PB83178830

Information Circular 8901

Real-Time Calculation of Product-of-Combustion Spread in a Multilevel Mine

By John C. Edwards and Rudolf E. Greuer

UNITED STATES DEPARTMENT OF THE INTERIOR
James G. Watt, Secretary

BUREAU OF MINES
Robert C. Horton, Director

This publication has been cataloged as follows:

Edwards, John C

Real-time calculation of product-of-combustion spread in a multi-level mine.

(Information circular · United States Department of the Interior, Bureau of Mines ; 8901)

Includes bibliographical references.

Supt. of Docs. no.: I 28.27:8901.

1. Mine fires—Data processing. 2. Mine ventilation—Data processing. 3. Combustion gases—Data processing. 4. FORTRAN (Computer program language). 5. Real-time data processing. I. Greuer, Rudolf E. II. Title. III. Series: Information circular (United States. Bureau of Mines) ; 8901.

TN295.U4 [TN315] 622s [622' 8] 82-600293

CONTENTS

ILLUSTRATIONS

TABLES

REAL-TIME CALCULATION OF PRODUCT-OF-COMBUSTION SPREAD IN A MULTILEVEL MINE

By John C. Edwards [1] and Rudolf E. Greuer [2]

ABSTRACT

A computer program, developed for the Bureau of Mines under contract, predicts in a quasi-steady-state approximation the ventilation and contaminant concentrations and temperatures when a fire occurs in a multilevel mine. For periods of time in which there is no significant change in the ventilation, yet a fire is producing fumes, a real-time fume concentration throughout the mine is calculated. Multiple and time-variable contaminant sources can be simulated. Recirculation paths that can develop provide a mechanism for increasing the fume concentration in the mine network and are identified by the computer program. This report contains a listing of the Fortran computer program as well as the required format of the input data. Two examples are provided of the real-time spread of smoke from a fuel-rich fire throughout a multilevel mine. The first example considers an operational exhaust fan as well as a booster fan. The second example evaluates the real-time smoke spread following a failure in the exhaust fan; recirculation occurs in this latter case.

[1]Physicist, Pittsburgh Research Center, Bureau of Mines, Pittsburgh, Pa.
[2]Professor of mining engineering, Michigan Technological University, Houghton, Mich.

INTRODUCTION

The successful planning of miner escape and rescue measures in the event of a fire in a mine, as well as the implementation of a fire detection system, is contingent upon the capability to predict the time-dependent concentration of the products of combustion in the mine network. Michigan Technological University (MTU)[3] has developed for the Bureau of Mines under contract J0285002 a computer program for the real-time spread of fumes throughout a multilevel mine network. The program is a combination of an earlier program[4] developed by MTU, that was restructured for steady-state analysis[5] with a real-time modification and a program modification that gives the user the choice of using a least squares representation of the fan characteristic data as an alternative to a Lagrange interpolation of the fan data.

The computation procedure accounts for airway resistances, interaction of fans, and thermal exchange with the airway walls. The buoyancy induced natural ventilation is calculated directly from the airway temperatures, which change in a quasi-steady-state manner owing to thermal diffusion into the airway walls. The fire is quantified by its heat production in determining the effects of natural ventilation. Discussion of the program capability was reported earlier.[6]

This report furnishes the user a complete listing of the mine ventilation computer program for a real-time calculation of contaminant spread throughout a multilevel mine network. Instructions are provided on how to prepare the data, and two sample calculations are presented.

The mine ventilation computer program is used to simulate airflow in a multilevel mine network by designating each junction (crosscut and intersection) and branch (airway) with an identification number. The program internally forms closed paths (meshes) throughout the network. The conservation of energy is applied to each mesh, and the conservation of mass is applied to each junction. The program iteratively develops solutions to the airflow rates and temperatures throughout the mine. In the case where one or more fires are simulated, the program calculates the smoke concentration in each airway in the steady-state mode based upon an airflow rate computed for a fixed time after the inception of the fire. These airflow rates are further utilized to calculate the smoke spread throughout the mine network under the condition of one or more fires of various durations.

The real-time concentration calculation performed by the computer program assumes a steady ventilation flow. This is a reasonable approximation for fires in their incipient stage of growth. In this early stage changes occur primarily in the immediate vicinity of the fire. There are three ways to characterize the fire in an airway: (1) a specified

---

[3]Greuer, R. E. Real-Time Precalculation of the Distribution of Combustion Products and Other Contaminants in the Ventilation System of Mines. Final Report to Bureau of Mines (Contract J0285002 by Michigan Technological University). BuMines OFR 22-82, March 1981, 261 pp.; NTIS PB 82-183104.

[4]Greuer, R. E. Study of Mine Fires and Mine Ventilation. Part I. Computer Simulation of Ventilation Systems Under the Influence of Mine Fires. BuMines OFR 115(1)-78, October 1977, 162 pp.; NTIS PB 288 231/AS.

[5]Computer Sciences Corp. Computer Simulation of Ventilation Systems Under the Influence of Mine Fires. Program Users Manual and Program Maintenance Manual, 1980; prepared for the Bureau of Mines under GSA Contract GS-045-22715.

[6]Edwards, J. C. Computer-Aided Ventilation Modeling. Paper in underground Metal and Nonmetal Mine Fire Protection. BuMines IC 8865, 1981, pp. 78-85. Proceedings: Bureau of Mines Technology Transfer Seminars, Denver, Colo., Nov. 3, 1981, and St. Louis, Mo., Nov. 6, 1981.

concentration and heat input, (2) the oxygen concentration of the fumes that leave the fire zone, or (3) the fume and heat production associated with the oxygen delivered to the fire. Options 2 and 3 correspond to oxygen-rich and fuel-rich fires respectively.

The real-time computational feature of the computer program enables the user to discriminate between (1) airways that have subcritical product-of-combustion concentrations for a period of time adequate for rescue measures before reaching a critical level of concentration, and (2) airways that remain subcritical for long times. The word "critical" is applied to those airways that are unsafe for human survival.

In addition to a time-dependent evaluation of the product-of-combustion hazard throughout the mine network, the program can be used to evaluate the total exposure a miner receives while waiting for rescue in a specified airway.

The computational procedure for the network computation is explained elsewhere,[7] as is that for the real-time fume (product of combustion, contaminants).[8] To facilitate the real-time concentration calculation, the program generates control volumes of homogeneous contaminant concentrations that advance with the flow throughout the mine network. When two or more control volumes meet at a junction, a new control volume leaves the junction with a concentration determined by conservation of mass at the junction.

As part of the computer output, the terms "fumes" and "waves" are used. "Fumes" represents contaminated air, and "waves" represents the boundary between moving control volumes with different concentrations.

Waves are introduced to enable the program user to monitor the spread of contaminated air throughout the network. When contaminated air enters an airway at the starting junction of an airway with otherwise fresh air, the wave marks the interface between the contaminated and the fresh air. The wave travels with the airflow velocity in the airway and is identified with a number. When two waves of different concentration meet at a junction and further contamination or dilution occurs, a new wave is used to characterize the resultant contaminant concentration. In this manner, one or more waves are generated. The output of the program execution identifies in ascending order those airways that have contaminated air by the highest wave number for the airway, the concentration (volume-percent) of the contaminated air behind the front of the wave, and the starting time for the wave. Subsequent output specifies the start and arrival time and concentration for the last five waves generated. The number of waves generated depends upon the complexity of the ventilation system. If recirculation occurs, then potentially an infinite number of waves can be generated. The wave generation process is suspended when the difference between the concentration associated with two sequential waves becomes less than a user-specified threshold, designated CRITSM in the data input. A more detailed explanation of the wave generation mechanism is available.[9]

The program has a limitation of a maximum of five waves that can be stored per airway. If more than five waves are stored, wave compaction occurs through the removal of the excess waves and the advancement of the data in the remaining waves in the storage by the number of deleted waves.

The following section gives an overview of the structure of the input data and explains how to prepare the input data for a real-time calculation. This is followed by a section that presents the results of two sample calculations. A listing of the Fortran computer program is supplied in appendix A.

[7]Work cited in footnote 4.

[8]Work cited in footnote 3.

[9]Work cited in footnote 3.

INPUT DATA PREPARATION

There are three major sections of the input data: (1) network input, (2) concentration input, and (3) real-time input.

NETWORK INPUT

The network input furnishes a basic description of the mine network including the fan characteristic data and physical dimensions, airflow resistance, and thermal properties of the airways. This section controls the type of calculation requested, i.e., network airflow rates with or without concentration and temperature calculations. The following data cards are included: network control card, airway cards, junction cards, fan characteristic cards, and additional airway cards. (Tables 1-6, which illustrate these cards, appear on pages 6-7.) The network control card specifies the number of airways, NB, the number of junctions NJ, and the number of fans NFNUM in the network. If additional airway cards are used to supplement or replace the original airway cards to be read in, their number NADBC is entered. Further data on the network control card includes conditional values as to whether NJ junction cards will be entered for use in calculating the natural ventilation pressures as well as to whether a network, temperature, or concentration calculation will be made. The conditional values are set by the value 1 for occurrence and 0 for omission. Suggested values for the maximum number of network calculations and the maximum number of iterations within the network and concentration parts of the program are MADJ=10 and ITN=30 respectively. The reference air density DR and air temperature TR must be specified. If a real-time analysis is to be made, the marker IRTCC is set equal to 1; otherwise it is at 0.

The airway cards identify each airway by a number, NO, from starting junction JS to ending junction JF, as well as the type of airway, NWTYP. Each airway is one of three types: (1) a fixed-quantity airway, (2) a regular airway, or (3) an airway containing a fan. The airway resistance R is specified for each airway, or, if not, the program will calculate the resistance from the friction factor KF, length LA, cross-sectional area A, and perimeter O that are specified for each airway. The airflow rate Q is either the desired value in the case of no network calculation or a regulated airway, or the value estimated prior to the network calculation.

The junction cards are used to specify junction temperature and elevation in preparation for a natural ventilation calculation, as well as methane concentration in the case of a gassy mine.

The fan characteristic cards specify the airway number of the fan as well as the number of data points that will be used to represent the fan characteristic curve. The fan data points are entered as pairs--airflow rate QF and pressure PF.

The additional airway cards are used to supplement or replace airway data on the airway cards.

CONCENTRATION INPUT

The concentration input section is used to specify the contaminant source, either smoke from a fire or methane in a gassy mine, in preparation for a calculation of the steady-state contaminant distribution in a mine network. The concentration input (tables 7-11) consists of concentration control card, average value card, additional concentration airway cards, additional concentration junction cards, and contamination cards. The concentration control card specifies the number NDIM of concentration airway cards and the number NCH4C of junction cards, as well as the number INFLOW of contamination cards used to specify a contaminant source. It is recommended to let JSTART, the starting junction number from which the concentration calculation is calculated, be the surface junction. The accuracy required for the fume, methane, and temperature calculations, as well as the critical values for pressure loss, fume concentration, methane concentration, and temperature, are specified in the concentration control card. The word "critical" is used in the sense of prohibiting safe usage of an airway.

The average value card is used to specify average thermal properties and temperature of the airway walls, as well as average flow resistance for the airways. These values are used by the program if they were not made available elsewhere in the input data.

The additional concentration airway cards were used to assign methane production rates, either as volume production CH4VX or as volume production per unit surface area CH4PAX, and rock temperature TROCKX and thermal properties (rock thermal diffusivity HAX and rock thermal conductivity HKX) to airway number NOX. The airway elevation change can be entered through this card if the junction elevation had not been inserted on the junction cards.

The additional concentration junction cards can be used to specify methane concentration in the junctions. If the methane production has not been specified on the additional concentration airway cards, the methane concentration in the junctions will be used to calculate the methane production rate for that airway.

The contamination cards are used to specify for airway number NCENT a contaminant source in one of three ways. The first option is to specify the volume flow rate and concentration of contaminant inflow as well as the heat production in the airway. The second option is to specify the oxygen concentration of the gas leaving the fire zone for an oxygen-rich fire. The third option is to specify the fume and heat production for a fuel-rich fire. The options correspond to sections 1, 2, and 3 of the contamination card.

REAL-TIME INPUT

The real-time input is used if a real-time analysis of the contaminant spread from one or more fires throughout the mine network is desired. These fires can be of various durations. The airflow rate used for the calculation is output from the network concentration section. The real-time input includes a real-time control card and contamination cards (tables 12-13). The real-time control card specifies the number NACC of additional contamination cards, the duration IDUR of the simulation, and the time interval INC for printing output from the real-time simulation. The program internally calculates a time interval XINT for calculation of the time contaminants take to travel an airway with some exclusion of travel time and airways. The exclusion is introduced because airways with a travel time considerably less than that of the majority of the airways would produce an unnecessary number of calculations. The percent of travel time EPX and the percent REP of airways that can be excluded are entered on the real-time control card. A value of 5% is a reasonable choice for EPX and REP. Values of the threshold critical fume concentration and accuracy of the contamination calculation are entered on the real-time control card.

The contamination cards are the same as in the concentration input section except for the inclusion of the starting time ISTT and ending time IENDT of the contamination event.

TABLES 1-13

The input data are entered on 80-character punch cards (80 columns) as integer (I) or real (F) variables. The term "Symbol" specifies the variable name used in the program. A short definition of each variable name (symbol) is given. The column labeled "Option" describes when the variable must be stated in the input. The following abbreviations are used in this column:

C - Conditional, depends on details of the ventilation system.

O - optional for all calculations.

R - required.

RC - required for concentration calculations.

RN - required for network calculations.

RO - required, but optional modes of specification are possible.

RR - required for real time.

RT - required for temperature calculations.

TABLE 1. - Network control card

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NB	R	Number of airways in network.
6-10	I5	NJ	R	Number of junctions in network.
11-15	I5	NFNUM	C	Number of fan characteristics to be read in.
16-20	I5	NADBC	C	Number of additional airway cards to be read in.
21-25	I5	NVPN	C	Junction card marker; NVPN > 0 indicates that NJ junction cards shall be read in and the natural ventilation pressures will be calculated from the junction data as part of the network part of the program.
26-30	I5	NETW	RN	= 1 marker for network calculation.
31-35	I5	NCONC	RC	= 1 marker for concentration calculation.
36-40	I5	NTEMP	RT	= 1 marker for temperature calculation.
41-45	I5	MADJ	R	Maximum number of times a network calculation shall be performed in 1 program run.
46-50	I5	ITN	R	Maximum number of iterations permitted within the network and concentration parts of the program.
51-60	F10.5	DR	R	Reference air density, lb/ft^3.
61-70	F10.5	TR	R	Reference air temperature, ° F.
71-75	I5	IRTCC	RR	= 1 marker for real-time calculation.

TABLE 2. - Airway cards

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NO	R	Identification number of airway.
6-10	I5	JS	R	Starting junction number.
11-15	I5	JF	R	Ending junction number.
16-20	I5	NWTYP	R	Airway type: -1 = fixed quantity airway. 0 = regular airway. 1 = fan airway.
21-30	F10.3	R	C,RO	Resistance of airway, in wg/cfm^2 × 10^{10} (as fan pressure, in wg).
31-40	F10.0	Q	C	Desired or estimated airflow rate, cfm.
41-50	I10	KF	C	Friction factor of airway.
51-60	I10	LA	RO	Length of airway, ft.
61-70	F10.1	A	RO	Cross-sectional area, ft^2.
71-78	F8.0	O	C,RO	Perimeter of airway, ft.

TABLE 3. - Junction cards

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	JNO	R	Junction number.
11-16	F5.1	T	R	Air temperature in junction, ° F.
20-26	F6.0	Z	R	Elevation of junction, ft.
27-31	F5.2	CH4C	O	Methane concentration in junction, pct.

TABLE 4. - Fan characteristic card 1

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NOF	R	Airway number of fan.
6-10	I5	MPTS	R	Number of points that will be used to define the fan curve; 2 are required, 10 is maximum.

TABLE 5. - Fan characteristic card 2

Column	Format	Symbol	Option	Definition of symbol
1-8	F8.0	QF	R	Airflow rate at point on fan curve, cfm.
9-14	F6.2	PF	R	Fan pressure at point on fan curve, in wg.
15-22	F8.0	QF	R	Airflow rate.
23-28	F6.2	PF	R	Fan pressure.
29-36	F8.0	QF	R	Airflow rate.
37-42	F6.2	PF	R	Fan pressure.
43-50	F8.0	QF	R	Airflow rate.
51-56	F6.2	PF	R	Fan pressure.
57-64	F8.0	QF	R	Airflow rate.
65-70	F6.2	PF	R	Fan pressure.

TABLE 6. - Additional airway cards

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NOX	R	Airway number.
41-50	I10	KX	O	Friction factor K.
51-60	I10	LX	O	Airway length, ft.
61-70	F10.1	AX	O	Cross-sectional area of airway, ft^2.
71-80	F10.1	OX	O	Perimeter of airway, ft.

TABLE 7. - Concentration control card

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NDIM	C	Number of concentration airway cards.
6-10	I5	NCH4C	C	Number of concentration junction cards.
11-15	I5	NAV	C	Marker for presence of average value card (NAV = 0, NO; NAV > 0, Yes).
16-20	I5	MAXJ	R	Highest junction number used in network NOT number of junctions.
21-25	I5	INFLOW	C	Number of contamination cards to be read.
26-30	I5	JSTART	R	Number of junctions from which concentration calculation shall start.
31-35	F5.1	TSTART	RT	Air temperature in JSTART, ° F.
36-43	F8.2	TIME	RT	Elapsed time since the start of contamination, hr.
44-50	F7.2	CRITSM	RC	Accuracy of fume and methane concentrations pct
51-55	F5.3	CRITGS	RC	and temperature (° F) calculation when recircu-
56-61	F6.3	CRITHT	RT	lation occurs.
62-66	F4.2	WRNPR	R	Pressure loss (in wg), fume concentration pct,
67-71	F6.4	WRNSM	RC	methane concentration pct, and temperatures
72-75	F4.1	WRNGS	RC	(° F) that shall be considered critical.
76-80	F5.0	WRNHT	RT	

TABLE 8. - Average value card

Column	Format	Symbol	Option	Definition of symbol
1-10	F10.5	TAVR	O	Rock temperature, ° F.
11-20	F10.5	HAAVR	O	Rock diffusivity, ft^2/hr.
21-30	F10.5	HKAVR	O	Rock thermal conductivity, Btu/hr/ft^2/° F/ft.
31-40	I10	KFAVR	O	Friction factor.
41-50	I10	LAAVR	O	Length airway, ft.
51-60	F10.2	AAVR	O	Cross-sectional area, ft^2.
61-70	F10.2	OAVR	O	Perimeter of airway, ft.

TABLE 9. - Additional concentration airway cards

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NOX	R	Airway number.
6-15	F10.2	CH4VX	O	Methane volume production, cfm.
16-20	F10.5	CH4PAX	O	Methane volume production rate per unit surface area, cfm/ft^2.
26-35	F10.5	TROCKX	O	Average rock temperature in airway, ° F.
36-45	F10.5	HAX	O	Thermal diffusivity of rock, ft^2/hr.
46-55	F10.5	HKX	O	Thermal conductivity of rock, Btu/hr/ft^2/° F/ft.
56-65	F10.1	DZRDX	RO	Elevation change in airway, ft.

TABLE 10. - Additional concentration junction cards

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	JNOX	R	Junction number.
26-30	F5.2	CH4CX	O	Methane concentration in junction, pct.

TABLE 11. - Contamination cards, steady-state input

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NCENT	R	Airway number into which contaminant enters.
				SECTION 1
6-15	F10.0	CONT	O	Volume flow rate of contaminant inflow, cfm.
16-25	F10.5	CONC	O	Concentration of contaminant inflow, pct.
26-35	F10.2	HEAT	O	Heat entering airway, Btu/min.
				SECTION 2
36-45	F10.5	O2MIN	O	Oxygen concentration with which fumes leave fire zone, pct used for oxygen-rich fires.
				SECTION 3
46-55	F10.5	SMPO2	O	Fume production per ft^3 of oxygen delivery for fuel-rich fires, ft^3.
56-65	F10.5	HTPO2	O	Heat production per ft^3 of oxygen delivery for fuel-rich fires, Btu.

TABLE 12. - Real-time control card

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NACC	C	Number of additional contamination cards.
6-10	I5	IDUR	R	Simulation duration, min.
11-15	I5	INC	R	Interval at which conditions are output, min.
16-21	F6.2	EPX	R	Average fume travel time that can be excluded in the calculation of XINT, pct.
22-27	F6.2	REP	R	Maximum airways that can be excluded in the calculation of XINT, pct.
28-35	F8.4	WRNSM	R	Threshold value for critical fume contamination, pct.
36-40	I5	JSURF	R	Number of atmospheric junction.
41-46	F6.5	CRITSM	R	Accuracy of contamination calculation, pct.

TABLE 13. - Contamination cards, real-time input

Column	Format	Symbol	Option	Definition of symbol
1-5	I5	NCENT	R	Airway number into which contaminant enters.
				SECTION 1
6-15	F10.0	CONT	O	Volume flow rate of contaminant inflow, cfm.
16-25	F10.5	CONC	O	Concentration of contaminant inflow, pct.
26-35	F10.2	HEAT	O	Heat entering airway, Btu/min.
				SECTION 2
36-45	F10.5	O2MIN	O	Oxygen concentration with which fumes leave fire zone, pct used for oxygen-rich fires.
				SECTION 3
46-55	F10.5	SMPO2	O	Fume production per ft^3 of oxygen delivery for fuel-rich fires, ft^3.
56-65	F10.5	HTPO2	O	Heat production per ft^3 of oxygen delivery for fuel-rich fires, Btu.
66-70	I5	ISTT	O	Starting time of contamination event, min.
71-75	I5	IENDT	O	Ending time of contamination event, min.

APPLICATIONS

Figure 1 shows the base schematic of a small multilevel mine with an exhaust fan in airway 51 and a booster fan in airway 6 as well as the airflow direction. (See figure 2 for identification of airways.) The computer program was used to perform both a steady-state and a real-time analysis following the occurrence of a fuel-rich fire in passageway 20, which is a descensionally ventilated raise (downcast shaft). As a second application, ventilation calculations were made for the same network under

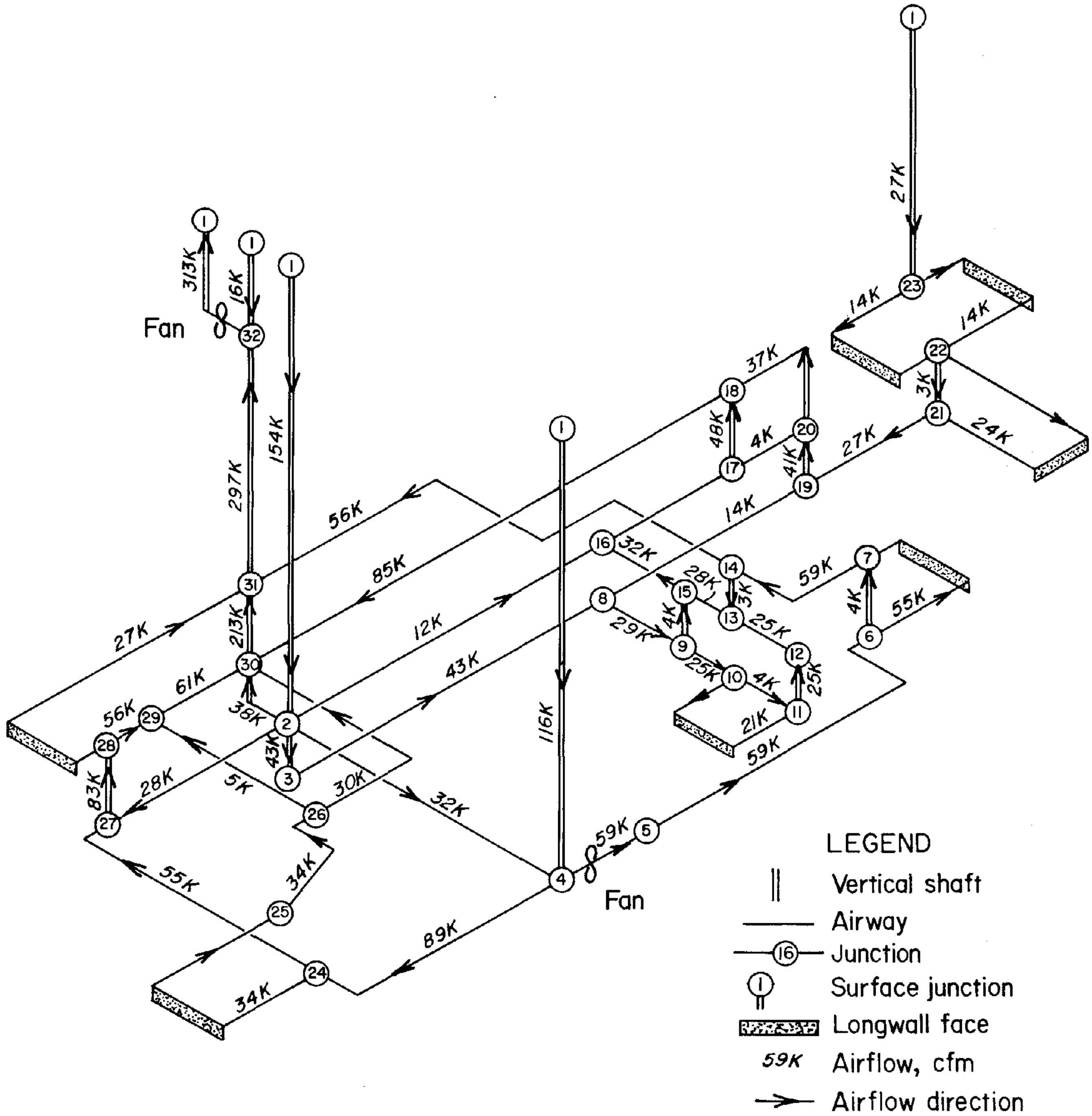

FIGURE 1. - Base schematic of small multilevel mine with an exhaust fan and booster fan.

the condition of a failure of the exhaust fan.

In both applications the mine is slightly gassy with methane and there is buoyancy-driven natural ventilation. A steady-state calculation is made of methane and smoke concentration, followed by a real-time calculation of smoke spread. The input parameter WRNSM is set to 0.001% as the threshold for critical fume concentration, and the threshold for wave generation, CRITSM, is set to 0.001%. Figure 1 shows the base schematic-flow rates and direction before the fire and with both fans operational.

FUEL-RICH FIRE IN A DOWNCAST SHAFT

The fuel-rich fire in passageway 20 is characterized by a production of 1 cu ft of fumes and 300 Btu per cubic foot of delivered oxygen. The input data are listed in appendix B. A steady-state ventilation network and temperature calculation was made with the program for a time of 1 hr after the fire occurred. During this 1-hr period thermal exchange between the ventilation air and the wall surface and thermal diffusion into the mine wall occurred, thereby altering the ventilation flows. The results of this calculation are listed in appendix C.

The steady-state ventilation calculation is followed by a real-time calculation. The airflow reversal that occurred in airways 20 and 21 as a result of the fire provides a direct path via airways 11, 49, and 51 to the surface for the fumes generated by the fire, thereby precluding the occurrence of contamination in the remainder of the mine. The output from the real-time analysis in appendix C covers a period of 10 min with output at 2-min increments. Only one wave is generated, and it reaches the surface via airway 51 at 8.68 min, at which time a steady-state fume concentration is established in the mine network. Based on the steady-state increase in the total exposure, evaluated as parts per million per hour the junctions, the user can make linear projections of the total contaminant concentration for extended periods of time.

FUEL-RICH FIRE IN A DOWNCAST SHAFT WITH A FAN FAILURE

An additional hazard that could occur in a mine following a fire would be a fan failure. The above example will be reevaluated with the additional constraint of an operational failure of the exhaust fan in airway 51. Those airways that undergo a flow reversal as a result of the fan failure that differ from flow reversals that occur in the above example 1 hr after the occurrence of the fire are indicated by arrows in figure 2. Appendix D lists the input data for the calculation, and appendix E contains the output for the steady-state and real-time analysis. A comparison of appendixes E and C shows that the number of airways with a critically high fume (smoke) concentration has increased from 4 to 44. The complexity of the fume spread in this latter case is analyzed with the real-time position of the program. The real-time results are tabulated in appendix E at 60-min increments for a duration of 360 min. A steady-state real-time fume concentration is not achieved until 174 min has elapsed. After 120 min has elapsed, the number of waves in airway 48 exceeds five. When this occurs, these waves are replaced internally by the program to permit the generation of new waves. The wave generation process is only suspended when the difference between successive waves becomes less than CRITSM, which equals 0.001% in these examples.

Since the methane production in an airway is determined from the concentrations at the airway ends and the volumetric flow rate, which may be positive or negative depending upon the flow direction, it is possible to have a negative methane production, as the output shows. This is a computational artifice. As the output shows for the temperatures and concentrations of smoke and methane in junctions 1 hr after the fire occurs, the methane

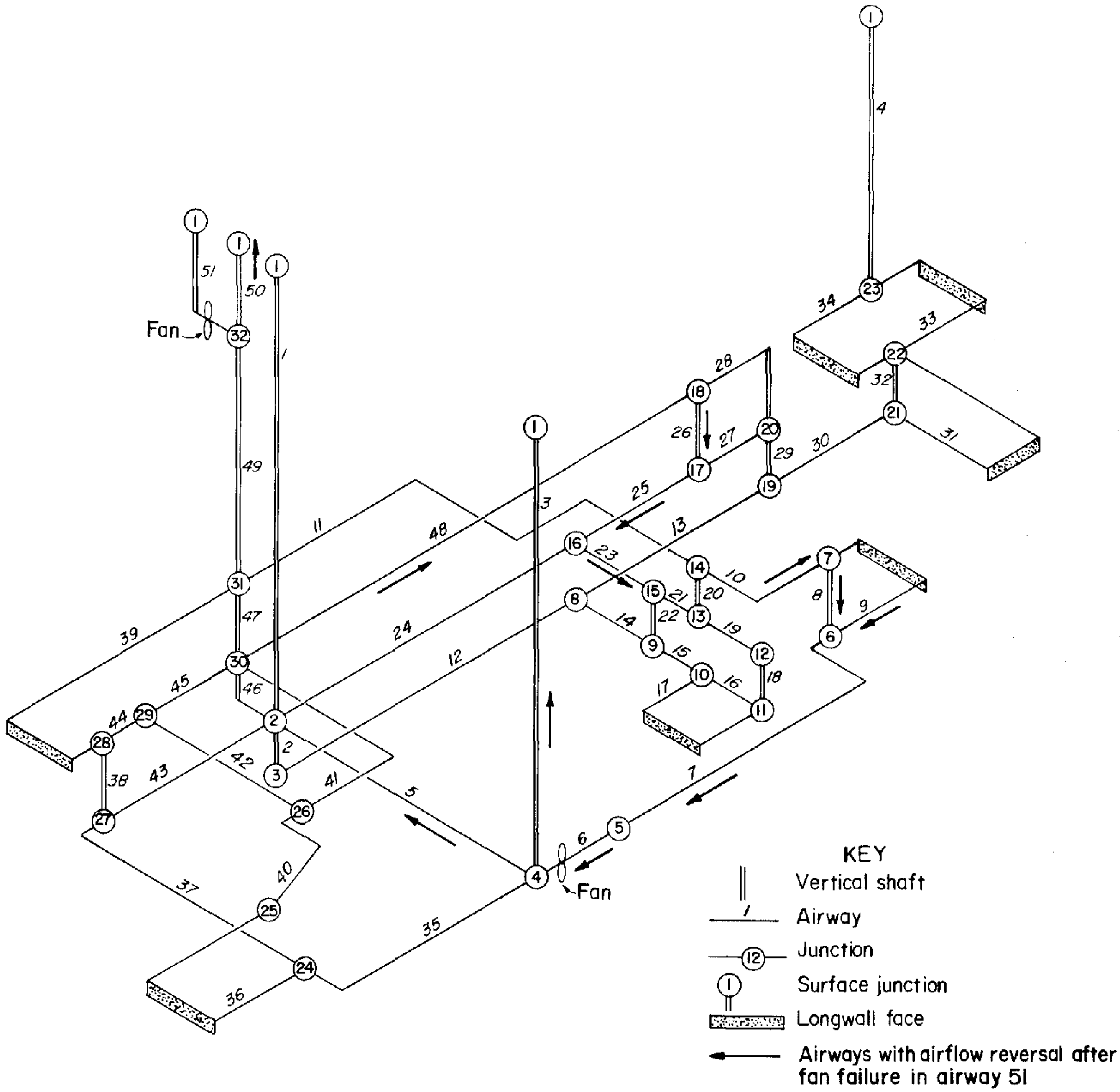

FIGURE 2. - Schematic of flow reversal in small multilevel mine with failure of exhaust fan.

concentrations are positive quantities at junctions.

The real-time analysis of the mine network shows that the failure of the exhaust fan produced a recirculation of contaminated air. The recirculated air occurs through airways 5, 46, 48, 26, 25, 23, 21, 20, 10, 8, 7, and 6. The computer output identifies airways 5 and 26 as closing the recirculation path through flow reversal. The list of temperatures and concentrations at the airway ends shown that junctions 2 and 17 have a negative sign. This is used to indicate that it is the flow into these junctions that closes the recirculation path.

The program can be used to evaluate fume concentrations from more than one fire by increasing the number NACC of contamination cards. Each fire may be specified by its start and completion time. The program could be used to predict the restoration of the mine to a fresh air condition following the suppression of contaminant fume production.

CONCLUSION

The computer program listed in the appendix can be used to describe the real-time spread of smoke from one or more fires throughout a multilevel mine that is ventilated by fans and temperature-induced natural ventilation. Paths of recirculation are identified as part of the program output. Each airway of the mine can be a regular airway, can be a regulated airway, or can contain a fan. The program can be used for planning ventilation control measures, as well as miner escape and rescue in case of a hazardous event such as a fire.

EXPLANATION OF APPENDIXES

The computer program is divided into a main program and subroutines. The subroutines and their purpose are enumerated below:

Subroutines	Purpose
NETWRK..........	Initializes network and forms meshes.
ITT.............	Solves for flow rates using Hardy-Cross method.
RESIST..........	Calculates resistance of regulators.
RDCONC..........	Reads concentration and temperature data and initializes for selected mine scenarios.
FLOWSK..........	Checks for airflow reversals.
ROADWY..........	Computes temperature and concentration for airways due to temperature change.
NATVP1..........	Calculates natural ventilation pressure and adjusts resistance due to temperature change.
SQRS............	Used for least squares representation of fan data.
MINV............	Used for least squares representation of fan data.
WRITR...........	Writes output results.
RTIME1..........	Reads input data for real-time fume spread calculation and selects time interval.
RTIME2..........	Performs real-time calculation of fume spread.
CTPAM.COM.......	Defines array sizes.
CTCONN.COM......	Common block for subroutines.

The program automatically represents the fan characteristic data by a Lagrange interpolation. If the user wishes to represent the data by a least squares approximation, the parameter IFAN in the main program should be set to any nonzero integer value.

References to page numbers in the program refer to Gruer's "Study of Mine Fires and Mine Ventilation."[1]

[1]Work cited in text footnote 4.

APPENDIX A.--LISTING OF COMPUTER PROGRAM

```
C         11111111112222222222333333333344444444445555555555666666666677
C2345678901234567890123456789012345678901234567890123456789012345678901
C
C      COMBINED PROGRAMS FOR NETWORK, CONCENTRATION, AND TEMPERATURE
C
C                                  CALCULATIONS
C         AND REAL TIME CONCENTRATION SPREAD
C
C
C
C       DATA DIVISION.
C       COMMON SECTION.
C
            INCLUDE 'CTPAM.COM'
            INCLUDE 'CTCONN.COM'
       COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
      1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,PDT,
      2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
      3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
      4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
      5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
      6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
      7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
      8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
      9ITRUE,IFALSE
       COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
      1KCO,MESC,N1,KE,NMIN,NUC,MMIN
       COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
      1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
       COMMON/RESCOM/NWRN
       COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
      1WRNSUM,WRNGS
       COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
      1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
      2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
       COMMON/FLOCOM/MM
       COMMON/NATCOM/E,B,G,GX,GXX,TMRD,TMSQR,TRA
       COMMON/CNNGE1/QO(IAR)
       COMMON/LEAST/ATA(3,3),ATY(3),CL(40,6),LK(5),MQ(5),IFAN
       COMMON/RTNCOM/NACC,IDUR,INC,EPX,REP,SNRW,JSURF
      1          ,MULT,XINT
      2     ,ISCOB(IAR),IENDT(20),RTAC(IAR,240,4),RTJC(IAR,2)
       COMMON/RTMCOM/MRKL
       COMMON/RTSC/EXPO(8),MINER(8),JMST(8),ARSJ(8),DEPSJ(8),
      1            NJR(8),NOTR(8),JREST(8,10),RESTT(8,10),NESC(8,
      2            10),VESC(8,10),SPFCT(8,10),JFESC(8,10),EXRTA(8,
      3            10),EXRTJ(8,10,2),NEXPO,MINO
       COMMON/CHECKK/JTMP(300)
C
C       WORKING-STORAGE SECTION.
C
       LOGICAL LGTO20
C
C       PROCEDURE DIVISION.
C
C
C       INITIALIZATION SECTION.
C
C
C INITIALIZATION-OPERATIONS.
C
        IST=1
        IFAN=0
```

```
          IFALSE=0
          ITRUE=1
          LP=2
          IO=1
          NSNVP=IFALSE
          NSFLOW=IFALSE
          DO 182 I=1,IAR
182            NREV(I)=0
          DO 202 I=1,10
202            RGRAD(I)=0.0
C
C READ-INPUT-DATA.
C
C                   READ NETWORK CONTROL CARD
          OPEN(UNIT=IO,FILE='MRTIM2.DAT',TYPE='OLD')
          OPEN(UNIT=LP,FILE='MRTAM2.LST',TYPE='UNKNOWN')
          READ(IO,241) NB,NJ,NFNUM,NADBC,NVPN,NETW,NCONC,NTEMP,MADJ,ITN,
         ;      DR,TR,IRTCC
241       FORMAT (10I5,2F10.5,I5)
          IF (IRTCC .NE. 1) IRTCC=0
          IF(NVPN.NE.IFALSE)NVPN=ITRUE
          IF(NETW.NE.IFALSE)NETW=ITRUE
          IF(NCONC.NE.IFALSE)NCONC=ITRUE
          IF(NTEMP.NE.IFALSE)NTEMP=ITRUE
C                 READ NETWORK AIRWAY CARDS
          DO 1234 K=1,NB
          READ(IO,301)  NO(K),JS(K),JF(K),NWTYP(K),R(K),Q(K),KF(K),LA(K),
         1              A(K),O(K)
 1234 CONTINUE
301            FORMAT (4I5,F10.3,F10.0,2I10,2F10.1)
          DO 355 I=1,NB
          QO(I)=Q(I)
 355      CONTINUE
C         CHECK IF CORRECT NO. BRANCHES/JUNCTIONS
          K=0
          MXJ=-1
          MAXSF=1
          DO 352 J=1,NJ
          DO 354 I=1,NB
          IF(JS(I).GT.MAXSF) MAXSF=JS(I)
          IF(JF(I).GT.MAXSF) MAXSF=JF(I)
          IF(JS(I).EQ.J.OR.JF(I).EQ.J) GO TO 352
354       CONTINUE
          K=K+1
          JTMP(K)=J
          MXJ=K
352       CONTINUE
           IF(MXJ.GT.0) WRITE(2,4323)
4323       FORMAT(5X,'INCORRECT NO AIRWAYS/JUNCTIONS')
           IF(MXJ.GT.0) WRITE(2,4321) (JTMP(K),K=1,MXJ)
           IF(MXJ.GT.0) WRITE(2,4322) MXJ,MAXSF
4321        FORMAT(5(4X,I4))
4322        FORMAT(4X,'MXJ=',I4,3X,'MAXSF=',I4)
C                     IF(NVPN) READ NETWORK JUNCTION CARDS
          IF(NVPN.EQ.ITRUE)READ(IO,321) (JNO(K),T(K),PROP(K),PRCH4(K),
         ;        K=1,NJ)
321            FORMAT (I5,T11,F5.1,T20,F6.0,F5.2)
          IF(NFNUM.LE.0)GOTO 410
            DO 400 K=1,NFNUM
C                 READ FAN CARDS
               READ(IO,361)NOF(K),MPTS(K)
361                FORMAT (2I5)
               INDEX=MPTS(K)
```

```
C             READ FAN-CHARACTERISTIC CARDS
          READ (IO,391) (QF(K,I),PF(K,I),I=1,INDEX)
391           FORMAT (5(F8.0,F6.2))
400       CONTINUE
C
C FINISH-READING-INPUT-DATA.
C
410     IF(NADBC.LE.0)GOTO 580
          L=0
          DO 550 I=1,NADBC
C                  READ ADDITIONAL NETWORK AIRWAY CARDS
            READ (IO,451) NOX,KX,LX,AX,OX
451             FORMAT (I5,T41,2I10,2F10.1)
            DO 480 J=1,NB
              IF(NOX.EQ.NO(J))GOTO 500
480             CONTINUE
              GO TO 548
500           L=L+1
                KF(J)=KX
                LA(J)=LX
                A(J)=AX
                O(J)=OX
548         CONTINUE
550         CONTINUE
          IF(NADBC.NE.L)WRITE(LP,571)
571           FORMAT (/////,' MISTAKE IN ADDITIONAL NETWORK AIRWAY CARDS%',
     1          /,'      INVALID AIRWAY NUMBER IN _NOX_ ON SOME CARDS.',
     2          /,'      OR WRONG NUMBER OF CARDS.')
580     CONTINUE
        MARKD=IFALSE
        IF(NETW.NE.ITRUE)GOTO 720
          DO 700 I=1,NB
            IF(NWTYP(I).NE.0 .OR. R(I).GT. 0.0)GOTO 690
              IF(A(I).GT. 0.0)GOTO 680
                WRITE (LP,651) NO(I)
651                 FORMAT (/////,' NO RESISTANCE OR DIMENSIONS WERE ',
     1               'STATED FOR AIRWAY NO',I10)
                MARKD=ITRUE
                GO TO 688
C                   _R(I)_ EQUATIONS% USED TO ADJUST _HL_ ON PAGE 12.
C    ;                    _R_ IS ESTIMATED ON PAGE 13.
C680           R(I)=KF(I)*LA(I)*O(I)/(5.2*A(I)**3)*DR/0.075
 680          R(I)=FLOAT(KF(I))*FLOAT(LA(I))*O(I)/(5.2
     1               *A(I)**3)*DR/0.075
688         CONTINUE
690         RSTD(I)=R(I)
700         CONTINUE
        IF(MARKD.NE.ITRUE .AND. NETW.EQ.ITRUE)GOTO 770
C       WRITE INPUT DATA AND BYPASS NETWORK INITIALIZATION
720       WRITE (LP,731)
731           FORMAT(/////,T17,' NO NETWORK CALCULATION HAS BEEN ',
     1          'PERFORMED. THESE ARE THE INPUT DATA',
     2          //,' AIRWAY  FROM    TO      AIRFLOW     AIRWAY TYPE',
     3          '        LENGTH    AREA   RESISTANCE      K  PERIMETER')
          WRITE(LP,751) (NO(K),JS(K),JF(K),Q(K),NWTYP(K),LA(K),A(K),R(K),
                KF(K),O(K),K=1,NB)
751             FORMAT (I5,I7,I7,F13.0,8X,I5,8X,I7,F9.1,F10.3,I7,F10.3)
          GO TO 1370
770     CONTINUE
C
C        NETWORK SECTION.
C
C INITIALIZE-NETWORK.
```

```
C
      NSW=IFALSE
      MADJC=0
      MARKN=IFALSE
      ITCT=0
C
C CALL-NETWRK.
C
 818  CONTINUE
 820  CONTINUE
      IF(IFAN.EQ.0) GO TO 1915
      DO 1910 KK=1,NFNUM
      INDEX=MPTS(KK)
      CALL SQRS(KK,INDEX)
      CALL MINV(ATA,3)
      CALL SQRSS(KK,INDEX)
 1910 CONTINUE
 1915 CONTINUE
      CALL NETWRK
C             CALCULATE NATURAL VENTILATION PRESSURE
C     WRITE(LP,841)NSNVP,NVPN,NSFLOW
C841      FORMAT(1X,'DRIVER,L841%NSNVP,NVPN,NSFLOW=',3I5)
      IF(NSNVP.NE.ITRUE)GOTO 890
        IF(NSFLOW.EQ.ITRUE)GOTO 1190
          NNVP=ITRUE
          GO TO 1470
 890    IF(NVPN.NE.ITRUE)GOTO 1188
C
C NATURAL-VENTILATION-PRESSURE-0.
C
C              COMPUTE _FNVP_ FOR EACH MESH USING NEWTORK INPUT DATA
C    ;               FOR EQUATIONS, SEE PAGE 21.
C     WRITE(LP,911)
C911      FORMAT(1X,'DRIVER,L911% ENTER NATVPO')
      MBEGW=1
      DO 1180 K=1,MNO
        MENDW=MEND(K)
        FNVP(K)=0.
        NT=0
        TSU=0.
        DO 1140 J=MBEGW,MENDW
          N=MSL(J)
          NX=IABS(N)
          DO 1080 L=1,NJ
            IF(JS(NX).NE.JNO(L))GOTO 1050
C                     _TO_ IS _TS_ IN EQUATION ON BOTTOM OF PAGE 21.
              TO=T(L)+460.
C                     _ZO_ IS _ZS_ IN EQUATION ON BOTTOM OF PAGE 21.
              ZO=PROP(L)
 1050       IF(JF(NX).NE.JNO(L))GOTO 1078
C                     _T1_ IS _TF_ IN EQUATION ON BOTTOM OF PAGE 21.
              T1=T(L)+460.
C                     _Z1_ IS _ZF_ IN EQUATION ON BOTTOM OF PAGE 21.
              Z1=PROP(L)
 1078         CONTINUE
 1080         CONTINUE
          H=TO*Z1-T1*ZO
          IF(N.LT.0)H=-H
C                  _FNVP_ IS _HN_ IN EQUATION ON BOTTOM OF PAGE 21.
          FNVP(K)=FNVP(K)+H
          TSU=TSU+TO+T1
          NT=NT+1
 1140     CONTINUE
```

```
          TM=TSU/NT
C                  _FNVP_ IS _HN_ IN EQUATION ON BOTTOM OF PAGE 21.
          FNVP(K)=FNVP(K)*DR/(5.2*TM)
          MBEGW=MENDW+1
1180      CONTINUE
C
C ITERATION.
C
1184  CONTINUE
1186  CONTINUE
1188  CONTINUE
1190  CONTINUE
      CALL ITT(LGTO20)
      IF(LGTO20)GOTO 820
C
C     WRITE(LP,1231)NSNVP,NSFLOW
C1231     FORMAT(1X,'DRIVER,L1231% NSNVP,NSFLOW=',2I5)
      IF(NSNVP.NE.ITRUE)GOTO 1350
C
C DETECT-INSTABLE-AIRWAYS.
C
C                NOTE% THE ONLY PLACE IN THIS ENTIRE SUBSYSTEM WHERE
C    ;                FLAG _NSFLOW_ MAY BE SET TO _ITRUE_ IS THE FIRST
C    ;                STATEMENT IN PARAGRAPH _CHECK-FOR-AIRFLOW-REVERSALS_ IN
C    ;                SUBROUTINE _FLOWSK_, FOR REASONS OF SAFETY AND
C    ;                RELIABILITY% IF IN DOUBT AS TO AIRFLOW-REVERSALS,
C    ;                CALL _FLOWSK_.  _NSFLOW_ IS TRUE ONLY AFTER SUBROUTINE
C    ;                _FLOWSK_ CHECKS ALL AIRWAYS FOR AIRFLOW-REVERSAL
C    ;                AND FINDS NONE.
          DO 1310 I=1,NB
            IF(Q(I).GT. 0.0)GOTO 1300
              IF(MADJC.GE.MADJ)WRITE(LP,1281)NO(I)
1281              FORMAT (//,T20,' AIRWAY NO',I7,'   IS AN UNSTABLE ',
     ;                  'AIRWAY WITH CHANGING AIRFLOW DIRECTIONS')
              NSFLOW=IFALSE
1300        Q(I)=Q(I)*100000.
1310        CONTINUE
          ITCT=0
          IF(NSFLOW.EQ.ITRUE)GOTO 1430
            GOTO 1420
C
1350  CONTINUE
C
C CALCULATE-RESISTANCE-OF-REGULATORS.
C
      CALL RESIST
C
C
C     CONCENTRATION SECTION.
C
C CHECK-FOR-CONCENTRATION.
C
1370   IF (NCONC.EQ.ITRUE .OR. NTEMP.EQ.ITRUE)GOTO 1410
         WRITE (LP,1391)
1391          FORMAT (/////,' NO TEMPERATURE OR CONCENTRATION ',
     ;               'CALCULATIONS WERE DEMANDED')
          GO TO 2098
1410  CALL RDCONC
C
C CALL-FLOWSK.
C
1420  CALL FLOWSK
C
```

```
C CALL-ROADWY.
C
1430  CALL ROADWY
      IF(NTEMP.NE.ITRUE .OR. NETW.NE.ITRUE)GOTO 2090
C     CALCULATION OF NATURAL VENTILATION PRESSURE
      CALL NATVP1
      IF(NSFLOW.NE.ITRUE)GOTO 1930
C
1470  CONTINUE
C
C NATURAL-VENTILATION-PRESSURE-2.
C
C              COMPUTE _FNVP_ FOR EACH MESH USING CONCENTRATION
C    ;                 INPUT DATA
C     WRITE(LP,1491)
C1491     FORMAT(1X,'DRIVER,L1470% ENTER NATVP2')
      MBEGW=1
      DNVP=0.0
      DO 1850 K=1,MNO
        ONVP=FNVP(K)
        MENDW=MEND(K)
        FNVP(K)=0.
        ZUP=0.0
        ZDOWN=0.0
        HSU=0.
        TSU=0.
        DO 1740 J=MBEGW,MENDW
          N=MSL(J)
          IF(N.GE.0)GOTO 1660
              FACT=-1.
              NX=-N
              GO TO 1680
1660        FACT=1.
              NX=N
1680      HSU=HSU+FACT*FRNVP(NX)
          TSU=TSU+ABS(FRNVP(NX))
          IF (DZRD(NX)*FACT) 1730,1736,1710
1710          ZUP=ZUP+DZRD(NX)*FACT
              GO TO 1738
1730        ZDOWN=ZDOWN+DZRD(NX)*FACT
1736        CONTINUE
1738      CONTINUE
1740      CONTINUE
        IF(ZDOWN+ZUP.EQ.0)GOTO 1780
          HSU=HSU-(ZUP+ZDOWN)*TR
          TSU=TSU+ABS((ZUP+ZDOWN)*TR)
1780    IF(TSU.GT. 0.0)GOTO 1810
            FNVP(K)=0.0
            GO TO 1830
1810      FNTM=TSU/(ZUP-ZDOWN)
            FNVP(K)=HSU*DR/(5.2*(FNTM+460.))
1830    DNVP=DNVP+ABS(ONVP-FNVP(K))
        MBEGW=MENDW+1
1850    CONTINUE
C     WRITE(LP,1871) NNVP
C1871     FORMAT(1X,'DRIVER,L1850% LEAVE NATVP2 WITH NNVP=',I5)
      IF(NNVP.NE.ITRUE)GOTO 1920
          NNVP=IFALSE
          ITCT=0
          GO TO 1186
C
C CHECK-FOR-END-OF-RUN.
C
```

```
C1920     IF(DNVP/MNO.LE.0.001)GOTO 2070
1920      CONTINUE
         IF(IST.EQ.1) GO TO 1935
         ITFLG=0
         IF(DNVP/MNO.GT.0.001) ITFLG=1
         DO 1925 J=1,NB
         TEST=ABS(Q(J)-QO(J))/ABS(QO(J))
         IF(TEST.GT.0.001) ITFLG=1
         QO(J)=Q(J)
1925     CONTINUE
         IF(ITFLG.EQ.0) GO TO 2070
1935     CONTINUE
         IST=0
C
C CHECK-FOR-NEXT-NETWORK-PASS.
C
C                REROUTE TO APPROPRIATE PROGRAM SECTION
1930        IF(MADJC.GE.MADJ)GOTO 2050
              NSNVP=ITRUE
              MADJC=MADJC+1
              ITCT=0
              MARKN=IFALSE
              DO 2010 I=1,NB
                JF(I)=IABS(JF(I))
                Q(I)=Q(I)/100000.
2010            CONTINUE
              IF(NSFLOW.EQ.ITRUE)GOTO 1184
                NSW=ITRUE
                GO TO 818
C
C      OUTPUT-OF-RESULTS SECTION.
C
C WRITE-RESULTS-RUN-TOO-LONG.
C
2050  WRITE (LP,2061)
2061      FORMAT (/////,' THE CALCULATION WAS NOT COMPLETED SINCE THE ',
     1        'NUMBER OF EXCHANGES BETWEEN NETWORK AND CONCENTRATION'/
     2        ' PARTS OF THE PROGRAM BECAME EXCESSIVE')
C
C WRITE-RESULTS-TEMPERATURE.
C
2070  CALL WRITR
      GOTO 2100
C
C WRITE-RESULTS-NO-TEMPERATURE.
C
2090  CALL WRITS
C
2098  CONTINUE
2100  CONTINUE
C
C      REAL-TIME-CALCULATION
C
      IF(IRTCC) 2096,2096,2095
2095  CALL RTIME1
      CALL RTIME2
2096  CONTINUE
C
C      END OF RUN
C
      WRITE(LP,2121)
2121      FORMAT(1X,1H /16X,'END OF RUN'/1X,1H )
      CLOSE(UNIT=LP)
```

```
          CLOSE(UNIT=ID)
          STOP
    C
          END
```

```
      SUBROUTINE NETWRK
C        111111111122222222223333333333444444444455555555556666666666777
C23456789012345678901234567890123456789012345678901234567890123456789012
C
C      "NETWRK" INITIALIZES NETWORK OF MINE PRIOR TO
C           ITERATIONS BY SUBROUTINE "ITT" BY GENERATING "MSL" LIST OF
C           AIRWAYS IN MESHES AND "MEND" INDEX OF LAST AIRWAY
C           IN EACH MESH.
C           THE "INU"(LIST OF AIRWAYS WITH ASC. "RQ"), "KNO"
C           (LIST OF AIRWAYS IN BASE SYSTEM), "KJS"(BASE SYSTEM "JS"),
C           AND "KJF"(BASE SYSTEM "JF") AREINTERMEDIATE LISTS
C           TO MAKE "MSL" AND "MEND" FROM, AND WILL NOT BE NEEDED FOR
C           THE SAME PURPOSE AFTER RETURN FROM THIS SUBROUTINE.
C
C      DATA DIVISION.
C      COMMON SECTION.
C
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/RESCOM/NWRN
      COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
      COMMON/FLOCOM/MM
      COMMON/NATCOM/E,B,G,GX,GXX,TMRD,TMSQR,TRA
C
C      PROCEDURE DIVISION WITH ENTRY POINT NETWRK.
C
C NETWRK.
C
C     WRITE(LP,121)
C121      FORMAT(1X,'ENTERING NETWRK')
C
C MAKE-INU-LIST SECTION.
C
C INU-LIST-FLAG-AIRWAYS.
C
C               ARRANGE ORDINARY AIRWAYS IN ASC. ORDER OF ABS(R*Q)
C                    INTO "INU" LIST
      NBU=NB
      NBL=1
      DO 320 K=1,NB
        IF (NSW.NE.ITRUE)Q(K)=Q(K)/100000.
        DO 190 J=1,NFNUM
          IF (NOF(J).EQ.NO(K)) GOTO 210
190         CONTINUE
          IF (NWTYP(K)) 220,250,280
```

```
210        NFREG(J)=K
220          INU(NBU)=K
               NBU=NBU-1
               GO TO 310
250          RQ(K)=ABS(R(K)*Q(K))
               NWTYP(K)=2
               GO TO 300
280          INU(NBL)=K
               NBL=NBL+1
300        CONTINUE
310        CONTINUE
320      CONTINUE
C
C INU-LIST-BUBBLE-SORT.
C
330    IF (NBU.LT.NBL) GOTO 470
         NRETU=IFALSE
         DO 420 K=1,NB
           IF (NWTYP(K).LT.2) GOTO 410
             IF (NRETU.EQ.ITRUE)GOTO 400
               MMIN=K
               NRETU=ITRUE
400          IF (RQ(MMIN).GT.RQ(K)) MMIN=K
410        CONTINUE
420        CONTINUE
         INU(NBL)=MMIN
         NBL=NBL+1
         NWTYP(MMIN)=0
         GOTO 330
C
C SET-UP-BASE-SYSTEM-SECTION.
C             MAKE "KJS","KJF",AND "KNO" LISTS TO CONNECT JUNCTIONS
C
C BASE-SYSTEM-INIT.
C
470    IND=INU(1)
C                SUBSCRIPT "IND" COVERS AIRWAY NUMBERS WITH ASCENDING "RQ"
       KJF(NJ)=JS(IND)
       KJS(NJ-1)=JS(IND)
C             IF (JS(IND).LT.0), THEN LOOK UP "KNO" LIST TO FIND "IND"
       JS(IND)=-JS(IND)
       KJF(NJ-1)=JF(IND)
       KNO(NJ-1)=IND
       KNUM=NJ-1
C
C BASE-SYSTEM-HUNT.
C
540    CONTINUE
550    DO 690 NUC=2,NB
         IND=INU(NUC)
C                 SUBSCRIPT "IND" COVERS AIRWAY NUMBERS WITH ASCENDING
C    %                  "RQ" IS "JS" OR "JF"
         IF (JS(IND).LT.0) GOTO 688
           N1=IFALSE
           NO=IFALSE
           DO 630 K=KNUM,NJ
C                     HUNT FOR "JS(IND)" AND "JF(IND)" IN (KJF(K),K=KNUM,NJ)
C                     SUBSCRIPT "KNUM" COVERS JUNCTIONS IN ASC. "RQ" ORDER
C    %                      FOR LISTS "KJS" AND "KJF"
C                     "KJS" AND "KJF" ARE JUNCTIONS FOR SECONDARY AIRWAYS:
C    %                      "KNO(KNUM)" IS THE SECONDARY AIRWAY WITH THE
C    %                      HIGHEST "RQ" CONNECTED TO THE PRIMARY AIRWAY
C    %                      "NO(IND)": IF "(KNO(KNUM).LT.0)", THEN "JF" OF
```

```
C     %               THIS AIRWAY CONNECTS TO "JS OF THE PRIMARY AIRWAY
                IF (JS(IND).EQ.KJF(K)) NO=ITRUE
                IF (JF(IND).EQ.KJF(K)) N1=ITRUE
630             CONTINUE
              IF(N1.NE.NO)GOTO 760
                IF(N1.NE.ITRUE .AND.  NO.NE.ITRUE)GOTO 680
                  JS(IND)=-JS(IND)
                  JF(IND)=-JF(IND)
680             CONTINUE
688         CONTINUE
690         CONTINUE
          IF (KNUM.EQ.1) GOTO 910
            DO 740 K=1,NB
              IF (JS(K).GT.0) WRITE (LP,731)NO(K)
C                 IF THIS MESSAGE GETS PRINTED AND THE AIRWAY IS NOT
C                     REALLY A DEAD-END, THEN REFER TO THE NEWTORK AIRWAY
C                     INPUT DATA CARD FOR THIS AIRWAY AND MAKE SURE THAT
C                     "JS" AND "JF" (STARTING AND ENDING JUNCTIONS) FOR
C                     THIS AIRWAY ARE WHAT YOUR MINE-NETWORK DIAGRAM SAYS
C                     THEY ARE: IF NO MISTAKES ARE FOUND ON THIS CARD,
C                     CHECK NETWORK AIRWAY CARDS FOR ALL AIRWAYS WHICH
C                     CONNECT TO THIS AIRWAY FOR GOOD "JS" AND "JF".
C                     THEN RE-SUBMIT YOUR CORRECTED DATA FOR
C                     THE NEXT RUN.
731               FORMAT(/////,7H AIRWAY,I5,' IS ISOLATED FROM NETWORK')
740           CONTINUE
              GO TO 900
760       IF (NWTYP(IND).LT.0) WRITE (LP,771)NO(IND)
C                 IF YOU GET THIS MESSAGE, SCREAM H-E-L-P TO THE SOFTWARE
C                     MAINTENANCE PEOPLE: THIS SHOULD NEVER HAPPEN
771           FORMAT(/////,'ERROR: REGULATOR',I5,' IN BASE SYSTEM')
          KNUM=KNUM-1
          IF (NO.EQ.ITRUE) GOTO 850
C
C BASE-SYSTEM-INSERT-FOR-JF.
C
C                      HERE FOR (N1.EQ.1.AND.NO.EQ.0):  JF(IND)IS IN KJF(K),
C     %                          K=KNUM,NJ
            KJS(KNUM)=JF(IND)
            KJF(KNUM)=JS(IND)
            KNO(KNUM)=-IND
            JS(IND)=-JS(IND)
            GO TO 550
C
C BASE-SYSTEM-INSERT-FOR-JS.
C
C                       HERE FOR (NO.EQ.ITRUE.AND.N1.EQ.IFALSE): JS(IND)IS IN
C     %                           KJF(K),K=KNUM,NJ)
850        KJS(KNUM)=JS(IND)
            KJF(KNUM)=JF(IND)
            KNO(KNUM)=IND
            JS(IND)=-JS(IND)
            GO TO 540
C
C BASE-SYSTEM-EXIT.
C
900       CONTINUE
910       CONTINUE
          DO 920 K=1,NB
920         JS(K)=IABS(JS(K))
C
C FORM-MESHES-SECTION.
C
```

```
C FORM-MESHES.
C
C                AT LAST: MAKE "MSL" LIST AND "MEND" INDEX
      MESC=0
      MNO=0
      DO 1240 K=1,NB
        IF (JF(K).GE.0) GOTO 1230
          JF(K)=-JF(K)
          MNO=MNO+1
          JBM=JS(K)
          JEM=JF(K)
          NK=K
1020      CONTINUE
1030      CONTINUE
C         REPEAT UNTIL (KB.EQ.KE);
            MESC=MESC+1
C                 "MEND(MNO)" CONTAINS LAST "MSL" SUBSCRIPT
C                     FOR THIS AIRWAY
            MEND(MNO)=MESC
C                 "MSL" GETS ALL AIRWAYS IN THIS MESH
            MSL(MESC)=NK
            DO 1090 KCO=1,NJ
              IF (JBM.EQ.KJF(KCO)) GOTO 1100
1090            CONTINUE
1100        KB=KCO
            DO 1130 KCO=1,NJ
              IF (JEM.EQ.KJF(KCO)) GOTO 1140
1130            CONTINUE
1140        KE=KCO
            IF (KB-KE) 1160,1220,1190
1160            NK=KNO(KB)
                JBM=KJS(KB)
                GO TO 1030
1190          NK=-KNO(KE)
                JEM=KJS(KE)
                GO TO 1020
1220          CONTINUE
C           END REPEAT(KB.EQ.KE);
1230    CONTINUE
1240    CONTINUE
C
C SATISFY-JUNCTION-EQUATIONS-SECTION.
C SATISFY-JUNCTION-EQUATIONS.
C
      MBEGW=2
      DO 1320 K=1,MNO
        MENDW=MEND(K)
        DO 1300 J=MBEGW,MENDW
          N=IABS(MSL(J))
          Q(N)=0.
1300      CONTINUE
        MBEGW=MENDW+2
1320    CONTINUE
      MBEGW=1
      DO 1490 K=1,MNO
        MENDW=MEND(K)
        N=IABS(MSL(MBEGW))
        Q1=Q(N)
        M=MBEGW+1
        DO 1470 J=M,MENDW
          N=MSL(J)
          FACT=1.
          IF (N.GE.0) GOTO 1450
```

```
                N=-N
                FACT=-1.
 1450         CONTINUE
              Q(N)=Q(N)+Q1*FACT
 1470         CONTINUE
              MBEGW=MENDW+1
 1490       CONTINUE
C
C NETWRK-BOOGIE SECTION.
C NETWRK-BOOGIE.
C
C     WRITE(LP,1511)
C1511         FORMAT(1X,'RETURN FROM NETWRK')
      RETURN
      END
```

```
      SUBROUTINE ITT(LGTO20)
C         1111111111222222222233333333334444444444555555555566666666667777
C2345678901234567890123456789012345678901234567890123456789012345678901 2
C
C       "ITT" ADJUSTS "Q" (AIRFLOW) WITHIN THE MINE NETWORK FOR
C            THE INFLUENCE OF MESHES AND COMPUTED AIRFLOW OF FANS,
C            COMPUTES AIRFLOW OF FANS AFTER ACCOUNTING FOR
C            INFLUENCE OF AIRFLOW OF OTHER AIRWAYS, AND THEN REPEATS
C            THIS COMPUTATION FOR AIRFLOWS AND FANS UNTIL CONVERGENCE
C            IS REACHED OR MAXIMUM NUMBER OF ITERATIONS IS EXCEEDED.
C
C
C       DATA DIVISION.
C       COMMON SECTION.
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/LEAST/ATA(3,3),ATY(3),CL(40,6),LK(5),MQ(5),IFAN
C
C       LINKAGE SECTION.
      LOGICAL LGTO20
C
C       PROCEDURE DIVISION USING LGTO20
C     %        WITH ENTRY POINT ITERATION-ITT.
C
C ITERATION-ITT.
C
C     WRITE(LP,101)
C101        FORMAT(1X,'ENTERING ITT')
      LGTO20=.FALSE.
      IT=0
C
C ITERATION-MASSAGE-Q.
C
110   CONTINUE
120   DQSUM=0.
      MBEGW=1
      DO 530 K=1,MNO
C              MASSAGE "Q" FOR MESHES AND COMPUTE "DQSUM"
C     %              IN ACCORDANCE WITH EQUATION AT TOP OF PAGE 22
C     %              (4.1.8, "CROSS CORRECTION" FORMULA).
        MENDW=MEND(K)
        DPSUM=0.
        RQSUM=0.
        N=IABS(MSL(MBEGW))
        IF (NWTYP(N).EQ.-1) GOTO 520
          DO 410 J=MBEGW,MENDW
C              COMPUTE "RQSUM", "DPSUM", AND "DQ" FOR ONE MESH
            N=MSL(J)
```

```
                FACT=1.
                IF (N.GE.0)GOTO 260
                  N=-N
                  FACT=-1.
      260       IF (NWTYP(N)) 400,270,320
      270           RQ2=R(N)*ABS(Q(N))*2
                    RQSUM=RQSUM+RQ2
                    DP=R(N)*Q(N)*ABS(Q(N))
      C                     "DPSUM" GOES TO NUMERATOR IN EQUATION AT
      C     %                   TOP OF PAGE 22.
                    DPSUM=DPSUM+FACT*DP
                    GO TO 390
      320         DPSUM=DPSUM-FACT*R(N)
      C                   "R" AND "RGRAD" FOR FANS GETS COMPUTED IN PARA-
      C     %                 GRAPH "FANCHARACTERISTICS" IN THIS SUBROUTINE
                    DO 350 L=1,NFNUM
                      IF (NFREG(L).EQ.N) GOTO 370
      350               CONTINUE
                      GO TO 380
      C
      C                         "RGRAD" IS DH(F(I))" IN EQUATION AT TOP
      C     %                       OF PAGE 22.
      370             RQSUM=RQSUM-RGRAD(L)
      380           CONTINUE
      390         CONTINUE
      400       CONTINUE
      410       CONTINUE
      C                "FNVP" IS "HN" IN EQUATION AT TOP OF PAGE 22.
      C     %              "RQSUM" GOES TO DENOMINATOR IN EQUATION AT
      C     %              TOP OF PAGE 22.
              DQ=(DPSUM-FNVP(K))/RQSUM
              DO 500 J=MBEGW,MENDW
      C                MASSAGE "Q" FOR AIRWAYS IN THIS MESH AND
      C     %              ACCUMULATE "DQSUM"
                N=MSL(J)
                FACT=1.
                IF (N.GE.0)GOTO 490
                  N=-N
                  FACT=-1.
      490       Q(N)=Q(N)-(DQ*FACT)
      500       CONTINUE
      C                "DQ" IS AIRFLOW CHANGE FOR THIS MESH: WHEN "DQSUM"
      C     %              IS ZERO OR VERY SMALL, "ITT" CAN RETURN
              DQSUM=DQSUM+ABS(DQ)
      520   MBEGW=MENDW+1
      530   CONTINUE
      C
      C FANCHARACTERISTICS.
      C
          DO 1090 J=1,NFNUM
            NFCW(J)=IFALSE
            DO 580 K=1,NB
      C              HUNT FOR FAN "J" IN AIRWAY "K"
              IF (NOF(J).EQ.NO(K)) GOTO 600
      580       CONTINUE
              GO TO 1080
      C
      600     NPTS=MPTS(J)
              IF(NVPN.EQ.ITRUE.OR.MADJC.GT.0)GOTO 640
                TABF=TR
                GO TO 720
      640     NABF=JS(K)
                DO 700 L=1,NJ
```

```
C                     HUNT FOR JUNCTION "L" FOR FAN "J" IN AIRWAY "K"
C                     GET TEMPERATURE FROM "T(L)" FOR "FANQ"
              IF (NABF.NE.JNO(L)) GOTO 690
                  TABF=T(L)
                  GO TO 710
690             CONTINUE
700               CONTINUE
710           CONTINUE
720       FANQ=Q(K)*100000.*(TABF+460.)/(TR+460.)
          NBDR=MPTS(J)-1
          QBL=QF(J,2)
          QBR=QF(J,NBDR)
C                 COMPUTE "FANP" FOR "R(K)"
          IF (FANQ.GE.QBL) GOTO 800
              R(K)=PF(J,2)
              NFCW(J)=ITRUE
              GO TO 1070
C
800       IF (FANQ.LE.QBR) GOTO 840
              R(K)=PF(J,NBDR)
              NFCW(J)=ITRUE
              GO TO 1060
C
840       FANP=0.
        IF(IFAN.EQ.1) GO TO 1055
          DO 960 L=1,NPTS
C                   THIS DO-LOOP COMPUTES "FANP" IN EQUATION IN
C     %                 4.1.9 AT BOTTOM OF PAGE 22
C     %                 (LAGRANGE'S INTERPOLATION FORMULA).
            ANUM=1.0
            ADEN=1.0
            DO 930 M=1,NPTS
              IF (M.EQ.L) GOTO 920
                ANUM=ANUM*(FANQ-QF(J,M))/10000
                ADEN=ADEN*(QF(J,L)-QF(J,M))/10000
920           CONTINUE
930           CONTINUE
            PART=ANUM*PF(J,L)/ADEN
            FANP=FANP+PART
960         CONTINUE
          DO 1030 L=1,NPTS
C                 COMPUTE "RGRAD" FOR USE IN "ITERATION-MASSAGE-Q":
C     %               "RGRAD" IS DERIVATIVE OF "PF" WITH RESPECT TO "QF"
            IF (FANQ.GT.QF(J,L)) GOTO 1020
              IF (L.LT.2) GOTO 1040
                LL=L-1
                RGRAD(J)=(PF(J,L)-PF(J,LL))*100000./(QF(J,L)-QF(J,LL))
                GO TO 1050
1020          CONTINUE
1030          CONTINUE
1040          RGRAD(J)=0.0
C                     STICK "FANP" INTO "R" FOR AIRWAY "K"
1050        R(K)=FANP
            GO TO 1060
 1055   CONTINUE
        FANP=CL(J,1)+CL(J,2)*Q(K)+CL(J,3)*Q(K)*Q(K)
        R(K)=FANP
        RGRAD(J)=CL(J,2)+2.*CL(3,J)*Q(K)
1060      CONTINUE
1070      CONTINUE
1080    CONTINUE
1090    CONTINUE
       IT=IT+1
```

```
         ITCT=ITCT+1
C
C ROUTE-TO-APPROPRIATE-PROGRAM-SECTION.
C
         IF (IT.LE.1) GOTO 120
           IF(DQSUM.LT.0.002) GOTO 1260
             IF (ITCT.GT.ITN) GOTO 1220
               IF (IT.LE.20) GOTO 110
C                         RETURN FOR FAILURE TO CONVERGE USING LOCAL
C    %                        COUNTER "IT"
                 NSW=ITRUE
                 NSFLOW=IFALSE
C                GO TO 20
                 LGTO20=.TRUE.
C                WRITE(LP,1201)
C1201                 FORMAT(1X,'LGTO20=.TRUE.  RETURN FROM ITT')
                 RETURN
C
1220         MARKN=ITRUE
C            WRITE(LP,1241)
C1241             FORMAT(1X,'MARKN=1 RETURN FROM ITT')
             RETURN
C
1260       CONTINUE
C          WRITE(LP,1281)
C1281           FORMAT(1X,'DQSUM.LT.  0.002 RETURN FROM ITT')
           RETURN
C
         END
```

```
      SUBROUTINE RESIST
C          1111111111222222222233333333334444444444555555555566666666667777
C234567890123456789012345678901234567890123456789012345678901234567890123456789012
C
C       "RESIST" CALCULATES RESISTANCE OF REGULATORS
C     %      AND WRITES NETWORK DATA AFTER ONE
C     %      PASS THRU THE NETWORK SECTION.
C
C       DATA DIVISION.
C       COMMON SECTION.
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
       COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
      1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
      2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
      3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
      4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
      5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
      6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
      7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
      8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
      9ITRUE,IFALSE
       COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
      1KCO,MESC,N1,KE,NMIN,NUC,MMIN
       COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
      1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
       COMMON/RESCOM/NWRN
       COMMON/LEAST/ATA(3,3),ATY(3),CL(40,6),LK(5),MQ(5),IFAN
C
C       PROCEDURE DIVISION WITH ENTRY POINT RESIST.
C
C RESIST.
C
C      WRITE(LP,101)
C101       FORMAT(1X,'ENTERING RESIST')
C
C CALCULATE-RESISTANCE-OF-REGULATORS.
C
       MBEGW=1
       DO 330 K=1,MNO
         DPSUM=0.
         MENDW=MEND(K)
         NX=IABS(MSL(MBEGW))
         IF (NWTYP(NX).GE.0) GOTO 320
           M=MBEGW+1
           DO 270 J=M,MENDW
C                  MASSAGE "R" FOR MESH AROUND "STATIC-Q" AIRWAY:
C     %                 A STATIC-Q AIRWAY IS CALLED A REGULATOR
             N=MSL(J)
             FACT=1.
             IF (N.GE.0) GOTO 220
               N=-N
               FACT=-1.
220          IF (NWTYP(N).LE.0) GOTO 250
                DP=-R(N)
                GO TO 260
250            DP=R(N)*Q(N)*ABS(Q(N))
260          DPSUM=DPSUM+DP*FACT
270          CONTINUE
             IF (NVPN.EQ.ITRUE) DPSUM=DPSUM-FNVP(K)
             RSTD(NX) =-DPSUM/(Q(NX))**2
             R(NX)=RSTD(NX)
```

```
                   NWTYP(NX)=0
 320               MBEGW=MENDW+1
 330          CONTINUE
C
C OUTPUT-OF-NETWORK.
C
           DO 400 L=1,NB
              IF (NWTYP(L).GT.0) GOTO 380
                   RQ(L)=R(L)*Q(L)*ABS(Q(L))
                   GO TO 390
 380            RQ(L)=R(L)
 390          CONTINUE
 400          CONTINUE
           WRITE (LP,421)
 421            FORMAT (1H1,'       ORDINARY AIRFLOW AND PRESSURE DISTRIBU',
      %            'TION BEFORE EVENT (BASED ON THE LISTED INPUT DATA)')
           WRITE (LP,441)
 441            FORMAT (1H0,T40,'REGULAR AIRWAYS'/// AIRWAY  FROM    TO      ',
      1           ' AIRFLOW    PRESSURE LOSS      LENGTH    AREA   ',
      2          'RESISTANCE      K  PERIMETER')
           L=0
           DO 540 K=1,NB
              IF (NWTYP(K).LE.0) GOTO 500
                   L=L+1
                   GO TO 530
 500            Q(K)=Q(K)*100000.
                   WRITE(LP,521) NO(K),JS(K),JF(K),Q(K),RQ(K),LA(K),A(K),
      %                      R(K),KF(K),O(K)
 521                  FORMAT (I5,I7,I7,F13.0,F13.3,8X,I7,F10.3,F13.3,I7,F10.3)
 530          CONTINUE
 540          CONTINUE
           IF (L.GT.0) GOTO 590
                WRITE (LP,571)
C                     IF YOU INTEND TO HAVE FANS AND YOU GET THIS MESSAGE,
C     %                      MAKE SURE THAT ALL YOUR AIRWAYS WITH FANS IN THEM
C     %                      HAVE NWTYP=1 IN YOUR NETWORK AIRWAY CARDS
 571                FORMAT (/////' NETWORK CONTAINS NO FANS')
                GO TO 770
 590          WRITE (LP,601)
 601               FORMAT (1H0,T20,'FANS'/// AIRWAY  FROM    TO      AIRFLOW ',
      %             '   FAN PRESSURE')
              DO 670 K=1,NB
            IF (NWTYP(K).LE.0) GOTO 660
                   Q(K)=Q(K)*100000.
                   WRITE (LP,651) NO(K),JS(K),JF(K),Q(K),RQ(K)
 651                  FORMAT (I5,I7,I7,F13.0,F13.3)
 660             CONTINUE
 670             CONTINUE
              IF (NFNUM.LE.0) GOTO 760
                 WRITE (LP,701) (NOF(K),K=1,NFNUM)
 701                FORMAT(////,' THESE CHARACTERISTICS WERE STORED FOR FANS',
      %                 10I6)
                 DO 750 K=1,NFNUM
                   L=MPTS(K)
                   WRITE (LP,741) (QF(K,I),PF(K,I),I=1,L)
 741                  FORMAT (//5(F10.0,F6.2)/5(F10.0,F6.2))
 750               CONTINUE
                   IF(IFAN.EQ.0) GO TO 2300
                 WRITE(LP,2000)
  2000           FORMAT(//10X,'LINEAR LEAST SQUARES FIT TO FAN DATA')
            DO 752 K=1,NFNUM
            WRITE(LP,754) K,(CL(K,IK),IK=1,3)
  754       FORMAT(/10X,'K=',I4,7X,'CL(K,IK)=',5(4X,E12.5))
```

```
 752  CONTINUE
 2300 CONTINUE
760   CONTINUE
770   WRITE (LP,781) NB,NJ
781       FORMAT (/////' THE STATED NUMBER OF AIRWAYS WAS',I7,'     THE',
     %        ' STATED NUMBER OF JUNCTIONS WAS',I7)
      DO 830 K=1,NFNUM
        NWRN=NFCW(K)
        IF (NWRN.EQ.ITRUE) WRITE (LP,821)NOF(K)
821         FORMAT(/////' THE FAN CHARACTERISTIC IS EXCEEDED FOR FAN NO',
     %           I5)
830     CONTINUE
C
C RESIST-EXIT.
C
C     WRITE(LP,851)
C851      FORMAT(1X,'RETURN FROM RESIST')
      RETURN
C
      END
```

```
      SUBROUTINE RDCONC
C              111111111122222222223333333333444444444455555555556666666666777
C23456789012345678901234567890123456789012345678901234567890123456789012
C
C       _RDCONC_ READS DATA FOR THE SCENARIO FOR THIS PARTICULAR MINE
C            NETWORK AND INITIALIZES THE CURRENT SCENARIO.
C
C
C
C       DATA DIVISION.
C       COMMON SECTION.
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/RESCOM/NWRN
      COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
      COMMON/RTMCOM/MRKL
C
C       PROCEDURE DIVISION
C            WITH ENTRY POINT RDCONC.
C
C
C      CONCENTRATION PART OF PROGRAM
C
C RDCONC.
C
C      WRITE(LP,101)
C101      FORMAT(1X,'ENTERING RDCONC')
       PI=3.141593
       NSFLOW=IFALSE
       ITCT=0
C
C READ-AND-COMPLETE-INPUT-DATA.
C
C                READ ONE CONCENTRATION-CONTROL CARD
       READ(IO,151) NDIM,NCH4C,NAV,MAXJ,INFLOW,JSTART,TSTART,TIME,CRITSM,
     ;          CRITGS,CRITHT,WRNPR,WRNSM,WRNGS,WRNHT
151       FORMAT (6I5,F5.1,F8.2,F7.5,F5.3,F6.3,F4.2,F6.4,F4.1,F5.0)
       IF (NAV.NE.IFALSE)NAV=ITRUE
C               IF(NAV)READ ONE CONCENTRATION AVERAGE-VALUE CARD
       IF(NAV.EQ.ITRUE)READ (IO,181) TAVR,HAAVR,HKAVR,KFAVR,
     ;          LAAVR,AAVR,OAVR
181       FORMAT (3F10.5,2I10,2F10.2)
       IF (NDIM.LE.0)GOTO  430
         L=0
         DO 370 I=1,NDIM
```

```
C               IF(NDIM.GT.0)READ CONCENTRATION AIRWAY CARDS
           READ (IO,231) NOX,CH4VX,CH4PAX,TROCKX,HAX,HKX,DZRDX
231             FORMAT (I5,F10.2,4F10.5,F10.1)
           DO 260 J=1,NB
             IF (NOX.EQ.NO(J)) GOTO 280
260             CONTINUE
             GO TO 360
280          L=L+1
                CH4V(J)=CH4VX
                RDCH4(J)=CH4PAX
                TROCK(J)=TROCKX
                HA(J)=HAX
                HK(J)=HKX
                DZRD(J)=DZRDX
                NO(J)=-NO(J)
360        CONTINUE
370        CONTINUE
         IF (NDIM.EQ.L) GOTO 420
           WRITE (LP,401)
C                   HERE% WRONG NUMBER OF CONCENTRATION AIRWAY CARDS OR
C     ;                 AT LEAST ONE _NOX_ IS NOT (REPEAT% NOT )
C     ;                 INCLUDED IN (NO(I),I=1,NB)
401             FORMAT (/////,' MISTAKE IN CONCENTRATION AIRWAY CARDS%',
      ;             /,'      INVALID AIRWAY NUMBER OR WRONG NUMBER OF ',
      ;             'AIRWAY CONCENTRATION CARDS.'
      ;             /,10X,'RUN ABORTED.',//,10X,'END OF RUN.')
           STOP
C
420    CONTINUE
       MRKL=0
430    DO 720 I=1,NB
C               THIS DO-LOOP STICKS AVERAGE VALUES IN AIRWAY DATA
C     ;                 NOT GREATER THAN 0
         IF(NO(I).LT.0) GOTO 550
           IF(NETW.EQ.ITRUE.AND.NTEMP.EQ.ITRUE.AND.NCONC.EQ.ITRUE)
      ;         GOTO 470
             IF(NCONC.EQ.ITRUE)GOTO 710
470             IF (NAV.EQ.ITRUE) GOTO 510
                  WRITE (LP,491)
491                   FORMAT(//////,' INSUFFICIENT DESCRIPTION OF AIRWAY',
      1                   ' PROPERTIES'/,6X,'(AVERAGE-VALUE CARD ',
      2                   'REQUIRED FOR AIRWAYS NOT ON CONCENTRATION'
      3                   ' AIRWAY CARDS)',/,10X,'RUN ABORTED.',
      4                   //,10X,'END OF RUN.'/)
                  STOP
C
510             NO(I)=-NO(I)
                  HA(I)=HAAVR
                  HK(I)=HKAVR
                  GO TO 580
550      IF (NAV.NE.ITRUE)GOTO 620
           IF (HA(I).LE.0.0) HA(I)=HAAVR
           IF (HK(I).LE.0.0) HK(I)=HKAVR
580        IF (KF(I).LE.0) KF(I)=KFAVR
       IF (LA(I).LE.0) LA(I)=LAAVR
       IF (LA(I).LE.0) MRKL=MRKL+1
       IF (A(I).LE.0)  MRKL=MRKL+1
           IF (A(I).LE.0.0) A(I)=AAVR
           IF (O(I).LE.0.0) O(I)=OAVR
620      IF (TROCK(I).GT.0.0) GOTO 700
           IF (NVPN.EQ.ITRUE) GOTO 670
             IF (NAV.NE.ITRUE) GOTO 690
                TROCK(I)=TAVR
```

```
                   GO TO 680
      670        NO(I)=-NO(I)
      680          CONTINUE
      690        CONTINUE
      700    CONTINUE
      710    CONTINUE
      720    CONTINUE
           DO 1040 J=1,NB
      C            THIS DO-LOOP COMPUTES _TROCK_S NOT ON YOUR CONCENTRATION
      C     ;          AIRWAY CARDS FROM JUNCTION DATA% IF JUNCTION DTAT IS
      C     ;          NOT AVAILABLE, THEN AVERAGE _TROCK_ FROM
      C     ;          _TAVR_ IS USED
             IF (NO(J).GT.0) GOTO 770
                 NO(J)=-NO(J)
                 GO TO 1030
      770      ES=0.0
                 EF=0.0
                 TRS=0.0
                 TRF=0.0
                 L=IFALSE
                 M=IFALSE
                 DO 950 I=1,NJ
                   IF (JS(J).NE.JNO(I)) GOTO 890
                       ES=PROP(I)
                       TRS=T(I)
                       L=ITRUE
                       GO TO 940
      890            IF (JF(J).NE.JNO(I)) GOTO 930
                       EF=PROP(I)
                       TRF=T(I)
                       M=ITRUE
      930            CONTINUE
      940          IF (L.EQ.ITRUE.AND.M.EQ.ITRUE) GOTO 970
      950                CONTINUE
      C
      C                  END DO((I),I=1,NJ);
                       GO TO 1010
      970            IF (DZRD(J).EQ.0.0) DZRD(J)=EF-ES
      C                      _X_ EQUATION% MIDDLE OF PAGE 29.
                     X=0.014*D(J)/(A(J)**0.8*(ABS(Q(J)))**0.2)
      C                      _TROCK_ EQUATION% BOTTOM OF PAGE 29%
      C     ;                     _TRF_ IS _T2_; _TRS_ IS _T1_.
      C              TROCK(J)=(TRF-TRS*EXP(-X*LA(J))+DZRD(J)/187.)/(1.-EXP
      C     ;           (-X*LA(J)))-DZRD(J)/(2.*187.)
                     XLA=X*FLOAT(LA(J))
                     TROCK(J)=(TRF-TRS*EXP(-XLA)+DZRD(J)/187.)/(1.-EXP
           1                       (-XLA))-DZRD(J)/(2.*187.)
                     IF (TROCK(J).GT.0.0)GOTO 1020
      1010         TROCK(J)=TAVR
      1020   CONTINUE
      1030   CONTINUE
      1040   CONTINUE
      C
      C SET-UP-JNO-LIST.
      C
           IF (NVPN.EQ.ITRUE) GOTO 1210
             L=1
             DO 1150 I=1,MAXJ
               DO 1100 J=1,NB
                 IF (JS(J).EQ.I) GOTO 1120
      1100         CONTINUE
                 GO TO 1140
      1120        JNO(L)=JS(J)
```

```
                    L=L+1
1140          CONTINUE
1150          CONTINUE
            IF (NJ.EQ.(L-1)) GOTO 1200
              WRITE (LP,1181)
C             WRITE(5,1234) NJ,L
C1234          FORMAT(2(4X,I4))
C                LM1=L-1
C1235         FORMAT(5(3X,I4))
C             WRITE(2,1235) (JNO(J),J=1,LM1)
C             WRITE(5,1235) (JNO(J),J=1,LM1)
C                        ALL JUNCTION NUMBERS MUST BE (JNO.LE.MAXJ), OR YOU
C     ;                        WILL GET THIS MESSAGE ALSO, JUST AS IF YOU HAD
C     ;                        ENTERED THE WRONG NUMBER IN _NJ_%  IN THIS
C     ;                        CASE, ANY (JNO.GT.MAXJ) WILL NOT BE USED
1181              FORMAT(/////,' STATED NUMBER OF JUNCTIONS IS WRONG AND ',
      ;                 'HAS BEEN CORRECTED')
              NJ=L-1
C
C CALCULATE-METHANE-EVOLUTION.
C
1200  CONTINUE
1210  IF (NCH4C.LE.0) GOTO 1360
         L=0
         DO 1330 I=1,NCH4C
C                 IF(NCH4C.GT.0)READ CONCENTRATION JUNCTION CARDS
           READ (IO,1251) JNOX,CH4CX
1251           FORMAT (I5,T26,F5.2)
           DO 1280 J=1,NJ
             IF (JNOX.EQ.JNO(J)) GOTO 1300
1280              CONTINUE
                 GO TO 1320
1300           PRCH4(J)=CH4CX
                 L=L+1
1320         CONTINUE
1330       CONTINUE
         IF (NCH4C.NE.L) WRITE(LP,1351)
1351            FORMAT (/////,' MISTAKE IN CONCENTRATION JUNCTION CARDS',
      ;               /,6X,'(CHECK FOR VALID _JNO_ IN EACH CARD AND',
      ;               ' FOR RIGHT NUMBER OF CARDS).')
1360  DO 1580 I=1,NB
         IF (CH4V(I).GT.0.0) GOTO 1570
C                 IF(CH4V(I).LE.0)COMPUTE DEFAULT METHANE VOLUME
C     ;                  PRODUCTION FOR THIS AIRWAY
C          CH4V(I)=RDCH4(I)*LA(I)*O(I)
           CH4V(I)=RDCH4(I)*FLOAT(LA(I))*O(I)
           IF (CH4V(I).GT.0.0)GOTO 1560
             M=IFALSE
             N=IFALSE

             DO 1500 L=1,NJ
               IF (JS(I).NE.JNO(L)) GOTO 1460
                 CH4S=PRCH4(L)
                 M=ITRUE
1460           IF (JF(I).NE.JNO(L))GOTO 1490
                 CH4F=PRCH4(L)
                 N=ITRUE
1490            IF (M.EQ.ITRUE.AND.N.EQ.ITRUE) GOTO 1530
1500              CONTINUE
C
1510              CH4V(I)=0.0
                   GO TO 1550
1530           IF (CH4F.LE.CH4S) GOTO 1510
```

```
                   CH4V(I)=(CH4F-CH4S)*Q(I)/100.0
1550    CONTINUE
1560    CONTINUE
1570    CONTINUE
1580    CONTINUE
C
      NRCT=0
C              IF(INFLOW.GT.0)READ CONTAMINATION CARDS
      IF (INFLOW.GT.0)READ(IO,1611) (NCENT(I),CONT(I),CONC(I),HEAT(I),
     ;         O2MIN(I),SMPO2(I),HTPO2(I),I=1,INFLOW)
1611      FORMAT (I5,F10.0,F10.5,F10.2,3F10.5)
C
C WRITE-CONC-INPUT-DATA.
C
      WRITE (LP,1631)
1631      FORMAT(1H1,T21,'INPUT DATA FOR CONCENTRATION AND TEMPERATURE',
     1         ' CALCULATIONS'///' AIRWAY  FROM    TO      ELEVATION DIFF',
     2         '.   ROCK  TEMP.   METHANE PROD.    CONDUCTIVITY    ',
     3         'DIFFUSIVITY')
      WRITE(LP,1651) (NO(I),JS(I),JF(I),DZRD(I),TROCK(I),CH4V(I),HK(I),
     ;         HA(I),I=1,NB)
1651      FORMAT (I5,2I7,T25,F10.1,T40,F10.1,T56,F10.1,T72,F10.1,T89,
     ;         F10.4)
      WRITE (LP,1671) TIME
1671       FORMAT (////,T20,' TIME AFTER BEGINNING OF EVENT',F7.2,'    ',
     ;         'HOURS')
      WRITE (LP,1691) TSTART,JSTART
1691      FORMAT (////,T20,' A TEMPERATURE OF',F6.1,'  WAS ASSIGNED TO',
     ;          ' JUNCTION NO',I7)
      IF (INFLOW.LE.0) GOTO 1760
          WRITE (LP,1721)
1721          FORMAT(////,T25,' THE FOLLOWING CONTAMINATION WAS ASSUMED',
     1              //,T18,'CONTAMINATION',T43,'OXYGEN CONCENTRATION',T67,
     2           'PRODUCTION PER CU FT OXYGEN',/,' AIRWAY   FLOWRATE   ',
     3             'CONCENTRAT.     HEAT        BEHIND FIRE            ',
     4             'SMOKE         HEAT')
          WRITE(LP,1741) (NCENT(I),CONT(I),CONC(I),HEAT(I),O2MIN(I),
     ;             SMPO2(I),HTPO2(I),I=1,INFLOW)
1741             FORMAT (I6,F11.3,F11.3,F12.3,9X,F6.2,10X,F8.3,7X,F8.3)
          GO TO 1780
1760     WRITE (LP,1771)
1771        FORMAT (/////,T20,' NO CONTAMINATION WAS SPECIFIED')
1780  CONTINUE
C     WRITE(LP,1801)
C1801     FORMAT(1X,'RETURN FROM RDCONC')
      RETURN
C
      END
```

```
      SUBROUTINE FLOWSK
C        111111111122222222223333333333444444444455555555556666666666777
C23456789012345678901234567890123456789012345678901234567890123456789012
C
C       "FLOWSK" RECORDS AIRFLOW-REVERSALS IN "NRCT" VECTOR
C    %      GENERATES FLOWSCHEME IN "INU", "KJS", "KJF", "KNO",
C    %      AND "JNOL" LISTS, AND SELECTS INITIAL
C    %      JUNCTION FROM "JSTART".
C
C       DATA DIVISION.
C       COMMON SECTION.
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/RESCOM/NWRN
      COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
      COMMON/FLOCOM/MM
C
C       PROCEDURE DIVISION WITH ENTRY POINT FLOWSCHEME.
C
C FLOWSCHEME.
C     WRITE(LP,111)
C111        FORMAT(1X,'ENTERING FLOWSK')
C
C CHECK-FOR-AIRFLOW-REVERSALS.
C
      NSFLOW=ITRUE
      DO 320 I=1,NB
        IF (Q(I).GE.0) GOTO 310
          NSFLOW=IFALSE
          J=JS(I)
          JS(I)=JF(I)
          JF(I)=J
          Q(I)=-Q(I)
          DZRD(I)=-DZRD(I)
          IF (NRCT.LE.0)GOTO 280
            DO 270 L=1,NRCT
              IF (NREV(L).NE.I) GOTO 260
                NREV(L)=0
                GO TO 300
260             CONTINUE
270               CONTINUE
280         NRCT=NRCT+1
              NREV(NRCT)=I
300             CONTINUE
```

```
310         CONTINUE
320         CONTINUE
C
C PACK-AIRFLOW-REVERSALS-IN-NREV.
C
        IF (NRCT.LE.0)GOTO 420
          L=0
            DO 400 I=1,NRCT
              IF (NREV(I).LE.0)GOTO 390
                L=L+1
                NREV(L)=NREV(I)
390           CONTINUE
400           CONTINUE
          NRCT=L
C
C MAKE-INU-KJS-KJF-KNO-JNOL-LIST.
C
420     L=0
        M=0
        N=1
        DO 660 I=1,MAXJ
          K=L
          DO 520 J=1,NB
            IF (JS(J).NE.I) GOTO 510
C                 AIRWAY "J" LEAVES JUNCTION "I": STICK IN "INU" LIST
              L=L+1
              INU(L)=J
C              WRITE(2,1234) I,L,JS(J),INU(L)
C1234             FORMAT(4X,'I,L,JS(J),INU(L)',4(3X,I4))
510         CONTINUE
520         CONTINUE
C               "KJS(N)" GETS LAST "L" IN "INU" LIST
C     %               FOR AIRWAYS LEAVING JUNCTION "I"
          KJS(N)=L
C              WRITE(2,1235) N,KJS(N)
C1235          FORMAT(4X,'N,KJS(N)',2(3X,I4))
          MM=M
          DO 600 J=1,NB
            IF (JF(J).NE.I) GOTO 590
C                 AIRWAY "J" ENTERS JUNCTION "I": STICK IN "KJF" LIST
              M=M+1
              KJF(M)=J
C           WRITE(2,1236) I,M,JF(J),KJF(M)
C1236         FORMAT(4X,'I,M,JF(J),KJF(M)',4(3X,I4))
590         CONTINUE
600         CONTINUE
C               "KNO(N)" GETS LAST "L" IN "KJF" LIST
C     %               FOR AIRWAYS LEAVING JUNCTION "I"
          KNO(N)=M
          IF ((MM.EQ.M).AND.(K.EQ.L)) GO TO 650
C               IF THIS JUNCTION IS USED, THEN "JNOL(N)"
C     %              ("N" IS THE SAME SUBSCRIPT FOR "KJS" AND "KNO")
C     %              GETS AIRWAY NUMBER FROM "I"
            JNOL(N)=I
            N=N+1
650       CONTINUE
660       CONTINUE
C
C RELATE-JNO-AND-JNOL-LISTS.
C
C          WRITE(2,889) (JNO(IK),IK=1,NJ)
C          WRITE(2,889) (JNOL(IK),IK=1,NJ)
C889         FORMAT(5(3X,I4))
```

```
         DO 740 I=1,NJ
           PROP(I)=0.0
           PRCH4(I)=0.0
           DO 720 J=1,NJ
             IF (JNOL(I).EQ.JNO(J)) GOTO 730
720            CONTINUE
C                      "JLR" CONTAINS THE "JNO" SUBSCRIPT FOR
C     %                    THE CURRENT "JNOL"
730        JLR(I)=J
740        CONTINUE
C
C INDICES-OF-STARTING-JUNCTION.
C
C                 GENERATE "MSTART" AND RELATED VARIABLES
C                NOTE:  PROPOSED CHANGES FOR DEFAULT "JSTART" HAVE BEEN
C     %              COMMENTED-OUT BECAUSE THERE WAS NO TIME TO TEST THEM
C        LSTART=ITRUE
         DO 770 I=1,NJ
           IF (JNOL(I).EQ.JSTART) GOTO 780
770          CONTINUE
C              I=1
C              LSTART=IFALSE
780      MSTART=I
         ISTART=JLR(I)
         T(ISTART)=TSTART
C        IF(LSTART.NE.ITRUE)WRITE(LP,805)JNOL(I)
C805          FORMAT(3X,'INVALID JUNCTION NUMBER IN "JSTART":  ',
C     %           'DEFAULT IS',I4)
C        WRITE(LP,821)
C821          FORMAT(1X,'RETURN FROM FLOWSK')
         RETURN
         END
```

```
      SUBROUTINE ROADWY
C        111111111122222222223333333333444444444455555555556666666666777
C2345678901234567890123456789012345678901234567890123456789012345678901
C
C       "ROADWY" DOES THE ITERATIONS FOR WHAT HAPPENS AT THE
C           ROADWAY JUNCTIONS DURING OUR DISASTER SCENE
C
C       DATA DIVISION.
C       COMMON SECTION.
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
C
C       WORKING-STORAGE SECTION.
      INTEGER LTEMP,IKJS
      REAL XDUM,CONTM1,DENOM,DENOM1,DENOM2
C     LABEL ICKY
C
C       PROCEDURE DIVISION WITH ENTRY POINT ROADWY.
C
C ROADWY.
C
      MRC=0
      MARKC=IFALSE
C
C CONDITIONS-AT-ALL-ROADWAY-ENDS.
C
100   L=ISTART
      NSTART=MSTART
C
C CONDITIONS-SELECTED-ROAD-ENDS.
C
120   CONTINUE
130   PROPJS=PROP(L)
      JX=L
      CH4JS=PRCH4(L)
      JNO(L)=-JNO(L)
      JY=1
C          "JY" IS SUBSCRIPT FOR THE FIRST AIRWAY
C    %         (IN "INU(JY)") LEAVING THE JUNCTION IN "JNOL(NSTART)"
      IF(NSTART.GT.1)JY=KJS(NSTART-1)+1
C          "JZ" IS SUBSCRIPT FOR THE LAST AIRWAY
C    %         (IN "INU(JZ)") LEAVING THE JUNCTION IN "JNOL(NSTART)"
      JZ=KJS(NSTART)
C     WRITE(LP,211) JY,JZ,NSTART,MSTART,L,(KJS(IKJS),IKJS=1,80)
C211     FORMAT(1X,'ROADWYL211:JY,JZ,NSTART,MSTART,L,KJS=',5I3,2(/40I3))
C     WRITE(LP,231) (JLR(IKJS),IKJS=1,80)
C231       FORMAT(5X,'JLR ='2(/40I3))
      DO 280 K=JY,JZ
```

```
C       PERFORM CK-CONC-CHANGE-AND-ADDED-HEAT THRU AIRWAY-BOOGIE
C     %     VARYING K FROM JY BY 1 UNTIL K > JZ.
C                         THIS "PERFORM" LOOP CRUNCHES TEMPERATURES AND
C     %                           CONCENTRATION CHANGES FOR ALL AIRWAYS LEAVING
C     %                           JUNCTION "JNOL(NSTART)"
C       IF(JY.EQ.JZ) WRITE(5,1234)  JY,JZ,NSTART,INU(JY)
C     1   ,JNOL(NSTART)
C1234 FORMAT(5(4X,I4))
C       IF(JY.EQ.JZ) STOP
              ASSIGN 270 TO ICKY
                GOTO 1660
270             CONTINUE
280     CONTINUE
C
C CONDITIONS-IN-JUNCTIONS.
C
C                   COMPUTE "PROP", "PRCH4", AND "T" FOR NEXT JUNCTION FROM
C     %                   AIRWAYS ENTERING JUNCTION.  CHOOSE NEXT
C     %                   JUNCTION FOR TEMPERATURE AND CONC. CHANGES ON
C     %                   AIRWAYS LEAVING IT
        DO 570 I=1,NJ
          L=JLR(I)
          IF (JNO(L).LT.0)GOTO 560
C                         "JNO" GETS FLAGGED NEGATIVE JUST BEFORE THE
C     %                       "PERFORM" LOOP TO COMPUTE TEMPERATURE AND CONC.
C     %                       CHANGES ON AIRWAYS LEAVING IT
            JY=1
            IF(I.NE.1)JY=KNO(I-1)+1
            JZ=KNO(I)
            SUMAIR=0.0
            SUMPR=0.0
            SUMCH4=0.0
            SUMHT=0.0
            DO 460 K=JY,JZ
C                       "KJF" IS AIRWAY ENTERING JUNCTION: HUNT FOR
C     %                     TEMPERATURE AND CONC. CHANGES FOR ALL AIRWAYS
C     %                     ENTERING THIS JUNCTION
              J=KJF(K)
              IF(JF(J).GE.0)GOTO 550
C                       "JF" GETS FLAGGED NEGATIVE IN "AIRWAY-BOOGIE" AT
C     %                     THE TAIL END OF THE "PERFORM" LOOP TO COMPUTE
C     %                     TEMPERATURE AND CONC. CHANGES FOR AIRWAYS
                  SUMAIR=SUMAIR+Q(J)
                  SUMPR=SUMPR+RDPROP(J)*Q(J)
                  SUMCH4=SUMCH4+RDCH4(J)*Q(J)
                  SUMHT=SUMHT+TRD(J)*Q(J)*(0.2376+0.000024*TRD(J))
460             CONTINUE
C                         IF YOU FALL THRU TO HERE, YOU HAVE FOUND A
C     %                       JUNCTION WHICH HAS TEMPERATURE AND CONC.
C     %                       COMPUTED FOR ALL AIRWAYS ENTERING (BUT
C     %                       NOT ALL AIRWAYS LEAVING) IT:
C     %                       GET "PROP", "PRCH4", AND "T" FOR THIS JUNCTION
C     %                       AND THEN GO BACK TO "CONDITIONS-SELECTED-
C     %                       ROAD-ENDS" FOR THE NEXT JUNCTION
              NSTART=I
              PROP(L)=SUMPR/SUMAIR
              PRCH4(L)=SUMCH4/SUMAIR
              RTCONT=4950.**2.+SUMHT/(SUMAIR*0.000024)
              T(L)=-4950.+SQRT(RTCONT)
C             WRITE(LP,531) L,JNO(L)
C531            FORMAT(1X,'ROADWYL531:HERE FROM JNO(L).GE.0:L,JNO(L)=',2I5)
              GO TO 130
C
```

```
550        CONTINUE
560       CONTINUE
570       CONTINUE
C                   ONCE YOU GET HERE, EACH JUNCTION HAS:
C     %                  (1) TEMPERATURE AND CONC. CHANGES COMPUTED FOR ALL
C     %                  AIRWAYS LEAVING IT, .OR. (2) TEMPERATURE AND CONC.
C     %                  CHANGES COMPUTED FOR NOT ALL AIRWAYS
C     %                  ENTERING IT
         NREC=1
C
C RECIRCULATION-FIRST-APPROXIMATION.
C
590      CONTINUE
C        REPEAT UNTIL (L.GE.NJ);
         L=0
         DO 930 I=1,NJ
           IF(JNO(I).GT.0)GOTO 640
              L=L+1
              GO TO 920
640        CONTINUE
C                     THIS JUNCTION DID NOT GET TEMPERATURE AND CONC.
C     %                   CHANGES COMPUTED FOR ITS EXITING AIRWAYS
             N=0
             M=0
             SRPR=0.0
             SRCH4=0.0
             STRD=0.0
             QIN=0.0
             QREC=0.0
             DO 850 J=1,NB
               IF(JNO(I)+JF(J).NE.0)GOTO 790
C                       HERE: AIRWAY "J" GOT ITS TEMPERATURE AND CONC.
C     %                     CHANGE COMPUTED
                   N=N+1
                   SRPR=SRPR+RDPROP(J)*Q(J)
                   SRCH4=SRCH4+RDCH4(J)
                   STRD=STRD+TRD(J)
                   QIN=QIN+Q(J)
                   GO TO 840
790              IF(JNO(I).NE.JF(J))GOTO 830
C                         HERE: AIRWAY "J" DID NOT GET ITS TEMPERATURE AND
C     %                       CONC. CHANGE COMPUTED: STICK IT IN "MEMREC"
                   M=M+1
                   MEMREC(M)=J
                   QREC=QREC+Q(J)
830              CONTINUE
840            CONTINUE
850            CONTINUE
             IF(N.LE.0)GOTO 910
                 AVRPR=SRPR/QIN
                 AVRCH4=SRCH4/N
                 AVTRD=STRD/N
C                         COOL IT!  "QREC/QIN" GETS LARGER FOR CONVERGENCE
C     %                       AND SMALLER FOR DIVERGENCE (NO, THIS IS NOT A
C     %                       TYPO!): JUST IN CASE "QREC/QIN" IS TOO
C     %                       SMALL, THIS COMPUTES "AVRPR", "AVRCH4", AND
C     %                       "AVTRD" FOR A RECIRCULATION TRY
                 IF(QREC*2.0/QIN.LT.NREC)GOTO 950
C
910            CONTINUE
920          CONTINUE
930          CONTINUE
C                     IF(L.GE.NJ), ALL JUNCTIONS GOT TEMPERATURE AND CONC.
```

```
C     %                  CHANGES COMPUTED FOR THEIR EXITING AIRWAYS
         IF(L.GE.NJ)GOTO 1380
           NREC=NREC+1
           GO TO 590
C        END REPEAT(N.GE.NJ);
C
C RECIRC-COMPUTE-MRCS-AND-NSTART.
C
950      CONTINUE
C            IF THE PROGRAM COMES TO THIS PARAGRAPH, IT IS FIXING TO FIND
C     %          ANOTHER "NSTART" FOR A NEW JUNCTION AND THEN GO BACK
C     %          TO "CONDITIONS-SELECTED-ROAD-ENDS" TO COMPUTE CONDITIONS
C     %          FOR AIRWAYS LEAVING THIS NEW JUNCTION
C             HERE: GENERATE "ESTPR(MRC)", "ESTCH4(MRC)", "ESTTR(MRC)",
C     %                "RDPROP(K),    "RDCH4(K)", AND "TRD(K)"
         DO 1060 L=1,M
           MRC=MRC+1
           K=MEMREC(L)
C                MOVE DELINQUENT AIRWAYS (I.E., AIRWAYS WHICH DID NOT
C     %                GET TEMPERATURE AND CONC. CHANGES COMPUTED) FROM
C     %                "MEMREC" TO "NOREC"
           NOREC(MRC)=K
           ESTPR(MRC)=AVRPR
           RDPROP(K)=ESTPR(MRC)
           ESTCH4(MRC)=AVRCH4
           RDCH4(K)=ESTCH4(MRC)
           ESTTR(MRC)=AVTRD
           TRD(K)=ESTTR(MRC)
           JF(K)=-JF(K)
1060       CONTINUE
C            HERE: GENERATE "NSTART" AND RELATED VARIABLES PERTINENT TO
C     %          THE NEW JUNCTION BEFORE GOING BACK TO
C     %          "CONDITIONS-SELECTED-ROAD-ENDS"
         DO 1090 J=1,NJ
C                IF "JNO(I).GT.0", THEN THIS JUNCTION DID NOT GET
C     %                TEMPERATURE AND CONC. CHANGES COMPUTED FOR ITS
C     %                EXITING AIRWAYS: SHAME, SHAME!  "I" IS LEFT-OVER
C     %                FROM "RECIRCULATION-FIRST-APPROXIMATION", WHERE
C     %                THIS DELINQUENT JUNCTION WAS FOUND
           IF(JNO(I).EQ.JNOL(J))GOTO 1100
1090          CONTINUE
1100     JY=1
         IF(J.NE.1)JY=KNO(J-1)+1
         JZ=KNO(J)
         SUMAIR=0.0
         SUMPR=0.0
         SUMCH4=0.0
         SUMHT=0.0
         DO 1250 K=JY,JZ
C                GET "SUMAIR", ETC. FROM AIRWAYS ENTERING "JNOL(J)"
           M=KJF(K)
           SUMAIR=SUMAIR+Q(M)
           SUMPR=SUMPR+RDPROP(M)*Q(M)
           SUMCH4=SUMCH4+RDCH4(M)*Q(M)
           SUMHT=SUMHT+TRD(M)*Q(M)*(0.2376+0.000024*TRD(M))
C          WRITE(LP,1241) K,M,Q(M),SUMAIR,RTCONT
C1241         FORMAT(1X,'ROADWY1241:K,M,Q(M),SUMAIR,RTCONT=',2I3,3F13.3)
1250       CONTINUE
         NSTART=J
         L=I
C        WRITE(LP,1291) SUMAIR,RTCONT
C1291        FORMAT(5X,'ROADWY AFTER END-DO-1250:SUMAIR,RTCONT=',2F13.3)
         PROP(L)=SUMPR/SUMAIR
```

```
         PRCH4(L)=SUMCH4/SUMAIR
         RTCONT=4950.**2.+SUMHT/(SUMAIR*0.000024)
         T(L)=-4950.+SQRT(RTCONT)
         GO TO 120
C
C RECIRCULATION-PREPARATION-FOR-ITERATION.
C
1380  CONTINUE
C               CHECK "DIFPR", "DIFCH4", AND "DIFTRD" FOR CONVERGENCE:
C    %               IF WITHIN LIMITS, THEN CONGRATULATIONS, YOU CAN
C    %               EXIT "ROADWY"!
         DO 1390 I=1,NB
1390       JF(I)=IABS(JF(I))
         DO 1410 I=1,NJ
1410       JNO(I)=IABS(JNO(I))
         LAGAIN=IFALSE
         IF(MRC.EQ.0)GOTO 1620
           DO 1560 I=1,MRC
C                    ONLY DELINQUENT AIRWAYS FROM "NOREC" ARE CHECKED
C    %                    FOR CONVERGENCE
              K=NOREC(I)
              DIFPR=ESTPR(I)-RDPROP(K)
              DIFCH4=ESTCH4(I)-RDCH4(K)
              DIFTRD=ESTTR(I)-TRD(K)
              IF (ABS(DIFPR).GE.CRITSM/100.) LAGAIN=ITRUE
              IF (ABS(DIFCH4).GE.CRITGS/100.) LAGAIN=ITRUE
              IF (ABS(DIFTRD).GE.CRITHT) LAGAIN=ITRUE
              ESTPR(I)=RDPROP(K)
              ESTCH4(I)=RDCH4(K)
              ESTTR(I)=TRD(K)
              JF(K)=-JF(K)
1560          CONTINUE
         ITCT=ITCT+1
         IF (LAGAIN.NE.ITRUE)GOTO 1610
           IF (ITCT.LE.ITN)GOTO 100
C
              MARKC=ITRUE
C                    NOTE: "MARKC=ITRUE" RETURN MEANS THAT "ROADWY" DID
C    %                    NOT CONVERGE WITHIN "ITN" TRIES ON INTERMEDIATE
C    %                    ITERATION COUNTER "ITCT": SUBROUTINE "WRITR"
C    %                    CHECKS "MARKC"
C
C ROADWY-BOOGIE.
C
1610  CONTINUE
1620   CONTINUE
         IF(NTEMP.NE.ITRUE)WRITE (LP,1641)
1641        FORMAT(////,' NO TEMPERATURE DETERMINATION WAS DEMANDED')
         RETURN
C
C             MAIN-LINE CODE FOR SUBROUTINE "ROADWY" ENDS HERE
C
C*****************************************************************
C
C             PARAGRAPHS PERFORMED FROM MAIN-LINE CODE
C                  WITHIN "ROADWY" START HERE
C
C
C CK-CONC-CHANGE-AND-ADDED-HEAT.
C
1660  CONTINUE
C          DETERMINE IF THIS AIRWAY HAS CONCENTRATION CHANGES,
C    %          ADDED CONTAMINATION, OR ADDED HEAT
```

```
            ICFTM=IFALSE
      C          "I" IS CURRENT AIRWAY LEAVING THIS JUNCTION
            I=INU(K)
            NM=IFALSE
            DO 1730 LTEMP=1,INFLOW
              L=LTEMP
      C            SUBROUTINE "RDCONC" READS: (NCENT(L),CONT(L),CONC(L),
      C     %          HEAT(L),O2MIN(L),SMPO2(L),HTPO2(L),L=1,INFLOW),
      C     %          ALL IN ONE WHACK IN ONE STATEMENT: THESE ARE COMPANION
      C     %          VARIABLES ALL WITH THE SAME SUBSCRIPT
      C            ALL VALUES SUBSCRIPTED "L" FROM HERE THRU "AIRWAY-BOOGIE"
      C     %          ARE CHOSEN BY THIS "IF(NCENT(L).EQ.NO(J))"
              IF (NCENT(L).EQ.NO(I))GOTO 1790
      1730      CONTINUE
              CONTAM=0.0
                CONTQ=0.0
                HEATAD=0.0
                TFS=0.0
                GO TO 2020
      C
      C CONC-CHANGE-AND-ADDED-HEAT.
      C
      1790  CONTINUE
      C         COMPUTE CONCENTRATION CHANGES, ADDED CONTAMINATION,
      C     %        AND ADDED HEAT
            NM=ITRUE
            IF (CONT(L).EQ.0.0)GOTO 1870
      C                EQUATIONS FOR "CONTAM", "CONTQ", "HEATAD":
      C     %              SEE 4.2.8.2, SECTION 1, PAGE 36
                CONTM1=CONT(L)*CONC(L)
                CONTAM=CONTM1/100.
      C         WRITE(LP,1841) CONTAM,CONTM1
      C1841          FORMAT(1X,25HROADWY1841:CONTM1,CONTAM=,2F13.3)
                CONTQ=CONT(L)
                GO TO 1890
      1870    CONTAM=0.0
                CONTQ=0.0
      1890  IF (HEAT(L).EQ. 0.0)GOTO 1920
                HEATAD=HEAT(L)
                GO TO 1930
      1920    HEATAD=0.0
      1930  IF (O2MIN(L).LE. 0.0)GOTO 1970
      C              EQUATIONS FOR "CONTAM", CONTQ", "HEATAD":
      C     %            SEE 4.2.8.2, SECTION 2, PAGE 36
              CONTAM=(0.21-PROPJS-O2MIN(L)/100.)*Q(I)
              CONTQ=0.0
              HEATAD=CONTAM*437.
      1970  IF (SMPO2(L).LE. 0.0)GOTO 2010
      C              EQUATIONS FOR "CONTAM", "CONTQ", "HEATAD":
      C     %            SEE 4.2.8.2, SECTION 3, PAGE 36
              CONTAM=(0.21-PROPJS)*Q(I)*SMPO2(L)
              CONTQ=0.0
              HEATAD=(0.21-PROPJS)*Q(I)*HTPO2(L)
      2010  CONTINUE
      C
      C MAKE-CHANGES-IN-EXIT-AIRWAYS.
      C
      2020  CONTINUE
            XDUM=10.0
      C     WRITE(LP,2041) XDUM
      C2041     FORMAT(1X,17HROADWY,L2041:XDUM=,F13.3)
      C                EQUATIONS FOR "RDCH4", "RDPROP":
      C     %              SEE 4.2.8.2, SECTION 3, PAGE 37
```

```
        DENOM=Q(I)+CH4V(I)
C       WRITE(LP,2071) K,I,Q(I),CH4V(I),DENOM
C2071       FORMAT(1X,34HROADWY2071:K,I,Q(I),CH4V(I),DENOM= ,2I3,3F13.3)
        RDCH4(I)=(CH4JS*Q(I)+CH4V(I))/DENOM
C       WRITE(LP,2071) K,I,Q(I),CH4V(I),DENOM
        RDPROP(I)=PROPJS*(Q(I)-CONTQ)/Q(I)+CONTAM/Q(I)
C       WRITE(LP,2071) K,I,Q(I)
        IF (NTEMP.EQ.ITRUE)GOTO 2150
            TRD(I)=0.0
            GO TO 2850
C
C TEMPERATURE-CALC-FOR-AIRWAY-I.
C
C               SEE 4.2.8.3 FOR EQUATIONS FROM HERE THRU "AIRWAY-BOOGIE"
2150    CONTINUE
        TJS=T(JX)
          IF (NM.NE.ITRUE)GOTO 2250
            IF (HEATAD.NE. 0.0)GOTO 2220
                TFSI(L)=TJS
                GO TO 2240
2220          VART=(4950.-TJS/2.)**2+9900.*TJS+HEATAD/(Q(I)*0.000024*DR)
C                         "TFS" EQUATIONS (NOTE: "TFS" IS "T" IN THE BOOK):
C     %                       LAST TWO ON PAGE 37 IN 4.2.8.3
                TFS=-4950.-TJS/2.+SQRT(VART)+TJS
                TJS=TFS
                TFSI(L)=TFS
2240        CONTINUE
2250    IF (ICFTM.EQ.ITRUE)GOTO 2280
            TM=(TJS+TROCK(I))/2.
            GO TO 2370
C
C TEMPERATURE-ITERATE-TDM-GRT-50.
C
2280    CONTINUE
2290    CONTINUE
C               EQUATIONS FOR "TM": TOP OF PAGE 38 ("TM" IS "T" IN BOOK)
        ARGMT=(TJS-TROCK(I))/(TRD(I)-TROCK(I))
          IF (ARGMT.GT. 1.0)GOTO 2340
             TM=(TJS+TRD(I))/2.
             GO TO 2360
C                     "X" EQUATION: JUST BELOW MIDDLE OF PAGE 41.
C2340        X=ALOG(ARGMT)/LA(I)
2340         X=ALOG(ARGMT)/FLOAT(LA(I))
C                     THIS "TM" EQUATION: JUST BELOW MIDDLE OF PAGE 41
C             TM=TROCK(I)+(TJS-TROCK(I))*(1.0-EXP(-X*LA(I)))/
C     %         (X*LA(I))
             XLA=X*FLOAT(LA(I))
             TM=TROCK(I)+(TJS-TROCK(I))*(1.0-EXP(-XLA))/
      %         XLA
C
C TEMPERATURE-MAIN-TDM-ITERATION.
C
2360    CONTINUE
C               "VISC", "WT" EQUATIONS: CLOSE TO BOTTOM OF PAGE 40
2370    WT=DR*(TR+460.)/(TM+460.)
        VISC=0.000145*((460.+TM)/492.)**1.75
C               "CP" IS USED IN THE MIDDLE OF PAGE 37
        CP=0.2376+0.000024*TM
C               "HKA" EQUATION: JUST BELOW MIDDLE OF PAGE 40
        HKA=0.014*((460.+TM)/492.)**0.81
        DENOM1=15.*WT*O(I)*VISC
C               "RN" EQUATION: TOP OF PAGE 41
        RN=Q(I)*DR/(15.*WT*O(I)*VISC)
```

```
           DENOM2=RN**0.237
C          WRITE(LP,2451) WT,D(I),VISC,DENOM1,RN,DENOM2
C2451          FORMAT(1X,41HROADWY2451:WT,D(I),VISC,DENOM1,RN,DENOM2=,6F13.3)
C                        "FRO" EQUATION: MIDDLE OF PAGE 40
           FRO=0.0032+0.221/RN**0.237
C                   "COR" EQUATION: SECOND GROUP ON PAGE 40
           POT=(100./RN)**0.125
           COR=((FLOAT(KF(I))*0.075)/(809*DR*FRO))**POT
C                   "HC" EQUATION: TOP OF PAGE 40
           HC=0.005*HKA*D(I)*RN**0.8*COR/A(I)
C                   "FO", "BI" EQUATIONS: TOP OF PAGE 39
           FO=TIME*HA(I)*D(I)**2/(4.*A(I)**2)
           BI=HC*2.*A(I)/(D(I)*HK(I))
C                   "X" EQUATION: MIDDLE OF PAGE 39
           X=(0.375+BI)*SQRT(FO)
           IF (X.GE.2.5)GOTO 2630
               N=0
               SUMT=0.0
               ADDT=X
2570           CONTINUE
C              REPEAT UNTIL (ABS(ADDT).LT. 0.00001);
C                        "SUMT" EQUATION: NEXT-TO-LAST ON PAGE 39
C     %                       ("SUMT" IS "PHI(X)" IN BOOK)  (FOR "X".LE. 2.5)
                 SUMT=SUMT+ADDT
                 N=N+1
C                ADDT=-ADDT*X**2*(2*N-1)/(N*(2*N+1))
                 X1N=FLOAT(N)
                 X2N=(2.*X1N-1.)/(X1N*(2.*X1N+1.))
                 ADDT=-ADDT*X**2*X2N
                 IF (ABS(ADDT).GE.0.00001)GOTO 2570
C                END REPEAT (ABS(ADDT).LT. 0.00001);
               FX=1.0-(EXP(X**2))*(1.0-(2.0/SQRT(PI))*SUMT)
               GO TO 2730
2630         N=0
               SUMT=0.0
               ADDT=1.0
C
2660           CONTINUE
C              REPEAT WHILE (ABS(ADDT).GE.0.00001
C     %                .AND. ABS(OLADDT).GT.ABS(ADDT));
                 SUMT=SUMT+ADDT
C                        "SUMT" EQUATIONS ("X".GT. 2.5): BOTTOM OF PAGE 39
                 N=N+1
                 OLADDT=ADDT
                 X1N=FLOAT(N)
                 ADDT=-ADDT*(2*X1N-1)/(2.0*X**2)
                 IF (ABS(ADDT).GE.0.00001 .AND.
      %                  ABS(OLADDT).GT.ABS(ADDT))GOTO 2660
C                END REPEAT (ABS(ADDT).GE.0.00001
C     %                  .AND. ABS(OLADDT).GT.ABS(ADDT));
C
               FX=1.0-1.0*SUMT/(SQRT(PI)*X)
C
C TEMPERATURE-FINISH-TDM-ITERAT.
C
2730  CONTINUE
C              WHEN THIS ITERATION ON "TDM" IS FINISHED, A FAIRLY CONVERGENT
C     %           "TRD(I)" FOR AIRWAY "I" WILL HAVE BEEN COMPUTED
           COAGE=BI-FX*BI**2/(0.375+BI)
C                   "XNEW" EQUATION: BOTTOM OF PAGE 41 AND TOP OF PAGE 42
C     %                   (RIGHT SIDE OF EQUATION MENTIONED JUST BELOW
C     %                    MIDDLE OF PAGE 38)
           XNEW(I)=HK(I)*FLOAT(LA(I))*D(I)**2.*COAGE/(120.*DR*Q(I)*CP*A(I))
```

```
        IF (ICFTM.EQ.ITRUE)GOTO 2780
            TOLD=TROCK(I)
            GO TO 2790
2780      TOLD=TRD(I)
C                   "TRD" EQUATION: MIDDLE OF PAGE 41
C     %                   (ALSO MENTIONED ON BOTTOM OF PAGE 38)
2790    TRD(I)=TROCK(I)+(TJS-TROCK(I))*EXP(-XNEW(I))-(DZRD(I)/(2.*
      %     778.26*CP))*(1.+EXP(-XNEW(I)))
        TDM=ABS(TOLD-TRD(I))
        IF (TDM.LE. 50.0)GOTO 2840
            ICFTM=ITRUE
            GO TO 2290
C
C
C AIRWAY-BOOGIE.
C
2840    CONTINUE
2850    CONTINUE
        JF(I)=-IABS(JF(I))
C        WRITE(5,4321) I,JF(I),TDM,TRD(I)
C4321     FORMAT(2(4X,I4),2(4X,E12.5))
        GOTO ICKY
        END
```

```
      SUBROUTINE NATVP1
C
C       "NATVP1" COMPUTES "FRNVP" FOR USE IN "NATURAL-VENTILATION-
C    %      PRESSURE-2" IN PROGRAM DRIVER, AND ADJUSTS "R" FOR ALL
C    %      REGULAR AIRWAYS AND "STATIC-Q" AIRWAYS
C
C
C       DATA DIVISION.
C       COMMON SECTION.
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/RESCOM/NWRN
      COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
      COMMON/FLOCOM/MM
      COMMON/NATCOM/E,B,G,GX,GXX,TMRD,TMSQR,TRA
C
C       PROCEDURE DIVISION WITH ENTRY POINT NATVP1.
C
C NATVP1.
C
C              CALCULATION OF NATURAL VENTILATION PRESSURE
      DO 320 I=1,NB
        DO 140 J=1,NJ
          IF (JS(I).EQ.JNO(J)) GO TO 150
140         CONTINUE
150     T1=T(J)
        DO 180 K=1,INFLOW
          IF (NCENT(K).EQ.NO(I))  GO TO 200
180         CONTINUE
          GO TO 210
200       T1=TFSI(K)
210     CP=0.2376+0.000012*(TRD(I)+T1)
C              "E" EQUATION: TOP OF PAGE 46.
        E=DZRD(I)/(2.*778.26*CP)
        B=T1-TROCK(I)
        G=XNEW(I)
        GX=EXP(-G)
        GXX=EXP(-2.*G)
        TRA=TROCK(I)+460.+E
C              "TMRD" IS "T(M)" IN EQUATION IN MIDDLE OF PAGE 46.
        TMRD=TROCK(I)-(B-E)*(GX-1.)/G
        FRNVP(I)=TMRD*DZRD(I)
        TMSQR=(TRA-E)**2.+E**2./3.-(B-E)*(GXX-1.)/(2.*G)-2.*TRA*
     %    (B-E)*(GX-1.)/G+4.*E*(B-E)*(GX*(1.+G)-1.)/G**2.
```

```
      IF (NWTYP(I).LE.0) R(I)=RSTD(I)*TMSQR/(460.+TR)**2.
  320 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SQRS(LY,NP)
C        1111111111222222222233333333334444444444555555555566666666667777
C234567890123456789012345678901234567890123456789012345678901234567890123456789012
C
C
C     LEAST SQUARES FIT OF FAN DATA
C
C
C       DATA DIVISION.
C       COMMON SECTION.
C       IMPLICIT DOUBLE PRECISION(A-H,O-Z)
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/RESCOM/NWRN
      COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
C
      COMMON/LEAST/ATA(3,3),ATY(3),CL(40,6),LK(5),MQ(5),IFAN
      DO 401 I=1,6
  401 CL(LY,I)=0.
      DO 402 I=1,3
      DO 402 J=1,3
  402 ATA(I,J)=0.
      ATA(1,1)=FLOAT(NP)
      DO 403 I=1,NP
      QF(LY,I)=QF(LY,I)/100000.
      ATA(1,2)=ATA(1,2)+QF(LY,I)
      ATA(1,3)=ATA(1,3)+QF(LY,I)*QF(LY,I)
      ATA(2,2)=ATA(1,3)
      ATA(2,3)=ATA(2,3)+QF(LY,I)*QF(LY,I)*QF(LY,I)
      ATA(3,3)=ATA(3,3)+QF(LY,I)*QF(LY,I)*QF(LY,I)*QF(LY,I)
      ATA(2,1)=ATA(1,2)
      ATA(3,1)=ATA(1,3)
      ATA(3,2)=ATA(2,3)
      QF(LY,I)=100000.*QF(LY,I)
  403 CONTINUE
      RETURN
      ENTRY SQRSS(LY,NP)
      DO 404 I=1,3
  404 ATY(I)=0.
      DO 405 I=1,NP
      QF(LY,I)=QF(LY,I)/100000.
      ATY(1)=ATY(1)+PF(LY,I)
      ATY(2)=ATY(2)+QF(LY,I)*PF(LY,I)
      ATY(3)=ATY(3)+QF(LY,I)*QF(LY,I)*PF(LY,I)
      QF(LY,I)=100000.*QF(LY,I)
```

```
 405  CONTINUE
      DO 406 I=1,3
      DO 406 J=1,3
 406  CL(LY,I)=CL(LY,I)+ATA(I,J)*ATY(J)
      RETURN
      END
```

```
      SUBROUTINE MINV(AAX,NV)
C        111111111122222222223333333333444444444455555555556666666666777
C23456789012345678901234567890123456789012345678901234567890123456789012
C
C
C              LEAST SQUARES FIT OF FAN
C
C
C       DATA DIVISION.
C       COMMON SECTION.
C       IMPLICIT DOUBLE PRECISION(A-H,O-Z)
        INCLUDE 'CTPAM.COM'
          DIMENSION AAX(20)
        INCLUDE 'CTCONN.COM'
       COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
       COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
       COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
       COMMON/RESCOM/NWRN
       COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
       COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
C
       COMMON/LEAST/ATA(3,3),ATY(3),CL(40,6),LK(5),MQ(5),IFAN
       DD=1.
       NKK=-NV
       DO 80 K=1,NV
       NKK=NKK+NV
       LK(K)=K
       MQ(K)=K
       KK=NKK+K
       BIGA=AAX(KK)
       DO 20 J=K,NV
       IZ=NV*(J-1)
       DO 20 I=K,NV
       IJ=IZ+I
   10  IF(ABS(BIGA)-ABS(AAX(IJ))) 15,20,20
   15  BIGA=AAX(IJ)
       LK(K)=I
       MQ(K)=J
   20  CONTINUE
       J=LK(K)
       IF(J-K) 35,35,25
   25  KI=K-NV
       DO 30 I=1,NV
       KI=KI+NV
       HOLD=-AAX(KI)
       JI=KI-K+J
       AAX(KI)=AAX(JI)
   30  AAX(JI)=HOLD
   35  I=MQ(K)
```

```
      IF(I-K) 45,45,38
38    JP=NV*(I-1)
      DO 40 J=1,NV
      JK=NKK+J
      JI=JP+J
      HOLD=-AAX(JK)
      AAX(JK)=AAX(JI)
40    AAX(JI)=HOLD
45    IF(BIGA) 48,46,48
46    DD=0.
      RETURN
48    DO 55 I=1,NV
      IF(I-K) 50,55,50
50    IK=NKK+I
      AAX(IK)=AAX(IK)/(-BIGA)
55    CONTINUE
      DO 65 I=1,NV
      IK=NKK+I
      HOLD=AAX(IK)
      IJ=I-NV
      DO 65 J=1,NV
      IJ=IJ+NV
      IF(I-K) 60,65,60
60    IF(J-K) 62,65,62
62    KJ=IJ-I+K
      AAX(IJ)=HOLD*AAX(KJ)+AAX(IJ)
65    CONTINUE
      KJ=K-NV
      DO 75 J=1,NV
      KJ=KJ+NV
      IF(J-K) 70,75,70
70    AAX(KJ)=AAX(KJ)/BIGA
75    CONTINUE
      DD=DD*BIGA
      AAX(KK)=1./BIGA
80    CONTINUE
      K=NV
100   K=K-1
      IF(K) 150,150,105
105   I=LK(K)
      IF(I-K) 120,120,108
108   JQ=NV*(K-1)
      JR=NV*(I-1)
      DO 110 J=1,NV
      JK=JQ+J
      HOLD=AAX(JK)
      JI=JR+J
      AAX(JK)=-AAX(JI)
 110  AAX(JI)=HOLD
 120  J=MQ(K)
      IF(J-K) 100,100,125
 125  KI=K-NV
      DO 130 I=1,NV
      KI=KI+NV
      HOLD=AAX(KI)
      JI=KI-K+J
      AAX(KI)=-AAX(JI)
130   AAX(JI)=HOLD
      GO TO 100
150   RETURN
      END
```

```
      SUBROUTINE WRITR
C         1111111111222222222233333333334444444444555555555566666666667777
C2345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
C
C       "WRITR" WRITES OUTPUT OF RESULTS
C
C       DATA DIVISION.
C       COMMON SECTION.
C
        INCLUDE 'CTPAM.COM'
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/NETWK/KNUM,JBM,NBL,JEM,KB,NBU,NK,NRETU,NO,Q1,IND,
     1KCO,MESC,N1,KE,NMIN,NUC,MMIN
      COMMON/ITTCOM/DQSUM,QBL,ADEN,IT,PART,QBR,RQSUM,ANUM,DP,
     1NBDR,RQ2,TABF,DPSUM,FANP,LL,DQ,FANQ,NPTS,NABF
      COMMON/RESCOM/NWRN
      COMMON/WRTCOM/MINREV,JFF,NRCT,MEMI,WRNHT,WRNPR,WRNSM,
     1WRNSUM,WRNGS
C
C       WORKING-STORAGE SECTION.
      INTEGER LRCIRC
C
C       PROCEDURE DIVISION WITH ENTRY POINTS WRITR WRITS.
C
C
C WRITR.
C
C               OUTPUT OF RESULTS
      DO 120 L=1,NB
        RQ(L)=R(L)
        IF(NWTYP(L).LE.0) RQ(L)=R(L)*(Q(L)/100000.)**2.
120     CONTINUE
C
C WRITS.
C
      ENTRY WRITS
      IF(MARKN.EQ.ITRUE) WRITE(LP,151)
151       FORMAT (/////,' THE NETWORK CALCULATION WAS NOT COMPLETED.  ',
     %          'MORE ITERATIONS ARE REQUIRED')
      IF(MARKC.EQ.ITRUE) WRITE (LP,171)
171       FORMAT (/////,' THE CALCULATION OF CONCENTRATIONS AND TEMPE',
     %          'RATURES WAS NOT COMPLETED.  MORE ITERATIONS ARE REQUIRED')
      WRITE (LP,191)
191       FORMAT (/////,T18,'TEMPERATURES AND CONCENTRATIONS AT AIRWAY',
     1          ' ENDS,  PRESSURES IN AIRWAYS',//,' AIRWAY',T10,'FROM',T18,
     2          'TO',T31,'AIRFLOW',T45,'TEMPERATURE',T63,'SMOKE',
     3          T77,'METHANE',T93,'PRESSURE',/)
      WRITE(LP,211) (NO(I),JS(I),JF(I),Q(I),TRD(I),RDPROP(I),RDCH4(I),
     %          RQ(I),I=1,NB)
211       FORMAT (' ',I5,2I7,T30,0PF8.0,T46,0PF7.2,T60,2PF8.4,T77,
     %          2PF6.2,T93,0PF6.3)
      WRITE (LP,231)
231      FORMAT (/////,T18,'TEMPERATURES AND CONCENTRATIONS OF SMOKE ',
```

```
      1          'AND METHANE IN JUNCTIONS',//,' JUNCTION',T13,'TEMPERA',
      2          'TURE',T28,'SMOKE',T37,'METHANE',T58,'JUNCTION',T69,
      3          'TEMPERATURE',T82,'SMOKE',T92,'METHANE'/)
       WRITE (LP,251) (JNO(I),T(I),PROP(I),PRCH4(I),I=1,NJ)
 251       FORMAT(I5,T15,OPF7.2,T25,2PF8.4,T36,2PF8.4,T57,I5,T71,OPF7.2,
      %          T79,2PF8.4,T91,2PF8.4)
       WRITE (LP,271) MADJC
 271       FORMAT (////,T22,'NUMBER OF ITERATIONS',I10)
       LRCIRC=IFALSE
       DO 360 I=1,NB
         IF(JF(I).GE.0)GOTO 350
           JFF=IABS(JF(I))
           WRITE (LP,331) NO(I),JFF
 331             FORMAT (' ',T18,'WITH AIRWAY NO',I7,'   INTO JUNCTION NO',
      %                I5)
           LRCIRC=ITRUE
 350     CONTINUE
 360   CONTINUE
       IF(LRCIRC.EQ.ITRUE) WRITE(LP,381)
 381       FORMAT (//,T18,'A RECIRCULATION PATH IS BEING CLOSED')
       WRNSUM=WRNPR+WRNGS+WRNSM+WRNHT
       IF (WRNSUM.GT.0)GOTO 440
           WRITE (LP,421)
 421             FORMAT (/////,' NO THRESHOLD LIMITS FOR CRITICAL STATES',
      %                ' WERE SPECIFIED')
           GO TO 850
C
C WRITE-CRITICAL-AIRWAYS.
C
 440   J=IFALSE
       DO 630 I=1,NB
         K=IFALSE
         L=IFALSE
         M=IFALSE
         N=IFALSE
         IF (100.*RDCH4(I).GE.WRNGS) K=ITRUE
         IF (100.*RDPROP(I).GE.WRNSM) L=ITRUE
         IF (TRD(I).GE.WRNHT) M=ITRUE
         IF (RQ(I).LT.WRNPR) N=ITRUE
         IF((K+L+M+N) .LT. ITRUE)GOTO 620
           IF (J.EQ.ITRUE)GOTO 590
             WRITE (LP,571) WRNGS,WRNSM,WRNHT,WRNPR
 571               FORMAT (/////,T23,'IN THE FOLLOWING AIRWAYS EXIST ',
      1                  'CRITICAL CONDITIONS',/,T27,'(THE STATED NUMBERS ',
      2                  'REFER TO AIRWAY ENDS)',/,' AIRWAY  FROM    TO   ',
      3                  'METHANE CONCENTRATION  SMOKE CONCENTRATION  TEMPE',
      4                  'RATURE  LOW VENTILAT. PRESSURE',/,T27,'HIGHER THAN'
      5                  ,T48,'HIGHER THAN',T66,'HIGHER THAN',T85,
      6                  'LOWER THAN',/,T26,F4.1,' PERCENT',T46,F6.3,' PERC',
      7                  'ENT',T65,F5.0,' DEGREES',T82,F5.3,' INCHES WG',//)
             J=ITRUE
 590       JFF=IABS(JF(I))
           WRITE (LP,611) NO(I),JS(I),JFF,RDCH4(I),RDPROP(I),TRD(I),RQ(I)
 611             FORMAT (I5,I7,I7,T29,2PF6.2,T50,2PF8.4,T67,OPF7.1,T87,
      %                OPF6.3)
 620     CONTINUE
 630     CONTINUE
       IF (J.EQ.ITRUE)GOTO 680
           WRITE (LP,661)
 661             FORMAT (/////,' NO CRITICAL CONDITIONS AT AIRWAY ENDS OR',
      %                ' IN JUNCTIONS WERE DETECTED')
           GO TO 860
C
```

```
C WRITE-CRITICAL-JUNCTIONS.
C
680    J=IFALSE
       DO 840 I=1,NJ
         K=IFALSE
         L=IFALSE
         M=IFALSE
         IF (100.*PRCH4(I).GE.WRNGS) K=ITRUE
         IF (100.*PROP(I).GE.WRNSM) L=ITRUE
         IF (T(I).GE.WRNHT) M=ITRUE
         IF (K+L+M .LT. ITRUE)GOTO 830
           IF (J.EQ.ITRUE)GOTO 810
             WRITE (LP,791) WRNGS,WRNSM,WRNHT
791              FORMAT (////,T24,' IN THE FOLLOWING JUNCTIONS EXIST ',
     1                'CRITICAL CONDITIONS',/,' JUNCTION      METHANE ',
     2                'CONCENTRATION          SMOKE CONCENTRATIONS',16X,
     3                'TEMPERATURE',/,T15,'HIGHER THAN',F4.1,' PERCENT',
     4                '         HIGHER THAN',F6.3,' PERCENT         MORE ',
     5                'THAN',F6.1,' DEGREES',//)
             J=ITRUE
810        WRITE (LP,821) JNO(I),PRCH4(I),PROP(I),T(I)
821            FORMAT (I5,T23,2PF5.1,T52,2PF8.4,T86,0PF7.1)
830      CONTINUE
840      CONTINUE
C
C WRITE-AIRFLOW-REVERSALS.
C
850    CONTINUE
860    CONTINUE
C              "NRCT" IS NUMBER OF REVERSED AIRWAYS(COMPUTED IN "FLOWSK")
       IF(NRCT-1) 1090,880,930
880        CONTINUE
C                  HERE IF ONLY ONE AIRWAY HAS AIRFLOW REVERSAL.
           WRITE(LP,1131)
           K=NREV(1)
           JFF=IABS(JF(K))
           WRITE(LP,1141) NO(K),JS(K),JFF
           GO TO 1100
C
930      CONTINUE
C                HERE FOR MORE THAN ONE AIRWAY WITH AIRFLOW REVERSAL
         WRITE (LP,1131)
           L=0
C
950      CONTINUE
C        REPEAT UNTIL (L.GT.NRCT);
C                  PICK LOWEST REMAINING AIRWAY NUMBER FOR NEXT WRITE
           MINREV=NREV(1)
           MEMI=1
           DO 1020 I=2,NRCT
             IF (MINREV.LE.NREV(I))GOTO 1010
               MINREV=NREV(I)
               MEMI=I
1010         CONTINUE
1020         CONTINUE
           L=L+1
C                  "L.GT.NRCT" TESTS FOR ALL AIRFLOW-REVERSALS WRITTEN
           IF (L.GT.NRCT)GOTO 1110
             JFF=IABS(JF(MINREV))
             WRITE (LP,1141) NO(MINREV),JS(MINREV),JFF
C                    STICK "NB+1" INTO CURRENT "NREV" TO MAKE IT TOO
C    %                     HIGH TO BE SELECTED FOR ANOTHER WRITE
             NREV(MEMI)=NB+1
```

```
                GO TO 950
C           END REPEAT(L.GT.NRCT);
C
C WRITER-BOOGIE.
C
1090  CONTINUE
1100  CONTINUE
1110  CONTINUE
      RETURN
C
C               MAIN-LINE CODE FOR "WRITR" ENDS HERE
C
C*************************************************************************
C
C        GLOBAL FORMATS
C
C              NOTE:  THESE FORMAT STATEMENTS ARE HERE BECAUSE THEY ARE EACH
C                  REFERENCED BY MORE THAN ONE "WRITE" STATEMENT.
C
1131  FORMAT (/////,T18,'REVERSAL OF AIRFLOW HAS OCCURRED IN THE FOLLOWI
     1NG PLACES',//)
1141  FORMAT (T18,'AIRWAY',I6,'  IS NOW CARRYING AIR FROM',I6,'  TO',I6)
      END
```

```
      SUBROUTINE RTIME1
C     REAL TIME FUME SPREAD
        INCLUDE 'CTPAM.COM'
      DIMENSION NW(IAR),NWAR(IAR),NWAL(IAR), VEL(IAR),ISTT(20)
     1, TOTEX(IJP),TOWEX(IJP), NGOUT(I
     2AR),LOUT(IAR),NGIN(IAR),MIN(IAR)
      INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FO,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
      COMMON/RTNCOM/NACC,IDUR,INC,EPX,REP,SNRW,JSURF
     1                 ,MULT,XINT
     2        ,ISCOB(IAR),IENDT(20),RTAC(IAR,240,4),RTJC(IAR,2)
      COMMON/RTMCOM/MRKL
      EQUIVALENCE (INU,NGOUT),(KJS,LOUT),(KJF,NGIN),(KNO,MIN)
      EQUIVALENCE (PROP,TOWEX),(T,TOTEX),(NWTYP,NW),(NREV,NWAR),(KF,NWAL
     1),(TROCK,VEL),(NOF,ISTT)
C
C
C     REAL TIME CALCULATION
C
C
C
C ******* SUBROUTINE FOR READING IN CONTAMINATION CARDS AND DETERM-
C           INING INTERNAL TIME INCREMENT FOR REAL TIME SIMULATION
      NWM=240
C *** INITIALIZATION OF JUNCTIONS
      DO 2145 I=1,NJ
C *** TOTAL EXPOSURE
      TOTEX(I)=0.0
C *** CURRENT FUME CONCENTRATION IN AIRWAY I
      RTJC(I,1)=0.0
C *** TIME OF FIRST CONTAMINATION IN AIRWAY I
      RTJC(I,2)=0.0
 2145 CONTINUE
      L=0
C *** IF AIRWAY LENGTH AND AREA NOT SPECIFIED, SET EQUAL TO AVG VALUE
      DO 2175 I=1,NB
      IF (A(I)) 2150,2150,2160
 2150 IF (AAVR) 2180,2180,2155
 2155 A(I)=AAVR
      L=L+1
 2160 IF (LA(I)) 2165,2165,2175
 2165 IF (LAAVR) 2180,2180,2170
 2170 LA(I)=LAAVR
      L=L+1
 2175 CONTINUE
      GO TO 2185
 2180 WRITE (LP,3105)
      GO TO 2800
C *** READ INFORMATION FOR ADDITIONAL CONTAMINATION CARDS
 2185 ICOR=0
      READ (IO,3115) NACC,IDUR,INC,EPX,REP,WRNSM,JSURF,CRITSM
```

```
      CRITSM=CRITSM/100.
      WRNSM=WRNSM/100.
      IF (NACC.GT.0) GO TO 2200
      IF(INFLOW) 2135,2135,2190
 2135 WRITE (LP,3100)
      GO TO 2800
 2190 DO 2195 I=1,INFLOW
      ISTT(I)=0
      IENDT(I)=IDUR
 2195 CONTINUE
      GO TO 2285
C *** READ ADDITIONAL CONTAMINATION CARDS
 2200 DO 2265 I=1,NACC
      J=I+INFLOW-ICOR
      READ(IO,3125) NCENT(J),CONT(J),CONC(J),HEAT(J),O2MIN(J),SMPO2(J),H
     1TPO2(J),ISTT(J),IENDT(J)
      IF((IENDT(J).LE.0).OR.(IENDT(J).GT.IDUR).OR.(IENDT(J).LE.ISTT(J)))
     1IENDT(J)=IDUR
      IF((ISTT(J).LT.0).OR.(ISTT(J).GT.IDUR).OR.(ISTT(J).GE.IENDT(J)))IS
     1TT(J)=0
      SUMC1=0.
      SUMC2=0.
      IJ=J-1
      IF (IJ.GT.0) GO TO 2205
      NCENT(J)=-NCENT(J)
      GO TO 2265
C *** CHECK IJ=J-1=I+INFLOW-ICOR-1 CARDS FOR DUPLICATION (ICOR=# OF CHECKS)
 2205 DO 2260 K=1,IJ
C *** IF DUPLICATION OF AIRWAY NOS, THEN COMPARE CARDS
      IF (ABS(NCENT(K))-NCENT(J)) 2260,2210,2260
 2210 IF (NCENT(K)) 2235,2260,2215
C *** IF AIRWAY NO < 0 GO TO 2235
 2215 SUMC1=CONT(J)+CONC(J)+O2MIN(J)+SMPO2(J)
      SUMC2=CONT(K)+CONC(K)+O2MIN(K)+SMPO2(K)
      IF (SUMC1-SUMC2) 2225,2220,2225
C *** IF CONTAMINANT FROM TWO SOURCES IS DIFFERENT, THEN GO TO 2235
C *** IF 2 CARDS WITH SAME AIRWAY NO. HAVE SAME TYPE AND SIZE OF CONTAM-
C     INANT SOURCE, DISREGARD FIRST CARD
 2220 ISTT(K)=ISTT(J)
      IENDT(K)=IENDT(J)
      ICOR=ICOR+1
      NCENT(K)=-NCENT(K)
      GO TO 2265
 2225 IF ((IENDT(K)-IENDT(J))+(ISTT(K)-ISTT(J))) 2265,2230,2265
C *** IF DIFFERENT CONTAMINANT SOURCES ACT ON SAME AIRWAY AT SAME TIME,
C     DISREGARD FIRST CARD
 2230 CONT(K)=CONT(J)
      CONC(K)=CONC(J)
      O2MIN(K)=O2MIN(J)
      SMPO2(K)=SMPO2(J)
      HEAT(K)=HEAT(J)
      HTPO2(K)=HTPO2(J)
      ISTT(K)=ISTT(J)
      IENDT(K)=IENDT(J)
      ICOR=ICOR+1
      NCENT(K)=-NCENT(K)
      GO TO 2265
 2235 SUMC1=CONT(J)+CONC(J)+O2MIN(J)+SMPO2(J)
      SUMC2=CONT(K)+CONC(K)+O2MIN(K)+SMPO2(K)
C *** IF CONTAMINANT DIFFERENT, GO TO 2250 AND COMPARE START AND FINISH
C     TIME
      IF (SUMC1-SUMC2) 2250,2240,2250
 2240 IF ((ISTT(K).EQ.ISTT(J)).AND.(IENDT(K).EQ.IENDT(J))) GO TO 2245
```

```
C *** IF TWO CARDS WITH SAME AIRWAY # HAVE SAME TYPE AND SIZE
C     OF CONTAMAMINANTSOURCE, AND TIMES ARE
C     DIFFERENT, DISREGARD FIRST CARD
      ISTT(K)=ISTT(J)
      IENDT(K)=IENDT(J)
2245  ICOR=ICOR+1
      GO TO 2265
2250  IF ((ISTT(K).EQ.ISTT(J)).AND.(IENDT(K).EQ.IENDT(J))) GO TO 2255
      GO TO 2265
C *** IF DIFFERENT CONTAMINANT SOURCES ACT ON SAME AIRWAY AT SAME
C     TIME, DISREGARD FIRST CARD
2255  CONT(K)=CONT(J)
      CONC(K)=CONC(J)
      O2MIN(K)=O2MIN(J)
      SMPO2(K)=SMPO2(J)
      HEAT(K)=HEAT(J)
      HTPO2(K)=HTPO2(J)
      ICOR=ICOR+1
      GO TO 2265
2260  CONTINUE
2265  CONTINUE
      DO 2280 I=1,INFLOW
      IF (NCENT(I)) 2275,2270,2270
C *** IF AN AIRWAY IN INFLOW CARDS DID NOT REAPPEAR IN NACC CARDS, THEN
C     SOURCE ACTS FOR ENTIRE REAL TIME CALCULATION
2270  ISTT(I)=0.
      IENDT(I)=IDUR
      GO TO 2280
2275  NCENT(I)=-NCENT(I)
2280  CONTINUE
C *** ICOR=# OF DELETIONS
      INFLOW=NACC+INFLOW-ICOR
2285  WRITE (LP,3120)
      IF ((L.GT.0).OR.(MRKL.GT.0)) WRITE (LP,3310) LAAVR,AAVR
      WRITE (LP,3130)
      WRITE(LP,3135) (NCENT(I),CONT(I),CONC(I),O2MIN(I),SMPO2(I),ISTT(I)
     1,IENDT(I),I=1,INFLOW)
C      CALCULATE INTERNAL INCREMENT (XINT) AND MULTIPLIER (MULT).
      TL=0.
C *** CALCULATE AIR VELOCITY AND TRAVEL TIME FOR EACH AIRWAY
      DO 2290 I=1,NB
      VEL(I)=Q(I)/A(I)
      TL=TL+LA(I)/VEL(I)
2290  CONTINUE
C *** CALCULATE AVERAGE TRAVEL TIME
      AVL=TL/NB
C *** XL5PC=LARGEST VALUE OF CONTAMINANT TRAVEL TIME THAT CAN BE EXCLUDED
C     NAD=# OF AIRWAYS THAT CAN BE EXCLUDED
      XL5PC=AVL*EPX/100.
      NAD=IFIX((NB*REP/100.))
      IF (NAD.EQ.0) GO TO 2305
      DO 2300 I=1,NAD
      AMIN=1.E10
C *** AMIN=MINIMUM TRAVEL TIME IN AIRWAYS NOT EXCLUDED
C     TEMPORARILY SET Q(J)=-Q(J) FOR EXCLUDED AIRWAYS
      DO 2295 J=1,NB
      IF (Q(J).LT.O.) GO TO 2295
      IF ((LA(J)/VEL(J)).GT.AMIN) GO TO 2295
      AMIN=LA(J)/VEL(J)
      K=J
2295  CONTINUE
      IF (AMIN.GT.XL5PC) GO TO 2305
      Q(K)=-Q(K)
```

```
2300  CONTINUE
2305  AMIN=1.E10
C *** CALC MIN TRAVEL TIME IN AIRWAYS OTHER THAN EXCLUDED AIRWAYS
      DO 2310 I=1,NB
      IF (Q(I).LT.0.) GO TO 2310
      TRTM=LA(I)/VEL(I)
      IF(TRTM.LE.AMIN)AMIN=TRTM
2310  CONTINUE
C *** IF AMIN<INC, CALCULATE LEAST 'MULT' SUCH THAT XINT=INC/MULT
C     WHERE XINT.LE.AMIN
      IF (AMIN.GE.INC) GO TO 2325
      DO 2315 I=1,IMSL
      MULT=I
      XINT=(FLOAT(INC))/(FLOAT(I))
      IF (XINT.LE.AMIN) GO TO 2320
2315  CONTINUE
2320  IF (XINT.LT.INC) GO TO 2330
C *** IF XINT.GE.INC, SET XINT.EQ.INC
2325  XINT=INC
      MULT=1
2330  DO 2335 I=1,NB
C *** RESET 'Q(I)' TO A POSITIVE QUANTITY
      IF(Q(I).LT.0)Q(I)=-Q(I)
      NW(I)=0
      ISCOB(I)=0
      NWAL(I)=0
      NWAR(I)=0
2335  CONTINUE
C     FORMATS
3100  FORMAT (1H0,'REAL TIME CALCULATION NOT COMPLETED NO ','CONTAMINATI
     1ON STATED')
3105  FORMAT (1H0,'REAL TIME CALCULATION NOT COMPLEATED AIRWAY',' LENGTH
     1 OR AREA NOT GIVEN')
3115  FORMAT (3I5,2F6.2,F8.4,I5,F6.5)
3120  FORMAT (1H1,T48,'R E A L     T I M E     A N A L Y S I S')
3125  FORMAT (I5,F10.0,F10.5,F10.2,3F10.5,2I5)
3130  FORMAT (////,T25,'THE FOLLOWING CONTAMINATION HISTORY ','WAS ASSUM
     1ED FOR THE REAL TIME ANALYSIS',//,T18,'CONTAMINATION',T43,'OXYGEN
     2CONCENTRATION',T67,'PRODUCTION PER % OXYGEN',T95,'TIME HISTORY OF
     3EVENT',/,' AIRWAY   FLOWRATE  CONCENTRAT.                        ','BEHIN
     4D FIRE                   FUMES',T95,'START',T105,'END')
3135  FORMAT (I6,F11.1,F11.1,22X,F6.2,17X,F8.2,T95,I5,T103,I5)
3140  FORMAT (1H0,////,134('*'))
3145  FORMAT (1H ,134('*'))
3185  FORMAT (1H0,'AIRWAY    CONC %  LOCATION START   ARRIVAL   ')
3295  FORMAT (1H0,///,T30,'AT',I5,' MIN. AFTER THE START OF CONTAMINATIO
     1N THE TOTAL EXPOSURE TO',/,T30,'THE CONTAMINANT MEASURED IN PPM*HO
     2URS WAS IN THE FOLLOWING JUNCTIONS')
3310  FORMAT (////,T30,'AVERAGE VALUES OF',I8,' FT    AND',F10.1,' SQFT
     1   WERE INTRODUCED, WHERE',/,T30,'AIRWAY LENGTH AND CROSS SECTIONA
     2L AREA HAD NOT BEEN SPECIFIED')
 2800 CONTINUE
      SNRW=WRNSM
       RETURN
      END
```

```
      SUBROUTINE RTIME2
C     REAL TIME FUME SPREAD
       INCLUDE 'CTPAM.COM'
      DIMENSION NW(IAR),NWAR(IAR),NWAL(IAR), VEL(IAR),ISTT(20)
     1, TOTEX(IJP),TOWEX(IJP), NGOUT(I
     2AR),LOUT(IAR),NGIN(IAR),MIN(IAR)
        INCLUDE 'CTCONN.COM'
      COMMON/SCLR1/ADDT,BI,COR,DIFCH4,FRO,I,ITN,K,MRC,NM,PI,RN,SUMAIR,
     1TDM,TOLD,X,ARGMT,CH4JS,CP,DIFPR,FX,ICFTM,J,L,MSTART,NREC,POT,
     2RTCONT,SUMCH4,TFS,TR,AVRCH4,COAGE,CRITGS,DIFTRD,HC,INFLOW,JX,LP,
     3N,NSTART,PROPJS,SRCH4,SUMHT,TIME,VART,AVRPR,CONTAM,CRITHT,DR,
     4HEATAD,ISTART,JY,M,NB,NTEMP,QIN,SRPR,SUMPR,TJS,VISC,AVTRD,CONTQ,
     5CRITSM,FC,HKA,ITCT,JZ,MARKC,NJ,OLADDT,QREC,STRD,SUMT,TM,WT,
     6AX,HSU,IO,NFNUM,NT,ONVP,TO,FACT,H,MADJC,MENDW,NADBC,NSFLOW,
     7OX,T1,ZDOWN,FNTM,MNO,NSNVP,NVPN,ZUP,INDEX,LX,MARKD,NCONC,
     8NNVP,NX,ZO,DNVP,KX,MARKN,NETW,NOX,NSW,TSU,Z1,MADJ,MBEGW,
     9ITRUE,IFALSE
      COMMON/RDCCOM/AAVR,CH4CX,CH4VX,ES,HAX,HKX,KFAVR,CH4F,
     1JNOX,NAV,NCH4C,JSTART,CH4PAX,DZRDX,NDIM,OAVR,CH4S,
     2HAAVR,HKAVR,LAAVR,MAXJ,TSTART,TRF,TROCKX,TAVR,TRS,EF
      COMMON/RTNCOM/NACC,IDUR,INC,EPX,REP,SNRW,JSURF
     1              ,MULT,XINT
     2   ,ISCOB(IAR),IENDT(20),RTAC(IAR,240,4),RTJC(IAR,2)
      COMMON/RTMCOM/MRKL
      EQUIVALENCE (INU,NGOUT),(KJS,LOUT),(KJF,NGIN),(KNO,MIN)
      EQUIVALENCE (PROP,TOWEX),(T,TOTEX),(NWTYP,NW),(NREV,NWAR),(KF,NWAL
     1),(TROCK,VEL),(NOF,ISTT)
C
C
C     REAL TIME CALCULATION
C
C
C
      NWM=240
      WRNSM=SNRW
C
C      REAL TIME CONCENTRATION AND FUME POSITION CALCULATION.
C
      DO 2795 I=INC,IDUR,INC
      DO 2695 J=1,MULT
      DO 2650 K=1,NB
C     CHECK AIRWAY CONDITION
      IF (NO(K)) 2650,2650,2340
C     CALCULATE CONCENTRATION  OF FUMES
2340  DO 2350 M=1,NJ
      IF (ABS(JS(K))-ABS(JNOL(M))) 2350,2345,2350
2345  M1=M
      GO TO 2355
2350  CONTINUE
2355  DO 2405 L=1,INFLOW
      IF (NCENT(L)-ABS(NO(K))) 2405,2360,2405
2360  IF ((I-INC.LT.ISTT(L)).OR.(I.GT.IENDT(L))) GO TO 2405
2365  IF (CONT(L)) 2370,2375,2370
2370  CONTAM=CONT(L)*CONC(L)/100.
      CONTQ=CONT(L)
      GO TO 2380
2375  CONTAM=0.0
      CONTQ=0.0
2380  IF (O2MIN(L)) 2390,2390,2385
2385  CONTAM=(.21-RTJC(M1,1)-O2MIN(L)/100.)*Q(K)
      CONTQ=0.0
2390  IF (SMPO2(L)) 2400,2400,2395
2395  CONTAM=(.21-RTJC(M1,1))*Q(K)*SMPO2(L)
```

```
           CONTQ=0.0
     2400  TEMPRC=(RTJC(M1,1)*(Q(K)-CONTQ)/Q(K)+CONTAM/Q(K))
           JY=NW(K)
           IF(JY.EQ.0)JY=1
     C     CHECK CONCENTRATION & START NEW WAVE IF NECESSARY.
           IF (ABS(TEMPRC-RTAC(K,JY,1)).LE.CRITSM) GO TO 2415
           GO TO 2410
     2405  CONTINUE
           JY=NW(K)
           IF(JY.EQ.0)JY=1
           IF (ABS(RTAC(K,JY,1)-RTJC(M1,1)).LE.CRITSM) GO TO 2415
           TEMPRC=RTJC(M1,1)
     2410  NW(K)=NW(K)+1
           JY=NW(K)
           RTAC(K,JY,3)=I-INC+(J-1)*XINT
           RTAC(K,JY,1)=TEMPRC
           RTAC(K,JY,2)=0.
           IF(ISCOB(K).NE.-1)ISCOB(K)=-1
     2415  IF (ISCOB(K)) 2425,2420,2420
     2420  NO(K)=-NO(K)
           GO TO 2650
     C     CALCULATE FUME ADVANCE FOR EACH WAVE IN AIRWAY.
     2425  JY=NW(K)-NWAL(K)
           IS=1+NWAR(K)
           IF ((JY.LE.0).OR.(IS.LE.0).OR.(JY.LT.IS)) GO TO 2420
           XSMOK=VEL(K)*XINT
           DO 2430 L=IS,JY
           RTAC(K,L,2)=RTAC(K,L,2)+XSMOK
     2430  CONTINUE
     C     CHECK IF ANY WAVES HAVE ARRIVED AT JF AND CALCULATE
     C     ARRIVAL TIME.

           K2=K
     2435  ITR=0
           DO 2440 L=IS,JY
           IF (RTAC(K2,L,2).LT.LA(K2)) GO TO 2440
           OVTM=(RTAC(K2,L,2)-LA(K2))/VEL(K2)
           RTAC(K2,L,2)=LA(K2)
           RTAC(K2,L,4)=I-INC+XINT*J-OVTM
           RTAC(K2,L,4)=-RTAC(K2,L,4)
           NWAR(K2)=NWAR(K2)+1
           ITR=-1
     2440  CONTINUE
           IF (ABS(JF(K2)).EQ.JSURF) GO TO 2420
           IF (ITR.NE.-1) GO TO 2420
     C.     FIND ALL WAVES EFFECTING JUNCTION DURING THIS XINT
           DO 2645 L=1,NJ
           IF (ABS(JF(K2))-ABS(JNOL(L))) 2645,2445,2645
     2445  M1=MIN(L-1)+1
           M2=MIN(L)
           IF(L.EQ.1)M1=1
           DO 2480 M=M1,M2
           IA=NGIN(M)
           DO 2475 M3=1,NB
           IF (ABS(NO(IA)).EQ.ABS(NO(K2))) GO TO 2480
           IF (ABS(NO(M3))-ABS(NO(IA))) 2475,2450,2475
     2450  IF (ISCOB(M3)) 2455,2480,2480
     2455  IF (NO(M3)) 2480,2460,2460
     2460  IF (JF(M3)) 2480,2465,2465
     2465  JF(M3)=-JF(M3)
           XSMOK=VEL(M3)*XINT
           JY2=NW(M3)-NWAL(M3)
           IS=1+NWAR(M3)
```

```
      IF (JY2.LE.0) GO TO 2480
C     ADVANCE ALL WAVES EFFECTING JUNCTION TO JUNCTION AND
C     CALCULATE ARRIVAL TIME.
      DO 2470 IY=IS,JY2
      IF ((XSMOK+RTAC(M3,IY,2)).LT.LA(M3)) GO TO 2480
      OVTM=(RTAC(M3,IY,2)+XSMOK-LA(M3))/VEL(M3)
      RTAC(M3,IY,2)=LA(M3)
      RTAC(M3,IY,4)=I-INC+XINT*J-OVTM
      RTAC(M3,IY,4)=-RTAC(M3,IY,4)
      NWAR(M3)=NWAR(M3)+1
2470  CONTINUE
2475  CONTINUE
2480  CONTINUE
C     FIND FIRST WAVE TO ARRIVE OF ALL WAVES ARRIVING.
2485  HIGH=-1.E+10
      NOH=0
      NWH=0
2490  DO 2510 M=M1,M2
      IA=NGIN(M)
      DO 2505 M3=1,NB
      IF (ABS(NO(M3))-ABS(NO(IA))) 2505,2495,2505
2495  JY2=NW(M3)-NWAL(M3)
      IF (JY2.LE.0) GO TO 2510
      DO 2500 M4=1,JY2
      IF (RTAC(M3,M4,4).GE.0.) GO TO 2500
      IF (RTAC(M3,M4,4).LT.HIGH) GO TO 2500
      HIGH=RTAC(M3,M4,4)
      NOH=M3
      NWH=M4
2500  CONTINUE
2505  CONTINUE
2510  CONTINUE
      IF (HIGH.EQ.-1.E+10) GO TO 2620
      IF(RTAC(NOH,NWH,4).LT.0)RTAC(NOH,NWH,4)=-RTAC(NOH,NWH,4)
      SUMAIR=0.0
      SUMPR=0.
C     CALCULATE JUNCTION CONDITIONS
      DO 2550 M=M1,M2
      IA=NGIN(M)
      DO 2545 M3=1,NB
      IF (ABS(NO(M3))-ABS(NO(IA))) 2545,2515,2545
2515  SUMAIR=SUMAIR+Q(M3)
      IF (M3-NOH) 2525,2520,2525
2520  SUMPR=SUMPR+RTAC(M3,NWH,1)*Q(M3)
      GO TO 2550
2525  JY2=NWAR(M3)
      IF (JY2) 2530,2530,2535
2530  C=0.
      GO TO 2540
2535  C=RTAC(M3,JY2,1)
2540  SUMPR=SUMPR+C*Q(M3)
      GO TO 2550
2545  CONTINUE
2550  CONTINUE
      EXPCN=RTJC(L,1)
      EXPT=RTJC(L,2)
      RTJC(L,1)=SUMPR/SUMAIR
      RTJC(L,2)=ABS(RTAC(NOH,NWH,4))
      TOTEX(L)=TOTEX(L)+EXPCN*(RTJC(L,2)-EXPT)*1000000./60.
C     ADVANCE WAVE BY REMANING TIME INTO ALL OUTGOING AIRWAYS
C     AND CALCULATE AIRWAY CONCENTRATIONS.
      M5=LOUT(L-1)+1
      M6=LOUT(L)
```

```
      IF(L.EQ.1)M5=1
      RT=(I-INC+XINT*J)-ABS(HIGH)
      DO 2615 M4=M5,M6
      IA=NGOUT(M4)
      DO 2610 M=1,NB
      IF (ABS(NO(M))-ABS(NO(IA))) 2610,2555,2610
2555  JY=NW(M)
      IF(JY.EQ.0)JY=1
      DO 2600 M3=1,INFLOW
      IF (NCENT(M3)-ABS(NO(M))) 2600,2560,2600
2560  IF ((I-INC.LT.ISTT(M3)).OR.(I.GT.IENDT(M3))) GO TO 2600
      IF (CONT(M3)) 2565,2570,2565
2565  CONTAM=CONT(M3)*CONC(M3)/100.
      CONTQ=CONT(M3)
      GO TO 2575
2570  CONTAM=0.
      CONTQ=0.
2575  IF (O2MIN(M3)) 2585,2585,2580
2580  CONTAM=(.21-RTJC(L,1)-O2MIN(M3)/100.)*Q(M)
      CONTQ=0.
2585  IF (SMPO2(M3)) 2595,2595,2590
2590  CONTAM=(.21-RTJC(L,1))*Q(M)*SMPO2(M3)
      CONTQ=0.0
2595  TEMPRC=(RTJC(L,1)*(Q(M)-CONTQ)/Q(M)+CONTAM/Q(M))
      IF (ABS(TEMPRC-RTAC(M,JY,1)).LE.CRITSM) GO TO 2615
      NW(M)=NW(M)+1
      JY=NW(M)
      RTAC(M,JY,1)=TEMPRC
      GO TO 2605
2600  CONTINUE
      IF (ABS(RTAC(M,JY,1)-RTJC(L,1)).LE.CRITSM) GO TO 2615
      NW(M)=NW(M)+1
      JY=NW(M)
      RTAC(M,JY,1)=RTJC(L,1)
2605  ISCOB(M)=-1
      NWAL(M)=NWAL(M)+1
      RTAC(M,JY,2)=VEL(M)*RT
      RTAC(M,JY,3)=ABS(RTAC(NOH,NWH,4))
      GO TO 2615
2610  CONTINUE
2615  CONTINUE
      GO TO 2485
C     CALCULATE IF FUMES REACHES MORE THAN ONE JUNCTION IN
C     ONE XINT.
2620  DO 2640 M4=M5,M6
      IA=NGOUT(M4)
      DO 2635 M=1,NB
      IF (ABS(NO(M))-ABS(NO(IA))) 2635,2625,2635
2625  JY=NW(M)
      IF (RTAC(M,JY,2).LT.LA(M)) GO TO 2640
      IF (ABS(JF(M)).EQ.JSURF) GO TO 2630
      K2=M
      IS=1+NWAR(K2)
      JY=NW(K2)-NWAL(K2)
      GO TO 2435
2630  OVTM=(RTAC(M,JY,2)-LA(M))/VEL(M)
      RTAC(M,JY,4)=I-INC+XINT*J-OVTM
      RTAC(M,JY,2)=LA(M)
      NWAR(M)=NWAR(M)+1
      GO TO 2640
2635  CONTINUE
2640  CONTINUE
      GO TO 2650
```

```
 2645 CONTINUE
 2650 CONTINUE
C     RESET MARKERS, COMPACT WAVES IF NECESSARY AND CHECK
C     FOR AIRWAYS WITH UNIFORM CONCENTRATIONS.
      DO 2690 IU=1,NB
      IF (NW(IU).LE.NWM) GO TO 2655
      WRITE (LP,3285) NO(IU)
      GO TO 2800
 2655 IF(NO(IU).LT.0)NO(IU)=-NO(IU)
      IF(JS(IU).LT.0)JS(IU)=-JS(IU)
      IF(JF(IU).LT.0)JF(IU)=-JF(IU)
      NWAL(IU)=0
      IF (NW(IU).LE.5) GO TO 2675
      M=0
      JY=NW(IU)
      DO 2660 IW=1,JY
      IF (RTAC(IU,IW,4).EQ.0) GO TO 2660
      M=M+1
      RTAC(IU,IW,1)=0.
      RTAC(IU,IW,2)=0.
      RTAC(IU,IW,3)=0.
      RTAC(IU,IW,4)=0.
      IF (M.EQ.5) GO TO 2665
 2660 CONTINUE
      IF (M.NE.0) GO TO 2665
      GO TO 2675
 2665 M1=M+1
      DO 2670 IW=M1,JY
      RTAC(IU,IW-M1+1,1)=RTAC(IU,IW,1)
      RTAC(IU,IW-M1+1,2)=RTAC(IU,IW,2)
      RTAC(IU,IW-M1+1,3)=RTAC(IU,IW,3)
      RTAC(IU,IW-M1+1,4)=RTAC(IU,IW,4)
      RTAC(IU,IW,1)=0.
      RTAC(IU,IW,2)=0.
      RTAC(IU,IW,3)=0.
      RTAC(IU,IW,4)=0.
 2670 CONTINUE
      NWAR(IU)=0
      NW(IU)=NW(IU)-M
C     WRITE (LP,3275) M,NO(IU)
 2675 IF (NW(IU).EQ.0) GO TO 2690
      JY=NW(IU)
      IF(RTAC(IU,1,4).LT.0.)RTAC(IU,1,4)=-RTAC(IU,1,4)
      IF ((NW(IU).EQ.1).AND.(RTAC(IU,1,2).EQ.LA(IU))) GO TO 2685
      IF (NW(IU).EQ.1) GO TO 2690
      DO 2680 ID=2,JY
      IF(RTAC(IU,ID,4).LT.0.)RTAC(IU,ID,4)=-RTAC(IU,ID,4)
      IF (RTAC(IU,ID,2).EQ.LA(IU)) GO TO 2680
      GO TO 2690
 2680 CONTINUE
 2685 ISCOB(IU)=1
 2690 CONTINUE
 2695 CONTINUE
C     OUTPUT
      WRITE (LP,3140)
      WRITE (LP,3145)
      WRITE (LP,3145)
      NWMAX=0
      DO 2705 M=1,NB
      JY=NW(M)
      NWE=NW(M)
      IF (NW(M).EQ.0) GO TO 2705
      DO 2700 M1=1,JY
```

```
      IF(RTAC(M,M1,1).LT.WRNSM)NWE=NWE-1
 2700 CONTINUE
      IF(NWE.GE.NWMAX)NWMAX=NWE
 2705 CONTINUE
      IF (NWMAX.GT.0) GO TO 2710
      WRITE (LP,3155) I,WRNSM
      GO TO 2795
 2710 WRITE (LP,3150) I,WRNSM
      WRITE (LP,3160)
      DO 2720 M=1,NB
      IF(O(M).LT.0)O(M)=O(M)*-1
      JY=NW(M)
      DO 2715 M2=1,JY
      IF (RTAC(M,M2,1).LT.WRNSM) GO TO 2715
      IF(O(M).GT.0)O(M)=O(M)*-1
      MM=NW(M)
      WRITE(LP,3165) NO(M),JS(M),JF(M),LA(M),NW(M),RTAC(M,MM,1),RTAC(M,M
     1M,3),RTAC(M,MM,2)
      GO TO 2720
 2715 CONTINUE
 2720 CONTINUE
      WRITE (LP,3170)
      IF (NWMAX.GE.2) WRITE (LP,3175)
      IF (NWMAX.GE.3) WRITE (LP,3180)
      WRITE (LP,3185)
      IF (NWMAX.GE.2) WRITE (LP,3190)
      IF (NWMAX.GE.3) WRITE (LP,3195)
      WRITE (LP,3200)
      IF (NWMAX.GE.2) WRITE (LP,3205)
      IF (NWMAX.GE.3) WRITE (LP,3210)
      DO 2745 M=1,NB
      IF (O(M).GT.0) GO TO 2745
      IF (NWMAX.GT.6) GO TO 2735
      GO TO (2725,2730,2735,2735,2735,2735), NWMAX
 2725 WRITE (LP,3260)
      GO TO 2740
 2730 WRITE (LP,3265)
      GO TO 2740
 2735 WRITE (LP,3270)
 2740 IF (NW(M).GT.0) WRITE (LP,3290) NO(M)
      IF(RTAC(M,1,1).GT.WRNSM) WRITE (LP,3215) RTAC(M,1,1),RTAC(M,1,2),R
     1TAC(M,1,3),RTAC(M,1,4)
      IF(RTAC(M,2,1).GT.WRNSM) WRITE (LP,3220) RTAC(M,2,1),RTAC(M,2,2),R
     1TAC(M,2,3),RTAC(M,2,4)
      IF(RTAC(M,3,1).GT.WRNSM) WRITE (LP,3225) RTAC(M,3,1),RTAC(M,3,2),R
     1TAC(M,3,3),RTAC(M,3,4)
      IF(NWMAX.LE.3)O(M)=-O(M)
 2745 CONTINUE
      IF (NWMAX.LE.3) GO TO 2780
      WRITE (LP,3230)
      IF (NWMAX.GE.5) WRITE (LP,3235)
      IF (NWMAX.GE.6) WRITE (LP,3240)
      WRITE (LP,3185)
      IF (NWMAX.GE.5) WRITE (LP,3190)
      IF (NWMAX.GE.6) WRITE (LP,3195)
      WRITE (LP,3200)
      IF (NWMAX.GE.5) WRITE (LP,3205)
      IF (NWMAX.GE.6) WRITE (LP,3210)
      DO 2770 M=1,NB
      IF (O(M).GT.0.) GO TO 2770
      IF (NW(M).LT.4) GO TO 2770
      IF (NWMAX.GT.6) GO TO 2760
      GO TO (2770,2770,2770,2750,2755,2760), NWMAX
```

```
 2750  WRITE (LP,3260)
       GO TO 2765
 2755  WRITE (LP,3265)
       GO TO 2765
 2760  WRITE (LP,3270)
 2765  IF (NW(M).GT.3) WRITE (LP,3290) NO(M)
       IF(RTAC(M,4,1).GT.WRNSM) WRITE (LP,3215) RTAC(M,4,1),RTAC(M,4,2),R
      1TAC(M,4,3),RTAC(M,4,4)
       IF(RTAC(M,5,1).GT.WRNSM) WRITE (LP,3220) RTAC(M,5,1),RTAC(M,5,2),R
      1TAC(M,5,3),RTAC(M,5,4)
       IF(RTAC(M,6,1).GT.WRNSM) WRITE (LP,3225) RTAC(M,6,1),RTAC(M,6,2),R
      1TAC(M,6,3),RTAC(M,6,4)
       O(M)=-O(M)
 2770  CONTINUE
       DO 2775 M=1,NB
       IF (NW(M).LE.6) GO TO 2775
       IBUF=NW(M)-6
       WRITE (LP,3280) IBUF,NO(M)
 2775  CONTINUE
 2780  WRITE (LP,3245) I,WRNSM
       WRITE (LP,3250)
       DO 2785 M=1,NJ
       IF(RTJC(M,1).GT.WRNSM) WRITE (LP,3255) JNOL(M),RTJC(M,1),RTJC(M,2)
 2785  CONTINUE
       WRITE (LP,3295) I
       WRITE (LP,3300)
       DO 2790 K=1,NJ
       TOWEX(K)=TOTEX(K)+(RTJC(K,1)*(I-RTJC(K,2)))*1000000./60.
 2790  CONTINUE
       WRITE (LP,3305) (JNOL(K),TOWEX(K),K=1,NJ)
 2795  CONTINUE
 2800  RETURN
C
C      FORMATS
 3140  FORMAT (1H0,////,120('*'))
 3145  FORMAT (1H ,120('*'))
 3150  FORMAT (1H0,///,T39,'AT ',I5,' MIN. AFTER THE START OF ','CONTAMIN
      1ATION CRITICAL',/,T39,' FUME CONCENTRATIONS ','(FUMES > ',2PF8.4,'
      2 %) NOW EXIST IN THE',/,T57,'FOLLOWING',' AIRWAYS')
 3155  FORMAT (1H ,'AT ',I5,' MIN. AFTER THE START OF ','CONTAMINATION NO
      1 CRITICAL  FUME CONDITIONS (FUMES > ',2PF8.4,' %) NOW EXIST')
 3160  FORMAT (1H0,///,T32,'AIRWAY',T92,'WAVE',//,T15,'NUMBER     FROM
      1 TO      LENGTH FT',T73,'NUMBER   CONC %   START TIME   LENGTH FT')
 3165  FORMAT (1H ,T16,I5,I8,I7,T42,I7,T74,I5,2PF9.4,T92,0PF7.2,T105,0PF7
      1.1)
 3170  FORMAT (1H0,///,T30,'WAVE 1')
 3175  FORMAT (1H+,T60,'WAVE 2')
 3180  FORMAT (1H+,T90,'WAVE 3')
 3185  FORMAT (1H0,'AIRWAY    CONC %  LOCATION START   ARRIVAL    ')
 3190  FORMAT (1H+,T46,' CONC %  LOCATION START   ARRIVAL    ')
 3195  FORMAT (1H+,T82,' CONC %  LOCATION START   ARRIVAL    ')
 3200  FORMAT (1H ,T9,'   ',T23,'FT',T29,'TIME',T37,'TIME',T45,'   ')
 3205  FORMAT (1H+,T58,'FT',T64,'TIME',T72,'TIME',T81,'   ')
 3210  FORMAT (1H+,T95,'FT',T101,'TIME',T108,'TIME',T117,'   ')
 3215  FORMAT (1H+,T11,2PF8.4,T20,0PF7.1,T29,F7.2,T37,F7.2)
 3220  FORMAT (1H+,T47,2PF8.4,T57,0PF7.1,T66,F7.2,T74,F7.2)
 3225  FORMAT (1H+,T83,2PF8.4,T93,0PF7.1,T102,F7.2,T110,F7.2)
 3230  FORMAT (1H0,///,T30,'WAVE 4')
 3235  FORMAT (1H+,T60,'WAVE 5')
 3240  FORMAT (1H+,T90,'WAVE 6')
 3245  FORMAT (1H0,///,T39,'AT ',I5,' MIN. AFTER THE START OF ','CONTAMIN
      1ATION CRITICAL',/,T39,' FUME CONCENTRATIONS ','(FUMES > ',2PF7.3,'
      2) % NOW EXIST IN THE',/,T57,'FOLLOWING ','JUNCTIONS')
```

```
3250  FORMAT (1HO,'JUNCTION',T15,'CURRENT  FUME CONCENTRATION',T50,'TIME
     1 OF FIRST CONTAMINATION')
3255  FORMAT (1H ,T3,I5,T25,2PF8.4,T63,OPF7.2)
3260  FORMAT (1H ,T9,'   ',T45,'   ')
3265  FORMAT (1H ,T9,'   ',T45,'   ',T81,'   ')
3270  FORMAT (1H ,T9,'   ',T45,'   ',T81,'   ',T117,'   ')
C3275 FORMAT (1H ,'**WARNING** THE FIRST ',I1,' WAVES OF ','AIRWAY',I5,'
C    1 ARE BEING REMOVED TO ALLOW FOR ','ADDITIONAL WAVES')
3280  FORMAT (1HO,///,' ',I5,' WAVES OF AIRWAY ',I5,' ARE BEING BUFFERD
     1UNTIL PRINTING SPACE IS AVALABLE')
3285  FORMAT (1HO,///,' PROGRAM EXECUTION TERMINATED DUE TO AN ','EXCESS
     1IVE NUMBER OF CONTAMINATION WAVES IN AIRWAY ',I5,'.',/,' TO RECEIV
     2E ','MORE DETAILED INFORMATION INTERNAL PROGRAM MODIFICATION IS '
     3,'NESSARY.')
3290  FORMAT (1H+,I5)
3295  FORMAT (1HO,///,T30,'AT',I5,' MIN. AFTER THE START OF CONTAMINATIO
     1N THE TOTAL EXPOSURE TO',/,T30,'THE CONTAMINANT MEASURED IN PPM*HO
     2URS WAS IN THE FOLLOWING JUNCTIONS')
3300  FORMAT (1HO,'JUNCTION',T14,'TOTAL EXPOSURE',T40,'JUNCTION',T54,'TO
     1TAL EXPOSURE',T80,'JUNCTION',T94,'TOTAL EXPOSURE')
3305  FORMAT (1H ,I8,T16,F10.2,T40,I8,T56,F10.2,T80,I8,T96,F10.2)
      END
```

```
C      CTPAM.COM
       PARAMETER  IAR=300, IJP=300, J5=300, IFIN=300, IMSL=9000
```

```
 CTCONN.COM
 COMMON NO(IAR),JS(IAR),JF(IAR),Q(IAR),
1JNOL(IJP),JNO(IJP),JLR(IJP),PROP(IJP),RDPROP(IAR),
2MEMREC(J5),NOREC(J5),ESTPR(J5),ESTCH4(J5),ESTTR(J5),HEAT(20),TR
3D(IAR),LA(IAR),A(IAR),O(IAR),KF(IAR),CH4V(IAR),
4T(IJP),NCENT(20),CONT(20),CONC(20),TROCK(IAR),HA(IAR),HK(
5IAR),DZRD(IAR),PRCH4(IJP),RDCH4(IJP),O2MIN(20),SMPO2(20),HTPO2(20)
6,TFSI(20),XNEW(IAR),R(IAR),MEND(IFIN),MSL(IMSL),RSTD(IAR),
7 FRNVP(IAR
8),QF(10,10),PF(10,10),RGRAD(10),NFCW(10),NFREG(10),MPTS(10),
9FNVP(IFIN),NWTYP(IAR),RQ(IAR),INU(IAR),KJS(IAR),KJF(IAR),KNO
$(IAR),NOF(20),NREV(IAR)
```

APPENDIX B.--INPUT DATA FOR FUEL-RICH FIRE IN A DOWNCAST SHAFT

```
 100        NETWORK   CONTROL   CARD
 200       NB    NJ NFUM NADBC NVPN NETW NCONC NTEMP MADJ ITN     DR          TR      IRTCC
 300       51    32    2    3    1    1     1     1   10   30    .075       70.00        1
 400        AIRWAY   CARDS
 500       NO    JS    JF NWTYP        R          Q           KF        LA         A          O
 600        1     1     2    0     0.156     200000          250      2597     200.0       50.0
 700        2     2     3    0     0.048      60000          250       325     200.0       50.0
 800        3     1     4    0     0.479     100000          250      2577     200.0       50.0
 900        4     1    23    0     0.995      30000          250      2580     200.0       50.0
1000        5     2     4    0     2.400      35000          100      2900      80.0       35.0
1100        6     4     5    1     4.000      60000          100       100      80.0       35.0
1200        7     5     6    0     2.307      60000          100      2700      80.0       35.0
1300        8     6     7    0  1888.233       5000          350       524     120.0       44.0
1400        9     6     7    0     9.923      60000          100      1700      80.0       35.0
1500       10     7    14    0     3.239      70000          100      1650      80.0       35.0
1600       11    14    31    0    20.002      70000          100      4500      80.0       35.0
1700       12     3     8    0     0.360      53600          100      2700      80.0       35.0
1800       13     8    19    0    41.490      20000          100      2050      80.0       35.0
1900       14     8     9    0     0.821      50000          100       600      80.0       35.0
2000       15     9    10    0     1.437      35000          100       600      80.0       35.0
2100       16    10    11    0   124.385       6000          100       600      80.0       30.0
2200       17    10    11    0     5.500      30000          100      1100      80.0       35.
2300       18    11    12    0     3.900      35000          350       319     120.0       44.0
2400       19    12    13    0     3.772      35000          100       600      80.0       35.0
2500       20    14    13    0     4.000       6000          350       524     120.0       44.0
2600       21    13    15    0     1.108      35000          100       550      80.0       35.0
2700       22     9    15    0   474.065       6000          350       318     120.0       44.0
2800       23    15    16    0     2.047      30000          100       600      80.0       35.0
2900       24     2    16    0    77.702      14800          100      2600      80.0       35.0
3000       25    16    17    0     2.285      60000          100      1050      80.0       35.0
3100       26    17    18    0     2.966      60000          350       228     120.0       44.0
3200       27    20    17    0     3.500       2000          100       800      80.0       35.0
3300       28    20    18    0     4.931      50000          100      1217      80.0       35.0
3400       29    19    20    0     4.565      50000          350       333     120.0       44.0
3500       30    21    19    0     0.475      31300          100      1100      80.0       35.0
3600       31    22    21    0    13.375      40000          100      1313      80.0       35.0
3700       32    22    21    0  1234.019       3000          350       313     120.0       44.0
3800       33    23    22    0    14.500      20000          100      1800      80.0       35.0
3900       34    23    22    0    14.500      20000          100      1800      80.0       35.0
4000       35     4    24    0     4.324     110000          100      2400      80.0       35.0
4100       36    24    25    0     5.572      45000          100      2600      80.0       35.0
4200       37    24    27    0     5.450      20000          100      3200      80.0       35.0
4300       38    27    28    0     1.066     100000          350       230     120.0       44.0
4400       39    28    31    0    14.000      40000          100      2292      80.0       35.0
4500       40    25    26    0    18.360      45000          100      2000      80.0       35.0
4600       41    26    30    0     3.630      38000          100      1700      80.0       35.0
4700       42    26    29    0     1.385       5000          100      1050      80.0       35.0
4800       43     2    27    0    65.065      35449          100      1650      80.0       35.0
4900       44    28    29    0     1.260      73000          100       750      80.0       35.0
5000       45    29    30    0     0.854      80000
5100       46     2    30    0    46.882      44000          100       525      80.0       35.0
5200       47    30    31    0     0.072     203000
5300       48    18    30    0     6.265     100000          100      4100      80.0       35.0
5400       50     1    32    0   441.000      20000          250        30     200.0       50.0
5500       49    31    32    0     0.610     288350
5600       51    32     1    1    10.000     450000          100       100      80.0       35.0
5700         JUNCTION   CARDS
5800      JNO         T            Z    CH4
5900        1        50.0        114
6000        2        65.06     -2465
6100        3        67.32     -2790
6200        4        64.39     -2463
6300        5        64.51     -2462  0.12
6400        6        69.88     -2462  0.20
```

```
6500       7       75.60     -1938 0.80
6600       8       72.54     -2787 0.12
6700       9       75.67     -2785 0.25
6800      10       77.09     -2785 0.30
6900      11       78.82     -2787 0.90
7000      12       79.31     -2468 0.95
7100      13       82.42     -2465 0.90
7200      14       81.62     -1942 0.85
7300      15       83.25     -2467 0.90
7400      16       78.56     -2466 0.90
7500      17       77.92     -2463
7600      18       78.39     -2235
7700      19       82.54     -2785 0.8
7800      20       80.90     -2452
7900      21       82.87     -2786 0.85
8000      22       73.28     -2473 0.70
8100      23       65.27     -2466
8200      24       69.95     -2462 0.15
8300      25       80.65     -2245 0.90
8400      26       86.57     -2247 0.95
8500      27       70.59     -2465
8600      28       68.59     -2235
8700      29       72.08     -2239
8800      30       76.80     -2240
8900      31       76.44     -1943
9000      32       65.70        88
9100         FAN  CHARACTERISTIC  CARDS
9200      NOF MPTS
9300       6   10
9400         QF     PF       QF     PF       QF     PF       QF     PF       QF     PF
9500      20000  3.60   25000  4.30   30000  4.60   40000  4.78   55000  4.58
9600      70000  4.29   85000  3.96  100000  3.70  150000  3.00  200000  2.52
9700      51    10
9800         QF     PF       QF     PF       QF     PF       QF     PF       QF     PF
9900      80000 12.25  100000 14.00  150000 14.90  200000 14.05  300000 12.00
10000    400000 10.25  500000  8.85  600000  7.80  700000  6.90  800000  6.20
10100        ADDITIONAL  AIRWAY  CARDS
10200     NO                                              KF        LA        A         D
10300     45                                             100       300      80.0      35.0
10400     47                                             250       297     200.0      50.0
10500     49                                             250      2031     200.0      50.0
10600        CONCENTRATION  CONTROL  CARD
10700    NDIM NCH4C NAV MAXJ INFLOW JSTART TSTART TIME CRITSM CRITGS CRITHT WRNPR WRNSM
10800    WRNGS WRNHT
10900      6     2     1    32     1      1 50.00    1.00 .005  0.10   .20  .01 .05   1.0  95.
11000       AVERAGE  VALUE  CARD
11100    TAVR       HAAVR      HKAVR          KFAVR      LAAVR     AAVR       DAVR
11200    70.0        0.10       3.0            100       1000     100.0      100.0
11300       ADDITIONAL  CONCENTRATION  AIRWAY  CARDS
11400    NOX    CH4VX                DZRDX
11500      9     320.0
11600     17      90.0
11700     33     120.0
11800     34      20.0
11900     36     250.0
12000     50                         50.00
12100      ADDITIONAL  CONCENTRATION  JUNCTION  CARDS
12200    JNOX                        CH4CX
12300     27                        0.60
12400     28                        0.60
12500      CONTAMINATION  CARD
12600    NCENT                                           SMPO2     HTPO2
12700     20                                              1.00     300.00
```

```
      REAL  TIME  CONTROL  CARD
NACC IDUR  INC   EXP  REP   WRNSM JSURF CRITSM
   1   10    2  2.00  2.00  0.001      1.001
      CONTAMINATION  CARD
NCENT                                                         SMPO2   HTPO2      ISTT  IENDT
  20                                                           1.00   300.00        0    10
```

APPENDIX C.--OUTPUT DATA FOR FUEL-RICH FIRE IN A DOWNCAST SHAFT CALCULATION

ORDINARY AIRFLOW AND PRESSURE DISTRIBUTION BEFORE EVENT (BASED ON THE LISTED INPUT DATA)

REGULAR AIRWAYS

AIRWAY	FROM	TO	AIRFLOW	PRESSURE LOSS	LENGTH	AREA	RESISTANCE	K	PERIMETER
1	1	2	153842.	0.369	2597	200.000	0.156	250	50.000
2	2	3	43346.	0.009	325	200.000	0.048	250	50.000
3	1	4	115697.	0.641	2577	200.000	0.479	250	50.000
4	1	23	27030.	0.073	2580	200.000	0.995	250	50.000
5	2	4	32114.	0.248	2900	80.000	2.400	100	35.000
7	5	6	59089.	0.805	2700	80.000	2.307	100	35.000
8	6	7	3994.	3.012	524	120.000	1888.233	350	44.000
9	6	7	55095.	3.012	1700	80.000	9.923	100	35.000
10	7	14	59089.	1.131	1650	80.000	3.239	100	35.000
11	14	31	56342.	6.349	4500	80.000	20.002	100	35.000
12	3	8	43346.	0.068	2700	80.000	0.360	100	35.000
13	8	19	14202.	0.837	2050	80.000	41.490	100	35.000
14	8	9	29145.	0.070	600	80.000	0.821	100	35.000
15	9	10	24837.	0.089	600	80.000	1.437	100	35.000
16	10	11	4313.	0.231	600	80.000	124.385	100	30.000
17	10	11	20524.	0.232	1100	80.000	5.500	100	35.000
18	11	12	24837.	0.241	319	120.000	3.900	350	44.000
19	12	13	24837.	0.233	600	80.000	3.772	100	35.000
20	14	13	2747.	0.003	524	120.000	4.000	350	44.000
21	13	15	27584.	0.084	550	80.000	1.108	100	35.000
22	9	15	4308.	0.880	318	120.000	474.065	350	44.000
23	15	16	31892.	0.208	600	80.000	2.047	100	35.000
24	2	16	11998.	1.118	2600	80.000	77.702	100	35.000
25	16	17	43890.	0.440	1050	80.000	2.285	100	35.000
26	17	18	47731.	0.676	228	120.000	2.966	350	44.000
27	20	17	3842.	0.005	800	80.000	3.500	100	35.000
28	20	18	37390.	0.689	1217	80.000	4.931	100	35.000
29	19	20	41231.	0.776	333	120.000	4.565	350	44.000
30	21	19	27030.	0.035	1100	80.000	0.475	100	35.000
31	22	21	24481.	0.802	1313	80.000	13.375	100	35.000
32	22	21	2549.	0.802	313	120.000	1234.019	350	44.000
33	23	22	13515.	0.265	1800	80.000	14.500	100	35.000
34	23	22	13515.	0.265	1800	80.000	14.500	100	35.000
35	4	24	88722.	3.404	2400	80.000	4.324	100	35.000
36	24	25	34147.	0.650	2600	80.000	5.572	100	35.000
37	24	27	54575.	1.623	3200	80.000	5.450	100	35.000
38	27	28	83055.	0.735	230	120.000	1.066	350	44.000
39	28	31	26833.	1.008	2292	80.000	14.000	100	35.000
40	25	26	34147.	2.141	2000	80.000	18.360	100	35.000
41	26	30	29620.	0.318	1700	80.000	3.630	100	35.000
42	26	29	4526.	0.003	1050	80.000	1.385	100	35.000
43	2	27	28480.	5.277	1650	80.000	65.065	100	35.000
44	28	29	56222.	0.398	750	80.000	1.260	100	35.000
45	29	30	60748.	0.315	300	80.000	0.854	100	35.000
46	2	30	37904.	6.736	525	80.000	46.882	100	35.000
47	30	31	213394.	0.328	297	200.000	0.072	250	50.000
48	18	30	85121.	4.539	4100	80.000	6.265	100	35.000
50	1	32	16360.	11.804	30	200.000	441.000	250	50.000
49	31	32	296569.	5.365	2031	200.000	0.610	250	50.000

FANS

AIRWAY	FROM	TO	AIRFLOW	FAN PRESSURE
6	4	5	59089.	4.505
51	32	1	312929.	11.806

THESE CHARACTERISTICS WERE STORED FOR FANS 6 51

20000.	3.60	25000.	4.30	30000.	4.60	40000.	4.78	55000.	4.58
70000.	4.29	85000.	3.96	100000.	3.70	150000.	3.00	200000.	2.52

80000.	12.25	100000.	14.00	150000.	14.90	200000.	14.05	300000.	12.00
400000.	10.25	500000.	8.85	600000.	7.80	700000.	6.90	800000.	6.20

THE STATED NUMBER OF AIRWAYS WAS 51 THE STATED NUMBER OF JUNCTIONS WAS 32

INPUT DATA FOR CONCENTRATION AND TEMPERATURE CALCULATIONS

AIRWAY	FROM	TO	ELEVATION DIFF.	ROCK TEMP.	METHANE PROD.	CONDUCTIVITY	DIFFUSIVITY
1	1	2	-2579.0	58.2	0.0	3.0	0.1000
2	2	3	-325.0	67.6	0.0	3.0	0.1000
3	1	4	-2577.0	57.5	0.0	3.0	0.1000
4	1	23	-2580.0	58.4	0.0	3.0	0.1000
5	2	4	2.0	64.3	0.0	3.0	0.1000
6	4	5	1.0	65.7	70.9	3.0	0.1000
7	5	6	0.0	69.9	47.3	3.0	0.1000
8	6	7	524.0	80.1	24.0	3.0	0.1000
9	6	7	524.0	77.5	320.0	3.0	0.1000
10	7	14	-4.0	82.0	29.5	3.0	0.1000
11	14	31	-1.0	76.4	0.0	3.0	0.1000
12	3	8	3.0	72.6	52.0	3.0	0.1000
13	8	19	2.0	82.6	96.6	3.0	0.1000
14	8	9	2.0	77.1	37.9	3.0	0.1000
15	9	10	0.0	77.6	12.4	3.0	0.1000
16	10	11	-2.0	79.4	25.9	3.0	0.1000
17	10	11	-2.0	79.0	90.0	3.0	0.1000
18	11	12	319.0	83.1	12.4	3.0	0.1000
19	12	13	3.0	83.8	0.0	3.0	0.1000
20	14	13	-523.0	80.4	1.4	3.0	0.1000
21	13	15	-2.0	83.6	0.0	3.0	0.1000
22	9	15	318.0	91.7	28.0	3.0	0.1000
23	15	16	1.0	76.2	0.0	3.0	0.1000
24	2	16	-1.0	78.5	108.0	3.0	0.1000
25	16	17	3.0	77.8	0.0	3.0	0.1000
26	17	18	228.0	82.7	0.0	3.0	0.1000
27	20	17	-11.0	77.5	0.0	3.0	0.1000
28	20	18	217.0	78.7	0.0	3.0	0.1000
29	19	20	333.0	82.0	0.0	3.0	0.1000
30	21	19	1.0	82.5	0.0	3.0	0.1000
31	22	21	-313.0	82.6	36.7	3.0	0.1000
32	22	21	-313.0	87.7	3.8	3.0	0.1000
33	23	22	-7.0	73.3	120.0	3.0	0.1000
34	23	22	-7.0	73.3	20.0	3.0	0.1000
35	4	24	1.0	70.1	133.1	3.0	0.1000
36	24	25	217.0	81.3	250.0	3.0	0.1000
37	24	27	-3.0	70.5	245.6	3.0	0.1000
38	27	28	230.0	67.1	0.0	3.0	0.1000
39	28	31	292.0	77.3	0.0	3.0	0.1000
40	25	26	-2.0	86.7	17.1	3.0	0.1000
41	26	30	7.0	76.4	0.0	3.0	0.1000
42	26	29	8.0	71.2	0.0	3.0	0.1000
43	2	27	0.0	70.8	170.9	3.0	0.1000
44	28	29	-4.0	73.4	0.0	3.0	0.1000
45	29	30	-1.0	84.4	0.0	3.0	0.1000
46	2	30	225.0	85.8	0.0	3.0	0.1000
47	30	31	297.0	81.2	0.0	3.0	0.1000
48	18	30	-5.0	76.8	0.0	3.0	0.1000
50	1	32	0.0	50.0	0.0	3.0	0.1000
49	31	32	2031.0	71.2	0.0	3.0	0.1000
51	32	1	26.0	70.0	0.0	3.0	0.1000

TIME AFTER BEGINNING OF EVENT 1.00 HOURS

A TEMPERATURE OF 50.0 WAS ASSIGNED TO JUNCTION NO 1

THE FOLLOWING CONTAMINATION WAS ASSUMED

	CONTAMINATION			OXYGEN CONCENTRATION	PRODUCTION PER CU FT OXYGEN	
AIRWAY	FLOWRATE	CONCENTRAT.	HEAT	BEHIND FIRE	SMOKE	HEAT
20	0.000	0.000	0.000	0.00	1.000	300.000

TEMPERATURES AND CONCENTRATIONS AT AIRWAY ENDS, PRESSURES IN AIRWAYS

AIRWAY	FROM	TO	AIRFLOW	TEMPERATURE	SMOKE	METHANE	PRESSURE
1	1	2	162196.	64.98	0.0000	0.00	0.392
2	2	3	66815.	67.28	0.0000	0.00	0.021
3	1	4	98838.	64.34	0.0000	0.00	0.446
4	1	23	33157.	65.26	0.0000	0.00	0.104
5	2	4	10514.	64.30	0.0000	0.00	0.026
6	4	5	18590.	64.57	0.0000	0.38	4.300
7	5	6	18590.	69.84	0.0000	0.63	0.079
8	6	7	1304.	78.37	0.0000	2.43	0.330
9	6	7	17286.	75.87	0.0000	2.44	0.302
10	7	14	18590.	81.82	0.0000	2.59	0.116
11	14	31	61833.	78.21	14.6862	1.12	10.948
12	3	8	66815.	72.34	0.0000	0.08	0.161
13	8	19	17856.	82.46	0.0000	0.62	1.374
14	8	9	48959.	75.01	0.0000	0.16	0.200
15	9	10	42038.	76.56	0.0000	0.18	0.260
16	10	11	7304.	78.63	0.0000	0.54	0.683
17	10	11	34733.	78.60	0.0000	0.44	0.683
18	11	12	42038.	79.40	0.0000	0.49	0.713
19	12	13	42038.	81.99	0.0000	0.49	0.694
20	13	14	43242.	947.49	21.0000	0.49	5.479
21	15	13	1205.	83.87	0.0000	0.56	0.000
22	9	15	6922.	86.12	0.0000	0.56	2.374
23	15	16	5717.	77.97	0.0000	0.56	0.007
24	2	16	18178.	78.47	0.0000	0.59	2.626
25	16	17	23895.	77.87	0.0000	0.58	0.134
26	17	18	40458.	78.76	0.0000	0.58	0.501
27	20	17	16563.	78.18	0.0000	0.57	0.099
28	20	18	34450.	78.35	0.0000	0.57	0.606
29	19	20	51013.	80.92	0.0000	0.57	1.241
30	21	19	33157.	82.52	0.0000	0.54	0.055
31	22	21	30059.	82.54	0.0000	0.54	1.251
32	22	21	3098.	85.97	0.0000	0.54	1.234
33	23	22	16579.	73.17	0.0000	0.72	0.400
34	23	22	16579.	73.17	0.0000	0.12	0.400
35	4	24	90762.	69.56	0.0000	0.15	3.534
36	24	25	34382.	80.51	0.0000	0.87	0.680
37	24	27	56380.	70.49	0.0000	0.58	1.734
38	27	28	84968.	68.47	0.0000	0.58	0.768
39	28	31	27214.	76.35	0.0000	0.58	1.056
40	25	26	34382.	86.41	0.0000	0.92	2.293
41	26	30	29967.	76.94	0.0000	0.92	0.338
42	26	29	4415.	71.74	0.0000	0.92	0.003
43	2	27	28589.	70.42	0.0000	0.59	5.295
44	28	29	57754.	71.54	0.0000	0.58	0.421
45	29	30	62169.	75.56	0.0000	0.61	0.335
46	2	30	38100.	75.65	0.0000	0.00	6.828
47	30	31	205144.	75.69	0.0000	0.53	0.310
48	18	30	74908.	76.81	0.0000	0.57	3.611
50	1	32	17031.	50.00	0.0000	0.00	11.844
49	31	32	294191.	65.60	3.0867	0.66	5.299
51	32	1	311222.	64.85	2.9178	0.62	11.848

TEMPERATURES AND CONCENTRATIONS OF SMOKE AND METHANE IN JUNCTIONS

JUNCTION	TEMPERATURE	SMOKE	METHANE	JUNCTION	TEMPERATURE	SMOKE	METHANE
1	50.00	0.0000	0.0000	2	64.98	0.0000	0.0000
3	67.28	0.0000	0.0000	4	64.34	0.0000	0.0000
5	64.57	0.0000	0.3800	6	69.84	0.0000	0.6326
7	76.04	0.0000	2.4377	8	72.34	0.0000	0.0778
9	75.01	0.0000	0.1551	10	76.56	0.0000	0.1845
11	78.60	0.0000	0.4589	12	79.40	0.0000	0.4883
13	82.04	0.0000	0.4902	14	701.18	14.6862	1.1245
15	86.12	0.0000	0.5573	16	78.35	0.0000	0.5826
17	78.00	0.0000	0.5762	18	78.57	0.0000	0.5720
19	82.50	0.0000	0.5671	20	80.92	0.0000	0.5671
21	82.86	0.0000	0.5412	22	73.17	0.0000	0.4196
23	65.26	0.0000	0.0000	24	69.56	0.0000	0.1464
25	80.51	0.0000	0.8672	26	86.41	0.0000	0.9164
27	70.46	0.0000	0.5844	28	68.47	0.0000	0.5844
29	71.56	0.0000	0.6080	30	76.24	0.0000	0.5270
31	76.28	3.0867	0.6579	32	64.75	2.9178	0.6219

NUMBER OF ITERATIONS 6

IN THE FOLLOWING AIRWAYS EXIST CRITICAL CONDITIONS
(THE STATED NUMBERS REFER TO AIRWAY ENDS)

AIRWAY	FROM	TO	METHANE CONCENTRATION HIGHER THAN 1.0 PERCENT	SMOKE CONCENTRATION HIGHER THAN 0.050 PERCENT	TEMPERATURE HIGHER THAN 95. DEGREES	LOW VENTILAT. PRESSURE LOWER THAN 0.010 INCHES WG
8	6	7	2.43	0.0000	78.4	0.330
9	6	7	2.44	0.0000	75.9	0.302
10	7	14	2.59	0.0000	81.8	0.116
11	14	31	1.12	14.6862	78.2	10.948
20	13	14	0.49	21.0000	947.5	5.479
21	15	13	0.56	0.0000	83.9	0.000
23	15	16	0.56	0.0000	78.0	0.007
42	26	29	0.92	0.0000	71.7	0.003
49	31	32	0.66	3.0867	65.6	5.299
51	32	1	0.62	2.9178	64.8	11.848

IN THE FOLLOWING JUNCTIONS EXIST CRITICAL CONDITIONS

JUNCTION	METHANE CONCENTRATION HIGHER THAN 1.0 PERCENT	SMOKE CONCENTRATIONS HIGHER THAN 0.050 PERCENT	TEMPERATURE MORE THAN 95.0 DEGREES
7	2.4	0.0000	76.0
14	1.1	14.6862	701.2
31	0.7	3.0867	76.3
32	0.6	2.9178	64.8

REVERSAL OF AIRFLOW HAS OCCURRED IN THE FOLLOWING PLACES

AIRWAY 20 IS NOW CARRYING AIR FROM 13 TO 14
AIRWAY 21 IS NOW CARRYING AIR FROM 15 TO 13

R E A L   T I M E   A N A L Y S I S

THE FOLLOWING CONTAMINATION HISTORY WAS ASSUMED FOR THE REAL TIME ANALYSIS

AIRWAY	CONTAMINATION FLOWRATE	CONTAMINATION CONCENTRAT.	OXYGENCONCENTRATION BEHIND FIRE	PRODUCTION PER % OXYGEN FUMES	TIME HISTORY OFEVENT START	TIME HISTORY OFEVENT END
20	0.0	0.0	0.00	1.00	0	10

****
****
****

AT 2 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE FOLLOWING AIRWAYS

AIRWAY NUMBER	AIRWAY FROM	AIRWAY TO	AIRWAY LENGTH FT	WAVE NUMBER	WAVE CONC %	WAVE START TIME	WAVE LENGTH FT
11	14	31	4500	1	14.6862	1.45	421.9
20	13	14	524	1	21.0000	0.00	524.0

WAVE 1

AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
11	14.6862	421.9	1.45	0.00
20	21.0000	524.0	0.00	1.45

AT 2 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
14	14.6862	1.45

AT 2 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	0.00	3	0.00
4	0.00	5	0.00	6	0.00
7	0.00	8	0.00	9	0.00
10	0.00	11	0.00	12	0.00
13	0.00	14	1336.13	15	0.00
16	0.00	17	0.00	18	0.00
19	0.00	20	0.00	21	0.00
22	0.00	23	0.00	24	0.00
25	0.00	26	0.00	27	0.00
28	0.00	29	0.00	30	0.00
31	0.00	32	0.00		

****
****
****

AT 4 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
11	14	31	4500	1	14.6862	1.45	1967.7
20	13	14	524	1	21.0000	0.00	524.0

WAVE 1

AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
11	14.6862	1967.7	1.45	0.00
20	21.0000	524.0	0.00	1.45

AT 4 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
14	14.6862	1.45

AT 4 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO
THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	0.00	3	0.00
4	0.00	5	0.00	6	0.00
7	0.00	8	0.00	9	0.00
10	0.00	11	0.00	12	0.00
13	0.00	14	6231.53	15	0.00
16	0.00	17	0.00	18	0.00
19	0.00	20	0.00	21	0.00
22	0.00	23	0.00	24	0.00
25	0.00	26	0.00	27	0.00
28	0.00	29	0.00	30	0.00
31	0.00	32	0.00		

****
****
****

AT 6 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE
FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
11	14	31	4500	1	14.6862	1.45	3513.6
20	13	14	524	1	21.0000	0.00	524.0

WAVE 1

AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
11	14.6862	3513.6	1.45	0.00
20	21.0000	524.0	0.00	1.45

AT 6 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE
FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
14	14.6862	1.45

AT 6 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO
THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	0.00	3	0.00
4	0.00	5	0.00	6	0.00
7	0.00	8	0.00	9	0.00
10	0.00	11	0.00	12	0.00
13	0.00	14	11126.93	15	0.00
16	0.00	17	0.00	18	0.00
19	0.00	20	0.00	21	0.00
22	0.00	23	0.00	24	0.00
25	0.00	26	0.00	27	0.00
28	0.00	29	0.00	30	0.00
31	0.00	32	0.00		

****
****
****

AT 8 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE
FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
11	14	31	4500	1	14.6862	1.45	4500.0
20	13	14	524	1	21.0000	0.00	524.0
49	31	32	2031	1	3.0867	7.28	1064.6

WAVE 1

AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
11	14.6862	4500.0	1.45	7.28
20	21.0000	524.0	0.00	1.45
49	3.0867	1064.6	7.28	0.00

AT 8 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE
FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
14	14.6862	1.45
31	3.0867	7.28

AT 8 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO
THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	0.00	3	0.00
4	0.00	5	0.00	6	0.00
7	0.00	8	0.00	9	0.00
10	0.00	11	0.00	12	0.00
13	0.00	14	16022.34	15	0.00
16	0.00	17	0.00	18	0.00
19	0.00	20	0.00	21	0.00
22	0.00	23	0.00	24	0.00
25	0.00	26	0.00	27	0.00
28	0.00	29	0.00	30	0.00
31	372.32	32	0.00		

****
****
****

AT 10 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE
FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
11	14	31	4500	1	14.6862	1.45	4500.0
20	13	14	524	1	21.0000	0.00	524.0
49	31	32	2031	1	3.0867	7.28	2031.0
51	32	1	100	1	2.9178	8.66	100.0

WAVE 1

AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
11	14.6862	4500.0	1.45	7.28
20	21.0000	524.0	0.00	1.45
49	3.0867	2031.0	7.28	8.66
51	2.9178	100.0	8.66	8.68

AT 10 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE
FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
14	14.6862	1.45
31	3.0867	7.28
32	2.9178	8.66

AT 10 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO
THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	0.00	3	0.00
4	0.00	5	0.00	6	0.00
7	0.00	8	0.00	9	0.00
10	0.00	11	0.00	12	0.00
13	0.00	14	20917.74	15	0.00
16	0.00	17	0.00	18	0.00
19	0.00	20	0.00	21	0.00
22	0.00	23	0.00	24	0.00
25	0.00	26	0.00	27	0.00
28	0.00	29	0.00	30	0.00
31	1401.23	32	653.10		

END OF RUN

APPENDIX D.--INPUT DATA FOR FUEL-RICH FIRE IN A DOWNCAST SHAFT CALCULATION WITH FAN FAILURE

NETWORK CONTROL CARD

NB	NJ	NFUM	NADBC	NVPN	NETW	NCONC	NTEMP	MADJ	ITN	DR	TR	IRTCC
51	32	1	3	1	1	1	1	10	30	075	70.00	1

AIRWAY CARDS

NO	JS	JF	NWTYP	R	Q	KF	LA	A	O
1	1	2	0	0.156	200000	250	2597	200.0	50.0
2	2	3	0	0.048	60000	250	325	200.0	50.0
3	1	4	0	0.479	100000	250	2577	200.0	50.0
4	1	23	0	0.995	30000	250	2580	200.0	50.0
5	2	4	0	2.400	35000	100	2900	80.0	35.0
6	4	5	1	4.000	60000	100	100	80.0	35.0
7	5	6	0	2.307	60000	100	2700	80.0	35.0
8	6	7	0	1888.233	5000	350	524	120.0	44.0
9	6	7	0	9.923	60000	100	1700	80.0	35.0
10	7	14	0	3.239	70000	100	1650	80.0	35.0
11	14	31	0	20.002	70000	100	4500	80.0	35.0
12	3	8	0	0.360	53600	100	2700	80.0	35.0
13	8	19	0	41.490	20000	100	2050	80.0	35.0
14	8	9	0	0.821	50000	100	600	80.0	35.0
15	9	10	0	1.437	35000	100	600	80.0	35.0
16	10	11	0	124.385	6000	100	600	80.0	30.0
17	10	11	0	5.500	30000	100	1100	80.0	35.
18	11	12	0	3.900	35000	350	319	120.0	44.0
19	12	13	0	3.772	35000	100	600	80.0	35.0
20	14	13	0	4.000	6000	350	524	120.0	44.0
21	13	15	0	1.108	35000	100	550	80.0	35.0
22	9	15	0	474.065	6000	350	318	120.0	44.0
23	15	16	0	2.047	30000	100	600	80.0	35.0
24	2	16	0	77.702	14800	100	2600	80.0	35.0
25	16	17	0	2.285	60000	100	1050	80.0	35.0
26	17	18	0	2.966	60000	350	228	120.0	44.0
27	20	17	0	3.500	2000	100	800	80.0	35.0
28	20	18	0	4.931	50000	100	1217	80.0	35.0
29	19	20	0	4.565	50000	350	333	120.0	44.0
30	21	19	0	0.475	31300	100	1100	80.0	35.0
31	22	21	0	13.375	40000	100	1313	80.0	35.0
32	22	21	0	1234.019	3000	350	313	120.0	44.0
33	23	22	0	14.500	20000	100	1800	80.0	35.0
34	23	22	0	14.500	20000	100	1800	80.0	35.0
35	4	24	0	4.324	110000	100	2400	80.0	35.0
36	24	25	0	5.572	45000	100	2600	80.0	35.0
37	24	27	0	5.450	20000	100	3200	80.0	35.0
38	27	28	0	1.066	100000	350	230	120.0	44.0
39	28	31	0	14.000	40000	100	2292	80.0	35.0
40	25	26	0	18.360	45000	100	2000	80.0	35.0
41	26	30	0	3.630	38000	100	1700	80.0	35.0
42	26	29	0	1.385	5000	100	1050	80.0	35.0
43	2	27	0	65.065	35449	100	1650	80.0	35.0
44	28	29	0	1.260	73000	100	750	80.0	35.0
45	29	30	0	0.854	80000				
46	2	30	0	46.882	44000	100	525	80.0	35.0
47	30	31	0	0.072	203000				
48	18	30	0	6.265	100000	100	4100	80.0	35.0
50	1	32	0	441.000	20000	250	30	200.0	50.0
49	31	32	0	0.610	288350				
51	32	1	0	10.000	450000	100	100	80.0	35.0

JUNCTION CARDS

JNO	T	Z	CH4
1	50.0	114	
2	65.06	-2465	
3	67.32	-2790	
4	64.39	-2463	
5	64.51	-2462	0.12
6	69.88	-2462	0.20
7	75.60	-1938	0.80
8	72.54	-2787	0.12
9	75.67	-2785	0.25
10	77.09	-2785	0.30
11	78.82	-2787	0.90
12	79.31	-2468	0.95
13	82.42	-2465	0.90
14	81.62	-1942	0.85
15	83.25	-2467	0.90
16	78.56	-2466	0.90
17	77.92	-2463	
18	78.39	-2235	
19	82.54	-2785	0.8
20	80.90	-2452	
21	82.87	-2786	0.85
22	73.28	-2473	0.70
23	65.27	-2466	
24	69.95	-2462	0.15
25	80.65	-2245	0.90
26	86.57	-2247	0.95
27	70.59	-2465	
28	68.59	-2235	
29	72.08	-2239	
30	76.80	-2240	
31	76.44	-1943	
32	65.70	88	

FAN CHARACTERISTIC CARDS

NOF	MPTS
6	10

QF	PF	QF	PF	QF	PF	QF	PF	QF	PF
20000	3.60	25000	4.30	30000	4.60	40000	4.78	55000	4.58
70000	4.29	85000	3.96	100000	3.70	150000	3.00	200000	2.52

ADDITIONAL AIRWAY CARDS

NO	KF	LA	A	O
45	100	300	80.0	35.0
47	250	297	200.0	50.0
49	250	2031	200.0	50.0

CONCENTRATION CONTROL CARD

NDIM	NCH4C	NAV	MAXJ	INFLOW	JSTART	TSTART	TIME	CRITSM	CRITGS	CRITHT	WRNPR	WRNSM	WRNGS	WRNHT
6	2	1	32	1	1	50.00	1.00	.005	0.10	.20	.01	.05	1.0	95.

AVERAGE VALUE CARD

TAVR	HAAVR	HKAVR	KFAVR	LAAVR	AAVR	OAVR
70.0	0.10	3.0	100	1000	100.0	100.0

ADDITIONAL CONCENTRATION AIRWAY CARDS

NOX	CH4VX	DZRDX
9	320.0	
17	90.0	
33	120.0	
34	20.0	
36	250.0	
50		50.00

```
  ADDITIONAL  CONCENTRATION  JUNCTION  CARDS
JNOX                       CH4CX
  27                      0.60
  28                      0.60
  CONTAMINATION  CARD
NCENT                                                  SMPO2    HTPO2
  20                                                    1.00    300.00
   REAL  TIME  CONTROL  CARD
NACC IDUR  INC    EXP  REP   WRNSM JSURF CRITSM
   1  360   60  2.00  2.00  0.001      1.001
   CONTAMINATION  CARD
NCENT                                                  SMPO2   HTPO2       ISTT  IENDT
  20                                                    1.00    300.00        0   360
```

APPENDIX E.--OUTPUT DATA FOR FUEL-RICH FIRE IN A DOWNCAST SHAFT CALCULATION WITH FAN FAILURE

ORDINARY AIRFLOW AND PRESSURE DISTRIBUTION BEFORE EVENT (BASED ON THE LISTED INPUT DATA)

REGULAR AIRWAYS

AIRWAY	FROM	TO	AIRFLOW	PRESSURE LOSS	LENGTH	AREA	RESISTANCE	K	PERIMETER
1	1	2	3709.	0.000	2597	200.000	0.156	250	50.000
2	2	3	-7929.	0.000	325	200.000	0.048	250	50.000
3	1	4	35910.	0.062	2577	200.000	0.479	250	50.000
4	1	23	-5216.	-0.003	2580	200.000	0.995	250	50.000
5	2	4	12405.	0.037	2900	80.000	2.400	100	35.000
7	5	6	51860.	0.620	2700	80.000	2.307	100	35.000
8	6	7	3505.	2.320	524	120.000	1888.233	350	44.000
9	6	7	48355.	2.320	1700	80.000	9.923	100	35.000
10	7	14	51860.	0.871	1650	80.000	3.239	100	35.000
11	14	31	20109.	0.809	4500	80.000	20.002	100	35.000
12	3	8	-7929.	-0.002	2700	80.000	0.360	100	35.000
13	8	19	4077.	0.069	2050	80.000	41.490	100	35.000
14	8	9	-12006.	-0.012	600	80.000	0.821	100	35.000
15	9	10	-10616.	-0.016	600	80.000	1.437	100	35.000
16	10	11	-1840.	-0.042	600	80.000	124.385	100	30.000
17	10	11	-8776.	-0.042	1100	80.000	5.500	100	35.000
18	11	12	-10616.	-0.044	319	120.000	3.900	350	44.000
19	12	13	-10616.	-0.043	600	80.000	3.772	100	35.000
20	14	13	31751.	0.403	524	120.000	4.000	350	44.000
21	13	15	21135.	0.049	550	80.000	1.108	100	35.000
22	9	15	-1390.	-0.092	318	120.000	474.065	350	44.000
23	15	16	19745.	0.080	600	80.000	2.047	100	35.000
24	2	16	-4256.	-0.141	2600	80.000	77.702	100	35.000
25	16	17	15489.	0.055	1050	80.000	2.285	100	35.000
26	17	18	8744.	0.023	228	120.000	2.966	350	44.000
27	20	17	-6745.	-0.016	800	80.000	3.500	100	35.000
28	20	18	5606.	0.015	1217	80.000	4.931	100	35.000
29	19	20	-1139.	-0.001	333	120.000	4.565	350	44.000
30	21	19	-5216.	-0.001	1100	80.000	0.475	100	35.000
31	22	21	-4722.	-0.030	1313	80.000	13.375	100	35.000
32	22	21	-494.	-0.030	313	120.000	1234.019	350	44.000
33	23	22	-2608.	-0.010	1800	80.000	14.500	100	35.000
34	23	22	-2608.	-0.010	1800	80.000	14.500	100	35.000
35	4	24	-3545.	-0.005	2400	80.000	4.324	100	35.000
36	24	25	2386.	0.003	2600	80.000	5.572	100	35.000
37	24	27	-5931.	-0.019	3200	80.000	5.450	100	35.000
38	27	28	-4518.	-0.002	230	120.000	1.066	350	44.000
39	28	31	-4689.	-0.031	2292	80.000	14.000	100	35.000
40	25	26	2386.	0.010	2000	80.000	18.360	100	35.000
41	26	30	1305.	0.001	1700	80.000	3.630	100	35.000
42	26	29	1081.	0.000	1050	80.000	1.385	100	35.000
43	2	27	1413.	0.013	1650	80.000	65.065	100	35.000
44	28	29	171.	0.000	750	80.000	1.260	100	35.000
45	29	30	1252.	0.000	300	80.000	0.854	100	35.000
46	2	30	2075.	0.020	525	80.000	46.882	100	35.000
47	30	31	18982.	0.003	297	200.000	0.072	250	50.000
48	18	30	14350.	0.129	4100	80.000	6.265	100	35.000
50	1	32	-4502.	-0.894	30	200.000	441.000	250	50.000
49	31	32	34402.	0.072	2031	200.000	0.610	250	50.000
51	32	1	29900.	0.894	100	80.000	10.000	100	35.000

FANS

AIRWAY	FROM	TO	AIRFLOW	FAN PRESSURE
6	4	5	51860.	4.658

THESE CHARACTERISTICS WERE STORED FOR FANS 6

20000.	3.60	25000.	4.30	30000.	4.60	40000.	4.78	55000.	4.58
70000.	4.29	85000.	3.96	100000.	3.70	150000.	3.00	200000.	2.52

THE STATED NUMBER OF AIRWAYS WAS 51 THE STATED NUMBER OF JUNCTIONS WAS 32

INPUT DATA FOR CONCENTRATION AND TEMPERATURE CALCULATIONS

AIRWAY	FROM	TO	ELEVATION DIFF.	ROCK TEMP.	METHANE PROD.	CONDUCTIVITY	DIFFUSIVITY
1	1	2	-2579.0	58.1	0.0	3.0	0.1000
2	2	3	-325.0	67.2	0.0	3.0	0.1000
3	1	4	-2577.0	57.4	0.0	3.0	0.1000
4	1	23	-2580.0	58.3	0.0	3.0	0.1000
5	2	4	2.0	64.3	0.0	3.0	0.1000
6	4	5	1.0	65.6	62.2	3.0	0.1000
7	5	6	0.0	69.9	41.5	3.0	0.1000
8	6	7	524.0	79.9	21.0	3.0	0.1000
9	6	7	524.0	77.5	320.0	3.0	0.1000
10	7	14	-4.0	82.0	25.9	3.0	0.1000
11	14	31	-1.0	76.4	0.0	3.0	0.1000
12	3	8	3.0	72.5	-9.5	3.0	0.1000
13	8	19	2.0	82.5	27.7	3.0	0.1000
14	8	9	2.0	76.7	-15.6	3.0	0.1000
15	9	10	0.0	77.5	-5.3	3.0	0.1000
16	10	11	-2.0	79.2	-11.0	3.0	0.1000
17	10	11	-2.0	78.9	90.0	3.0	0.1000
18	11	12	319.0	82.5	-5.3	3.0	0.1000
19	12	13	3.0	83.5	0.0	3.0	0.1000
20	14	13	-523.0	79.6	15.9	3.0	0.1000
21	13	15	-2.0	83.6	0.0	3.0	0.1000
22	9	15	318.0	89.5	-9.0	3.0	0.1000
23	15	16	1.0	76.5	0.0	3.0	0.1000
24	2	16	-1.0	78.5	-38.3	3.0	0.1000
25	16	17	3.0	77.8	0.0	3.0	0.1000
26	17	18	228.0	81.4	0.0	3.0	0.1000
27	20	17	-11.0	77.4	0.0	3.0	0.1000
28	20	18	217.0	78.8	0.0	3.0	0.1000
29	19	20	333.0	81.9	0.0	3.0	0.1000
30	21	19	1.0	82.5	0.0	3.0	0.1000
31	22	21	-313.0	82.2	-7.1	3.0	0.1000
32	22	21	-313.0	85.3	-0.7	3.0	0.1000
33	23	22	-7.0	73.2	120.0	3.0	0.1000
34	23	22	-7.0	73.2	20.0	3.0	0.1000
35	4	24	1.0	69.9	-5.3	3.0	0.1000
36	24	25	217.0	81.2	250.0	3.0	0.1000
37	24	27	-3.0	70.5	-26.7	3.0	0.1000
38	27	28	230.0	68.1	0.0	3.0	0.1000
39	28	31	292.0	77.2	0.0	3.0	0.1000
40	25	26	-2.0	86.5	1.2	3.0	0.1000
41	26	30	7.0	76.8	0.0	3.0	0.1000
42	26	29	8.0	71.7	0.0	3.0	0.1000
43	2	27	0.0	70.5	8.5	3.0	0.1000
44	28	29	-4.0	72.1	0.0	3.0	0.1000
45	29	30	-1.0	79.3	0.0	3.0	0.1000
46	2	30	225.0	80.4	0.0	3.0	0.1000
47	30	31	297.0	79.5	0.0	3.0	0.1000
48	18	30	-5.0	76.8	0.0	3.0	0.1000
50	1	32	0.0	50.0	0.0	3.0	0.1000
49	31	32	2031.0	71.1	0.0	3.0	0.1000
51	32	1	26.0	70.0	0.0	3.0	0.1000

TIME AFTER BEGINNING OF EVENT 1.00 HOURS

A TEMPERATURE OF 50.0 WAS ASSIGNED TO JUNCTION NO 1

THE FOLLOWING CONTAMINATION WAS ASSUMED

	CONTAMINATION			OXYGEN CONCENTRATION	PRODUCTION PER CU FT OXYGEN	
AIRWAY	FLOWRATE	CONCENTRAT.	HEAT	BEHIND FIRE	SMOKE	HEAT
20	0.000	0.000	0.000	0.00	1.000	300.000

TEMPERATURES AND CONCENTRATIONS AT AIRWAY ENDS, PRESSURES IN AIRWAYS

AIRWAY	FROM	TO	AIRFLOW	TEMPERATURE	SMOKE	METHANE	PRESSURE
1	1	2	47403.	65.01	0.0000	0.00	0.033
2	2	3	33371.	67.24	1.7453	0.13	0.005
3	4	1	26392.	50.58	21.0000	1.56	0.032
4	1	23	9466.	65.25	0.0000	0.00	0.009
5	4	-2	4297.	64.31	21.0000	1.56	0.004
6	5	4	46504.	69.60	21.0000	1.56	4.739
7	6	5	46504.	70.20	21.0000	1.43	0.506
8	7	6	3161.	86.02	21.0000	1.28	2.151
9	7	6	43343.	85.67	21.0000	1.35	2.134
10	14	7	46504.	159.11	21.0000	0.62	1.640
11	14	31	8097.	76.40	21.0000	0.56	0.170
12	3	8	33371.	72.44	1.7453	0.10	0.040
13	8	19	7011.	82.49	1.7453	0.49	0.212
14	8	9	26360.	75.23	1.7453	0.04	0.058
15	9	10	22869.	76.74	1.7453	0.02	0.077
16	10	11	3973.	78.70	1.7453	-0.26	0.202
17	10	11	18896.	78.70	1.7453	0.49	0.202
18	11	12	22869.	79.61	1.7453	0.34	0.211
19	12	13	22869.	82.20	1.7453	0.34	0.206
20	13	14	54601.	984.32	21.0000	0.56	8.418
21	15	13	31732.	81.36	2.8587	0.68	0.116
22	9	15	3491.	85.71	1.7453	-0.22	0.604
23	16	15	28241.	77.11	2.9963	0.79	0.168
24	2	16	7071.	78.50	1.7453	-0.42	0.398
25	17	16	21170.	78.03	3.4142	1.19	0.106
26	18	-17	10002.	80.62	6.3972	1.42	0.031
27	20	17	11168.	77.96	0.7426	0.99	0.045
28	20	18	5309.	78.28	0.7426	0.99	0.014
29	19	20	16477.	80.89	0.7426	0.99	0.129
30	21	19	9466.	82.51	0.0000	1.37	0.004
31	22	21	8622.	82.75	0.0000	1.37	0.103
32	22	21	845.	85.23	0.0000	1.36	0.092
33	23	22	4733.	73.20	0.0000	2.47	0.033
34	23	22	4733.	73.20	0.0000	0.42	0.033
35	4	24	15815.	69.90	21.0000	1.53	0.108
36	24	25	7193.	80.59	21.0000	4.84	0.030
37	24	27	8622.	70.50	21.0000	1.22	0.041
38	27	28	13343.	68.33	14.1881	0.90	0.019
39	28	31	3854.	76.41	14.1881	0.90	0.021
40	25	26	7193.	86.48	21.0000	4.85	0.101
41	26	30	5576.	76.85	21.0000	4.85	0.012
42	26	29	1617.	71.93	21.0000	4.85	0.000
43	2	27	4720.	70.48	1.7453	0.31	0.145
44	28	29	9488.	71.49	14.1881	0.90	0.011
45	29	30	11105.	75.53	15.1797	1.47	0.011
46	2	30	6537.	76.02	1.7453	0.13	0.202
47	30	31	18526.	76.25	12.7951	1.91	0.003
48	30	18	4693.	76.77	12.7951	1.91	0.014
50	32	1	4002.	64.32	15.1512	1.42	0.693
49	31	32	30478.	65.68	15.1512	1.42	0.057
51	32	1	26476.	66.26	15.1512	1.42	0.690

TEMPERATURES AND CONCENTRATIONS OF SMOKE AND METHANE IN JUNCTIONS

JUNCTION	TEMPERATURE	SMOKE	METHANE	JUNCTION	TEMPERATURE	SMOKE	METHANE
1	50.00	0.0000	0.0000	2	64.95	1.7453	0.1278
3	67.24	1.7453	0.1278	4	69.60	21.0000	1.5624
5	70.20	21.0000	1.4307	6	85.69	21.0000	1.3427
7	159.11	21.0000	0.6192	8	72.44	1.7453	0.0993
9	75.23	1.7453	0.0401	10	76.74	1.7453	0.0169
11	78.70	1.7453	0.3601	12	79.61	1.7453	0.3370
13	81.71	2.3924	0.5349	14	984.32	21.0000	0.5638
15	78.06	2.8587	0.6775	16	78.15	2.9963	0.7884
17	79.22	3.4142	1.1907	18	77.57	6.3972	1.4222
19	82.51	0.7426	0.9940	20	80.89	0.7426	0.9940
21	82.97	0.0000	1.3652	22	73.20	0.0000	1.4467
23	65.25	0.0000	0.0000	24	69.90	21.0000	1.5293
25	80.59	21.0000	4.8368	26	86.48	21.0000	4.8525
27	70.49	14.1881	0.8992	28	68.33	14.1881	0.8992
29	71.56	15.1797	1.4747	30	75.98	12.7951	1.9068
31	76.31	15.1512	1.4225	32	65.68	15.1512	1.4225

NUMBER OF ITERATIONS 8
WITH AIRWAY NO 5 INTO JUNCTION NO 2
WITH AIRWAY NO 26 INTO JUNCTION NO 17

A RECIRCULATION PATH IS BEING CLOSED

IN THE FOLLOWING AIRWAYS EXIST CRITICAL CONDITIONS
(THE STATED NUMBERS REFER TO AIRWAY ENDS)

AIRWAY	FROM	TO	METHANE CONCENTRATION HIGHER THAN 1.0 PERCENT	SMOKE CONCENTRATION HIGHER THAN 0.050 PERCENT	TEMPERATURE HIGHER THAN 95. DEGREES	LOW VENTILAT. PRESSURE LOWER THAN 0.010 INCHES WG
2	2	3	0.13	1.7453	67.2	0.005
3	4	1	1.56	21.0000	50.6	0.032
4	1	23	0.00	0.0000	65.2	0.009
5	4	2	1.56	21.0000	64.3	0.004
6	5	4	1.56	21.0000	69.6	4.739
7	6	5	1.43	21.0000	70.2	0.506
8	7	6	1.28	21.0000	86.0	2.151
9	7	6	1.35	21.0000	85.7	2.134
10	14	7	0.62	21.0000	159.1	1.640
11	14	31	0.56	21.0000	76.4	0.170
12	3	8	0.10	1.7453	72.4	0.040
13	8	19	0.49	1.7453	82.5	0.212
14	8	9	0.04	1.7453	75.2	0.058
15	9	10	0.02	1.7453	76.7	0.077
16	10	11	-0.26	1.7453	78.7	0.202
17	10	11	0.49	1.7453	78.7	0.202
18	11	12	0.34	1.7453	79.6	0.211
19	12	13	0.34	1.7453	82.2	0.206
20	13	14	0.56	21.0000	984.3	8.418
21	15	13	0.68	2.8587	81.4	0.116
22	9	15	-0.22	1.7453	85.7	0.604
23	16	15	0.79	2.9963	77.1	0.168
24	2	16	-0.42	1.7453	78.5	0.398
25	17	16	1.19	3.4142	78.0	0.106
26	18	17	1.42	6.3972	80.6	0.031
27	20	17	0.99	0.7426	78.0	0.045
28	20	18	0.99	0.7426	78.3	0.014
29	19	20	0.99	0.7426	80.9	0.129
30	21	19	1.37	0.0000	82.5	0.004
31	22	21	1.37	0.0000	82.8	0.103
32	22	21	1.36	0.0000	85.2	0.092
33	23	22	2.47	0.0000	73.2	0.033
35	4	24	1.53	21.0000	69.9	0.108
36	24	25	4.84	21.0000	80.6	0.030
37	24	27	1.22	21.0000	70.5	0.041
38	27	28	0.90	14.1881	68.3	0.019
39	28	31	0.90	14.1881	76.4	0.021
40	25	26	4.85	21.0000	86.5	0.101
41	26	30	4.85	21.0000	76.8	0.012
42	26	29	4.85	21.0000	71.9	0.000
43	2	27	0.31	1.7453	70.5	0.145
44	28	29	0.90	14.1881	71.5	0.011
45	29	30	1.47	15.1797	75.5	0.011
46	2	30	0.13	1.7453	76.0	0.202
47	30	31	1.91	12.7951	76.2	0.003
48	30	18	1.91	12.7951	76.8	0.014
50	32	1	1.42	15.1512	64.3	0.693
49	31	32	1.42	15.1512	65.7	0.057
51	32	1	1.42	15.1512	66.3	0.690

IN THE FOLLOWING JUNCTIONS EXIST CRITICAL CONDITIONS

JUNCTION	METHANE CONCENTRATION HIGHER THAN 1.0 PERCENT	SMOKE CONCENTRATIONS HIGHER THAN 0.050 PERCENT	TEMPERATURE MORE THAN 95.0 DEGREES
2	0.1	1.7453	65.0
3	0.1	1.7453	67.2
4	1.6	21.0000	69.6
5	1.4	21.0000	70.2
6	1.3	21.0000	85.7
7	0.6	21.0000	159.1
8	0.1	1.7453	72.4
9	0.0	1.7453	75.2
10	0.0	1.7453	76.7
11	0.4	1.7453	78.7
12	0.3	1.7453	79.6
13	0.5	2.3924	81.7
14	0.6	21.0000	984.3
15	0.7	2.8587	78.1
16	0.8	2.9963	78.1
17	1.2	3.4142	79.2
18	1.4	6.3972	77.6
19	1.0	0.7426	82.5
20	1.0	0.7426	80.9
21	1.4	0.0000	83.0
22	1.4	0.0000	73.2
24	1.5	21.0000	69.9
25	4.8	21.0000	80.6
26	4.9	21.0000	86.5
27	0.9	14.1881	70.5
28	0.9	14.1881	68.3
29	1.5	15.1797	71.6
30	1.9	12.7951	76.0
31	1.4	15.1512	76.3
32	1.4	15.1512	65.7

REVERSAL OF AIRFLOW HAS OCCURRED IN THE FOLLOWING PLACES

AIRWAY	3	IS NOW CARRYING AIR FROM	4	TO	1
AIRWAY	5	IS NOW CARRYING AIR FROM	4	TO	2
AIRWAY	6	IS NOW CARRYING AIR FROM	5	TO	4
AIRWAY	7	IS NOW CARRYING AIR FROM	6	TO	5
AIRWAY	8	IS NOW CARRYING AIR FROM	7	TO	6
AIRWAY	9	IS NOW CARRYING AIR FROM	7	TO	6
AIRWAY	10	IS NOW CARRYING AIR FROM	14	TO	7
AIRWAY	20	IS NOW CARRYING AIR FROM	13	TO	14
AIRWAY	21	IS NOW CARRYING AIR FROM	15	TO	13
AIRWAY	23	IS NOW CARRYING AIR FROM	16	TO	15
AIRWAY	25	IS NOW CARRYING AIR FROM	17	TO	16
AIRWAY	26	IS NOW CARRYING AIR FROM	18	TO	17
AIRWAY	48	IS NOW CARRYING AIR FROM	30	TO	18
AIRWAY	50	IS NOW CARRYING AIR FROM	32	TO	1

R E A L   T I M E   A N A L Y S I S

THE FOLLOWING CONTAMINATION HISTORY WAS ASSUMED FOR THE REAL TIME ANALYSIS

AIRWAY	CONTAMINATION FLOWRATE	CONTAMINATION CONCENTRAT.	OXYGENCONCENTRATION BEHIND FIRE	PRODUCTION PER % OXYGEN FUMES	TIME HISTORY OFEVENT START	TIME HISTORY OFEVENT END
20	0.0	0.0	0.00	1.00	0	360

****
****
****

AT 60 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE FOLLOWING AIRWAYS

AIRWAY NUMBER	AIRWAY FROM	AIRWAY TO	AIRWAY LENGTH FT	WAVE NUMBER	WAVE CONC %	WAVE START TIME	WAVE LENGTH FT
3	4	1	2577	2	21.0000	28.70	2577.0
5	4	2	2900	2	21.0000	28.70	1681.1
6	5	4	100	2	21.0000	28.53	100.0
7	6	5	2700	2	21.0000	23.88	2700.0
8	7	6	524	1	21.0000	3.99	524.0
9	7	6	1700	1	21.0000	3.99	1700.0
10	14	7	1650	1	21.0000	1.15	1650.0
11	14	31	4500	1	21.0000	1.15	4500.0
20	13	14	524	1	21.0000	0.00	524.0
35	4	24	2400	2	21.0000	28.70	2400.0
36	24	25	2600	2	21.0000	40.84	1722.8
37	24	27	3200	2	21.0000	40.84	2065.1
38	27	28	230	1	12.6482	53.78	230.0
39	28	31	2292	1	12.6482	55.84	200.3
40	25	26	2000	1	19.5726	53.00	629.3
44	28	29	750	1	12.6482	55.84	493.0
50	32	1	30	1	5.5793	58.94	21.3
49	31	32	2031	1	5.5793	45.61	2031.0
51	32	1	100	1	5.5793	58.94	100.0

AIRWAY	WAVE 1 CONC %	WAVE 1 LOCATION FT	WAVE 1 START TIME	WAVE 1 ARRIVAL TIME	WAVE 2 CONC %	WAVE 2 LOCATION FT	WAVE 2 START TIME	WAVE 2 ARRIVAL TIME
3	19.5726	2577.0	11.94	31.47	21.0000	2577.0	28.70	48.23
5	19.5726	2581.0	11.94	0.00	21.0000	1681.1	28.70	0.00
6	19.5726	100.0	11.77	11.94	21.0000	100.0	28.53	28.70
7	19.5726	2700.0	7.13	11.77	21.0000	2700.0	23.88	28.53
8	21.0000	524.0	3.99	23.88				
9	21.0000	1700.0	3.99	7.13				
10	21.0000	1650.0	1.15	3.99				
11	21.0000	4500.0	1.15	45.61				
20	21.0000	524.0	0.00	1.15				
35	19.5726	2400.0	11.94	24.08	21.0000	2400.0	28.70	40.84
36	19.5726	2600.0	24.08	53.00	21.0000	1722.8	40.84	0.00
37	19.5726	3200.0	24.08	53.78	21.0000	2065.1	40.84	0.00
38	12.6482	230.0	53.78	55.84				
39	12.6482	200.3	55.84	0.00				
40	19.5726	629.3	53.00	0.00				
44	12.6482	493.0	55.84	0.00				
50	5.5793	21.3	58.94	0.00				
49	5.5793	2031.0	45.61	58.94				
51	5.5793	100.0	58.94	59.24				

AT 60 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE
FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
4	21.0000	28.70
5	21.0000	28.53
6	21.0000	23.88
7	21.0000	3.99
14	21.0000	1.15
24	21.0000	40.84
25	19.5726	53.00
27	12.6482	53.78
28	12.6482	55.84
31	5.5793	45.61
32	5.5793	58.94

AT 60 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO
THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	0.00	3	0.00
4	164207.64	5	164809.73	6	181066.45
7	196034.67	8	0.00	9	0.00
10	0.00	11	0.00	12	0.00
13	0.00	14	205969.33	15	0.00
16	0.00	17	0.00	18	0.00
19	0.00	20	0.00	21	0.00
22	0.00	23	0.00	24	121717.37
25	22829.84	26	0.00	27	13122.41
28	8761.85	29	0.00	30	0.00
31	13381.06	32	987.75		

AT 120 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
2	2	3	325	2	1.7453	82.69	325.0
3	4	1	2577	2	21.0000	28.70	2577.0
5	4	2	2900	2	21.0000	28.70	2900.0
6	5	4	100	2	21.0000	28.53	100.0
7	6	5	2700	2	21.0000	23.88	2700.0
8	7	6	524	1	21.0000	3.99	524.0
9	7	6	1700	1	21.0000	3.99	1700.0
10	14	7	1650	1	21.0000	1.15	1650.0
11	14	31	4500	1	21.0000	1.15	4500.0
12	3	8	2700	2	1.7453	84.64	2700.0
13	8	19	2050	2	1.7453	91.11	2050.0
14	8	9	600	2	1.7453	91.11	600.0
15	9	10	600	2	1.7453	92.93	600.0
16	10	11	600	2	1.7453	95.03	600.0
17	10	11	1100	2	1.7453	95.03	1100.0
18	11	12	319	4	1.7453	107.11	319.0
19	12	13	600	4	1.7453	108.79	600.0
20	13	14	524	1	21.0000	0.00	524.0
21	15	13	550	5	0.8245	113.81	550.0
22	9	15	318	2	1.7453	92.93	318.0
23	16	15	600	3	0.7107	112.11	600.0
24	2	16	2600	2	1.7453	82.69	2600.0
25	17	16	1050	1	0.3651	105.91	1050.0
26	18	17	228	1	0.3674	118.51	124.0
27	20	17	800	2	0.7426	116.93	428.6
28	20	18	1217	2	0.7426	116.93	203.8
29	19	20	333	2	0.7426	114.50	333.0
35	4	24	2400	2	21.0000	28.70	2400.0
36	24	25	2600	2	21.0000	40.84	2600.0
37	24	27	3200	2	21.0000	40.84	3200.0
38	27	28	230	4	14.1881	110.66	230.0
39	28	31	2292	4	14.1881	112.73	350.5
40	25	26	2000	2	21.0000	69.76	2000.0
41	26	30	1700	2	21.0000	92.00	1700.0
42	26	29	1050	2	21.0000	92.00	565.8
43	2	27	1650	2	1.7453	82.69	1650.0
44	28	29	750	4	14.1881	112.73	750.0
45	29	30	300	4	12.1226	119.05	132.0
46	2	30	525	2	1.7453	82.69	525.0
47	30	31	297	2	11.3158	116.39	297.0
48	30	18	4100	7	11.3158	116.39	211.8
50	32	1	30	2	13.7059	116.74	30.0
49	31	32	2031	5	14.0572	119.59	61.8
51	32	1	100	2	13.7059	116.74	100.0

AIRWAY	WAVE 1				WAVE 2				WAVE 3			
	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
2	1.6267	325.0	65.94	67.89	1.7453	325.0	82.69	84.64				
3	19.5726	2577.0	11.94	31.47	21.0000	2577.0	28.70	48.23				
5	19.5726	2900.0	11.94	65.94	21.0000	2900.0	28.70	82.69				
6	19.5726	100.0	11.77	11.94	21.0000	100.0	28.53	28.70				
7	19.5726	2700.0	7.13	11.77	21.0000	2700.0	23.88	28.53				
8	21.0000	524.0	3.99	23.88								
9	21.0000	1700.0	3.99	7.13								
10	21.0000	1650.0	1.15	3.99								
11	21.0000	4500.0	1.15	45.61								
12	1.6267	2700.0	67.89	74.36	1.7453	2700.0	84.64	91.11				
13	1.6267	2050.0	74.36	97.75	1.7453	2050.0	91.11	114.50				
14	1.6267	600.0	74.36	76.18	1.7453	600.0	91.11	92.93				
15	1.6267	600.0	76.18	78.28	1.7453	600.0	92.93	95.03				
16	1.6267	600.0	78.28	90.36	1.7453	600.0	95.03	107.11				
17	1.6267	1100.0	78.28	82.94	1.7453	1100.0	95.03	99.69				
18	1.3441	319.0	82.94	84.61	1.6267	319.0	90.36	92.03	1.7247	319.0	99.69	101.36
19	1.3441	600.0	84.61	86.71	1.6267	600.0	92.03	94.13	1.7247	600.0	101.36	103.46
20	21.0000	524.0	0.00	1.15								
21	0.1790	550.0	87.11	88.50	0.5414	550.0	97.05	98.44	0.5545	550.0	103.87	105.25
22	1.6267	318.0	76.18	87.11	1.7453	318.0	92.93	103.87				
23	0.4073	600.0	95.35	97.05	0.6810	600.0	109.87	111.57	0.7107	600.0	112.11	113.81
24	1.6267	2600.0	65.94	95.35	1.7453	2600.0	82.69	112.11				
25	0.3651	1050.0	105.91	109.87								
26	0.3674	124.0	118.51	0.00								
27	0.6922	800.0	100.18	105.91	0.7426	428.6	116.93	0.00				
28	0.6922	1217.0	100.18	118.51	0.7426	203.8	116.93	0.00				
29	0.6922	333.0	97.75	100.18	0.7426	333.0	114.50	116.93				
35	19.5726	2400.0	11.94	24.08	21.0000	2400.0	28.70	40.84				
36	19.5726	2600.0	24.08	53.00	21.0000	2600.0	40.84	69.76				
37	19.5726	3200.0	24.08	53.78	21.0000	3200.0	40.84	70.53				
38	12.6482	230.0	53.78	55.84	13.5706	230.0	70.53	72.60	14.1461	230.0	93.90	95.97
39	12.6482	2292.0	55.84	103.42	13.5706	2283.8	72.60	0.00	14.1461	1157.7	95.97	0.00
40	19.5726	2000.0	53.00	75.25	21.0000	2000.0	69.76	92.00				
41	19.5726	1700.0	75.25	99.63	21.0000	1700.0	92.00	116.39				
42	19.5726	904.4	75.25	0.00	21.0000	565.8	92.00	0.00				
43	1.6267	1650.0	65.94	93.90	1.7453	1650.0	82.69	110.66				
44	12.6482	750.0	55.84	62.17	13.5706	750.0	72.60	78.92	14.1461	750.0	95.97	102.29
45	10.8069	300.0	62.17	64.33	11.5950	300.0	78.92	81.08	12.0868	300.0	102.29	104.46
46	1.6267	525.0	65.94	72.36	1.7453	525.0	82.69	89.12				
47	10.9730	297.0	104.46	107.66	11.3158	297.0	116.39	119.59				
48	5.1687	3265.5	64.33	0.00	5.6267	2794.2	72.36	0.00	6.0036	2282.8	81.08	0.00
50	12.1063	30.0	116.17	117.67	13.7059	30.0	116.74	118.24				
49	9.2490	2031.0	92.32	105.65	12.1063	2031.0	102.84	116.17	13.7059	2031.0	103.42	116.74
51	12.1063	100.0	116.17	116.47	13.7059	100.0	116.74	117.05				

AIRWAY	WAVE 4				WAVE 5				WAVE 6			
	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
18	1.7453	319.0	107.11	108.79								
19	1.7453	600.0	108.79	110.89								
21	0.7981	550.0	111.57	112.96	0.8245	550.0	113.81	115.20				
38	14.1881	230.0	110.66	112.73								
39	14.1881	350.5	112.73	0.00								
44	14.1881	750.0	112.73	119.05								
45	12.1226	132.0	119.05	0.00								
48	6.0370	1811.4	89.12	0.00	10.7378	1194.6	99.63	0.00	10.9730	911.8	104.46	0.00
49	13.8488	1880.2	107.66	0.00	14.0572	61.8	119.59	0.00				

1 WAVES OF AIRWAY 48 ARE BEING BUFFERDUNTIL PRINTING SPACE IS AVALABLE

AT 120 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
2	1.7453	82.69
3	1.7453	84.64
4	21.0000	28.70
5	21.0000	28.53
6	21.0000	23.88
7	21.0000	3.99
8	1.7453	91.11
9	1.7453	92.93
10	1.7453	95.03
11	1.7453	107.11
12	1.7453	108.79
13	1.2102	115.20
14	21.0000	1.15
15	0.8245	113.81
16	0.7107	112.11
17	0.3651	105.91
18	0.3674	118.51
19	0.7426	114.50
20	0.7426	116.93
24	21.0000	40.84
25	21.0000	69.76
26	21.0000	92.00
27	14.1881	110.66
28	14.1881	112.73
29	12.1226	119.05
30	11.3158	116.39
31	14.0572	119.59
32	13.7059	116.74

AT 120 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	15394.34	3	14827.77
4	374207.59	5	374809.72	6	391066.44
7	406034.66	8	12944.99	9	12415.31
10	11804.78	11	10074.94	12	9588.04
13	5260.23	14	415969.31	15	2771.73
16	2174.04	17	857.74	18	91.10
19	2613.00	20	2312.83	21	0.00
22	0.00	23	0.00	24	331717.38
25	230508.75	26	152655.94	27	149778.38
28	144886.92	29	111018.19	30	70983.38
31	113067.57	32	82314.81		

AT 180 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE
FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
2	2	3	325	2	1.7453	82.69	325.0
3	4	1	2577	2	21.0000	28.70	2577.0
5	4	2	2900	2	21.0000	28.70	2900.0
6	5	4	100	2	21.0000	28.53	100.0
7	6	5	2700	2	21.0000	23.88	2700.0
8	7	6	524	1	21.0000	3.99	524.0
9	7	6	1700	1	21.0000	3.99	1700.0
10	14	7	1650	1	21.0000	1.15	1650.0
11	14	31	4500	1	21.0000	1.15	4500.0
12	3	8	2700	2	1.7453	84.64	2700.0
13	8	19	2050	2	1.7453	91.11	2050.0
14	8	9	600	2	1.7453	91.11	600.0
15	9	10	600	2	1.7453	92.93	600.0
16	10	11	600	2	1.7453	95.03	600.0
17	10	11	1100	2	1.7453	95.03	1100.0
18	11	12	319	4	1.7453	107.11	319.0
19	12	13	600	4	1.7453	108.79	600.0
20	13	14	524	1	21.0000	0.00	524.0
21	15	13	550	3	2.5545	177.93	550.0
22	9	15	318	2	1.7453	92.93	318.0
23	16	15	600	1	2.6545	176.23	600.0
24	2	16	2600	2	1.7453	82.69	2600.0
25	17	16	1050	5	3.0103	177.09	770.4
26	18	17	228	3	5.5424	174.35	228.0
27	20	17	800	2	0.7426	116.93	800.0
28	20	18	1217	2	0.7426	116.93	1217.0
29	19	20	333	2	0.7426	114.50	333.0
35	4	24	2400	2	21.0000	28.70	2400.0
36	24	25	2600	2	21.0000	40.84	2600.0
37	24	27	3200	2	21.0000	40.84	3200.0
38	27	28	230	4	14.1881	110.66	230.0
39	28	31	2292	4	14.1881	112.73	2292.0
40	25	26	2000	2	21.0000	69.76	2000.0
41	26	30	1700	2	21.0000	92.00	1700.0
42	26	29	1050	2	21.0000	92.00	1050.0
43	2	27	1650	2	1.7453	82.69	1650.0
44	28	29	750	4	14.1881	112.73	750.0
45	29	30	300	1	15.1797	143.96	300.0
46	2	30	525	2	1.7453	82.69	525.0
47	30	31	297	5	12.7951	146.12	297.0
48	30	18	4100	5	12.7951	146.12	1987.3
50	32	1	30	5	15.1512	173.63	30.0
49	31	32	2031	4	15.1512	160.30	2031.0
51	32	1	100	5	15.1512	173.63	100.0

AIRWAY	WAVE 1 CONC %	WAVE 1 LOCATION FT	WAVE 1 START TIME	WAVE 1 ARRIVAL TIME	WAVE 2 CONC %	WAVE 2 LOCATION FT	WAVE 2 START TIME	WAVE 2 ARRIVAL TIME	WAVE 3 CONC %	WAVE 3 LOCATION FT	WAVE 3 START TIME	WAVE 3 ARRIVAL TIME
2	1.6267	325.0	65.94	67.89	1.7453	325.0	82.69	84.64				
3	19.5726	2577.0	11.94	31.47	21.0000	2577.0	28.70	48.23				
5	19.5726	2900.0	11.94	65.94	21.0000	2900.0	28.70	82.69				
6	19.5726	100.0	11.77	11.94	21.0000	100.0	28.53	28.70				
7	19.5726	2700.0	7.13	11.77	21.0000	2700.0	23.88	28.53				
8	21.0000	524.0	3.99	23.88								
9	21.0000	1700.0	3.99	7.13								
10	21.0000	1650.0	1.15	3.99								
11	21.0000	4500.0	1.15	45.61								
12	1.6267	2700.0	67.89	74.36	1.7453	2700.0	84.64	91.11				
13	1.6267	2050.0	74.36	97.75	1.7453	2050.0	91.11	114.50				
14	1.6267	600.0	74.36	76.18	1.7453	600.0	91.11	92.93				
15	1.6267	600.0	76.18	78.28	1.7453	600.0	92.93	95.03				
16	1.6267	600.0	78.28	90.36	1.7453	600.0	95.03	107.11				
17	1.6267	1100.0	78.28	82.94	1.7453	1100.0	95.03	99.69				
18	1.3441	319.0	82.94	84.61	1.6267	319.0	90.36	92.03	1.7247	319.0	99.69	101.36
19	1.3441	600.0	84.61	86.71	1.6267	600.0	92.03	94.13	1.7247	600.0	101.36	103.46
20	21.0000	524.0	0.00	1.15								
21	1.8544	550.0	159.38	160.77	1.8593	550.0	167.42	168.81	2.5545	550.0	177.93	179.32
22	1.6267	318.0	76.18	87.11	1.7453	318.0	92.93	103.87				
23	2.6545	600.0	176.23	177.93								
24	1.6267	2600.0	65.94	95.35	1.7453	2600.0	82.69	112.11				
25	1.8252	1050.0	145.00	148.96	1.9088	1050.0	153.72	157.68	1.9162	1050.0	161.75	165.72
26	3.2266	228.0	159.02	161.75	5.4320	228.0	169.53	172.27	5.5424	228.0	174.35	177.09
27	0.6922	800.0	100.18	105.91	0.7426	800.0	116.93	122.66				
28	0.6922	1217.0	100.18	118.51	0.7426	1217.0	116.93	135.27				
29	0.6922	333.0	97.75	100.18	0.7426	333.0	114.50	116.93				
35	19.5726	2400.0	11.94	24.08	21.0000	2400.0	28.70	40.84				
36	19.5726	2600.0	24.08	53.00	21.0000	2600.0	40.84	69.76				
37	19.5726	3200.0	24.08	53.78	21.0000	3200.0	40.84	70.53				
38	12.6482	230.0	53.78	55.84	13.5706	230.0	70.53	72.60	14.1461	230.0	93.90	95.97
39	12.6482	2292.0	55.84	103.42	13.5706	2292.0	72.60	120.17	14.1461	2292.0	95.97	143.54
40	19.5726	2000.0	53.00	75.25	21.0000	2000.0	69.76	92.00				
41	19.5726	1700.0	75.25	99.63	21.0000	1700.0	92.00	116.39				
42	19.5726	1050.0	75.25	127.21	21.0000	1050.0	92.00	143.96				
43	1.6267	1650.0	65.94	93.90	1.7453	1650.0	82.69	110.66				
44	12.6482	750.0	55.84	62.17	13.5706	750.0	72.60	78.92	14.1461	750.0	95.97	102.29
45	15.1797	300.0	143.96	146.12								
46	1.6267	525.0	65.94	72.36	1.7453	525.0	82.69	89.12				
47	10.9730	297.0	104.46	107.66	11.3158	297.0	116.39	119.59	11.3330	297.0	121.21	124.42
48	10.9730	4100.0	104.46	174.35	11.3158	3731.3	116.39	0.00	11.3330	3448.4	121.21	0.00
50	14.1843	30.0	137.74	139.24	15.0127	30.0	145.90	147.40	15.0855	30.0	156.87	158.37
49	15.0127	2031.0	132.57	145.90	15.0855	2031.0	143.54	156.87	15.1459	2031.0	149.33	162.66
51	14.1843	100.0	137.74	138.05	15.0127	100.0	145.90	146.20	15.0855	100.0	156.87	157.17

AIRWAY	WAVE 4 CONC %	WAVE 4 LOCATION FT	WAVE 4 START TIME	WAVE 4 ARRIVAL TIME	WAVE 5 CONC %	WAVE 5 LOCATION FT	WAVE 5 START TIME	WAVE 5 ARRIVAL TIME
18	1.7453	319.0	107.11	108.79				
19	1.7453	600.0	108.79	110.89				
25	2.9582	1050.0	172.27	176.23	3.0103	770.4	177.09	0.00
38	14.1881	230.0	110.66	112.73				
39	14.1881	2292.0	112.73	160.30				
44	14.1881	750.0	112.73	119.05				
47	12.6957	297.0	129.37	132.57	12.7951	297.0	146.12	149.33
48	12.6957	2970.0	129.37	0.00	12.7951	1987.3	146.12	0.00
50	15.1459	30.0	162.66	164.15	15.1512	30.0	173.63	175.12
49	15.1512	2031.0	160.30	173.63				
51	15.1459	100.0	162.66	162.96	15.1512	100.0	173.63	173.93

AT 180 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
2	1.7453	82.69
3	1.7453	84.64
4	21.0000	28.70
5	21.0000	28.53
6	21.0000	23.88
7	21.0000	3.99
8	1.7453	91.11
9	1.7453	92.93
10	1.7453	95.03
11	1.7453	107.11
12	1.7453	108.79
13	2.2156	179.32
14	21.0000	1.15
15	2.5545	177.93
16	2.6545	176.23
17	3.0103	177.09
18	5.5424	174.35
19	0.7426	114.50
20	0.7426	116.93
24	21.0000	40.84
25	21.0000	69.76
26	21.0000	92.00
27	14.1881	110.66
28	14.1881	112.73
29	15.1797	143.96
30	12.7951	146.12
31	15.1512	160.30
32	15.1512	173.63

AT 180 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	32847.38	3	32280.81
4	584207.63	5	584809.69	6	601066.44
7	616034.69	8	30398.04	9	29868.35
10	29257.82	11	27527.98	12	27041.08
13	20541.75	14	625969.31	15	16888.05
16	16428.53	17	15783.96	18	25852.22
19	10039.38	20	9739.21	21	0.00
22	0.00	23	0.00	24	541717.38
25	440508.72	26	362655.94	27	291659.19
28	286767.78	29	258564.30	30	196371.08
31	262216.09	32	228561.02		

AT 240 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
2	2	3	325	2	1.7453	82.69	325.0
3	4	1	2577	2	21.0000	28.70	2577.0
5	4	2	2900	2	21.0000	28.70	2900.0
6	5	4	100	2	21.0000	28.53	100.0
7	6	5	2700	2	21.0000	23.88	2700.0
8	7	6	524	1	21.0000	3.99	524.0
9	7	6	1700	1	21.0000	3.99	1700.0
10	14	7	1650	1	21.0000	1.15	1650.0
11	14	31	4500	1	21.0000	1.15	4500.0
12	3	8	2700	2	1.7453	84.64	2700.0
13	8	19	2050	2	1.7453	91.11	2050.0
14	8	9	600	2	1.7453	91.11	600.0
15	9	10	600	2	1.7453	92.93	600.0
16	10	11	600	2	1.7453	95.03	600.0
17	10	11	1100	2	1.7453	95.03	1100.0
18	11	12	319	4	1.7453	107.11	319.0
19	12	13	600	4	1.7453	108.79	600.0
20	13	14	524	1	21.0000	0.00	524.0
21	15	13	550	3	2.8587	224.42	550.0
22	9	15	318	2	1.7453	92.93	318.0
23	16	15	600	1	2.9963	222.72	600.0
24	2	16	2600	2	1.7453	82.69	2600.0
25	17	16	1050	4	3.4142	218.75	1050.0
26	18	17	228	2	6.3972	216.02	228.0
27	20	17	800	2	0.7426	116.93	800.0
28	20	18	1217	2	0.7426	116.93	1217.0
29	19	20	333	2	0.7426	114.50	333.0
35	4	24	2400	2	21.0000	28.70	2400.0
36	24	25	2600	2	21.0000	40.84	2600.0
37	24	27	3200	2	21.0000	40.84	3200.0
38	27	28	230	4	14.1881	110.66	230.0
39	28	31	2292	4	14.1881	112.73	2292.0
40	25	26	2000	2	21.0000	69.76	2000.0
41	26	30	1700	2	21.0000	92.00	1700.0
42	26	29	1050	2	21.0000	92.00	1050.0
43	2	27	1650	2	1.7453	82.69	1650.0
44	28	29	750	4	14.1881	112.73	750.0
45	29	30	300	1	15.1797	143.96	300.0
46	2	30	525	2	1.7453	82.69	525.0
47	30	31	297	5	12.7951	146.12	297.0
48	30	18	4100	5	12.7951	146.12	4100.0
50	32	1	30	5	15.1512	173.63	30.0
49	31	32	2031	4	15.1512	160.30	2031.0
51	32	1	100	5	15.1512	173.63	100.0

AIRWAY	WAVE 1 CONC %	WAVE 1 LOCATION FT	WAVE 1 START TIME	WAVE 1 ARRIVAL TIME	WAVE 2 CONC %	WAVE 2 LOCATION FT	WAVE 2 START TIME	WAVE 2 ARRIVAL TIME	WAVE 3 CONC %	WAVE 3 LOCATION FT	WAVE 3 START TIME	WAVE 3 ARRIVAL TIME
2	1.6267	325.0	65.94	67.89	1.7453	325.0	82.69	84.64				
3	19.5726	2577.0	11.94	31.47	21.0000	2577.0	28.70	48.23				
5	19.5726	2900.0	11.94	65.94	21.0000	2900.0	28.70	82.69				
6	19.5726	100.0	11.77	11.94	21.0000	100.0	28.53	28.70				
7	19.5726	2700.0	7.13	11.77	21.0000	2700.0	23.88	28.53				
8	21.0000	524.0	3.99	23.88								
9	21.0000	1700.0	3.99	7.13								
10	21.0000	1650.0	1.15	3.99								
11	21.0000	4500.0	1.15	45.61								
12	1.6267	2700.0	67.89	74.36	1.7453	2700.0	84.64	91.11				
13	1.6267	2050.0	74.36	97.75	1.7453	2050.0	91.11	114.50				
14	1.6267	600.0	74.36	76.18	1.7453	600.0	91.11	92.93				
15	1.6267	600.0	76.18	78.28	1.7453	600.0	92.93	95.03				
16	1.6267	600.0	78.28	90.36	1.7453	600.0	95.03	107.11				
17	1.6267	1100.0	78.28	82.94	1.7453	1100.0	95.03	99.69				
18	1.3441	319.0	82.94	84.61	1.6267	319.0	90.36	92.03	1.7247	319.0	99.69	101.36
19	1.3441	600.0	84.61	86.71	1.6267	600.0	92.03	94.13	1.7247	600.0	101.36	103.46
20	21.0000	524.0	0.00	1.15								
21	2.6425	550.0	199.51	200.90	2.8440	550.0	207.67	209.05	2.8587	550.0	224.42	225.81
22	1.6267	318.0	76.18	87.11	1.7453	318.0	92.93	103.87				
23	2.9963	600.0	222.72	224.42								
24	1.6267	2600.0	65.94	95.35	1.7453	2600.0	82.69	112.11				
25	3.0863	1050.0	189.02	192.99	3.0901	1050.0	193.84	197.81	3.3922	1050.0	202.00	205.97
26	6.3506	228.0	199.26	202.00	6.3972	228.0	216.02	218.75				
27	0.6922	800.0	100.18	105.91	0.7426	800.0	116.93	122.66				
28	0.6922	1217.0	100.18	118.51	0.7426	1217.0	116.93	135.27				
29	0.6922	333.0	97.75	100.18	0.7426	333.0	114.50	116.93				
35	19.5726	2400.0	11.94	24.08	21.0000	2400.0	28.70	40.84				
36	19.5726	2600.0	24.08	53.00	21.0000	2600.0	40.84	69.76				
37	19.5726	3200.0	24.08	53.78	21.0000	3200.0	40.84	70.53				
38	12.6482	230.0	53.78	55.84	13.5706	230.0	70.53	72.60	14.1461	230.0	93.90	95.97
39	12.6482	2292.0	55.84	103.42	13.5706	2292.0	72.60	120.17	14.1461	2292.0	95.97	143.54
40	19.5726	2000.0	53.00	75.25	21.0000	2000.0	69.76	92.00				
41	19.5726	1700.0	75.25	99.63	21.0000	1700.0	92.00	116.39				
42	19.5726	1050.0	75.25	127.21	21.0000	1050.0	92.00	143.96				
43	1.6267	1650.0	65.94	93.90	1.7453	1650.0	82.69	110.66				
44	12.6482	750.0	55.84	62.17	13.5706	750.0	72.60	78.92	14.1461	750.0	95.97	102.29
45	15.1797	300.0	143.96	146.12								
46	1.6267	525.0	65.94	72.36	1.7453	525.0	82.69	89.12				
47	10.9730	297.0	104.46	107.66	11.3158	297.0	116.39	119.59	11.3330	297.0	121.21	124.42
48	10.9730	4100.0	104.46	174.35	11.3158	4100.0	116.39	186.29	11.3330	4100.0	121.21	191.11
50	14.1843	30.0	137.74	139.24	15.0127	30.0	145.90	147.40	15.0855	30.0	156.87	158.37
49	15.0127	2031.0	132.57	145.90	15.0855	2031.0	143.54	156.87	15.1459	2031.0	149.33	162.66
51	14.1843	100.0	137.74	138.05	15.0127	100.0	145.90	146.20	15.0855	100.0	156.87	157.17

AIRWAY	WAVE 4 CONC %	WAVE 4 LOCATION FT	WAVE 4 START TIME	WAVE 4 ARRIVAL TIME	WAVE 5 CONC %	WAVE 5 LOCATION FT	WAVE 5 START TIME	WAVE 5 ARRIVAL TIME
18	1.7453	319.0	107.11	108.79				
19	1.7453	600.0	108.79	110.89				
25	3.4142	1050.0	218.75	222.72				
38	14.1881	230.0	110.66	112.73				
39	14.1881	2292.0	112.73	160.30				
44	14.1881	750.0	112.73	119.05				
47	12.6957	297.0	129.37	132.57	12.7951	297.0	146.12	149.33
48	12.6957	4100.0	129.37	199.26	12.7951	4100.0	146.12	216.02
50	15.1459	30.0	162.66	164.15	15.1512	30.0	173.63	175.12
49	15.1512	2031.0	160.30	173.63				
51	15.1459	100.0	162.66	162.96	15.1512	100.0	173.63	173.93

AT 240 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE
FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
2	1.7453	82.69
3	1.7453	84.64
4	21.0000	28.70
5	21.0000	28.53
6	21.0000	23.88
7	21.0000	3.99
8	1.7453	91.11
9	1.7453	92.93
10	1.7453	95.03
11	1.7453	107.11
12	1.7453	108.79
13	2.3924	225.81
14	21.0000	1.15
15	2.8587	224.42
16	2.9963	222.72
17	3.4142	218.75
18	6.3972	216.02
19	0.7426	114.50
20	0.7426	116.93
24	21.0000	40.84
25	21.0000	69.76
26	21.0000	92.00
27	14.1881	110.66
28	14.1881	112.73
29	15.1797	143.96
30	12.7951	146.12
31	15.1512	160.30
32	15.1512	173.63

AT 240 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO
THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	50300.42	3	49733.85
4	794207.63	5	794809.69	6	811066.38
7	826034.63	8	47851.08	9	47321.40
10	46710.87	11	44981.03	12	44494.12
13	43735.12	14	835969.25	15	44288.78
16	45155.75	17	48553.21	18	87308.57
19	17465.75	20	17165.59	21	0.00
22	0.00	23	0.00	24	751717.31
25	650508.75	26	572655.94	27	433540.09
28	428648.63	29	410361.78	30	324322.25
31	413727.88	32	380072.84		

AT 300 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE FOLLOWING AIRWAYS

AIRWAY NUMBER	FROM	TO	LENGTH FT	WAVE NUMBER	CONC %	START TIME	LENGTH FT
2	2	3	325	2	1.7453	82.69	325.0
3	4	1	2577	2	21.0000	28.70	2577.0
5	4	2	2900	2	21.0000	28.70	2900.0
6	5	4	100	2	21.0000	28.53	100.0
7	6	5	2700	2	21.0000	23.88	2700.0
8	7	6	524	1	21.0000	3.99	524.0
9	7	6	1700	1	21.0000	3.99	1700.0
10	14	7	1650	1	21.0000	1.15	1650.0
11	14	31	4500	1	21.0000	1.15	4500.0
12	3	8	2700	2	1.7453	84.64	2700.0
13	8	19	2050	2	1.7453	91.11	2050.0
14	8	9	600	2	1.7453	91.11	600.0
15	9	10	600	2	1.7453	92.93	600.0
16	10	11	600	2	1.7453	95.03	600.0
17	10	11	1100	2	1.7453	95.03	1100.0
18	11	12	319	4	1.7453	107.11	319.0
19	12	13	600	4	1.7453	108.79	600.0
20	13	14	524	1	21.0000	0.00	524.0
21	15	13	550	3	2.8587	224.42	550.0
22	9	15	318	2	1.7453	92.93	318.0
23	16	15	600	1	2.9963	222.72	600.0
24	2	16	2600	2	1.7453	82.69	2600.0
25	17	16	1050	4	3.4142	218.75	1050.0
26	18	17	228	2	6.3972	216.02	228.0
27	20	17	800	2	0.7426	116.93	800.0
28	20	18	1217	2	0.7426	116.93	1217.0
29	19	20	333	2	0.7426	114.50	333.0
35	4	24	2400	2	21.0000	28.70	2400.0
36	24	25	2600	2	21.0000	40.84	2600.0
37	24	27	3200	2	21.0000	40.84	3200.0
38	27	28	230	4	14.1881	110.66	230.0
39	28	31	2292	4	14.1881	112.73	2292.0
40	25	26	2000	2	21.0000	69.76	2000.0
41	26	30	1700	2	21.0000	92.00	1700.0
42	26	29	1050	2	21.0000	92.00	1050.0
43	2	27	1650	2	1.7453	82.69	1650.0
44	28	29	750	4	14.1881	112.73	750.0
45	29	30	300	1	15.1797	143.96	300.0
46	2	30	525	2	1.7453	82.69	525.0
47	30	31	297	5	12.7951	146.12	297.0
48	30	18	4100	5	12.7951	146.12	4100.0
50	32	1	30	5	15.1512	173.63	30.0
49	31	32	2031	4	15.1512	160.30	2031.0
51	32	1	100	5	15.1512	173.63	100.0

AIRWAY	WAVE 1 CONC %	LOCATION FT	START TIME	ARRIVAL TIME	WAVE 2 CONC %	LOCATION FT	START TIME	ARRIVAL TIME	WAVE 3 CONC %	LOCATION FT	START TIME	ARRIVAL TIME
2	1.6267	325.0	65.94	67.89	1.7453	325.0	82.69	84.64				
3	19.5726	2577.0	11.94	31.47	21.0000	2577.0	28.70	48.23				
5	19.5726	2900.0	11.94	65.94	21.0000	2900.0	28.70	82.69				
6	19.5726	100.0	11.77	11.94	21.0000	100.0	28.53	28.70				
7	19.5726	2700.0	7.13	11.77	21.0000	2700.0	23.88	28.53				
8	21.0000	524.0	3.99	23.88								
9	21.0000	1700.0	3.99	7.13								
10	21.0000	1650.0	1.15	3.99								
11	21.0000	4500.0	1.15	45.61								
12	1.6267	2700.0	67.89	74.36	1.7453	2700.0	84.64	91.11				
13	1.6267	2050.0	74.36	97.75	1.7453	2050.0	91.11	114.50				
14	1.6267	600.0	74.36	76.18	1.7453	600.0	91.11	92.93				
15	1.6267	600.0	76.18	78.28	1.7453	600.0	92.93	95.03				
16	1.6267	600.0	78.28	90.36	1.7453	600.0	95.03	107.11				
17	1.6267	1100.0	78.28	82.94	1.7453	1100.0	95.03	99.69				
18	1.3441	319.0	82.94	84.61	1.6267	319.0	90.36	92.03	1.7247	319.0	99.69	101.36
19	1.3441	600.0	84.61	86.71	1.6267	600.0	92.03	94.13	1.7247	600.0	101.36	103.46
20	21.0000	524.0	0.00	1.15								
21	2.6425	550.0	199.51	200.90	2.8440	550.0	207.67	209.05	2.8587	550.0	224.42	225.81
22	1.6267	318.0	76.18	87.11	1.7453	318.0	92.93	103.87				
23	2.9963	600.0	222.72	224.42								
24	1.6267	2600.0	65.94	95.35	1.7453	2600.0	82.69	112.11				
25	3.0863	1050.0	189.02	192.99	3.0901	1050.0	193.84	197.81	3.3922	1050.0	202.00	205.97
26	6.3506	228.0	199.26	202.00	6.3972	228.0	216.02	218.75				
27	0.6922	800.0	100.18	105.91	0.7426	800.0	116.93	122.66				
28	0.6922	1217.0	100.18	118.51	0.7426	1217.0	116.93	135.27				
29	0.6922	333.0	97.75	100.18	0.7426	333.0	114.50	116.93				
35	19.5726	2400.0	11.94	24.08	21.0000	2400.0	28.70	40.84				
36	19.5726	2600.0	24.08	53.00	21.0000	2600.0	40.84	69.76				
37	19.5726	3200.0	24.08	53.78	21.0000	3200.0	40.84	70.53				
38	12.6482	230.0	53.78	55.84	13.5706	230.0	70.53	72.60	14.1461	230.0	93.90	95.97
39	12.6482	2292.0	55.84	103.42	13.5706	2292.0	72.60	120.17	14.1461	2292.0	95.97	143.54
40	19.5726	2000.0	53.00	75.25	21.0000	2000.0	69.76	92.00				
41	19.5726	1700.0	75.25	99.63	21.0000	1700.0	92.00	116.39				
42	19.5726	1050.0	75.25	127.21	21.0000	1050.0	92.00	143.96				
43	1.6267	1650.0	65.94	93.90	1.7453	1650.0	82.69	110.66				
44	12.6482	750.0	55.84	62.17	13.5706	750.0	72.60	78.92	14.1461	750.0	95.97	102.29
45	15.1797	300.0	143.96	146.12								
46	1.6267	525.0	65.94	72.36	1.7453	525.0	82.69	89.12				
47	10.9730	297.0	104.46	107.66	11.3158	297.0	116.39	119.59	11.3330	297.0	121.21	124.42
48	10.9730	4100.0	104.46	174.35	11.3158	4100.0	116.39	186.29	11.3330	4100.0	121.21	191.11
50	14.1843	30.0	137.74	139.24	15.0127	30.0	145.90	147.40	15.0855	30.0	156.87	158.37
49	15.0127	2031.0	132.57	145.90	15.0855	2031.0	143.54	156.87	15.1459	2031.0	149.33	162.66
51	14.1843	100.0	137.74	138.05	15.0127	100.0	145.90	146.20	15.0855	100.0	156.87	157.17

AIRWAY	WAVE 4 CONC %	LOCATION FT	START TIME	ARRIVAL TIME	WAVE 5 CONC %	LOCATION FT	START TIME	ARRIVAL TIME
18	1.7453	319.0	107.11	108.79				
19	1.7453	600.0	108.79	110.89				
25	3.4142	1050.0	218.75	222.72				
38	14.1881	230.0	110.66	112.73				
39	14.1881	2292.0	112.73	160.30				
44	14.1881	750.0	112.73	119.05				
47	12.6957	297.0	129.37	132.57	12.7951	297.0	146.12	149.33
48	12.6957	4100.0	129.37	199.26	12.7951	4100.0	146.12	216.02
50	15.1459	30.0	162.66	164.15	15.1512	30.0	173.63	175.12
49	15.1512	2031.0	160.30	173.63				
51	15.1459	100.0	162.66	162.96	15.1512	100.0	173.63	173.93

AT 300 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
2	1.7453	82.69
3	1.7453	84.64
4	21.0000	28.70
5	21.0000	28.53
6	21.0000	23.88
7	21.0000	3.99
8	1.7453	91.11
9	1.7453	92.93
10	1.7453	95.03
11	1.7453	107.11
12	1.7453	108.79
13	2.3924	225.81
14	21.0000	1.15
15	2.8587	224.42
16	2.9963	222.72
17	3.4142	218.75
18	6.3972	216.02
19	0.7426	114.50
20	0.7426	116.93
24	21.0000	40.84
25	21.0000	69.76
26	21.0000	92.00
27	14.1881	110.66
28	14.1881	112.73
29	15.1797	143.96
30	12.7951	146.12
31	15.1512	160.30
32	15.1512	173.63

AT 300 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	67753.47	3	67186.89
4	1004207.56	5	1004809.63	6	1021066.31
7	1036034.75	8	65304.12	9	64774.44
10	64163.91	11	62434.07	12	61947.17
13	67658.85	14	1045969.31	15	72875.94
16	75119.23	17	82695.36	18	151281.02
19	24892.13	20	24591.96	21	0.00
22	0.00	23	0.00	24	961717.25
25	860508.69	26	782655.94	27	575420.88
28	570529.50	29	562159.25	30	452273.47
31	565239.69	32	531584.69		

AT 360 MIN. AFTER THE START OF CONTAMINATION CRITICAL
FUME CONCENTRATIONS (FUMES > 0.0010 %) NOW EXIST IN THE
FOLLOWING AIRWAYS

AIRWAY				WAVE			
NUMBER	FROM	TO	LENGTH FT	NUMBER	CONC %	START TIME	LENGTH FT
2	2	3	325	2	1.7453	82.69	325.0
3	4	1	2577	2	21.0000	28.70	2577.0
5	4	2	2900	2	21.0000	28.70	2900.0
6	5	4	100	2	21.0000	28.53	100.0
7	6	5	2700	2	21.0000	23.88	2700.0
8	7	6	524	1	21.0000	3.99	524.0
9	7	6	1700	1	21.0000	3.99	1700.0
10	14	7	1650	1	21.0000	1.15	1650.0
11	14	31	4500	1	21.0000	1.15	4500.0
12	3	8	2700	2	1.7453	84.64	2700.0
13	8	19	2050	2	1.7453	91.11	2050.0
14	8	9	600	2	1.7453	91.11	600.0
15	9	10	600	2	1.7453	92.93	600.0
16	10	11	600	2	1.7453	95.03	600.0
17	10	11	1100	2	1.7453	95.03	1100.0
18	11	12	319	4	1.7453	107.11	319.0
19	12	13	600	4	1.7453	108.79	600.0
20	13	14	524	1	21.0000	0.00	524.0
21	15	13	550	3	2.8587	224.42	550.0
22	9	15	318	2	1.7453	92.93	318.0
23	16	15	600	1	2.9963	222.72	600.0
24	2	16	2600	2	1.7453	82.69	2600.0
25	17	16	1050	4	3.4142	218.75	1050.0
26	18	17	228	2	6.3972	216.02	228.0
27	20	17	800	2	0.7426	116.93	800.0
28	20	18	1217	2	0.7426	116.93	1217.0
29	19	20	333	2	0.7426	114.50	333.0
35	4	24	2400	2	21.0000	28.70	2400.0
36	24	25	2600	2	21.0000	40.84	2600.0
37	24	27	3200	2	21.0000	40.84	3200.0
38	27	28	230	4	14.1881	110.66	230.0
39	28	31	2292	4	14.1881	112.73	2292.0
40	25	26	2000	2	21.0000	69.76	2000.0
41	26	30	1700	2	21.0000	92.00	1700.0
42	26	29	1050	2	21.0000	92.00	1050.0
43	2	27	1650	2	1.7453	82.69	1650.0
44	28	29	750	4	14.1881	112.73	750.0
45	29	30	300	1	15.1797	143.96	300.0
46	2	30	525	2	1.7453	82.69	525.0
47	30	31	297	5	12.7951	146.12	297.0
48	30	18	4100	5	12.7951	146.12	4100.0
50	32	1	30	5	15.1512	173.63	30.0
49	31	32	2031	4	15.1512	160.30	2031.0
51	32	1	100	5	15.1512	173.63	100.0

	WAVE 1				WAVE 2				WAVE 3			
AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
2	1.6267	325.0	65.94	67.89	1.7453	325.0	82.69	84.64				
3	19.5726	2577.0	11.94	31.47	21.0000	2577.0	28.70	48.23				
5	19.5726	2900.0	11.94	65.94	21.0000	2900.0	28.70	82.69				
6	19.5726	100.0	11.77	11.94	21.0000	100.0	28.53	28.70				
7	19.5726	2700.0	7.13	11.77	21.0000	2700.0	23.88	28.53				
8	21.0000	524.0	3.99	23.88								
9	21.0000	1700.0	3.99	7.13								
10	21.0000	1650.0	1.15	3.99								
11	21.0000	4500.0	1.15	45.61								
12	1.6267	2700.0	67.89	74.36	1.7453	2700.0	84.64	91.11				
13	1.6267	2050.0	74.36	97.75	1.7453	2050.0	91.11	114.50				
14	1.6267	600.0	74.36	76.18	1.7453	600.0	91.11	92.93				
15	1.6267	600.0	76.18	78.28	1.7453	600.0	92.93	95.03				
16	1.6267	600.0	78.28	90.36	1.7453	600.0	95.03	107.11				
17	1.6267	1100.0	78.28	82.94	1.7453	1100.0	95.03	99.69				
18	1.3441	319.0	82.94	84.61	1.6267	319.0	90.36	92.03	1.7247	319.0	99.69	101.36
19	1.3441	600.0	84.61	86.71	1.6267	600.0	92.03	94.13	1.7247	600.0	101.36	103.46
20	21.0000	524.0	0.00	1.15								
21	2.6425	550.0	199.51	200.90	2.8440	550.0	207.67	209.05	2.8587	550.0	224.42	225.81
22	1.6267	318.0	76.18	87.11	1.7453	318.0	92.93	103.87				
23	2.9963	600.0	222.72	224.42								
24	1.6267	2600.0	65.94	95.35	1.7453	2600.0	82.69	112.11				
25	3.0863	1050.0	189.02	192.99	3.0901	1050.0	193.84	197.81	3.3922	1050.0	202.00	205.97
26	6.3506	228.0	199.26	202.00	6.3972	228.0	216.02	218.75				
27	0.6922	800.0	100.18	105.91	0.7426	800.0	116.93	122.66				
28	0.6922	1217.0	100.18	118.51	0.7426	1217.0	116.93	135.27				
29	0.6922	333.0	97.75	100.18	0.7426	333.0	114.50	116.93				
35	19.5726	2400.0	11.94	24.08	21.0000	2400.0	28.70	40.84				
36	19.5726	2600.0	24.08	53.00	21.0000	2600.0	40.84	69.76				
37	19.5726	3200.0	24.08	53.78	21.0000	3200.0	40.84	70.53				
38	12.6482	230.0	53.78	55.84	13.5706	230.0	70.53	72.60	14.1461	230.0	93.90	95.97
39	12.6482	2292.0	55.84	103.42	13.5706	2292.0	72.60	120.17	14.1461	2292.0	95.97	143.54
40	19.5726	2000.0	53.00	75.25	21.0000	2000.0	69.76	92.00				
41	19.5726	1700.0	75.25	99.63	21.0000	1700.0	92.00	116.39				
42	19.5726	1050.0	75.25	127.21	21.0000	1050.0	92.00	143.96				
43	1.6267	1650.0	65.94	93.90	1.7453	1650.0	82.69	110.66				
44	12.6482	750.0	55.84	62.17	13.5706	750.0	72.60	78.92	14.1461	750.0	95.97	102.29
45	15.1797	300.0	143.96	146.12								
46	1.6267	525.0	65.94	72.36	1.7453	525.0	82.69	89.12				
47	10.9730	297.0	104.46	107.66	11.3158	297.0	116.39	119.59	11.3330	297.0	121.21	124.42
48	10.9730	4100.0	104.46	174.35	11.3158	4100.0	116.39	186.29	11.3330	4100.0	121.21	191.11
50	14.1843	30.0	137.74	139.24	15.0127	30.0	145.90	147.40	15.0855	30.0	156.87	158.37
49	15.0127	2031.0	132.57	145.90	15.0855	2031.0	143.54	156.87	15.1459	2031.0	149.33	162.66
51	14.1843	100.0	137.74	138.05	15.0127	100.0	145.90	146.20	15.0855	100.0	156.87	157.17

	WAVE 4				WAVE 5			
AIRWAY	CONC %	LOCATION FT	START TIME	ARRIVAL TIME	CONC %	LOCATION FT	START TIME	ARRIVAL TIME
18	1.7453	319.0	107.11	108.79				
19	1.7453	600.0	108.79	110.89				
25	3.4142	1050.0	218.75	222.72				
38	14.1881	230.0	110.66	112.73				
39	14.1881	2292.0	112.73	160.30				
44	14.1881	750.0	112.73	119.05				
47	12.6957	297.0	129.37	132.57	12.7951	297.0	146.12	149.33
48	12.6957	4100.0	129.37	199.26	12.7951	4100.0	146.12	216.02
50	15.1459	30.0	162.66	164.15	15.1512	30.0	173.63	175.12
49	15.1512	2031.0	160.30	173.63				
51	15.1459	100.0	162.66	162.96	15.1512	100.0	173.63	173.93

AT 360 MIN. AFTER THE START OF CONTAMINATION CRITICAL FUME CONCENTRATIONS (FUMES > 0.001) % NOW EXIST IN THE FOLLOWING JUNCTIONS

JUNCTION	CURRENT FUME CONCENTRATION	TIME OF FIRST CONTAMINATION
2	1.7453	82.69
3	1.7453	84.64
4	21.0000	28.70
5	21.0000	28.53
6	21.0000	23.88
7	21.0000	3.99
8	1.7453	91.11
9	1.7453	92.93
10	1.7453	95.03
11	1.7453	107.11
12	1.7453	108.79
13	2.3924	225.81
14	21.0000	1.15
15	2.8587	224.42
16	2.9963	222.72
17	3.4142	218.75
18	6.3972	216.02
19	0.7426	114.50
20	0.7426	116.93
24	21.0000	40.84
25	21.0000	69.76
26	21.0000	92.00
27	14.1881	110.66
28	14.1881	112.73
29	15.1797	143.96
30	12.7951	146.12
31	15.1512	160.30
32	15.1512	173.63

AT 360 MIN. AFTER THE START OF CONTAMINATION THE TOTAL EXPOSURE TO THE CONTAMINANT MEASURED IN PPM*HOURS WAS IN THE FOLLOWING JUNCTIONS

JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE	JUNCTION	TOTAL EXPOSURE
1	0.00	2	85206.52	3	84639.94
4	1214207.50	5	1214809.75	6	1231066.25
7	1246034.63	8	82757.16	9	82227.48
10	81616.95	11	79887.11	12	79400.20
13	91582.59	14	1255969.38	15	101463.10
16	105082.70	17	116837.52	18	215253.45
19	32318.50	20	32018.34	21	0.00
22	0.00	23	0.00	24	1171717.25
25	1070508.75	26	992655.88	27	717301.69
28	712410.31	29	713956.75	30	580224.63
31	716751.50	32	683096.44		

END OF RUN

☆U.S. GOVERNMENT PRINTING OFFICE: 1982 - 605 - 015/109 INT.-BU.OF MINES,PGH.,PA. 26455

50272-101

PB83-178830

REPORT DOCUMENTATION PAGE

1. Report No. BuMines IC 8901

2.

4. Title and Subtitle
Real-Time Calculation of Product of Combustion Spread in a Multilevel Mine

5. Report Date January 1983

6.

7. Author(s)
John C. Edwards and Rudolf E. Greuer

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
Assistant Director, Division of Mining Research
Bureau of Mines
U.S. Department of the Interior
Washington, D. C. 20241

13. Type of Report & Period Covered
Information Circular

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

A computer program, developed for the Bureau of Mines under contract, predicts in a quasi-steady-state approximation the ventilation and contaminant concentrations and temperatures when a fire occurs in a multilevel mine. For periods of time in which there is no significant change in the ventilation, yet a fire is producing fumes, a real-time fume concentration throughout the mine is calculated. Multiple and time-variable contaminant sources can be simulated. Recirculation paths that can develop provide a mechanism for increasing the fume concentration in the mine network and are identified by the computer program. This report contains a listing of the Fortran computer program as well as the required format of the input data. Two examples are provided of the real-time spread of smoke from a fuel-rich fire throughout a multilevel mine. The first example considers an operational exhaust fan as well as a booster fan. The second example evaluates the real-time smoke spread following a failure in the exhaust fan; recirculation occurs in this latter case.

17. Document Analysis a. Descriptors
Mine Ventilation
Computerized Simulation

b. Identifiers/Open-Ended Terms
Ventilation
Mathematical Model

c. COSATI Field/Group 08 09 Mining Engineering; 13 01 Ventilation

18. Availability Statement
Release to the Public

19. Security Class (This Report) Unclassified

20. Security Class (This Page)

21. No. of Pages [illegible]

22. Price

(See ANSI–Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4–77) (Formerly NTIS–35) Department of Commerce