRC10 - min time for Steady; STPMX
SRCcut     .0001     SRC10 - min height for blanket
htcut      .10       SRC1 - min height for blanket heat transfer
ERNOBL     1.0005    NOBL - CONVERGENCE CRITERIA ratio
NOBLPT     100.      NOBL - NUMBER OF POINTS
!                       USED ON THE LAST PORTION OF THE SOURCE
!
```

Figure III.4. SYS$DEGADIS:EXAMPLE.ER1 listing.

```
crfser      0.008     error criteria in building GEN3 vectors
!
epsilon     0.59      epsilon USED IN AIR ENTRAINMENT SPECIFICATION
!
! /SPRD_CON/
!
ce          1.15      constant in gravity slumping equation
delrhomin   0.025     stop cloud spread if delrho<delrhomin
!
!
! /SZFC/
!
szstp0      0.01      SZF - Initial step size
szerr       0.001     SZF - Error criteria
szstpmx     5.0       SZF - Maximum step size [=] m
szsz0       0.01      SZF - Initial Value of dellay*Ueff*Heff
!
!
!   /ALPHcom/
!
ialpfl      1.        ALPHI - calculation flag; 0) alpha=alpco; 1)1/(1+z); 2)1
alpco       0.2       ALPHI - Value for alpha if IALPFL = 0
!
!
!   /PHIcom/
!
iphifl      3.        PHIF - calc flag
dellay      2.15      Ratio of Hl/Heff
!
!
!
!   /VUcom/
!
vua         1.3       Constant Av in source model
vub         1.2       Constant Bv in source model
vuc         20.0      Constant Ev in source model
vud         .64       Constant Dv in source model
vudelta     0.20      Constant DELTAv in source model
!
! End-of-File
```

Figure III.4. (continued)

III.3 Pseudo-Steady State Module--DEGADIS2

DEGADIS2 performs the downwind dispersion portion of the calculation for each of several observers released successively over the transient source described by DEGADIS1. DEGADIS2 is composed of the following subroutines (Figure III.5):

(*) AFGEN — is a utility which linearly interpolates between a pair of points based on a list of supplied values (C-2).

(*) DEGADIS2 — contains the program overhead and sequentially calls the routines to recover the information generated in DEGADIS1, recover the numerical parameter file RUNNAME.ER2, and perform the simulation (C-19).

(*) ESTRT2 — recovers the numerical parameters contained in the file RUNNAME.ER2, particularly the number of observers NOBS (C-39).

(*) OB — contains the ordinary differential equations which average the gas source for each observer (C-69).

(*) PSS — contains the ordinary differential equations which describe the portion of the downwind dispersion calculation when b > 0 (C-72).

(*) PSSOUT — governs the output of calculated points to the file RUNNAME.PSD when PSS is active (C-75).

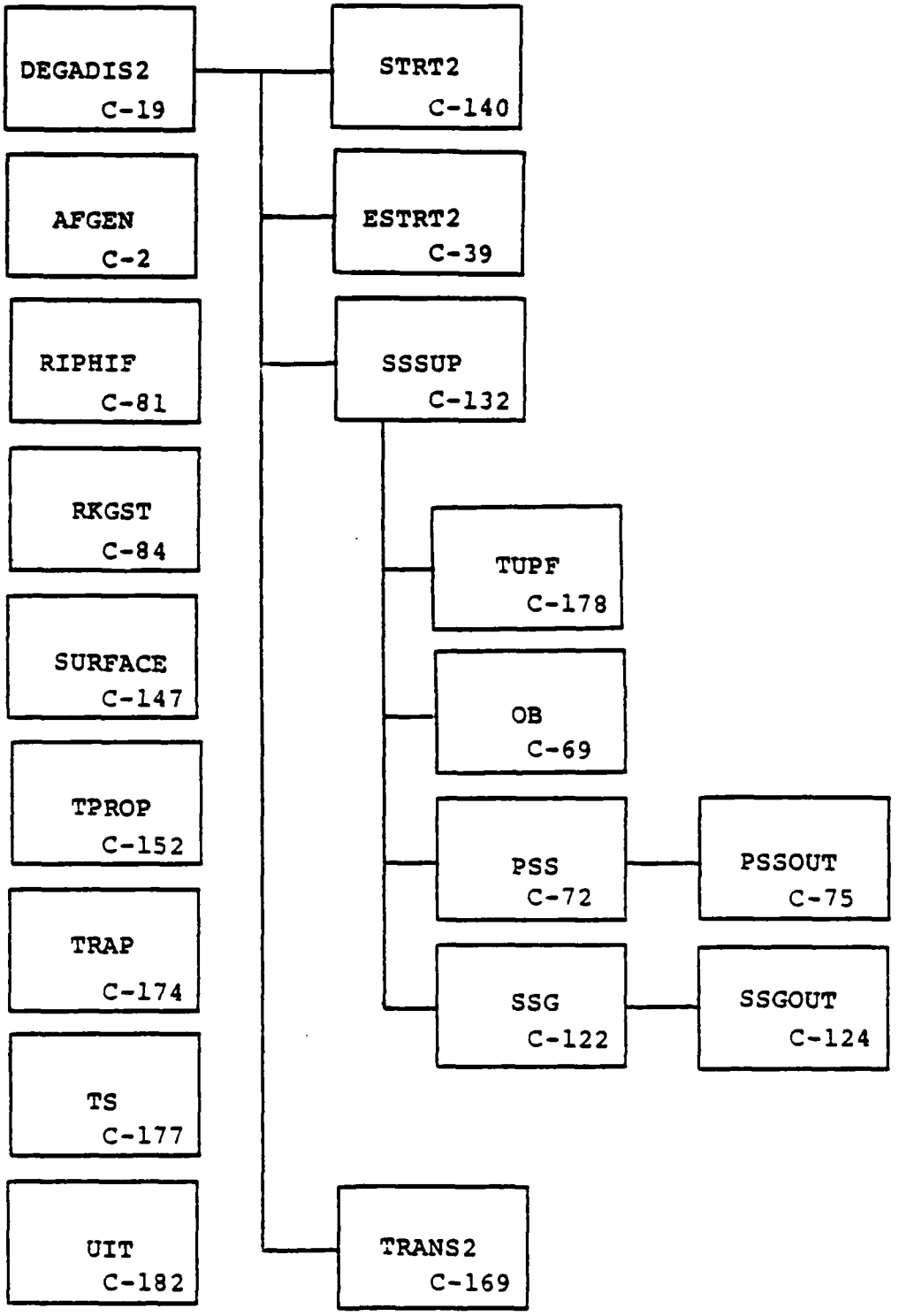


Figure III.5. DEGADIS2 flow chart.

(*) RIPHIF — is a series of utilities which calculates the Richardson number and the value of ϕ(Ri) (C-81).

(*) RKGST — is a utility routine which performs numerical integration of a specified system of equations using a modified fourth order Runge-Kutta method (C-84).

(*) SSG — contains the ordinary differential equations which describe the portion of the downwind dispersion calculation when b = 0 (C-122).

(*) SSGOUT — governs the output of calculated points to the file RUNNAME.PSD when SSG is active (C-124).

(*) SSSUP — is a supervisor routine which controls the averaging of the source for each observer, the portion of the downwind dispersion calculation when b > 0, and the portion of the downwind dispersion calculation when b = 0 (C-132).

(*) STRT2 — recovers the information generated in DEGADIS1 contained in the file RUNNAME.TR2 (C-140).

(*) SURFACE — is a utility routine which estimates heat and water transfer rates across the bottom surface of the gas layer (C-147).

(*) TPROP is a series of utility routines which estimate the thermodynamic properties of a given gas mixture (C-152).

(*) TRANS2 writes the information necessary for DEGADIS3 to the file (RUNNAME.TR3) (C-169).

(*) TRAP is a utility included for program diagnostics (C-174).

(*) TS calculates the time when a given observer will be at a given downwind distance (C-177).

(*) TUPF contains the two routines which determine the intersection of the upwind/downwind edge of the secondary gas source with a given observer (C-178).

(*) UIT is a series of routines to calculate observer position and velocity as a function of time (C-182).

As input, DEGADIS2 requires two files:

(*) RUNNAME.ER2 contains various numerical parameters, particularly the number of observers NOBS. For most simulations, a copy of the SYS$DEGADIS:EXAMPLE.ER2 file will be adequate. See Figure II.1 or II.2. A copy of SYS$DEGADIS:EXAMPLE.ER2 is included in Figure III.6

(*) RUNNAME.TR2 contains the basic simulation definition as well as calculated secondary source parameters.

DEGADIS2 generates the following output files:

(*) RUNNAME.PSD contains the calculated downwind dispersion parameters for each observer. DEGADIS3 sorts this information to determine the downwind concentration profiles as a function of time.

(*) RUNNAME.TR3 contains the simulation definition and the number of each record type written to RUNNAME.PSD.

III.4. Time Sort Module--DEGADIS3

DEGADIS3 sorts the downwind dispersion calculation for each of several observers for concentration information at several given times; the along-wind dispersion correction is then applied as desired. DEGADIS3 uses the following subroutines (Figure III.7):

(*) DEGADIS3 contains the program overhead and sequentially calls the routines to recover the information generated in DEGADIS2, recover the numerical parameter file RUNNAME.ER3, sort and apply the along-wind dispersion correction to the results of DEGADIS2, and output the results (C-24).

```
   ! This is an example for an 'ER2' run parameter file.
   ! The same rules apply as for the 'ER1' files.
   !
   !2345678901234567890123456789O
   !--------1---------2---------3
   !
   ! These values are in common area /ERROR/
   !
*  SYOER       0.03     SSSUP - RKGST - INITIAL SY
   ERRO        0.005    SSSUP - RKGST(OBS) - ERROR BOUND
   SZOER       0.01     SSSUP - RKGST(OBS) - INITIAL SZ
   WTAIO       1.0      SSSUP - RKGST(OBS) - WEIGHT FOR AI
   WTQOO       1.0      SSSUP - RKGST(OBS) - WEIGHT FOR Q
   WTSZO       1.0      SSSUP - RKGST(OBS) - WEIGHT FOR SZ
*  ERRP        0.003    SSSUP - RKGST(PSS) - ERROR BOUND
*  SMXP        10.      SSSUP - RKGST(PSS) - MAXIMUM STEP
*  WTSZP       1.0      SSSUP - RKGST(PSS) - WEIGHT FOR SZ
*  WTSYP       1.0      SSSUP - RKGST(PSS) - WEIGHT FOR SY
*  WTBEP       1.0      SSSUP - RKGST(PSS) - WEIGHT FOR BEFF
*  WTDH        1.0      SSSUP - RKGST(PSS) - WEIGHT FOR DH
*  ERRG        0.003    SSSUP - RKGST(SSG) - ERROR BOUND
*  SMXG        10.      SSSUP - RKGST(SSG) - MAXIMUM STEP SIZE
   ERTDNF      0.0005   TDNF - CONVERGENCE CRITERIA
   ERTUPF      0.0005   TUPF - CONVERGENCE CRITERIA
*  WTRUH       1.0      SSSUP - RKGST(SSG) - WEIGHT FOR RUH
*  WTDHG       1.0      SSSUP - RKGST(SSG) - WEIGHT FOR DH
   !
   ! These values are in common area /STP/
   !
   STPO        0.05     SSSUP - RKGST(OBS) - INITIAL STEP
*  STPP        0.05     SSSUP - RKGST(PSS) - INITIAL STEP
*  ODLP        0.06     SSSUP - RKGST(PSS) - RELATIVE OUTPUT DELTA
*  ODLLP       80.      SSSUP-RKGST(PSS)-MAXIMUM DISTANCE BETWEEN OUTPUTS(m)
*  STPG        0.05     SSSUP - RKGST(SSG) - INITIAL STEP
*  ODLG        0.045    SSSUP - RKGST(SSG) - RELATIVE OUTPUT DELTA
*  ODLLG       80.      SSSUP-RKGST(SSG)-MAXIMUM DISTANCE BETWEEN OUTPUTS(m)
   !
   ! The last variable NOBS is in /CNOBS/
   !
   ! Note: it is read in as a real value even though it is integer type
   !     in the program.
   !
   NOBS        30.
   !
   !
   !
   ! End-of-File
```

*used by steady state simulation

Figure III.6. SYS$DEGADIS:EXAMPLE.ER2 listing

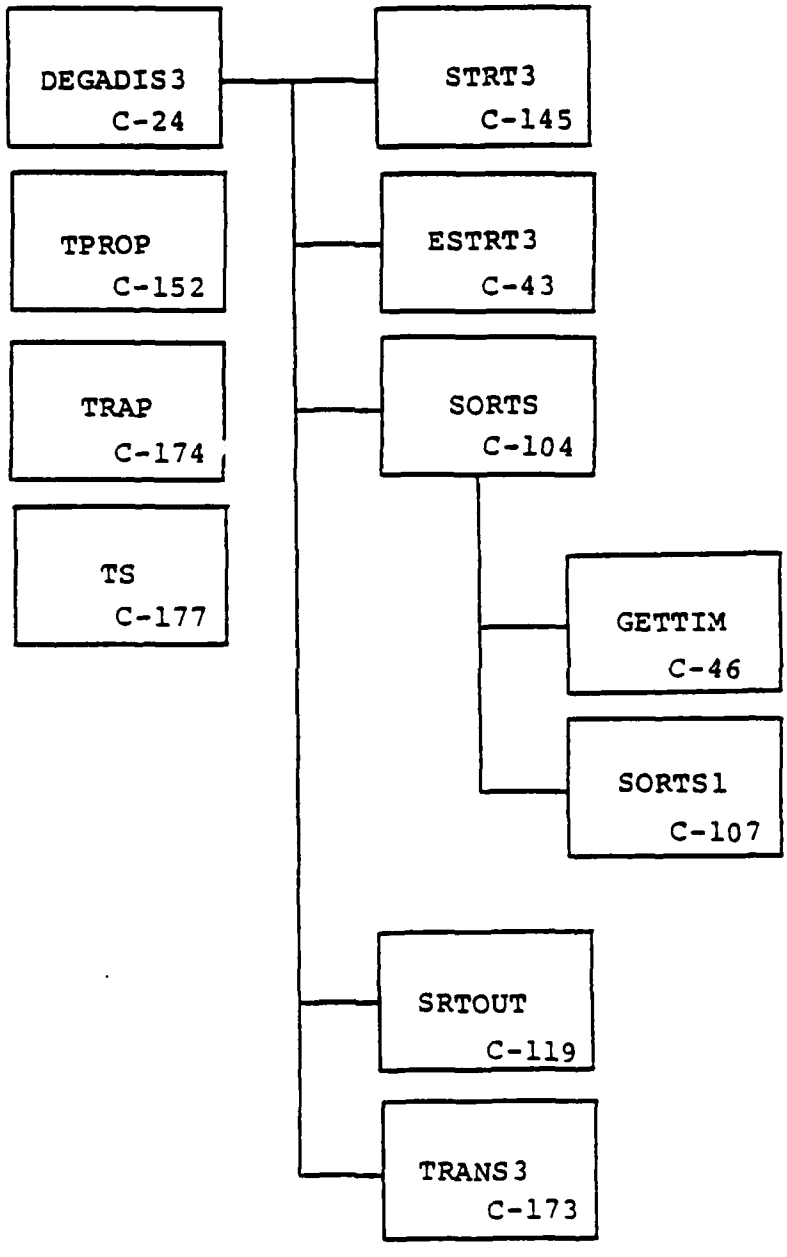


Figure III.7. DEGADIS3 flow chart.

(*) ESTRT3 recovers the numerical parameters contained in the file RUNNAME.ER3, particularly the time sort parameters (C-43).

(*) GETTIM sets the default time sort parameters as needed (C-46).

(*) SORTS recovers the information in RUNNAME.PSD and arranges the information according to the time sort parameters in the file RUNNAME.ER3 (C-104).

(*) SORTS1 applies the along-wind dispersion correction to the time-sorted information (C-107).

(*) SRTOUT generates the formatted output file RUNNAME.SR3 (C-119).

(*) STRT3 recovers the information generated in DEGADIS2 contained in the file RUNNAME.TR3 (C-145).

(*) TPROP is a series of utility routines which estimate the thermodynamic properties of a given gas mixture (C-152).

(*) TRANS3 writes RUNNAME.TR4 which contains the necessary information to recover the other output files for this simulation (C-173).

(*) TRAP is a utility included for program diagnostics (C-174).

(*) TS calculates the time when a given observer will be at a given downwind distance (C-177).

As input, DEGADIS3 requires three files:

(*) RUNNAME.ER3 contains various numerical parameters including the time sort parameters and the flag which dictates whether the along-wind dispersion correction is applied. A copy of SYS$DEGADIS:EXAMPLE.ER3 file uses the default time sort parameters and includes the along-wind dispersion correction which should apply for most simulations. See Figure II.2. A copy of SYS$DEGADIS:EXAMPLE.ER3 is included in Figure III.8.

(*) RUNNAME.PSD contains the calculated downwind dispersion parameters for each observer. DEGADIS3 sorts this information to determine the downwind concentration profiles as a function of time.

(*) RUNNAME.TR3 contains the number of each record type written to RUNNAME.PSD as well as the simulation definition.

```
! This is an example for an 'ER3' run parameter file.
! The same rules apply as for the 'ER1' files.
!
!23456789012345678901234567890
!--------1---------2---------3
!
! These values are in common area /ERROR/
!
ERT1        20.        FIRST SORT TIME
ERDT        5.         SORT TIME DELTA
ERNTIM      20.        NUMBER OF TIMES FOR THE SORT
!
!    Note: ERNTIM is entered as a real variable even though
!          it is an integer type variable in the program.
!
!  The value of CHECK5 determines whether the above sort parameters
!     are used.  CHECK5 is initialized through the passed transfer
!     files to .FALSE.  CHECK5 is set to .TRUE. if a real value of 1.
!     is passed in this file.
!
CHECK5       0.        USE THE DEFAULT TIME PARAMETERS
!CHECK5      1.        USE THE TIME PARAMETERS GIVEN ABOVE
!
!
sisx_flag    1.        correction for x-direction dispersion is to be made
!sisx_flag    0.       no correction for x-direction dispersion
!
!
!
! End-of-File
```

Figure III.8. SYS$DEGADIS:EXAMPLE.ER3 listing.

As output, DEGADIS3 generates two new files:

(*) RUNNAME.SR3 is the formatted output list of the time-sorted concentration parameters. Concentration contours are generated for the specified upper and lower flammability at the specified height entered in DEGADISIN. An example is included in Section IV.

(*) RUNNAME.TR4 contains the necessary information to recover the other output files to facilitate further processing.

III.5 Steady-State Module--SDEGADIS2

SDEGADIS2 is a simplification of DEGADIS2 which uses many of the same subroutines. SDEGADIS2 performs the downwind dispersion portion of the calculation for a steady state source described by DEGADIS1. SDEGADIS2 is composed of the following subroutines (Figure III.9):

(*) AFGEN is a utility which linearly interpolates between a pair of points based on a list of supplied values (C-2).

(*) ESTRT2SS recovers a subset of the numerical parameters contained in the file RUNNAME.ER2 (C-41).

(*) PSS is the same subroutine used in DEGADIS2; it contains the ordinary differential equations which describe the downwind dispersion calculation when $b > 0$ (C-72).

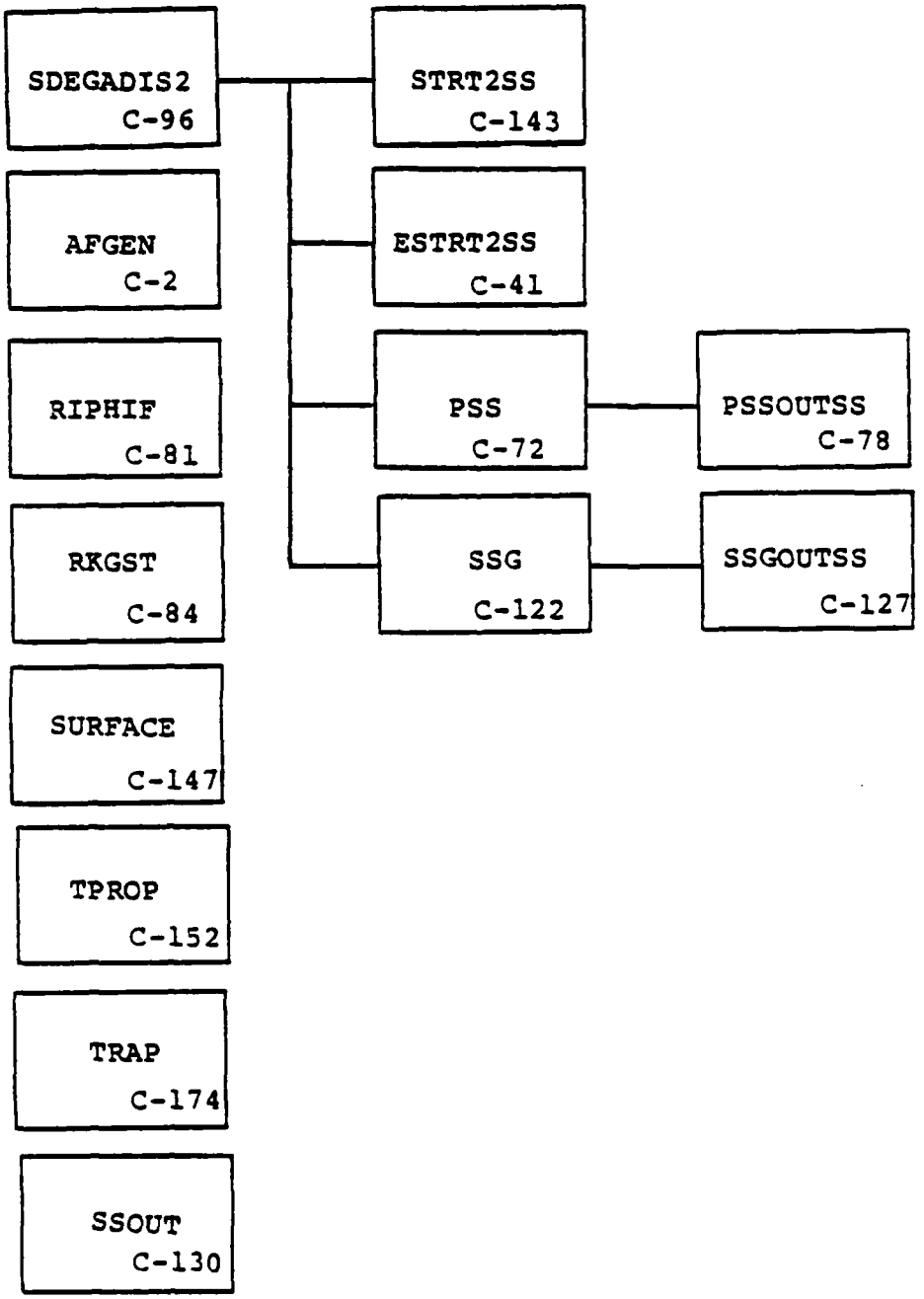


Figure III.9. SDEGADIS2 flow chart.

(*) PSSOUTSS governs the output of calculated points to the file RUNNAME.SR3 when PSS is active (C-78).

(*) RIPHIF is a series of utilities which calculates the Richardson number and the value of ϕ(Ri) (C-81).

(*) RKGST is a utility routine which performs numerical integration of a specified system of equations using a modified fourth order Runge-Kutta method (C-84).

(*) SDEGADIS2 contains the program overhead and sequentially calls the routines to recover the information generated in DEGADIS1, recover the numerical parameters file RUNNAME.ER2, and perform the steady state simulation (C-96).

(*) SSG is the same subroutine used in DEGADIS2; it contains the ordinary differential equations which describe the downwind dispersion calculation when b = 0 (C-122).

(*) SSGOUT governs the output of calculated points to the file RUNNAME.SR3 when SSG is active (C-124).

(*) SSOUT writes RUNNAME.SR3 and calculates the concentration contours (C-130).

(*) STRT2SS recovers a subset of the information generated in DEGADIS1 contained in the file RUNNAME.TR2 (C-143).

(*) SURFACE is a utility routine which estimates heat and water transfer rates across the bottom surface of the gas layer (C-147).

(*) TPROP is a series of utility routines which estimate the thermodynamic properties of a given gas mixture (C-152).

(*) TRAP is a utility included for program diagnostics (C-174).

As input, SDEGADIS2 require two files:

(*) RUNNAME.ER2 contains various numerical parameters; the steady state simulation requires only part of these. For most simulations, a copy of the SYS$DEGADIS:EXAMPLE.ER2 file will be adequate. See Figure II.1. A copy of SYS$DEGADIS:EXAMPL.ER2 is included in Figure III.6.

(*) RUNNAME.TR2 contains the basic simulation definition as well as calculated secondary source parameters; the steady state simulation requires only part of these.

As output, SDEGADIS2 generates the following files:

(*) RUNNAME.SR3 is the formatted output list of the downwind concentration parameters. Concentration contours are generated for the specified upper and lower flammability at the specified height entered in DEGADISIN.

(*) RUNNAME.TR3 contains the necessary information to recover the other output files to facilitate further processing.

IV. EXAMPLE SIMULATIONS

In 1980, the U.S. Department of Energy sponsored at China Lake, California, a series of nine LNG releases referred to as the BURRO series of experiments (Koopman et al., 1982). The input conditions (Table IV.1) for the numerical examples in this sections are those of BURRO 9 which was modeled both as a steady state and transient (time-limited) release. As suggested by the Shell Maplin Sands LNG releases (Blackmore et al., 1982), the liquid source diameter was determined using a boiling rate of 0.085 kg/m^2 s for LNG on water.

TABLE IV.1
SUMMARY OF BURRO9 TEST CONDITIONS
USED IN EXAMPLE SIMULATIONS

Source Rate:	130.0 kg/s
Source Radius:	22.06 m
Wind Speed:	6.5 m/s at 8.0 m
Atmospheric Stability:	C (Pasquill)
Monin-Obukhov Length:	-140. m
Surface Roughness:	2.05×10^{-4} m
Air Temperature:	35.4° C
Atmospheric Humidity:	12.5%
Surface Temperature:	310 K

IV.1. Example Input Sessions

The input procedures for simulation of the transient release (RUNNAME=BURRO9) and the steady state release (RUNNAME=BURRO9S) are very similar. Therefore, only the specification of the source rate and extent have been included for the transient release. In the point-by-point discussion of the input procedure, note the following:

(*) A line terminator (normally a carriage return) must end every line entered by the user.

(*) The file name specification RUNNAME must satisfy system restrictions.

(*) When DEGADISIN requests the user to choose an option, all acceptable responses are a single character (capital or lower case). The default responses are denoted by a capital letter inside angle brackets (e.g. <N>). When applicable, a menu of responses is included inside parentheses.

(*) For numerical responses, a comma, space, tab, or line terminator (carriage return) may separate the numbers.

(*) When a file is used as input (i.e. for the density or transient source input), DEGADISIN reads the same information from the file which would be entered at the terminal in the same order and in the same format.

NOTES ON STEADY STATE SIMULATION OF BURRO9

(1) Begin the input procedure by execution of DEGADISIN.

(2) The file name specification must follow system restrictions. The DEGADIS model uses this file name along with various file extensions for input and output.

(3) The Title Block is used to carry any desired comments such as information on the specification of certain parameters.

(4) The wind field parameters include the wind velocity (m/s) at a specified height (m) and the surface roughness (m).

(5) The Pasquill stability class is used to generate estimates of other atmospheric parameters which follow.

(6) The current settings of pertinent atmospheric parameters are displayed in this list. If any of these are to be changed, the first letter of the parameter to be changed is entered. Note that the default--indicated by <N>--is No for no changes.

(7) The Monin-Obukhov length (Length in the list) is to be changed, so L is entered in response to the prompt.

(8) The list is redisplayed to verify the change and to request any further changes. The (default) response of No causes the program to go to the next question.

(9) The ambient temperature and pressure are entered.

(10) DEGADISIN calculates the ambient air density for the given input parameters.

```
(1)  $ run desadisin

                    DEnse GAs DISpersion Model input module.

(2)  Enter the simulation name : [DIR]RUNNAME burro9s
         INPUT MODULE -- DEGADIS MODEL

         xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
(3)      Enter Title Block -- up to 4 lines of 80 characters
         To stop, type '//'
     Steady state simulation of BURRO 9
     //
(4)      ENTER WIND PARAMETERS -- U0 (m/s), Z0 (m), and ZR(m)
         U0 -- Wind velocity at reference height Z0
         ZR -- Surface Roughness
     6.5,8.,2.05e-4

(5)      Enter the Pasquill stability class: (A,B,C,D,E,F) <D> c

(6)  The values for the atmospheric parameters are set as follows:
     DELTA:                          0.2000
     BETA:                           0.9000
     Monin-Obukhov length:          -9.3344 m
     Sigma X Coefficient:            0.0200
     Sigma X Power:                  1.2200
     Sigma X Minimum Distance:     130.0000 m
(7)  Do you wish to change any of these?
     (No,Delta,Beta,Length,Coefficient,Power,Minimum) <N> L
     Note: For infinity, ML = 0.0
     Enter the desired Monin-Obukhov length: (m) -140.

(8)  The values for the atmospheric parameters are set as follows:
     DELTA:                          0.2000
     BETA:                           0.9000
     Monin-Obukhov length:        -140.0000 m
     Sigma X Coefficient:            0.0200
     Sigma X Power:                  1.2200
     Sigma X Minimum Distance:     130.0000 m
     Do you wish to change any of these?
     (No,Delta,Beta,Length,Coefficient,Power,Minimum) <N>

(9)  Enter the ambient temperature(C) and pressure(atm): 35.4,0.94

     The ambient humidity can be entered as Relative or Absolute.
     Enter either R or A <R or a>:
     Enter the relative humidity (%): 12.5

(10) Ambient Air density is    1.0731     kg/m**3
```

(11) If the release is isothermal, respond "Y". A positive response causes DEGADISIN to ask for a list of concentration, density, and mole fraction points for the gas mixture. The default response is negative.

(12) If the release is simulated as adiabatic, the default negative response is chosen. For inclusion of heat transfer effects, the surface temperature and the method of calculating the heat transfer coefficient must be specified.

(13) Water transfer to the source blanket (if present) can be included in the calculation.

(14) Enter the three-letter designation of the diffusing gas. The properties of LNG as methane and LPG as propane are included.

(15) A list of the properties for the specified gas (if available) is given. If any of the parameters are to be changed, the first letter of the parameter to be changed in the list is given to the prompt. Here, the level at which the flammability contours are calculated is changed from 0.5 m to 1.0 m.

(16) The gas property list is displayed again. The default response is no change.

(17) The lowest concentration of interest is the concentration at which the calculations are stopped.

(11) Is this an Isothermal spill? <y or N>

(12) Is heat transfer to be included in the calculations <y or N> y
Enter the surface temperature [=] K : 310.
Do you want to use the built in correlation, the LLNL correlation, or
enter a particular value?
(Corr,LLNLcorr,Value) <C>

(13) Is water transfer to be included in the source <y or N>

(14) Enter the code name of the diffusing species: lng

(15) The characteristics for the gas are set as follows:

Molecular weight:	16.04
Storage temperature [K]:	111.70
Density at storage temperature, PAMB [kg/m**3]:	1.6845
Mean Heat capacity constant	5.60000E-08
Mean Heat capacity power	5.0000
Upper Flammability Limit [mole frac]	0.15000
Lower Flammability Limit [mole frac]	5.00000E-02
Height of Flammability Limit [m]	0.50000

Do you wish to change any of these? (No,Mole,Temp,Den,Heat,Power,Upper,Lower,Z) <N> z
Enter the desired Height for the flammable limit calculations: 1.0

(16) The characteristics for the gas are set as follows:

Molecular weight:	16.04
Storage temperature [K]:	111.70
Density at storage temperature, PAMB [kg/m**3]:	1.6845
Mean Heat capacity constant	5.60000E-08
Mean Heat capacity power	5.0000
Upper Flammability Limit [mole frac]	0.15000
Lower Flammability Limit [mole frac]	5.00000E-02
Height of Flammability Limit [m]	1.0000

(17) Do you wish to change any of these? (No,Mole,Temp,Den,Heat,Power,Upper,Lower,Z) <N>
Enter the LOWEST CONCENTRATION OF INTEREST (kg/m**3) : 5.e-3

(18) A initial mass of gas can be specified over the source. This can be used to model aboveground release such as the Thorney Island Trials and should be zero for steady state releases.

(19) If a steady state release is to be simulated, type "Y" to the prompt. For a steady simulation, the steady state mass evolution rate (kg/s) and primary source extent (m) are required.

(20) A note about the numerical parameter files is included. These files contain various constant values used in the programs to which the user has access without recompiling the programs. Access is granted as a convenience.

(21) DEGADISIN will generate a command procedure suitable for running the model under VMS.

(22) If so desired, DEGADISIN will initiate the command procedure under VMS. If not, the program returns to the operating system.

Specification of source rate and extent.

(18) Enter the initial mass of pure gas over the source. (kg)
(Positive or zero): 0.

(19) Is this a Steady state simulation? <y or N> y

Enter the desired evolution rate [=] kg/sec : 130.
Enter the desired source radius [=] m : 22.06

(20) In addition to the information just obtained, DEGADIS requires a series of numerical parameter files which use the same name as [DIR]RUNNAME given above.

For convenience, example parameter files are included for each step. They are:

EXAMPLE.ER1 and
EXAMPLE.ER2

Note that each of these files can be edited during the course of the simulation if a parameter proves to be out of specification.

(21) Do you want a command file to be generated to execute the procedure? <Y or n>
The command file will be generated under the file name:

burro9s.com

(22) Do you wish to initiate this procedure? <y or N>
$

NOTES ON TRANSIENT SIMULATION OF BURRO 9

Beginning with the specification of the source rate and extent the responses to all of the previous questions except the simulation name (RUNNAME) are the same for the steady state case and are not repeated.

(23) An initial mass of gas can be specified over the source. This can be used to model aboveground releases such as the Thorney Island Trials.

(24) The default response is for a transient release.

(25) The transient source description consists of ordered triples of time, evolution rate, and source radius.

(26) An input file can be used to enter the data triples to avoid typing errors or to use as output from another model such as a liquid spreading model. The file format is the same as the terminal entry format.

(27) The first item is the number of triples used in the description followed by the triples with the last two values showing no gas present.

(28) DEGADISIN will generate a command procedure suitable for running the model under VMS.

(29) If so desired, DEGADISIN wil initiate the procedure under VMS. If not, the program returns to the operating system.

Specification of source rate and extent.

(23) Enter the initial mass of pure gas over the source, (kg)
(Positive or zero): 0.

(24) Is this a Steady state simulation? <y or N>

Source Description

(25) The same form used by the density description
is used by the source description as follows

first point — time=0 E,R1 at initial (nonzero) values
.
.
.
nxt to last point — time=TEND E,R1=0.
last point time=TEND+ E,R1=0.

(26) Note: the final time is the last time entered where E and R1 are non-zero
Do you have an input file for the Source Description? [y or N]

(27) ENTER THE NUMBER OF TRIPLES (max= 30) FOR THE SOURCE DESCRIPTION: 4

Enter TIME (sec), EVOLUTION RATE (kg/m**3), and POOL RADIUS (m)
0.,130.,22.06
80.,130.,22.06
81.,0.,0.
82.,0.,0.

In addition to the information just obtained, DEGADIS
requires a series of numerical parameter files which use
the same name as [DIR]RUNNAME given above.

For convenience, example parameter files are included for
each step. They are:
EXAMPLE.ER1,
EXAMPLE.ER2, and
EXAMPLE.ER3
Note that each of these files can be editted during the course of the
simulation if a parameter proves to be out of specification.

(28) Do you want a command file to be generated to execute the procedure? <Y or n>
The command file will be generated under the file name:
burro9.com

(29) Do you wish to initiate this procedure? <y or N>
$

The generated INP files for BURRO9S and BURRO9 are shown in Figures IV.1 and IV.2. If necessary, the user may edit the INP file before beginning the simulation. The generated command procedures are shown in Figures II.1 and II.2.

IV.2. Example Simulation Output

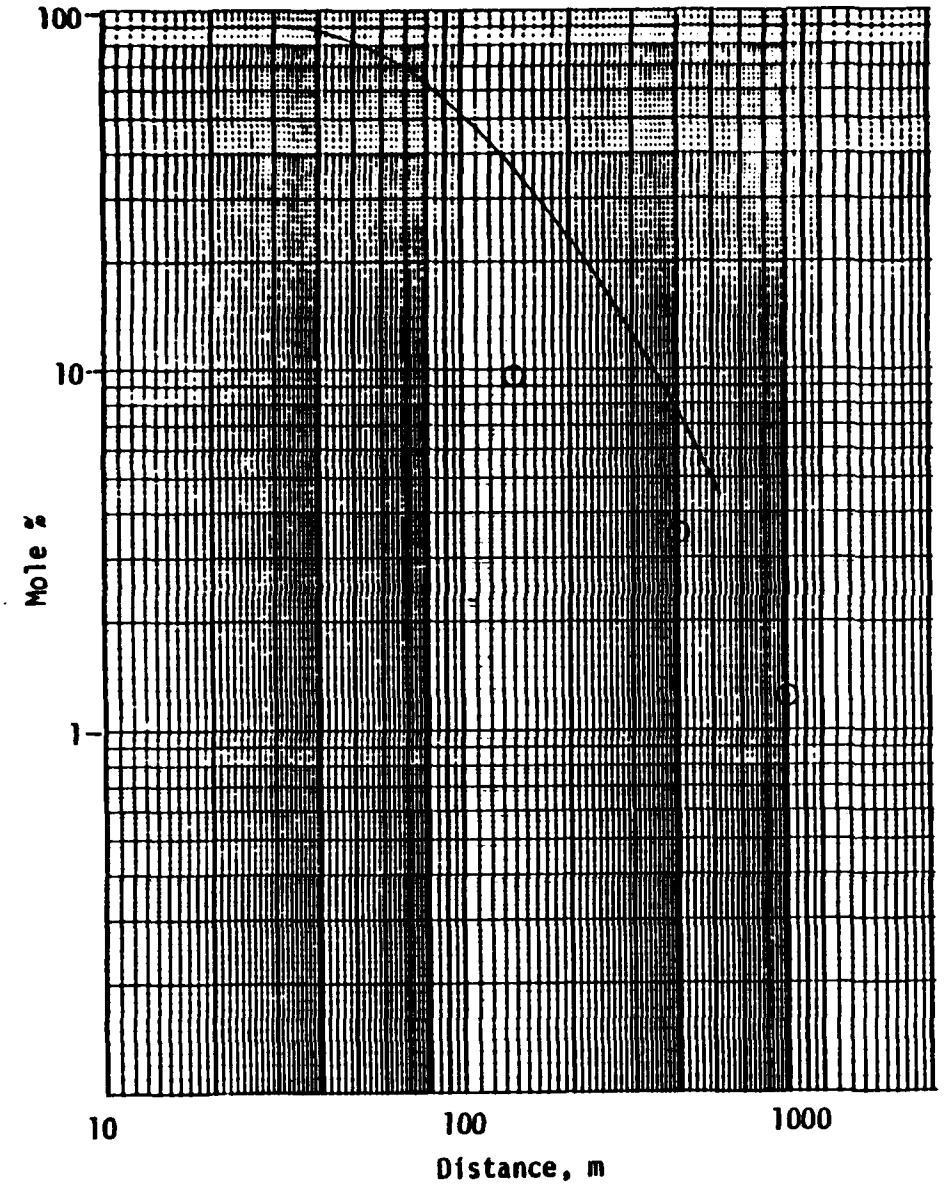
After proper completion of the model, BURRO9.LIS and BURRO9S.LIS contain the output listing for the transient and steady state releases, respectively. Figure IV.3 shows the predicted maximum ground level centerline concentration for BURRO9 as well as the maximum reported concentration as a function of downwind distance.

```
Steady state simulation of BURRO 9


   6.500000        8.000000        2.0500000E-04
    3
  0.2000000       0.9000000       -140.0000
  2.0000000E-02   1.220000         130.0000
   308.5500       0.9400000       5.1530441E-03
    0   310.0000
    1  0.0000000E+00
    0  0.0000000E+00
lns
   16.04000        111.7000        1.684480
  5.6000001E-08   5.000000
  0.1500000       5.0000001E-02   1.000000
  4.9999999E-03
  0.0000000E+00
    4
  0.0000000E+00   130.0000        22.06000
   6023.000       130.0000        22.06000
   6024.000       0.0000000E+00   0.0000000E+00
   6025.000       0.0000000E+00   0.0000000E+00
 F F F F T F
16-MAY-1985 04:43:28.92
   130.0000        39.10033        39.10033
```

Figure IV.1. BURRO9S.INP listing.

```
Transient simulation of BURRO 9

   6.500000        8.000000        2.0500000E-04
    3
  0.2000000       0.9000000       -140.0000
  2.0000000E-02    1.220000        130.0000
   308.5500       0.9400000       5.1530441E-03
    0   310.0000
    1  0.0000000E+00
    0  0.0000000E+00
lns
   16.04000        111.7000        1.684480
  5.6000001E-08    5.000000
  0.1500000       5.0000001E-02    1.000000
  4.9999999E-03
  0.0000000E+00
    4
  0.0000000E+00    130.0000        22.06000
   80.00000        130.0000        22.06000
   81.00000       0.0000000E+00   0.0000000E+00
   82.00000       0.0000000E+00   0.0000000E+00
 F F F F F F
16-MAY-1985 04:37:58.67
```

Figure IV.2. BURRO9.INP listing.



TEST: Burro 9

Source Description

Type: Steady, Time-Limited LNG
Primary Source Radius (m): 22.1
Primary Source Flux (kg/m^2 s): 0.085
Rate (kg/s): 130.0
Temperature: 112

Meteorological Conditions

Wind Velocity (m/s): 6.5
@ Height (m): 8.0
Surface Roughness (m): 2.05 E-4
Pasquill Stability: C
Monin-Obukhov Length (m): -140.0
Air Temperature (K): 308.55
Relative Humidity (%): 13
Surface Temperature (K): 310.0

Release Richardson Number

Volumetric Release Rate (m^3/s): 76.9
Characteristic Width (m): 39.1
Estimated Friction Velocity (m/s): 0.219

$$Ri_0^c = g\left(\frac{\rho_j - \rho_a}{\rho_a}\right)\frac{Q}{u\,u_*^2 D} : \quad 36$$

Figure IV.3. DEGADIS-predicted centerline maximum concentration vs. maximum reported concentration--BURRO9.

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APPENDIX A

DEGADIS MODEL INSTALLATION ON VAX/VMS

DEGADIS was developed under VAX/VMS V3.5 and VAX-11 Fortran V3.5 although there should be no installation difficulty for VAX/VMS V3.2 or later.

The directory which contains the Fortran source code for DEGADIS must be equivalenced with the logical name SYS$DEGADIS:. If the full directory specification is DQA0:[HACS.DEGADIS], issue the VAX/VMS command:

```
$ ASSIGN DQA0:[HACS.DEGADIS] SYS$DEGADIS:
```

with either the /PROCESS, /GROUP, or /SYSTEM qualifier (/SYSTEM is recommended). Once this assignment is made, the files must be compiled and linked to form DEGADISIN, DEGADIS1, DEGADIS2, DEGADIS3, and SDEGADIS2. The process which compiles and links DEGADIS must have READ, WRITE, and EXECUTE access privileges to SYS$DEGADIS while only READ and EXECUTE access privileges are needed to execute the existing models.

APPENDIX B

CONSIDERATIONS FOR INSTALLATION OTHER THAN VAX/VMS

There are two types of problems which may occur when attempting to install DEGADIS on a different computer or operating system. The first source of difficulty is the use of non-standard ANSI Fortran 77 language elements. The second source of difficulty is the use of external VAX/VMS routines in DEGADIS.

The following list is a collection of the VAX-11 Fortran extensions which have been used in DEGADIS:

(*) In-line comments--An exclamation mark (!) is used to include comments at the end of a valid statement.

(*) Special characters--The underscore (_) is used in variable names.

(*) DO loops--DO loops are used with the structure:

```
DO v = e1,e2[,e3]
 .
 .
 .
END DO
```

where v is a variable name and e1, e2, and e3 are numeric expressions. The numeric expressions have the standard Fortran 77 meaning.

(*) INCLUDE statements--INCLUDE statements simply allow other source files to be inserted in the routine being compiled at this point in the source. The system

table '($SSDEF)' is used to check the status of returning system routines.

(*) OPEN keyword NAME--The OPEN keyword NAME specifies the file name to be opened.

(*) Format descriptors--The Q descriptor obtains the integer number of characters remaining in the input record during a READ operation. The dollar sign ($) descriptor suppresses the carriage return at the end of a line on output.

(*) Continuation lines--Continuation lines have been expressed by using either a non-blank character in column 6 or by beginning the line with a tab and a number in the next column.

(*) Concatenation of character strings--Character strings are concatenated using two slashes (//).

The following VAX/VMS subroutines have been used in DEGADIS:

(*) SECNDS

TIME = SECNDS(TIMEO)

SECNDS returns to TIME the difference between the number of seconds after midnight on the system clock and the value of TIMEO.

(*) LIB$DATE_TIME

ISTAT = LIB$DATE_TIME (STRING)

LIB$DATE_TIME returns a 24-character ASCII string with the system date and time. ISTAT is an integer variable which accepts the return status.

(*) LIB$DO_COMMAND

ISTAT = LIB$DO_COMMAND (STRING)

LIB$DO_COMMAND issues the command STRING (a character string) to VAX/VMS. If the command is issued, the calling process is terminated, and ISTAT will contain a failure code.

APPENDIX C

CODE LISTING

```
C.....................................................
C
C     THIS FUNCTION LINEARLY INTERPOLATES FROM THE GIVEN
C         PAIR OF DATA POINTS.
C
      FUNCTION AFGEN(TAB,X,SPEC)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
      common/nend/poundn,pound
c
      character*4 pound
      character*(*) SPEC
      DIMENSION TAB(1)
C
      IF(X .GE. TAB(1)) GO TO 95
      WRITE(lunlog,1100) x,spec
      AFGEN = TAB(2)
      RETURN
C
 95   continue
      ix = 1
  100 Ix = ix + 2
C
      IY = IX + 1
      IF( TAB(IX).EQ.POUNDN .AND. TAB(IY).EQ.POUNDN ) GO TO 500
      IF(X .GE. TAB(IX)) GO TO 100
C
      IXP = IX-2
      IYP = IXP + 1
C
      SL = (TAB(IY) - TAB(IYP))/(TAB(IX) - TAB(IXP))
      AFGEN = SL*(X - TAB(IXP)) + TAB(IYP)
      RETURN
C
  500 CONTINUE
      IX = IX-2
      IY = IY-2
      IXP = IX-2
      IYP = IY-2
C
      SL = (TAB(IY) - TAB(IYP))/(TAB(IX) - TAB(IXP))
      AFGEN = SL*(X - TAB(IXP)) + TAB(IYP)
C
 1100 FORMAT(2X,'?AFGEN? UNDERFLOW; argument: ',1pg13.5,5X,A20)
      RETURN
      END
####


 1 -- sys$desadis:AFGEN.FOR
```

```
C.....................................................................
C
C     SUBROUTINES TO CALCULATE THE VALUE OF ALPHA
C
      SUBROUTINE ALPH

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$degadis:DEGADIS1.dec'
C
      COMMON
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtab,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/ALP/ALPHA,alpha1
     $/alphcom/ ialpfl,alpco
C
      REAL*8 ML,K
C
      EXTERNAL ALPHI
C
      PSI = PSIF(Z0,ML)
      USTAR = U0*K/(dLOG((Z0+ZR)/ZR) - PSI)
c
      if(u0 .eq. 0.) then
              alpha = 0.
              ustar = 0.
              return
              endif
c
      if(ialpfl.eq. 0) then
              alpha = alpco
              return
              endif
C
C*** RMTI USED TO DETERMINE THE ROOT OF THE REQUIRED INTEGRAL EQUATION
C
      IEND = 40
      IER = 0
C
      CALL RTMI(X,F,ALPHI,XLI,XRI,EPS,IEND,IER)
      IF( IER .NE. 0 ) CALL trap(19,IER)
      ALPHA = X
C
      RETURN
      END
c
c
C.....................................................................

1 -- sys$degadis:ALPH.FOR
```

```
C
C     FUNCTION TO EVALUATE THE WEIGHTED EUCLIDEAN NORM OF THE
C      ERROR ASSOCIATED WITH THE POWER LAW FIT OF THE WIND PROFILE.
C
      FUNCTION ALPHI(X)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
C
      COMMON
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTtm,WTya,wtyc,wteb,wtmb,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/ALP/ALPHA,alpha1
C
      REAL*8 ML,K
C
      DIMENSION Y(1),DERY(1),PRMT(5),AUX(8)
      EXTERNAL ARG,ARGOUT
C
      ALPHA = X
C
      PRMT(1) = Z0
      PRMT(2) = dmax1(ZLOW,zr)        ! to take care of large zr
      PRMT(3) = STPINZ
      PRMT(4) = ERBNDZ
      PRMT(5) = STPMXZ
C
      Y(1) = 0.0D00
C
      DERY(1) = 1.0D00
C
      NDIM = 1
      IHLF = 0
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,ARG,ARGOUT,AUX)
C
      IF(IHLF .GE. 10) CALL trap(18,IHLF)
      ALPHI = Y(1)
      RETURN
      END
c
c
C.....................................................................
C
C     FUNCTION TO EVALUATE THE ARGUMENT OF THE INTEGRAL EXPRESSION
C
      SUBROUTINE ARG(Z,Y,D,PRMT)

2 -- sys$desadis:ALPH.FOR
```

```
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
C
      COMMON
     $/PARM/U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/ALP/ALPHA,alpha1
     $/alphcom/ ialpfl,alpco
C
      REAL*8 ML,K
C
      DIMENSION Y(1),D(1),PRMT(1)
C
C*** WEIGHT FUNCTION USED
C
      W = 1.D00/(1.D00 + Z)
      if(ialpfl.eq. 2) w= 1.D00
C
C*** WIND VELOCITY @ Z -- BEST FIT
C
      UBST = USTAR/K*(dLOG((Z+ZR)/ZR) - PSIF(Z,ML))
C
C*** WIND VELOCITY @ Z -- POWER LAW APPROXIMATION
C
      UALP = U0 * (Z/Z0) ** ALPHA
C
      D(1) = W * (UBST - UALP) * dLOG(Z/Z0) * UALP
      RETURN
      END
C
C
      SUBROUTINE ARGOUT
      RETURN
      END
####
```

```
C.....................................................................
C
C     SUBROUTINE TO CREATE RADG,QSTR,srcden,srcwc,srcwa,srcenth DATA LISTS
C
C     PARAMETERS  --  TABLE - WORKSPACE VECTOR
C                     NTAB - DIMENSION OF TABLE DIVIDED BY iout_src
C                     RER - RELATIVE ERROR BOUND OF CREATED
C                             DATA PAIRS BY LINEAR INTERPOLATION
C
C     VALUES OF TIME, RADG, height, QSTR, SZO, wc, wa, rho, Ri,
c             wc,wa,enthalpy,temp
c       ARE READ INTO
C       TABLE(1) TO TABLE(13) RESPECTIVELY.
C
C.....................................................................
C
      SUBROUTINE CRFG(TABLE,NTAB,rer)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      DIMENSION TABLE(1)
C
      include 'sys$desadis:DEGADIS1.dec'
      parameter (zero= 1.e-20)
c
      COMMON
     $/GEN3/ rads(2,maxl),qstr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/NEND/ POUNDN,POUND
c
      character*4 pound
c
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      DATA NI/1/
c
      data iti/1/      ! time - element no 1 in record
      data irq/2/      ! Rads - element no 2 in record
      data iqs/4/      ! Qstar - element no 4 in record
      data idn/8/      ! rho - element no 8 in record
      data iwc/10/     ! wc - element no 10 in record
      data iwa/11/     ! wa - element no 11 in record
      data ien/12/     ! enthalpy - element no 12 in record
c
C
C     OUTPUT CREATED VECTORS TO A PRINT FILE
C

1 -- sys$desadis:CRFG.FOR
```

```
C
      READ(9,*) (TABLE(J),J=1,iout_src)
C
      WRITE(8,1111)
      WRITE(8,1105)
      if(isofl.eq. 1) then
      WRITE(8,1102)
      WRITE(8,1103)
      WRITE(8,1140) (TABLE(J),J=1,6),table(8),table(9)
      else
      WRITE(8,1100)
      WRITE(8,1104)
      WRITE(8,1140) (TABLE(J),J=1,6),table(8),table(13),table(9)
      endif
      ispace = 1
C
 1100   FORMAT(/,5X,'Time',5X,2x,'Gas Radius',2x,4X,'Height',4X,
     $4x,'Qstar',5x,2x,'SZ(x=L/2.)',2x,1X,'Mole frac C',2x,
     $3x,'Density',4x,1x,'Temperature',2x,3x,'Rich No.',3x)
 1102   FORMAT(/,5X,'Time',5X,2x,'Gas Radius',2x,4X,'Height',4X,
     $4x,'Qstar',5x,2x,'SZ(x=L/2.)',2x,1X,'Mole frac C',2x,
     $3x,'Density',4x,3x,'Rich No.',3x)
 1103 FORMAT(1H ,5X,'sec',6X,6X,'m',7X,6X,'m',7X,
     $2X,'kg/m**2/s',3X,6X,'m',7X,14x,3x,'kg/m**3',4x,14x,/)
 1104 FORMAT(1H ,5X,'sec',6X,6X,'m',7X,6X,'m',7X,
     $2X,'kg/m**2/s',3X,6X,'m',7X,14x,3x,'kg/m**3',4x,6x,'K',7x,14x,/)
 1105 FORMAT(1H ,23X,'*****',21X,'CALCULATED SOURCE PARAMETERS',21X,
     $'*****')
C
      RADG(1,1) = 0.
      RADG(2,1) = TABLE(2)
      QSTR(1,1) = 0.
      QSTR(2,1) = TABLE(4)
      srcden(1,1) = 0.
      srcden(2,1) = table(8)
      srcwc(1,1) = 0.
      srcwc(2,1) = table(10)
      srcwa(1,1) = 0.
      srcwa(2,1) = table(11)
      srcenth(1,1) = 0.
      srcenth(2,1) = table(12)
C
      READ(9,*) (TABLE(J),J=1,iout_src)
      L = 2
C
C*** L IS THE NUMBER OF RECORDS WHICH HAVE BEEN READ
C
  100   CONTINUE
      DO 120 I=2,NTAB
C
C*** MOVE LAST RECORD READ INTO THE LAST ACTIVE POSITION OF TABLE

2 -- sys$desadis:CRFG.FOR
```

```
C
      DO 130 J = 1,iout_src
      KK = iout_src * (I-1) + J
  130   TABLE(KK) = TABLE(J)
      KK = iout_src * I
C
C*** READ THE NEXT RECORD.  INCREMENT L.
C
      L = L + 1
      READ(9,*,END=900) (TABLE(J),J=1,iout_src)
C
C
      DO 140 Kkk = 2,I
C
      KT    = iout_src*(Kkk-1) + iti
      KRG   = iout_src*(Kkk-1) + irg
      KQSTR = iout_src*(Kkk-1) + iqs
      KCA   = iout_src*(Kkk-1) + idn
      Kwc   = iout_src*(Kkk-1) + iwc
      Kwa   = iout_src*(Kkk-1) + iwa
      Ken   = iout_src*(Kkk-1) + ien
C
      timeslot = rads(1,ni)
      ratio = (table(kt) - timeslot) / (table(iti) - timeslot)
c
      ANSRG = (TABLE(irg) - RADG(2,NI)) * ratio + RADG(2,NI)
      ANSQ = (TABLE(iqs) - QSTR(2,NI)) * ratio + QSTR(2,NI)
      ANSCA = (TABLE(idn) - srcden(2,NI)) * ratio + srcden(2,NI)
      ANSwC = (TABLE(iwc) - srcwc(2,NI)) * ratio + srcwc(2,NI)
      ANSwa = (TABLE(iwa) - srcwa(2,NI)) * ratio + srcwa(2,NI)
      ANSen = (TABLE(ien) - srcenth(2,NI)) * ratio + srcenth(2,NI)
C
      ERRG = ABS(ANSRG - TABLE(KRG))/TABLE(KRG)
      ERQSTR = ABS(ANSQ - TABLE(KQSTR))/(TABLE(KQSTR)+zero)
      ERO = dMAX1(ERRG,ERQSTR)
c
      ERCA = ABS(ANSCA - TABLE(KCA))/TABLE(KCA)
      ERO = dMAX1(ERO,ERCA)
c
      ERwC = ABS(ANSwC - TABLE(KwC))/(TABLE(KwC)+ zero)
      ERO = dMAX1(ERO,ERwC)
      ERwa = ABS(ANSwa - TABLE(Kwa))/(TABLE(Kwa)+ zero)
      ERO = dMAX1(ERO,ERwa)
      ERen = ABS(ANSen - TABLE(Ken))/(TABLE(Ken)+ zero)
      ERO = dMAX1(ERO,ERen)
C
      IF(ERO .GT. RER) GO TO 150
  140   CONTINUE
  120   CONTINUE
C
      WRITE(lunlog,1110)

3 -- sys$desadis:CRFG.FOR
```

```
C
C*** RECORD NEXT DATA PAIR. SINCE ERROR EXCEEDED, RECORD THE LAST
C***  DATA PAIR WHICH SATISFIED THE ERROR CRITERIA WHICH IS STORED
C***  IN TABLE(KK-(iout_src-1)) TO TABLE(KK)
C
  150   NI = NI + 1
        IF(NI .GT. MAXL)CALL trap(5)
c
        KT    = KK - iout_src + iti
        KRG   = KK - iout_src + irg
        KQSTR = KK - iout_src + iqs
        KCA   = KK - iout_src + idn
        KwC   = KK - iout_src + iwc
        Kwa   = KK - iout_src + iwa
        Ken   = KK - iout_src + ien
C
        RADG(1,NI)    = TABLE(KT)
        RADG(2,NI)    = TABLE(KRG)
        QSTR(1,NI)    = TABLE(KT)
        QSTR(2,NI)    = TABLE(KQSTR)
        srcden(1,NI) = TABLE(KT)
        srcden(2,NI) = TABLE(KCA)
        srcwc(1,NI)  = TABLE(KT)
        srcwc(2,NI)  = TABLE(KWC)
        srcwa(1,NI)  = TABLE(KT)
        srcwa(2,NI)  = TABLE(KWA)
        srcenth(1,NI)  = TABLE(KT)
        srcenth(2,NI)  = TABLE(KEN)
C
C*** WRITE THE POINTS JUST RECORDED TO UNIT=8
C
        if(isof1.eq. 1) then
        WRITE(8,1140) (TABLE(J),J=kt,kt+5),table(kt+7),table(kt+8)
        else
        WRITE(8,1140) (TABLE(J),J=kt,kt+5),table(kt+7),
        1       table(kt+12),table(kt+8)
        endif
        ispace = ispace + 1
        if(ispace.eq. 3) then
                ispace = 0
                write(8,1111)
                endif
C
        GO TO 100
C
  900 CONTINUE                  ! EOF encountered
C
        NI   = NI   + 1
        IF(NI+1 .GT. MAXL) CALL trap(5)
c
        RADG(1,NI)    = TABLE(iti)

4 -- sys$desadis:CRFG.FOR
```

```
      RADG(2,NI)   = TABLE(irs)
      QSTR(1,NI)   = TABLE(iti)
      QSTR(2,NI)   = TABLE(ios)
      srcden(1,NI) = TABLE(iti)
      srcden(2,NI) = TABLE(idn)
      srcwc(1,NI)  = TABLE(iti)
      srcwc(2,NI)  = TABLE(iwc)
      srcwa(1,NI)  = TABLE(iti)
      srcwa(2,NI)  = TABLE(iwa)
      srcenth(1,NI)  = TABLE(iti)
      srcenth(2,NI)  = TABLE(ien)
C
      if(isofl.eq. 1) then
      WRITE(8,1140) (TABLE(J),J=1,6),table(8),table(9)
      else
      WRITE(8,1140) (TABLE(J),J=1,6),table(8),table(13),table(9)
      endif
      ispace = ispace + 1
      if(ispace.eq. 3) then
              ispace = 0
              write(8,1111)
              endif
C
      NI   = NI   + 1
      DO 910 I =1,2
      RADG(I,NI)    = POUNDN
      QSTR(I,NI)    = POUNDN
      srcden(I,NI)  = POUNDN
      srcwc(I,NI)   = POUNDN
      srcwa(I,NI)   = POUNDN
      srcenth(I,NI) = POUNDN
  910 CONTINUE
C
      RETURN
C
 1110 FORMAT(' ?CRFG? TABLE exceeded without point selection ',
     $'- execution continuing')
 1111 FORMAT(1H )
c1140 FORMAT(1H ,<iout_src>(1PG13.6,1X))
 1140 FORMAT(1H ,9(1PG13.6,1X))
      END
$$$$
```

5 -- sys$desadis:CRFG.FOR

```
C.....................................................
C
C
C     DIMENSIONS/DECLARATIONS for DEGADIS1
C
      include 'sys$degadis:DEGADISIN.dec'
c
c  maxl is the length of the /GEN3/ output vectors
c
      parameter (     lunlog= 6,
     1                sqrtpi= 1.77 245 3851,          ! sqrt(pi)
     2                maxl= 600,
     3                maxl2= 2*maxl,
     4                iout_src= 13)
C
****
```

```
      PROGRAM DEGADIS1
C
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C     Program description:
C
C     DEGADIS1 estimates the ambient wind profile power alpha and
C     characterizes the primary gas source.
C
C
C     Program usage:
C
C     Consult Volume III of the Final Report to U. S. Coast Guard
C     contract DT-CG-23-80-C-20029 entitled 'Development of an
C     Atmospheric Dispersion Model for Heavier-than-Air Gas Mixtures'.
C
C     J. A. Havens
C     T. O. Spicer
C
C     University of Arkansas
C     227 Engineering Buildings
C     Department of Chemical Engineering
C     Fayetteville, AR 72701
C
C     April 1985
C
C
C     This project was sponsored by the U. S. Coast Guard and the Gas
C     Research Institute under contract DT-CG-23-80-C-20029.
C
C
C     Disclaimer:
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C     Arkansas as an account of work sponsored by the U. S. Coast Guard
C     and the Gas Research Institute.  Neither the University of Arkansas,
C     nor any person acting on its behalf:
C
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C         of the information contained in this computer code material,
C         or that the use of any apparatus, method, numerical model,
C         or process disclosed in this computer code material may not
C         infringe privately owned rights; or
C
C     b.  Assumes any liability with respect to the use of, or for
C         damages resulting from the use of, any information,
C         apparatus, method, or process disclosed in this computer
C         code material.

1 -- sys$desadis:DEGADIS1.FOR
```

```
C
C
C*****************************************************************************
C*****************************************************************************
C*****************************************************************************
C
C
C     DIMENSIONS/DECLARATIONS
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$degadis:DEGADIS1.dec'
C
C  ntab is the dimension of table divided by iout_src
C
      parameter (     ntab0=910,
     $                        ntab=ntab0/iout_src)
C
      include '($ssdef)'
C
C     BLOCK COMMON
C
      COMMON
     $/GEN3/ rads(2,max1),astr(2,max1),srcden(2,max1),srcwc(2,max1),
     $ srcwa(2,max1),srcenth(2,max1)
     $/TITL/ TITLE
     $/GEN1/ ET(2,isen),RIT(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTtm,WTya,wtyc,wteb,wtmb,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/SZFC/ szstp0,szerr,szstpmx,szsz0
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl,swcl,swal,senl,srhl
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/vucom/ vua,vub,vuc,vud,vudelta,vuflag
     $/com_sigx/ sigx_coeff,sigx_pow,sigx_min_dist,sigx_flag
     $/com_ENTHAL/ H_masrte,H_airrte,H_watrte
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/alphcom/ ialpfl,alpco
     $/phicom/ iphifl,dellay
     $/spcd_con/ ce, delrhomin
     $/COM_SURF/ HTCUTS
C

C -- sys$degadis:DEGADIS1.FOR
```

```
C
      character*80 TITLE(4)
C
      character*4 pound
      character*24 TSRC,TINP,TOBS,TSRT
      character*3 gas_name
C
      real*4 t1
      REAL*8 ML,K
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      logical vuflas
C
      REAL*8 L,L0
      DIMENSION PRMT(25),Y(7),DERY(7),AUX(8,7)
      EXTERNAL SRC1,SRC10
      character*40 opnrup1
      character OPNRUP(40)
      character*4 INP,ER1,SCD,TR2,scl
c
      dimension table(ntab0)
c
      equivalence(opnrup(1),opnrup1)
c
C.....................................................
C
C     DATA
C
      DATA POUNDN/-1.E-20/,POUND/'//  '/
      DATA USTAR/0./,GAMMAF/0./
      DATA G/9.81/,K/0.35/
      DATA GAMMAF/0./
      DATA PRMT/25*0./
      DATA Y/7*0./,DERY/7*0./
      DATA TIME0/0./,NDIM/0/
      DATA EMAX/0./,TSC1/0./
      DATA ET/isen*0.,isen*0./,R1T/isen*0.,isen*0./
      data DEN/isen*0.,isen*0.,isen*0,isen*0.,isen*0./
c
C
      DATA INP/'.inp'/,ER1/'.er1'/
      DATA SCD/'.scd'/,TR2/'.tr2'/
      data scl/'.scl'/
C
C.....................................................
C
C     MAIN
C
C*** GET THE EXECUTION TIME
C
      t1 = secnds(0.)
      istat = lib$date_TIME(TSRC)

3 -- sys$degadis:DEGADIS1.FOR
```

```
      if(istat .ne. ss$_normal) stop'lib$date_time failure'
C
C*** GET THE FILE NAME FOR FILE CONTROL
C
c     WRITE(lunlog,1130)
c1130 FORMAT(5X,'Enter the file name beins used for this run: ',$)
      read(5,1000) nchar,opnrup        ! unit 5 sets command file too
 1000 format(q,40a1)
c
      opnrup1 = opnrup1(1:nchar) // er1(1:4)
c
      CALL ESTRT1(OPNRUP1)
      HTCUTS = HTCUT
C
      opnrup1 = opnrup1(1:nchar) // inp(1:4)
      CALL IO(tend,smass0,OPNRUP1)
      CALL ALPH
C
      alpha1 = alpha+1.
      WRITE(lunlog,1105) ALPHA
 1105 FORMAT(5X,'THE VALUE OF ALPHA IS ',F6.4)
C
C
      GAMMAF = GAMMA(1./ALPHA1)
      TSC1 = TEND
C
c
c*** set the density and enthalpy functions in TPROP
c
      call setenthal(h_masrte,h_airrte,h_watrte)
      call setden(1.D00,0.D00,h_masrte)
C
C.....................................................
C
C     SOURCE INTEGRATION (CA = RHOE)
C
      opnrup1 = opnrup1(1:nchar) // scd(1:4)
c
      OPEN(UNIT=9,NAME=OPNRUP1,recl=202,TYPE='SCRATCH',
     $  carriagecontrol='list',
     $  recordtype='variable')
c
      smass  = smass0
C
C.....................................................
C
C     START THE GAS BLANKET?
C
      L = SQRTPI*AFGEN(R1T,TIME0,'R1T-MN')
      QSTRE = AFGEN(ET,TIME0,'ET-MN')/L/L
c

4 -- sys$desadis:DEGADIS1.FOR
```

```
c
      qstar = 0.
      if(u0 .ne. 0.)
     1 qstar = rhoe*k*ustar*alpha1*delay/(delay-1.)/phihat(rhoe,L)
c
c
      write(lunlog,3010) time0,l,sz,qstar,qstre
      IF(QSTRE.lt.QSTaR .and. smass0.eq.0.) then
              tsc1 = 0.
              GOTO 105
              endif
C
  100 CONTINUE
      check3 = .false.
C
C*** INITIAL CONDITIONS
C
      if(time0.ne. 0.) then
              L0 = SQRTPI*AFGEN(R1T,TIME0,'R1T-MN')
              QSTRE = AFGEN(ET,TIME0,'ET-MN')/L0/L0
c
      qstar =0.
      if(u0.ne. 0.)
     1 qstar = rhoe*k*ustar*alpha1*delay/(delay-1.)/phihat(rhoe,L0)
c
              endif
C
C*** SET UP INTEGRATION PARAMETERS
C
C*** VARIABLE      SUBSCRIPT
C*** --------      ---------
C***  RG              Y(1)
C***  mass            Y(2)
C***  massc           Y(3)
C***  massa           Y(4)
C***  Enthalpy        Y(5)
c***  moe             y(6)
C***  TIME            X
C
      PRMT(1) = TIME0
      PRMT(2) = 6.023E23
      PRMT(3) = STPIN
      PRMT(4) = ERBND
      PRMT(5) = STPMX
C     PRMT(6) = EMAX -- OUTPUT
c
      do iii = 6,23
      prmt(iii) = 0.
      enddo
C
      Y(1) = AFGEN(R1T,TIME0,'R1T-MN')

$ -- sys$desadis:DEGADIS1.FOR
```

```
      Y(2) = dmax1( smass, (pi*Y(1)**2*1.1*srccut*rhoe))
      vuflag = .false.
      htod = smass/rhoe/2./pi/Y(1)**3
      prmt(22) = htod * 2.*Y(1)       ! initial height of the tail
      prmt(24) = prmt(22)
      prmt(23) = 0.                   ! initial height of the head
      prmt(25) = prmt(23)
      if(htod .gt. 0.1) vuflag = .true.
      Y(3) = Y(2)
      Y(4) = 0.0
      Y(5) = Y(3) * h_masrte
      y(6) = 0.0
C
      DERY(1) = WTRG
      DERY(2) = WTtm
      DERY(3) = WTyc
      DERY(4) = WTya
      DERY(5) = WTeb
      dery(6) = wtmb
C
      NDIM = 6
C
C*** PERFORM INTEGRATION
C
      WRITE(lunlog,1145)
 1145 FORMAT(5X,'Beginning Integration Step - Gas blanket')
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,SRC1,SRC10,AUX)
C
      IF(IHLF .GT. 10) CALL trap(1,IHLF)
      IF(CHECK3) then
              TEND = TSC1
              GO TO 110
      end if
C
C.....................................................
C
C     RESTART THE GAS BLANKET?
C
      TIME0 = TSC1
      L = SQRTPI*AFGEN(R1T,TIME0,'R1T-MN')
      QSTRE = AFGEN(ET,TIME0,'ET-MN')/L/L
c
      qstar = 0.
      if(u0.ne. 0.)
      1 qstar = rhoe*k*ustar*alpha1*dellay/(dellay-1.)/phihat(rhoe,L)
c
      write(lunlog,3010) time0,l,sz,qstar,qstre
 3010 format(//,' time0: ',1pg13.5,t40,'l: ',1pg13.5,
     $/,' sz0: ',1pg13.5,/,' qstar: ',1pg13.5,t40,'qstre: ',1pg13.5)
      IF(QSTRE .Gt. QSTaR) GO TO 100

6 -- sys$desadis:DEGADIS1.FOR
```

```
C.....................................................
C
C     SOURCE INTEGRATION -- NO GAS BLANKET
C
  105 continue
      WRITE(lunlog,1146)
 1146 FORMAT(5X,'Source calculation - No Gas blanket')
C
      CALL NOBL(timeout)
c
      if(check3) then          ! restart blanket calculation
              time0 = timeout
              goto 100
      end if
C
C
  110 RMAX = 1.01*RMAX         ! GUARANTEE A GOOD VALUE
      aleph = 0.
      if(u0 .ne. 0.)
      1       ALEPH = U0/GAMMAF*(SZM/Z0)**ALPHA
      2               /(SQRTPI/2.*RM +RMAX)**(ALPHA/ALPHA1)
C
c
      rewind (unit=9)
      opnrup1 = opnrup1(1:nchar) // scl(1:4)
      open(unit=8,name=opnrup1, type='new',
     $        carriagecontrol='fortran', recordtype='variable')
c
      call head(smass0)
      call crfs(table,ntab,crfser)
      call head(smass0)
c
      CLOSE(UNIT=9)
      close(unit=8)
C
      opnrup1 = opnrup1(1:nchar) // tr2(1:4)
      CALL TRANS(OPNRUP1)
C
C*** CALCULATE EXECUTION TIME
C
      tt1 = t1
      t1 = Secnds(tT1)/60.
      WRITE(lunlog,2000) TSRC
      WRITE(lunlog,2010) T1
 2000 FORMAT(1X,'BEGAN AT ',A24)
 2010 FORMAT(5X,' ***** ELAPSED TIME ***** ',1pg13.5,' min ')
C
      STOP
      END
####


? -- sys$desadis:DEGADIS1.FOR
```

```
C.....................................................
C
C
C     DIMENSIONS/DECLARATIONS for DEGADIS2
C
      include 'sys$degadis:DEGADIS1.dec/list'
C
C   MAXNOB IS THE MAXIMUM NUMBER OF OBSERVERS ALLOWED.
C
      parameter(      maxnob = 50,
     1                RT2= 1.41 421 3562,     ! sqrt(2.0)
     2                sqpio2= 1.25 331 4137)  ! sqrt(pi/2.)
C
****
```

1 -- sys$degadis:DEGADIS2.DEC

```
      PROGRAM DEGADIS2
C
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C     Program description:
C
C     DEGADIS2 performs the downwind dispersion portion of the calculation
C     for each of several observers released successively over the transient
C     gas source described by DEGADIS1.
C
C
C     Program usage:
C
C     Consult Volume III of the Final Report to U. S. Coast Guard
C     contract DT-CG-23-80-C-20029 entitled 'Development of an
C     Atmospheric Dispersion Model for Heavier-than-Air Gas Mixtures'.
C
C     J. A. Havens
C     T. O. Spicer
C
C     University of Arkansas
C     227 Engineering Building
C     Department of Chemical Engineering
C     Fayetteville, AR 72701
C
C     April 1985
C
C
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C
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C         damages resulting from the use of, any information,
C         apparatus, method, or process disclosed in this computer

1 -- sys$degadis:DEGADIS2.FOR
```

```
C         code material.
C
C
C*************************************************************************************
C*************************************************************************************
C*************************************************************************************
C
C
C
c
c
C
C     DIMENSIONS/DECLARATIONS
C
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS2.dec/list'
      include '($ssdef)'
c
      COMMON
     $/GEN3/ rads(2,maxl),astr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/SSCON/ NREC(maxnob,2),TO(maxnob),XV(maxnob)
     $/TITL/ TITLE
     $/GEN1/ ET(2,isen),RIT(2,isen)
     $/GEN2/ DEN(5,isen)
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_error/ sas_aw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/ITI/ TI,TINP,TSRC,TOBS,TSRT
     $/ERROR/SYOER,ERRO,SZOER,WTAIO,WTQOO,WTSZO,ERRP,SMXP,
     $ WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,ERTDNF,ERTUPF,WTRUH,WTDHG
     $/comsta/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/STP/ STPO,STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flag
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
     $/COM_SURF/ HTCUT
     $/STOPIT/ TSTOP
     $/CNOBS/ NOBS
c
      character*80 TITLE(4)
c
      character*4 pound
      character*24 TINP,TSRC,TOBS,TSRT

2 -- sys$desadis:DEGADIS2.FOR
```

```
      character*3 sas_name
c
      real*4 tt1
      REAL*8 K,ML,L
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      character*4 TR2,ER2,PSD,TR3
      character OPNRUP(40)
      character*40 OPNRUP1
      equivalence (opnrup(1),opnrup1)
C
C.....................................................
C
C     DATA
C
      DATA TSTOP/0./
      DATA POUND/'//  '/,POUNDN/-1.E-20/
C
      DATA TIME0/0./,NDIM/0/
      DATA RADG/max12*0./,QSTR/max12*0./,srcden/max12*0./
      DATA NREC/maxnob*0,maxnob*0/,T0/maxnob*0./,XV/maxnob*0./
C
      DATA TR2/'.TR2'/,ER2/'.ER2'/
      DATA PSD/'.PSD'/,TR3/'.TR3'/
C
C.....................................................
C
C     MAIN
C
      T1 = SECNDS(0.)
      istat = lib$date_TIME(TOBS)
      if(istat .ne. ss$_normal) stop'lib$date_time failure'
C
C*** GET THE FILE NAME FOR FILE CONTROL
C
c     WRITE(5,1130)
c1130 FORMAT(' Enter the file name being used for this run: ',$)
      read(5,1130) nchar,opnrup
 1130 format(q,40a1)
C
      opnrup1 = OPNRUP1(1:nchar) // er2(1:4)
      CALL ESTRT2(OPNRUP1)
C
C*** GET THE COMMON VARIABLES CARRIED FROM DEGADIS1
C
      opnrup1 = OPNRUP1(1:nchar) // tr2(1:4)
      CALL STRT2(OPNRUP1,H_masrte)
C
C
C.....................................................
C
```

3 -- sys$degadis:DEGADIS2.FOR

```
C     PSEUDO STEADY STATE CALCULATIONS
C     INTEGRATION IN SUBROUTINE SUPERVISOR
C
      opnrup1 = OPNRUP1(1:nchar) // psd(1:4)
      OPEN(UNIT=9,TYPE='NEW',NAME=OPNRUP1,
     $  carriagecontrol='list',
     $  recordtype='variable')
C
      CALL SSSUP(H_masrte)
C
C.....................................................................
C
      CLOSE(UNIT=9)
c
c
      call setden(1.,0.,H_masrte)     ! adiabatic mixing w/ pure stuff
c
C
      opnrup1 = OPNRUP1(1:nchar) // tr3(1:4)
      CALL TRANS(OPNRUP1)
C
      tt1 = t1
      T1 = SECNDS(tT1)
      T1 = T1/60.
      WRITE(lunlog,4000) TOBS
      WRITE(lunlog,4010) T1
 4000 FORMAT(3X,'BEGAN AT ',A40)
 4010 FORMAT(3X,'*** ELAPSED TIME *** ',1pG13.5,' min')
C
      STOP
      END
****
```

```
C.....................................................
C
C     declarations for DEGADIS3
C
      include 'sys$desadis:DEGADIS2.dec/list'
C
      parameter (     maxnt=40,
     $                        maxtnob=maxnt*maxnob)
C
####
```

```
      PROGRAM DEGADIS3
C
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C     Program description:
C
C     DEGADIS3 sorts the downwind dispersion calculation made for each of
C     the several observers in DEGADIS2.  The output concentrations at
C     several given times may then be corrected for along-wind dispersion
C     as desired.
C
C
C     Program usage:
C
C     Consult Volume III of the Final Report to U. S. Coast Guard
C     contract DT-CG-23-80-C-20029 entitled 'Development of an
C     Atmospheric Dispersion Model for Heavier-than-Air Gas Mixtures'.
C
C     J. A. Havens
C     T. O. Spicer
C
C     University of Arkansas
C     227 Engineering Building
C     Department of Chemical Engineering
C     Fayetteville, AR 72701
C
C     April 1985
C
C
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C     Research Institute under contract DT-CG-23-80-C-20029.
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C
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C
C     b.  Assumes any liability with respect to the use of, or for
C         damages resulting from the use of, any information,

1 -- sys$desadis:DEGADIS3.FOR
```

```
C         apparatus, method, or process disclosed in this computer
C         code material.
C
C
C*************************************************************************************
C*************************************************************************************
C*************************************************************************************
C
c
C
C


      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$degadis:DEGADIS3.dec/list'
      include '($ssdef)'
C
C*** MINIMUM DIMENSION ON TABLE IS 6 * MAXNOB + 1
C
      parameter (ntab0=10*maxnob+1)
C
      COMMON
     $/SORT/ TCA(maxnob,maxnt),TCASTR(maxnob,maxnt),
     $        Tyc(maxnob,maxnt),Trho(maxnob,maxnt),
     $        Tgamma(maxnob,maxnt),Ttemp(maxnob,maxnt),
     $        TSY(maxnob,maxnt),TSZ(maxnob,maxnt),TB(maxnob,maxnt),
     $        TDIST0(maxnob,maxnt),TDIST(maxnob,maxnt),KSUB(maxnt)
     $/SSCON/ NREC(maxnob,2),T0(maxnob),XV(maxnob)
     $/SORTIN/ TIM(maxnt),NTIM,ISTRT
     $/GEN2/ DEN(5,igen)
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CALOW
     $/com_sprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sigx/ sigx_coeff,sigx_pow,sigx_min_dist,sigx_flag
     $/ERROR/ ERT1,ERDT,ERNTIM
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/CNOBS/ NOBS
C
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      REAL*8 ML,K
      DIMENSION TABLE(ntab0)
c
      character*24 tsrc,tinp,tobs,tsrt
C
      character*3 gas_name
      character*4 TR3,PSD,Er3,SR3,Tr4

2 -- sys$degadis:DEGADIS3.FOR
```

```
      character*40 opnrup1
      character opnrup(40)
C
      EQUIVALENCE (OPNRUP(1),opnrup1)
C.....................................................
C
C     DATA
C
      DATA POUNDN/-1.E-20/,POUND/'//  '/
      DATA TCA/maxtnob*0./,TCASTR/maxtnob*0./,TSY/maxtnob*0./
      data TSZ/maxtnob*0./,KSUB/maxnt*0/
      DATA TB/maxtnob*0./,TDIST0/maxtnob*0./,TDIST/maxtnob*0./
C
      DATA TR3/'.TR3'/,PSD/'.PSD'/
      DATA Er3/'.Er3'/,SR3/'.SR3'/,Tr4/'.Tr4'/
C
C*** UNITS
C*** 8 -- OUTPUT TO A PRINT FILE
C*** 9 -- I/O WITH DISK
C
      T1 = SECNDS(0.)
      istat = lib$date_time(tsrt)
      if(istat .ne. ss$_normal) stop'lib$date_time failure'
C
C
C*** GET THE FILE NAME FOR FILE CONTROL
C
c     WRITE(5,1130)
c1130 FORMAT(' Enter the file name used for this run: ',$)
      read(5,1130) nchar,opnrup
 1130 format(q,40a1)
C
C*** GET THE VERSION NUMBER
C
c 100 WRITE(5,1140)
c1140 FORMAT(' Enter the version number (between 00 and 99) for',
c    $' this sort: ',$)
c     CALL GTLIN(DUMMY)
c     NCAR = LEN(DUMMY)
c     IF(NCAR .EQ. 0) GO TO 110
C
c     IF(IVERIF(DUMMY,STRING) .NE. 0) GO TO 110
c     IF(NCAR-2) 130,140,120
C
c 110 WRITE(5,1150)
c1150 FORMAT(' ?DEGADIS3? - Invalid character for version number')
c     GO TO 100
C
c 120 WRITE(5,1160)
c1160 FORMAT(' ?DEGADIS3? - Too many characters in the version number')
c     GO TO 100

3 -- sys$desadis:DEGADIS3.FOR
```

```
C
c 130 DOT(1) = '060
c     DOT(2) = DUMMY(1)
c     GO TO 150
C
c 140 DOT(1) = DUMMY(1)
c     DOT(2) = DUMMY(2)
C
c 150 CONTINUE
c     CALL CONCAT(Er3,DOT,Er3)
c     CALL CONCAT(Sr3,DOT,Sr3)
c     CALL CONCAT(Tr4,DOT,Tr4)
C
C*** NOW, REPLACE THE FILE NAME IN OPNRUP
C
c     CALL SCOPY(BFILE,OPNRUP)
C
C*** THATS IT
C
      opnrup1 = opnrup1(1:nchar) // tr3(1:4)
      CALL STRT3(OPNRUP1)
C
      opnrup1 = opnrup1(1:nchar) // er3(1:4)
      CALL ESTRT3(OPNRUP1)
C
      opnrup1 = opnrup1(1:nchar) // psd(1:4)
      OPEN(UNIT=9,NAME=OPNRUP1,TYPE='OLD')
C
C.....................................................................
C
C     TIME SORT SUPERVISOR -- CALCULATE DOWNWIND DISPERSION CORRECTION
C
      CALL SORTS(TABLE)
C
      CLOSE(UNIT=9)
C
C.....................................................................
C
C     OUTPUT SORTED PARAMETERS
C
      opnrup1 = opnrup1(1:nchar) // SR3(1:4)
      CALL SRTOUT(OPNRUP1)
C
      opnrup1 = opnrup1(1:nchar) // tr4(1:4)
      CALL TRANS(OPNRUP1)
C
      STOP
      END
$$$$
```

4 -- sys$degadis:DEGADIS3.FOR

```
C.....................................................
C
c     declarations for DEGADISIN
C
C
      parameter(      isen= 30,    ! dimension of /sen1/ and /sen2/
      1               pi= 3.14 159 2654)
C
$$$$
```

AD-A171 524 DEVELOPMENT OF AN ATMOSPHERIC DISPERSION MODEL FOR HEAVIER-THAN-AIR GAS M... (U) ARKANSAS UNIV FAYETTEVILLE DEPT OF CHEMICAL ENGINEERING J A HAVENS ET AL. MAY 85 2/3

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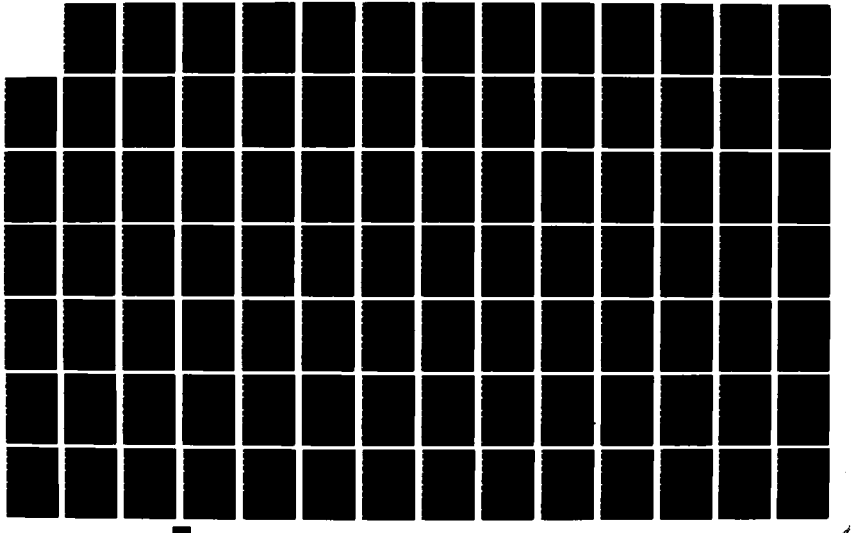

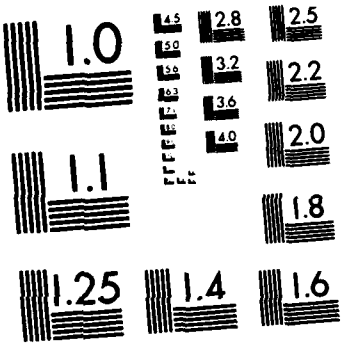

```
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C     PROGRAM DEGADISIN
C
C     Program description:
C
C     DEGADISIN acts as an interactive input module to the programs
C     which make up the DEGADIS model.  The user is guided through a
C     series of questions which supply the model with the necessary
C     input information.
C
C
C     Program usage:
C
C     Consult Volume III of the Final Report to U. S. Coast Guard
C     contract DT-CG-23-80-C-20029 entitled 'Development of an
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1 -- sys$desadis:DEGADISIN.FOR
```

```
C         apparatus, method, or process disclosed in this computer
C         code material.
C
C
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C
C
C     INITIAL INPUT FOR DEGADIS ROUTINES
c
c     note: this series of programs relies on the system wide
c             logical symbol SYS$DEGADIS which denotes the source
c             and executable code for these images.
C
c
      PROGRAM DEGADISIN

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'SYS$DEGADIS:degadisin.dec'
c
      COMMON
     $/TITL/ TITLE
     $/GEN1/ ET(2,isen),RIT(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_dprop/ sas_aw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flas
     $/NEND/ POUNDN,POUND
C
      character*80 TITLE(4)
C
      character*3 sas_temp
      character*4 pound
      character*24 TSRC,TINP,TOBS,TSRT
C
      REAL*8 ML,K
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
c
c check1
c check2=t    cloud type release with no liquid source; SRC1  DEGADIS1
c again              local communications in SSSUP                SSSUP
c check3      local communications between SRC1 and NORL      DEGADIS1
c check4=t    steady state simulation                         DEGADISIN

2 -- sys$desadis:DEGADISIN.FOR
```

```
c check5=t    operator sets sort parameters                    ESTRT3
c
      data CHECK1/.false./,CHECK2/.false./,AGAIN/.false./
      data CHECK3/.false./,CHECK4/.false./,CHECK5/.false./
C
      character*100 OPNRUP
      character OPNRUP1(100)
      equivalence (opnrup1(1),opnrup)
      character*4 INP,er1,er2,er3,com,scl,sr3,lis
      character*4 dumay
      character*3 plus
      character*2 con
      DATA POUND/'//  '/,POUNDN/-1.E-20/
C
      DATA ET/isen*0.,isen*0./,R1T/isen*0.,isen*0./
      data DEN/isen*0.,isen*0.,isen*0.,isen*0.,isen*0./
      DATA INP/'.INP'/,er1/'.er1'/,er2/'.er2'/,er3/'.er3'/
      data scl/'.scl'/,sr3/'.sr3'/,lis/'.lis'/
      data com/'.com'/
      data plus/' + '/,con/' -'/
c
C*** GET THE FILE NAME TO BE USED BY ALL OF THE ROUTINES
C
      WRITE(6,800)
      WRITE(6,810)
      READ(5,820) NCHAR,opnrup
      opnrup = opnrup(1:nchar) // inp(1:4)
C
C*** NOW GET THE REST OF THE DESIRED INFORMATION
C
      CALL IOT(OPNRUP)
      WRITE(6,1000)
      if(check4) then
      write(6,1001)   ! continuous
      else
              if(u0 .eq. 0.) then
                      write(6,1009)
              else
                      WRITE(6,1002)   ! transient
              endif
      endif
      write(6,1010)
C
C*** FORMATS
C
  800 FORMAT(//,16X,'DEnse GAs DISpersion Model input module.')
  810 FORMAT(/,' Enter the simulation name',
     $' : [DIR]RUNNAME ',$)
  820 FORMAT(Q,A40)
 1000 FORMAT(' ',/,
     $' In addition to the information just obtained,',

3 -- sys$desadis:DEGADISIN.FOR
```

```
     $' DEGADIS',/,' requires a series of numerical parameter',
     $' files which use',/,' the',
     $' same name as [DIR]RUNNAME given above. ',//,
     $'    For convenience, example parameter files are included for',/,
     $' each step.  They are:')
 1001 FORMAT(10X,'EXAMPLE.ER1 and',/,10X,'EXAMPLE.ER2')
 1002 format(10X,'EXAMPLE.ER1,',/,10X,'EXAMPLE.ER2, and',/,
     $10X,'EXAMPLE.ER3')
 1009 format(10x,'EXAMPLE.ER1')
 1010 format('  Note that each of',
     $' these files can be edited during the course of the',/,
     $' simulation if a parameter proves to be out of specification.',/)
c
c
      write(6,1200)
 1200 format(' Do you want a command file to be generated to execute',
     $' the procedure? <Y or n> ',$)
      REad(5,1210) dummy
 1210 format(a4)
      if(dummy.eq.'n' .or. dummy.eq.'N') goto 3000
      opnrup = opnrup(1:nchar) // com(1:4)
      write(6,1220) opnrup
 1220 format(' The command file will be generated under the file',
     $' name:',/,10x,a40)
c
      open(unit=8,name=opnrup,type='new',
     $ carriagecontrol='list',recordtype='variable')
c
      opnrup = opnrup(1:nchar) // er1(1:4)
c
      write(8,1250) (opnrup1(i),i=1,nchar+4)
 1250 format('$ copy/log SYS$DEGADIS:example.er1 ',40a1)
      IF(u0 .eq. 0.) then
              write(8,1280)
              write(8,1290) (opnrup1(i),i=1,nchar)
              goto 1340
              endif
      opnrup = opnrup(1:nchar) // er2(1:4)
c
      write(8,1260) (opnrup1(i),i=1,nchar+4)
 1260 format('$ copy/log SYS$DEGADIS:example.er2 ',40a1)
      opnrup = opnrup(1:nchar) // er3(1:4)
c
      if(.not.check4) then            ! transient
c
              write(8,1270) (opnrup1(i),i=1,nchar+4)
 1270         format('$ copy/log SYS$DEGADIS:example.er3 ',40a1)
c
              write(8,1280)
 1280         format('$ run SYS$DEGADIS:DEGADIS1')
              write(8,1290) (opnrup1(i),i=1,nchar)

4 -- sys$degadis:DEGADISIN.FOR
```

```
 1290          format(40a1)
               write(8,1300)
 1300          format('$ run SYS$DEGADIS:DEGADIS2')
               write(8,1290) (opnrup1(i),i=1,nchar)
               write(8,1320)
 1320          format('$ run SYS$DEGADIS:DEGADIS3')
               write(8,1290) (opnrup1(i),i=1,nchar)
c
               opnrup = opnrup(1:nchar) // scl(1:4) //
     1         plus(1:3) // opnrup(1:nchar) // sr3(1:4) // con(1:2)
               write(8,1370) (opnrup1(i),i=1,2*nchar+13)
 1370          format('$ copy/log ',100a1)
c
               opnrup = opnrup(1:nchar) // lis(1:4)
               write(8,1390) (opnrup1(i),i=1,nchar+4)
 1390          format('  ',40a1)
       else
               write(8,1280)
               write(8,1290) (opnrup1(i),i=1,nchar)
c
               write(8,1330)
 1330          format('$ run SYS$DEGADIS:SDEGADIS2')
               write(8,1290) (opnrup1(i),i=1,nchar)
c
               opnrup = opnrup(1:nchar) // scl(1:4) //
     1         plus(1:3) // opnrup(1:nchar) // sr3(1:4) // con(1:2)
               write(8,1370) (opnrup1(i),i=1,2*nchar+13)
               opnrup = opnrup(1:nchar) // lis(1:4)
               write(8,1390) (opnrup1(i),i=1,nchar+4)
       endif
c
 1340  close(unit=8)
       write(6,1350)
 1350  format(/,' Do you wish to initiate this procedure? ',
      $' <y or N> ',$)
       REad(5,1210) dummy
       if(dummy.eq.'y' .or. dummy.eq.'Y') goto 2000
       goto 3000
 2000  opnrup = '@' // opnrup(1:nchar) // ' '
       istat = lib$do_command(opnrup)
       write(6,2100)
 2100  format(/,' ?DEGADISIN? command file failed to start.')
c
 3000  continue
       CALL EXIT
       END
$$$$
```

```
C.....................................................
C
C     ROUTINE TO GET RUN PARAMETERS FROM A FILE
C
      SUBROUTINE ESTRT1(OPNRUP)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
C
      parameter(      iend= 22,
     1                iend1= iend+1,
     1                iiiend= 2,
     1                iiiend1= iiiend+1,
     1                iiend= 2,
     1                iiend1= iiend+1,
     1                Jend= 4,
     1                Jend1= Jend+1,
     1                mend= 5,
     1                mend1= mend+1)
C
C     BLOCK COMMON
C
      COMMON
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtmb,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/vucom/ vua,vub,vuc,vud,vudelta,vuflag
     $/szfc/ szstp0,szerr,szstpmx,szsz0
     $/alphcom/ ialpfl,alpco
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
C
      EQUIVALENCE
     $(RLBUF(1),STPIN),    !MAIN - RKGST - INITIAL STEP SIZE
     $(RLBUF(2),ERBND),    !MAIN - RKGST - ERROR BOUND
     $(RLBUF(3),STPMX),    !MAIN - RKGST - MAXIMUM STEP SIZE
     $(RLBUF(4),WTRG),     !MAIN - RKGST - WEIGHT FOR RG
     $(RLBUF(5),WTta),     !MAIN - RKGST - WEIGHT FOR Total mass
     $(RLBUF(6),WTya),     !MAIN - RKGST - WEIGHT FOR Ya
     $(RLBUF(7),WTyc),     !MAIN - RKGST - WEIGHT FOR Yc
     $(RLBUF(8),WTeb),     !MAIN - RKGST - WEIGHT FOR Energy Balance
     $(RLBUF(9),WTmb),     !MAIN - RKGST - WEIGHT FOR Momentum Balance
     $(RLBUF(10),WTuh),    !MAIN - RKGST - WEIGHT FOR Ueff*Heff
     $(RLBUF(11),XLI),     !ALPH - LOWER LIMIT OF SEARCH FOR ALPHA
     $(RLBUF(12),XRI),     !ALPH - UPPER LIMIT OF SEARCH FOR ALPHA
     $(RLBUF(13),EPS)      !ALPH - ERROR BOUND USED BY 'RTMI'
      equivalence
     $(RLBUF(14),ZLOW),    !ALPHI - BOTTOM HEIGHT FOR FIT OF ALPHA
     $(RLBUF(15),STPINZ),  !ALPHI - INITIAL RKGST STEP <0.

1 -- sys$desadis:ESTRT1.FOR
```

```
     $(RLBUF(16),ERBNDZ), !ALPHI - ERROR BOUND FOR RKGST
     $(RLBUF(17),STPMXZ), !ALPHI - MAXIMUM STEP FOR RKGST
     $(RLBUF(18),SRCOER), !SRC10 - OUTPUT error criteria
     $(RLBUF(19),SRCSS),  !SRC10 - min time for Steady=4*STPMX
     $(RLBUF(20),SRCcut), !SRC10 - min height for blanket
     $(RLBUF(21),htcut),  !SRC1 - min height for blanket heat transfer
     $(RLBUF(iend),ERNOBL), !NOBL - CONVERGENCE CRITERIA
     $(RLBUFi(1),crfser), !CRFG - Error criteria for buildins tables
     $(RLBUFi(iiiend),epsilon)!SRC1 - Coefficient in Air entrainment
c
      equivalence
     $(rlbufa(1),ce), !SRC1 - Coefficient gravity slumping EQ
     $(RLBUFa(iiend),delrhomin) ! stop spread for delrho<delrhomin
c
      equivalence
     $(rlbuf1(1),szstp0),  ! SZF - Initial step size
     $(rlbuf1(2),szerr),   ! SZF - Error criteria
     $(rlbuf1(3),szstpmx), ! SZF - Maximum step size
     $(rlbuf1(4),szsz0)    ! SZF - Initial value of rho*dellay*UHeff
C
c
      equivalence
     $(rlbuf4(1),vua),        ! Constant Av in SRC1
     $(rlbuf4(2),vub),        ! Constant Bv in SRC1
     $(rlbuf4(3),vuc),        ! Constant Ev in SRC1
     $(rlbuf4(4),vud),        ! Constant Dv in SRC1
     $(rlbuf4(5),vudelta)     ! Constant DELTAv in SRC1
c
      character*40 OPNRUP
      character DUMMY(1:132)
      DIMENSION RLBUF(iend), rlbufi(iiiend), rlbufa(iiend)
      dimension rlbuf1(jend)
      dimension rlbuf4(mend)
c
      logical vuflag
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD',err=2000)
C
C*** READ A LINE AND DETERMINE ITS PURPOSE
C
      I = 1
  100 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 100
      DECODE(20,1010,DUMMY,ERR=400) RLBUF(I)
      I = I + 1
      if(i .eq. iend1) goto 110
      GO TO 100

  110 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY

2 -- sys$dessdis:ESTRT1.FOR
```

```
      IF(DUMMY(1) .EQ. '!') GO TO 110
      DECODE(20,1010,DUMMY,ERR=400) ptnobl
      NOBLPT = INT(PTNOBL)

      I = 1
  120 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 120
      DECODE(20,1010,DUMMY,ERR=400) RLBUFi(I)
      I = I + 1
      if(i .eq. iiiend1) goto 140
      GO TO 120
C
C*** READ A LINE AND DETERMINE ITS PURPOSE for /sprd_con/
C
  140 I = 1
  150 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 150
      DECODE(20,1010,DUMMY,ERR=400) RLBUFa(I)
      I = I + 1
      if(i .eq. iiend1) goto 190
      GO TO 150
C
C*** READ A LINE AND DETERMINE ITS PURPOSE to fill szfc
C
  190 I = 1
  200 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 200
      DECODE(20,1010,DUMMY,ERR=400) RLBUF1(I)
      I = I + 1
      if(i .eq. jend1) goto 230
      GO TO 200
C
C*** READ A LINE AND DETERMINE ITS PURPOSE to fill /alphcom/
C
  230 I = 1
  240 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 240
      DECODE(20,1010,DUMMY,ERR=400) Ralpfl

      ialpfl = int(ralpfl)

  250 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 250
      DECODE(20,1010,DUMMY,ERR=400) alpco
C
C*** READ A LINE AND DETERMINE ITS PURPOSE to fill /phicom/

3 -- sys$desadis:ESTRT1.FOR
```

```
C
  260 I = 1
  270 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 270
      DECODE(20,1010,DUMMY,ERR=400) Rphif1

      iphif1 = int(rphif1)

  275 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 275
      DECODE(20,1010,DUMMY,ERR=400) dellay
C
C*** READ A LINE AND DETERMINE ITS PURPOSE to fill /vucom/
C
  280 I = 1
  290 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 290
      DECODE(20,1010,DUMMY,ERR=400) RLBUF4(I)
      I = I + 1
      if(i .eq. mend1) goto 300
      GO TO 290
C
C*** EXIT THE PROCEEDINGS
C
  300 CONTINUE
      CLOSE(UNIT=9)
      RETURN
C
  350 call trap(20)
C
  400 CONTINUE
      CALL trap(21)
C
 1000 FORMAT(Q,132A1)
 1010 FORMAT(10X,G10.4)
C
 2000 call trap(22)
      END
$$$$
```

```
C.....................................................
C
C     ROUTINE TO GET RUN PARAMETERS FROM A FILE
C
      SUBROUTINE ESTRT2(OPNRUP)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS2.dec/list'
c
      parameter (     ienda= 18,
     1                ienda1= ienda+1,
     2                iendb= 7,
     3                iendb1= iendb+1)
c
      common
     $/ERROR/SYOER,ERRO,SZOER,WTAIO,WTQOO,WTSZO,ERRP,SMXP,
     $ WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,ERTDNF,ERTUPF,WTRUH,WTDHG
     $/STP/STPO,STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/CNOBS/NOBS
C
      EQUIVALENCE
     $(RLBUF(1),SYOER),    !SSSUP - RKGST - INITIAL SY
     $(RLBUF(2),ERRO),     !SSSUP - RKGST(OBS) - ERROR BOUND
     $(RLBUF(3),SZOER),    !SSSUP - RKGST(OBS) - INITIAL SZ
     $(RLBUF(4),WTAIO),    !SSSUP - RKGST(OBS) - WEIGHT FOR AI
     $(RLBUF(5),WTQOO),    !SSSUP - RKGST(OBS) - WEIGHT FOR Q
     $(RLBUF(6),WTSZO),    !SSSUP - RKGST(OBS) - WEIGHT FOR SZ
     $(RLBUF(7),ERRP),     !SSSUP - RKGST(PSS) - ERROR BOUND
     $(RLBUF(8),SMXP),     !SSSUP - RKGST(PSS) - MAXIMUM STEP
     $(RLBUF(9),WTSZP),    !SSSUP - RKGST(PSS) - WEIGHT FOR SZ
     $(RLBUF(10),WTSYP),   !SSSUP - RKGST(PSS) - WEIGHT FOR SY
     $(RLBUF(11),WTBEP),   !SSSUP - RKGST(PSS) - WEIGHT FOR BEFF
     $(RLBUF(12),WTDH),    !SSSUP - RKGST(PSS) - WEIGHT FOR DH
     $(RLBUF(13),ERRG),    !SSSUP - RKGST(SSG) - ERROR BOUND
     $(RLBUF(14),SMXG),    !SSSUP - RKGST(SSG) - MAXIMUM STEP SIZE
     $(RLBUF(15),ERTDNF), !TDNF - CONVERGENCE CRITERIA
     $(RLBUF(16),ERTUPF), !TUPF - CONVERGENCE CRITERIA
     $(RLBUF(17),WTruh),   !SSSUP - RKGST(SSG) - WEIGHT FOR RUH
     $(RLBUF(ienda),WTdhg)!SSSUP - RKGST(SSG) - WEIGHT FOR DH
C
      EQUIVALENCE
     $(RLBUF1(1),STPO),    !SSSUP - RKGST(OBS) - INITIAL STEP
     $(RLBUF1(2),STPP),    !SSSUP - RKGST(PSS) - INITIAL STEP
     $(RLBUF1(3),ODLP),    !SSSUP - RKGST(PSS) - RELATIVE OUTPUT DELTA
     $(RLBUF1(4),ODLLP),   !SSSUP - RKGST(PSS) - MAXIMUM DISTANCE TO OUT
     $(RLBUF1(5),STPG),    !SSSUP - RKGST(SSG) - INITIAL STEP
     $(RLBUF1(6),ODLG),    !SSSUP - RKGST(SSG) - RELATIVE OUTPUT DELTA
     $(RLBUF1(iendb),ODLLG)!SSSUP- RKGST(SSG) - MAXIMUM DISTANCE TO OUT
C

1 -- sys$desadis:ESTRT2.FOR
```

```
      character*40 OPNRUP
      character dummy(1:132)
      DIMENSION RLBUF(ienda),RLBUF1(iendb)
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD')
C
C*** FIRST, FILL RLBUF
C
C*** READ A LINE AND DETERMINE ITS PURPOSE
C
      I = 1
  100 CONTINUE
      READ(9,1000,END=300) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 100
      DECODE(20,1010,DUMMY,ERR=400) RLBUF(I)
      I = I + 1
      IF(I .EQ. ienda1) GO TO 200
      GO TO 100
C
C*** NOW, FILL RLBUF1
C
  200 I = 1
  210 CONTINUE
      READ(9,1000,END=300) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 210
      DECODE(20,1010,DUMMY,ERR=400) RLBUF1(I)
      I = I + 1
      IF(I .EQ. iendb1) GO TO 260
      GO TO 210
C
C*** NOW, PICK UP NOBS
C
  260 CONTINUE
      READ(9,1000,END=300) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 260
      DECODE(20,1010,DUMMY,ERR=400) RBUF
      NOBS = INT(RBUF)
C
C*** EXIT THE PROCEEDINGS
C
      CLOSE(UNIT=9)
      RETURN
C
  300 call trap(20)
  400 CALL trap(21)
C
 1000 FORMAT(Q,132A1)
 1010 FORMAT(10X,G10.4)
      END
****


2 -- sys$desadis:ESTRT2.FOR
```

```
C.....................................................
C
C     ROUTINE TO GET RUN PARAMETERS FROM A FILE
C
      SUBROUTINE ESTRT2SS(OPNRUP)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

c
      include 'sys$desadis:DEGadis2.dec/list'
c
      parameter(      ienda= 18,
     1                ienda1= ienda+1,
     2                iendb= 7,
     3                iendb1= iendb+1)
C
      COMMON
     $/ERROR/SYOER,ERRP,SMXP,WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,
     $ WTRUH,WTDHG
     $/STP/STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
C
c
      character*40 OPNRUP
      character DUMMY(1:132)
      DIMENSION RLBUF(ienda),RLBUF1(iendb)
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD')
C
C*** FIRST, FILL RLBUF
C
C*** READ A LINE AND DETERMINE ITS PURPOSE
C
      I = 1
  100 CONTINUE
      READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 100
      DECODE(20,1010,DUMMY,ERR=400) RLBUF(I)
      I = I + 1
      IF(I.EQ. ienda1) GOTO200
      GO TO 100
C
C*** NOW, FILL RLBUF1
C
  200 i = 1
  210 READ(9,1000,END=350) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 210
      DECODE(20,1010,DUMMY,ERR=400) RLBUF1(I)
      I = I + 1
      if(i.eq. iendb1) goto 300
      GO TO 210
C

1 -- sys$desadis:ESTRT2SS.FOR
```

```
C*** EXIT THE PROCEEDINGS
C
  300 CONTINUE
      swOer = rlbuf(1)  !SSSUP - RKGST - INITIAL SY
      errp  = rlbuf(7)  !SSSUP - RKGST(PSS) - ERROR BOUND
      smxp  = rlbuf(8)  !SSSUP - RKGST(PSS) - MAXIMUM STEP
      wtszp = rlbuf(9)  !SSSUP - RKGST(PSS) - WEIGHT FOR SZ
      wtsyp = rlbuf(10) !SSSUP - RKGST(PSS) - WEIGHT FOR SY
      wtbep = rlbuf(11) !SSSUP - RKGST(PSS) - WEIGHT FOR BEFF
      wtDH  = rlbuf(12) !SSSUP - RKGST(PSS) - WEIGHT FOR BEFF
      errs  = rlbuf(13) !SSSUP - RKGST(SSG) - ERROR BOUND
      smxs  = rlbuf(14) !SSSUP - RKGST(SSG) - MAXIMUM STEP SIZE
      wtRUH = rlbuf(17) !SSSUP - RKGST(PSS) - WEIGHT FOR BEFF
      wtDHG = rlbuf(18) !SSSUP - RKGST(PSS) - WEIGHT FOR BEFF
C
      stpp  = rlbuf1(2) !SSSUP - RKGST(PSS) - INITIAL STEP
      odlp  = rlbuf1(3) !SSSUP - RKGST(PSS) - RELATIVE OUTPUT DELTA
      odllp = rlbuf1(4) !SSSUP - RKGST(PSS) - MAXIMUM DISTANCE TO OUT
      stps  = rlbuf1(5) !SSSUP - RKGST(SSG) - INITIAL STEP
      odls  = rlbuf1(6) !SSSUP - RKGST(SSG) - RELATIVE OUTPUT DELTA
      odlls = rlbuf1(7) !SSSUP - RKGST(SSG) - MAXIMUM DISTANCE TO OUT
C
      CLOSE(UNIT=9)
      RETURN
C
  350 call trap(20)   ! premature EOF
C
  400 CALL trap(21)
C
 1000 FORMAT(Q,132A1)
 1010 FORMAT(10X,G10.4)
C
      END
****
```

```
C.....................................................
C
C     ROUTINE TO GET RUN PARAMETERS FROM A FILE
C
      SUBROUTINE ESTRT3(OPNRUP)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )
C
      COMMON
     $/PHLAG/CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flag
     $/ERROR/ERT1,ERDT,ERNTIM
C
      EQUIVALENCE
     $(RLBUF(1),ERT1),     !FIRST SORT TIME - USER OPTION
     $(RLBUF(2),ERDT),     !SORT TIME DELTA - USER OPTION
     $(RLBUF(3),ERNTIM)    !NUMBER OF SORT TIMES - USER OPTION
C
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      character DUMMY(1:132)
      character*40 opnrup
      DIMENSION RLBUF(3),RBUF(6)
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD')
C
C*** READ A LINE AND DETERMINE ITS PURPOSE
      I = 1
  100 CONTINUE
      READ(9,1000,END=300) NCHAR,DUMMY
      IF(DUMMY(1) .EQ. '!') GO TO 100
      DECODE(20,1010,DUMMY,ERR=400) RBUF(I)
      I = I + 1
      GO TO 100
C
C*** EXIT THE PROCEEDINGS AND DETERMINE CHECK5
  300 CONTINUE
C
      DO 310 I = 1,3
  310 RLBUF(I) = RBUF(I)
      CHECK5 = .FALSE.                ! IN ORDER FOR FLAG TO WORK
      IF(RBUF(4) .EQ. 1.) CHECK5 = .TRUE.
C
      sisx_flag = rbuf(5)
      CLOSE(UNIT=9)
      RETURN
C
  400 CALL trap(21)
 1000 FORMAT(Q,132A1)
 1010 FORMAT(10X,G10.4)
      END
$$$$

 1 -- sys$desadis:ESTRT3.FOR
```

```
C
C     ..............................................................
C
C     SUBROUTINE GAMMA
C
C.....................................................................
C
C     This routine was originally supplied by Digital Equipment
C     Corporation as part of the Scientific Subroutine Package
C     available for RT-11 as part of the Fortran Enhancement
C     Package.  It was upgraded for use in this package.
C
C.....................................................................
C
C     PURPOSE
C             COMPUTES THE GAMMA FUNCTION FOR A GIVEN ARGUMENT
C
C     USAGE
C             GF = GAMMA(XX)
C
C     DESCRIPTION OF PARAMETERS
C             XX -THE ARGUMENT FOR THE GAMMA FUNCTION
C
C     IER-RESULTANT ERROR CODE WHERE
C             IER=0  NO ERROR
C             IER=1  XX IS WITHIN .000001 OF BEING A NEGATIVE INTEGER
C             IER=2  XX GT 34.5, OVERFLOW
C             IF IER .NE. 0 PROGRAM TAKES A DIP IN THE POOL!
C
C     REMARKS
C             NONE
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C             NONE
C
C     METHOD
C             THE RECURSION RELATION AND POLYNOMIAL APPROXIMATION
C             BY C.HASTINGS,JR., 'APPROXIMATIONS FOR DIGITAL COMPUTERS',
C             PRINCETON UNIVERSITY PRESS, 1955
C
C     MODIFIED TO FUNCTION FORM FROM ORIGINAL SUBROUTINE FORM
C
C     ..............................................................
C
      FUNCTION GAMMA(XX)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      IF(XX-34.5)6,6,4
    4 IER=2
      GAMMA=1.E38

1 -- sys$desadis:GAMMA.FOR
```

```
      GO TO 1000
    6 X=XX
      ERR=1.0E-6
      IER=0
      GAMMA=1.0
      IF(X-2.0)50,50,15
   10 IF(X-2.0)110,110,15
   15 X=X-1.0
      GAMMA=GAMMA*X
      GO TO 10
   50 IF(X-1.0)60,120,110
C
C        SEE IF X IS NEAR NEGATIVE INTEGER OR ZERO
C
   60 IF(X-ERR)62,62,80
   62 Y=FLOAT(INT(X))-X
      IF(ABS(Y)-ERR)130,130,64
   64 IF(1.0-Y-ERR)130,130,70
C
C        X NOT NEAR A NEGATIVE INTEGER OR ZERO
C
   70 IF(X-1.0)80,80,110
   80 GAMMA=GAMMA/X
      X=X+1.0
      GO TO 70
  110 Y=X-1.0
      GY=1.0+Y*(-0.5771017+Y*(+0.9858540+Y*(-0.8764218+Y*
     $(+0.8328212+Y*(-0.5684729+Y*(+0.2548205+Y*(-0.05149930)))))))
      GAMMA=GAMMA*GY
  120 RETURN
  130 IER=1
 1000 CONTINUE
      IF(IER.EQ.1) WRITE(5,1100)
      IF(IER.EQ.2) WRITE(5,1110)
 1100 FORMAT(5X,'?GAMMA?--ARGUMENT LESS THAN 0.000001')
 1110 FORMAT(5X,'?GAMMA?--ARGUMENT GREATER THAN 34.5--OVERFLOW')
      CALL EXIT
      END
$$$$
```

2 -- sys$desadis:GAMMA.FOR

```
C.....................................................
C
C     SUBROUTINE TO ESTABLISH THE TIME SORT PARAMETERS
C
      SUBROUTINE GETTIM

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

c
      include 'sys$desadis:DESADIS3.dec/list'
C
      COMMON
     $/SSCON/ NREC(maxnob,2),TO(maxnob),XV(maxnob)
     $/SORTIN/ TIM(maxnt),NTIM,ISTRT
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/ERROR/ ERT1,ERDT,ERNTIM
     $/ALP/ ALPHA,alpha1
     $/CNOBS/ NOBS
C
      LOGICAL CHECK1,CHECK2,CHECK3,CHECK4,CHECK5,AGAIN
C
      DATA T1/0./,DT/0./,TF/0./
C
C*** IF CHECK5 IS SET, GET THE TIME SORT PARAMETERS FROM /ERROR/
C
      IF(.NOT.CHECK5) GO TO 90
C
      T1 = ERT1
      DT = ERDT
      NTIM = INT(ERNTIM)
      GO TO 95
C
C
C*** This subroutine sets the default time sort windows.
C
C*** The first sort time is set for potential low wind speed cases,
C***   while the last sort time is set for potential high wind speed
C***   cases.  The first sort time is taken to be when the first
C***   observer passes through x=RMAX.  The last sort time is taken
C***   to be when the last observer passes through x=6*RMAX.
C***   The default value for the number of sort times is set to 10.
C***   Obviously, these values generate some sort times which will be
C***   useless; hopefully, these values will show the user where to
C***   look on the next go around.
C
  90  CONTINUE
C
      T1 = TO(1) + (2.*RMAX)**(1./ALPHA1)/ALEPH
      TF = TO(NOBS) + (6.*RMAX)**(1./ALPHA1)/ALEPH
      NTIM = 10

1 -- sys$desadis:GETTIM.FOR
```

```
C
      DT = (TF-T1)/FLOAT(NTIM-1)
      DT = FLOAT(INT(DT+.5))
C
      IF(DT .GE. 5.) GO TO 95
      DT = 5.
      NTIM = INT((TF - T1)/DT) + 1
C
   95 CONTINUE
C
      T1 = FLOAT(INT(T1))      !MAKE T1 AN INTEGER VALUE
C
      DO 100 I = 1,NTIM
      TIM(I) = DT*FLOAT(I-1) + T1
  100 CONTINUE
C
      RETURN
      END
$$$$
```

```
      SUBROUTINE HEAD(smass0)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
      include '($ssdef)'
c
      COMMON
     $/GEN3/ RADG(2,maxl),QSTR(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/TITL/ TITLE
     $/GEN1/ ET(2,isen),RIT(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/ TI,TINP,TSRC,TOBS,TSRT
     $/ERROR/ STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtab,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl,swcl,swal,senl,srhl
     $/phlag/ check1,check2,again,check3,check4,check5
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/alphcom/ ialpfl,alpco
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
c
      character*80 TITLE(4)
c
      character*4 pound
      character*24 TINP,TSRC,TOBS,TSRT
      character*3 gas_name
      character*1 stabil(6)
      character*24 id
c
      logical check1,check2,again,check3,check4,check5
c
      REAL*8 K,ML
c
      data stabil/'A','B','C','D','E','F'/
      data iparm/0/
C
      if(iparm .eq. 1) goto 190
      WRITE(8,1100)
 1100 FORMAT(1HO,'**********************',9X,'U O A _ D E G A D I S ',
     $2X,'M O D E L ',2X,'O U T P U T ',2X,'- - ',2X,'V E R S I O N ',
     $2X,'1.2',8X,'**********************')
C

1 -- sys$desadis:HEAD.FOR
```

```
C
      WRITE(8,1111)
C
      WRITE(8,1102) tsrc
 1102 FORMAT(1H ,'**********************',23X,
     $'**********************',1X,a24,1X,
     $'**********************',23X,'**********************')
C
      WRITE(8,1111)
C
      WRITE(8,1112) TINP
      WRITE(8,1114) TSRC
      IF(tOBS(1:2).NE.'  ' .and. .not.check4) WRITE(8,1116) TOBS
      IF(tOBS(1:2).NE.'  ' .and. check4) WRITE(8,1117) TOBS
      IF(tSRT(1:2) .NE. '  ') WRITE(8,1118) TSRT
 1112 FORMAT(1H ,'Data input on',22X,a24)
 1114 FORMAT(1H ,'Source program run on',14X,a24)
 1116 FORMAT(1H ,'Pseudo Steady-State program run on ',a24)
 1117 FORMAT(1H ,'Steady-State program run on',7X,a24)
 1118 FORMAT(1H ,'Time sort program run on',11X,a24)
      WRITE(8,1111)
C
      write(8,1119)
 1119 format(//,
      11h ,10x,22('*****'),/,
      21h ,10x,'*',t121,'*',/,
      31h ,10x,'*',t20,'NOTE:',t121,'*',/,
      21h ,10x,'*',t20,'-----',t121,'*',/,
      21h ,10x,'*',t121,'*',/,
      21h ,10x,'*',t20,'>',t25,'All Calculations are lim',
      3'ited to circular liquid sources.',t121,'*',/,
      21h ,10x,'*',t121,'*',/,
      11h ,10x,22('*****'),//)
      WRITE(8,1110)
      WRITE(8,1111)
C
 1110 FORMAT(1H0,10X,'TITLE BLOCK')
 1111 FORMAT(1H )
C
      DO 100 I = 1,4
      WRITE(8,1120) TITLE(I)
  100 CONTINUE
C
 1120 FORMAT(1H ,A80)
C
      WRITE(8,1111)
      WRITE(8,1130) UO
      WRITE(8,1140) ZO
      WRITE(8,1150) ZR
      write(8,1155) stabil(istab)
      WRITE(8,1160) ML

2 -- sys$desadis:HEAD.FOR
```

```
      WRITE(8,1170) DELTA
      WRITE(8,1180) BETA
      WRITE(8,1190) ALPHA
      WRITE(8,1192) USTAR
      WRITE(8,1194) tamb
      if(isofl.eq.0 .and. ihtfl.ne.0) write(8,1195) tsurf
      WRITE(8,1196) pamb
      WRITE(8,1198) humid
      vaporp = 6.0298e-3* exp(5407.* (1./273.15- 1./tamb)) ! atm
      relhumid = 100.* humid/(0.622*vaporp / (pamb- vaporp))
      write(8,1199) relhumid
C
 1130 FORMAT(1H ,5X,'Wind velocity at reference height ',20X,F6.2,2X,
     $'m/s')
 1140 FORMAT(1H ,5X,'Reference height ',37X,F6.2,2X,'m')
 1150 FORMAT(1H0,5X,'Surface roughness length ',25X,1PG10.3,2X,'m')
 1155 FORMAT(1H0,5X,'Pasquill Stability class ',25X,4x,a1)
 1160 FORMAT(1H0,5X,'Monin-Obukhov length ',29X,1PG10.3,2X,'m')
 1170 FORMAT(1H ,5X,'Gaussian distribution constants ',4X,'Delta',
     $10X,F9.5,2X,'m')
 1180 FORMAT(1H ,5X,32X,4X,'Beta',11X,F9.5)
 1190 FORMAT(1H0,5X,'Wind velocity power law constant',4X,'Alpha',
     $10X,F9.5)
 1192 FORMAT(1H ,5X,'Friction velocity',15X,4X,5X,10X,F9.5,2X,'m/s')
 1194 FORMAT(1H0,5X,'Ambient Temperature ',33X,F6.2,2X,'K')
 1195 FORMAT(1H0,5X,'Surface Temperature ',35X,F6.2,2X,'K')
 1196 FORMAT(1H ,5X,'Ambient Pressure ',37X,F6.3,2X,'atm')
 1198 FORMAT(1H ,5X,'Ambient Absolute Humidity',25X,1PG10.3,2X,
     $'kg/kg BDA')
 1199 FORMAT(1H ,5X,'Ambient Relative Humidity',25X,4X,F6.2,2X,'%')
C
      WRITE(8,1111)
C
      if(isofl .eq. 0) goto 135
      WRITE(8,1200)
      WRITE(8,1205)
      ii = -1
      DO 130 I = 1,isen
      IF(DEN(1,I).gt. 1.) goTO 148
      ii = ii+1
      if(ii.eq. 3) then
              write(8,1211)
              ii = 0
              endif
  130 WRITE(8,1210) DEN(1,I),DEN(2,I),den(3,i)
      goto 148
  135 write(8,1207)
      write(8,1208)
      ii = -1
      DO 138 I = 1,isen
      IF(DEN(1,I).gt. 1.) goTO 148

3 -- sys$desadis:HEAD.FOR
```

```
      ii = ii+1
      if(ii.eq. 3) then
              write(8,1211)
              ii = 0
              endif
  138 WRITE(8,1212) DEN(1,I),DEN(2,I),den(3,i),den(4,i),den(5,i)
  148 continue
C
 1200 FORMAT(1H ,5X,'Input:     ',6X,3x,'Mole fraction',4x,
     1       'CONCENTRATION OF C',6X,'GAS DENSITY')
 1205 FORMAT(1H ,14X,20x,2(13X,'kg/m**3'))
 1207 FORMAT(1H ,5X,'Adiabatic Mixing:',3x,'Mole fraction',3x,
     1       'CONCENTRATION OF C',6X,'GAS DENSITY',5x,
     1       6x,'Enthalpy',6x,4x,'Temperature')
 1208 FORMAT(1H ,14X,20x,2(13X,'kg/m**3'),7x,8x,'J/kg',8x,9x,'K')
 1210 FORMAT(1H ,14X,3(12X,F8.5))
 1211 format(1H )
 1212 FORMAT(1H ,14X,3(12X,F8.5),6x,3x,1pg13.5,7x,1pg13.5)
C
      WRITE(8,1111)
      WRITE(8,1220) smass0
      WRITE(8,1230)
C
      DO 150 I=1,IGEN
      IF(R1T(1,I).EQ.POUNDN .AND. R1T(2,I).EQ.POUNDN) GO TO 160
  150 WRITE(8,1240) ET(1,I),ET(2,I),R1T(2,I)
  160 CONTINUE
C
 1220 FORMAT(1H ,'Source input data points',//,
     1       1h ,15x,'Initial mass in cloud: ',1pg13.5,//,
     1       1h ,24x,8X,'TIME',10X,'SOURCE S',
     2       'TRENGTH',6X,'SOURCE RADIUS')
 1230 FORMAT(1H ,34X,'s',17X,'kg/s',18X,'m')
 1240 FORMAT(1H ,24X,3(4X,1PG12.5,4X))
 1241 format(1h0,5x,'Calculation procedure for ALPHA: ',I2)
 1242 format(1h0,5x,'Entrainment prescription for PHI: ',I2)
 1244 format(1h0,5x,'Layer thickness ratio used for average depth: ',
     1       1pg13.5)
 1250 format(1h0,5x,'Air entrainment coefficient used: ',f5.3)
 1251 format(1h0,5x,'NON Isothermal calculation')
 1252 format(1h0,5x,'Gravity slumping velocity coefficient used: ',f5.3)
 1253 format(1h0,5x,'Heat transfer calculated with fixed coefficient: ',
     1       1pg13.5,' J/m**2/s/K')
 1254 format(1h0,5x,'Heat transfer not included')
 1255 format(1h0,5x,'Heat transfer calculated with correlation: ',I2)
 1256 format(1h0,5x,'Isothermal calculation')
 1257 format(1h0,5x,'Water transfer calculated with fixed coefficient: ',
     1       1pg13.5,' /m**2/s/atm')
 1258 format(1h0,5x,'Water transfer not included')
 1259 format(1h0,5x,'Water transfer calculated with correlation')
C

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```

```
      WRITE(8,1111)
      write(8,1241) ialpfl
      write(8,1242) iphifl
      write(8,1244) dellay
      write(8,1250) epsilon
      write(8,1252) ce
      if(isofl.eq. 0) write(8,1251)
      if(isofl.ne. 0) write(8,1256)
      if(ihtfl.lt. 0) write(8,1253) htco
      if(ihtfl.eq. 0) write(8,1254)
      if(ihtfl.gt. 0) write(8,1255) ihtfl
      if(iwtfl.lt. 0) write(8,1257) wtco
      if(iwtfl.eq. 0) write(8,1258)
      if(iwtfl.gt. 0) write(8,1259)
      WRITE(8,1111)
      ipara =1
      return
C
  190 continue
      if(.not.check4) return
      RAD = SQRT(SLEN*SWID/pi)
      WRITE(8,1300) ESS,RAD
      WRITE(8,1320) SLEN,SWID
      astar = ess/out1**2
      WRITE(8,1340) OUTCc,OUTSZ,astar
      write(8,1350) swcl,swal,senl,srhl
      WRITE(8,1360) OUTL,OUTB
C
C
C
 1300 FORMAT(1HO,'Source strength [kg/s] : ',18X,1PG13.5,T60,
     $'Equivalent Primary source radius [m] : ',1PG13.5)
 1320 FORMAT(1H ,'Equivalent Primary source length [m] : ',4X,
     $1PG13.5,T60,'Equivalent Primary source width [m] : ',1X,1PG13.5)
 1340 FORMAT(/,' Secondary source concentration [kg/m**3] : ',
     $1PG13.5,T60,'Secondary source SZ [m] : ',13X,1PG13.5,//,
      1 ' Contaminant flux rate: ',1pg13.5,/)
 1350 format(/,' Secondary source mass fractions... contaminant: ',
      1       1pg13.6,2x,' air: ',1pg13.5,/,' ',10x,' Enthalpy: ',
      1       1pg13.5,5x,' Density: ',1pg13.5)
 1360 FORMAT(1H ,'Secondary source length [m] : ',13X,1PG13.5,T60,
     $'Secondary source half-width [m] : ',5X,1PG13.5)
C
C
      RETURN
      END
$$$$
```

```
5 -- sys$desadis:HEAD.FOR
```

```
C.....................................................
C
C     INPUT SUBROUTINE FOR DEGADIS MODEL
C
      SUBROUTINE IO(tend,smass0,OPNRUP)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )
c
      include 'sys$desadis:DEGADIS1.dec'
c
C     BLOCK COMMON
C
      COMMON
     $/TITL/TITLE
     $/GEN1/ ET(2,isen),R1T(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_crk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl
     $/phlag/check1,check2,again,check3,check4,check5
     $/com_sigx/ sigx_coeff,sigx_pow,sigx_min_dist,sigx_flag
     $/NEND/POUNDN,POUND
C
C
      character*80 TITLE(4)
      character*4 pound
      character*24 TSRC,TINP,TOBS,TSRT
      character*3 sas_name
C
      REAL*8 ML,K
      logical check1,check2,again,check3,check4,check5
C
      character*40 OPNRUP
C
      OPEN(UNIT=9, NAME=OPNRUP, TYPE='OLD')
C
      DO 90 I=1,4
      READ(9,2000) TITLE(I)
   90 CONTINUE
 2000 FORMAT(A80)
C
      READ(9,*) U0,Z0,zr
      read(9,*) istab
      READ(9,*) DELTA,BETA,ml
      read(9,*) sigx_coeff,sigx_pow,sigx_min_dist
      read(9,*) tamb,pamb,humid
      read(9,*) isofl,tsurf
      read(9,*) ihtfl,htco

1 -- sys$desadis:IO.FOR
```

```
      read(9,*) iwtfl,wtco
      read(9,2020) gas_name
 2020 FORMAT(A3)
      read(9,*) gas_mw,gas_temp,gas_rhoe
      read(9,*) gas_cpk,gas_cpp
      read(9,*) gas_ufl,gas_lfl,gas_zsp
C
      if(isofl .eq. 0) then
              rhoe = gas_rhoe * pamb
              rhoa = pamb*(1.+humid)/(.00283+ 0.00456*humid)/tamb
              goto 105
              endif
      READ(9,*) NP
      DO 100 I=1,NP
  100 READ(9,*) DEN(1,I),DEN(2,I),den(3,I),den(4,i),den(5,i)
      RHOE = DEN(3,NP)
      RHOA = DEN(3,1)
      den(1,np+1) = 2.
C
  105 READ(9,*) CcLOW
C
      read(9,*) gmass0
      READ(9,*) NP
      DO 110 I=1,NP
  110 READ(9,*) ET(1,I),ET(2,I),R1T(2,I)
      TEND = ET(1,NP-2)
      I = NP + 1
      ET(1,I)  = POUNDN
      ET(2,I)  = POUNDN
      R1T(1,I) = POUNDN
      R1T(2,I) = POUNDN
C
      DO 120 I=1,NP
  120 R1T(1,I) = ET(1,I)
C
      read(9,*) check1,check2,again,check3,check4,check5
c
      tobs = ' '
      tsrt = ' '
      READ(9,2010) TINP
 2010 format(a24)
C
      if(check4) read(9,*) ess,slen,swid
c
      CLOSE(UNIT=9)
      RETURN
      END
$$$$
```

2 -- sys$desadis:IO.FOR

```
      SUBROUTINE IOT(OPNRUP)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADISIN.dec'
c
      COMMON
     $/TITL/ TITLE
     $/GEN1/ ET(2,isen),RIT(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_aw,sas_temp,sas_rhoe,sas_cpk,sas_cpp
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl
     $/FHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flag
     $/NEND/ POUNDN,POUND
C
      character*80 TITLE(4)
      character*3 sas_name
      character*4 pound
      character*24 TSRC,TINP,TOBS,TSRT
C
      REAL*8 ML,K
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      character*(*) OPNRUP
      character*40 STRING
      character*4 dummy
C
      WRITE(6,1100)
      WRITE(6,1110)
C
C*** OPEN THE INPUT FILE
C
      OPEN(UNIT=8,NAME=OPNRUP,TYPE='NEW',
     $  carriagecontrol='list',recordtype='variable')
C
C*** NOW GET THE TITLE BLOCK
C
      WRITE(6,1120)
      WRITE(6,1130)
C
      DO 100 I=1,4
      READ(5,1134) TITLE(I)
      dummy = title(i)
      IF(dummy(1:4) .EQ. POUND(1:4)) GO TO 110
      WRITE(8,1135) TITLE(I)
  100 CONTINUE

1 -- sys$desadis:IOT.FOR
```

```
      GO TO 130
C
  110 CONTINUE                  ! FILL OUT THE BLOCK
      II = I
      DO 120 I = II,4
      TITLE(I) = ' '
      WRITE(8,1135) TITLE(I)
  120 CONTINUE
  130 CONTINUE
C
c*** Atmospheric parameters:
c
      WRITE(6,1140)
      WRITE(6,1142)
      READ(5,*) U0,Z0,ZR
      WRITE(8,1020) U0,Z0,ZR
C
c*** stability
c
      WRITE(6,1150)
      READ(5,1310) NCHAR,STRING
      istab = 4                          ! default is D stability
      IF(STRING.eq.'A' .or. string.eq.'a') istab=1
      IF(STRING.eq.'B' .or. string.eq.'b') istab=2
      IF(STRING.eq.'C' .or. string.eq.'c') istab=3
      IF(STRING.eq.'D' .or. string.eq.'d') istab=4
      IF(STRING.eq.'E' .or. string.eq.'e') istab=5
      IF(STRING.eq.'F' .or. string.eq.'f') istab=6
      goto(161,162,163,164,165,166) istab
  161 delta = 0.5               ! A
      beta = 0.9
      ml = -11.43 * zr**0.103
      sigx_coeff = 0.02
      sigx_pow = 1.22
      sigx_min_dist = 130.
      goto 170
  162 delta = 0.33              ! B
      beta = 0.9
      ml = -25.98 * zr**0.171
      sigx_coeff = 0.02
      sigx_pow = 1.22
      sigx_min_dist = 130.
      goto 170
  163 delta = 0.20              ! C
      beta = 0.9
      ml = -123.4 * zr**0.304
      sigx_coeff = 0.02
      sigx_pow = 1.22
      sigx_min_dist = 130.
      goto 170
  164 delta = 0.13              ! D

2 -- sys$desadis:IOT.FOR
```

```
      beta = 0.9
      al = 0.0                  ! used for infinity
      sisx_coeff = 0.04
      sisx_pow = 1.14
      sisx_min_dist = 100.
      goto 170
 165  delta = 0.1               ! E
      beta = 0.9
      al = 123.4 * zr**0.304
      sisx_coeff = 0.17
      sisx_pow = 0.97
      sisx_min_dist = 50.
      goto 170
 166  delta = 0.064             ! F
      beta = 0.9
      al = 25.98 * zr**0.171
      sisx_coeff = 0.17
      sisx_pow = 0.97
      sisx_min_dist = 50.
C
 170  WRITE(8,1040) istab
C
 172  WRITE(6,1160) delta,beta,al,sisx_coeff,sisx_pow,sisx_min_dist
      read(5,1310) nchar,strins
      if(strins.eq.'d' .or. strins.eq.'D') then
              write(6,1600)
              read(5,*) delta
              goto 172
      else if(strins.eq.'b' .or. strins.eq.'B') then
              write(6,1620)
              read(5,*) beta
              goto 172
      else if(strins.eq.'l' .or. strins.eq.'L') then
              write(6,1660)
              read(5,*) al
              goto 172
      else if(strins.eq.'c' .or. strins.eq.'C') then
              write(6,1670)
              read(5,*) sisx_coeff
              goto 172
      else if(strins.eq.'p' .or. strins.eq.'P') then
              write(6,1680)
              read(5,*) sisx_pow
              goto 172
      else if(strins.eq.'m' .or. strins.eq.'M') then
              write(6,1690)
              read(5,*) sisx_min_dist
              goto 172
      else if(nchar.eq.0 .or. strins.eq.'n' .or. strins.eq.'N') then
              WRITE(8,1020) DELTA,BETA,al
              WRITE(8,1020) sisx_coeff,sisx_pow,sisx_min_dist

3 -- sys$desadis:IOT.FOR
```

```
      else
      goto 172
      endif
c
c*** ambient pressure, temperatures, and humidity
c
      write(6,1500)
      read(5,*) tamb,pamb
      tamb = tamb + 273.15    ! K
      vaporp = 6.0298e-3* exp(5407.* (1./273.15- 1./tamb)) ! atm
      sat = 0.622*vaporp / (pamb- vaporp)
      write(6,1580)
      read(5,1310) nchar,string
      if(string.eq.'a' .or. string.eq.'A') then
              write(6,1585)
              read(5,*) humid
              relhumid = 100.*humid/sat
              write(6,1586) relhumid
              goto 200
              endif
      write(6,1587)
      read(5,*) relhumid
      humid = relhumid/100. * sat
  200 rhoa = pamb*(1.+humid)/(.00283+.00456*humid)/tamb
      write(6,1588) rhoa
      write(8,1025) tamb,pamb,humid
c
      isofl = 0
      ihtfl = 0
      htco  = 0.
      iwtfl = 0
      wtco  = 0.
c
      write(6,2000)
      read(5,1310) nchar,string
      if(string.eq.'Y' .or. string.eq.'y') then
              isofl = 1
              tsurf = tamb
              goto 250
              endif
c
      write(6,2020)
      read(5,1310) nchar,string
      if(string.eq.'Y' .or. string.eq.'y') then
              write(6,2030)
              read(5,*) tsurf
  220         write(6,2040)
              read(5,1310) nchar,string
                      if(string.eq.'V' .or. string.eq.'v') then
                      ihtfl = -1      ! constant value
                      write(6,2050)

4 -- sys$desadis:IOT.FOR
```

```
                read(5,*) htco
      else if(strins.eq.'C' .or. strins.eq.'c' .or. nchar.eq.0) then
                        ihtfl = 1       ! local correlation
                else if(strins.eq.'L' .or. strins.eq.'l') then
                        ihtfl = 2       ! LLNL correlation
                        htco = 0.0125   ! [=]m/s
                        write(6,2043) htco
                        read(5,1310) nchar,strins
                        if(strins.eq.'Y' .or. strins.eq.'y')
     1                          read(5,*) htco
                else
                goto 220
                endif
      else
      goto 250
      endif
c
      write(6,2100)
      read(5,1310) nchar,strins
      if(strins.eq.'Y' .or. strins.eq.'y') then
              iwtfl = 1
              write(6,2045)
              read(5,1310) nchar,strins
                      if(strins.eq.'V' .or. strins.eq.'v') then
                      iwtfl = -1
                      write(6,2120)
                      read(5,*) wtco
                      endif
              endif
c
 250  continue
      write(8,1060) isofl,tsurf
      write(8,1060) ihtfl,htco
      write(8,1060) iwtfl,wtco
c
C
c*** gas characteristics
c
      write(6,1510)
      read(5,1415) gas_name
      write(8,1415) gas_name
      gas_mw = 16.04
      gas_temp = 111.7
      gas_rhoe = 1.792*pamb   ! correct to pamb
      gas_cpk = 2730.
      gas_cpp = 1.00
      gas_ufl= 0.15
      gas_lfl= 0.05
      gas_zsp= 0.5
      if(gas_name.eq.'LNG' .or. gas_name.eq.'lng') then
              gas_mw = 16.04

3 -- sys$desadis:IOT.FOR
```

```
            sas_temp = 111.7
            sas_rhoe = 1.792*pamb   ! correct to pamb
            sas_cpk = 5.6e-8
            sas_cpp = 5.00
            sas_ufl= 0.15
            sas_lfl= 0.05
            sas_zsp= 0.5
            endif
      if(sas_name.eq.'LPG' .or. sas_name.eq.'lpg') then
            sas_mw = 44.09
            sas_temp = 231.
            sas_rhoe = 2.400*pamb   ! correct to pamb
            sas_cpk = 15.4
            sas_cpp = 2.25
            sas_ufl= 0.10
            sas_lfl= 0.02
            sas_zsp= 0.5
            endif
  270 write(6,1520) sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     1       sas_ufl,sas_lfl,sas_zsp
      read(5,1310) nchar,string
      if(string.eq.'m' .or. string.eq.'M') then
            write(6,1550)
            read(5,*) sas_mw
            goto 270
      else if(string.eq.'t' .or. string.eq.'T') then
            write(6,1530)
            read(5,*) sas_temp
            goto 270
      else if(string.eq.'d' .or. string.eq.'D') then
            write(6,1535)
            read(5,*) sas_rhoe
            goto 270
      else if(string.eq.'h' .or. string.eq.'H') then
            write(6,1570)
            read(5,*) sas_cpk
            goto 270
      else if(string.eq.'p' .or. string.eq.'P') then
            write(6,1571)
            read(5,*) sas_cpp
            goto 270
      else if(string.eq.'u' .or. string.eq.'U') then
            write(6,1572)
            read(5,*) sas_ufl
            goto 270
      else if(string.eq.'l' .or. string.eq.'L') then
            write(6,1573)
            read(5,*) sas_lfl
            goto 270
      else if(string.eq.'z' .or. string.eq.'Z') then
            write(6,1574)

6 -- sys$desadis:IOT.FOR
```

```
            read(5,*) sas_zsp
            goto 270
      else if(nchar.eq. 0 .or. string.eq.'n' .or. string.eq.'N') then
            WRITE(8,1020) sas_mw, sas_temp,sas_rhoe
            write(8,1020) sas_cpk,sas_cpp
            WRITE(8,1020) sas_ufl,sas_lfl,sas_zsp
      else
      goto 270
      endif
c
c density curve if isothermal
c
      if(isofl .eq. 0) goto 460
      WRITE(6,1161)
      WRITE(6,1162)
      WRITE(6,1163)
      WRITE(6,1164) rhoa
      WRITE(6,1165)
      WRITE(6,1166)
      goto 320
C
 280  write(6,1290)
C
 320  LUNIN = 5
      WRITE(6,1300)
      READ(5,1310) NCHAR,STRING
      IF(STRING.EQ.'y' .or. string.eq.'Y') GO TO 360
      GO TO 400
  360 WRITE(6,1320)
      READ(5,1310) NCHAR,STRING
      OPEN(UNIT=10,NAME=STRING,TYPE='OLD',err=280)
      LUNIN = 10
  400 CONTINUE
      IF(LUNIN .EQ. 5) WRITE(6,1170) isen
      READ(LUNIN,*) NP
      WRITE(8,1040) NP
      IF(LUNIN .EQ. 5) WRITE(6,1180)
C
      DO 440 I=1,NP
      den(4,i) = 0.                          ! 0.0 by default for isotherm
      den(5,i) = tamb                        ! tamb for isotherm
      READ(LUNIN,*) DEN(1,I),DEN(2,I),DEN(3,I)
      if(i .eq.1 .and.
     1       (den(3,1)/rhoa.gt.1.005 .or. rhoa/den(3,1).gt.1.005)) then
            den(3,1) = rhoa
            write(6,1340) rhoa
            endif
      if(i.eq.np) THEN
            IF(     den(2,i)/sas_rhoe .gt. 1.005
     1      .or.    sas_rhoe/den(2,i) .gt. 1.005
     1      .or.    den(3,i)/sas_rhoe .gt. 1.005

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```

```
     1        .or.    gas_rhoe/den(3,i) .gt. 1.005) then
              den(2,i) = gas_rhoe
              den(3,i) = gas_rhoe
              write(6,1341) gas_rhoe
              endif
              endif
      WRITE(8,1025) DEN(1,I),DEN(2,I),DEN(3,I),Den(4,I),den(5,i)
  440 CONTINUE
      IF(LUNIN .EQ. 10) CLOSE(UNIT=10)
C
c
 460  WRITE(6,1280)
      READ(5,*) CcLOW
      if(cclow .le. 0.) cclow=0.005   ! don't let 0. set throush
      WRITE(8,1010) CcLOW
c
c
c*** source description
c
      write(6,1440)
      read(5,*) smass0
      write(8,1020) smass0
c
c
      check4 = .false.
      write(6,1400)
      read(5,1410) dummy
      if(dummy.eq.'y' .or. dummy.eq.'Y') goto 480
      goto 520
 480  continue
      write(6,1420)
      read(5,*) ess
      write(6,1430)
      read(5,*) riss
      np = 4
c
      tend = 6023. ! [=] sec
c
      et(1,1) = 0.
      et(2,1) = ess
      rit(2,1)= riss
      et(1,2) = tend
      et(2,2) = ess
      rit(2,2)= riss
      et(1,3) = tend + 1.
      et(2,3) = 0.
      rit(2,3)= 0.
      et(1,4) = tend + 2.
      et(2,4) = 0.
      rit(2,4)= 0.
      slen = sqrt(pi*riss**2)

3 -- sys$desadis:IOT.FOR
```

```
      swid = slen
      check4 = .true.          ! steady state run
      goto 760
C
 520  continue
C
      WRITE(6,1190)
      WRITE(6,1200)
      WRITE(6,1210)
      WRITE(6,1220)
      WRITE(6,1165)
      WRITE(6,1230)
      WRITE(6,1240)
      WRITE(6,1250)
      goto 600
C
 560  write(6,1290)
C
 600  LUNIN = 5
      WRITE(6,1330)
      READ(5,1310) NCHAR,STRING
      IF(STRING.eq.'Y' .or. string.eq.'y') goto 640
      goto 680
  640 WRITE(6,1320)
      READ(5,1310) NCHAR,STRING
      OPEN(UNIT=10,NAME=STRING,TYPE='OLD',err=560)
      LUNIN = 10
  680 CONTINUE
      IF(LUNIN .EQ. 5) WRITE(6,1260) isen
      READ(LUNIN,*) NP
      IF(LUNIN .EQ. 5) WRITE(6,1270)
C
      DO 720 I=1,NP
      READ(LUNIN,*) ET(1,I),ET(2,I),R1T(2,I)
  720 CONTINUE
      IF(LUNIN .EQ. 10) CLOSE(UNIT=10)
C
  760 continue
      WRITE(8,1040) NP
      DO 800 I=1,NP
  800 WRITE(8,1030) ET(1,I),ET(2,I),R1T(2,I)
C
      if(et(2,1).eq.0. .and. gmass0.ne.0.) check2=.true. ! HSE type spill
      write(8,*) check1,check2,again,check3,check4,check5
C
      istat = lib$date_time(tinp)
      WRITE(8,1050) TINP
C
      if(check4) write(8,1020) ess,slen,swid          ! steady state
C
C

9 -- sys$desadis:IOT.FOR
```

```
      CLOSE(UNIT=8)
C
C
 1010 format(1x,1pg14.7)
 1020 format(3(1x,1pg14.7))
 1025 format(5(1x,1pg14.7))
 1030 format(1x,2(1pg14.7,1x),1pg14.7)
 1040 format(1x,i4)
 1050 format(a24)
 1060 format(1x,i4,1x,1pg14.7)
C
 1100 FORMAT(5X,'INPUT MODULE -- DEGADIS MODEL')
 1110 FORMAT(/,5X,'**********************************')
 1120 FORMAT(5X,'Enter Title Block -- up to 4 lines of 80',
     $' characters')
 1130 FORMAT(5X,'To stop, type "//"')
 1134 FORMAT(A80)
 1135 FORMAT(A80)
 1140 FORMAT(5X,'ENTER WIND PARAMETERS -- U0 (m/s), Z0 (m), ',
     $'and ZR(m)')
 1142 format(5x,'U0 -- Wind velocity at reference height Z0',
     $/,5X,'ZR -- Surface Roughness')
 1150 FORMAT(/,5X,'Enter the Pasquill stability class: (A,B,C,',
     $'D,E,F) <D> ',$)
 1160 format(/,' The values for the atmospheric parameters',
     $' are set as follows:',
     $/,' DELTA:                    ',F12.4,
     $/,' BETA:                     ',F12.4,
     $/,' Monin-Obukhov length:     ',F12.4,' m',
     $/,' Sigma X Coefficient:      ',F12.4,
     $/,' Sigma X Power:            ',F12.4,
     $/,' Sigma X Minimum Distance: ',F12.4,' m',
     $/,' Do you wish to change any of these?',
     $/,' (No,Delta,Beta,Length,Coefficient,Power,Minimum) <N> ',$)
 1161 FORMAT(/,5X,'The density is determined as a function of con',
     $'centration')
 1162 FORMAT(5X,'by a listing of ordered pairs supplied by the user')
 1163 FORMAT(5X,'Use the following form:')
 1164 FORMAT(/,5X,5X,'first point',6X,'-- pure air  y=0.0,Cc=0.,',
      1       'RHOG=RHOA ',1pg13.5)
 1165 FORMAT(3(15X,'.',/))
 1166 FORMAT(5X,5X,'last point',7x,'-- pure gas  y=1.0,Cc=RHOE,',
      1       'RHOG=RHOE')
 1170 FORMAT(/,5X,'ENTER THE NUMBER OF DATA TRIPLES (max=',i2,')',
     $' FOR THE DENSITY FUNCTION: ',$)
 1180 FORMAT(/,5X,'Enter Mole frac, Cc (kg/m**3), then RHOG ',
      1       '(kg/m**3) by triples')
C
C
 1190 FORMAT(/,5X,10X,'Source Description')
 1200 FORMAT(1X,/,5X,'The same form used by the density description')

10 -- sys$desadis:IOT.FOR
```

```
 1210 FORMAT(5X,'is used by the source description as follows')
 1220 FORMAT(/,5X,5X,'first point',6X,'-- time=0  E,R1 at initial ',
     $'(nonzero) values')
 1230 FORMAT(5X,5X,'nxt to last point -- time=TEND  E,R1=0.')
 1240 FORMAT(5X,5X,'last point',6X,'time=TEND+  E,R1=0.')
 1250 FORMAT(/,5X,'Note: the final time is the last time entered ',
     $'where E and R1 are non-zero')
 1260 FORMAT(/,5X,'ENTER THE NUMBER OF TRIPLES (max= ',i2,') FOR ',
     $'THE SOURCE DESCRIPTION: ',$)
 1270 FORMAT(/,5X,'Enter TIME (sec), EVOLUTION RATE (kg/m**3), ',
     $'and POOL RADIUS (m)')
 1280 FORMAT(5X,'Enter the LOWEST CONCENTRATION OF INTEREST (kg/',
     $'m**3) : ',$)
 1290 format(/,' This file was not found.')
 1300 FORMAT(/,' Do you have an input file for the Density ',
     $'function? [y or N] ',$)
 1310 FORMAT(Q,A20)
 1320 FORMAT(' Enter the file name: [DIR]FILE_NAME.EXT ',$)
 1330 FORMAT(' Do you have an input file for the Source ',
     $'Description? [y or N] ',$)
 1340 format(/,' Air density corrected to ',1pg13.5' kg/m**3',/)
 1341 format(/,' Contaminant density corrected to ',1pg13.5' kg/m**3',/)
C
C
 1400 format(//,' Is this a Steady state simulation? <y or N> ',$)
 1410 format(a4)
 1415 format(a3)
 1420 format(/,' Enter the desired evolution rate [=] kg/sec : ',$)
 1430 format(' Enter the desired source radius [=] m : ',$)
 1440 format(/,' Specification of source rate and extent.',
     $///,' Enter the initial mass of pure gas',
     $' over the source. (kg)',/,' (Positive or zero): ',$)
C
C
 1500 format(/,' Enter the ambient temperature(C) and pressure',
      1       '(atm): ',$)
 1510 format(/,' Enter the code name of the diffusing species: ',$)
 1520 format(/,' The characteristics for the gas are set as follows:',/,
     $' Molecular weight:                                  ',f7.2,/,
     $' Storage temperature [K]:                           ',1pg13.5,/,
     $' Density at storage temperature, PAMB  [kg/m**3]:   ',1pg13.5,/,
     $' Mean Heat capacity constant                        ',1pg13.5,/,
     $' Mean Heat capacity power                           ',1pg13.5,/,
     $' Upper Flammability Limit [mole frac]               ',1pg13.5,/,
     $' Lower Flammability Limit [mole frac]               ',1pg13.5,/,
     $' Height of Flammability Limit [m]                   ',1pg13.5,/,
     $' Do you wish to change any of these? ',
     $'(No,Mole,Temp,Den,Heat,Power,Upper,Lower,Z)',
     $' <N> ',$)
 1530 format(' Enter the desired Storage Temperature: ',$)
 1535 format(' Enter the desired Density at Storage ',

11 -- sys$desadis:IOT.FOR
```

```
     1       'Temperature and',' ambient pressure: ',$)
 1550 format(' Enter the desired Molecular Weight: ',$)
 1570 format(' Enter the desired Mean Heat Capacity constant: ',$)
 1571 format(' Enter the desired Mean Heat Capacity power: ',$)
 1572 format(' Enter the desired Upper Flammability Limit: ',$)
 1573 format(' Enter the desired Lower Flammability Limit: ',$)
 1574 format(' Enter the desired Height for the flammable limit calcula',
     1       'tions: ',$)
 1580 format(/,' The ambient humidity can be entered as Relative ',
     1       'or Absolute.',/,' Enter either R or A <R or a>: ',$)
 1585 format(' Enter the absolute humidity (kg water/kg BDA): ',$)
 1586 format(' This is a relative humidity of ',1pg13.5,' %')
 1587 format(' Enter the relative humidity (%): ',$)
 1588 format(/,' Ambient Air density is ',1pg13.5,' kg/m**3')
C
C
 1600 format(' Enter the desired DELTA: ',$)
 1620 format(' Enter the desired BETA: ',$)
 1660 format(' Note: For infinity, ML = 0.0',/,
    $        ' Enter the desired Monin-Obukhov length: (m) ',$)
 1670 format(' Enter the desired Sigma X Coefficient: ',$)
 1680 format(' Enter the desired Sigma X Power: ',$)
 1690 format(' Enter the desired Sigma X Minimum distance: (m) ',$)
C
 2000 format(/,' Is this an Isothermal spill? <y or N> ',$)
 2020 format(/,' Is heat transfer to be included in the',
     1       ' calculations <y or N> ',$)
 2030 format(' Enter the surface temperature [=] K : ',$)
 2040 format(' Do you want to use the built in correlation,',
     1       ' the LLNL correlation, or',/,' enter',
     1       ' a particular value?',/,
     1       ' (Corr,LLNLcorr,Value)  <C> ',$)
 2043 format(/,' The form of the correlation is:',/,
     1       6x,'Q = (Vh * rho * cp) * area * (tsurf-temp)',///,
     1       ' with Vh = ',1pg13.5,' m/s.',//,
     1       ' Do you wish to change the value of Vh? (y or N): ',$)
 2045 format(' Do you want to use the built in correlation or enter',
     1       ' a particular value?',/,' <C or v> ',$)
 2050 format(' Enter the HT coefficient value [=] J/m**2/s/K : ',$)
 2100 format(/,' Is water transfer to be included in the',
     1       ' source <y or N> ',$)
 2120 format(' Enter the WT coefficient value [=] kmol/m**2/s/atm : ',$)
C
C
      RETURN
      END
####
```

12 -- sys$desadis:IOT.FOR

```
C.....................................................
C
C     SUBROUTINE FOR SOURCE EVALUATION WHEN NO GAS BLANKET
C        IS PRESENT.
C
      SUBROUTINE NOBL(timeout)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
C
      COMMON
     $/GEN1/ ET(2,isen),R1T(2,isen)
     $/ERROR/ STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtab,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl,swcl,swal,senl,srhl
     $/phlag/ check1,check2,again,check3,check4,check5
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
C
      REAL*8 ML,K
c
      LOGICAL REV
      logical check1,check2,again,check3,check4,check5
      DATA REV/.TRUE./
      REAL*8 L
c
      data h/0./,Ri/0./
      data delt_min/0.5/
C
      DELTAT = (TEND - TSC1)/FLOAT(NOBLPT)
      if(deltat .lt. delt_min) then
              noblpt = int((tend-tsc1)/delt_min) +1
              deltat = (tend-tsc1)/float(noblpt)
              endif
C
      T0 = TSC1
      IF(DELTAT .LT. 2.) GO TO 100
C
      WRITE(lunlog,1100)
      WRITE(lunlog,*) DELTAT
 1100 FORMAT(5X,'TIME INCREMENT USED ON LAST PORTION OF SOURCE CALC')
C
  100 CONTINUE
C
C     ESTABLISH LOOP TO FINISH SOURCE

1 -- sys$desadis:NOBL.FOR
```

```
C
      DO 110 I = 1,NOBLPT
C
      TIME = TO + FLOAT(I)*DELTAT
      IF(I .EQ. NOBLPT) TIME = TEND
      L = SQRTPI*AFGEN(R1T,TIME,'R1T-BL')
      erate = AFGEN(ET,TIME,'ET-BL')
      flux = ERATE/L/L
C
      astar = rhoe * k*ustar*alphai*dellay/(dellay-1.)/phihat(rhoe,L)
      if(abs(flux/astar) .st. ernobl) then
              check3 = .true.
              timeout = time
              return
              end if
C
      call szf(flux,L,sz,cclay,wclay,rholay)
      cc = cclay*dellay
C
      call adiabat(0,wc,wa,yc,ya,cc,rho,wm,enthalpy,temp)
C
      IF(Erate .LT. EMAX) GO TO 220
      EMAX = Erate
      RM = AFGEN(R1T,TIME,'R1T-BL')
      SZM = SZ
  220 CONTINUE
      RLIST = AFGEN(R1T,TIME,'R1T-BL')
      RMAX = dMAX1(RMAX,RLIST)
C
      WRITE(9,2000) TIME,RLIST,h,flux,SZ,yc,ya,rho,Ri,wc,wa,enthalpy,temp
C
      if(i.eq.5  .and.  check4) goto 500      ! steady
C
  110 CONTINUE
      RETURN
C
C
  500 continue                ! steady state completion
      outcc = cc
      swcl = wc
      swal = wa
      senl = enthalpy
      srhl = rho
      outsz = sz
      outl  = sqrtpi * rlist
      outb  = outl/2.
      return
 2000 format(1pe16.9,1x,1pe16.9,<iout_src-2>(1x,1pe13.6))
      END
####


 2 -- sys$desadis:NOBL.FOR
```

```
C.....................................................
C
C     SUBROUTINES OB AND OBOUT ARE USED IN THE OBSERVER INTEGRATIONS
C          OVER THE SOURCE.
C
      SUBROUTINE OB(time,Y,D,PRMT)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )
C
      include 'sys$desadis:DEGADIS2.dec'
c
      COMMON
     $/GEN3/ radg(2,maxl),qstr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/PARM/U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
     $/phicom/ iphifl,dellay
c
      REAL*8 K,ML
      logical flag
C
      DIMENSION Y(1),D(1),PRMT(1)
      INTEGER HWIDTH,Mrate,Crate,BDArate,Hrate
      DATA HWIDTH/1/,Mrate/2/,Crate/3/,BDArate/4/,Hrate/5/
C
C*** PASS TO IN PRMT(6)
C
      flag = isofl.eq. 1 .or. ihtfl.eq. 0
c
      TO1 = PRMT(6)
      TUP = prmt(7)
      XI = XIT(TIME,TO1)
      RG = AFGEN(RADG,TIME,'RADG')
      RLEN = PRMT(13)
C
      BIPR = 0.
      IF((ABS(XI)-RG)/RG .GE. 0.01) WRITE(lunlog,1000) XI,RG
      IF(ABS(XI) .LT. RG) BIPR = sqrt(RG*RG - XI*XI)
C
      UI = UIT(TIME,TO1)
C
      Q    = AFGEN(QSTR,TIME,'QSTR')
      wc   = AFGEN(srcwc,time,'srcwc')
      wa   = AFGEN(srcwa,time,'srcwa')
      enth = AFGEN(srcenth,time,'srcenth')
c
      wclay   = Y(Crate)/Y(Mrate)
      walay   = Y(BDArate)/Y(Mrate)
      if(.not.flag) enthlay = Y(Hrate)/Y(Mrate)

1 -- sys$desadis:OB.FOR
```

```
c
      call tprop(1,wclay,walay,enthlay,yc,ya,wa,temp,rholay,cp)
      cclay = wclay*rholay
c
      prmt(8) = cclay
      prmt(9) = wclay
      prmt(10)= walay
      prmt(11)= enthlay
      prmt(12)= rholay
c
      cc  = cclay*dellay
      rho = dellay*(rholay-rhoa) + rhoa
c
      szob = 0.01
      arg = Q*(xi-xup)/cc/(u0*z0/alpha1)
      if(xi.gt. xup .and. arg.gt.0.)
     1 szob = arg**(1./alpha1) * z0
c
      HEFF = GAMMAF/ALPHA1* SZOB
      RISTR=RIF(RHO,HEFF)
      PHI = PHIF(RISTR,0.)
      welay = dellay * K*USTAR* ALPHA1/PHI
C
      D(HWIDTH)= UI * BIPR / RLEN
      D(Crate) = D(HWIDTH)*RLEN * Q
      D(Mrate) = (Q/wc + rhoa*welay) * D(HWIDTH)*RLEN
      D(BDArate)= (1*wa/wc + rhoa*welay/(1.+humid)) * D(HWIDTH)*RLEN
      if(flag) return
      D(Hrate) = Q * enth/wc * D(HWIDTH)*RLEN
C
 1000 FORMAT(' ?OB? -- Value of XI ',1pG13.4,'; Value of RG ',
     $  1pG13.4)
      RETURN
      END
c
c
      SUBROUTINE OBOUT( X, Y, DERY, IHLF, NDIM, PRMT)
C
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      DIMENSION X(1), Y(1), DERY(1), PRMT(1)
C
      PRMT(14) = prmt(8)      ! cclay
      PRMT(15) = prmt(9)      ! wclay
      PRMT(16) = prmt(10)     ! walay
      PRMT(17) = prmt(11)     ! enthlay
      PRMT(18) = prmt(12)     ! rholay
      RETURN
      END
$$$$


 2 -- sys$desadis:OB.FOR
```

```
C.....................................................
C
C     FUNCTION PSI
C
C*** AS PER COLENBRANDER --
C
C*** THIS FUNCTION HAS BEEN DERIVED FROM BUSINGER,J.A.
C***  WORKSHOP ON MICROMETEOROLOGY, CHAPTER 2, HAUGEN,D.A. (ED.)
C***  AMERICAN METEOROLOGICAL SOCIETY.
C
      FUNCTION PSIF(Z,ML)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS1.dec'
C
      REAL*8 ML
C
      IF( ML ) 10,20,30
C
 10   A = (1.-15.*Z/ML)**.25
      PSIF = 2.*dLOG((1.+A)/2.) + dLOG((1.+A*A)/2.) - 2.*daTAN(A) +
     $ PI/2.
      RETURN
C
 20   PSIF = 0.
      RETURN
C
 30   PSIF = -4.7*Z/ML
      RETURN
      END
$$$$
```

1 -- sys$desadis:PSIF.FOR

```
C.....................................................
C
C     SUBROUTINES FOR PSEUDO-STEADY STATE INTEGRATION.
C
      SUBROUTINE PSS(DIST,Y,DERY,PRMT)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS2.dec/list'
c
      parameter (zero=1.D-10, rcrit=2.D-3)
c
      COMMON
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/ALP/ ALPHA,alphai
     $/phicom/ ishifl,dellay
     $/sprd_con/ ce, delrhomin
c
      REAL*8 K,ML
C
      DIMENSION Y(1),DERY(1),PRMT(1)
      DATA rhouh/1/,SY/2/,BEFF/3/,dh/4/
      INTEGER rhouh,SY,BEFF,dh
C
C*** PRMT I/O SETUP
C***  I       VALUE            IN/OUT
C***  ----    -----            ------
C***   6       E                 IN
C***   7       Cc               OUT
C***   8       B                OUT
C***   9      CON DERY(BEFF)     IN
C***  10      CON DERY(SZ)       IN
C***  11      NREC(I,1)        OUT -- STARTS OUTPUT COUNTER
C***  12      DIST             OUT
c***  13
c***  14      yc               out
c***  15      rho              out
c***  16      temp             out - if recorded
c***  17      gamma            out - if recorded
c***  18
c***  19
c***  20
c***  21      sz
c***  22      sz
C
      Erate = PRMT(6)
      B = Y(BEFF) - SQrtPI/2.*Y(SY)
c
c

: -- sys$desadis:PSS.FOR
```

```
c using the last value for Sz
c
      sz0 = prmt(22)
      sz = sz0
C
C*** MATERIAL BALANCE
C
      iii = 0
 100  Cc = Erate*ALPHA1/2./U0*(Z0/SZ)**ALPHA/SZ/Y(BEFF)
      call adiabat(0,wc,wa,yc,ya,cc,rho,wm,enth,temp)
      cclay = cc/dellay
      call adiabat(0,wc,wa,yclay,ya,cclay,rholay,wml,enth,temlay) ! for wm
      call addheat(cclay,y(dh),rholay,temlay,cp)
      prod = dmax1( Y(rhouh)/rholay/prmt(18), zero)
      sz = ( prod )**(1./alpha1) * z0
      dif = abs(sz - sz0)/(abs(sz)+abs(sz0)+zero)
      if(dif .gt. rcrit) then
             sz0 = sz
             iii=iii+1
             if(iii .gt. 20) call trap(32)
             goto 100
             endif
      prmt(20) = rholay
      prmt(21) = sz
      HEFF = GAMMAF/ALPHA1*SZ
c
      rit = 0.
      temp = temlay
      if(isofl.eq.0 .or. ihtfl.ne.0) then
             rho = dellay*(rholay-rhoa) + rhoa       ! estimate
             temp = (wm/rho)*(rholay*temlay/wml)     ! estimate
             rit = rift(temp,heff)
             endif
      RISTR = RIF(RHO,HEFF)
      PHI = PHIF(RISTR,rit)
C
C*** CALCULATE DERIVATIVES
C
      DERY(BEFF) = 0.
      delrho = rho-rhoa
      IF(delrho .GT. delrhomin) DERY(BEFF) = PRMT(9)*sqrt(delrho/rhoa)
     $    *(SZ/Z0)**(.5 - ALPHA)
C
      DERY(SY) = 4.*BETA/PI/Y(SY)*Y(BEFF)**2 *
     $    (DELTA*SQPIO2/Y(BEFF)) ** (1./BETA)
C
c
      heish = heff*dellay
      call surface(temlay,heish,rholay,wml,cp,watrte,arte)
      if(temp.ge. tsurf .or. temlay.ge. tamb) arte = 0.
      rhouhb = rholay* prmt(18) * (sz/z0)**alpha1 * Y(beff)

2 -- sys$desadis:PSS.FOR
```

```
      d_rhouhb = prmt(19)*y(beff)/phi
      dERY(dh) = (arte*Y(beff)/dellay - Y(dh)*d_rhouhb)/rhouhb
      dERY(rhouh) = (d_rhouhb-Y(rhouh)*DERY(beff))/Y(beff)
C
C*** RETURNED VALUES
C
      PRMT(7) = Cc
      PRMT(8) = B
      prmt(14)= yc
      prmt(15)= rho
      prmt(16)= temp
      prmt(17)= (rholay-rhoa)/cclay          ! samma
C
      RETURN
      END
###!
```

```
C.....................................................................
C
C     SUBROUTINE PSSOUT
C
      SUBROUTINE PSSOUT(X,Y,D,IHLF,NDIM,PRMT)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS2.dec'
c
      parameter (npss=9, zero=1.e-10)
c
      COMMON
     $/PARM/U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/STP/STP0,STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/PHLAG/CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/STOPIT/TSTOP
c
      REAL*8 K,ML
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      DIMENSION Y(1),D(1),PRMT(1),BKSP(npss),OUT(npss),CURNT(npss)
C
C*** OUTPUT PARAMETERS
C
C*** FROM PSS            OUTPUT TO MODEL
C*** --------            ---------------
C***  X                        DIST
C***  PRMT(7)                  Cc
C***  Y(1)                     SZ
C***  Y(2)                     SY
C***  PRMT(8)                  B
C***  PRMT(13)                 TO(I)
c***  prmt(14)                 yc
c***  prmt(15)                 rho
c***  prmt(16)                 temp
c***  prmt(17)                 gamma
c
      ERM = 0.
      TSL = TS(PRMT(13),X)
      prmt(22) = prmt(21)
      IF(PRMT(11) .NE. 0.) GO TO 90
C
C*** STARTUP FOR THE OUTPUT ROUTINE
C
      RII = -100./STPP
      RI = 0.
      CURNT(1) = X
      curnt(2) = prmt(14)      ! yc
      CURNT(3) = PRMT(7)       ! cc

1 -- sys$desadis:PSSOUT.FOR
```

```
      curnt(4) = prmt(15)      ! rho
      curnt(5) = prmt(17)      ! gamma
      curnt(6) = prmt(16)      ! temp
      CURNT(7) = prmt(21)      ! sz
      CURNT(8) = Y(2)          ! sy
      CURNT(9) = PRMT(8)       ! b
      IF(prmt(8) .LE. 0.) CALL trap(16)
   90 CONTINUE
C
C*** STOP INTEGRATION WHEN THE HALF WIDTH B < 0.
C
      IF( PRMT(8) .LE. 0.) GO TO 1000
C
C*** STOP INTEGRATION AND GET A NEW OBSERVER WHEN Cc<CcLOW
C
      IF(PRMT(7).GT.CcLOW .OR. TSL.LT.TSTOP) GO TO 95
              if(prmt(11) .lt. 5.) then       ! guarantee 5 records
                      erm = odlp              ! force output
                      goto 95
                      endif
      TSTOP = TSL
      AGAIN = .TRUE.
      GO TO 1000
   95 CONTINUE
C
C*** SET THE CURRENT AND PREVIOUS RECORD
C
      DO 100 II=1,npss
  100 BKSP(II) = CURNT(II)
C
      CURNT(1) = X
      curnt(2) = prmt(14)      ! yc
      CURNT(3) = PRMT(7)       ! cc
      curnt(4) = prmt(15)      ! rho
      curnt(5) = prmt(17)      ! gamma
      curnt(6) = prmt(16)      ! temp
      CURNT(7) = prmt(21)      ! sz
      CURNT(8) = Y(2)          ! sy
      CURNT(9) = PRMT(8)       ! b
C
      RI = RI + 1.
      II = 2                   ! skip DIST,YC; 1 and 2
  110 II = II + 1
      ER1 = ABS( (CURNT(II)-BKSP(II))/(CURNT(II)+zero) )
      ER2 = ABS( (CURNT(II)-OUT(II))/(CURNT(II)+zero) )
      ERM = dMAX1(ER1,ER2,ERM)
      IF(II .EQ. 3) II = II + 1        ! skip RHO;4
      IF(II .EQ. 7) II = II + 1        ! skip SY;8
      IF(II .EQ. 5) II = II + 1        ! skip TEMP;6
      IF(II .LT. npss) GO TO 110
C

2 -- sys$desadis:PSSOUT.FOR
```

```
C*** RECORD POINT IF ODLP IS EXCEEDED OR 80 METERS SINCE LAST RECORD
C*** RECORD FIRST POINT
C
      DX = CURNT(1) - OUT(1)
      IF( RI.NE.1. .AND. ERM.LT.ODLP .AND. DX.LE.ODLLP) RETURN
C
C*** IF THE NEXT INTEGRATION AFTER A POINT IS RECORDED VIOLATES THE
C*** ERROR BOUND, THE CURRENT POINT MUST BE RECORDED. OTHERWISE, THE
C*** LAST POINT TO SATISFY THE ERROR LIMITS IS RECORDED.
C
      DO 120 II=1,npss
      IF(RI .EQ. RII+1.) BKSP(II) = CURNT(II)
  120 OUT(II) = BKSP(II)
C
      RI = RII
      PRMT(11) = PRMT(11) + 1.
C
      WRITE(9,*) (OUT(II),II=1,npss)
      RETURN
C
 1000 CONTINUE
C
C*** STOP INTEGRATION
C
      PRMT(12) = X
C
      IF(CURNT(1) .EQ. OUT(1)) GO TO 130
C
      PRMT(11) = PRMT(11) + 1.
      WRITE(9,*) (CURNT(II),II=1,npss)
C
  130 CONTINUE
      PRMT(5) = 1.
      RETURN
      END
####
```

I -- sys$desadis:PSSOUT.FOR

```
C.....................................................................
C
C     SUBROUTINE PSSOUT
C
      SUBROUTINE PSSOUT(X,Y,DERY,IHLF,NDIM,PRMT)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$desadis:DEGADIS2.dec/list'
c
      parameter (npss=9, zero=1.e-10)
c
      COMMON
     $/PARM/UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/STP/STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/PHLAG/CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_fl/ cflag,clfl,cufl
     $/ALP/ALPHA,alpha1
C
      logical cflag
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      REAL*8 ML,K
C
      DIMENSION Y(1),DERY(1),PRMT(1)
      dimension BKSP(npss),OUT(npss),CURNT(npss)
C
C*** OUTPUT PARAMETERS
C
C*** FROM PSS            OUTPUT TO MODEL
C*** --------            ---------------
C***  X                        DIST
C***  PRMT(7)                  Cc
C***  Y(1)                     SZ
C***  Y(2)                     SY
C***  PRMT(8)                  B
C
      ERM = 0.
      prmt(22) = prmt(21)
C
      IF(PRMT(11) .NE. 0.) GO TO 90
C
C*** STARTUP FOR THE OUTPUT ROUTINE
C
      RII = -100./STPP
      RI = 0.
      CURNT(1) = X
      CURNT(2) = PRMT(14)      ! yc
      CURNT(3) = prmt(7)       ! cc
      CURNT(4) = prmt(15)      ! rho

1 -- sys$desadis:PSSOUTSS.FOR
```

```
      CURNT(5) = PRMT(17)      ! gamma
      curnt(6) = prmt(16)      ! temp
      curnt(7) = prmt(8)       ! b
      curnt(8) = prmt(21)      ! sz
      curnt(9) = Y(2)          ! sy
C
   90 CONTINUE
C
C*** STOP INTEGRATION WHEN THE HALF WIDTH B < 0.
C
      IF( PRMT(8) .LE. 0.) GO TO 1000
C
C*** STOP INTEGRATION when Cc<CcLOW
C
      IF(PRMT(7).GT.CcLOW) GO TO 95
              if(prmt(11) .lt. 5.) then       ! force output
                      erm = odlp
                      goto 95
                      endif
      AGAIN = .TRUE.
      GO TO 1000
   95 CONTINUE
C
C*** SET THE CURRENT AND PREVIOUS RECORD
C
      DO 100 II=1,npss
  100 BKSP(II) = CURNT(II)
C
      CURNT(1) = X
      CURNT(2) = PRMT(14)      ! yc
      CURNT(3) = prmt(7)       ! cc
      CURNT(4) = prmt(15)      ! rho
      CURNT(5) = PRMT(17)      ! gamma
      curnt(6) = prmt(16)      ! temp
      curnt(7) = prmt(8)       ! b
      curnt(8) = prmt(21)      ! sz
      curnt(9) = Y(2)          ! sy
C
      RI = RI + 1.
      II = 1
  110 II = II + 1
      ER1 = ABS( (CURNT(II)-BKSP(II))/(CURNT(II)+zero) )
      ER2 = ABS( (CURNT(II)-OUT(II))/(CURNT(II)+zero) )
      ERM = dMAX1(ER1,ER2,ERM)
      IF(II .EQ. 3) II = 6     ! skip density,gamma,temp
      IF(II .LT. npss-1) GO TO 110     ! skip sy
C
C*** RECORD POINT IF ODLP IS EXCEEDED OR 80 METERS SINCE LAST RECORD
C*** RECORD FIRST POINT
C
      DX = CURNT(1) - OUT(1)

2 -- sys$desadis:PSSOUTSS.FOR
```

```
      IF( RI.NE.1. .AND. ERM.LT.ODLP .AND. DX.LE.ODLLP) RETURN
C
C*** IF THE NEXT INTEGRATION AFTER A POINT IS RECORDED VIOLATES THE
C*** ERROR BOUND, THE CURRENT POINT MUST BE RECORDED. OTHERWISE, THE
C*** LAST POINT TO SATISFY THE ERROR LIMITS IS RECORDED.
C
      DO 120 II=1,npss
      IF(RI .EQ. RII+1.) BKSP(II) = CURNT(II)
  120 OUT(II) = BKSP(II)
C
      RI = RII
      PRMT(11) = PRMT(11) + 1.
C
      call ssout(out)
      RETURN
C
 1000 CONTINUE
C
C*** STOP INTEGRATION
C
      PRMT(12) = X
C
      IF(RI .EQ. 0.) CALL trap(16)
C
      IF(CURNT(1) .EQ. OUT(1)) GO TO 130
C
      PRMT(11) = PRMT(11) + 1.
      call ssout(out)
C
  130 CONTINUE
      PRMT(5) = 1.
C
      RETURN
      END
$$$$
```

```
C.....................................................
C
C     RICHARDSON NUMBER (RI*)
C
      FUNCTION RIF(RHOG,HEFF)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      COMMON
     $ /PARM/UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
C
      REAL*8 ML,K
C
      RIF = G*(RHOG-RHOA)/RHOA*HEFF/USTAR/USTAR
C
      RETURN
      END
C
C.....................................................
C
C     RICHARDSON NUMBER (RIt)
C
      FUNCTION RIFt(temp,HEFF)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      COMMON
     $ /PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/alp/ alpha,alphai
C
      REAL*8 ML,K
C
      wind = u0*(heff/z0)**alpha
      RIFt = dmax1(G*(tsurf-temp)/temp*HEFF/USTAR/wind,0.D0)
C
      RETURN
      END
C
C.....................................................................
C
C     PHI FUNCTION
C
      FUNCTION PHIF(RI,rit)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

c
      common /phicom/ iphifl,dellay

1 -- sys$desadis:RIPHIF.FOR
```

```
C
      phif= 0.
      goto(10,1000,2000,3000,9000),iphif1
      goto 9000
C
  10  IF(RI) 100,200,300
C
 100  PHIF = 0.74/(1. + 0.65*ABS(RI)**.6)
      RETURN
C
 200  PHIF = 0.74
      RETURN
C
 300  PHIF = 0.74 + 0.25*(RI)**0.7 + 1.2E-7*RI*RI*RI
      RETURN
C
C
 1000 IF(RI) 1100,1200,1300
C
 1100 PHIF = 0.88/(1. + 0.65*ABS(RI)**.6)
      RETURN
C
 1200 PHIF = 0.88
      RETURN
C
 1300 PHIF = 0.88 + 9.9e-2*(RI)**1.04 + 1.4E-25*RI**5.7
      RETURN
C
C
C
 2000 corr1 = 0.25* rit**.666666 + 1.
      corr = sqrt(corr1)
      riw = ri/corr1
      IF(RI) 2100,2200,2300
C
 2100 PHIF = 0.88/(1. + 0.65*ABS(RIw)**.6)/corr
      RETURN
C
 2200 PHIF = 0.88/corr
      RETURN
C
 2300 PHIF = (0.88 + 9.9e-2*(RIw)**1.04 + 1.4E-25*RIw**5.7)/corr
      RETURN
C
C
 3000 corr1 = 0.25* rit**.666666 + 1.
      corr = sqrt(corr1)
      riw = ri/corr1
      IF(RI) 3100,3200,3300
C
 3100 PHIF = 0.88/corr

2 -- sys$desadis:RIPHIF.FOR
```

```
      RETURN
C
 3200 PHIF = 0.88/corr
      RETURN
C
 3300 PHIF = (0.88 + 9.9e-2*(RIw)**1.04 + 1.4E-25*RIw**5.7)/corr
      RETURN
c
c
 9000 call trap(29)
      return
      END
c
c
c.....................................................
c
c
      function phihat(rho,fetch)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

c
      common
     $/parm/ u0,z0,zr,ml,ustar,k,g,rhoe,rhoa,delta,beta,gammaf,cclow
     $/alp/ alpha,alpha1
     $/phicom/ iphif1,dellay
c
      real*8 k,ml
c
      data phic/3.1/
c
      if(rho .le. rhoa) then
              phihat = 0.88
              return
              endif
c
      pow = 1./alpha1
      p1 = 1.04/alpha1
      Ci = g*(rho-rhoa)/rhoa*z0/ustar**2*gammaf/alpha1
      Ci =Ci* (k*ustar*alpha1**2 /u0/z0/ phic*dellay/(dellay-1.)) ** pow
c
      Cip = 0.099*Ci**1.04
c
      phihat = dlog((.88+ Cip*fetch**p1)/.88)/Cip/fetch
      phihat = 1./phihat
c
      return
      end
$$$$
```

3 -- sys$desadis:RIPHIF.FOR

```
C     ...................................................
C
C     SUBROUTINE RKGST
C
C.....................................................................
C
C     This routine was originally supplied by Digital Equipment
C     Corporation as part of the Scientific Subroutine Package
C     available for RT-11 as part of the Fortran Enhancement
C     Package.  It was upgraded for use as the integration
C     routine in this package.
C
C.....................................................................
C
C     PURPOSE
C             TO SOLVE A SYSTEM OF FIRST ORDER ORDINARY DIFFERENTIAL
C             EQUATIONS WITH GIVEN INITIAL VALUES.
C
C     USAGE
C             CALL RKGST (PRMT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX)
C             PARAMETERS FCT AND OUTP REQUIRE AN EXTERNAL STATEMENT.
C
C     DESCRIPTION OF PARAMETERS
C
C     PRMT    AN INPUT AND OUTPUT VECTOR WITH DIMENSION GREATER
C             OR EQUAL TO 5, WHICH SPECIFIES THE PARAMETERS OF
C             THE INTERVAL AND OF ACCURACY AND WHICH SERVES FOR
C             COMMUNICATION BETWEEN SUBROUTINES OUTP AND FCT
C             (FURNISHED BY THE USER) AND SUBROUTINE RKGST.
C             EXCEPT PRMT(5) THE COMPONENTS ARE NOT DESTROYED
C             BY SUBROUTINE RKGST AND THEY ARE:
C     PRMT(1) LOWER BOUND OF THE INTERVAL (INPUT),
C     PRMT(2) UPPER BOUND OF THE INTERVAL (INPUT),
C     PRMT(3) INITIAL INCREMENT OF THE INDEPENDENT VARIABLE
C             (INPUT),
C     PRMT(4) UPPER ERROR BOUND (INPUT). IF RELATIVE ERROR IS
C             GREATER THAN PRMT(4), INCREMENT GETS HALVED.
C             IF RELATIVE ERROR LESS THAN PRMT(4)*EXPAND,
C             INCREMENT GETS DOUBLED.
C             THE USER MAY CHANGE PRMT(4) BY MEANS OF HIS
C             OUTPUT SUBROUTINE.
C     PRMT(5) MAXIMUM STEP SIZE ORDER OF MAGNITUDE (INPUT).
C             SUBROUTINE RKGST INITIALIZES
C             PRMT(5)=0. IF THE USER WANTS TO TERMINATE
C             SUBROUTINE RKGST AT ANY OUTPUT POINT, HE HAS TO
C             CHANGE PRMT(5) TO NON-ZERO BY MEANS OF SUBROUTINE
C             OUTP. FURTHER COMPONENTS OF VECTOR PRMT ARE
C             FEASIBLE IF ITS DIMENSION IS DEFINED GREATER
C             THAN 5. HOWEVER SUBROUTINE RKGST DOES NOT REQUIRE
C             AND CHANGE THEM. NEVERTHELESS THEY MAY BE USEFUL
C             FOR HANDING RESULT VALUES TO THE MAIN PROGRAM

1 -- sys$desadis:RKGST.FOR
```

```
C             (CALLING RKGST) WHICH ARE OBTAINED BY SPECIAL
C             MANIPULATIONS WITH OUTPUT DATA IN SUBROUTINE OUTP.
C     Y       INPUT VECTOR OF INITIAL VALUES.  (DESTROYED)
C             LATER, Y IS THE RESULTING VECTOR OF DEPENDENT
C             VARIABLES COMPUTED AT INTERMEDIATE POINTS X.
C     DERY    INPUT VECTOR OF ERROR WEIGHTS.  (DESTROYED)
C             ERROR WEIGHTS ARE CENTERED AT ONE. IF ONE PARA-
C             METER NEEDS A TIGHTER ERROR CRITERIA,THE WEIGHT IS
C             GREATER THAN ONE. IF A PARAMETER NEED NOT BE DETER-
C             MINED SO PRECISELY,THE WEIGHT SHOULD BE LESS
C             THAN ONE.IN OTHER WORDS,
C                     ERROR CRITERIA(I) = PRMT(4) / WEIGHT(I)
C             WHERE I IS THE SUBSCRIPT OF A DEPENDENT VARIABLE.
C             LATER, DERY IS THE VECTOR OF DERIVATIVES, WHICH
C             BELONG TO FUNCTION VALUES Y AT A POINT X.
C     NDIM    AN INPUT VALUE, WHICH SPECIFIES THE NUMBER OF
C             EQUATIONS IN THE SYSTEM.
C     IHLF    AN OUTPUT VALUE, WHICH SPECIFIES THE NUMBER OF
C             BISECTIONS OF THE INITIAL INCREMENT. IF IHLF BE-
C             COMES GREATER THAN 10, SUBROUTINE RKGST RETURNS THE
C             ERROR MESSAGE IHLF=11 INTO MAIN PROGRAM. ERROR
C             MESSAGE IHLF=12 OR IHLF=13 APPEARS IN CASE
C             PRMT(3)=0 OR IN CASE SIGN(PRMT(3)).NE.SIGN(PRMT(2)-
C             PRMT(1)) RESPECTIVELY.
C     FCT     THE NAME OF AN EXTERNAL SUBROUTINE USED. THIS
C             SUBROUTINE COMPUTES THE RIGHT HAND SIDES DERY OF
C             THE SYSTEM TO GIVEN VALUES X AND Y. ITS PARAMETER
C             LIST MUST BE X,Y,DERY,PRMT. SUBROUTINE FCT SHOULD
C             NOT DESTROY X AND Y.
C     OUTP    THE NAME OF AN EXTERNAL OUTPUT SUBROUTINE USED.
C             ITS PARAMETER LIST MUST BE X,Y,DERY,IHLF,NDIM,PRMT.
C             NONE OF THESE PARAMETERS (EXCEPT, IF NECESSARY,
C             PRMT(4),PRMT(5),...) SHOULD BE CHANGED BY
C             SUBROUTINE OUTP. IF PRMT(5) IS CHANGED TO NON-ZERO,
C             SUBROUTINE RKGST IS TERMINATED.
C     AUX     AN AUXILIARY STORAGE ARRAY WITH 8 ROWS AND NDIM
C             COLUMNS.
C
C     REMARKS
C
C     THE PROCEDURE TERMINATES AND RETURNS TO CALLING PROGRAM, IF
C     (1) MORE THAN 10 BISECTIONS OF THE INITIAL INCREMENT ARE
C             NECESSARY TO GET SATISFACTORY ACCURACY (ERROR MESSAGE
C             IHLF=11),
C     (2) INITIAL INCREMENT IS EQUAL TO 0 OR HAS WRONG SIGN
C             (ERROR MESSAGES IHLF=12 OR IHLF=13),
C     (3) THE WHOLE INTEGRATION INTERVAL IS WORKED THROUGH,
C     (4) SUBROUTINE OUTP HAS CHANGED PRMT(5) TO NON-ZERO.
C
C     SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C     THE EXTERNAL SUBROUTINES FCT(X,Y,DERY,PRMT) AND

C -- sys$desadis:RKGST.FOR
```

```
C     OUTP(X,Y,DERY,IHLF,NDIM,PRMT) MUST BE FURNISHED BY THE USER.
C
C     METHOD
C     EVALUATION IS DONE BY MEANS OF FOURTH ORDER RUNGE-KUTTA
C     FORMULAE IN THE MODIFICATION DUE TO GILL. ACCURACY IS
C     TESTED COMPARING THE RESULTS OF THE PROCEDURE WITH SINGLE
C     AND DOUBLE INCREMENT.
C     SUBROUTINE RKGST AUTOMATICALLY ADJUSTS THE INCREMENT DURING
C     THE WHOLE COMPUTATION BY HALVING OR DOUBLING. IF MORE THAN
C     10 BISECTIONS OF THE INCREMENT ARE NECESSARY TO GET
C     SATISFACTORY ACCURACY, THE SUBROUTINE RETURNS WITH
C     ERROR MESSAGE IHLF=11 INTO MAIN PROGRAM.
C     TO GET FULL FLEXIBILITY IN OUTPUT, AN OUTPUT SUBROUTINE
C     MUST BE FURNISHED BY THE USER.
C     FOR REFERENCE, SEE
C     RALSTON/WILF, MATHEMATICAL METHODS FOR DIGITAL COMPUTERS,
C     WILEY, NEW YORK/LONDON, 1960, PP.110-120.
C
C     SOME NOTES ON THE PROGRAM/RALSTON AND WILF
C
C     AUX
C     ---
C
C     AUX(1,I) -- CURRENT VALUE OF Y
C     AUX(2,I) -- CURRENT VALUE OF Y'
C     AUX(3,I) -- LAST GOOD VALUES OF Q
C     AUX(4,I) -- Y AFTER ONE RK STEP H
C     AUX(5,I) -- Y AFTER ONE OR TWO RK STEPS OF H/2.
C     AUX(6,I) -- CURRENT VALUES OF Q
C     AUX(7,I) -- Y' AFTER ONE OR TWO RK STEPS OF H/2.
C     AUX(8,I) -- 2/15 * WEIGHTS
C
C     A(4),B(4),C(4)
C     ---------------
C
C     Y  = Y    + A  *(K  - B *Q   )
C      i    i-1    i    i    i  i-1
C
C     Q  = Q    + 3*(A *(K  - B *Q   ) - C *K
C      i    i-1       i   i    i  i-1     i  i
C
C     FOR VALUES OF I BETWEEN 1 AND 4, AND FOR VALUES OF K AS FOLLOWS
C
C     K  = H * F(X ,Y )
C      1          0  0
C
C     K  = H * F(X +H/2,Y )
C      2          0     1
C
C     K  = H * F(X +H/2,Y )
C      3          0     2
```

3 -- sys$desadis:RKGST.FOR

```
C
C     K   = H * F(X +H,Y )
C      4           0    3
C
C     RELATIVE ERROR
C     -------- -----
C
C     AS PER RICHARDSON QUOTED IN RALSTON/WILF (P117),
C
C     ABS ERROR = WEIGHT/15*ABS(Y2 - Y1)
C
C     THEN, RELATIVE ERROR
C
C     REL ERROR = WEIGHT*2/15*ABS(Y2 - Y1)/SUM
c
c     where SUM = ABS(Y2 + Y1)
C
C     The solution tries to use SUM=abs(y2+y1) first. If this is zero,
C     then SUM=.25*ABS(Y1) is used since y1 and y2 must be oposite in
C     sign with equal magnitude. If this
C     quantity is zero as well, the values y2 and y1 both must be zero;
C     therefore, the difference is also zero which satisfies the
C     error criteria.
C
C     ..................................................................
C
      SUBROUTINE RKGST(PRMT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
C
      PARAMETER (EXPAND=0.05)
      DATA ERRSET/1./          ! dummy value
C
      DIMENSION Y(1),DERY(1),AUX(8,NDIM),A(4),B(4),C(4),PRMT(1)
C
      DO 10 I=1,NDIM
   10 AUX(8,I)=.13333333*DERY(I)
      X=PRMT(1)
      XEND=PRMT(2)
      H=PRMT(3)
      IHLFMX = INT(dLOG(ABS(PRMT(5)/PRMT(3)))/.6931472 + .5)
      PRMT(5)=0.
      CALL FCT(X,Y,DERY,PRMT)
C
C*** ERROR TEST
C
      IF(H*(XEND-X))380,370,20
C
C*** PREPARATIONS FOR RUNGE-KUTTA METHOD

4 -- sys$desadis:RKGST.FOR
```

```
C
   20 A(1)=.5
      A(2)=.2928932
      A(3)=1.707107
      A(4)=.1666667
      B(1)=2.
      B(2)=1.
      B(3)=1.
      B(4)=2.
      C(1)=.5
      C(2)=.2928932
      C(3)=1.707107
      C(4)=.5
C
C*** PREPARATIONS OF FIRST RUNGE-KUTTA STEP
C
      DO 30 I=1,NDIM
      AUX(1,I)=Y(I)
      AUX(2,I)=DERY(I)
      AUX(3,I)=0.
   30 AUX(6,I)=0.
      IREC=0
      H=H+H
      IHLF=-1
      ISTEP=0
      IEND=0
C
C*** START OF A RUNGE-KUTTA STEP
C*** STEP = 2 * SPECIFIED STEP
C
   40 IF((X+H-XEND)*H)70,60,50
   50 H=XEND-X
   60 IEND=1
C
C*** RECORDING OF INITIAL VALUES OF THIS STEP
C
   70 CALL FCT(X,Y,DERY,PRMT)
      CALL OUTP(X,Y,DERY,IREC,NDIM,PRMT)
      IF(PRMT(5))400,80,400
   80 ITEST=0
   90 ISTEP=ISTEP+1
C
C*** START OF INNERMOST RUNGE-KUTTA LOOP
C
      J=1
  100 AJ=A(J)
      BJ=B(J)
      CJ=C(J)
      DO 110 I=1,NDIM
      R1=H*DERY(I)
      R2=AJ*(R1-BJ*AUX(6,I))

3 -- sys$desadis:RKGST.FOR
```

```
      Y(I)=Y(I)+R2
      R2=R2+R2+R2
  110 AUX(6,I)=AUX(6,I)+R2-CJ*R1
      IF(J-4)120,150,150
  120 J=J+1
      IF(J-3)130,140,130
  130 X=X+H/2.
  140 CALL FCT(X,Y,DERY,PRMT)
      GOTO 100
C
C*** END OF INNERMOST RUNGE-KUTTA LOOP
C
C*** TEST OF ACCURACY
C
  150 IF(ITEST)160,160,200
C
C*** IN CASE ITEST=0 THERE IS NO POSSIBILITY FOR TESTING OF ACCURACY
C*** IF(ITEST=0) RK STEP JUST PERFORMED WAS FOR TWICE THE SPECIFIED STEP
C
  160 DO 170 I=1,NDIM
  170 AUX(4,I)=Y(I)
      ITEST=1
      ISTEP=ISTEP+ISTEP-2
  180 IHLF=IHLF+1
      X=X-H
      H=H/2.
      DO 190 I=1,NDIM
      Y(I)=AUX(1,I)
      DERY(I)=AUX(2,I)
  190 AUX(6,I)=AUX(3,I)
      GOTO 90
C
C*** IN CASE ITEST=1 TESTING OF ACCURACY IS POSSIBLE ONLY IF EACH
C*** HALF OF THE INTERVAL IS DONE(I.E.,IFF ISTEP IS EVEN)
C
  200 IMOD=ISTEP/2
      IF(ISTEP-IMOD-IMOD)210,230,210
  210 CALL FCT(X,Y,DERY,PRMT)
      DO 220 I=1,NDIM
      AUX(5,I)=Y(I)
  220 AUX(7,I)=DERY(I)
      GOTO 90
C
C*** ORIGINAL VERSION; absolute error
C
C     COMPUTATION OF TEST VALUE DELT
C  230        DELT=0.                    !Good so far
C     DO 240 I=1,NDIM
C  240        DELT=DELT+AUX(8,I)*ABS(AUX(4,I)-Y(I))
C     IF(DELT-PRMT(4))290,280,250
C

$ -- sys$desadis:RKGST.FOR
```

```
C*** RELATIVE ERROR
C
  230 DELT = 0.
      DO 240 I=1,NDIM
      ARG = ABS(AUX(4,I) + Y(I))
      IF(ARG .EQ. 0.) arg = .25*ABS(AUX(4,I))
      IF(ARG .EQ. 0.) ARG = ERRSET !if here,aux(4,i)=y(i)=0.0; rer=0.
      RER = AUX(8,I)*ABS(AUX(4,I) - Y(I))/ARG
  240 DELT = dMAX1(DELT,RER)
      IF(DELT-PRMT(4)) 280,280,250
C
C*** ERROR IS TOO GREAT
C
  250 IF(IHLF-10)260,360,360
  260 DO 270 I=1,NDIM
  270 AUX(4,I)=AUX(5,I)
C     WRITE(5,1200) DELT
C 1200        FORMAT(' ?RKGST? -- ERROR TOO GREAT',G13.5)
      ISTEP=ISTEP+ISTEP-4
      X=X-H
      IEND=0
      GOTO 130
C
C*** RESULT VALUES ARE GOOD
C
  280 CALL FCT(X,Y,DERY,PRMT)
      DO 290 I=1,NDIM
      AUX(1,I)=Y(I)
      AUX(2,I)=DERY(I)
      AUX(3,I)=AUX(6,I)
      Y(I)=AUX(5,I)
  290 DERY(I)=AUX(7,I)
      CALL FCT(X-H,Y,DERY,PRMT)
      CALL OUTP(X-H,Y,DERY,IHLF,NDIM,PRMT)
      IF(PRMT(5))400,300,400
  300 DO 310 I=1,NDIM
      Y(I)=AUX(1,I)
  310 DERY(I)=AUX(2,I)
      IREC=IHLF
      IF(IEND)320,320,390
C
C*** INCREMENT GETS DOUBLED TO KEEP UP WITH ERROR HALVING
C
  320 IHLF=IHLF-1
      ISTEP=ISTEP/2
      H=H+H
C
C*** ALLOW THE PROGRAM TO EXPAND BEYOND ORIGINAL STEP SIZE SPECIFICATION
C*** UP TO THE MAXIMUM
C
      IF(IHLF+IHLFMX)40,330,330

7 -- sys$desadis:RKGST.FOR
```

```
  330 IMOD=ISTEP/2
      IF(ISTEP-IMOD-IMOD)40,340,40
C
C*** EXPAND H DUE TO LOW ERROR VALUE
C*** ONLY IF TWO CONSECUTIVE STEPS WITHOUT MENTION OF ERROR HAVE
C*** COMPLETED. FACTOR USED FOR EXPANSION (EXPAND) WAS SHOWN TO WORK
C*** REASONABLY WELL FOR A PERIODIC FUNCTION. VALUES AS HIGH AS
C*** EXPAND=.5 WILL PRODUCE GOOD RESULTS FOR MONOTONIC FUNCTIONS.
C
  340 IF(DELT-EXPAND*PRMT(4)) 350,350,40
  350 IHLF=IHLF-1
      ISTEP=ISTEP/2
      H=H+H
      GOTO 40
C
C*** RETURNS TO CALLING PROGRAM
C
  360 IHLF=11
      CALL FCT(X,Y,DERY,PRMT)
      GOTO 390
  370 IHLF=12
      GOTO 390
  380 IHLF=13
  390 CALL FCT(X,Y,DERY,PRMT)
      CALL OUTP(X,Y,DERY,IHLF,NDIM,PRMT)
  400 RETURN
      END
$$$$
```

```
C
C     ...............................................................
C
C        SUBROUTINE RTMI
C
C.....................................................
C
c     This routine was originally supplied by Digital Equipment
c     Corporation as part of the Scientific Subroutine Package
c     available for RT-11 as part of the Fortran Enhancement
c     Package.  It was adapted for use in this package.
c
C.....................................................
C
C        PURPOSE
C           TO SOLVE GENERAL NONLINEAR EQUATIONS OF THE FORM FCT(X)=0
C           BY MEANS OF MUELLER-S ITERATION METHOD.
C
C        USAGE
C           CALL RTMI (X,F,FCT,XLI,XRI,EPS,IEND,IER)
C           PARAMETER FCT REQUIRES AN EXTERNAL STATEMENT.
C
C        DESCRIPTION OF PARAMETERS
C           X      - RESULTANT ROOT OF EQUATION FCT(X)=0.
C           F      - RESULTANT FUNCTION VALUE AT ROOT X.
C           FCT    - NAME OF THE EXTERNAL FUNCTION SUBPROGRAM USED.
C           XLI    - INPUT VALUE WHICH SPECIFIES THE INITIAL LEFT BOUND
C                    OF THE ROOT X.
C           XRI    - INPUT VALUE WHICH SPECIFIES THE INITIAL RIGHT BOUND
C                    OF THE ROOT X.
C           EPS    - INPUT VALUE WHICH SPECIFIES THE UPPER BOUND OF THE
C                    ERROR OF RESULT X.
C           IEND   - MAXIMUM NUMBER OF ITERATION STEPS SPECIFIED.
C           IER    - RESULTANT ERROR PARAMETER CODED AS FOLLOWS
C                      IER=0 - NO ERROR,
C                      IER=1 - NO CONVERGENCE AFTER IEND ITERATION STEPS
C                              FOLLOWED BY IEND SUCCESSIVE STEPS OF
C                              BISECTION,
C                      IER=2 - BASIC ASSUMPTION FCT(XLI)*FCT(XRI) LESS
C                              THAN OR EQUAL TO ZERO IS NOT SATISFIED.
C
C        REMARKS
C           THE PROCEDURE ASSUMES THAT FUNCTION VALUES AT INITIAL
C           BOUNDS XLI AND XRI HAVE NOT THE SAME SIGN. IF THIS BASIC
C           ASSUMPTION IS NOT SATISFIED BY INPUT VALUES XLI AND XRI, THE
C           PROCEDURE IS BYPASSED AND GIVES THE ERROR MESSAGE IER=2.
C
C        SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C           THE EXTERNAL FUNCTION SUBPROGRAM FCT(X) MUST BE FURNISHED
C           BY THE USER.
C

1 -- sys$desadis:RTMI.FOR
```

```
C        METHOD
C           SOLUTION OF EQUATION FCT(X)=0 IS DONE BY MEANS OF MUELLER-S
C           ITERATION METHOD OF SUCCESSIVE BISECTIONS AND INVERSE
C           PARABOLIC INTERPOLATION, WHICH STARTS AT THE INITIAL BOUNDS
C           XLI AND XRI. CONVERGENCE IS QUADRATIC IF THE DERIVATIVE OF
C           FCT(X) AT ROOT X IS NOT EQUAL TO ZERO. ONE ITERATION STEP
C           REQUIRES TWO EVALUATIONS OF FCT(X). FOR TEST ON SATISFACTORY
C           ACCURACY SEE FORMULAE (3,4) OF MATHEMATICAL DESCRIPTION.
C           FOR REFERENCE, SEE G. K. KRISTIANSEN, ZERO OF ARBITRARY
C           FUNCTION, BIT, VOL. 3 (1963), PP.205-206.
C
C     ..................................................................
C
      SUBROUTINE RTMI(X,F,FCT,XLI,XRI,EPS,IEND,IER)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
C
C     PREPARE ITERATION
      IER=0
      XL=XLI
      XR=XRI
      X=XL
      TOL=X
      F=FCT(TOL)
      IF(F)1,16,1
    1 FL=F
      X=XR
      TOL=X
      F=FCT(TOL)
      IF(F)2,16,2
    2 FR=F
      IF(dSIGN(1.D0,FL)+dSIGN(1.D0,FR))25,3,25
C
C     BASIC ASSUMPTION FL*FR LESS THAN 0 IS SATISFIED.
C     GENERATE TOLERANCE FOR FUNCTION VALUES.
    3 I=0
      TOLF=100.*EPS
C
C
C     START ITERATION LOOP
    4 I=I+1
C
C     START BISECTION LOOP
      DO 13 K=1,IEND
      X=.5*(XL+XR)
      TOL=X
      F=FCT(TOL)
      IF(F)5,16,5
    5 IF(dSIGN(1.D0,F)+dSIGN(1.D0,FR))7,6,7

2 -- sys$desadis:RTMI.FOR
```

```
C
C     INTERCHANGE XL AND XR IN ORDER TO GET THE SAME SIGN IN F AND FR
    6 TOL=XL
      XL=XR
      XR=TOL
      TOL=FL
      FL=FR
      FR=TOL
    7 TOL=F-FL
      A=F*TOL
      A=A+A
      IF(A-FR*(FR-FL))8,9,9
    8 IF(I-IEND)17,17,9
    9 XR=X
      FR=F
C
C     TEST ON SATISFACTORY ACCURACY IN BISECTION LOOP
      TOL=EPS
      A=ABS(XR)
      IF(A-1.)11,11,10
   10 TOL=TOL*A
   11 IF(DABS(XR-XL)-TOL)12,12,13
   12 IF(DABS(FR-FL)-TOLF)14,14,13
   13 CONTINUE
C     END OF BISECTION LOOP
C
C     NO CONVERGENCE AFTER IEND ITERATION STEPS FOLLOWED BY IEND
C     SUCCESSIVE STEPS OF BISECTION OR STEADILY INCREASING FUNCTION
C     VALUES AT RIGHT BOUNDS. ERROR RETURN.
      IER=1
   14 IF(dABS(FR)-dABS(FL))16,16,15
   15 X=XL
      F=FL
   16 RETURN
C
C     COMPUTATION OF ITERATED X-VALUE BY INVERSE PARABOLIC INTERPOLATION
   17 A=FR-F
      DX=(X-XL)*FL*(1.+F*(A-TOL)/(A*(FR-FL)))/TOL
      XM=X
      FM=F
      X=XL-DX
      TOL=X
      F=FCT(TOL)
      IF(F)18,16,18
C
C     TEST ON SATISFACTORY ACCURACY IN ITERATION LOOP
   18 TOL=EPS
      A=ABS(X)
      IF(A-1.)20,20,19
   19 TOL=TOL*A
   20 IF(dABS(DX)-TOL)21,21,22

3 -- sys$desadis:RTMI.FOR
```

```
   21 IF(dABS(F)-TOLF)16,16,22
C
C     PREPARATION OF NEXT BISECTION LOOP
   22 IF(DSIGN(1.D0,F)+dSIGN(1.D0,FL))24,23,24
   23 XR=X
      FR=F
      GO TO 4
   24 XL=X
      FL=F
      XR=XM
      FR=FM
      GO TO 4
C     END OF ITERATION LOOP
C
C
C     ERROR RETURN IN CASE OF WRONG INPUT DATA
   25 IER=2
      RETURN
      END
####
```

```
      PROGRAM SDEGADIS2
C
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C     Program description:
C
C     SDEGADIS2 is a simplification of DEGADIS2 which performs the downwind
C     dispersion portion of the calculation for a steady state source
C     described by DEGADIS1.
C
C
C     Program usage:
C
C     Consult Volume III of the Final Report to U. S. Coast Guard
C     contract DT-CG-23-80-C-20029 entitled 'Development of an
C     Atmospheric Dispersion Model for Heavier-than-Air Gas Mixtures'.
C
C     J. A. Havens
C     T. O. Spicer
C
C     University of Arkansas
C     227 Engineering Building
C     Department of Chemical Engineering
C     Fayetteville, AR 72701
C
C     April 1985
C
C
C     This project was sponsored by the U. S. Coast Guard and the Gas
C     Research Institute under contract DT-CG-23-80-C-20029.
C
C
C     Disclaimer:
C
C     This computer code material was prepared by the University of
C     Arkansas as an account of work sponsored by the U. S. Coast Guard
C     and the Gas Research Institute.  Neither the University of Arkansas,
C     nor any person acting on its behalf:
C
C     a.  Makes any warranty or representation, express or implied,
C         with respect to the accuracy, completeness, or usefulness
C         of the information contained in this computer code material,
C         or that the use of any apparatus, method, numerical model,
C         or process disclosed in this computer code material may not
C         infringe privately owned rights; or
C
C     b.  Assumes any liability with respect to the use of, or for
C         damages resulting from the use of, any information,
C         apparatus, method, or process disclosed in this computer

1 -- sys$degadis:SDEGADIS2.FOR
```

```
C         code material.
C
C
C*************************************************************************
C*************************************************************************
C*************************************************************************
C
C
C
C


      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS2.dec'
      include '($ssdef)'
C
C
      EXTERNAL PSS,PSSOUT,SSG,SSGOUT
C
C
      COMMON
     $/TITL/ TITLE
     $/GEN2/ DEN(5,isen)
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_error/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/ITI/ TI,TINP,TSRC,TOBS
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/ERROR/ SYOER,ERRP,SMXP,WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,
     $ WTRUH,WTDHG
     $/STP/ STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/com_ss/ ESS,SLEN,SWID,OUTCc,OUTSZ,OUTB,OUTL,swcl,swal,senl,srhl
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_fl/ cflag,clfl,cufl
     $/MEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
     $/COM_SURF/ HTCUT
C
C
C     DIMENSIONS/DECLARATIONS
C
      logical cflag

      real*4 tt1
      REAL*8 K,ML,L
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      character*24 tinp,tsrc,tobs
      character*80 title(4)

C -- sys$desadis:SDEGADIS2.FOR
```

```
      character*4 pound
      character*3 sas_name
C
      character*4 TR2,ER2,Sr3,SSD,TR3
C
      character*40 opnrup1
      character opnrup(40)
      EQUIVALENCE (OPNRUP(1),opnrup1)
C
      dimension prmt(22),w(4),dery(4),aux(8,4)
C
C.....................................................
C
C     DATA
C
      DATA POUND/'//  '/,POUNDN/-1.E-20/
C
      DATA TIME0/0./,NDIM/0/
C
      DATA TR2/'.TR2'/,ER2/'.ER2'/
      DATA Sr3/'.Sr3'/
      DATA SSD/'.SSD'/,TR3/'.TR3'/
C
C
C.....................................................
C
C     MAIN
C
      T1 = SECNDS(0.)
      istat = lib$date_time(TOBS)
      if(istat .ne. ss$_normal) stop'lib$date_time failure'
C
C*** GET THE FILE NAME FOR FILE CONTROL
C
      read(5,1135) nchar,opnrup
 1135 format(q,40a1)
C
      opnrup1 = opnrup1(1:nchar) // ER2(1:4)
      CALL ESTRT2ss(OPNRUP1)
C
C*** GET THE COMMON VARIABLES CARRIED FROM DEGADIS1
C
      opnrup1 = opnrup1(1:nchar) // tr2(1:4)
      CALL STRT2(OPNRUP1,H_masrte)
C
      opnrup1 = opnrup1(1:nchar) // sr3(1:4)
      OPEN(UNIT=8,TYPE='NEW',NAME=OPNRUP1,
     $ CARRIAGECONTROL='FORTRAN')
C
      cflag = isofl.eq. 1.or. ihtfl.eq. 0
C

3 -- sys$desadis:SDEGADIS2.FOR
```

```
      WRITE(8,1119)
      if(cflag) then
              WRITE(8,1116) (100.*gas_lfl),(100.*gas_ufl),gas_zsp
              WRITE(8,1118)
      else
              WRITE(8,1115) (100.*gas_lfl),(100.*gas_ufl),gas_zsp
              WRITE(8,1117)
              endif
      WRITE(8,1119)
c
C
C
 1115 FORMAT(1H0,1X,'Distance',2x,3x,'Mole',3x,
     1       'Concentration',1x,'Density',2x,3x,'Gamma',4x,
     1       'Temperature',3x,'Half',4x,4x,'Sz',5x,4x,'Sy',5x,
     1       1x,'Width to',3x,'Width',/,1x,11x,1x'Fraction',2x,
     1       11x,11x,11x,11x,3x,'Width',3x,11x,9x,
     1       2(1pg9.3,'mole%',1x),/,1h ,
     1       99x,4x,'at z= ',0pf6.2,' m')
 1116 FORMAT(1H0,1X,'Distance',2x,3x,'Mole',3x,
     1       'Concentration',1x,'Density',2x,
     1       'Temperature',3x,'Half',4x,4x,'Sz',5x,4x,'Sy',5x,
     1       1x,'Width to',3x,'Width',/,1x,11x,1x'Fraction',2x,
     1       11x,11x,11x,3x,'Width',3x,11x,9x,
     1       2(1pg9.3,'mole%',1x),/,1h ,
     1       98x,4x,'at z= ',0pf6.2,' m')
 1117 FORMAT(1H ,4X,'(m)',4x,11x,
     1       2(1X,'(kg/m**3)',1x),12x,4x,'(K)',
     1       5(8X,'(m)'))
 1118 FORMAT(1H ,4X,'(m)',4x,11x,
     1       2(1X,'(kg/m**3)',1x),4x,'(K)',
     1       5(8X,'(m)'))
 1119 FORMAT(1H )
C
C
C
C.....................................................
C
C     STEADY STATE CALCULATIONS
C
C
      opnrup1 = opnrup1(1:nchar) // ssd(1:4)
c     OPEN(UNIT=9,TYPE='NEW',NAME=OPNRUP1)
C
C
      AGAIN = .FALSE.
C
C
      L = OUTL
      B = OUTB
      SZO = OUTSZ

4 -- sys$desadis:SDEGADIS2.FOR
```

```
      Erate = ESS
      QSTR0 = Erate/2./L/B
      Cc = OUTCc
      wc = swc1
      wa = swa1
      enth = senl
      rho = srhl
c
      call setden(wc,wa,enth)
c
 200  if(cflag) then
             call adiabat(2,twc,twa,gas_lfl,ya,clfl,r,w,t,tt)
             call adiabat(2,twc,twa,gas_ufl,ya,cufl,r,w,t,tt)
             endif
      ratio1= u0*z0/alpha1/ z0**alpha1 * cc /b/qstr0/l
      ratio = ratio1* sz0**alpha1 * (B + sqrtpi/2.*sy0er)
      if(ratio.le. 1.) then
             sy0er = (1./(ratio1*sz0**alpha1) - b)*2./sqrtpi
      else
             sz0 = (1./((B+ sqrtpi/2.*sy0er)*ratio1))**(1./alpha1)
      endif
      if(cc.gt. rhoe) then
             write(lunlog,1126) cc,rhoe
 1126        format(/,' ',10('****'),/,' cc: ',1pg13.5,' is greater',
     1        ' than rhoe: ',1pg13.5,/,' ',10('****'),/)
             cc =rhoe
             endif
C
      cclay = cc/dellay
      call adiabat(0,wclay,walay,yclay,yalay,cclay,rholay,w,enthlay,t)
c
C
C*** let everyone know
C
      WRITE(lunlog,1170) L,B
      WRITE(lunlog,1180) QSTR0,SZ0
      write(lunlog,1185) wclay,walay,rholay,cclay,t
      write(lunlog,1186) wc,wa,rho,cc,temp
c
 1170 FORMAT(' LENGTH: ',1pG13.5,' BEFF: ',1pG13.5)
 1180 FORMAT(' TAKEUP FLUX: ',1pG13.5,' SZ0: ',1pG13.5)
 1185 format(' wclay: ',1pg12.5,' walay: ',1pg12.5,
     1        ' rholay: ',1pg12.5,' Cclay: ',1pg12.5,/,
     1        ' temlay: ',1pg13.5)
 1186 format(' wc: ',1pg12.5,'  wa: ',1pg13.5,/,
     1        ' rho: ',1pg12.5,' Cc: ',1pg12.5,' temp: ',1pg12.5)
C
C*** PREPARE FOR STEADY STATE INTEGRATION.
C
      PRMT(1) = L/2.
      PRMT(2) = 6.023E13

5 -- sys$desadis:SDESADIS2.FOR
```

```
      PRMT(3) = STPP
      PRMT(4) = ERRP
      PRMT(5) = SMXP
      PRMT(6) = Erate
      PRMT(7) = Cc     ! OUTPUT
      PRMT(8) = B      ! OUTPUT
C
C*** PRMT(9) & PRMT(10) ARE CONSTANTS FOR D(SY) & D(SZ)
C
      PRMT(9) = Ce*sqrt(G*Z0/ALPHA1*GAMMAF) *GAMMAF/U0
      PRMT(10)= Z0**ALPHA*K*USTAR*ALPHA1 * ALPHA1/U0
C     PRMT(11)= NREC
C     PRMT(12)=
C     PRMT(13)=
      prmt(18)= u0*z0/alpha1
      prmt(19)= rhoa*k*ustar*alpha1
      prmt(20)= rholay
      prmt(21)= sz0
      prmt(22)= sz0
C
      Y(1) = rholay*prmt(18)*(SZ0/z0)**alpha1 ! rholay*ueff*heff
      Y(2) = SY0ER
      Y(3) = B + sqrtpi/2.*sy0er
      Y(4) = 0.                          ! added heat
C
      DERY(1) = WTSZP
      DERY(2) = WTSYP
      DERY(3) = WTBEP
      dery(4) = wtdh
C
      NDIM = 4
C
      WRITE(lunlog,1130)
 1130 FORMAT('  Entering Integration Step -- B > 0. ')
C
C*** PERFORM INTEGRATION
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,PSS,PSSOUT,AUX)
C
      IF(IHLF .GE. 10) CALL trap(9,IHLF)
C
      NREC = INT(PRMT(11))
      WRITE(lunlog,1100)NREC
 1100 FORMAT(3X,'NUMBER OF RECORDS IN PSS = 'I10)
C
      IF(AGAIN) GO TO 120
C
C*** GAUSIAN COMPLETION OF THE INTEGRATION
C
C*** PSSOUT FORCES THE ABOVE INTEGRATION TO FINISH WHEN B<0 FOR THE
C***  FIRST TIME. THE STEP BEFORE THIS OCCURS IS RECORDED ON UNIT 7.

6 -- sys$degadis:SDEGADIS2.FOR
```

```
C***  THE STEP WHEN B GOES NEGATIVE IS CURRENTLY IN Y.
C
C*** THE CALCULATION METHOD CHANGES THE CURRENT VALUE OF SY TO A VALUE
C***  CALCULATED AS IF BEFF=SY RETAINING THE LAST VALUE OF Cc IN THE
C***  MATERIAL BALANCE.
C
      heat = Y(4)
      rholay = prmt(20)
      Cc = PRMT(7)
      rhouh = Y(1)
      SZ = ( rhouh/rholay/prmt(18) )**(1./alphai) * z0
      SYT = Erate*ALPHA1 *(Z0/SZ)**ALPHA/U0/SZ/Cc/SQRTPI
C
      XT = PRMT(12)
      XV = (SYT/RT2/DELTA)**(1./BETA) - XT
C
C*** SET UP INTEGRATION FOR THE GAUSSIAN DISPERSION PHASE.
C
      do i=1,22
      prmt(i) = 0.
      enddo
c
      PRMT(1) = XT
      PRMT(2) = 6.023E23
      PRMT(3) = STPG
      PRMT(4) = ERRG
      PRMT(5) = SMXG
      PRMT(6) = Erate
      PRMT(7) = Cc              !-- OUTPUT
      PRMT(8) = XV
C     PRMT(9) = 'BLANK'
C     PRMT(10)= 'BLANK'
C     PRMT(11)= 'BLANK'
C     PRMT(12)= DIST AT COMPLETION -- OUTPUT
C
      prmt(18) = u0*z0/alphai
      prmt(19) = rhoa*k*ustar*alphai
      prmt(20) = rholay
      prmt(21) = sz
      prmt(22) = sz
c
      Y(1) = rhouh
      Y(2) = heat
C
      DERY(1) = utruh
      dery(2) = utdhs
C
      NDIM = 2
C
      WRITE(lunlog,1140)
 1140 FORMAT(' Entering Gaussian Stage of Integration ')

? -- sys$desadis:SDEGADIS2.FOR
```

```
C
C*** PERFORM INTEGRATION
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,SSG,SSGOUT,AUX)
C
      IF(IHLF .GE. 10) CALL trap(10,IHLF)
C
      NREC = INT(PRMT(11))
C
  120 CONTINUE
C
C
C.....................................................................
C
C     CLOSE(UNIT=9)
      CLOSE(UNIT=8)
C
      opnrup1 = opnrup1(1:nchar) // tr3(1:4)
      CALL TRANS(OPNRUP1)
C
      tt1 = t1
      T1 = SECNDS(tT1)/60.
      WRITE(lunlog,4000) TOBS
      WRITE(lunlog,4010) T1
 4000 FORMAT(//,'SDEGADIS2 -->',//,3X,'BEGAN AT ',A40)
 4010 FORMAT(3X,'*** ELAPSED TIME *** ',1PG13.5,' min')
C
      STOP
      END
****
```

```
C.....................................................
C
C     TIME SORT SUPERVISOR
C
      SUBROUTINE SORTS(TABLE)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

c
      include 'sys$desadis:DEGADIS3.dec/list'
C
      COMMON
     $/SORT/ TCc(maxnob,maxnt),TCcSTR(maxnob,maxnt),
     $        Tyc(maxnob,maxnt),Trho(maxnob,maxnt),
     $        Tgamma(maxnob,maxnt),Ttemp(maxnob,maxnt),
     $         TSY(maxnob,maxnt),TSZ(maxnob,maxnt),TB(maxnob,maxnt),
     $         TDISTO(maxnob,maxnt),TDIST(maxnob,maxnt),KSUB(maxnt)
     $/SSCON/ NREC(maxnob,2),TO(maxnob),XV(maxnob)
     $/SORTIN/ TIM(maxnt),NTIM,ISTRT
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/CNOBS/ NOBS
C
      DIMENSION TABLE(1)
C
      REAL*8 ML,K
C
      CALL GETTIM
C
C
C*** TABLE(I) VALUES
C***  I             PARAMETER
C***   --             ---------
C***  1  11          DIST            1 TO 10 CURRENT READ
C***  2  12          Yc
C***  3  13          Cc              11 TO 20 PREVIOUS READ
C***  4  14          rho
C***  5  15          gamma
C***  6  16          temp
C***  7  17          SZ
C***  8  18          SY
C***  9  19          B
C***  10 20          TS
C
C***  21             DISTO
C***  22             INTERPOLATION FRACTION
C
      DO 100 I = 1,NOBS
C
      IT = 0
C
      DO 105 J=1,20

1 -- sys$desadis:SORTS.FOR
```

```
  105 TABLE(J) = 0.
C
      II = NREC(I,1)

      if( ii .eq. 0) goto 130
C
C*** read first record
C
      read(9,*) (table(k1),k1=1,9)
      table(10) = ts( t0(I), table(1) )
      table(21) = table(1)
C
C*** loop through and read each record even if not pertinent
C
      DO 110 J = 2,II
C
              DO K1 = 1,10
              KK = K1 + 10
              TABLE(KK) = TABLE(K1)
              enddo
C
      READ(9,*) (TABLE(K1),K1=1,9)
      TABLE(10) = TS( T0(I), TABLE(1) )
C
      it1 = int( (table(10)-tim(1)) / (tim(2)-tim(1)) + 0.9999999 )
      it1 = min( ntim, it1)
      itf = int( (table(20)-tim(1)) / (tim(2)-tim(1)) + 0.9999999 ) + 1
      itf = max( 1, itf)

      do it = itf, it1, 1             ! do all points in range
C
C*** RECORD AN INTERPOLATED TIME SORTED POINT.
C
      KSUB(IT) = KSUB(IT) + 1
C
      TABLE(22) = (TIM(IT) - TABLE(20))/(TABLE(10) - TABLE(20))
C
      TDIST0(I,IT) = TABLE(21)
      TDIST(I,IT)  = TABLE(11) + (TABLE(1) - TABLE(11)) * TABLE(22)
      Tyc(I,IT)    = TABLE(12) + (TABLE(2) - TABLE(12)) * TABLE(22)
      TCc(I,IT)    = TABLE(13) + (TABLE(3) - TABLE(13)) * TABLE(22)
      Trho(I,IT)   = TABLE(14) + (TABLE(4) - TABLE(14)) * TABLE(22)
      Tgamma(I,IT) = TABLE(15) + (TABLE(5) - TABLE(15)) * TABLE(22)
      Ttemp(I,IT)  = TABLE(16) + (TABLE(6) - TABLE(16)) * TABLE(22)
      TSZ(I,IT)    = TABLE(17) + (TABLE(7) - TABLE(17)) * TABLE(22)
      TSY(I,IT)    = TABLE(18) + (TABLE(8) - TABLE(18)) * TABLE(22)
      TB(I,IT)     = TABLE(19) + (TABLE(9) - TABLE(19)) * TABLE(22)
C
      enddo
  110   CONTINUE
C

2 -- sys$desadis:SORTS.FOR
```

```
C
  130 II = NREC(I,2)
      IF(II .EQ. 0) GO TO 100

      DO 200 J=1,II
C
              DO K1 = 1,10
              KK = K1 + 10
              TABLE(KK) = TABLE(K1)
              enddo
C
      READ(9,*) (TABLE(K1),K1=1,7)
C
      TABLE(8) = RT2*DELTA*(TABLE(1) + XV(I))**BETA
      TABLE(9) = 0.
      TABLE(10) = TS(T0(I),TABLE(1))
C
      itl = int( (table(10)-tim(1)) / (tim(2)-tim(1)) + 0.9999999 )
      itl = min( ntim, itl)
      itf = int( (table(20)-tim(1)) / (tim(2)-tim(1)) + 0.9999999 ) + 1
      itf = max( 1, itf)

      do it = itf, itl, 1             ! do all points in range
C
C*** RECORD A TIME SORTED VALUE
C
      KSUB(IT) = KSUB(IT) + 1
      TABLE(22) = (TIM(IT) - TABLE(20))/(TABLE(10) - TABLE(20))
C
      TDIST0(I,IT) = TABLE(21)
      TDIST(I,IT)  = TABLE(11) + (TABLE(1) - TABLE(11)) * TABLE(22)
      Tvc(I,IT)    = TABLE(12) + (TABLE(2) - TABLE(12)) * TABLE(22)
      TCc(I,IT)    = TABLE(13) + (TABLE(3) - TABLE(13)) * TABLE(22)
      Trho(I,IT)   = TABLE(14) + (TABLE(4) - TABLE(14)) * TABLE(22)
      Tgamma(I,IT) = TABLE(15) + (TABLE(5) - TABLE(15)) * TABLE(22)
      Ttemp(I,IT)  = TABLE(16) + (TABLE(6) - TABLE(16)) * TABLE(22)
      TSZ(I,IT)    = TABLE(17) + (TABLE(7) - TABLE(17)) * TABLE(22)
      TSY(I,IT)    = TABLE(18) + (TABLE(8) - TABLE(18)) * TABLE(22)
      TB(I,IT)     = TABLE(19) + (TABLE(9) - TABLE(19)) * TABLE(22)
C
      enddo
  200 CONTINUE
C
  100 CONTINUE
C
      CALL SORTS1(TABLE)
C
      RETURN
      END
$$$$


3 --, sys$desadis:SORTS.FOR
```

```
C.....................................................
C
C
      SUBROUTINE SORTS1(TABLE)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

c
      include 'sys$desadis:DEGADIS3.dec/list'
C
      COMMON
     $/SORT/TCc(maxnob,maxnt),TCcSTR(maxnob,maxnt),
     $       Tyc(maxnob,maxnt),Trho(maxnob,maxnt),
     $       Tgamma(maxnob,maxnt),Ttemp(maxnob,maxnt),
     $       TSY(maxnob,maxnt),TSZ(maxnob,maxnt),TB(maxnob,maxnt),
     $       TDIST0(maxnob,maxnt),TDIST(maxnob,maxnt),KSUB(maxnt)
     $/SSCON/NREC(maxnob,2),T0(maxnob),XV(maxnob)
     $/SORTIN/TIM(maxnt),NTIM,ISTRT
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ccm_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flag
     $/CNOBS/NOBS
C
      DIMENSION TABLE(1)
C
      REAL*8 ML,K
C
C*** DETERMINE IF ANY TIME VECTORS HAVE NO ENTRIES
C
      DO 192 I=1,NTIM
  192 IF(KSUB(I).GT. 2) GO TO 194     ! 1or2 points is of little value
      call trap(23)
  194 ISTRT = I
      DO 196 I=ISTRT,NTIM
  196 IF(KSUB(I).LE. 2) GO TO 198
      GO TO 199
  198 NTIM = I - 1
  199 CONTINUE
C
C*** REVERSE TIME SORTED VECTORS
C
      DO 200 K1 = ISTRT,NTIM
C
      II = KSUB(K1)
      DO 170 J = 1,NOBS
C
      IF(TDIST(J,K1).NE.0. .OR. TB(J,K1).NE.0.) GO TO 180
  170   CONTINUE
  180   II = II + J - 1
C
      DO 190 J = 1,II

1 -- sys$desadis:SORTS1.FOR
```

```
C
      TABLE(II +        + 1 - J) =    TCc(J,K1)
      TABLE(II +   NOBS + 1 - J) =    Tyc(J,K1)
      TABLE(II + 2*NOBS + 1 - J) =   Trho(J,K1)
      TABLE(II + 3*NOBS + 1 - J) = Tsigma(J,K1)
      TABLE(II + 4*NOBS + 1 - J) =  Ttemp(J,K1)
      TABLE(II + 5*NOBS + 1 - J) =    TSY(J,K1)
      TABLE(II + 6*NOBS + 1 - J) =    TSZ(J,K1)
      TABLE(II + 7*NOBS + 1 - J) =     TB(J,K1)
      TABLE(II + 8*NOBS + 1 - J) = TDISTO(J,K1)
      TABLE(II + 9*NOBS + 1 - J) =  TDIST(J,K1)
C
  190   CONTINUE
C
      DO 210 J = 1,II
C
         TCc(J,K1) = TABLE(J)
         Tyc(J,K1) = TABLE(J +   NOBS)
        Trho(J,K1) = TABLE(J + 2*NOBS)
      Tsigma(J,K1) = TABLE(J + 3*NOBS)
       Ttemp(J,K1) = TABLE(J + 4*NOBS)
         TSY(J,K1) = TABLE(J + 5*NOBS)
         TSZ(J,K1) = TABLE(J + 6*NOBS)
          TB(J,K1) = TABLE(J + 7*NOBS)
      TDISTO(J,K1) = TABLE(J + 8*NOBS)
       TDIST(J,K1) = TABLE(J + 9*NOBS)
C
  210 CONTINUE
  200 CONTINUE
C
C
      if(sigx_flag.eq. 0.) then              ! no correction
C
              write(lunlog,*) ' No X-direction dispersion correction'
              DO 220 K1 = ISTRT,NTIM
              II = KSUB(K1)
              DO 220 I = 1,II
              TCcSTR(I,K1) = TCc(i,k1)
  220         CONTINUE
              return
              endif
C
C*** GENERATE TCcSTR -- CENTER LINE CONCENTRATION CORRECTED FOR
C***  DOWNWIND DISPERSION.
C
      DO 230 K1 = ISTRT,NTIM
C
      II = KSUB(K1)
      DO 240 I = 1,II
C
c calculation for XP = TDIST(I,K1)

2 -- sys$desadis:SORTS1.FOR
```

```
c
      TCcSTR(I,K1) = 0.
C
      DO 260 J = 1,II
C
      TABLE(J) = 0.
c     DIST = TDIST(J,K1) + RMAX
      DIST = TDIST(J,K1) - Tdist0(J,K1)
      delta = ABS(tdist(i,k1) - tdist(j,k1))
c
      if(dist.lt. sisx_min_dist) then
              if(i.eq. j) then        ! i.e. delta = 0.
                      table(j) = (tdist(j+1,k1)- tdist(j-1,k1))/2.
                      if(j.eq.1)table(j)= (tdist(2,k1)- tdist(1,k1))/2.
                      if(j.eq. ii)table(j)=tdist(ii,k1)- tdist(ii-1,k1)
                      table(j) = TCc(j,k1) / table(j) * RT2*SQRTPI
                      endif
              goto 260
              endif
c
      SX = sisx_coeff* DIST**sisx_pow
C
      ARG = (delta/SX)**2/2.
C
      IF(ARG .EQ. 0.) TABLE(J) = TCc(J,K1)/SX
      IF(ARG .NE. 0. .AND. ARG .LE. 80.)
     $                  TABLE(J) = TCc(J,K1)/SX/EXP(ARG)
C
  260   CONTINUE
C
      III = KSUB(K1)
      TCcSTR(I,K1) = TABLE(1)* (TDIST(2,K1)- TDIST(1,K1))/2.
      TCcSTR(I,K1) = TABLE(iii)* (TDIST(iii,K1)- TDIST(iii-1,K1))
      1                                          + TCcSTR(I,K1)
      iii = ksub(k1) - 1
C
      DO 280 J = 2,III
C
      TCcSTR(I,K1) = TABLE(J)* (TDIST(J+1,K1)- TDIST(J-1,K1))/2.
      1                                          + TCcSTR(I,K1)
C
  280   CONTINUE
c
      TCcSTR(I,K1) = TCcSTR(I,K1)/RT2/SQRTPI
c
c*** correct yc, rho, and temp values
c
              cc = Tccstr(i,k1)
      if(isofl.eq. 1 .or. ihtfl.eq. 0) then
              call adiabat(0,wc,wa,yc,ya,cc,rho,wm,enth,temp)
      else

3 -- sys$desadis:SORTS1.FOR
```

```
                enth = Tgamma(i,K1)
                call adiabat(-1,wc,wa,yc,ya,cc,rho,wa,enth,temp)
        endif
        Tyc(i,K1) = yc
        Trho(i,K1)= rho
C
  240   CONTINUE
C
  230   CONTINUE
C
        RETURN
        END
****
```

```
C     SOURCE EQUATIONS -- Gas Blanket present

      SUBROUTINE SRC1(time,Y,D,PRMT)


      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS1.dec'

      parameter(      delt= 0.1,
     1                delto2= delt/2.,
     2                zero= 1.e-20,
     3                rcrit= 0.002)

      COMMON
     $/GEN1/ ET(2,isen),R1T(2,isen)
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtmb,wtUH,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/vucom/ vua,vub,vue,vud,vudelta,vuflag
     $/com_enthal/ h_masrte,h_airrte,h_watrte
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin

      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      logical vuflag

      REAL*8 ML,K
      REAL*8 L,masrte,mole
      INTEGER R,mass,massc,massa,ebal,mbal
      DIMENSION Y(7),D(7),PRMT(25)
      DATA R/1/,mass/2/,massc/3/,massa/4/,ebal/5/,mbal/6/


      if( prmt(20).lt. 0.D0) vuflag = .false.

      if(Y(mass) .le. 0.D0) then
              wc = dmax1(prmt(15),1.d-10)
              if(wc.gt. 1.) wc=1.d-10
              wa = 1. - wc
              enthalpy = wc*h_masrte          ! air contributes nothing
      else
              wc = Y(massc)/Y(mass)
              wa = Y(massa)/Y(mass)
              enthalpy = Y(ebal)/Y(mass)
      endif


1 -- sys$desadis:SRC1.FOR
```

```
      call tprop(1,wc,wa,enthalpy,yc,ya,mole,temp,rho,cp)

      RADP = AFGEN(R1T,TIME,'R1TSRC')
      hei   = Y(mass)/pi/Y(r)/Y(r)/rho
      hei   = dmax1( Y(mass)/pi/Y(r)/Y(r)/rho , 0.D0 )
      delrho = rho-rhoa
      gprime = g*delrho/rhoa *hei

C*** CALCULATE D(R),airrte,vel

      D(R) = 0.
      vel = 0.
      airrte = 0.
      Ri = 0.
      D(mbal)  = 0.

      IF(Gprime.GT. 0.) then
         slump = Ce*sqrt(Gprime)

         if(vuflag) then              ! momentum balance
              iii = 0          ! initialize loop counter
              vel = prat(14)           ! old velocity value
              velmin = 0.
              velmax= dmax1( slump, 0.1D0, vel)

 100          hh = vel*vel/Ce/Ce/g/ (delrho/rhoa)
              rh = Y(r)-vua*vub*hh
              value = Y(r)**2/rh**2

                 if(prat(25).ge. prat(24)) then       ! hh .ge. ht

              ht = 2.*(value*hei - vua*hh*(value-1.)) - hh
              velc = Y(mbal)/(0.4*pi*rho*(2./3.*ht + hh)*rh**3/Y(r)
     1           + 2./3.*pi*vua*rho*hh* (Y(r)**2 - rh*rh*rh/Y(r))
     2           + vue*pi*Y(r)*hei**2*rhoa)
              D(mbal) = pi*g*delrho*Y(r)*ht**2
     1           - vua*vud*pi*rhoa*Y(r)*hh*vel**2
                 else

              ht = value*hei - vua*hh*(value-1.)
              velc = Y(mbal)/(2./3.*pi*rho*ht*rh**3/Y(r)
     1           + 2./3.*pi*vua*rho*hh* (Y(r)**2 - rh*rh*rh/Y(r))
     2           + vue*pi*Y(r)*hei**2*rhoa)
              D(mbal) = pi*g*delrho*(rh*ht**2 + vua*vub*hh*hh*hh)
     1           - vua*vud*pi*rhoa*Y(r)*hh*vel**2
                 endif

              dif = abs(vel-velc)             ! convergence check
              sum = abs(vel) + abs(velc) + zero

                 if(dif/sum .le. rcrit) then

2 -- sys$degadis:SRC1.FOR
```

```
                        vel = (vel+velc)/2.
                        prmt(13) = vel

                            if(vel .gt. 0.) then
                                Ri = gprime / vel**2
                    airrte= 2.*pi* epsilon/Ri *rhoa*Y(r)*hei* vel
                                D(r) = vel
                                prmt(20) = slump
                            endif
                        else

                            dif = vel-velc

                            if(velc.lt.velmin) velmin= dmin1(velc, 0.D0)
                            if(velc.gt.velmax) velmax=velc

                            if(dif .gt. 0.) then
                                velmax = vel
                                vel = 0.5D0*(velmax-velmin) + velmin
                            else
                                velmin = velc
                                vel = (1.D0-0.5D0)*(velmax-velmin) + velmin
                            endif

                            iii = iii+1
                            if(iii .gt. 40) stop'SRC1 velocity loop'
                            goto 100
                        endif

                    else

                        vel= slump      ! gravity slumping
                        hh = hei
                        ht = hei
                        Ri = gprime / vel**2
                        airrte= 2.*pi* epsilon/Ri *rhoa*Y(r)*hei* vel
                        D(r) = vel
                    endif
                endif

C
                IF(delrho.Lt.delrhomin .and. .not.(check2 .or. u0.eq.0.))
                1       D(R) = 0. ! not for HSE types or no wind cases
C
                area = pi * (Y(r)**2 - radp**2)
                IF(Y(R).LT. RADP) THEN
                        AREA = 0.
                        Y(R) = RADP
                        IF(time.gt. delto2) then ! delt; num prob
                                D(R) = dmax1(0.D0,
                1                       ((AFGEN(R1T,TIME+delto2,'R1TSRD')-

T -- sys$desadis:SRC1.FOR
```

```
     2                       AFGEN(R1T, (TIME-delto2),'R1TSRe'))/ delt))
             else
                     D(R) = dmax1(0.D0,
     1                       ((AFGEN(R1T,delto2,'R1TSRD')-
     2                       AFGEN(R1T, 0.,'R1TSRe'))/ delto2))
             endif
     ENDIF
C
C    calculate totrteout
C
     masrte = AFGEN(ET,TIME,'src1')
     L = SQRTPI * Y(R)
C
     cc = wc*rho
C
C
     astrmx = 0.
     if(u0 .ne. 0.)
     1   astrmx = cc*K*USTAR*ALPHA1*dellay/(dellay-1.)/phihat(rho,L)
C
C
C
     astrll = astrmx * L*L
     totrteout = astrll/wc
C
C    surface effects
C
     watrte = 0.
     surface_a = 0.
     call surface(temp,hei,rho,mole,cp,watrte,surface_a)
     surface_a = area * surface_a
     if(surface_a.lt. 0.) surface_a = 0. ! don't let the cloud cool
     watrte = area * watrte
C
 500 totrtein  = airrte + masrte + watrte
C
     IF(totrtein.lt.totrteout .and. .not.check2
     1               ) then  ! check2 is True for HSE type spills
             D(R) = 0.
             totrtein  = airrte + masrte + watrte
             endif
C
C    CALCULATE D(mass),D(massc),D(massa),D(anything left)
C
     D(mass)  = totrtein - totrteout
     D(massc) = masrte - astrll
     D(massa) = airrte/(1.+humid) - wa/wc*astrll
     D(ebal)  = 0.
     if(ihtfl.ne. 0) ! equivalent to adiabatic mixing from TPROP for ihtfl=0
     1       D(ebal)  = h_masrte*masrte + h_airrte*airrte
     1               + h_watrte*watrte - enthalpy*totrteout + surface_a

4 -- sys$desadis:SRC1.FOR
```

```
c
c
            uheff = qstrmx*L/cc
      sz = 0.
      if(u0 .ne. 0.) sz = ( uheff*alpha1/u0/z0 )**(1./alpha1) * z0
c
c
C
      PRMT(6) = QSTRMX
      prmt(7) = sz
      prmt(8) = hei
      prmt(9) = rho
      prmt(10)= Ri
      prmt(11)= yc
      prmt(12)= ya
      prmt(13)= D(r)
      prmt(16) = wc
      prmt(17) = wa
      prmt(18) = enthalpy
      prmt(19) = temp
      prmt(21) = qasrte
      prmt(22) = ht
      prmt(23) = hh
      RETURN
      END
c
c
C.....................................................
C
C     SUBROUTINE FOR OUTPUT FROM SOURCE in the presence of a Blanket
C
      SUBROUTINE SRC1O(TIME,Y,DERY,IHLF,NDIM,PRMT)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      include 'sys$degadis:DEGADIS1.dec'
C
      COMMON
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtmb,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfser,epsilon
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl,swcl,swal,senl,srhl
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/ALP/ ALPHA,alpha1
C
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      DIMENSION Y(6),DERY(6),PRMT(25)

5 -- sys$degadis:SRC1.FOR
```

```
      DIMENSION CURNT(iout_src),BKSP(iout_src),OUTP(iout_src)
C
      DATA I/0/,III/0/
      DATA EMAX/0./,tlast/0./
C
      REAL*8 ML,K
      INTEGER R,mass,massc,massa,ebal
      DATA R/1/,mass/2/,massc/3/,massa/4/,ebal/5/
C
      data nrec1/0/
C
      I = I + 1
      III = III + 1
C
      astr = prmt(6)
      sz = prmt(7)
      hei = prmt(8)
      rho = prmt(9)
      Ri  = prmt(10)
      uc = prmt(11)
      ua = prmt(12)
      vel = prmt(13)
      prmt(14) = vel
      if(vel .gt. prmt(20)) prmt(20) = -prmt(20)
      prmt(15) = prmt(16)     ! wc
      wc = prmt(16)
      cc = wc * rho
      ua = prmt(17)
      enthalpy = prmt(18)
      temp = prmt(19)
      prmt(24) = prmt(22)     ! ht
      prmt(25) = prmt(23)     ! hh
C
      IF(hei .Le. 0.0) GO TO 1000
C
      QSAV = PI*Y(R)*Y(R)*astr
      IF(QSAV .LT. EMAX) GO TO 110
      EMAX = QSAV
      RM = Y(R)
      SZM = SZ
  110   CONTINUE
      RMAX = dMAX1(RMAX,Y(R))
C
      IF(hei .Le. srccut) GO TO 1000
      if(cc .le. cclow .and. u0 .eq. 0.) goto 1000    ! no wind
      if(time.gt.tend+1. .and. u0.eq.0. .and. vel.eq.0.)goto 1000!no wind LNG
C
      IF(I .NE. 1) GO TO 115
      CURNT(1) = TIME
      CURNT(2) = Y(R)
      CURNT(3) = hei

ó -- sys$desadis:SRC1.FOR
```

```
      CURNT(4) = astr
      CURNT(5) = sz
      CURNT(6) = wc
      CURNT(7) = wa
      CURNT(8) = rho
      CURNT(9) = ri
      CURNT(10)= wc
      CURNT(11)= wa
      CURNT(12)= enthalpy
      CURNT(13)= temp
      III = 1
      GO TO 125
  115 IF(I .EQ. 0) RETURN
C
      DO 116 II=1,iout_src
  116 BKSP(II) = CURNT(II)
C
      CURNT(1) = TIME
      CURNT(2) = Y(R)
      CURNT(3) = hei
      CURNT(4) = astr
      CURNT(5) = sz
      CURNT(6) = wc
      CURNT(7) = wa
      CURNT(8) = rho
      CURNT(9) = ri
      CURNT(10)= wc
      CURNT(11)= wa
      CURNT(12)= enthalpy
      CURNT(13)= temp
C
      ERM = 0.
      erass = 0.
      DO 120 II=2,iout_src
      div = curnt(ii)
      if(div .eq. 0.) div = srcoer
      ER1 = ABS( (CURNT(II)-BKSP(II))/div )
      ER2 = ABS( (CURNT(II)-OUTP(II))/div )
      if(II.ne.3 .and. ii.ne.9 .and. ii.ne.12 .and. ii.ne.7 .and. ii.ne.11)
     1       erass = dMAX1(ER1,ER2,ERMss) ! ex hei,QSTR,Ri,enth,wa,ya for SS
  120 ERM = dMAX1(ER1,ER2,ERM)
C
      if(check4) then                  ! steady state
             if( .not. (vel.eq. 0..and.time.gt.srcss)) goto 124
  122                check3 = .true.
                     outcc = wc * rho
                     swc1 = wc
                     swa1 = wa
                     srh1 = rho
                     sen1 = enthalpy
                     out1  = sqrtpi * Y(r)

7 -- sys$degadis:SRC1.FOR
```

```
                    Qstar = prmt(21)/pi/Y(r)**2
          if(u0.ne. 0.) sz = (alphai/u0/z0*Qstar*outl/outcc)**(1./alphai) * z0
                    outsz = sz
                    outb  = outl/2.
                    goto 1000

  124           if(ermss .gt. srcoer) goto 125

                if( time-tlast .gt. srcss) goto 122
          return
                endif
C
      IF(ERM .LT. SRCOER) RETURN
C
  125 CONTINUE
      tlast = time
      DO 130 II=1,iout_src
      IF(III.EQ.1) BKSP(II) = CURNT(II)
  130 OUTP(II) = BKSP(II)
C
      III = 0
      NREC1 = NREC1 + 1
      WRITE(9,2000) (OUTP(II),II=1,iout_src)
      RETURN
C
 1000   CONTINUE
      I = -1
      IF(TIME .GE. TEND) CHECK3 = .TRUE.
      NREC1 = NREC1 + 1
      WRITE(lunlos,1100)
      WRITE(lunlos,*) Hei,TIME
      TSC1 = TIME
      if(hei .le. 0.) then
                hei = 0.
                y(r) = dmin1(rmax,y(r))
                endif
      WRITE(9,2000)
      1       TIME,Y(R),hei,qstr,sz,yc,ya,rho,ri,wc,wa,enthalpy,temp
      WRITE(lunlos,1110) NREC1
C
      PRMT(5) = 1.
C
      RETURN
 1100   FORMAT(5X,'VALUE OF Hei AT SOURCE TERMINATION -- @ TIME')
 1110   FORMAT(5X,'NUMBER OF LINES -->  ',I8)
 2000 format(1pe16.9,1x,1pe16.9,<iout_src-2>(1x,1pe13.6))
      END
####



 @ -- sys$desadis:SRC1.FOR
```

```
      SUBROUTINE SRTOUT(OPNRUP)
C
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$degadis:DEGADIS3.dec/list'
C
      COMMON /SORT/TCc(maxnob,maxnt),TCcSTR(maxnob,maxnt),
     $        Tyc(maxnob,maxnt),Trho(maxnob,maxnt),
     $        Tgamma(maxnob,maxnt),Ttemp(maxnob,maxnt),
     $        TSY(maxnob,maxnt),TSZ(maxnob,maxnt),TB(maxnob,maxnt),
     $        TDIST0(maxnob,maxnt),TDIST(maxnob,maxnt),KSUB(maxnt)
     $/SORTIN/TIM(maxnt),NTIM,ISTRT
     $/com_gprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/com_sigx/ sigx_coeff,sigx_pow,sigx_min_dist,sigx_flag
     $/alp/ alpha,alpha1
C
      logical cflag,cflag1
C
      character*3 gas_name
      character*40 OPNRUP
C
      OPEN(UNIT=8,TYPE='NEW',NAME=OPNRUP,CARRIAGECONTROL='FORTRAN')
C
      WRITE(8,1100)
      if(sigx_flag.eq. 0.) then
              write(8,1102)
      else
              write(8,1104)
              write(8,1105) sigx_coeff,sigx_pow,sigx_min_dist
              endif
C
      cflag = isofl.eq. 1.or. ihtfl.eq. 0
      cflag1= isofl.eq.1
      if(cflag) then
              call adiabat(2,wc,wa,gas_lfl,ya,cc_lfl,r,w,t,tt)
              call adiabat(2,wc,wa,gas_ufl,ya,cc_ufl,r,w,t,tt)
              endif
C
      DO 110 I=ISTRT,NTIM
C
      WRITE(8,1119)
      WRITE(8,1119)
      WRITE(8,1110) TIM(I)
      if(cflag1) then
              WRITE(8,1116) (100.*gas_lfl),(100.*gas_ufl),gas_zsp
              WRITE(8,1118)
      else
              WRITE(8,1115) (100.*gas_lfl),(100.*gas_ufl),gas_zsp

1 -- sys$degadis:SRTOUT.FOR
```

```
            WRITE(8,1117)
            endif
      WRITE(8,1119)
      ip = 0
      II = KSUB(I)
c
      DO 120 J=1,II
c
      cc    = tccstr(J,i)
      rho   = Trho(J,i)
      yc    = Tyc(J,i)
      temp  = Ttemp(J,i)
      gamma = Tgamma(J,i)
      b     = tb(J,i)
      sz    = tsz(J,i)
      sy    = tsy(J,i)
      blf1  = 0.
      buf1  = 0.
c
      if(.not.cflag) then
            call adiabat(-2,wc,wa,gas_lfl,ya,cc_lfl,r,w,gamma,tt)
            call adiabat(-2,wc,wa,gas_ufl,ya,cc_ufl,r,w,gamma,tt)
            endif
c
      arg = (gas_zsp/sz)**alpha1
      if(arg .ge. 80.) goto 600
c
      ccz = cc/exp(arg)
      if(ccz .lt. cc_lfl) then
            if(cflag1) then
      WRITE(8,1120) TDIST(J,I),yc,Cc,rho,temp,B,SZ,SY
                  else
      WRITE(8,1120) TDIST(J,I),yc,Cc,rho,gamma,temp,B,SZ,SY
                  endif
            goto 600
            endif
      arg = -(dlog(cc_lfl/cc) + (gas_zsp/sz)**alpha1)
      blf1 = sqrt(arg)*sy + b
c
      if(ccz .lt. cc_ufl) then
            if(cflag1) then
      WRITE(8,1120) TDIST(J,I),yc,Cc,rho,temp,B,SZ,SY,blf1
                  else
      WRITE(8,1120) TDIST(J,I),yc,Cc,rho,gamma,temp,B,SZ,SY,blf1
                  endif
            goto 600
            endif
      arg = -(dlog(cc_ufl/cc) + (gas_zsp/sz)**alpha1)
      buf1 = sqrt(arg)*sy + b
            if(cflag1) then
      WRITE(8,1120) TDIST(J,I),yc,Cc,rho,temp,B,SZ,SY,blf1,buf1

2 -- sys$disk:[dis]SRTOUT.FOR
```

```
                    else
      WRITE(8,1120) TDIST(J,I),yc,Cc,rho,gamma,temp,B,SZ,SY,blfl,bufl
                    endif
C
  600 continue
      ip = ip + 1
      if(ip .eq. 3) then
              ip = 0
              write(8,1119)
              endif
  120 CONTINUE
  110 CONTINUE
C
      CLOSE(UNIT=8)
C
C
 1100 FORMAT(1H0,5X,'Sorted values for each specified time.')
 1102 format(1H0,5x,'X-Direction correction was NOT applied.')
 1104 format(1H0,5x,'X-Direction correction was applied.')
 1105 format(1h ,5x,5x,'Coefficient:      ',1pg13.5,/,
     1       1h ,5x,5x,'Power:            ',1pg13.5,/,
     1       1h ,5x,5x,'Minimum Distance: ',1pg13.5' m')
 1110 FORMAT(1H0,5X,'Time after beginning of spill ',G14.7,' sec')
 1115 FORMAT(1H0,1X,'Distance',2x,3x,'Mole',3x,
     1       'Concentration',1x,'Density',2x,3x,'Gamma',3x,
     1       'Temperature',3x,'Half',4x,4x,'Sz',5x,4x,'Sy',5x,
     1       1x,'Width to',3x,'Width',/,1x,11x,1x'Fraction',2x,
     1       11x,11x,11x,11x,3x,'Width',3x,11x,9x,
     1       2(1pg9.3,'mole%',1x),/,1h ,
     1       99x,4x,'at z= ',0pf6.2,' m')
 1116 FORMAT(1H0,1X,'Distance',2x,3x,'Mole',3x,
     1       'Concentration',1x,'Density',2x,
     1       'Temperature',3x,'Half',4x,4x,'Sz',5x,4x,'Sy',5x,
     1       1x,'Width to',3x,'Width',/,1x,11x,1x'Fraction',2x,
     1       11x,11x,11x,3x,'Width',3x,11x,9x,
     1       2(1pg9.3,'mole%',1x),/,1h ,
     1       88x,4x,'at z= ',0pf6.2,' m')
 1117 FORMAT(1H ,4X,'(m)',4x,11x,
     1       2(1X,'(kg/m**3)',1x),11x,4x,'(K)',
     1       5(3X,'(m)'))
 1118 FORMAT(1H ,4X,'(m)',4x,11x,
     1       2(1X,'(kg/m**3)',1x),4x,'(K)',
     1       5(3X,'(m)'))
 1119 FORMAT(1H )
 1120 FORMAT(1H ,3(1X,1PG9.3,1X),2x,0pf7.4,2x,1X,1PG10.3,1X,
     1       6(1X,1PG9.3,1X))
C
      RETURN
      END
$$$$
```

```
3 -- sys$desadis:SRTOUT.FOR
```

```
C.....................................................
C
C
      SUBROUTINE SSG(DIST,Y,D,PRMT)

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

C
      DIMENSION Y(1),D(1),PRMT(1)
C
      include 'sys$desadis:DEGADIS2.dec'
c
      parameter (zero=1.D-10, rcrit=2.5D-3)
c
      COMMON
     $/PARM/U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
c
      REAL*8 K,ML
C
      INTEGER rhouh,dh
      DATA rhouh/1/,dh/2/
C
C*** PRMT(I) I/O
C***  I            VALUE           IN/OUT
C***   --          -----           ------
C***  6              E               IN
C***  7              Cc              OUT
C***  8              XV(I)           IN
C***  9              T0(I)           IN
C***  10             -               -
C***  11             NREC(I,2)       OUT -- STARTS OUTPUT UNIT=9
C***  12             DIST            OUT
c***  13             sz
c***  14             yc              out
c***  15             rho             out
c***  16             temp            out
c***  17             gamma           out
c***  18
c***  19
c***  20             rholay
c***  21             sz
C
      XV1 = PRMT(8)
      SY = RT2*DELTA*(DIST + XV1)**BETA
      Erate = PRMT(6)
c
c
      sz0 = prmt(22)

1 -- sys$desadis:SSG.FOR
```

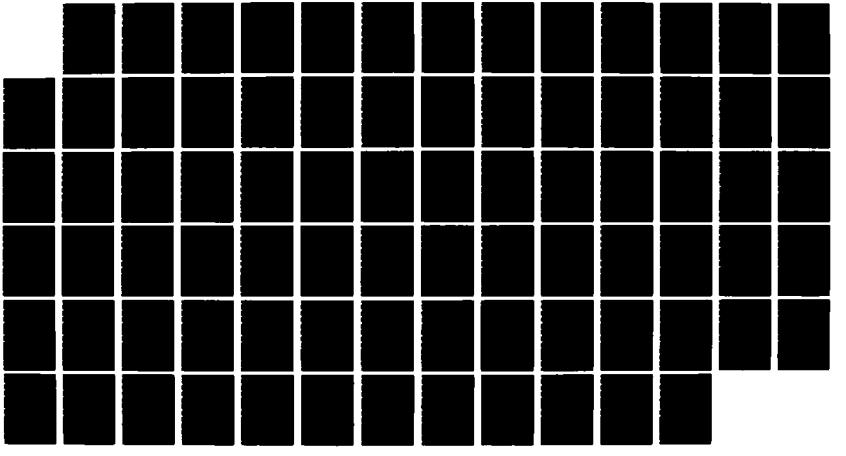
```
      sz = sz0
C
C*** MATERIAL BALANCE
C
      iii = 0
 100  Cc = Erate*ALPHA1*(Z0/SZ)**ALPHA/U0/SZ/SQRTPI/SY
c
      call adiabat(0,wc,wa,yc,ya,cc,rho,wm,enth,temp)
      cclay = cc/dellay
      call adiabat(0,wc,wa,yclay,ya,cclay,rholay,wml,enth,temlay)
      call addheat(cclay,Y(dh),rholay,temlay,cp)
      prod = dmax1( Y(rhouh)/rholay/prmt(18), zero)
      sz = ( prod ) **(1./alpha1) * z0
      dif = abs(sz - sz0)/(abs(sz)+abs(sz0)+zero)
      if(dif.gt. rcrit) then
              iii = iii+1
              if(iii.gt. 20) call trap(33)
              sz0 = sz
              goto 100
              endif
      prmt(20) = rholay
      prmt(21) = sz
      HEFF = GAMMAF*SZ/ALPHA1
      rit = 0.
c
      temp = temlay
      if(isofl.eq.0 .or. ihtfl.ne.0) then
              rho = dellay*(rholay-rhoa) + rhoa        ! estimate
              temp = (wm/rho)*(rholay*temlay/wml)      ! estimate
              rit = rift(temp,ieff)
              endif
C
      RISTR = RIF(RHO,HEFF)
      PHI = PHIF(RISTR,rit)
C
      d(rhouh) = prmt(19)/phi
      heigh = heff*dellay
      call surface(temlay,heigh,rholay,wml,cp,watrte,arte)
      if(temp.ge. tsurf .or. temlay.ge. tamb) arte = 0.
      d(dh) = ( arte/dellay-Y(dh)*D(rhouh) )/Y(rhouh)
C
      PRMT(7) = Cc
      PRMT(12) = DIST
      prmt(14) = yc
      prmt(15) = rho
      prmt(16) = temp
      prmt(17) = (rholay-rhoa)/cclay
      RETURN
      END
####

2 -- sys$desadis:SSG.FOR
```

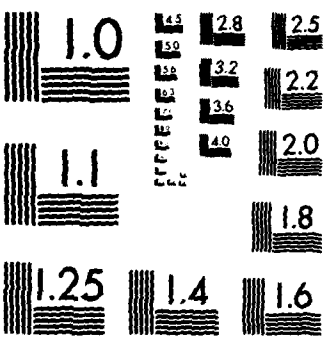
```
C.....................................................
C
      SUBROUTINE SSGOUT(X,Y,D,IHLF,NDIM,PRMT)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS2.dec'
c
      parameter (nssg=7, zero=1.e-10)
c
      DIMENSION Y(1),D(1),PRMT(1),BKSP(nssg),OUT(nssg),CURNT(nssg)
C
      COMMON
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/STP/ STPO,STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/STOPIT/ TSTOP
c
      REAL*8 K,ML
C
C*** PARAMETER OUTPUT
C
C***  FROM SSG                    OUTPUT TO MODEL
C***  --------                    ---------------
C***  X                       DIST
C***  PRMT(7)                 Cc
C***  Y(1)                    SZ
c***  prmt(14)                yc
c***  prmt(15)                rho
C***  prmt(16)                temp
c***  prmt(17)                gamma
C
      ERM = 0.
      T01 = PRMT(9)
      TSL = TS(T01,X)
      prmt(22) = prmt(21)     ! sz
C
      IF(PRMT(11) .NE. 0.) GO TO 90
C
C*** STARTUP FOR OUTPUT ROUTINE
C
      RII = -100./STPG
      RI = 0.
      CURNT(1) = X
      curnt(2) = prmt(14)     ! yc
      CURNT(3) = PRMT(7)      ! cc
      curnt(4) = prmt(15)     ! rho
      curnt(5) = prmt(17)     ! gamma
      curnt(6) = prmt(16)     ! temp
      CURNT(7) = prmt(21)     ! sz

1 -- sys$desadis:SSGOUT.FOR
```

```
C
   90 CONTINUE
C
C*** RECORD THE CURRENT AND PREVIOUS RECORDS
C
      RI = RI + 1.
C
      DO 100 II=1,nsss
 100  bksp(II) = curnt(II)
C
      CURNT(1) = X
      curnt(2) = prmt(14)      ! yc
      CURNT(3) = PRMT(7)       ! cc
      curnt(4) = prmt(15)      ! rho
      curnt(5) = prmt(17)      ! samma
      curnt(6) = prmt(16)      ! temp
      CURNT(7) = prmt(21)      ! sz
C
C*** stop integration when cc<cclow and time is satisfied
C
      IF(PRMT(7).LT.CcLOW .AND. TSL.GE.TSTOP) GO TO 1000
C
C*** CHECK FOR OUTPUT
C
      DO 110 II=3,nsss
      ER1 = ABS( (CURNT(II)-BKSP(II))/(CURNT(II)+zero) )
      ER2 = ABS( (CURNT(II)-OUT(II))/(CURNT(II)+zero) )
  110 ERM = dMAX1(ER1,ER2,ERM)
C
C*** OUTPUT RECORD IF ODLG IS EXCEEDED OR 100 METERS SINCE LAST OUTPUT
C
      DX = CURNT(1) - OUT(1)
      IF( RI.NE.1. .AND. ERM.LT.ODLG .AND. DX.LE.ODLLG) RETURN
C
C*** RECORD THE LAST POINT TO BE UNDER THE ERROR CRITERIA. IN CASE
C*** THE FIRST POINT AFTER A RECORD EXCEEDS THE ERROR BOUND, RECORD
C*** THAT POINT AS WELL.
C
      DO 120 II=1,nsss
      IF(RI .EQ. RII+1.) BKSP(II) = CURNT(II)
  120 OUT(II) = BKSP(II)
C
      RI = RII
      PRMT(11) = PRMT(11) + 1.
C
      WRITE(9,*) (OUT(II),II=1,nsss)
      RETURN
C
 1000 CONTINUE
C
C*** STOP INTEGRATION

2 -- sys$desadis:SSGOUT.FOR
```

AD-A171 524 DEVELOPMENT OF AN ATMOSPHERIC DISPERSION MODEL FOR HEAVIER-THAN-AIR GAS M... (U) ARKANSAS UNIV FAYETTEVILLE DEPT OF CHEMICAL ENGINEERING J A HAVENS ET AL. MAY 85 3/3

UNCLASSIFIED USCG-D-24-85 DTCG23-80-C-20029 F/G 20/4 NL





```
C
      PRMT(12) = X
      TSTOP = TSL
      PRMT(11) = PRMT(11) + 1.
      WRITE(9,*) (CURNT(II),II=1,nsss)
C
      PRMT(5) = 1.
C
      RETURN
      END
$$$$
```

```
C.....................................................................
C
      SUBROUTINE SSGOUT(X,Y,D,IHLF,NDIM,PRMT)
c
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      parameter (nsss=9, zero=1.e-10)
C
      DIMENSION Y(1),D(1),PRMT(1),BKSP(nsss),OUT(nsss),CURNT(nsss)
C
      include 'sys$desadis:DEGADIS2.dec/list'
c
      COMMON
     $/PARM/UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/STP/STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/ALP/ALPHA,alphal
C
c
      REAL*8 ML,K
C
C*** PARAMETER OUTPUT
C
C***  FROM SSG                    OUTPUT TO MODEL
C***  --------                    ---------------
C***  X                         DIST
C***  PRMT(7)                   Cc
C***  Y(1)                      SZ
C***  PRMT(8)                   XV
C
      ERM = 0.
      prmt(22) = prmt(21)
C
      IF(PRMT(11) .NE. 0.) GO TO 90
C
C*** STARTUP FOR OUTPUT ROUTINE
C
      RII = -100./STPG
      RI = 0.
      CURNT(1) = X
      CURNT(2) = PRMT(14)      ! yc
      CURNT(3) = prmt(7)       ! cc
      CURNT(4) = PRMT(15)      ! rho
      curnt(5) = prmt(17)      ! gamma
      curnt(6) = prmt(16)      ! temp
      curnt(7) = 0.0           ! b
      curnt(8) = prmt(21)      ! sz
      curnt(9) = rt2*delta*(x+prmt(8))**beta  ! sy
C
   90 CONTINUE
C

1 -- sys$desadis:SSGOUTSS.FOR
```

```
C*** RECORD THE CURRENT AND PREVIOUS RECORDS
C
      RI = RI + 1.
C
      DO 100 II=1,nsss
  100 BKSP(II) = CURNT(II)
      CURNT(1) = X
      CURNT(2) = PRMT(14)      ! yc
      CURNT(3) = prmt(7)       ! cc
      CURNT(4) = PRMT(15)      ! rho
      curnt(5) = prmt(17)      ! sames
      curnt(6) = prmt(16)      ! temp
      curnt(7) = 0.0           ! b
      curnt(8) = prmt(21)      ! sz
      curnt(9) = rt2*delta*(x+prmt(8))**beta  ! sy
C
C*** STOP INTEGRATION WHEN Cc < CcLOW
C
      IF(PRMT(7).LT.CcLOW) GO TO 1000
C
C*** CHECK FOR OUTPUT
C
      DO 110 II=2,nsss
      if(ii.eq.7) goto 110
      ER1 = ABS( (CURNT(II)-BKSP(II))/(CURNT(II)+zero) )
      ER2 = ABS( (CURNT(II)-OUT(II))/(CURNT(II)+zero) )
  110 ERM = dMAX1(ER1,ER2,ERM)
C
C*** OUTPUT RECORD IF ODLG IS EXCEEDED OR 100 METERS SINCE LAST OUTPUT
C
      DX = CURNT(1) - OUT(1)
      IF( RI.NE.1. .AND. ERM.LT.ODLG .AND. DX.LE.ODLLG) RETURN
C
C*** RECORD THE LAST POINT TO BE UNDER THE ERROR CRITERIA. IN CASE
C*** THE FIRST POINT AFTER A RECORD EXCEEDS THE ERROR BOUND, RECORD
C*** THAT POINT AS WELL.
C
      DO 120 II=1,nsss
      IF(RI .EQ. RII+1.) BKSP(II) = CURNT(II)
  120 OUT(II) = BKSP(II)
C
      RI = RII
      PRMT(11) = PRMT(11) + 1.
C
      call ssout(out)
      RETURN
C
 1000 CONTINUE
C
C*** STOP INTEGRATION
C

2 -- sys$desadis:SSGOUTSS.FOR
```

```
      PRMT(12) = X
      PRMT(11) = PRMT(11) + 1.
C
      call ssout(curnt)
C
      PRMT(5) = 1.
C
      RETURN
      END
####
```

```
      subroutine ssout(out)
c
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      dimension out(9)
c
      common
     $/com_sprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/com_fl/ cflag,clfl,cufl
     $/alp/ alpha,alpha1
c
      character*3 gas_name
c
      data ip/0/
c
      logical cflag
c
c
      dist = out(1)
      vc = out(2)
      cc = out(3)
      rho = out(4)
      gamma = out(5)
      temp = out(6)
      b = out(7)
      sz = out(8)
      sy = out(9)
c
      if(.not.cflag) then
              call adiabat(-2,vc,va,gas_lfl,ya,clfl,r,w,gamma,tt)
              call adiabat(-2,vc,va,gas_ufl,ya,cufl,r,w,gamma,tt)
              endif
c
      arg = (gas_zsp/sz)**alpha1
      if(arg .ge. 80.) goto 600
c
      ccz = cc/exp(arg)
      if(ccz .lt. clfl) then
              if(cflag) then
      WRITE(8,1120) DIST,vc,Cc,rho,temp,B,SZ,SY
                        else
      WRITE(8,1125) DIST,vc,Cc,rho,gamma,temp,B,SZ,SY
                        endif
              goto 600
              endif
      arg = -(dlog(clfl/cc) + (gas_zsp/sz)**alpha1)
      blfl = sqrt(arg)*sy + b
c
      if(ccz .lt. cufl) then

1 -- sys$degadis:SSOUT.FOR
```

```
              if(cflag) then
        WRITE(8,1120) DIST,yc,Cc,rho,temp,B,SZ,SY,blfl
                      else
        WRITE(8,1125) DIST,yc,Cc,rho,gamma,temp,B,SZ,SY,blfl
                      endif
              goto 600
              endif
        arg = -(dlog(cufl/cc) + (gas_zsp/sz)**alpha1)
        bufl = sqrt(arg)*sy + b
              if(cflag) then
        WRITE(8,1120) DIST,yc,Cc,rho,temp,B,SZ,SY,blfl,bufl
                      else
        WRITE(8,1125) DIST,yc,Cc,rho,gamma,temp,B,SZ,SY,blfl,bufl
                      endif
C
  600 continue
        ip = ip + 1
        if(ip .eq. 3) then
              ip = 0
              write(8,1119)
              endif
C
C
 1119 FORMAT(1H )
 1120 FORMAT(1H ,11(1X,1PG9.3,1X))
 1125 FORMAT(1H ,3(1X,1PG9.3,1X),2x,0PF7.4,2x,1X,1PG10.3,1X,
     1       6(1X,1PG9.3,1X))
C
        return
        end
****
```

C -- sys$desadis:SSOUT.FOR

```
C.....................................................
C
C     PSEUDO-STEADY STATE SUPERVISOR
C
      SUBROUTINE SSSUP(H_masrte)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DESADIS2.dec/nolist'
C
      COMMON
     $/GEN3/ rads(2,maxl),gstr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/SSCON/ NREC(maxnob,2),TO(maxnob),XV(maxnob)
     $/GEN1/ ET(2,isen),R1T(2,isen)
     $/sen2/ den(5,isen)
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/ERROR/SYOEP,ERRO,SZOER,WTAIO,WTQOO,WTSZO,ERRP,SMXP,
     $ WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,ERTDNF,ERTUPF,WTRUH,WTDHG
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/STP/ STPO,STPP,ODLP,ODLLP,STPG,ODLG,ODLLG
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/ALP/ ALPHA,alphal
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
     $/STOPIT/ TSTOP
     $/CNOBS/ NOBS
C
      REAL*8 K,ML,L
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      logical pup,pdn
C
      character*3 sas_name
C
      EXTERNAL PSS,PSSOUT,SSG,SSGOUT,OB,OBOUT
C
      DIMENSION PRMT(22),Y(5),DERY(5),AUX(8,5)
C
      DATA RTOT/0./
C
C

      R = AFGEN(RADG,0.0,'RADG')
      TO1 = TOOB(R,0.0)
      XEND = AFGEN(RADG,TEND,'RADG')
      TOF = TOOB(-XEND,TEND)
C
      DTOB = (TOF-TO1)/FLOAT(NOBS+1)

1 -- sys$desadis:SSSUP.FOR
```

```
      T01 = T01 + DTOB
C
C
      DO 120 I = 1,NOBS
C
C*** RESET AGAIN
C
      AGAIN = .FALSE.
C
      T0(I) = DTOB*float(I-1) + T01
      pup = .true.
      pdn = .true.
C
C*** IF(XEND .GT. XIT(TEND,T0(I))) -- IS
C***  TRUE WHEN THE SOURCE WILL TERMINATE BEFORE THE OBSERVER
C***  CAN REACH THE DOWNWIND EDGE.
C
      IF(XEND .GT. XIT(TEND,T0(I))) then
              pdn = .false.
              TDOWN = TEND
              end if
C
C*** IF(XIT(0.0,T0(I)) .gt. -R) -- IS
C***  TRUE WHEN THE SOURCE WILL begin after THE OBSERVER
C***  has passed THE DOWNWIND EDGE @ t=0.0
C
      R = AFGEN(RADG,0.0,'RADG')
      IF(t0(i).le.0. .and. XIT(0.0,T0(I)).gt.-R) then
              pup = .false.
              TUP = 0.0
              endif
C
      if(pup) TUP = TUPF(T0(I))
      if(pdn) TDOWN = TDNF(T0(I))
C
      XDOWN = XIT(TDOWN,T0(I))
      XUP = XIT(TUP,T0(I))
      WRITE(lunlog,1160) TUP,XUP,TDOWN,XDOWN
C
C*** SET UP INTEGRATION PARAMETERS FOR EACH OBSERVER.
C
      do ijk=1,22
      prmt(ijk) =0.
      enddo
      do ijk=1,5
      y(ijk) = 0.
      dery(ijk)= 0.
      do ijkl=1,8
      aux(ijkl,ijk) = 0.
      enddo
      enddo

2 -- sys$desadis:SSSUP.FOR
```

```
c
      PRMT(1) = TUP
      PRMT(2) = TDOWN
      PRMT(3) = STPO
      PRMT(4) = ERRO
      PRMT(5) = dMAX1(1.D0,(TDOWN-TUP)/50.D0)
      PRMT(6) = T0(I)
      prmt(7) = xup
      PRMT(13)= XDOWN - XUP
C
      Y(1) = 0.
      Y(2) = sz0er     ! Hrate
c     Y(3) = SZOER
      y(3) = sz0er     ! Crate
      y(4) = 0.
      y(5) = sz0er*H_masrte    ! Hrate
C
      DERY(1) = WTAIO
      DERY(2) = WTQOO
      DERY(3) = WTSZO
      DERY(4) = 1.
      DERY(5) = 1.
C
      NDIM = 4
      if(isofl.eq. 0 .and. ihtfl.ne. 0) ndim=5
C
C*** PERFORM INTEGRATION.
C
      WRITE(lunlog,1120) I
 1120 FORMAT(/,'  Entering Observer Integration Step for Observer # ',
     $I3)
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,OB,OBOUT,AUX)
C
      IF(IHLF .GE. 10) CALL trap(8,IHLF)
c
      write(lunlog,1125)
 1125 format(' ',10x,'Observer Integration complete...')
c
c
      cclay = prmt(14)
      cc = cclay*dellay
      uclay = prmt(15)
      ualay = prmt(16)
      enthlay=prmt(17)
      rholay = prmt(18)

      call setden(uclay,ualay,enthlay)
      if(isofl.eq. 1) goto 200
      do iii= 1,isen
      if(den(1,iii) .gt. 1.) then

3 -- sys$desadis:[SSSUP.FOR
```

```
                ii = iii+1
                rholay = den(3,iii-1)
                temlay = den(5,iii-1)
                if(ii .gt. isen .or. iii.le.3) call trap(2)
                cc = cclay*dellay
        if(cc.gt. rhoe) then
                write(lunlog,1126) cc,rhoe
 1126           format(/,' ',10('****'),/,' cc: ',1pg13.5,' is greater',
        1        ' than rhoe: ',1pg13.5,/,' ',10('****'),/)
                cc =rhoe
                endif
                rho = cc*(rholay-rhoa)/cclay + rhoa
                wc = cc/rho
                w2 = den(2,iii-2)/den(3,iii-2)
                w1 = den(2,iii-1)/den(3,iii-1)
                slope = (wc-w1)/(w2-w1)
                Yc= dmax1(1.D0, slope*(den(1,iii-2)-den(1,iii-1))+den(1,iii-1))
                den(1,iii) = Yc
                den(2,iii) = cc
                den(3,iii) = rho
                if(den(3,iii-2).ne. den(3,iii-1)) then
                slope = (1./rho-1./den(3,iii-1))/
        1               (1./den(3,iii-2)-1./den(3,iii-1))
                den(4,iii) = slope*(den(4,iii-2)-den(4,iii-1))+den(4,iii-1)
                den(4,iii) = dmax1(h_nasrte,den(4,iii))
                den(5,iii) = slope*(den(5,iii-2)-den(5,iii-1))+den(5,iii-1)
                den(5,iii) = dmax1(gas_temp,den(5,iii))
                else
                        den(4,iii) = den(4,iii-1)
                        den(5,iii) = den(5,iii-1)
                        endif
                temp = den(5,iii)
                den(1,ii) = 2.  ! end-of-record
C       if(cc.gt. rhoe) call trap(31)
                goto 200
                endif
        enddo
C
 200    L = XDOWN - XUP
        B = Y(1)
        AREA = B*L
        QSTR0 = Y(3)/area
        sz0 = (qstr0*L/cc * alpha1/u0/z0)**(1./alpha1) * z0
C
        ratio1= u0*z0/ALPHA1/ Z0**ALPHA1 *Cc /B/qstr0/L
        ratio = ratio1* sz0**alpha1 * (B + sqrtpi/2.*sy0er)
        if(ratio.le. 1.) then
                sy0er = (1./(ratio1*sz0**alpha1) - B)*2./sqrtpi
        else
                sz0 = (1./((B+ sqrtpi/2.*sy0er)*ratio1))**(1./alpha1)
        endif

$ -- sys$desadis:SSSUP.FOR
```

```
      Erate = 2.*astr0*L*b
      IF(Cc .GT. RHOE) then
              WRITE(lunlog,1180) QSTR0,SZ0,Cc
              call trap(30)
              endif
C
C*** SHOW THE OPERATOR WHAT IS GOING ON
C
      WRITE(lunlog,1160) TUP,XUP,TDOWN,XDOWN
      WRITE(lunlog,1170) AREA,L,B
      WRITE(lunlog,1180) QSTR0,SZ0,sy0er
      write(lunlog,1185) wclay,walay,rholay,cclay,temlay
      write(lunlog,1186) wc,rho,cc,temp
 1160 FORMAT(/,' TUP: ',1pG13.5,' XUP: ',1pG13.5,' TDOWN: ',
     $ 1pG13.5,' XDOWN: ',1pG13.5)
 1170 FORMAT(' AREA: ',1pG13.5,' LENGTH: ',1pG13.5,' B: ',1pG13.5)
 1180 FORMAT(' TAKEUP FLUX: ',1pG12.5,' SZ0: ',1pG12.5,
     $ ' sy0: ',1pg12.5)
 1185 format(' wclay: ',1pg12.5,' walay: ',1pg12.5,
      1        ' rholay: ',1pg12.5,' Cclay: ',1pg12.5,/,
      1        ' temlay: ',1pg13.5)
 1186 format(' wc: ',1pg12.5,
      1        ' rho: ',1pg12.5,' Cc: ',1pg12.5,' temp: ',1pg12.5)
C
C*** PREPARE FOR PSEUDO-STEADY STATE INTEGRATION.
C
      do ijk=1,22
      prmt(ijk) =0.
      enddo
      do ijk=1,5
      y(ijk) = 0.
      dery(ijk)= 0.
      do ijkl=1,8
      aux(ijkl,ijk) = 0.
      enddo
      enddo
C
      PRMT(1) = XDOWN
      PRMT(2) = 6.023E23
      PRMT(3) = STPP
      PRMT(4) = ERRP
      PRMT(5) = SMXP
      PRMT(6) = Erate
      PRMT(7) = Cc     ! -- OUTPUT
      PRMT(8) = B      ! -- OUTPUT
C
C*** PRMT(9) & PRMT(10) ARE CONSTANTS FOR D(SY) & D(SZ)
C
      PRMT(9) = Ce*sqrt(G*Z0/ALPHA1*GAMMAF)*GAMMAF/U0
      PRMT(10)= Z0**ALPHA*K*USTAR*ALPHA1*ALPHA1/U0
      PRMT(11)= NREC(I,1)

$ -- sys$desadis:SSSUP.FOR
```

```
C     PRMT(12)= DIST AT COMPLETION -- OUTPUT
      PRMT(13)= T0(I)
c     prmt(14)= yc    ! output
c     prmt(15)= rho   ! output
c     prmt(16)= temp  ! output; not recorded if isofl=1
c     prmt(17)= gamma ! output; not recorded if isofl=1 .or. ihtfl=0
      prmt(18)= u0*z0/alpha1
      prmt(19)= rhoa*k*ustar*alpha1
      prmt(20)= rholay
      prmt(21)= sz0
      prmt(22)= sz0
C
      Y(1) = rholay*prmt(18)*(SZ0/z0)**alpha1          ! rho*ueff*heff
      Y(2) = SY0ER
      Y(3) = B + sqrtpi/2.*sy0er
      y(4) = 0.                ! added heat
C
      DERY(1) = WTSZP
      DERY(2) = WTSYP
      DERY(3) = WTBEP
      dery(4) = WTDH
C
      NDIM = 4
C
      WRITE(lunlog,1130)
 1130 FORMAT('  Entering Integration Step -- B > 0. ')
C
C*** PERFORM INTEGRATION
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,PSS,PSSOUT,AUX)
C
      IF(IHLF .GE. 10) CALL trap(9,IHLF)
C
      NREC(I,1) = INT(PRMT(11))
      WRITE(lunlog,1100) NREC(I,1),T0(I)
 1100 FORMAT(3X,'NUMBER OF RECORDS IN PSS = 'I10,' FOR T0='1pg13.5)
C
      IF(AGAIN) GO TO 119
C
C*** GAUSIAN COMPLETION OF THE INTEGRATION
C
C*** PSSOUT FORCES THE ABOVE INTEGRATION TO FINISH WHEN B<0 FOR THE
C***  FIRST TIME. THE STEP BEFORE THIS OCCURS IS RECORDED ON UNIT 7.
C***  THE STEP WHEN B GOES NEGATIVE IS CURRENTLY IN Y.
C
C*** THE CALCULATION METHOD CHANGES THE CURRENT VALUE OF SY TO A VALUE
C***  CALCULATED AS IF BEFF=sqrtpi*SY/2. RETAINING THE LAST VALUE OF Cc IN THE
C***  MATERIAL BALANCE.
C
      heat = y(4)
      rholay = prmt(20)

6 -- sys$desadis:SSSUP.FOR
```

```
      Cc = PRMT(7)
      rhouh = Y(1)
      sz = ( rhouh/rholay/prmt(18) )**(1./alpha1) * z0
      SYT = Erate*ALPHA1*(Z0/SZ)**ALPHA/U0/SZ/Cc/SQRTPI
C
      XT = PRMT(12)
      XV(I) = (SYT/RT2/DELTA)**(1./BETA) - XT
C
C*** SET UP INTEGRATION FOR THE GAUSSIAN DISPERSION PHASE.
C
      do ijk=1,22
      prmt(ijk) =0.
      enddo
      do ijk=1,5
      y(ijk) = 0.
      dery(ijk)= 0.
      do ijkl=1,8
      aux(ijkl,ijk) = 0.
      enddo
      enddo
c
      PRMT(1) = XT
      PRMT(2) = 6.023E23
      PRMT(3) = STPG
      PRMT(4) = ERRG
      PRMT(5) = SMXG
      PRMT(6) = Erate
      PRMT(7) = Cc    ! -- OUTPUT
      PRMT(8) = XV(I)
      PRMT(9) = T0(I)
C     PRMT(10)= 'BLANK'
      PRMT(11)= NREC(I,2)
C     PRMT(12)= DIST AT COMPLETION -- OUTPUT
c     prmt(13)= 'blank'
c     prmt(14)= wc            ! output
c     prmt(15)= rho           ! output
c     prmt(16)= temp          ! output
c     prmt(17)= gamma         ! output
      prmt(18)= u0*z0/alpha1
      prmt(19)= rhoa*k*ustar*alpha1
      prmt(20)= rholay
      prmt(21)= sz
      prmt(22)= sz
C
      Y(1) = rhouh
      Y(2) = heat
C
      DERY(1) = WTRUH
      dery(2) = WTDHG
C
      NDIM = 2

? -- sys$desadis:SSSUP.FOR
```

```
C
      WRITE(lunlog,1140)
 1140 FORMAT(' Entering Gaussian Stage of Integration ')
C
C*** PERFORM INTEGRATION
C
      CALL RKGST(PRMT,Y,DERY,NDIM,IHLF,SSG,SSGOUT,AUX)
C
      IF(IHLF .GE. 10) CALL trap(10,IHLF)
C
      NREC(I,2) = INT(PRMT(11))
      RTOT = RTOT + FLOAT(NREC(I,1) + NREC(I,2))
      WRITE(lunlog,1110) RTOT,I
 1110 FORMAT(5X,'TOTAL NUMBER OF RECORDS = ',1PG13.4,' THROUGH',
     $' OBS # ',I3)
C
      IF(RTOT .GT. 120000.) CALL trap(11)
C
  119 CONTINUE
  120 CONTINUE
C
      RETURN
      END
****
```

```
C.....................................................................
C
      SUBROUTINE STRT2(OPNRUP,H_masrte)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$dusadis:DEGADIS2.dec'
C
      COMMON
     $/GEN3/ rads(2,maxl),astr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/TITL/ TITLE
     $/GEN1/ ET(2,isen),R1T(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/ TI,TINP,TSRC,TOBS,TSRT
     $/ERROR/SYOER,ERRO,SZOER,WTAIO,WTQOO,WTSZO,ERRP,SMXP,
     $ WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,ERTDNF,ERTUPF,WTRUH,WTDHG
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_aw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flag
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
     $/COM_SURF/ HTCUT
C
      character*80 TITLE(4)
C
      character*4 pound
      character*24 TINP,TSRC,TOBS,TSRT
      character*3 sas_name
C
      REAL*8 K,ML
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      character*40 OPNRUP
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD')
C
      DO 90 I = 1,4
   90 READ(9,1000) TITLE(I)
 1000 FORMAT(A80)
C
      READ(9,*) NP
      DO 100 I=1,NP
  100 READ(9,*) ET(1,I),ET(2,I),R1T(2,I)

1 -- sys$desadis:STRT2.FOR
```

```
      DO 110 I=1,NP
  110 R1T(1,I) = ET(1,I)
      I = NP + 1
      ET(1,I)  = POUNDN
      ET(2,I)  = POUNDN
      R1T(1,I) = POUNDN
      R1T(2,I) = POUNDN
C
      READ(9,*) NP
      DO 220 I=1,NP
  220 READ(9,*) DEN(1,I),DEN(2,I),den(3,I),den(4,i),den(5,i)
      den(1,np+1) = 2.
C
      READ(9,*) NP
      DO 300 I=1,NP
      READ(9,*) rads(1,I),rads(2,I),astr(2,I),srcden(2,I),srcwc(2,i),
     1       srcwa(2,i),srcenth(2,i)
      astr(1,I) = rads(1,I)
      srcden(1,I) = rads(1,I)
      srcwc(1,i) = rads(1,i)
      srcwa(1,i) = rads(1,i)
      srcenth(1,i) = rads(1,i)
  300 continue
      I = NP + 1
      rads(1,I)  = POUNDN
      rads(2,I)  = POUNDN
      astr(1,I) = POUNDN
      astr(2,I) = POUNDN
      srcden(1,I) = POUNDN
      srcden(2,I) = POUNDN
      srcwc(1,I) = POUNDN
      srcwc(2,I) = POUNDN
      srcwa(1,I) = POUNDN
      srcwa(2,I) = POUNDN
      srcenth(1,I) = POUNDN
      srcenth(2,I) = POUNDN
C
      READ(9,1010) TINP,TSRC
      READ(9,1010) tobs,TSRT
C
      READ(9,*) UO,ZO,ZR,ML,USTAR
      read(9,*) K,G,RHOE,RHOA,DELTA
      read(9,*) BETA,GAMMAF,CcLOW
C
      READ(9,*) RM,SZM,EMAX,RMAX,TSC1
      read(9,*) ALEPH,TEND
C
      READ(9,*) CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      READ(9,*) ALPHA
      alphal = alpha + 1.

2 -- sys$desadis:STRT2.FOR
```

```
c
      read(9,1020) sas_name
      read(9,*) sas_mw,sas_temp,sas_rhoe
      read(9,*) sas_cpk,sas_cpp
      read(9,*) sas_ufl,sas_lfl,sas_zsp
c
      read(9,*) istab
      read(9,*) tamb,pamb,humid
      read(9,*) isofl,tsurf
      read(9,*) ihtfl,htco
      read(9,*) iwtfl,wtco
c
      read(9,*) sigx_coeff,sigx_pow,sigx_min_dist
c
      read(9,*) iphifl,dellay
c
      H_aasrte = 0.
      if(isofl.eq. 0) read(9,*) H_aasrte
C
      READ(9,*) HTCUT, ce, delrhomin
c
 1010 format(2(a24,1x))
 1020 format(a3)
C
      CLOSE(UNIT=9)
C
      RETURN
      END
####
```

```
C.....................................................................
C
      SUBROUTINE STRT2(OPNRUP,H_masrte)
C
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      INCLUDE 'sys$desadis:DEGADIS2.DEC/LIST'
C
C.....................................................................
C
C     BLOCK COMMON
C
      COMMON
     $/TITL/ TITLE
     $/GEN2/ DEN(5,IGEN)
     $/ITI/ T1,TINP,TSRC,TOBS
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_ss/ ESS,SLEN,SWID,OUTCc,OUTSZ,OUTB,OUTL,swcl,swal,senl,srhl
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
     $/COM_SURF/ HTCUT
C
      character*80 TITLE(4)
      character*24 TSRC,TINP,TOBS
      character*40 OPNRUP
      character*3 sas_name
      character*4 pound
C
      REAL*8 K,ML
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD')
C
      DO 90 I = 1,4
   90 READ(9,1000) TITLE(I)
 1000 FORMAT(A80)
C
      read(9,*) np
      do 100 i=1,np
  100 read(9,*) dummy1,dummy2,dummy3
c
      READ(9,*) NP
      DO 120 I=1,NP
  120 READ(9,*) DEN(1,I),DEN(2,I),den(3,i),den(4,i),den(5,i)
      I = NP + 1

1 -- sys$desadis:STRT2SS.FOR
```

```
      DEN(1,I) = 2.
C
      read(9,*) np
      do 140 i=1,np
  140 read(9,*) dummy1,dummy2,dummy3,dummy4,dum5,dum6,dum7
C
      read(9,1100) tinp,tsc
      read(9,1100) tobs,tsrt
 1100 format(a24,1x,a24)
C
      READ(9,*) U0,Z0,ZR,ML,USTAR
      Read(9,*) K,G,RHOE,RHOA,DELTA
      read(9,*) BETA,GAMMAF,CcLOW
C
      read(9,*) dummy1
      read(9,*) dummy1
C
      READ(9,*) CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      READ(9,*) ALPHA
      alpha1 = alpha + 1.
C
      read(9,1200) sas_name
      read(9,*) sas_nw,sas_temp,sas_rhoe
      read(9,*) sas_crk,sas_cpp
      read(9,*) sas_ufl,sas_lfl,sas_zsp
C
      read(9,*) istab
      read(9,*) tamb,pamb,humid
      read(9,*) isofl,tsurf
      read(9,*) ihtfl,htco
      read(9,*) iwtfl,wtco
C
      read(9,*) dummy1
C
      READ(9,*) ESS,SLEN,SWID
      read(9,*) OUTCc,OUTSZ,OUTB,OUTL
      read(9,*) swcl,swal,senl,srhl
C
      read(9,*) iphifl,dellay
C
      h_masrte = 0.
      if(isofl.eq. 0) read(9,*) H_masrte
C
      READ(9,*) HTCUT, ce, delrhomin
C
      CLOSE(UNIT=9)
      RETURN
 1200 format(a3)
      END
$$$$

  2 -- sys$desadis:STRT2SS.FOR
```

```
C.....................................................
C
      SUBROUTINE STRT3(OPNRUP)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desad.s:DEGABIS3.dec/list'
C
C     BLOCK COMMON
C
      COMMON
     $/SSCON/ NREC(maxnob,2),T0(maxnob),XV(maxnob)
     $/GEN2/ DEN(5,isen)
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_sw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/comsta/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sisx/ sisx_coeff,sisx_pow,sisx_min_dist,sisx_flag
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alpha1
     $/CNOBS/ NOBS
C
      character*3 sas_name
      character*40 OPNRUP
      character*24 TINP,TSRC,TOBS,TSRT
C
      REAL*8 K,ML
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='OLD')
C
      READ(9,*) NOBS
      DO 125 I=1,NOBS
  125 READ(9,*) NREC(I,1),NREC(I,2),T0(I),XV(I)
c
      READ(9,*) Npts
      DO 140 I=1,Npts
  140 READ(9,*) den(1,i),den(2,i),den(3,i),den(4,i),den(5,i)
      den(1,npts+1) = 2.
c
      READ(9,*) U0,Z0,ZR,ML,USTAR
      read(9,*) K,G,RHOE,RHOA,DELTA
      read(9,*) BETA,GAMMAF,CcLOW
c
      READ(9,1010) TINP,TSRC
      read(9,1010) TOBS,TSRT
 1010 format(2(a24,1x))

1 -- sys$desadis:STRT3.FOR
```

```
C
      READ(9,*) RM,SZM,EMAX,RMAX,TSC1
      read(9,*) ALEPH,TEND
C
      read(9,1020) sas_name
      read(9,*) sas_aw,sas_temp,sas_rhoe
      read(9,*) sas_cpk,sas_cpp
      read(9,*) sas_ufl,sas_lfl,sas_zsp
      read(9,*) istab
      read(9,*) tamb,pamb,humid
      read(9,*) isofl,tsurf
      read(9,*) ihtfl,htco
      read(9,*) iwtfl,wtco
      read(9,*) six_coeff,six_pow,six_min_dist
 1020 format(a3)
C
      READ(9,*) CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      READ(9,*) ALPHA
      alphai = alpha + 1.
C
      CLOSE(UNIT=9)
C
      RETURN
      END
####
```

```
C -- sys$desadis:STRT3.FOR
```

```
C     Surface effects
C
      SUBROUTINE Surface(temp,height,rho,mole,cp,watrte,erte)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS1.dec'
c
C
      COMMON
     $/PARM/ U0,Z0,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/ALP/ ALPHA,alpha1
     $/phicom/ iphifl,dellay
     $/COM_SURF/ HTCUT
C
c
      REAL*8 ML,K
      REAL*8 L,massrte,mole
C
      vapor_p(txxx) = 6.0298e-3* exp(5407. *(1./273.15- 1./txxx))
c
c
c
      watrte = 0.
      erte = 0.
      if(isofl.eq.1 .or. ihtfl.eq.0) return
      if(height.le. htcut) return
      delta_t = tsurf - temp
      if(delta_t .lt. 0.) return
      top_vel = u0 * (height/z0)**alpha
      u10 = u0*(10./z0)**alpha
      prod_nat = ((rho/mole)**2 * abs(delta_t)) ** 0.333333
      if(ihtfl .eq. 1) then           ! local correlation
             hn = 18. * prod_nat
             hf = 0.
             if(top_vel .ne.0.) hf = 1.22 * rho*cp * ustar**2/top_vel
c            hf = 1.22 * rho*cp * (ustar/u10)**2*top_vel
             ho = dmax1(hn,hf)
      else if(ihtfl .eq. 2) then              ! LLNL correlation
             ho = htco* rho* cp
      else if(ihtfl .eq. 3) then              ! Colenbrander's method
             av_temp= (tsurf + temp)/2.
             hn = 89.*(delta_t/av_temp**2)**.33333
             hf = 1.22 * rho*cp * ustar**2/u10
             ho = dmax1(hn,hf)
      else
             ho = htco       ! ihtfl=-1
      endif
      erte = ho * delta_t

1 -- sys$desadis:SURFACE.FOR
```

```
      if(arte .lt. 0.) then
             write(6,8000) arte,ho,delta_t
 8000        format(' SURFACE? ht < 0.0! ',1pg13.5,2x,'ho: ',
     1       1pg13.5,/,' delta_t: ',1pg13.5)
             call trap(4)
             endif
      watrte = 0.
      if(iwtfl .eq. 0) return
      fo = wtco
             if(iwtfl .gt. 0) then
             fn = 9.9e-3 * prod_nat
             ff = 20.7 * ho /cp /mole
             fo = dmax1(fn,ff)
             endif
      watrte = fo/pamb * (vapor_p(tsurf) - vapor_p(temp))
C
      return
      end
####
```

```
C.....................................................................
C
C     FUNCTION TO RETURN SZ0 CALCULATED over the source without
c      a blanket present underneath
c
c     NOTE: Uses the integration package RKGST and cannot
c             be used with any other routine without a local copy
c             of RKGST.
C
      subroutine SZF(Q,L,sz,cclay,wclay,rholay)
c

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      external szlocal,szloco
C
      REAL*8 L
C
      include 'sys$desadis:DEGADIS1.dec'
c
C
      COMMON
     $/szfc/ szstp0,szerr,szstpmx,szsz0
C
      dimension Y(2),D(2),PRMT(17),aux(8,2)
c
c
      prmt(1) = 0.
      prmt(2) = L
      prmt(3) = szstp0
      prmt(4) = szerr
      prmt(5) = szstpmx
      prmt(6) = Q
c
      Y(1) = szsz0     ! rho*tdel*u0*z0/(1.+alpha)*(sz/z0)**(1.+alpha)
c
      ndim = 1
c
      call rkgst(prmt,y,d,ndim,ihlf,szlocal,szloco,aux)
c
      if(ihlf.ge. 10) call trap(3,ihlf)
c
      cclay = prmt(13)
      wclay = prmt(14)
      rholay = prmt(15)
      cc = prmt(16)
      sz = prmt(17)
C
      RETURN
      END
c

1 -- sys$desadis:SZF.FOR
```

```
c
c
      subroutine szlocal(x,y,d,prmt)
c
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      dimension y(1),d(1),prmt(1)
c
      common
     $/parm/ u0,z0,zr,ml,ustar,k,g,rhoe,rhoa,delta,beta,gammaf,cclow
     $/alp/ alpha,alpha1
     $/phicom/ iphifl,dellay
c
      real*8 ml,k
c
      integer rhouhlay/1/
c
      Q = prmt(6)
      wclay = Q*x/Y(rhouhlay)
c
      call adiabat(1,wclay,walay,yc,ya,cclay,rholay,wm,enth,temp)
      cc = cclay*dellay
      call adiabat(0,wc,wa,yc,ya,cc,rho,wm,enth,temp) ! centerline
c
      uheff = Y(rhouhlay)/rholay/dellay
c
      sz = ( uheff/u0/z0*(alpha1) )**(1./alpha1) * z0
      heff = gammaf*sz/alpha1
      ristar = rif(rho,heff)
      phi = phif(ristar,0.)
      wel = dellay * k*ustar*alpha1/phi
      D(rhouhlay) = wel*rhoa + Q
c
      prmt(8) = cclay
      prmt(9) = wclay
      prmt(10)= rholay
      prmt(11)= cc
      prmt(12) = sz
c
      return
      end
c
c
c
      subroutine szloco(x,y, dery,ihlf,ndim, prmt)
c
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      dimension x(1),y(1), dery(1), prmt(1)

2 -- sys$desadis:SZF.FOR
```

```
C

      prmt(13) = prmt(8)
      prmt(14) = prmt(9)
      prmt(15) = prmt(10)
      prmt(16) = prmt(11)
      prmt(17) = prmt(12)
      return
      end
####
```

```
      subroutine tprop(ifl,wc,wa,enthalpy,yc,ya,wm,temp,rho,cp)
c
c     subroutine to return:
c             mole fractions (y's)
c             molecular weight (wm)
c             temperature (temp[=]K)
c             density (rho[=]kg/m**3)
c             heat capacity (cp[=]J/kg/K)
c
c     for a mixture from:
c             mass fractions (w's)
c             enthalpy (J/kg)          for ifl.ne.0
c
c             adiabatic mixing of:     emitted gas @ gas_temp
c                                      entrained ambient humid air @ tamb
c                                      entrained water from surface @ tsurf
c                             for ifl.eq.0 calculate and return
c
c             adiabatic lookup CALL ADIABAT
c                             for isofl.eq.1 .or. ihtfl.eq.0.and.ifl.ne.1
c

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$degadis:DEGADIS1.dec'
c
      parameter (tfrac=0.618, tfrac1=1.-tfrac,
     1       rcrit=0.0005, acrit=1., zero=1.e-20)
c
      common
     $/GEN2/ DEN(5,isen)
     $/com_gprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_xsp,gas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
c
      character*3 gas_name
c
c*** data for air/water sys
c
      data wma/28.96/          ! molecular weight of air
      data wmw/18./            ! molecular weight of water
      data rho_water/1000./    ! liquid water density [=] kg/m**3
      data cpa/1.0063e3/       ! heat capacity of air [=]J/kg/K
      data cpw/1865./          ! heat capacity of water vapor[=]J/kg/K
      data dhvap/2.5023e6/     !latent heat of vap [=]J/kg water
      data dhfus/0.33e6/       !latent heat of fus [=]J/kg water
c
      logical rev
c
c
      vapor_p(txxx) = 6.0298e-3* exp(5407. *(1./273.15- 1./txxx))

1 -- sys$degadis:TPROP.FOR
```

```
      sat_hum(p_tot,p_vp) = 0.622* p_vp/ (p_tot- p_vp) ! kg w/kg BDA
      ropw_air(p_tot,humxx) =
     1       (.00283+ .00456*humxx)/p_tot/(1.+humxx) ! m**3/kg /K
c
c
      ww = 1.-wc-wa
      wm = 1./(wc/gas_mw + wa/wma + ww/wmw)
      yc = wm/gas_mw *wc
      ya = wm/wma *wa
c
c
      if(isofl.eq. 1) then
              call adiabat(1,wc,wa,yc,ya,cc,rho,wm,enthalpy,temp)
              return          ! interp density from wc
              endif
c
c
      if(ifl.eq. 0)
     1  enthalpy = wc*cpc(gas_temp)*(gas_temp - tamb)
     1       + (ww - wa*humid)*cpw*(tsurf - tamb)
c     1       + wa*(1.+humid)*cpa*(tamb - tamb)       ! TR=tamb
c
c
c
      if(ifl.eq. 1 .and. ihtfl.eq.0) then
              call adiabat(1,wc,wa,yc,ya,cc,rho,wm,enthalpy,temp)
              return          ! interp density from wc
              endif
c
c
      rev = .false.
  100 continue
      tmin = dmin1(gas_temp,tsurf)
      tmin0 = tmin
      tmax = dmax1(tsurf,tamb)
      tmax0 = tmax
      temp = (tmin+tmax)/2.
c
      do 300 j=1,35
      guess = enthal(wc,wa,temp)
      dif = enthalpy - guess
      sum = (abs(enthalpy) + abs(guess))/2. + zero
      if(abs(dif)/sum.le.rcrit .or. abs(dif).le.acrit) goto 400
c
      if(dif.lt. 0.) then
              if(rev) tmax = temp
              if(.not.rev) tmin = temp
              temp = tmin + (tmax-tmin) * tfrac
      else
              if(rev) tmin = temp
              if(.not.rev) tmax = temp

2 -- sys$desadis:TPROP.FOR
```

```
            temp = tmin + (tmax-tmin) * tfrac1
      endif
c
 300  continue
      rev = .not.rev
      if(rev) goto 100
      write(lunlog,8050) wc,wa,enthalpy
 8050 format(' TPROP? wc: ',1pg12.5,1x,
     1       'wa: ',1pg12.5,1x,'enthalpy: ',1pg12.5)
      elow = enthal(wc,wa,tmin0)
      if(enthalpy.lt. elow) then      ! catch out of bounds numbers
            temp = tmin0
            enthalpy = elow
            goto 400
            endif
      elow = enthal(wc,wa,tmax0)
      if(enthalpy.gt. elow) then
            temp = tmax0
            enthalpy = elow
            goto 400
            endif
c
      call trap(24)
c
c
 400  continue                ! density calculation
      vp = vapor_p(temp)
      sat = dmin1( sat_hum(pamb,vp), humid)
      rho = 1./(temp*ropw_air(pamb,sat)*wa*(1.+sat)
     1       + wc*temp/gas_temp/gas_rhoe + (ww-wa*sat)/rho_water)
c
      tmin = temp + 10.
      if(tmin .gt. tmax0) tmin = temp - 10.
      if(tmin .lt. tmin0) tmin = temp + .1
c
      tmax = enthal(wc,wa,tmin)
      cp = (enthalpy - tmax)/(temp - tmin)
      if(cp .lt. cpa) cp = cpa                ! nominal value of air
c
      return
      end
c
c
      function cpc(temp)
c

      implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      common
     $/com_gprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name

3 -- sys$desadis:TPROP.FOR
```

```
c
      data con/3.33e4/
c
      character*3 sas_name
c
      cpc = con
      if(temp .ne. sas_temp) then
             cpc = con + sas_cpk*
     1 (temp**sas_cpp - sas_temp**sas_cpp)/(temp- sas_temp)
             endif
      cpc = cpc/sas_aw
      return
      end
c
c
      function enthal(wc,wa,temp)      ! used by TPROP
c

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      parameter (delta=10.)
c
      common
     $/com_sprop/ sas_aw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
c
      character*3 sas_name
c
      data cpa/1006.3/         ! heat capacity of air [=]J/kg/K
      data cpw/1865./          ! heat capacity of water vapor[=]J/kg/K
      data dhvap/2.5023e6/     !latent heat of vap [=]J/kg water
      data dhfus/0.33e6/       !latent heat of fus [=]J/kg water
c
c
      ww = 1.-wa-wc
      vp = 6.0298e-3* exp(5407. *(1./273.15- 1./temp))
      sat = 0.622 * vp/ (pamb - vp) ! kg w/kg BDA
      wwstar = wa * sat
c
      dh = dhvap
      frac = 0.
      if(temp .lt. 273.15) frac = dmin1( (273.15D0-temp)/delta,1.D0)
      dh = dhvap + dhfus*frac
      if(wa .eq. 0.) goto 1000
      cloud_hum = ww/wa
      if(cloud_hum.le. sat) dh = 0.0
c
 1000 enthal = wc*cpc(temp)*(temp - tamb)
     1       - dmax1((ww- wwstar),0.D0)*dh
     1       + (ww- wa*humid)*cpw*(temp - tamb)

4 -- sys$desadis:TPROP.FOR
```

```
     1       + wa*(1.+humid)*cpa*(temp - tamb)       ! TR=tamb
c
      return
      end
c
c
      subroutine adiabat(ifl,wc,wa,yc,ya,cc,rho,wm,enthalpy,temp)
c
c     subroutine to return:
c             mass fractions (w's)
c             mole fractions (y's)
c             concentration (cc[=]kg/m**3)
c             density (rho[=]kg/m**3)
c             molecular weight (wm)
c             enthalpy ([=]J/kg)
c             temperature (temp[=]K)
c
c     for a mixture from DEN lookup of adiabatic mixing calculation
c     den(1,i)        mole fraction (yc)
c     den(2,i)        concentration (cc [=] kg c/m**3)
c     den(3,i)        mixture density (rho [=] kg mix/m**3)
c     den(4,i)        mixture enthalpy (enthalpy [=] J/kg)
c     den(5,i)        mixture temperature (temp [=] K)
c
c     ifl indicates given information:
c     -2)mole fraction (Yc) and assumption of constant gamma in enthalpy
c     -1)concentration (cc) and assumption of constant gamma in enthalpy
c     0) concentration (cc)
c     1) mass fraction c (wc)
c     2) mole fraction (Yc)
c

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADISIN.dec'
c
      common
     $/GEN2/ DEN(5,isen)
     $/parm/ u0,z0,zr,ml,ustar,k,g,rhoe,rhoa,delta,beta,gammaf,cclow
     $/com_gprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
c
      character*3 gas_name
      real*8 ml,k
c
c*** data for air/water sys
c
      data wma/28.96/          ! molecular weight of air
      data wmw/18./            ! molecular weight of water
c

S -- sys$desadis:TPROP.FOR
```

```
c
      if(ifl.ne. 0) goto 1000
      ccl = cc
      if(cc .lt. 0.) ccl=0.
              i = 2
 30           if(den(1,i) .gt. 1.) then
                      i=i-1
                      if(cc.gt. den(2,i)) ccl=den(2,i)
                      goto 50
                      endif
              if(cc.le. den(2,i)) goto 50     ! lookup in concentration
              i=i+1
              goto 30
 50   slope = (den(3,i)-den(3,i-1)) / (den(2,i)-den(2,i-1)) ! interp in conc
              rho = (ccl - den(2,i-1))*slope + den(3,i-1)
      wcl = ccl / rho
      wc = wcl
      wa = (1.-wc)/(1.+humid)          ! no choice with given information
      ww = humid*wa
      wm = 1./(wc/gas_mw + wa/wma + ww/wmw)
      yc = wm/gas_mw * wc
      ya = wm/wma * wa
      goto 8000
c
c
 1000 if(ifl.ne. -1) goto 1500
      ccl = cc
      if(ccl.lt. 0.) ccl=0.
      gamma = enthalpy
      wc = ccl/(rhoa+ccl*gamma)
      wa = (1.-wc)/(1.+humid)          ! no choice with given information
      ww = 1.-wa-wc
      wm = 1./(wc/gas_mw + wa/wma + ww/wmw)
      yc = wm/gas_mw * wc
      ya = wm/wma * wa
      rho = ccl/wc
      return
c
c
 1500 if(ifl.ne. -2) goto 1700
      ycl = yc
      if(ycl.lt. 0.) ycl=0.
      gamma = enthalpy
      yw = (1.-ya-ycl)
      wm = yc*gas_mw + ya*wma + yw*wmw
      wc = gas_mw/wm * ycl
      wa = wma/wm * ya
      cc = wc*rhoa/(1. - gamma*wc)
      rho = cc/wc
      return
c

6 -- sys$desadis:TPROP.FOR
```

```
c
 1700 if(ifl.ne. 2) goto 2000
      ycl = yc
      if(yc .lt. 0.) then
          ycl = 0.
          wa = 1./(1.+humid)
          ww = 1.-wa
          wm = 1./(wma/wa + wmw/ww)
          ya = wm/wma * wa
          endif
      if(yc .gt. 1.) then
          ycl = 1.
          ya = 0.
          endif
      i = 2
 1730 if(den(1,i) .gt. 1.) then
              i = i-1
              goto 1750               ! extrapolate
              endif
      if(yc.le. den(1,i)) goto 1750   ! lookup in mole frac
      i=i+1
      goto 1730
 1750 slope = (den(2,i)-den(2,i-1)) / (den(1,i)-den(1,i-1))   ! interp in y
              cc = (ycl - den(1,i-1)) *slope + den(2,i-1)
      slope = (den(3,i)-den(3,i-1)) / (den(1,i)-den(1,i-1)) ! interp in y
              rho = (ycl - den(1,i-1))*slope + den(3,i-1)

      wc = cc/rho
      wm = ycl*mas_mw + ya*wma + (1.-ycl-ya)*wmw
      wa = ya*wma/wm

      i = 2
 1760 if(den(1,i) .gt. 1.) then
              i = i-1
              goto 1800               ! extrapolate
              endif
      cwc = den(2,i)/den(3,i)
      if(wc.le. cwc) goto 1800        ! lookup in mass frac
      i=i+1
      goto 1760
 1800         w1 = den(2,i-1)/den(3,i-1)
              w2 = den(2,i)/den(3,i)
      slope = (den(4,i)-den(4,i-1)) / (w2 - w1)       ! interp in w
              enthalpy = (wc - w1) *slope + den(4,i-1)
      slope = (den(5,i)-den(5,i-1)) / (w2 - w1)       ! interp in w
              temp = (wc - w1) *slope + den(5,i-1)
c
      return
c
c
 2000 if(ifl.ne. 1) goto 9000

7 -- sys$desadis:TPROP.FOR
```

```
      wcl = wc
          if(wc .lt. 0.) then
              wcl = 0.
              wa = 1./(1.+humid)
              endif
          if(wc .gt. 1.) then
              wcl = 1.
              wa = 0.
              endif
      ww = 1.-wa-wcl
      wm = 1./(wcl/gas_mw + wa/wma + ww/wmw)
      yc = wm/gas_mw *wcl
      ya = wm/wma *wa
      i = 2
 2030 if(den(1,i) .gt. 1.) then
              i = i-1
              goto 2050               ! extrapolate
              endif
      if(yc.le. den(1,i)) goto 2050   ! lookup in mole frac
      i=i+1
      goto 2030
 2050 slope = (den(3,i)-den(3,i-1)) / (den(1,i)-den(1,i-1))
      rho = (yc-den(1,i-1))*slope + den(3,i-1)
      slope = (den(2,i)-den(2,i-1)) / (den(1,i)-den(1,i-1))
      cc = (yc-den(1,i-1))*slope + den(2,i-1)
      i = 2
 2060 if(den(1,i) .gt. 1.) then
              i = i-1
              goto 8000               ! extrapolate
              endif
      cwc = den(2,i)/den(3,i)
      if(wcl.le. cwc) goto 8000       ! lookup in mass frac
      i=i+1
      goto 2060
c
c
 8000         w1 = den(2,i-1)/den(3,i-1)
              w2 = den(2,i)/den(3,i)
      slope = (den(4,i)-den(4,i-1)) / (w2 - w1)       ! interp in w
              enthalpy = (wcl - w1) *slope + den(4,i-1)
      slope = (den(5,i)-den(5,i-1)) / (w2 - w1)       ! interp in w
              temp = (wcl - w1) *slope + den(5,i-1)
c
      return
c
 9000 call trap(26)
      end
c
c
      subroutine setenthal(h_masrte,h_airrte,h_watrte)
c

$ -- sys$desadis:TPROP.FOR
```

```
c     subroutine to load /com_ENTHAL/ through passed arguments if needed
c
c

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include '$sys$desadis:DESADISIN.dec'
c
      common
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
c
      character*3 sas_name
c
c*** data for air/water sys
c
      data cpa/1.0063e3/      ! heat capacity of air [=]J/kg/K
      data cpw/1865./         ! heat capacity of water vapor[=]J/kg/K
c
      h_masrte = 0.
      h_airrte = 0.
      h_watrte = 0.
c
      if(isofl.eq. 1) return
c
      h_masrte = cpc(sas_temp)*(sas_temp - tamb)      ! TR=tamb
c
c h_airrte = (1.+humid)*cpa*(tamb - tamb) = 0.
c
      if(iwatfl .eq. 0) return
      h_watrte = cpw*(tsurf - tamb)
c
      return
      end
c
c
c
      subroutine setden(wc,wa,enthalpy)
c
c     subroutine to load /GEN2/ as needed
c
c     adiabatic mixing of:    WC
c                             WA
c                             WW @ specified enthalpy
c
c             with ambient humid air @ tamb
c
c     den(1,i)        mole fraction (yc)
c     den(2,i)        concentration (cc [=] kg c/m**3)
c     den(3,i)        mixture density (rho [=] kg mix/m**3)

9 -- sys$desadis:TPROP.FOR
```

```
c     den(4,i)        mixture enthalpy (enthalpy [=] J/kg)
c     den(5,i)        mixture temperature (temp [=] K)
c
c


      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$dcsadis:DEGADISIN.dec'
c
      parameter (tcrit=0.002, zero=1.e-20)
      parameter (iils=200, ils=iils-1, iback=25)
c
      common
     $/GEN2/ DEN(5,isen)
     $/com_gprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
c
      character*3 gas_name
c
      dimension curnt(5),backsp(5,iback)
c
c*** data for air/water sys
c
      data wma/28.96/          ! molecular weight of air
      data wmw/18./            ! molecular weight of water
      data cpa/1.0063e3/       ! heat capacity of air [=]J/kg/K
      data cpw/1865./          ! heat capacity of water vapor[=]J/kg/K
c
c
c
      if(isofl.eq. 1) return
c
c
      k = 1
      den(1,k) = 0.0           ! yc
      den(2,k) = 0.0           ! cc
      den(3,k) = pamb*(1.+humid)/(.00283+ .00456*humid)/tamb  ! rhoa
      den(4,k) = 0.0           ! enthalpy of ambient air; TR=tamb
      den(5,k) = tamb
c
c
      do 300 i= ils,1,-1
      zbda = (float(i)/float(iils)) / (1.+humid)
      zw = zbda*humid
      zs = 1.-zbda-zw
c
c     enmix = zs*enthalpy + zbda*(1.+humid)*cpa*tamb  ! TR=tamb
      enmix = zs*enthalpy
c
      zbda = zbda + zs*wa

10 -- sys$desadis:TPROP.FOR
```

```
      zs   =        zs*wc
      call tprop(2,zs,zbda,enmix,yc,ya,wa,temp,rho,cp)
      cc = zs*rho
c
c
      curnt(1) = yc
      curnt(2) = cc
      curnt(3) = rho
      curnt(4) = enmix
      curnt(5) = temp
c
      if(i .eq. ils) then
             ind = 1
             do 150 jj= 1,5
 150         backsp(jj,ind) = curnt(jj)
             goto 300
             endif
c
c     ADIABAT interpolation scheme
c
      err = 0.
      do 180 iind = 1,ind
      yc    = backsp(1,iind)
      cc    = backsp(2,iind)
      rho   = backsp(3,iind)
      enmix = backsp(4,iind)
      temp  = backsp(5,iind)
      slope = (den(2,k)- curnt(2)) / (den(1,k)- curnt(1))
             ccint = (yc - curnt(1))*slope + curnt(2)
      err = dmax1(err,2.D0* abs(cc - ccint)/(abs(cc + ccint) + zero))
      slope = (den(3,k)- curnt(3)) / (den(1,k)- curnt(1))
             rhoint = (yc - curnt(1))*slope + curnt(3)
      err = dmax1(err,2.D0* abs(rho - rhoint)/(abs(rho + rhoint) + zero))
      wccal = cc / rhoint
             w1 = curnt(2)/curnt(3)
             w2 = den(2,k)/den(3,k)
      slope = (den(4,k)- curnt(4)) / (w2 - w1)
             entint = (wccal - w1)*slope + curnt(4)
      err = dmax1(err,2.D0* abs(enmix - entint)/(abs(enmix + entint) + zero))
      slope = (den(5,k) - curnt(5)) / (w2 - w1)
             temint = (wccal - w1)*slope + curnt(5)
      err = dmax1(err,2.D0* abs(temp - temint)/(abs(temp + temint) + zero))
 180  continue
c
      if(err .le. tcrit) then
             if(ind .ge. iback) goto 200
             ind = ind + 1
             do 190 jj=1,5
 190         backsp(jj,ind) = curnt(jj)
             goto 300
             endif

11 -- sys$desadis:TPROP.FOR
```

```
c
c     record a point in DEN
c
c
 200  k = k+1
      if(k.ge. isen) call trap(28)
      do 250 jj=1,5
      den(jj,k) = backsp(jj,ind)
 250  backsp(jj,1) = curnt(jj)
      ind = 1
c
 300  continue
c
      k = k+1
      if(k.ge. isen) call trap(28)
      if(wc.eq. 1.D00) then
              den(1,k) = 1.D00          ! yc
              den(2,k) = gas_rhoe       ! cc
              den(3,k) = gas_rhoe       ! rhoe
              den(4,k) = enthalpy       ! enthalpy
              den(5,k) = gas_temp       ! temp
      else
      call tprop(2,wc,wa,enthalpy,den(1,k),ya,wm,den(5,k),den(3,k),cp)
      den(2,k) = wc*den(3,k)  ! cc
      den(4,k) = enthalpy
      endif
      den(1,k+1) = 2.           ! .gt. 1. end-of-record indicator
c
      return
      end
c
c
c
c
      subroutine addheat(cc,dh,rho,temp,cp)
c
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS1.dec'
c
      parameter (tfrac=0.618, tfrac1=1.-tfrac,
      1       rcrit=0.005, acrit=1., zero=1.e-20)
c
      common
     $/GEN2/ DEN(5,isen)
     $/com_gprop/ gas_mw,gas_temp,gas_rhoe,gas_cpk,gas_cpp,
     $ gas_ufl,gas_lfl,gas_zsp,gas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
c
      character*3 gas_name

12 -- sys$desadis:TPROP.FOR
```

```
c
c*** data for air/water sys
c
      data wma/28.96/          ! molecular weight of air
      data wmw/18./            ! molecular weight of water
      data rho_water/1000./    ! liquid water density [=] kg/m**3
      data cpa/1.0063e3/       ! heat capacity of air [=]J/kg/K
      data cpw/1865./          ! heat capacity of water vapor[=]J/kg/K
      data dhvap/2.5023e6/     !latent heat of vap [=]J/kg water
      data dhfus/0.33e6/       !latent heat of fus [=]J/kg water
c
      logical rev
c
c
      vapor_p(txxx) = 6.0298e-3* exp(5407. *(1./273.15- 1./txxx))
      sat_hum(p_tot,p_vp) = 0.622* p_vp/ (p_tot- p_vp) ! kg w/kg BDA
      ropw_air(p_tot,humxx) =
     1       (.00283+ .00456*humxx)/p_tot/(1.+humxx) ! m**3/kg /K
c
c
      cp = cpa
      IF(isof1.eq.1 .or. ihtf1.eq.0) return   ! adiabatic mixing is valid
      rhoa = den(3,1)
c
      call adiabat(0,wc,wa,yc,ya,cc,rho,wm,enthalpy,amt)
      temp = amt
      if(dh.eq. 0.) return
      enthalpy = enthalpy + dh
c
c
      if(dh.lt. 0.) return            ! catch colder surface temperatures
c
c
c
      if(enthalpy.gt. 0.) then
              temp = tamb
              goto 400
              endif
c
c
c
 100  continue
      tmin = amt       ! adiabatic mixing temp
      tmin0 = tmin
      tmax = dmax1(tsurf,tamb)
      tmax0 = tmax
      temp = (tmin+tmax)/2.
c
      do 300 j=1,35
      guess = enthal(wc,wa,temp)
      dif = enthalpy - guess

13 -- sys$degadis:TPROP.FOR
```

```
      sum = (abs(enthalpy) + abs(guess))/2. + zero
      if(abs(dif)/sum.le.rcrit .or. abs(dif).le.acrit) goto 400
c
      if(dif.lt. 0.) then
              if(rev) tmax = temp
              if(.not.rev) tmin = temp
              temp = tmin + (tmax-tmin) * tfrac
      else
              if(rev) tmin = temp
              if(.not.rev) tmax = temp
              temp = tmin + (tmax-tmin) * tfrac1
      endif
c
  300 continue
      rev = .not.rev
      if(rev) goto 100
c     write(lunlog,8050) wc,wa,enthalpy,guess,temp
c8050 format(' ADDHEAT? wc: ',1pg12.5,1x,
c     1       'wa: ',1pg12.5,1x,'enthalpy: ',1pg12.5,/,
c     1       '       guess: ',1pg13.5,'  temp: ',1pg13.5)
      if(temp.lt. amt) call trap(17)
      elow = enthal(wc,wa,tmin0)
      if(enthalpy.lt. elow) then      ! catch out of bounds numbers
              temp = tmin0
              enthalpy = elow
              goto 400
              endif
      elow = enthal(wc,wa,tmax0)
      if(enthalpy.gt. elow) then
              temp = tmax0
              enthalpy = elow
              goto 400
              endif
c
      call trap(17)
c
c
  100 continue                ! density calculation
      vp = vapor_p(temp)
      sat = dmin1( sat_hum(pamb,vp), humid)
      rho = 1./(temp*ropw_air(pamb,sat)*wa*(1.+sat)
      1        + wc*temp/gas_temp/gas_rhoe + (ww-wa*sat)/rho_water)
      if(temp.ne.amt) cp = dmax1(dh/(temp-amt),cpa)
      if(temp.lt.amt) stop' ADDHEAT? wrong way.'
c
c
c
      return
      end
####


14 -- sys$desadis:TPROP.FOR
```

```
C.....................................................
C
C     FILE NAME TRANS1 -- FOR USE IN DEGADIS1
C
C.....................................................
C
      SUBROUTINE TRANS(FILE)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$degadis:DEGADIS1.dec'
C
C     BLOCK COMMON
C
      COMMON
     $/GEN3/ rads(2,maxl),astr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/TITL/TITLE
     $/GEN1/ ET(2,isen),R1T(2,isen)
     $/GEN2/ DEN(5,isen)
     $/ITI/T1,TINP,TSRC,TOBS,TSRT
     $/ERROR/STPIN,ERBND,STPMX,WTRG,WTta,WTya,wtyc,wteb,wtmb,wtuh,XLI,
     $ XRI,EPS,ZLOW,STPINZ,ERBNDZ,STPMXZ,SRCOER,srcss,srccut,
     $ htcut,ERNOBL,NOBLpt,crfger,epsilon
     $/PARM/UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comata/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/com_ss/ ess,slen,swid,outcc,outsz,outb,outl,swcl,swal,senl,srhl
     $/PHLAG/CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sigx/ sigx_coeff,sigx_pow,sigx_min_dist,sigx_flag
     $/com_enthal/ h_masrte,H_airrte,H_watrte
     $/NEND/ POUNDN,POUND
     $/ALP/ ALPHA,alphal
     $/phicom/ iphifl,dellay
     $/sprd_con/ ce, delrhomin
     $/COM_SURF/ HTCUTS
C
      character*80 TITLE(4)
C
      character*4 pound
      character*24 TSRC,TINP,TOBS,TSRT
      character*3 sas_name
C
      REAL*8 ML,K
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      character*(*) file
C

1 -- sys$degadis:TRANS1.FOR
```

```
      OPEN(UNIT=8,NAME=FILE,TYPE='NEW',
     $  carriagecontrol='list',
     $  recordtype='variable')
C
      WRITE(8,1000) (TITLE(I),I=1,4)
 1000 FORMAT(A80)
C
      DO 100 I=1,isen
  100 IF(ET(1,I).EQ.POUNDN .AND. ET(2,I).EQ.POUNDN) GO TO 105
      stop ' POUND WAS NOT DETECTED '
  105 NP = I - 1
      WRITE(8,1040) NP
      DO 110 I=1,NP
  110 WRITE(8,1030) ET(1,I),ET(2,I),RIT(2,I)
c
      DO 120 I=1,isen
  120 IF(DEN(1,I) .gt. 1.) GOTO 125
      DO 122 I=1,isen
  122 WRITE(8,1060) DEN(1,I),DEN(2,I),den(3,i),den(4,i),den(5,i)
      stop ' density function blew the loop'
  125 NP = I - 1
      WRITE(8,1040) NP
      DO 130 I=1,NP
  130 WRITE(8,1060) DEN(1,I),DEN(2,I),den(3,i),den(4,i),den(5,i)
c
      DO 140 I=1,maxl
c     cc = srcwc(2,i)*srcden(2,i)
c     if(cc.lt. cclow) then
c             fcc = 0.
c             do ii=i+1,maxl
c             fcc = amax1(srcwc(2,ii)*srcden(2,ii),fcc)
c             enddo
c             if(fcc.ge. cc) goto 140
c             np = i
c             tend = srcwc(1,i)
c             goto 146
c             endif
  140 IF(rads(1,I).EQ.POUNDN .AND. rads(2,I).EQ.POUNDN) GO TO 145
      stop ' POUND WAS NOT DETECTED '
  145 NP = I - 1
  146 WRITE(8,1040) NP
      DO 150 I=1,NP
  150 WRITE(8,1060) rads(1,i),rads(2,i),astr(2,i),srcden(2,i),srcwc(2,i)
      1       ,srcws(2,i),srcenth(2,i)
c
 1020 format(1x,i4,1x,1pg14.7)
 1030 format(3(1x,1pg14.7))
 1040 format(1x,i4)
 1050 format(2(a24,1x))
 1060 format(7(1x,1pg14.7))
 1070 format(1x,1pg14.7)

2 -- sys$desadis:TRANS1.FOR
```

```
 1080 format(a3)
c
      WRITE(8,1050) TINP,TSRC
      write(8,1050) TOBS,TSRT
      WRITE(8,1060) UO,ZO,ZR,ML,USTAR
      write(8,1060) K,G,RHOE,RHOA,DELTA
      write(8,1030) BETA,GAMMAF,CcLOW
      WRITE(8,1060) RM,SZM,EMAX,RMAX,TSC1
      write(8,1030) ALEPH,TEND
      WRITE(8,*) CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
      WRITE(8,1070) ALPHA
      write(8,1080) gas_name
      write(8,1030) gas_mw,gas_temp,gas_rhoe
      write(8,1030) gas_cpk,gas_cpp
      write(8,1030) gas_ufl,gas_lfl,gas_zsp
      write(8,1040) istab
      write(8,1030) tamb,pamb,humid
      write(8,1020) isofl,tsurf
      write(8,1020) ihtfl,htco
      write(8,1020) iwtfl,wtco
      write(8,1030) sigx_coeff,sigx_pow,sigx_min_dist
c
      if(check4) then
             write(8,1030) ess,slen,swid
             write(8,1060) outcc,outsz,outb,outl
             write(8,1060) swcl,swal,senl,srhl
             end if
c
      write(8,1020) iphifl,dellay
c
      if(isofl.eq. 0) write(8,1030) H_masrte
c
      WRITE(8,1030) HTCUTS, ce, delrhomin
c
      CLOSE(UNIT=8)
c
      RETURN
      END
####
```

```
C.....................................................................
C
C     FILE NAME TRANS2 -- USE WITH DEGADIS2
C
      SUBROUTINE TRANS(FILE)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS2.dec'
C
      COMMON
     $/SSCON/ NREC(maxnob,2),TO(maxnob),XV(maxnob)
     $/GEN2/ DEN(5,isen)
     $/ITI/ T1,TINP,TSRC,TOBS,TSRT
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/PARMSC/ RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/PHLAG/ CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/com_sigx/ sigx_coeff,sigx_pow,sigx_min_dist,sigx_flag
     $/nend/ poundn,pound
     $/ALP/ ALPHA,alpha1
     $/CNOBS/ NOBS
C
      character*3 sas_name
      character*80 TITLE(4)
      character*24 TINP,TSRC,TOBS,TSRT
      character*(*) file
C
      REAL*8 K,ML
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      OPEN(UNIT=9,NAME=FILE,TYPE='NEW',
     $  carriagecontrol='list',
     $  recordtype='variable')
C
      WRITE(9,1040) NOBS
      DO 125 I=1,NOBS
  125 WRITE(9,1010) NREC(I,1),NREC(I,2),TO(I),XV(I)
C
      DO 140 I=1,isen
  140 IF(DEN(1,I).gt. 1.) GOTO 145
      stop ' density function error in TRANS'
  145 NP = I - 1
      WRITE(9,1040) NP
      DO 150 I=1,NP
  150 WRITE(9,1060) DEN(1,I),DEN(2,I),den(3,i),den(4,i),den(5,i)
C
      WRITE(9,1060) UO,ZO,ZR,ML,USTAR

1 -- sys$desadis:TRANS2.FOR
```

```
      write(9,1060) K,G,RHOE,RHOA,DELTA
      write(9,1030) BETA,GAMMAF,CcLOW
C
      WRITE(9,1050) TINP,TSRC
      write(9,1050) TOBS,TSRT
C
      WRITE(9,1060) RM,SZM,EMAX,RMAX,TSC1
      write(9,1020) ALEPH,TEND
C
      write(9,1080) sas_name
      write(9,1030) sas_mw,sas_temp,sas_rhoe
      write(9,1020) sas_cpk,sas_cpp
      write(9,1030) sas_ufl,sas_lfl,sas_zsp
      write(9,1040) istab
      write(9,1030) tamb,pamb,humid
      write(9,1025) isofl,tsurf
      write(9,1025) ihtfl,htco
      write(9,1025) iwtfl,wtco
      write(9,1030) sisx_coeff,sisx_pow,sisx_min_dist
C
      WRITE(9,*) CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      WRITE(9,1070) ALPHA
C
 1010 format(1x,i8,1x,i8,2(1x,1pg14.7))
 1020 format(2(1x,1pg14.7))
 1025 format(1x,i4,1x,1pg14.7)
 1030 format(3(1x,1pg14.7))
 1040 format(1x,i4)
 1050 format(2(a24,1x))
 1060 format(5(1x,1pg14.7))
 1070 format(1x,1pg14.7)
 1080 format(a3,1x)
C
      CLOSE(UNIT=9)
      RETURN
      END
$$$$
```

```
C.....................................................
C
C     FILE NAME TRANS2 -- USE WITH SDEGADIS2
C
C.....................................................
C
      SUBROUTINE TRANS(FILE)
C
C
C
C


      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      COMMON
     $/PARM/ UO,ZO,ZR,ML,USTAR,K,G,RHOE,RHOA,DELTA,BETA,GAMMAF,CcLOW
     $/com_sprop/ sas_mw,sas_temp,sas_rhoe,sas_cpk,sas_cpp,
     $ sas_ufl,sas_lfl,sas_zsp,sas_name
     $/comatm/ istab,tamb,pamb,humid,isofl,tsurf,ihtfl,htco,iwtfl,wtco
     $/ITI/ t1,TINP,TSRC,TOBS
     $/PHLAG/CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
     $/ALP/ALPHA,alpha1
C
      character*24 TSRC,TINP,TOBS
      character*3 sas_name
      character*(*) file
C
      REAL*8 K,ML
      LOGICAL CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5
C
      OPEN(UNIT=9,NAME=FILE,TYPE='NEW')
C
      WRITE(9,1060) UO,ZO,ZR,ML,USTAR
      write(9,1060) K,G,RHOE,RHOA,DELTA
      write(9,1030) BETA,GAMMAF,CcLOW
c
      WRITE(9,1050) TINP,TSRC
      write(9,1050) TOBS
c
      write(9,1080) sas_name
      write(9,1030) sas_mw,sas_temp,sas_rhoe
      write(9,1020) sas_cpk,sas_cpp
      write(9,1030) sas_ufl,sas_lfl,sas_zsp
c
      write(9,1040) istab
      write(9,1030) tamb,pamb,humid
      write(9,1025) isofl,tsurf
      write(9,1025) ihtfl,htco
      write(9,1025) iwtfl,wtco
c
      WRITE(9,*) CHECK1,CHECK2,AGAIN,CHECK3,CHECK4,CHECK5

1 -- sys$degadis:TRANS2SS.FOR
```

```
      WRITE(9,1070) ALPHA
C
      CLOSE(UNIT=9)
C
 1020 format(2(1x,1pg14.7))
 1025 format(1x,i4,1x,1pg14.7)
 1030 format(3(1x,1pg14.7))
 1040 format(1x,i4)
 1050 format(2(a24,1x))
 1060 format(5(1x,1pg14.7))
 1070 format(1x,1pg14.7)
 1080 format(a3,1x)
C
      RETURN
      END
$$$$
```

```
C     FILE NAME TRANS3 FOR USE WITH DEGADIS3
C
C.....................................................
C
      SUBROUTINE TRANS(OPNRUP)
c

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS3.dec/list'
C
      COMMON /SORT/TCc(maxnob,maxnt),TCcSTR(maxnob,maxnt),
     $        Tsc(maxnob,maxnt),Trho(maxnob,maxnt),
     $        Tgamma(maxnob,maxnt),Temp(maxnob,maxnt),
     $        TSY(maxnob,maxnt),TSZ(maxnob,maxnt),TB(maxnob,maxnt),
     $        TDIST0(maxnob,maxnt),TDIST(maxnob,maxnt),KSUB(maxnt)
     $/SORTIN/TIM(maxnt),NTIM,ISTRT
     $/ITI/T1,TINP,TSRC,TOBS,TSRT
C
      character*24 tinp,tsrc,tobs,tsrt
C
      character*(*) OPNRUP
C
      T0 = TIM(ISTRT)
      DT = TIM(ISTRT+1) - TIM(ISTRT)
C
      OPEN(UNIT=9,NAME=OPNRUP,TYPE='NEW',
     $        carriagecontrol='list',recordtype='variable')
C
C
      DO 110 I = ISTRT,NTIM
      II = I - ISTRT + 1
  110 KSUB(II) = KSUB(I)
      NTIM = NTIM - ISTRT + 1
      IF(NTIM .EQ. maxnt) GO TO 120
      II = NTIM + 1
      DO 115 I=II,maxnt
  115 KSUB(I) = 0
C
  120 CONTINUE
C
      WRITE(9,*) T0,DT,NTIM
      WRITE(9,*) KSUB
C
      CLOSE(UNIT=9)
C
      RETURN
      END
####
```

1 -- sys$desadis:TRANS3.FOR

```
C.....................................................................
C
C     SUBROUTINE TRAP -- DIAGNOSTICS
C
      SUBROUTINE trap(N,N1)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS1.dec'
c
      COMMON /ITI/T1,TINP,TSRC,TOBS,TSRT

      real*4 tt1
c
      character*24 TINP,TSRC,TOBS,TSRT
c
      character*24 tt
C
      WRITE(lunlog,1100)
      WRITE(lunlog,1110)
      write(lunlog,1115) n
C
      IF(N .EQ. 1 ) WRITE(lunlog,2010) N1
      IF(N .EQ. 2 ) WRITE(lunlog,2020)
      IF(N .EQ. 3 ) WRITE(lunlog,2030) N1
      IF(N .EQ. 4 ) WRITE(lunlog,2040)
      IF(N .EQ. 5 ) WRITE(lunlog,2050)
      IF(N .EQ. 6 ) WRITE(lunlog,2060)
      IF(N .EQ. 7 ) WRITE(lunlog,2070)
      IF(N .EQ. 8 ) WRITE(lunlog,2080) N1
      IF(N .EQ. 9 ) WRITE(lunlog,2090) N1
      IF(N .EQ. 10) WRITE(lunlog,2100) N1
      IF(N .EQ. 11) WRITE(lunlog,2110)
      IF(N .EQ. 12) WRITE(lunlog,2120)
      IF(N .EQ. 13) WRITE(lunlog,2130)
      IF(N .EQ. 14) WRITE(lunlog,2140)
      IF(N .EQ. 15) WRITE(lunlog,2150)
      IF(N .EQ. 16) WRITE(lunlog,2160)
      IF(N .EQ. 17) WRITE(lunlog,2170)
      IF(N .EQ. 18) WRITE(lunlog,2180) N1
      IF(N .EQ. 19) WRITE(lunlog,2190) N1
      IF(N .EQ. 20) WRITE(lunlog,2200)
      IF(N .EQ. 21) WRITE(lunlog,2210)
      IF(N .EQ. 22) WRITE(lunlog,2220)
      IF(N .EQ. 23) WRITE(lunlog,2230)
      IF(N .EQ. 24) WRITE(lunlog,2240)
      IF(N .EQ. 25) WRITE(lunlog,2250)
      IF(N .EQ. 26) WRITE(lunlog,2260)
      IF(N .EQ. 27) WRITE(lunlog,2270)
      IF(N .EQ. 28) WRITE(lunlog,2280)

1 -- sys$desadis:TRAP.FOR
```

```
      IF(N .EQ. 29) WRITE(lunlog,2290)
      IF(N .EQ. 30) WRITE(lunlog,2300)
      IF(N .EQ. 31) WRITE(lunlog,2310)
      IF(N .EQ. 32) WRITE(lunlog,2320)
      IF(N .EQ. 33) WRITE(lunlog,2330)
C
 1100 FORMAT(5X,'The best laid plans of mice and men...')
 1110 FORMAT(5X,'You have entered a TRAP -- the land of no RETURN.')
 1115 format(' Code: ',i4)
 2010 FORMAT(5X,'DEGADIS1? SOURCE INTEGRATION HAS RETURNED IHLF=',I3)
 2020 FORMAT(5X,'Reserved')
 2030 format(5x,'SZF? Local integration failed; IHLF=',I3)
 2040 format(5x,'SURFACE? Negative QRTE for positive DELTA_T')
 2050 FORMAT(5X,'CRFG? MORE POINTS FOR GEN3 WERE NEEDED')
 2060 FORMAT(5X,'TUPF? OBSERVER CALCULATIONS -- TUPF FAILED')
 2070 FORMAT(5X,'TUPF? OBSERVER CALCULATIONS -- TDNF FAILED')
 2080 FORMAT(5X,'SSSUP? OBSERVER INTEGRATION FAILED, IHLF=',I3)
 2090 FORMAT(5X,'SSSUP/SDEGADIS2? PSEUDO-STEADY INTEG FAILED, IHLF=',I3)
 2100 FORMAT(5X,'SSSUP/SDEGADIS2? GAUSSIAN INTEGRATION FAIL, IHLF=',I3)
 2110 FORMAT(5X,'SSSUP/SDEGADIS2? TOTAL No. OF RECORDS EXCEED 120000')
 2120 FORMAT(5X,'Reserved')
 2130 FORMAT(5X,'Reserved')
 2140 FORMAT(5X,'Reserved')
 2150 FORMAT(5X,'Reserved')
 2160 FORMAT(5X,'PSSOUT/PSSOUTSS? PSS STARTED WITH B<0.')
 2170 format(5x,'TPROP/ADDHEAT? Enthalpy out of bounds')
 2180 FORMAT(5X,'ALPH? ALPHA INTEGRATION FAILED, IHLF=',I3)
 2190 FORMAT(5X,'ALPH? RTMI HAS FAILED TO LOCATE ALPHA IERR: ',I4)
 2200 format(5x,'ESTRT? Premature EOF in RUN_NAME.ER1 or RUN_NAME.ER2.')
 2210 FORMAT(5X,'ESTRT1/ESTRT2/ESTRT2SS/ESTRT3? DECODE failed')
 2220 format(5x,'ESTRT1? The parameter file RUN_NAME.ER1 wasnot found.')
 2230 format(5x,'SORTS1? Fewer than 3 points sorted for any time.')
 2240 format(5x,'TPROP? Trial and error loop compromised')
 2250 format(5x,'TPROP? Isothermal density loop compromised')
 2260 format(5x,'TPROP? Invalid entry flag in ADIABAT')
 2270 format(5x,'Reserved')
 2280 format(5x,'TPROP? IGEN request too large in SETDEN')
 2290 format(5x,'PHIF? flag out of bounds')
 2300 format(5x,'SSSUP/SDEGADIS2? concentration greater than RHOE')
 2310 format(5x,'SSSUP? concentration greater than RHOE')
 2320 format(5x,'PSS? Sz conversence failure.')
 2330 format(5x,'SSG? Sz conversence failure.')
C
      CLOSE(UNIT=9)
C
      CALL TRANS('trap.DBG')
C
      istat = lib$date_time(TT)
      tt1 = t1
      ttime = secnds(tt1)/60.
C

: -- sys$desadis:TRAP.FOR
```

```
  140 WRITE(lunlog,3000) TT
      WRITE(lunlog,3010) Ttime
 3000 FORMAT(1X,' -- ENDing AT ',A24)
 3010 FORMAT(5X,' ***** ELAPSED TIME ***** ',1pg13.5,' MIN ')
C
      CALL EXIT
      END
$$$$
```

```
C.....................................................................
C
C     FUNCTION TO CALCULATE A SPECIFIED TIME
C
      FUNCTION TS(T01,DIST)
C
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      COMMON
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
C
      TS = T01 + (DIST+RMAX)**(1./ALPHA1) /ALEPH
C
      RETURN
      END
****
```

1 -- sys$desadis:TS.FOR

```
C.....................................................
C
C     OBSERVER TRIAL AND ERROR FUNCTIONS
C       --- TUPF ---- TDNF ---
C
c     Modified 4 Nov 85 to account for more general forms of the
c            Gas Radius as a function of time.
C
      FUNCTION TUPF(TO1)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS2.dec'
c
      COMMON
     $/GEN3/ rads(2,maxl),gstr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/ERROR/SYOER,ERRO,SZOER,WTAIO,WTQOQ,WTSZO,ERRP,SMXP,
     $ WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,ERTDNF,ERTUPF,WTRUH,WTDHG
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
C
      LOGICAL REV,LAST,pflag
      REV = .FALSE.
      LAST= .FALSE.
      pflag = .false.
C
              stop ' use tupf.old as the source for this routine'
      TMAXO = RMAX**(1./ALPHA1)/ALEPH + TO1
      TMINO = TOL
  130   TMIN = TMINO
      TMAX = TMAXO
      IF(TO1 .LT. 0.) TMIN = 0.
      T1 = (TMAX + TMIN)/2.
C
      DO 100 I = 1,100
      II = 0
  110 XG = -AFGEN(RADG,T1,'tupf')
      XO = XIT(T1,TO1)
      IF(XO .LT. 0.) GO TO 120
      T1 = (T1+TMIN)/2.
      II = II + 1
      if(pflag) write(6,5020) t1,t01,xg,xo
 5020 format(' t1:',1pg13.5,' t01:',1pg13.5,' xg:',1pg13.5,
     1 ' xo:',1pg13.5)
      IF(II.EQ. 20) GOTO 101
      GO TO 110
C
  120 CONTINUE
      DIF = XO - XG

1 -- sys$desadis:TUPF.FOR
```

```
      sum = (xo + xs)/2.
      IF(ABS(DIF)/ABS(sum) .LT. ERTUPF) GO TO 1000
      if(pflag) write(6,5040) tmin,tmax,t1,xo,xs
 5040 format(' tmin:',1pe13.5,' tmax:',1pe13.5,' t1:',1pe13.5,
     1 ' xo:',1pe13.5,' xs:',1pe13.5)
      IF(REV) GO TO 140
      IF(DIF .GT. 0.) TMAX = T1
      IF(DIF .LT. 0.) TMIN = T1
      GO TO 100
C
  140 IF(DIF .LT. 0.) TMAX = T1
      IF(DIF .GT. 0.) TMIN = T1
C
  100 T1 = TMIN + 0.5*(TMAX-TMIN)
C
  101 IF(.NOT. REV) GO TO 150
      IF(LAST) then
      if(pflag) write(6,4000) RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND,alpha
 4000 format(' rm:',1pe13.5,' szm:',1pe13.5,' emax: ',1pe13.5,/,
     1 ' rmax:',1pe13.5,' tsc1:',1pe13.5,' aleph:',1pe13.5,/,
     2 ' tend:',1pe13.5,' alpha:',1pe13.5)
      if(pflag) write(6,4010) tmax0,tmin0
 4010 format(' tmax0: ',1pe13.5,' tmin0: ',1pe13.5)
             CALL trap(6)
      endif
             TMAX0 = 1.1*TMAX0
             TMIN0 = 0.92*TMIN0
             REV = .FALSE.
             LAST=.TRUE.
             pflag=.true.
  150 CONTINUE
      t1 = TL+.01
      T2 = TL-.01
      XG1 = AFGEN(RADG,T1,'tupf')
      xg2 = AFGEN(RADG,T2,'tupf')
      dif = abs(xg1-xg2)
      if(dif.gt. 100. .AND. (XO.GE.XG2 .AND. XO.LE.XG1)) then
             tupf = t2                ! JUMP FROM BLANKET TO NOBLANKET
             RETURN
             ENDIF
      REV = .TRUE.
      GO TO 130
C
 1000 TUPF = T1
      IF(REV) WRITE(lunlog,1100)
 1100 FORMAT(1X,'?TUPF? -- REV WAS TRUE -- ',49X,'%')
      RETURN
      END
C
      FUNCTION TDNF(TO1)
C

: -- sys$desadis:TUPF.FOR
```

```
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      include 'sys$desadis:DEGADIS2.dec'
C
      COMMON
     $/GEN3/ rads(2,maxl),gstr(2,maxl),srcden(2,maxl),srcwc(2,maxl),
     $ srcwa(2,maxl),srcenth(2,maxl)
     $/ERROR/SYOER,ERRO,SZOER,WTAIO,WTQOO,WTSZO,ERRP,SMXP,
     $ WTSZP,WTSYP,WTBEP,WTDH,ERRG,SMXG,ERTDNF,ERTUPF,WTRUH,WTDHG
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
C
      LOGICAL REV,LAST,pflag
      REV = .FALSE.
      LAST= .FALSE.
      pflag = .false.
C
      TMINO = RMAX**(1./ALPHA1)/ALEPH + TO1
      TMAXO = (2.*RMAX)**(1./ALPHA1)/ALEPH + TO1
C
  100 TMIN = TMINO
      TMAX = TMAXO
      IF(TMIN .LT. 0.) TMIN = 0.
      T = (TMAX + TMIN)/2.
C
      DO 110 I = 1,100
      II = 0
  120 XG = AFGEN(RADG,T,'tdnf')
      XO = XIT(T,TO1)
C
      IF(XO .GT. 0.) GO TO 130
      T = (TMAX + T)/2.
      II = II + 1
      if(pflag) write(6,5020) t,to1,xg,xo
 5020 format(' t:',1pg13.5,' to1:',1pg13.5,' xg:',1pg13.5,
     1 ' xo:',1pg13.5)
      IF(II.EQ. 20) GOTO 111
      GO TO 120
  130 CONTINUE
C
      DIF = XO - XG
      sum = xo+xg
      IF(ABS(DIF)/abs(sum) .LT. ERTDNF) GO TO 1000
      if(pflag) write(6,5040) tmin,tmax,t,xo,xg
 5040 format(' tmin:',1pg13.5,' tmax:',1pg13.5,' t:',1pg13.5,
     1 ' xo:',1pg13.5,' xg:',1pg13.5)
C
      IF(REV) GO TO 140
      IF(DIF .GT. 0.) TMAX = T
      IF(DIF .LT. 0.) TMIN = T

3 -- sys$desadis:TUPF.FOR
```

```
      GO TO 110
C
  140 IF(DIF .LT. 0.) TMAX = T
      IF(DIF .GT. 0.) TMIN = T
C
  110 T = TMIN + 0.5*(TMAX - TMIN)
C
  111 IF(.NOT. REV) GO TO 150
      IF(LAST) then
      if(pflag) write(6,4000) RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND,alpha
 4000 format(' rm:',1pg13.5,' szm:',1pg13.5,' emax: ',1pg13.5,/,
      1 ' rmax:',1pg13.5,' tsc1:',1pg13.5,' aleph:',1pg13.5,/,
      2 ' tend:',1pg13.5,' alpha:',1pg13.5)
      if(pflag) write(6,4010) tmax0,tmin0
 4010 format(' tmax0: ',1pg13.5,' tmin0: ',1pg13.5)
           CALL trap(7)
      endif
           TMAX0 = 1.1*TMAX0
           TMIN0 = 0.92*TMIN0
           REV = .FALSE.
           LAST=.TRUE.
           pflag = .true.
      GOTO 100
C
  150 CONTINUE
      t1 = T+.01
      T2 = T-.01
      XG1 = AFGEN(RADG,T1,'tdnf')
      xg2 = AFGEN(RADG,T2,'tdnf')
      dif = abs(xg1-xg2)
      if(dif.gt. 100. .AND. (XO.LE.XG2 .AND. XO.GE.XG1)) then
           tdnf = t2                ! JUMP FROM BLANKET TO NOBLANKET
           RETURN
           ENDIF
      REV = .TRUE.
      GO TO 100
 1000 TDNF = T
      IF(REV) WRITE(lunlog,1100)
 1100 FORMAT(5X,'?TDNF? -- REV WAS TRUE',49X,'Z')
      RETURN
      END
####
```

```
) -- sys$desadis:TUPF.FOR
```

```
C.....................................................
C
C     FUNCTIONS ASSOCIATED WITH THE OBSERVER CALCULATIONS
C
C.....................................................
C
C     FUNCTION TO RETURN OBSERVER VELOCITY AS A FUNCTION OF TIME
C
      FUNCTION UIT(T,T01)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      COMMON
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
C
      UIT = ALPHA1 * ALEPH**ALPHA1 *(T-T01)**ALPHA
C
      RETURN
      END
c
c
C.....................................................
C
C     FUNCTION TO RETURN POSITION AS A FUNCTION OF TIME AND TO
C
C
      FUNCTION XIT(T1,T01)
C

      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      COMMON
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
C
      xit = -rmax
      arg = t1-t01
      if(arg .le. 0.) return
      XIT = (ALEPH*(T1 - T01))**ALPHA1 - RMAX
C
      RETURN
      END
c
c
C.....................................................
C
C
C     FUNC TO RETURN A VALUE OF TO BASED ON A POSITION AND TIME
C

1 -- sys$desadis:UIT.FOR
```

```
      FUNCTION TOOB(X,T)
C
      Implicit Real*8 ( A-H, O-Z ), Integer*4 ( I-N )

      COMMON
     $/PARMSC/RM,SZM,EMAX,RMAX,TSC1,ALEPH,TEND
     $/ALP/ALPHA,alpha1
C
      ARG = 0.
      CHECK = ABS((ABS(X)-ABS(RMAX)))/(ABS(X)+ABS(RMAX))
      IF(CHECK .GT. 0.001) ARG = (X + RMAX)**(1./ALPHA1)/ALEPH
      TOOB = T - ARG
      RETURN
      END
$$$$
```

APPENDIX D

ERROR MESSAGES

To assist the user in determining the source of any problems, a diagnostic procedure has been included in DEGADIS. The subroutine TRAP is meant to cause an orderly termination of the program for many detected errors. It performs two basic functions: TRAP displays an error code and a single line diagnostic message giving the reason for premature termination, and TRAP forces an output of the COMMON area data sets to the file TRAP.DBG.

The first three lines sent to the execution log (default=TERMINAL) include the TRAP introductory lines and the error code number:

```
The best laid plans of mice and men . . .
You have entered a TRAP--THE LAND OF NO RETURN
CODE:  NN
```

where NN represents the code of the error message which follows in the log. The error message begins with the name of the calling routine.

The following is a list of the error codes, error messages, and suggested actions for each problem.

Code: 1

DEGADIS1? Source integration has returned IHLF=NN

Action: This error occurs during integration of the equations describing the gas source. NN is an error code returned by the integration package RKGST.

When NN=11, more than 10 bisections of the initial increment of the independent variable were necessary to take an integration step within the specified error. Reduce the initial step size of the independent variable (ER1 file). If this does not work, it will be necessary to either increase the error criteria for all of the dependent variables being integrated (ER1 file) or increase the error criteria for the variable violating the criteria by decreasing the error weight for that variable (ER1 file).

When NN=12, the initial increment of the independent variable is 0. Correct the ER1 file and execute the program again.

When NN=13, the initial increment of the independent variable is not the same sign as the difference between the upper bound of the interval and the lower bound of the interval. Correct the ER1 file and execute the program again.

Code: 2
Reserved

Action: Not applicable

Code: 3
SZF? Local integration failed; IHLF=NN

Action: This error occurs during estimation of the value of S_z over the source when no gas blanket is present. See Code: 1 for appropriate actions.

Code: 4

SURFACE? Negative QRTE for positive DELTA_T

Action: Diagnostic message indicating an error in estimation of the heat capacity.

Code: 5

CRFG? More points for GEN3 were needed

Action: The COMMON area /GEN3/ stores representative values of the calculated source parameters. If this condition occurs, relax the CRFG error criteria in the ER2 file. If this is a common problem, the length of the /GEN3/ vectors can be increased by changing the value of MAXL in DEGADIS1.DEC and reinstalling DEGADIS.

Code: 6

TUPF? Observer calculations--TUPF failed

Action: The trial and error search associated with finding the upwind edge of the gas source for an observer failed. Often this problem can be avoided by adding one or two additional observers to the present number of observers (which moves the solution of the trial and error). Another possibility is to increase the error criteria for this function in the ER2 file.

Code: 7

TUPF? Observer calculations--TDNF failed

Action: The trial and error search associated with finding the downwind edge of the gas source for an observer failed. Often this problem can be avoided by adding one or two additional observers to the present number of observers (which moves the solution of the trial and error). Another possibility is to increase the error criteria for this function in the ER2 file.

Code: 8

SSSUP? Observer integration failed; IHLF=NN

Action: This error occurs during integration of the four differential equations which average the source for each observer. See Code: 1 for appropriate actions.

Code: 9

SSSUP/SDEGADIS2? Pseudo-Steady integration failed, IHLF=NN

Action: This error occurs during integration of the four differential equations describing the portion of the downwind calculation when $b > 0$. The routine calling TRAP is SSSUP if a transient simulation is being executed; if a steady state simulation is being executed, the calling routine is SDEGADIS2. See Code: 1 for appropriate actions.

Code: 10
SSSUP/SDEGADIS2? Gaussian integration failed, IHLF=NN

Action: This error occurs during integration of the differential equations which describe the portion of the downwind calculation when b = 0. The routine calling TRAP is SSSUP if a transient simulation is being executed; SDEGADIS2 is calling TRAP if a steady state simulation is being executed. See Code: 1 for appropriate actions.

Code: 11
SSSUP/SDEGADIS2? TOTAL NO. OF RECORDS EXCEEDS 120,000

Action: This is an arbitrary stopping point for the process in order to keep a runaway simulation from filling up disk space. Relax the output specifications in the ER2 file in order to generate less output.

Code: 12
Reserved

Action: Not applicable

Code: 13
Reserved

Action: Not applicable

Code: 14
Reserved

Action: Not applicable

Code: 15
Reserved

Action: Not applicable

Code: 16
PSSOUT/PSSOUTSS? PSS started with b < 0

Action: This condition is checked at the beginning of the downwind calculation in order to confirm proper handling of the movement to the Gaussian phase of the downwind calculation. Correct the initial conditions and execute the program again.

Code: 17
TPROP/ADDHEAT? Enthalpy out of bounds

Action: Diagnostic message indicating an enthalpy lower than the adiabatic mixing enthalpy was passed to ADDHEAT.

Code: 18

ALPH? ALPHA integration failed; IHLF=NN

Action: The integration which determines the integral least squares fit for ALPHA has failed. See Code: 1 for appropriate actions. Note that large values of Monin-Obukhov length ($\lambda >$ O(1.0 m)) in combination with stable atmospheric conditions may cause this integration to fail.

Code: 19

ALPH? RTMI has failed to locate ALPHA; IERR: NN

Action: The search procedure to determine the value of ALPHA has failed. NN is an error code returned by the routine RTMI.

When NN=1, the search for ALPHA failed after a specified number of iterations.

When NN=2, the basic assumption that the function which governs the search for ALPHA changes sign over the specified interval is false.

This error is probably the result of an unusual velocity specification such as small values for the Monin-Obukhov length ($\lambda <$ O(1.0 m)) or small values for the reference height ($z_0 <$ O(10λ)). Also see Code: 18.

Code: 20

ESTRT? Premature EOF in RUN_NAME.ER1 or RUN_NAME.ER2.

Action: The portion of the program which reads ER1 and ER2 files encountered an end-of-file before all of the information had been gathered. Confirm these files and execute the program again. If necessary, copy and edit an EXAMPLE file for your application and execute the program again.

Code: 21
ESTRT1/ESTRT2/ESTRT2SS/ESTRT3? DECODE failed

Action: The portion of the program which reads the ER1, ER2, or ER3 file failed to understand a numerical entry. The numbers must appear in columns 11-20 of the line with no alphabetic characters in the field. This does not apply to comment lines which contain an exclamation point (!) in the first column of the line.

Code: 22
ESTRT1? The parameter file RUNNAME.ER1 was not found

Action: The ER1 file was not found for the current simulation (RUNNAME). Copy the EXAMPLE.ER1 file to RUNNAME.ER1 and edit it as necessary. Execute the program again.

Code: 23
SORTS1? Fewer than 3 points sorted for any time

Action: Only one or two simulation points were applicable for the sort times specified. There are two possible causes for this condition: First, sort times specified were either before the simulation had developed significantly, or after the simulation was completed. If additional information is desired at the end of the simulation, restart the simulation and specify a lower concentration of interest in the input step (DEGADISIN). Second, the number of observers specified for the problem was too low to give a good resolution of the downwind concentration field. Increase the number of observers in the ER2 file.

Code: 24
TPROP? Trial and error loop compromised

Action: TPROP estimates the temperature of a mixture based upon the composition and enthalpy of the mixture. Ensure the properties for the diffusing species are entered correctly and execute the simulation again.

Code: 25
Reserved

Action: Not applicable

Code: 26
TPROP? Invalid entry flag in ADIABAT

Action: This is a programming diagnostic. This error should never occur.

Code: 27
Reserved

Action: Not applicable

Code: 28

TPROP? IGEN request too large in SETDEN

Action: The subroutine SETDEN performs a series of adiabatic mixing calculations with a specified gas mixture and ambient air and places the results in the array DEN(5,IGEN). This error indicates more points are needed in DEN than were originally requested. Increase the allocation for DEN by changing the value of IGEN in DEGADISIN.DEC and reinstalling DEGADIS.

Code: 29

PHIF? flag out of bounds

Action: This is programming diagnostic. This error should never occur.

Code: 30

SSSUP/SDEGADIS2? concentration greater than RHOE

Action: If the concentration of the contaminant becomes greater than the pure component density for an isothermal simulation, this error will occur. However, this situation should never occur.

Code: 31

Reserved

Action: Not applicable

Code: 32

PSS? Sz convergence failure

Action: This is a programming diagnostic. This error should never occur.

Code: 33

SSG? Sz convergence failure

Action: This is a programming diagnostic. This error should never occur.

APPENDIX E

PARTIAL LISTING OF PROGRAM VARIABLES

Variable	Data Type	Symbol	Units	Comments
AGAIN	LOGICAL			Local communications in SSSUP
ALEPH	REAL			Collection of constants to calculate observer position and velocity
ALPHA	REAL	α	n/a	Power law velocity profile power
ALPHA1	REAL	$(1.0 + \alpha)$	n/a	
BETA	REAL	β	n/a	Lateral similarity power
CCLOW	REAL		kg/m^3	Lowest mixture concentration of interest
CHECK1	LOGICAL			Unused logical flag
CHECK2	LOGICAL			When true, release type without a liquid source
CHECK3	LOGICAL			Local communications flag used in DEGADIS1

Variable	Data Type	Symbol	Units	Comments
CHECK4	LOGICAL			When true, steady state release
CHECK5	LOGICAL			When true, user sets time sort parameters
DELTA	REAL	δ	$m^{1-\beta}$	Lateral similarity coefficient
DEN(1,I)	REAL	y_c	mole fraction	Contaminant mole fraction
DEN(2,I)	REAL	c_c	kg/m^3	Contaminant concentration for the given mole fraction
DEN(3,I)	REAL	ρ	kg/m^3	Mixture density for the given mole fraction
DEN(4,I)	REAL	h	J/kg	Mixture enthalpy for the given mole fraction
DEN(5,I)	REAL	T	K	Mixture temperature for the given mole fraction
EMAX	REAL		kg/s	Maximum of secondary source mass evolution rate
ESS	REAL	E	kg/s	Steady state release rate
ET(1,I)	REAL	t	s	Independent variable time for ordered pairs ET

Variable	Data Type	Symbol	Units	Comments
ET(2,I)	REAL	E(t)	kg/s	Source mass evolution rate as a function of time characterized by ordered pairs
G	REAL	g	m/s^2	Acceleration due to gravity
GAMMAF	REAL	$\Gamma(1/(1+\alpha))$	n/a	
GAS_CPK	REAL	q_1	J/kmol	Constant for contaminant heat capacity
GAS_CPP	REAL	p_1	n/a	Power for contaminant heat capacity
GAS_LFL	REAL		mole fraction	Lower flammability limit of contaminant
GAS_MW	REAL	MW_C	kg/kmol	Contaminant molecular weight
GAS_NAME	CHARACTER*3			Name of contaminant
GAS_RHOE	REAL	ρ_0	kg/m^3	Saturated vapor density of contaminant at T_0
GAS_TEMP	REAL	T_0	K	Contaminant storage temperature
GAS_UFL	REAL		mole fraction	Upper flammability limit of contaminant

Variable	Data Type	Symbol	Units	Comments
GAS_ZSP	REAL		m	Height for estimating flammability contours
GMASS0	REAL		kg	Initial mass of gas over the primary source
HTCO	REAL	h_0	J/m^2sK	Constant coefficient when IHTFL=-1
		V_H	m/s	LLNL heat transfer velocity when IHTFL=2
HUMID	REAL		kg water/ kg dry air	Ambient absolute humidity
IHTFL	INTEGER			Heat transfer flag: IHTFL=-1 constant coefficient; IHTFL=0 no heat transfer; IHTFL=1 DEGADIS coefficient; IHTFL=2 LLNL coefficient
ISOFL	INTEGER			Isothermal release when ISOFL=1
ISTAB	INTEGER			Pasquill atmospheric stability indicator (ISTAB=1 for A, (ISTAB=2 for B, etc.)
IWTFL	INTEGER			Water transfer flag IWTFL=-1 constant coefficient; IWTFL=0 no water transfer; IWTFL=1 DEGADIS coefficient

Variable	Data Type	Symbol	Units	Comments
K	REAL	k	n/a	von Karman's constant 0.35
LUNLOG	INTEGER			Fortran logical unit number which acts as a simulation log
MAXNOB	INTEGER			Maximum number of observers
ML	REAL	λ	m	Monin-Obukhov length
NOBS	INTEGER			Number of observers for the pseudo-steady state simulation
NREC(I,1)	INTEGER			Number of records generated in PSSOUT for observer I
NREC(I,2)	INTEGER			Number of records generated in SSGOUT for observer I
PAMB	REAL	p	atm	Ambient pressure
POUND	CHARACTER*4			Character string to signal end of data ('// ')
POUNDN	REAL			Numerical value to signal end of data (-1.E-20)

Variable	Data Type	Symbol	Units	Comments
QSTR(1,I)	REAL	t	s	Independent variable time for ordered pairs QSTR
QSTR(2,I)	REAL	Q_*	kg/m^2s	Atmospheric takeup rate as a function of time
RADG(1,I)	REAL	t	s	Independent variable time for ordered pairs RADG
RADG(2,I)	REAL	R	m	Secondary source radius as a function of time
RELHUMID	REAL		%	Ambient relative humidity
RHOA	REAL	ρ_a	kg/m^3	Ambient air density
RM	REAL	R_m	m	Radius at EMAX (when secondary source mass evolution rate is a maximum)
RMAX	REAL	R_{max}	m	Maximum secondary source radius
RT2	REAL	$\sqrt{2}$.	n/a	Constant
R1SS	REAL	R_p	m	Steady state primary source radius
R1T(1,I)	REAL	t	s	Independent variable time for ordered pairs R1T

Variable	Data Type	Symbol	Units	Comments
R1T(2,I)	REAL	R_p	m	Primary source radius as a function of time characterized by ordered pairs
SIGX_COEFF	REAL			Along-wind similarity coefficient
SIGX_MIN_DIST	REAL		m	Minimum distance to apply along-wind dispersion correction
SIGX_POW	REAL		n/a	Along-wind similarity power
SLEN	REAL	L	m	Steady state source length
SQPIO2	REAL	$\sqrt{\pi/2}$.	n/a	Constant
SQRTPI	REAL	$\sqrt{\pi}$		Constant
SRCDEN(1,I)	REAL	t	s	Independent variable time for ordered pairs SRCDEN
SRCDEN(2,I)	REAL	ρ	kg/m^3	Secondary source density as a function of time
SRCENTH(1,I)	REAL	t	s	Independent variable time for ordered pairs SRCENTH

Variable	Data Type	Symbol	Units	Comments
SRCENTH(2,I)	REAL	h	J/kg	Secondary source enthalpy as a function of time
SRCWA(1,I)	REAL	t	s	Independent variable time for ordered pairs SRCWA
SRCWA(2,I)	REAL	w_a	mass fraction	Secondary source air mass fraction as a function of time
SRCWC(1,I)	REAL	t	s	Independent variable time for ordered pairs SRCWC
SRCWC(2,I)	REAL	w_c	mass fraction	Secondary source contaminant mass fraction as a function of time
SWID	REAL		m	Steady state source width
SZM	REAL	S_{z0m}	m	Value of S_{z0} at EMAX (when secondary source mass evolution rate is a maximum)
TAMB	REAL	T	K	Ambient temperature
TEND	REAL		s	Termination time of secondary source

Variable	Data Type	Symbol	Units	Comments
TINP	CHARACTER*24			Time DEGADISIN was executed
TITLE(1:4)	CHARACTER*80			Text title block 4 lines of 80 spaces
TO(I)	REAL		s	Time of release for observer I
TSURF	REAL	T_s	K	Surface temperature
USTAR	REAL	u_*	m/s	Friction velocity
UO	REAL	u_0	m/s	Ambient velocity at height z_0
WTCO	REAL	F	kmol/m^{2}satm	Mass transfer coefficient when IWTFL=-1
XV(I)	REAL	x_v	m	Virtual source position for estimation of S_y in SSG
ZO	REAL	z_0	m	Height for velocity u_0
ZR	REAL	z_R	m	Roughness length

END

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DTIC