NASA CR-132470

Aerotherm Project 6259

November 1973

(NASA-CR-132470) USER'S MANUAL FOR RAD/EQUIL/1973: A GENERAL PURPOSE RADIATION TRANSPORT PROGRAM (Aerotherm Corp.) 204 p HC $5.75 CSCL 20M

N74-34403

Unclas

G3/33 50161

Aerotherm Report
UM-73-43

USER'S MANUAL FOR RAD/EQUIL/1973, A GENERAL PURPOSE RADIATION TRANSPORT PROGRAM

by

W. E. Nicolet

Prepared for

National Aeronautics and Space Administration

Contract NAS1-12,160

Technical Management
NASA Langley Research Center
Hampton, Virginia
Hypersonic Vehicles Division
Jerald Walberg
Kenneth Sutton

OCT 197 RECEIVED NASA STI FACILITY

AEROTHERM
ACUREX Corporation

FOREWORD

The present report describes extensions to and generalizations of a radiation transport calculation procedure developed over a period of several years at first the Aerotherm Corporation, then the Aerotherm Division of the Acurex Corporation, Mountain View, California. The initial effort was done under Contract N :9-6719 for the NASA Manned Spacecraft Center, Structures and Mechanics Division. This effort included the development of the basic radiation properties and transport models. A subsequent effort was performed under Contract NAS1-9399 for Langley Research Center, Applied Material and Physics Division. On this effort, an equilibrium chemistry capability was incorporated into the procedure. The present effort was performed under Contract1-12160 for the Langley Research Center, Hypersonic Vehicles Division. On this effort the radiation transport procedure was generalized to allow the equivalent width approximation, and molecular species properties associated with the Teflon and Silicon systems were added to the radiation model and the manner in which the far wings of the hydrogen lines are calculated was modified.

ABSTRACT

A procedure is described for implementing the RAD/EQUIL/1973 program, a general purpose radiation transport calculation procedure. Instructions are given which allow the program input to be prepared, the output to be interpreted, the operating procedures identified which must be followed and the meaning of the error messages to be understood. The structure of the program is described through a verbal description, a Fortran variables list and a listing of the program.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

USER'S MANUAL FOR RAD/EQUIL/1973

A GENERAL PURPOSE RADIATION TRANSPORT PROGRAM

by

W. E. Nicolet

SECTION 1

INTRODUCTION

This report describes the RAD/EQUIL/1973 computer program which can be viewed as a modified and generalized version of the Aerotherm developed RAD/EQUIL program which has been described elsewhere (References 1 and 2). The novel features of the RAD/EQUIL/1973 include (1) the capability to solve the transport equation by means of the (very rapid) equivalent width method as described in Reference 3; (2) the consideration of the far wings of hydrogen lines as part of the continuum transport events, which allows accurate calculations for elemental systems dominated by hydrogen; (3) the generalization of the code to allow many of the radiation properties to be specified by card input; and (4) the provision for efficient flow field coupling.

A general elemental system is allowed, although certain constraints must be satisfied (see Section 2). As of this writing, solutions have been obtained for various combinations of the C-H-O-N-He-Si system which is representative of shock layers adjacent to many ablating bodies. Local thermodynamic equilibrium is assumed to exist at all times. Molecular, atomic and ionic species are all considered with those which appear in the 3000°K to 15,000°K temperature range and 0.1 to 10 atmospheres pressure range being given primary consideration. A description of the properties model was given in Reference 1 and updated in Reference 3.

The RAD/EQUIL/1973 code requires as input information sufficient information to describe the spatial distribution of the thermodynamic state. This information can be obtained in a variety of forms, e.g., pressure, temperature, concentrations of base species (or elements), or enthalpy can replace temperature, or shock wave conditions can be specified. From these data it calculates the intensities along a ray; or if the gas is confined in a plane - parallel slab, it can calculate radiant fluxes directly. If the radiation is to be observed behind a window, frequency dependent transmission factors are included which can be used to simulate its transmittance. The wall radiation can also be included and allowed to interact with the gases.

The following seven sections describe the operating aspects of the code in terms of INPUT, OUTPUT, SAMPLE CASES, OPERATING PROCEDURES, ERROR MESSAGES, CODE STRUCTURE and FORTRAN VARIABLES LIST. A listing is presented in the appendix.

SECTION 2

INPUT

The program uses punched cards as the input media. Two data decks are required, A and B. Deck A contains basic radiation and spectroscopic data, e.g., f-numbers, line widths and centers, definition of line groups, energies and statistical weights of levels, etc. Deck A is not changed unless changes to the basic radiation model are to be performed; consequently, it is often referred to as permanent data. Deck B contains case data such as path length, temperatures, pressures, etc.

Figure 2-1 shows a typical data deck setup. Permanent data is always read in first, followed by case data. The first set of case data must be complete; that is, it must include a setup of the spatial nodes and the boundary conditions. The following cases can be read, in abbreviated form. Each case starts with a control card (KR, title) and ends with a C4 card. Successive cases are read in and run until a 1 appears on the C4 card. This terminates the run. A complete description of the two data decks is given in Table 2-1.

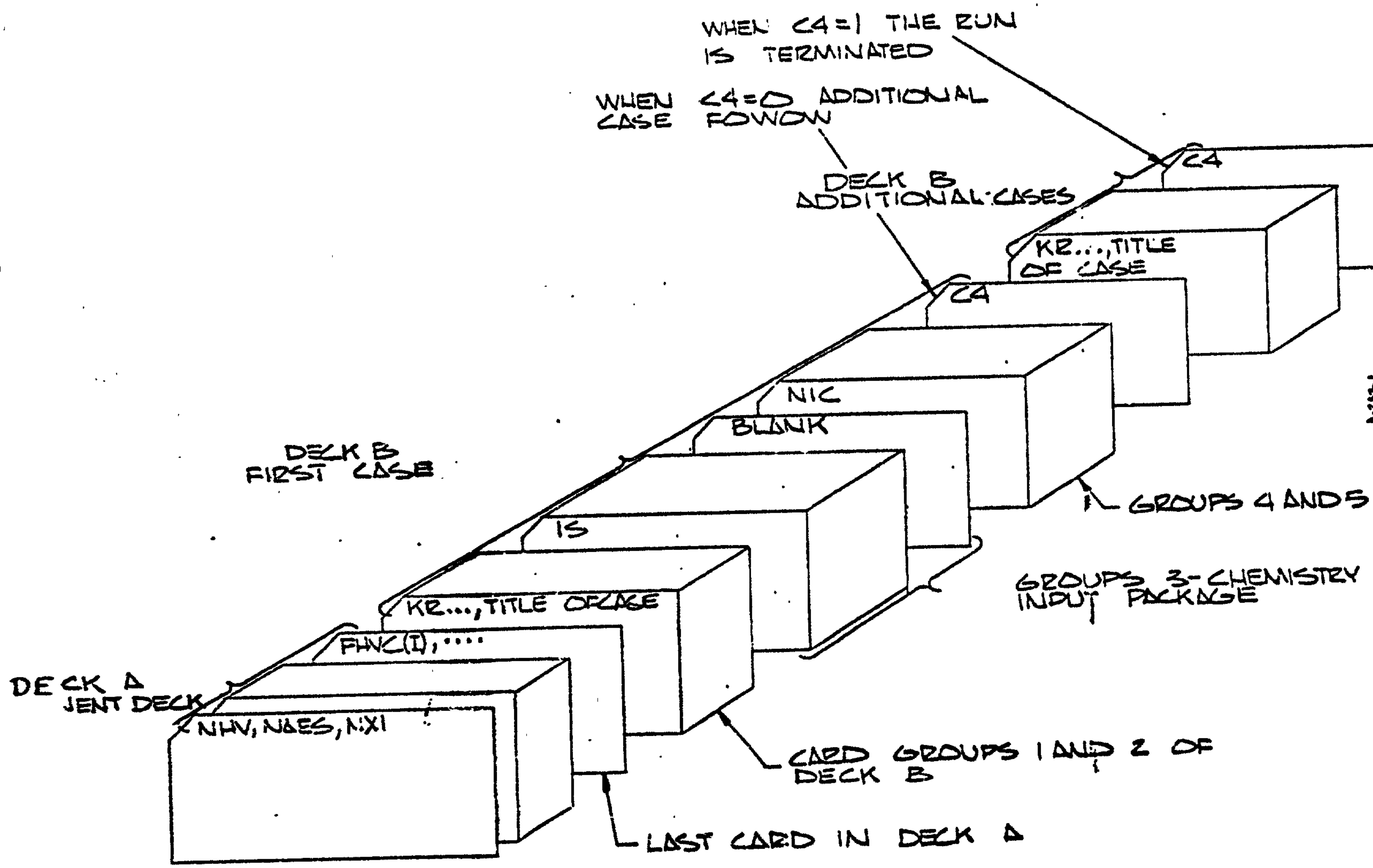


FIGURE 2.1 — DATA DECK SETUP

TABLE 2.1

INPUT CARDS

DECK A - PERMANENT DATA

Group 1 - Basic Radiation Data

Card 1, Format (I2, 2X, I2, 2X, I2, 2X, I2)

Field 1, (Columns 1 - 2), NHV

This is the number of line groups to be included in the calculation (maximum of 25). A discussion of the judgements involved in selecting the appropriate number of line groups is given in the discussion of the FHVM and FHVP values.

Field 2, (Columns 5 - 6), NXI

This is the number of special hydrogen lines for which no (half) half width data is read in. When the hydrogen lines are to be included, NXI = 4. Otherwise, it equals zero. The four lines given special treatment are the Lyman α and β and the Balmer α and β. Half width information is read in for each of the remaining hydrogen lines.

Field 3, (Columns 9 - 10), IZZ

This is flag which determines how the far wings of the special hydrogen lines are handled. If IZZ = 0, the far wing contributions are added into the next lower lying line group. If IZZ = 1, they are added into the continuum.

Field 4, (Columns 13 - 14), NOUT

This variable determines if Deck A is to be read in. If NOUT equals zero, Deck A is read in. If NOUT is greater than zero, the remainder of Deck A is not read in.

Group 2 - Atomic, Statistical and Continuum Radiation Data

A sequence of cards is to be used to describe the atomic energy levels, degeneracies and continuum radiation provided for each of the radiating species. The input is grouped by families where a family is made up of species having the same atomic number but different atomic charge. For each family, the first set of data is input for the most highly charged specie, then additional data follows for the succeeding (lessor charged) species down to the neutral atom. Radiation data for the first specie of each family is obtained by estimate, so it should not be present in significant concentrations. The data for a two family O, N system might be input as follows:

[O^{++} data]
[O^{+} data]
[O data]
[N^{++} data]
[N^{+} data]
[N data]
[Blank]

For each specie the following data is required:

Card 1, Format (3I3, E11.3, E10.3, 40X, 2A4)

Field 1 (Columns 1 - 3), IAT
Atomic number of the specie.

Field 2 (Columns 4 - 6), NN
Number of photoionization edges to be considered explicitely for the specie.

Field 3 (Columns 7 - 9), NBN
NBN is set to 1 if the low frequency contributions are to be treated with the approximate theory due to Biberman and Norman (the usual case). NBN is set to 0 if the low frequency contributions are to be treated differently.

Field 4 (Colums 11 - 20), Z
The charge on the residual ion. Thus, Z = 1 for neutrals, 2 for singly ionized ions, 3 for doubly ionized ions, etc.

Field 5 (Columns 21 - 30), XION
The ionization energy for the species in ev.

Fields 6 and 7 (Columns 71 - 78), BETA, BETB
Two part alphanumeric name for the specie.

Card 2, Format (8E10.3)

Fields 1, 2, 3... (Columns 1 - 10, 11 - 20, 21 - 30, etc.), GEE
These are the statistical weights of the atomic and ionic levels. For unlumped levels GEE = 2J + 1 where J is the inner quantum number of the level and can be obtained from tabulations (Reference 4). For lumped levels, GEE is

obtained by summing the contributions from individual levels. The program is currently dimensioned to handle 8 quantum levels per specie, maximum.

Card 3, Format (8E10.3)

Fields 1, 2, 3... (Columns 1 - 10, 11 - 20, 21 - 30, etc.), EPS

These are the energies of the levels (in ev). For nlumped levels, values can be obtained from tabulations (Reference 4). For lumped values the equation

$$EPS\Big|_{lumped} = \frac{\Sigma GEE * EPS}{\Sigma GEE}$$

is applicable where the summations are taken over all the levels to be lumped.

Card 4, Format (8E10.3) (Skip if NBN = 0)

Field 1 (Columns 1 - 10), HVG

In their theory, Biberman and Norman supply two approximate relations valid in the very low frequency range and the moderately low frequency range, repsectively. This value (HVG) specifies where (in ev) the code transists from one relation to the other for the particular specie in question.

Field 2 (Columns 11 - 20), TTHRES

This value and the two following in succeeding fields form a temperature dependent correction which can be applied to the low frequency Biberman and Norman relations. The correction has the form

$$\mu = \mu\Big|_{BN}$$

$$\text{for } T < T_{threshold} \text{ and}$$

$$\mu = \mu\Big|_{BN} \times (coef_1 + coef_2 * T)$$

$$\text{for } T > T_{threshold}$$

where TTHRES is the threshold temperature.

Field 3 (Columns 21 - 30), COEFA

See the discussion given for the previous field. This value is the first coefficient - $coef_1$.

Field 4 (Columns 31 - 40), COEFB

See the discussion given for the previous two fields. This value is the second coefficient - $coef_2$.

Card 5, Format (8E10.3) (skip if NBN = 0)

Fields 1, 2, 3 (Columns 1 - 10, 11 - 20, 21 - 30, etc.), XIS

These are the ξ factors employed in the Biberman and Norman theory. Eight values must be given for each specie at the frequencies 0, 1, 2, 3, 4, 6, 8, 10 ev.

Card 6, Format (59X, E14.5, I3) (skip if NN = 0)

Field 1 (Columns 60 - 73), HVT

This is the threshold frequency for the first photoionization level to be considered explicitely (ev).

Field 2 (Columns 74 - 76), LEV

Index on the absorbing level assigned to the first photoionization level.

Card 7, Format (17X, 7E9.2) (skip if NN = 0)

Field 1, 2, ... 8, (Columns 18 -26, 27 - 35,...), CSS

These are the cross sections σ in $cm^2 \times 10^{18}$ used to define the first photoionization level to be considered explicitely. Eight values must be given at the following frequency increments measured from the threshold frequency (ev): 0, 1, 2, 4, 6, 8, 10, 20.

Cards 8, 9 (skip if NN $\leq$ 1)

The input data given on these two cards is identical to that given on cards 6 and 7, except that it is applicable to the second photoionization level to be considered explicitly

Cards 10, 11, ..., N1-1, N1 (skip if NN $\leq$ 2, ... etc.)

This defines the input for the remaining photoionization levels assigned to the first specie. Note that a maximum of 30 individual photoionization levels (summed over all species) are allowed in a given data deck. Card N1 is the last card assigned to the continuum data for the first specie.

Cards N1 + 1, ... N2

The input data given on this card set is identical to that given on cards 1 to N1 of Group 2, except that it applies to the second radiating specie in the family.

Cards N2 + 1, ... N3

Data for the remaining species in the first family and in the subsequent families are given on these cards, again in the same form as that given on cards 1 to N1 of Group 2.

Card N3 + 1

A blank card is read to identify the end of the group 2 data.

Group 3 - Molecular Species Radiation

Card 1, Format (20A4)

Fields 1, 2, ... (Columns 1 - 4, 5 - 8, ...), BA

These are the alphanumeric names of the species which have molecular band system absorption coefficients programmed into subroutine MU. A maximum of 16 are allowed. A typical list might include the following: N_2^+, NO, O_2, N_2, CO, H_2, C_2, CN, C^-, H^-, C_3, OSi, O^-.

Card 2, Format (20A4)

Fields 1, 2, ... (Columns 1 - 4, 5 - 8, ...), BB

These are the alphanumeric names of the species which have molecular band systems which are to be included in the calcualtions. This list must be selected only from the BA list and must be in the same order, e.g., H_2, C_2, C^-, H^-, C_3.

Group 4 - Line Group Specification

Cards 1, 2, ... N4, Format (6E12.4)

Field, 1,2, ... (Columns 1 - 12, 13 - 24, etc.), FHVM

These are the low frequency boundaries on the line groups. An FHVM value along with an FHVP value defines a frequency increment. All the lines with their centers within that increment define a line group. The continuum properties and the black body functions are evaluated at only one frequency point for each line group. Therefore, the frequency boundaries on the line group should not be so wide as to allow appreciable changes in these quantities. In addition, contributions to the transport from sources outside the boundaries of the line group are not taken into account. Therefore, the boundaries on a line group should never be too close to the center of a line within the group.

Cards N1 + 1, N1 + 2, ... N2, Format (6E12.4)

Field 1, (Columns 1 - 12, 13 - 24, etc.), FHVP

These are the high frequency boundaries on the line groups.

Cards N2 + 1, N2 + 2, ... N3, Format (6E12.4)

Field 1, (Columns 1 - 12, 13 - 24, etc.), FHV

These are the frequencies at which the continuum properties and the black body function are evaluated for each line group. They are usually taken to be roughly midway between FHVP and FHVM. Thus, FHV is often referred to as the "average" frequency of the line group.

Group 5 - Hydrogen Index (Skip this group if NXI = 0)

Card 1, Format (40I2)

Field 1 (Columns 1 - 2, 3 - 4, etc.), IA

These are the indices on the line groups which contain the special hydrogen lines (one per line group, maximum). The line groups are always numbered sequentially starting with those at the lowest frequency.

Group 6 - Number of Lines Per Line Group

Card 1, Format (40I2)

Field 1, (Columns 1 - 2, 3 - 4, etc.), NU

This is the number of lines which are situated within each line group and which are treated individually. This number must equal the number of line data cards read in for each group. Whenever a line is incorrectly assigned to a line group the program will stop and write out the message "LINE CENTER OUT OF GROUP FREQUENCY RANGE." To satisfy the dimension limits, the condition must be satisfied

$$\text{No. lines in group} \times \text{No. freq points per line} \leq 200.$$

where the number of frequency points per line is usually taken to be 15. If IZZ = 0 and NXI ≠ 0, the far wings of each of the hydorgen lines are included in each of the adjacent and just lower lying (in frequency) line groups (AJLL line group). The program views each of the AJLL line groups as having an extra line and, consequently, allows a maximum of lines from the input deck of

(No. of lines input to group + 1)

x No. of frequency points per line $\leq$ 200

Group 7 - Base Data for Line Transitions

Cards 1, 2, ... No. of Lines, Format (2A4, I2, F104, 2E12.1, 3E12.2)

Field 1 and 2, (Columns 1 - 8), BL, BM

These are a two part alphanumeric name for the species to which the line is assigned.

Field 3 (Columns 9 - 10), ND

This is the index for the absorbing level for each line. It is relative to the input data read in under Group 2 for each specie. Thus, ND = 2 indicates that the line is to be assigned to the second level of species BL, BM with an energy and statistical weight obtained from the Group 2 data. Obviously, sufficient data must be input in Group 2 to support all the assignments in the group.

Field 4 (Columns 11 - 20), EXPN

For nonhydrogen lines the (half) half width data for the stark broadening events are calculated by relations of the form

$$\gamma_k(T) = \gamma_k(10000°K)\left(\frac{T}{10000}\right)^{EXPN_k}$$

where EXPN is the temperature exponent for each line.

For common hydrogen lines, set

$$EXPN = n_u^2$$

where n_u is the principal quantum of the upper level assigned to the line transition.

For a special hydrogen line, set

$$EXPN = 0$$

Field 5 (Columns 21 - 32), HVL

Frequency of the center of the line (in ev).

Field 6 (Columns 33 - 44), FF

This is the f number of the line when the lower level of the transition is unlumped. When it is lumped

$$FF = \frac{GEE*f}{GEE|_{lumped}}$$

where GEE is the statistical weight of the unlumped lower level of the transition.

Field 7 (Columns 45 - 56), GAMP

For non hydrogen lines, this is the (half) half width per free electron of each line due to Stark Broadening, evaluated at 10,000°K.

For common hydrogen lines this is

$$GAMP = n_\ell^5 + n_u^5$$

that is, the sum of the 5th powers of the upper and lower principal quantum numbers assigned to the line transition.

Field 8 (Columns 57 - 68), XNOL

Each of these is the number of lines in a given line group which have identical properties. It is used only when the properties of several lines are to be averaged and transport calculated for the averaged line, then multiplied by the number of original lines to obtain the total. Only lines in the low frequency region (less than 5 ev, roughly) should be averaged in this manner.

Field 9 (Columns 69 - 80), GUP

Each of these is the statistical weight of the upper level of the line (used in resonance broadening calculation, only).

Group 8 - Frequency Nodes for the Continuum

Card 1, Format (24I3)

Field 1 (Columns 1 - 3), NIHVC

This is the number of continuum frequency points (a maximum of 50 is allowed).

Cards 2, 3, ..., Format (6E12.1)

Field 1 (Columns 1 - 12, 13 - 24, etc.), FHVC

These are the continuum frequency points which are selected. Care must be taken to insure that the photoionization edges in the ultraviolet are adequately resolved. In addition, if NXI ≠ 0 and IZZ = 1, pairs of sequential continuum frequency points must be selected to coincide with the boundary points for the line groups containing the special hydrogen lines.

DECK B - CASE DATA

Group 1 - Control Card and Title

Card 1, Format (20I1, 15A4)

Field 1 (Columns 1 - 20), KR

Column 1 determines the type of the calculation

0	Calculate intensities
1	Calculate fluxes
2	Calculate absorption coefficients
3-6	Do not use

Column 2 sets the conditions for the radiating layer

0	Allows arbitrary specification of thermodynamic state across the layer
1	Allows arbitrary specifications of thermodynamic state but requires that the properties be uniform across the layer
2	Allows the thermodynamic state to be determined from specified shock wave conditions. The properties behind the shock wave must be uniform across the layer.

Column 3 determines if molecules are to be included in the calculation

0	Molecules can be included with the bandless model approximation (standard case)
1	Molecules are not included
2	Molecules can be included using the JORL approximation (this option is not active for all code versions)
3	Molecules can be included using an Elsasser Band model applicable for infrared band systems (this option is not active for all code versions).

Column 4 determines how line contributions are calculated

0	Include lines but allow weak lines to be treated approximately
1	Include lines in full detail
2	Exclude lines
3	Employ equivalent width approximation (much faster than 0 or 1 options if H is absent or if IZZ = 1)

Column 5 determines the optical conditions of the wall

0 Requires a cold, black wall

1 Requres a black wall but allows it an arbitrary temperature

2 Allows a wall with an arbitrarily specified temperature, emittance and/or transmittance

3 Arbitrary wall emittance and transmittance, sets TW = TEE(1) if KF(1) = 0

4 Black wall, sets TW = TEE(1) if KF(1) = 0

5 Transparent wall

6, 7, 8 Same as 3, 4, 5 (respectively) except that the boundary condition on the outer boundary is assumed to be black body at TEE(NY)

Column 6 specifies the type of flux or intensity calculated at the wall

0 Incident flux or intensity

1 Flux or intensity transmitted through the surface

Column 7 determines how the thermodynamic state conditions of the radiating species are obtained

0 Uses the resident values

1 Performs chemistry calculation

2 Reads in mole fractions, temperature pressures and (when required) density. The density is required in the density stretched coordinate system (KR(13) > 2)

Column 8 determines whether frequency or wave length is used for output

0 Uses frequency, $h\nu$ (ev)

1 Uses wavelength, λ (microns)

2 Uses frequency, prints out $I^{+}-B$ or $F^{+}-E$ (more accurate when transport is approaching the diffusive limit). This option is not active for KP(17) = 1.

Column 9 determines if the program is to check the validity of the continuum frequency grid

0 The grid is checked - use for energy transfer calculations

1 The grid is not checked - use when only a selected part of the spectrum is of interest.

Column 10 determines where the program obtains (1) normalized spatial nodes, (2) index on spatial nodes to determine where fluxes or intensities are to be printed out and (3) the optical properties of the wall.

0 Uses resident values

1 Reads in new values (required for first case).

Column 11 - Not used.

Column 12 determines if the chemistry input package is to be read

0 Read in new data for element and molecular, atomic and ionic species; input data will not appear in output.

1 Use resident elemental and species data

2 Same as KR(12) = 0 except that data will appear in output.

Column 13 determines nature and source of spatial length parameter, DELTA

0 Reads it in as optical path length

1 Takes it equal to the stand off distance of the bow shock of a sphere (the spherical radius (cm) is read in).

2 Same as KR(13) = 1 except that the spherical radius is in feet

3 Set equal to edge value for a density stretched coordinate system, i.e.

$$\text{DELTA} = \eta_e$$

where

$$\eta_e = Z\int_0^{y_{edge}} \rho dy$$

where Z = 1 unless the code is modified internally.

Column 14
Column 15 } Not used
Column 16

Column 17 determines the amount of radiative output

0 Normal radiative output

1 Extensive radiative output

2 No output from radiation calculations.

Column 18
Column 19 } Not used
Column 20

Field 2 (Columns 21 - 80), CASE

This is the title of the case (alphanumeric) used for identification of printed output.

Group 2 - Chemistry Control Card (skip this group if KR(7) = 0)

Card 1, Format (20I1, 5E10.3)

Field 1 (Columns 1 - 10), KQ

Column 1 determines which variables are used to specify thermodynamic state

0 Temperature

1 Not active

2 Enthalpy (if KQ(5) = 0) or shock wave conditions (if KQ(5) = 1)

Column 2 determines if chemistry package is to be read in (see KR(12), also)

0 Use resident data

1 Read in new data (required for first case)

Column 3 must be the same as column 2

Column 4 determines if second order partial derivatives are to be calculated for external use (they are not required for the radiation calculations)

0 Does not calculate them (allows faster calculations)

1 Calculates them (not active for all code versions)

Column 5 determines if the shock wave option is to be used

0 Not used

1 Shock jump conditions will be calculated

Column 6 determines the form of the A(I,J) array for external use (it is not required for the radiation calculations)

0 Partial derivatives are obtained assuming that the elemental mass fractions can take on any value.

1 The mass fraction of the last heavy (non-electron) element is forced to vary so that the elemental mass fractions always sum to unity.

Column 7 determines the output from the chemistry subroutines

0-8 Normal output

9 No output

Columns 8-20 Not used

Field 2 (Columns 21 - 30), THETA

This is the angle between the shock wave normal and the free stream velocity vector (e. g. THETA = 0 for a stagnation point at zero angle of attack). An entry here has meaning only when the shock wave option is to be used. This is also true for the next four fields.

Field 3 (Columns 31 - 40), SV1

This is the velocity (ft/sec) upstream of the shock wave.

Field 4 (Columns 41 - 50), SP1

This is the pressure (atm) upstream of the shock wave.

Field 5 (Columns 51 - 60), SR1

This is the density (lb/ft^3) upstream of the shock wave.

Field 6 (Columns 61 - 70), HS

This is the static enthalpy (Btu/lb) upstream of the shock wave.

Group 3 - Chemistry Input (Skip this if KR(7) ≠ 1 or KR(12) = 1)

Card 1, Format (I3,F7.0)

Field 1 (Columns 1 - 3), IS

Number of elements in the system including electrons if considered.

Cards 2,3. . .,IS, (One for each element, see Card 1, Field 1 of this group), Format(I3, 3A4, 4F10.5)

Field 1 (Columns 1 - 3), KAT(K)

Atomic number of element (99 for electron), cards must be ordered with this number ascending with electron last (when considered)

Field 2 (Columns 4 - 15) ATA(K), ATB(K), ATC(K)

Name of element (used for output only). For best looking output, elements with 3 or 4 letters (e.g., iron) should start in Column 6, elements with 5, 6, or 7 letters (e.g., carbon) should start in Column 5, and elements with 8 or more letters (e.g., nitrogen) should start in Column 4.

Field 3 (Columns 16 - 25), WAT(K)

Atomic weight of element

Group 4 - Thermodynamic Data (Skip this if KR(7) $\neq$ 1 or KR(12) = 1)

There are three cards for each molecular, atomic, condensed, or ionic species. A total of 40 species of all types are allowed. The number of allowable condensed-phase materials is (12-IS). A blank card after the last set concludes the thermodynamic data. The arrangement of these cards sets is of consequence in so far as it determines the base species upon which mass balances are performed, the first independent set of base species being selected. Singular matrices can result from certain sets of theoretically-acceptable base species due to round-off errors. Furthermore, mass balances, etc. for the (NSP)th base species is obtained by difference. Therefore, the element represented by this base species should be present in appreciable quantities. For example, for air, molecular nitrogen is a good choice for the (NSP)TH base species. Except for these considerations, atomic, molecular, and condensed species can be arranged in any order. When ionized flows are considered, the atomic, molecular, and condensed species data must appear first and be followed by, first, electron species data, and then the ionic species data (which can be in any order). The data format accepted by the program (described below) are as generated by the Aerotherm TCDATA program and are the same as that used in NAVWEPS Report 7043. Thermochemical data decks have been generated for about 600 species, based mostly on curve fits of JANAF data.

Cards 1, 4, 7, ... One for each molecule, Format (7(F3.0, I3), 30X, 2A4)

Fields 1, 3, 5 ... One for each element in molecule (Columns 1-3, 7-9, 13-15 ...), ALPT(N) in each field

Number of atoms (of atomic number given in subsequent field in a molecule of this species. If field one is zero this card is presumed to be end of thermodynamic data.

Fields 2, 4, 6 ... One for each element in molecule, (Columns 4-6, 10-12, 16-18, ...), JAT(N) in each field

Atomic numbers of elements in molecules (listed in ascending sequence).

Last Field, (Columns 73 - 80)

Molecular designation (e.g., SIO2) for output

Cards 2, 5, 8, ... One for each molecule, Format (6E9.6, 6X, F6.0, I1)

Field 1, (Columns 1 - 9), RA(J)

Heat of formation of molecule at 298°K from JANAF base state (elements in most natural from at 298°K), cal/mole.

Fields 2 - 6, (Columns 10 - 18, 19 -27, 28 - 36, 37 - 45, and 46 - 54), CH(J,1), RC(J,1), RD(J,1), RE(J,1), RF(J,1)

Constants appropriate to lower temperature range of thermodynamic data. Taking F2, F3,..., as Fields 2, 3, etc., the curve fits are as follows with T in °K, H in cal/mole, and S in cal/mole °K.

Heat capacity, CP = F3 + F4* T + F5/T**2

Enthalpy, H - H298 = F2 + F3*(T - 3000) + 0.5*F4*
(T**2 - 3000**2) - F5*(1/T - 1/3000)

Entropy, S = F6 + F3*LN(T/3000) + F4* (T - 3000)
- 0.5*F5*(1/T**2 - 1/3000**2)

Field 7, (Columns 61 - 66), TU(J,1)

Upper limit of lower temperature range in °K. (For condensed-phase materials which melt, it is appropriate to use melt temperatures).

Field 8, (Column 67), KPHA(1)

1 signifies gaseous species

2 signifies solid species

3 signifies liquid species

Cards 3, 6, 9, ... One for each molecule, Format (6E9.6, 6X, F6.0, I1)

Fields 1 - 8, (Columns 1 - 67)

Same as Cards 2, 5, 8 ... except use constants for upper temperature range and Field 7 is ignored.

Last Card - A blank card is used to signify the end of thermodynamic data.

Group 5 - Nodal Input and Surface Properties (Skip this group if KR(10) ≠ 1)

Card 1, Format (24I3)

Field 1, (Columns 1 - 3), NIC

This is the number of spatial stations at which transport is to be printed. This number must be equal to or less than 20 for normal output or 1 for extensive output.

Card 2, Format (24I3)

Field 1, (Columns 1 - 3, 4 - 6 ...), NICN

These are the indices on the spatial stations where transport is to be printed. The nodal points usually start with 1 at the wall and increase away from the wall.

Card 3, Format (5I3)

Field 1, (Columns 1 - 3), NY

This is the number of spatial nodes used to describe the slab (or ray). It must be equal to or less than 20.

Field 2, (Columns 4 - 6), NI

This is the index on the spatial point at which the line frequency coordinate system is to be evaluated. For a layer in which the elemental composition does not vary greatly, use the high temperature boundary. When the elemental concentration does vary significantly, select a point where the temperatures are the highest but all the elements are still present.

Cards 4,... N5, Format (6E12.4)

Field 1, (Columns 1 - 12, 13 - 24,...), (YY(I), I = 1,NY)

If KR(13) < 3, these are the normalized distances from the wall to each spatial station. If KR(13) $\geq$ 3

$$YY(I) = \eta(I)/\eta_e$$

where $\eta(I)$ is a density stretched coordinate normal to the wall. For both cases, values should be selected so that the thermodynamic variation of the slab (or ray) is well described.

----Skip the Rest of Group 5 if KR(5) $\neq$ 2, 3 or 6----

Cards N5+1, N5+2, ...,N6, (Format (6E12.1)

Field 1, (Columns 1 - 12, 13 - 24, ...), AHV

These are the absorptances or emittances of the wall - one for each continuum frequency point.

Cards N6+1, ...,N7, Format (6E12.1)

Field 1, (Columns 1 - 12, 13 - 24, ...), HVL

These are the absorptances or emittances of the wall - one for each line group center frequency.

Cards N7+1, N7+2, ...,N8, Format (6E12.1)

Field 1, (Columns 1 - 12, 13 - 24, ...), TMSW

Continuum transmittances of the wall - one for each continuum frequency point

Cards N8+1, N8+2, ...,N9, Format (6E12.1)

Field 1, (Columns 1 - 12, 13 - 24, ...), TMSWL

Line group transmittances of the wall - one for each line group center frequency.

<u>Group 6 - Uniform Conditions Input (Skip this group if KR(2) = 0)</u>

Card 1, Format (6E12.4)

Field 1, (Columns 1 - 12), DELTA

DELTA is the radiation path length paramter. Its meaning is discussed along with the discussion of the KR(13) variable.

Field 2, (Columns 13 - 24), PRES(1)

The variables in this field and the following three fields have meaning only when KR(7) $\geq$ 1. PRES(1) is the pressure (atm) to be assigned to the uniform layer. If KR(2) = 2, this value will be overridden by the downstream shockwave pressure.

Field 3, (Columns 25 - 36), TEE(1)

If KQ(1) = 0, TEE(1) is the temperature (°K). If KQ(1) = 2, TEE is the enthalpy (Btu/lb).

Field 4, (Columns 37 - 48), SLOPE

The variable in this field has meaning only if the radiation path length is to be set equal to the standoff distance of a spherical body (KR(13) $\neq$ 0 or 3). If SLOPE = 0., the classical standoff formula is employed, i.e.

$$\delta = SDR * DELTA/(1. + \sqrt{\frac{8}{3} SDR})$$

where SDR is the density ratio across the normal shock wave. If SLOPE > 0, the standoff distance formula employed is

$$\delta = SDR * DELTA * SLOPE$$

which is consistent with the recommendations of some of the more recent studies.

Field 5, (Columns 49 - 60), V

This is the density (lb/ft^3) of the gases in the radiating layer. It has meaning only if a chemistry solution is not going to be obtained (KR(7) = 2) and if a density stretched coordinate system is to be used (KR(13) $\geq$ 3).

Card 2, Format (6E12.4)

Field 1, (Columns 1 - 12), TW

The temperature (°K) which is used to calculate the emission from the wall. If KR(15) = 3, 4, 6 or 7, this value will be overridden by the program.

----IF KR(7) ≠ 1, Skip the Next Card----

Card 3, Format (8E10.3)

Fields 1, 2, ...(Columns 1 - 10, 11 - 20, ...), (SP(I), I = 1, ISM)

These are the mass fractions of the base species. Their order must be identical to that used for the species in the chemistry input (Group 3). When elements are used as base species, these variables become the usual elemental mass fractions.

----IF KR(7) ≠ 2, Skip the Next Card----

Card 4, Format (24I3)

Field 1, (Columns 1 - 3), NSPEC

This is the number of radiating species to be read in.

----IF KR(7) ≠ 2, Skip the Following Card Sets----

Read one card set per radiating species to be read in for a total of NSPEC card sets. A card set must be included for the electron specie.

Card 5, 6, ...Format (2A4, 2X, 7E10.2)

Fields 1 and 2 (Columns 1 - 4, 5 - 8), FAMOA(J), FAMOB(J)

These are the two-part names of the radiating species. They must correspond exactly with the names used in DECK A.

Field 3 (Columns 11 - 20) FR(J,1)

These are the mole fractions assigned to each of the species.

Group 7 - Nonuniform Conditions Input (Skip this group if KF(2) ≠ 0)

Card 1, Format (1E12.1)

Field 1, (Columns 1 - 12), DELTA

DELTA is the radiation path length parameter. Its meaning is discussed along with the discussion of the KR(13) variable.

----Skip the Next Three Card Sets if KR(7) = 0----

Cards 2, ...N11, Format (6E12.4)

Fields 1, 2, ...(Columns 1 - 12, 13 - 24, ...) (PRES(I), I = 1,NY)

These are the pressures (atm) at each spatial node.

Cards N11 + 1, ...N12, Format (6E12.4)

Fields 1, 2, ...(Columns 1 - 12, 13 - 14, ...)(TEE(I), I = 1,NY)

If KQ(1) = 0, these are the temperatures (°K) at each spatial node. If KQ(1) = 2, they are the enthalpies (Btu/lb).

----Skip the Next Card Set if KR(7) ≠ 2 or KR(13) ≤ 2----

Cards N12 + 1, ...N13, Format (6E12.4)

Field 1,2, ...(Columns 1 - 12, 13 - 24, ...)(RHO(I), I = 1,NY)

These are the gas phase densities (lb/ft^3) at each spatial point.

Card N13 + 1, Format (6E12.4)

Field 1 (Columns 1 - 12) TW

This variable was described previously in Group 6.

----Skip these Card Sets if KR(7) ≠ 1----

Read in one card set per spatial node,I.

Card N13+2, ...N14, Format (8E10.3)

Fields 1, 2, ...(Columns 1 - 10, 11 - 20, ...)(SP(I,J), J = 1, ISM)

These are the mass fractions of the base species at each spatial node I. The odering of the species must be the same as that used in Group 3.

----Card N15, Format (24I3)

Field 1 (Columns 1 - 3) NSPEC

This is the number of radiation species to be read in .

----Skip the Following Card Sets if KR(7) ≠ 2----

Read one card set per radiating specie to be read in for a total of NSPEC card sets. A card set must be included for electrons. A minimum of two cards per specie is required.

Cards N15 + 1, ...N16, Format (2A4, 2X, 7E10.2/(8E10.2))

Fields 1 and 2 (Columns 1 - 4, 5 - 8) FAMOA(J), FAMOB(J)

These are the two-part names ofthe radiating species. They must correspond exactly with the names used in DECK A.

Fields 3, 4, ...(Columns 11 - 20, 21 - 30, ...)(FR(J,I), I = 1,NY)

These are the mole fractions of the Jth specie at each of the Ith spatial points across the radiating layer. The wall is usually positioned at I = 1.

Group 8 - Termination of Run

Card 1, Format (6E12.4)

Field 1, (Columns 1 - 12), C4

If C4 = 0, begin reading in a new case starting with Group 1 of DECK B. If C4 = 1., stop calculations.

SECTION 3

OUTPUT

3.1 NORMAL OUTPUT

For a given case, the normal output consists of five sets of data, each of from one to three or four pages in length. The first set summarizes the permanent data deck being used. The second set gives the radiation and chemistry control numbers and defines the radiative boundary conditions for the case being run. The third set defines the spatial variations of the thermodynamic state properties, starting with chemistry solutions at the wall and each successive spatial mode and finishing with the ray length (or the wiath of the radiating layer) and a summary of the number densities of the radiating species. The fourth set gives the results of the continium transport calculations, and the fifth gives the results of the line transport calculations. When more than one case is calculated in a given run, the first set of data is printed out for the first case only. The other four sets are printed out for each case.

The first set of data is given the title "DECK A". Twelve columns of data are printed out under the following headings:

GROUP, HV, HV+, HV-, N, NAME, K(I), HV(I), F(I), GAM(I), EXPN(I), NOL

The first five columns define the properties of the line groups; the second seven define the properties of the lines within each line group. With one exception, these variables are the same as the input variables, although slightly different terminology is used. In terms of input variables the headings are the following:

```
LINE
GROUP                      SPECIES
INDEX, FHV, FHVP, FHVM, NU, NAME, ND, HVL, FF, GAMP, EXPN, XNOL
```

The exception is the K(I) or ND variable where the input variable is an index on the absorbing level relative to the ground level of its species; where as, the ND variable is the index of the absorbing level relative to all the levels considered in the data deck. The remaining variables were defined in Section 2.

The second set of data is titled "CASE-XXXX" where XXXX is the case title which was read in on the first card of Deck B. The radiation control numbers (KR(I)) and the control numbers (KQ(I)) are given which describe the case. An output block is also given for flow control numbers which are set internally in the code and are not used to define cases. These are followed by the "RADIATIVE BOUNDARY CONDITIONS" given in terms of the emittance and the transmittance of the wall and the outer boundary and as a function of both the continuum and line group frequencies (corresponding wave lengths are also given).

The third set of data is always given in title "THERMODYNAMIC STATES ACROSS THE LAYER-STARTING WITH WALL." The thermodynamic data printed out at each space station includes temperature (°K), pressure (atm), molecular weight, enthalpy (cal/gm), entropy (cal/gm-°K), density (gm/cm^3) and the names of the species with their mole fractions. At the end of these thermodynamic data, the path length parameter DELTA is given followed by a block of number densities given for each radiating specie at each space station across the layer.

The fourth set of data is given either the title "CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX" or "CONTINUUM CONTRIBUTION TO THE SPECTRAL INTENSITY" depending on the type of calculation being performed. The next row gives the normalized distances to the space nodes where the transport integrals were evaluated. The first column gives the nodal points in frequency used in the continuum calculation. When the transport integrals are to be evaluated at 6 points or less (NIC $\leq$ 6), the next 2 times NIC columns represent F_ν^- and F_ν^+ or I_ν^- and I_ν^+) given alternately, one combination for each node at which the transport integrals were evaluated. When NIC > 6, there are two rows of output for each continuum frequency point. The top row is F_ν^- (or I_ν^-) and the bottom row (which is slightly displaced to the right) is F_ν^+ (or I_ν^+). Frequency integrated values are given at the bottom of the page for the NIC spatial nodes being considered.

The fifth set of data is given the title "LINE RADIATION." The next row gives the normalized distances to the nodes where the transport integrals were evaluated. The first column gives the index on the line group being considered. The next column gives the center frequency of the line group. The first row gives the line correction (F_ν^L or I_ν^L - see Equation 66 of Ref. 1) integrated over the frequency increment of the line group and in the negative direction. The second line is displaced slightly to the right and gives the corresponding value in the positive direction. The total line correction to the directional fluxes are given at the bottom of the page.

3.2 EXTENSIVE OUTPUT

The extensive output package may be activated at a single specified spatial point. This consists of seven sets of output data, five of which are roughly one to three or four pages in length, one of which is roughly twenty pages in length (extensive continuum output) and one of which is roughly one hundred pages in length (extensive line output). The first three sets of data are identical to the first three sets of the normal output data. The fourth set gives the extensive continuum output; the fifth gives the continuum output summary; the sixth set gives the extensive line output, and the seventh set gives the line output summary.

In the fourth data set, three dependent variables (B,FMU, and TAU) are presented as functions of frequency (HV in ev, as printed out) and spatial position. For each of the continuum frequency points, the entire spatial array of each variable is given, starting with the wall value. The variable B represents the Planck function (or the black body emissive power); the variable FMU represents the continuum (only) absorption coefficient, and the variable TAU represents the optical depth along the ray of interest (or the 60 degree ray for a plane-parallel slab).

The fifth set of data is given either the title "CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX" or "CONTINUUM CONTRIBUTION TO THE SPECTRAL INTENSITY" depending on the type of calculation being performed. The second row of the title gives the normalized spatial station specified for the transport print-out. The spectral points for the continuum are given in the first column. The next three give the continuum transport quantities in the negative direction (away from the wall). The spectral fluxes (or intensities) are given first; then the integral of the spectral flux (or intensity) over frequency is given as a function of frequency (each entry represents the integral from the first frequency point to the current frequency point; finally, the third column gives the same information as the second, except that its entries are normalized against the final value of the integral. The information given in the last three columns is the same as in the three just described, except that the transport quantities in the positive direction are considered. When KR(8) = 1, the spectral quantities are presented as functions of wavelength instead of frequency.

The sixth set of data gives additional details about the line group and the line transport calculation. For each line group the continuum absorption coefficients and the appropriate black body function at the "average" frequency of the line group are given as a function of the spatial points. The positive and negative continuum fluxes (or intensities) are given at the specified spatial station. At each of the frequency points within the line group (frequency interval), the total (line+continuum) absorption coefficients and optical depths are given as a function of spatial points. The spectral flux (or intensity) is also given for each of the two directions. Finally, an integral over the line group is given.

The seventh set of output data gives a summary of the line calculations. The first column gives the line group index. The second and third columns give the lower and upper frequency (or wavelength) boundaries for each line group with labels NEG (lower) and POS (upper) assigned. The next two columns give the spectral and total (frequency integrated over the line group) contributions to the positive (wall directed) component of the flux (or intensity). In this output block, the spectral flux (or intensity) is an artifice, defined as the total assigned to the line group divided by the frequency increment assigned to the line group. These spectral output quantities are meant to be used only for easy graphical display of the results of the calculations and/or for its qualitative interpretation. The last two columns give the spectral and line group integrated totals for the fluxes (or intensities) in the negative direction (away from the wall). The spectral fluxes (or intensities) are subject to the same considerations and restrictions discussed previously for the positive spectral fluxes (or intensities). Finally, the total (summed over line groups) flux (or intensity) in each direction is given at the bottom of the output block.

SECTION 4

SAMPLE CASES

Presented in this section are six sample problems which were run on a UNIVAC 1108. These problems are relatively simple but do exercise many of the program options. For each sample problem, the following is presented:

- A brief discussion of the nature of the problem and solution
- A listing and/or description of the input deck
- A selected number of pages of the program output

4.1 SAMPLE PROBLEM 1

A 20 group line model and 48 point continuum model are employed to calculate the radiative flux emanating from a plane-parallel slab with the thermodynamic conditions (temperature, pressure, elemental composition) specified across the layer. This combination of elemental system ($C-O-N-E^-$), the values of the thermodynamic variables and cold black wall boundary conditions make the calculation a reasonable representation of the thermal events occuring in the inviscid flow region of a Venus entry body. The results of the calculation are presented in terms of the frequency variable and in standard output format.

```
20
 8     1 2,        35,146      GILMORE                                      O+
 4,       10,      6,          12,       10,       18,       54,       90,
0,        3,3250   5,0171      14,8694   20,5797   23,135    25,938    28,833
20,
 1,       ,76      ,62         ,55       ,55       ,85       1,42      2,
 8  2  1 1,        13,614      GILMORE                                  O
9,        5,       10,         5,        3,        15,       9,        40,
,0096     1,967    4,189       9,144     9,519     10,74     10,99     12,08
4,4       8000,    ,1415       1,0737-04
1,        ,71      ,51         ,34       ,21       ,27       ,58       1,05
          O GROUND STATE                                     13,4          1
 O GD STATE     4,03     4,29      4,16      6,0       9,0      10,      10,
 O GD STATE     8,0
          O EXCITED STATE                                    4,22          4
O EX STATE     6,5      5,929     5,433     4,672     4,215    4,062     4,215
O EX STATE     4,215
 7  1  12,         29,605      GILMORE                                  N+
 9,       5,       1,          5,        15,       12,       36,       60,
,011      1,8989   4,0528      5,8005    11,4366   18,4801   20,9555   23,2704
18,
 1,       ,76      ,62         ,55       ,55       ,85       1,42      2,
 N+ GD STATE (ESTIMATE)                                      29,6          1
N+ GD STATE     5,        5,        5,        5,        5,        5,        5,
N+ GD STATE     5,        5,        5,        5,        5,        5,        5,
 7  3  11,         14,54       GILMORE                                  N
 4,         10,    6,          18,       54,       90,       1,
    0,         2,384     3,576     10,45     11,88     13,   14,
 4,       8000,    ,867        2,80  -05
 1,       ,67      ,45         ,26       ,22       ,41       ,9        1,6
     N GROUND STATE                                          14,5          1
 N GD STATE      7,86      8,16      9,16    [illegible],16      16,8     16,1     16,1
 N GD STATE      8,
N 1ST EX STATE     2,88398E 04   8,33333E-01   1.32530E 05   1.20000E 01  2
N 1ST EX STATE  6,4      6,4       6,4       6,4       5,4       6,4       6,4
N 1ST EX STATE  6,4
N 2ND EX STATE     2,88398E 04   1.50000E 00   1,17314E 05   1.08000E 01  3
11 1 2121 1 213118,643E 008,541E 008,045E 006,842E 005,375E 005.120E 003,189E 00
11 1 2121 1 213127,417E-011,337E-011,321E-022,633E-038,432E-043,475E-042,376E-04
 6  1  1  2,       24,376              WILSON AND NICOLET           C+
6,        12,      10,         2,        6,
0,        5,32     9,28        11,95     13,7
12,47
 1,       ,76      ,62         ,55       ,55       ,85       1,42      2,
          C+ 1ST EXCITED ST                                  19,03         2
C+ 1ST EX ST     5,2      5,2       5,2       5,2       5,2       5,2       5,2
C+ 1ST EX ST     5,2
 6  3  1  1,       11,26       WILSON AND NICOLET                   C
9,        5,       1,          5,        12,       15,       36,
0,        1,2639   2,75        4,1825    7,5351    7,9461    8,6442
3,78      4000,    ,927        1,925 -05
1,        ,64      ,42         ,3        ,33       ,68       1,17      1,6
          C GROUND STATE                                     11,26         1
 C GD STATE      11,       11,       11,       10,4      9,55      8,7      7,85
 C GD STATE      4,5
 C FIRST EXCITED STATE                                       10,0          2
C 1ST EX STATE   17,       17,       17,       17,       16,       14,      4,0
C 1ST EX STATE   ,2
  C SECOND EXCITED STATE                                     8,51          3
C 2ND EX STATE   22,       22,       22,       22,       22,       22,      22,
C 2ND EX STATE   22,

N2+ NO  O2  N2  CO  H2  C2  CN  C-  H-  C3  OSI O-
N2+ NO  O2  N2  CO  C2  CN  C-  O-
```

INPUT - SAMPLE PROBLEM 1

0,60 +00	0,81 +00	0,96 +00	0,12 +01	0,14 +01	0,162 +01
0,24 +01	0,34 +01	0,40 +01	0,62 +01	0,80 +01	0,88 +01
0,77 +01	0,1045+02	0,1080+02	0,1170+02	0,1210+02	0,1280+02
0,1340+02	0,1380+02	0,00 +00	0,00 +00	0,00 +00	0,00 +00
0,80 +00	0,95 +00	0,12 +01	0,14 +01	0,16 +01	0,24 +01
0,3500+01	0,40 +01	0,60 +01	0,80 +01	0,90 +01	1,00 +01
0,1045+02	0,1080+02	0,1170+02	0,1210+02	0,1280+02	0,1340+02
0,1380+02	0,1450+02	0,00 +00	0,00 +00	0,00 +00	0,00 +00
0,69 +00	0,89 +00	0,1050+01	0,1290+01	0,1460+01	0,1850+01
0,2850+01	0,3700+01	0,5000+01	0,7110+01	0,8400+01	0,94 +01
0,1007+02	0,1062+02	0,1120+02	0,1190+02	0,1241+02	0,1304+02
0,1358+02	0,1420+02	, +	, +	, +	, +

5 6 8 6 5 5 4 1 1 810 911 712 7 8 4 4 4

O	8	,46	,685	,1960	,1100-20	6,	
C	6	,3930	,68590	,04400	,3210-20	3,	
N	6	,25	0,689	0,1597	,1870-19	6,	,
C	7	,1340	,71000	,20800	,6390-17	4,0000	
N	5	,25	0,7525	0,0149	,4460-20		,
C	6	,3540	,84400	,08080	,4120-20	3,	
C	5	,4570	,85200	,06870	,1080-20	-,0000	-,0000
N	5	,25	0,875	0,0366	,3800-20	4,	,
O	7	,46	,884	,1570	,3670-20		
N	4	,25	0,9158	0,00847	,7390-21		,
N	6	,25	0,9304	0,0253	,3870-19	2,	,
N	6	,25	0,965	0,0262	,3870-19	4,	,
O	8	,46	,991	,0805	,3090-19	2,	
C	7	,6120	1,01900	,03290	,2050-18	4,	
N	5	,25	1,0355	0,0735	,3310-20	7,	,
C	6	,3540	1,08280	,10080	,3200-20	8,	
O	7	,46	1,098	,7490	,3440-20		
O	6	,46	1,132	,2010	,3670-20		
C	5	,4020	1,16300	,47400	,1080-20	-,0000	-,0000
C	6	,3610	1,22400	,02850	,2620-20	-,0000	-,0000
N	5	,25	1,2610	0,118	,3120-20	3,	,
N	4	,25	1,3190	0,1833	,9840-21		,
C	5	,3470	1,32600	,20600	,1380-20	3,	
O	6	,46	1,338	,9130	,3420-20		
N	5	,25	1,3677	0,0387	,2930-20		,
N	4	,25	1,4380	0,256	,8240-21	3,	,
O	5	,46	1,467	,9500	,8650-21		
C	5	,2910	1,48700	,04050	,2180-20	-,0000	-,0000
N	5	,25	1,5527	0,0030	,2930-19		,
O	4	,46	1,594	1,0300	,7090-21		
N	4	,25	1,6630	0,0923	,9580-21		,
O	7	,46	1,767	,0226	,2750-19	3,	
C	6	,3780	1,81400	,00390	,3500-19	5,	
N	5	,25	1,8357	0,00566	,2930-19	5,	,
O	6	,46	2,015	,0258	,2750-19	3,	
N	4	,25	2,925	0,0070	,1060-19	3,	,
O	5	,46	3,000	,0100	,8100-20	2,	
O	4	,46	3,167	,00826	,5200-20		
N	4	,25	3,4724	0,00861	,4520-19	3,	,
O	4	,46	3,711	,0143	,1100-19		
C	3	,3150	5,00200	,06760	,1130-20	-,0000	-,0000
C	2	,3150	6,42400	,07290	,1130-20	-,0000	-,0000
C	3	,3390	7,01300	,01410	,5000-20	-,0000	-,0000
C	3	,3610	7,07800	,07400	,2620-20	-,0000	-,0000
N	3	,25	07,111	0,0634	,9120-21		,
C	1	,3230	7,48100	,10500	,8730-21	-,0000	-,0000
C	3	,3260	7,71700	,00534	,2200-19	-,0000	-,0000
C	3	,6260	7,72100	,03670	,1090-18	-,0000	-,0000
C	1	,9570	7,94700	,28300	,2080-21	-,0000	-,0000
C	3	,8400	8,03000	,00457	,6900-18	-,0000	-,0000
C	3	,7520	8,19100	,01160	,1300-17	-,0000	-,0000

INPUT - SAMPLE PROBLEM 1

```
C         1    -.4220    13.11900      .37900     .1010-20    -.0000      -.0000
N         2    .25         13.190      0.0489     .2990-19                 .
N         2    .25         13.508      0.0291     .6960-18                 .
N         7    .25         13.543      0.1610     .9500-23                 .
C         2     .1610    13.60100      .29500     .1590-21    -.0000      -.0000
N         1    .25         13.677      0.0957     .2930-19                 .
N         1    .25         13.993      0.0584     .5320-19                 .
N         1    .25         14.160      0.0342     .7960-19                 .
N         1    .25         14.257      0.0212     .2680-18                 .
N         1    .25         14.332      0.0138     .4370-18                 .
 48
  0.02       0.1        0.2        0.5        0.6        0.8
  1.00        1.50       2.00      2.5        2.75        3.0
  3.25        3.50      3.75       4.0        4.5         5.0
 6.00        7.00       8.00       8.50       8.52        8.98
 9.00        9.19       9.21       9.99       10.01       10.79
 10.81       11.00      11.25      11.27      11.99       12.01
 12.18       12.20      12.98      13.00      13.39       13.41
 13.59       13.61      14.29      14.31      14.55       15.00
1002501011340000000  VENUS RADIATION FLUX
0110000000                      50000.      .01       .00001    1.
23    1201
  4
  6 CARBON      12.011
  7 NITROGEN    14.008
  8 OXYGEN      16.0
 99 ELECTRON     0.00055
  1006                                      JANAF 03/61                 C
 170886+6 135500+5 444433+1 228125-3 409830+6 492870+2  500. 3000.1   0.C
 170886+6 135500+5 412212+1 261908-3 262886+7 492870+2 3000. 5000.1   0.C
  1007                                      JANAF 03/61                 N
 112965+6 134370+5 486944+1 383516-4 958460+5 480900+2  500. 3000.1   0.N
 112965+6 134370+5 428957+1 240844-3-417273+6 480900+2 3000. 5000.1   0.N
  1008                                      JANAF 06/62                 O
 595590+5 135220+5 497228+1 380768-5 154749+5 500960+2  500. 3000.1   0.O
 595590+5 135220+5 657489+1-224268-3-891782+7 500960+2 3000. 5000.1   0.O
  1  6  1  8                                JANAF 9-30-65              CO
-264169+5 223569+5 808732+1 281527-3-332124+6 653699+2   500  30001  -0CO
-264169+5 223569+5 885923+1 582009-4-124951+7 653699+2  3000  60001  -0CO
  2  7                                      JANAF 9-30-65              N2
      0+0 221649+5 793097+1 319649-3-314295+6 637650+2   500  30001  -0N2
      0+0 221649+5 878236+1 68 830-4-119262+7 637650+2  3000  60001  -0N2
  2  8                                      JANAF 9-30-65              O2
      0+0 234459+5 808690+1 497028-3-242932+6 679729+2   500  30001  -0O2
      0+0 234459+5 100924+2 636677-4-659192+7 679729+2  3000  60001  -0O2
  1  6  1  7                                JANAF 12-31-66             CN
 110999+6 232479+5 706816+1 994584-3-107243+6 669760+2   500  30001  -0CN
 110999+6 232479+5 126220+2-175667-3-184680+8 669760+2  3000  60001  -0CN
  1  6  2  8                                JANAF 9-30-65             CO2
-940539+5 365349+5 135296+2 479823-3-865470+6 798480+2   500  30001 -0CO2
-940539+5 365349+5 144684+2 176547-3-130622+7 798480+2  3000  60001 -0CO2
  2  6                                        JANAF 12/69     KS       C2
 200223+6 246779+5 776830+1 671194-3 208014+6 685590+2   300  30001  10C2
 200223+6 246779+5 843360+1 447514-3 259636+6 685590+2  3000  60001  10C2
  3  6                                        JANAF 12/69     KS       C3
 195999+6 309579+5 996626+1 976478-3-168299+6 812359+2   300  30001  10C3
 195999+6 309579+5 129505+2 166809-3-516560+7 812359+2  3000  60001  10C3
  1007 01 08                                JANAF 06/63                NO
 215800+5 227000+5 877623+1 899031-4-789656+6 688490+2  500. 3000.1  0.NO
 215800+5 227000+5 916260+1 657085-5-212519+7 688490+2 3000. 5000.1  0.NO
  1 99                                      JANAF 3-31-65              E-
      0+0 134229+5 496800+1 000000-0-700991-3 164589+2   500  30001  -0E-
      0+0 134229+5 496799+1 000000-0 216503-0 164589+2  3000  60001  -0E-
  1  8  1 99                                JANAF 6-30-65              O-
```

INPUT - SAMPLE PROBLEM 1

```
 242999+5 134819+5 497058+1-566327-6 190609+5 492849+2   500  30001    -00-
 242999+5 134819+5 496546+1 402558-6 389305+5 492849+2  3000  60001    -00-
  1  6  1 99  0  0  0  0  0  0  0  0  0 UJANAF TAPE 7/71  9/65           C-
 140499+6 134412+5 492461+1 271340-4 955979+4 476326+2  500, 2500,1   -0,C-
 140499+6 134276+5 277636+1 523408-3 568184+7 476277+2 2500, 6000,1   -0,C-
  1  6  1  8 -1 99                         CONVAIR ZPH-122 12/61        CO+
+294283+6+243830+5+893619+1+378000-4-150900+7+666595+22000, 10000,1     CO+
+294283+6+243830+5+893619+1+378000-4-150900+7+666595+22000, 10000,1     CO+
  1  6 -1 99                               CONVAIR ZPH-122 12/61        C+
+428985+6+150120+5+489657+1+180700-4+340000+5+484232+22000, 10000,1     C+
+428985+6+150120+5+489657+1+180700-4+340000+5+484232+22000, 10000,1     C+
  1  7 -1 99                               CONVAIR ZPH-122 12/61        N+
+446641+6+151310+5+501751+1+617100-4-184100+7+496847+22000, 10000,1     N+
+446641+6+151310+5+501751+1+617100-4-184100+7+496847+22000, 10000,1     N+
  1  7  1  8 -1 99                         JANAF 6-30-66                NO+
 236659+6 221499+5 792263+1 320385-3-313163+6 653320+2   500  30001   -0NO+
 236659+6 221499+5 892163+1 385863-4-169555+7 653320+2  3000  60001   -0NO+
  2  7 -1 99                               CONVAIR ZPH-122 12/61        N2+
+357258+6+251470+5+136508+2-327940-3-225630+8+656601+22000, 10000,1     N2+
+357258+6+251470+5+136508+2-327940-3-225630+8+656601+22000, 10000,1     N2+
  1  8 -1 99                               CONVAIR ZPH-122 12/61        O+
+371999+6+149290+5+336271+1+306710-3+590200+7+484849+22000, 10000,1     O+
+371999+6+149290+5+336271+1+306710-3+590200+7+484849+22000, 10000,1     O+
  1  6  1  7 -1 99                            JANAF 6/69     KS         CN+
 429399+6 238859+5 811795+1 517816-3-138643+6 702739+2   300  30001   -0CN+
 429399+6 238859+5 102410+2-992339-5-499752+7 702739+2  3000  60001   -0CN+

 10
  1  2  3  4  5  6  7  8  9 10
 10 10
 0.             .05             .125            .250            .375            .500
 .625           .750            .875            1.000
 1.33
 1.201          1.201           1.201           1.200           1.199           1.196
 1.192          1.185           1.177           1.164
 8663.          9814.           10075.          10291.          10407.          10486.
 10544.         10590.          10633.          10690.

 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 .2676        .0193        .7131
 1.
```

INPUT - SAMPLE PROBLEM 1

DECK A

GROUP	HV	HV+	HV-	N	NAME	K(I)	HV(I)	F(I)	GAM(I)	EXPN(I)	NOL
1	,690	,800	,600	5	O	16	,685	1,96-01	1.10-21	4.60-01	6,
					C	46	,686	4.40-02	3.21-21	3.95-01	3,
					N	30	,689	1.60-01	1,87-20	2.50-01	6,
					C	47	,710	2,06-01	6,39-18	1,34-01	4,
					N	29	,752	1.49-02	4,06-21	2.50-01	1,
2	,890	,950	,810	6	C	46	,844	8.08-02	4.12-21	3.54-01	3.
					C	45	,852	6.87-02	1.06-21	4.57-01	1,
					N	29	,875	3.66-02	3.60-21	2.50-01	4.
					O	15	,884	1.57-01	3.67-21	4.60-01	1,
					N	28	,916	6.50-03	7.00-18	2.50-01	1,
					N	30	,930	2,53-02	3,67-20	2.50-01	2,
3	1,050	1,200	,960	8	N	30	,965	2.62-02	3.67-20	2.50-01	4,
					O	16	.991	8.05-02	3,09-20	4.60-01	2,
					C	47	1,019	3.2[illegible]-02	2.05-19	6.12-01	4,
					N	29	1.036	7.35-02	3,31-21	2.50-01	7,
					C	46	1.063	1.01-01	3.29-21	3.54-01	8,
					O	15	1,078	7,49-01	3.44-21	4.60-01	1,
					O	14	1.132	2.01-01	3.67-21	4.60-01	1,
					C	45	1.163	4,73-01	1.04-21	4,02-01	1,
4	1,290	1,400	1,200	6	C	46	1.228	2.85-02	2.62-21	3.63-01	1,
					N	29	1.261	1.16-01	3.12-21	2.50-01	3,
					N	28	1.319	1.03-01	9.64-22	2.50-01	1,
					C	45	1,326	2,06-01	1,36-21	3,47-01	3,
					O	14	1.339	9,13-01	3.42-21	4.60-01	1,
					N	29	1.368	3.67-02	2.92-21	2.50-01	1,
5	1,460	1,600	1,400	5	N	28	1.438	2.59-01	8,24-22	2,50-01	3,
					O	13	1,467	9.50-01	8.65-22	4.60-01	1.
					C	45	1,467	4.05-02	2.18-21	2,91-01	1,
					N	29	1.553	3.00-03	2.93-20	2.50-01	1.
					O	12	1.594	1.03+00	7.09-22	4.60-01	1,
6	1,850	2,400	1,620	5	N	28	1.563	9.23-02	9.56-22	2.50-01	1,
					O	15	1.767	2.26-02	2,73-20	4.60-01	3,
					C	46	1,814	3.90-03	3.50-20	3.76-01	5,
					N	29	1.836	5.60-03	6,00-16	2,50-01	5,
					O	14	2,015	2,58-02	2,75-20	4,60-01	3,
7	2,850	3,500	2,400	4	N	28	2,925	7.00-03	1.06-20	2.50-01	3,
					O	13	3,000	1.00-02	8.10-21	4.60-01	2,
					O	12	3.167	8,26-03	5.20-21	4,60-01	1,
					N	28	3,472	8,60-03	1,00-16	2,50-01	3,
8	3,700	4,000	3,400	1	O	12	3.711	1,43-02	1.10-20	4.60-01	1,
9	5,000	6,000	4,000	1	C	43	5,002	6.76-02	1.13-21	3.15-01	1,
10	7,110	8,000	6,200	8	C	42	6.424	7,29-02	1.13-21	3.15-01	1,
					C	43	7.013	1.41-02	5,00-21	3.39-01	1,
					C	43	7,078	7.48-02	2.52-21	3.61 01	1.
					N	27	7.111	6.34-02	9.12-22	2.50-01	1,
					C	41	7.481	1,05-01	8,73-22	3.23-01	1,
					C	43	7.717	5,34-03	2.20-20	3.26-01	1,
					C	43	7.721	3,67-02	1.09-19	6.26-01	1,
					C	41	7.947	2.83-01	2.08-22	9.57-01	1,
11	8,400	9,000	8,000	10	C	43	8,036	4.57-03	6.90-19	8.40-01	1,
					C	43	8,191	1.16-02	1.30-18	7,52-01	1,
					C	43	8.203	1,47-03	1.19-19	3.30-01	1,
					C	43	8.302	8,31-03	5.38-18	2.69-01	1,
					N	26	8.302	7.40-02	9.12-22	2.50-01	1,
					C	42	8,368	1.10-02	2,14-21	4,77-01	1,
					C	43	8,377	5,01-03	6,77-18	8,48-01	1,

OUTPUT - SAMPLE PROBLEM 1

					C	42	8,433	1.42-02	5.00-21	3.39-01	1.
					C	42	8,474	6,25-02	2,48-21	3.79-01	1.
					N	27	8.781	4.35-02	6.61-22	2.50-01	1.
12	9,400	10,000	8,800	9	C	42	9.159	4,15-02	9.60-20	6.20-01	1.
					N	27	9.301	1.65-02	4.46-21	2,50-01	1.
					C	41	9,332	2,03-01	5.57-23	1.06+00	1.
					N	27	9.394	1.19-02	2.29-21	2.50-01	1.
					C	42	9,450	2.18-02	6,99-19	8,19-01	1.
					N	27	9.460	3.60-02	3.36-21	2.50-01	1.
					O	9	9.501	4.71-02	5,48-22	4,60-01	1.
					C	42	9.612	1.28-02	1.17-18	7.50-01	1.
					C	41	9.697	2.33-02	8,57-21	3,42-01	1.
13	10,070	10,450	9,700	11	C	41	9.709	7.67-02	2.35-21	3.72-01	1.
					C	42	9.722	8.19-03	5.58-19	2,89-01	1.
					C	42	9.797	4.58-03	6.77-18	8,44-01	1.
					C	41	9.834	2.00-02	2.93-21	3,22-01	1.
					N	26	9,973	8.90-02	4.61-22	2.50-01	1.
					N	27	10,102	3,74-02	2.75-20	2.50-01	1.
					O	11	10.182	1.51-01	6.53-22	4,60-01	1.
					N	25	10.332	1.89-01	6.21-22	2.50-01	1.
					C	41	10.401	7.19-03	2.21-20	[illegible]	1.
					C	41	10.405	4,95-02	1.09-19	6.26-01	1.
					N	27	10.418	2.25-02	5.32-20	2.50-01	1.
14	10,620	10,800	10,450	7	N	26	10,473	1.57-02	4,96-20	2.50-01	1.
					N	27	10.565	1.31-02	7.96-20	2.50-01	1.
					N	26	10.619	5.33-02	3.12-21	2.50-01	1.
					N	27	10.682	6.10-03	9.00-15	2.50-01	1.
					C	41	10,714	2.48-02	6.99-19	8.19-01	1.
					N	27	10.757	3.10-03	8.00-15	2.50-01	1.
					O	10	10.761	1.20-01	6.53-22	4.60-01	1.
15	11,200	11,700	10,800	12	C	42	10.873	7,05-01	6,39-21	-5.46-01	1.
					C	41	10.875	1.55-02	1.30-18	7.53-01	1.
					C	41	10.887	1.95-03	1.19-19	3.31-01	1.
					N	25	10.927	4,54-01	1.61-23	2.50-01	1.
					C	41	10.986	1.10-02	2.55-19	3,28-01	1.
					O	11	11.007	1.05-02	3.67-21	4,60-01	1.
					C	41	11.061	6,59-03	6.77-18	8,48-01	1.
					N	27	11.200	2,00-02	4.46-21	2.50-01	1.
					N	26	11.293	8,18-02	2.93-20	2.50-01	1.
					N	27	11.310	2.54-02	3.23-21	2,50-01	1.
					N	31	11.428	2.26-01	1.43-23	2.50-01	1.
					N	26	11,609	2.50-02	5,32-20	2.50-01	1.
16	11,900	12,100	11,700	7	N	26	11.776	2.20-02	7,96-20	2.50-01	1.
					O	11	11.806	4.90-03	1.45-20	4.60-01	1.
					O	9	11.852	1.99-02	3.67-21	4,60-01	1.
					N	26	11,874	9.10-03	2.68-19	2.50-01	1.
					N	26	11,948	5.70-03	5.00-15	2.50-01	1.
					N	27	12.000	2.69-02	2.99-20	2.50-01	1.
					O	9	12.067	2.18-02	3.44-21	4,60-01	1.
17	12,410	12,300	12,100	8	O	11	12.160	1.90-03	1.28-20	4.60-01	1.
					C	43	12,181	1.05+00	1.59-22	1.61-01	1.
					N	27	12.316	1.56-02	6.96-20	2.50-01	1.
					O	10	12.404	4.61-02	6.53-22	4.60-01	1.
					N	26	12.416	5.74-02	3.90-21	2.50-01	1.
					N	26	12.511	2.79-02	3.37-21	2.50-01	1.
					O	9	12.521	7.75-02	6.33-22	4.60-01	1.
					O	9	12.651	5.24-03	1.45-20	4.60-01	1.
18	13,040	13,400	12,800	4	N	25	12,877	2.30-02	4,46-21	2.50-01	1.
					N	25	13,008	1.32-01	2.94-21	2.50-01	1.
					C	41	13,119	3,79-01	1,01-21	-4,22-01	1.

					N	26	13.190	4.89-02	2.99-20	2.50-01	1.
					N	26	13.508	2.91-02	6.96-19	2.50-01	1.
19	13,560	13,800	13,400	4	N	31	13.543	1.61-01	9.50-24	2.50-01	1.
					C	42	13.601	2.95-01	1.59-22	1.61-01	1.
					N	25	13.677	9.57-02	2.93-20	2.50-01	1.
					N	25	13.993	5.84-02	5.32-20	2.50-01	1.
20	14,200	14,500	13,800	4	N	25	14.160	3.42-02	7.96-20	2.50-01	1.
					N	25	14.257	2.12-02	2.60-19	2.50-01	1.
					N	25	14.332	1.38-02	4.37-19	2.50-01	1.

CASE = VENUS RADIATION FLUX

RADIATION CONTROL NUMBERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	0	0	0	5	0	1	0	1	1	3	0	0	0	0	0	0	0	0	0

CHEMISTRY CONTROL NUMBERS	1	2	3	4	5	6	7	8	9	10
	0	1	1	0	0	0	0	0	0	0

FLOW CONTROL NUMBERS	1	2	3	4	5	6	7	8	9	10
	2	3	0	0	0	0	1	2	0	1

RADIATIVE BOUNDARY CONDITIONS

------CONTINUUM------

FREQ. (EV)	WAVE LENGTH (A)	EMITTANCE WALL	EMITTANCE /OUTER BOUND.	TRANSMITTANCE WALL	TRANSMITTANCE /OUTER BOUND.
.020	.620+06	.000	.000	1.000	1.000
.100	.124+06	.000	.000	1.000	1.000
.200	.620+05	.000	.000	1.000	1.000
.500	.248+05	.000	.000	1.000	1.000
.600	.207+05	.000	.000	1.000	1.000
.800	.155+05	.000	.000	1.000	1.000
1.000	.124+05	.000	.000	1.000	1.000
1.500	.827+04	.000	.000	1.000	1.000
2.000	.620+04	.000	.000	1.000	1.000
2.500	.496+04	.000	.000	1.000	1.000
2.750	.451+04	.000	.000	1.000	1.000
3.000	.413+04	.000	.000	1.000	1.000
3.250	.382+04	.000	.000	1.000	1.000
3.500	.354+04	.000	.000	1.000	1.000
3.750	.331+04	.000	.000	1.000	1.000
4.000	.310+04	.000	.000	1.000	1.000
4.500	.276+04	.000	.000	1.000	1.000
5.000	.248+04	.000	.000	1.000	1.000
6.000	.207+04	.000	.000	1.000	1.000
7.000	.177+04	.000	.000	1.000	1.000
8.000	.155+04	.000	.000	1.000	1.000
8.500	.146+04	.000	.000	1.000	1.000
8.520	.145+04	.000	.000	1.000	1.000
8.980	.138+04	.000	.000	1.000	1.000
9.030	.138+04	.000	.000	1.000	1.000
9.190	.135+04	.000	.000	1.000	1.000
9.210	.135+04	.000	.000	1.000	1.000
9.990	.124+04	.000	.000	1.000	1.000
10.010	.124+04	.000	.000	1.000	1.000
10.790	.115+04	.000	.000	1.000	1.000
10.810	.115+04	.000	.000	1.000	1.000
11.000	.113+04	.000	.000	1.000	1.000
11.250	.110+04	.000	.000	1.000	1.000
11.270	.110+04	.000	.000	1.000	1.000
11.990	.103+04	.000	.000	1.000	1.000
12.010	.103+04	.000	.000	1.000	1.000
12.180	.102+04	.000	.000	1.000	1.000
12.200	.102+04	.000	.000	1.000	1.000
12.980	.955+03	.000	.000	1.000	1.000
13.000	.954+03	.000	.000	1.000	1.000
13.390	.926+03	.000	.000	1.000	1.000

------LINE GROUPS------

FREQ. (EV)	WAVE LENGTH (A)	EMITTANCE WALL	EMITTANCE /OUTER BOUND.	TRANSMITTANCE WALL	TRANSMITTANCE /OUTER BOUND
.690	.180+05	.000	.000	1.000	1.000
.890	.139+05	.000	.000	1.000	1.000
1.050	.118+05	.000	.000	1.000	1.000
1.290	.961+04	.000	.000	1.000	1.000
1.460	.849+04	.000	.000	1.000	1.000
1.650	.672+04	.000	.000	1.000	1.000
2.850	.435+04	.000	.000	1.000	1.000
3.700	.335+04	.000	.000	1.000	1.000
5.070	.244+04	.000	.000	1.000	1.000
7.110	.174+04	.000	.000	1.000	1.000
8.470	.148+04	.000	.000	1.000	1.000
9.470	.132+04	.000	.000	1.000	1.000
10.070	.123+04	.000	.000	1.000	1.000
10.620	.117+04	.000	.000	1.000	1.000
11.290	.111+04	.000	.000	1.000	1.000
11.900	.104+04	.000	.000	1.000	1.000
12.410	.999+03	.000	.000	1.000	1.000
13.040	.951+03	.000	.000	1.000	1.000
13.580	.913+03	.000	.000	1.000	1.000
14.200	.873+03	.000	.000	1.000	1.000

13,410	.925+03	.000	.000	1.000	1.000
13,590	.912+03	.000	.000	1.000	1.000
13,610	.911+03	.000	.000	1.000	1.000
14,290	.866+03	.000	.000	1.000	1.000
14,310	.867+03	.000	.000	1.000	1.000
14,550	.852+03	.000	.000	1.000	1.000
15.000	.827+03	.000	.000	1.000	

OUTPUT - SAMPLE PROBLEM 1

```
                THERMODYNAMIC STATES ACROSS THE LAYER -STARTING WITH WALL

        TEMP=   8662.9989 DEG-K      PRES =     1.201 ATM      MOL WT = 14.8001602
         ENTHALPY =   .9408498+04 CAL/GM    ENTROPY =   .38372+01 CAL/GM-DEG K
         DENSITY =   .250049-04 GM/CM3

     SPECIES   MOLE FR.         SPECIES   MOLE FR.         SPECIES   MOLE FR.
     C            .29157+00     N            .20221-01     O            .63424+00
     E-           .14760-01     CO           .24154-01     N2           .18799-04
     O2           .53910-04     CN           .44961-04     CO2          .59259-06
     C2           .10990-03     C3           .90892-08     NO           .37424-04
     O-           .11431-04     C-           .26425-05     CO+          .93570-04
     C+           .13659-01     N+           .42583-04     NO+          .68736-05
     N2+          .16315-07     O+           .97564-03     CN+          .50285-06

        TEMP=   9813.9989 DEG-K      PRES =     1.201 ATM      MOL WT = 14.1188456
         ENTHALPY =   .1076904+05 CAL/GM    ENTROPY =   .39850+01 CAL/GM-DEG K
         DENSITY =   .210562-04 GM/CM3

     SPECIES   MOLE FR.         SPECIES   MOLE FR.         SPECIES   MOLE FR.
     C            .27484+00     N            .19225-01     O            .62149+00
     E-           .40395-01     CO           .55164-02     N2           .31767-05
     O2           .22896-04     CN           .11747-04     CO2          .36908-07
     C2           .35911-04     C3           .70514-09     NO           .11364-04
     O-           .17684-04     C-           .41573-05     CO+          .60570-04
     C+           .36050-01     N+           .19318-03     NO+          .44437-05
     N2+          .17136-07     O+           .41083-02     CN+          .55019-06

        TEMP=  10074.9987 DEG-K      PRES =     1.201 ATM      MOL WT = 13.9777044
         ENTHALPY =   .1108310+05 CAL/GM    ENTROPY =   .40166+01 CAL/GM-DEG K
         DENSITY =   .203057-04 GM/CM3

     SPECIES   MOLE FR.         SPECIES   MOLE FR.         SPECIES   MOLE FR.
     C            .26589+00     N            .18970-01     O            .61502+00
     E-           .48828-01     CO           .23461-02     N2           .22392-05
     O2           .19161-04     CN           .87973-05     CO2          .21500-07
     C2           .27630-04     C3           .39939-09     NO           .89930-05
     O-           .19179-04     C-           .43996-05     CO+          .54558-04
     C+           .43056-01     N+           .26125-03     NO+          .40411-05
     N2+          .17331-07     O+           .54752-02     CN+          .55369-06

        TEMP=  10290.9985 DEG-K      PRES =     1.200 ATM      MOL WT = 13.8534690
         ENTHALPY =   .1136109+05 CAL/GM    ENTROPY =   .40440+01 CAL/GM-DEG K
         DENSITY =   .196864-04 GM/CM3

     SPECIES   MOLE FR.         SPECIES   MOLE FR.         SPECIES   MOLE FR.
     C            .25747+00     N            .18733-01     O            .60675+00
     E-           .56629-01     CO           .16841-02     N2           .16808-05
     O2           .16577-04     CN           .69350-05     CO2          .13566-07
     C2           .22165-04     C3           .24963-09     NO           .73043-05
     O-           .20160-04     C-           .45567-05     CO+          .50097-04
     C+           .49385-01     N+           .33191-03     NO+          .38090-05
     N2+          .17447-07     O+           .66824-02     CN+          .54762-06

        TEMP=  10406.9990 DEG-K      PRES =     1.199 ATM      MOL WT = 13.7833544
         ENTHALPY =   .1151846+05 CAL/GM    ENTROPY =   .40593+01 CAL/GM-DEG K
```

OUTPUT - SAMPLE PROBLEM 1

```
       DENSITY =    ,193523-04 GM/CM3

    SPECIES   MOLE FR,          SPECIES   MOLE FR,          SPECIES   MOLE FR,
    C            ,25260+00      N             ,18595-01     O             ,60302+00
    E-           ,61134-01      CO            ,14174-02     N2            ,14442-05
    O2           ,15347-04      CN            ,61042-05     CO2           ,10626-07
    C2           ,19687-04      C3            ,19388-09     NO            ,65752-05
    O-           ,20646-04      C-            ,46244-05     CO+           ,47765-04
    C+           ,52974-01      N+            ,37605-03     NO+           ,36715-05
    N2+          ,17488-07      O+            ,77575-02     CN+           ,54461-06

      TEMP=  10485,9991 DEG-K      PRES =      1,196 ATM      MOL WT = 13,7333449
       ENTHALPY =     ,1163047+05 CAL/GM     ENTROPY =    ,40704+01 CAL/GM-DEG K
       DENSITY =    ,190899-04 GM/CM3

    SPECIES   MOLE FR,          SPECIES   MOLE FR,          SPECIES   MOLE FR,
    C            ,24909+00      N             ,18494-01     O             ,60350+00
    E-           ,64380-01      CO            ,12565-02     N2            ,13110-05
    O2           ,14537-04      CN            ,55844-05     CO2           ,89728-08
    C2           ,18097-04      C3            ,16248-09     NO            ,61113-05
    O-           ,20937-04      C-            ,46576-05     CO+           ,46172-04
    C+           ,55532-01      N+            ,40920-03     NO+           ,35777-05
    N2+          ,17469-07      O+            ,64140-02     CN+           ,54141-06

      TEMP=  10543,9993 DEG-K      PRES =      1,192 ATM      MOL WT = 13,6951567
       ENTHALPY =     ,1171578+05 CAL/GM     ENTROPY =    ,40790+01 CAL/GM-DEG K
       DENSITY =    ,188678-04 GM/CM3

    SPECIES   MOLE FR,          SPECIES   MOLE FR,          SPECIES   MOLE FR,
    C            ,24640+00      N             ,18416-01     O             ,60119+00
    E-           ,66874-01      CO            ,11465-02     N2            ,12036-05
    O2           ,13949-04      CN            ,52219-05     CO2           ,79340-08
    C2           ,16974-04      C3            ,14219-09     NO            ,57316-05
    O-           ,21122-04      C-            ,46733-05     CO+           ,44085-04
    C+           ,57483-01      N+            ,43539-03     NO+           ,35177-05
    N2+          ,17472-07      O+            ,69323-02     CN+           ,53330-06

      TEMP=  10589,9989 DEG-K      PRES =      1,185 ATM      MOL WT = 13,6628664
       ENTHALPY =     ,1178721+05 CAL/GM     ENTROPY =    ,40866+01 CAL/GM-DEG K
       DENSITY =    ,186315-04 GM/CM3

    SPECIES   MOLE FR,          SPECIES   MOLE FR,          SPECIES   MOLE FR,
    C            ,24412+00      N             ,18350-01     O             ,59339+00
    E-           ,68991-01      CO            ,10657-02     N2            ,11278-05
    O2           ,13854-04      CN            ,49323-05     CO2           ,70293-08
    C2           ,16064-04      C3            ,12691-09     NO            ,55176-05
    O-           ,21221-04      C-            ,46728-05     CO+           ,43774-04
    C+           ,59132-01      N+            ,45789-03     NO+           ,34474-05
    N2+          ,17426-07      O+            ,93782-02     CN+           ,53159-06

      TEMP=  10632,9991 DEG-K      PRES =      1,177 ATM      MOL WT = 13,6316087
       ENTHALPY =     ,1185614+05 CAL/GM     ENTROPY =    ,40941+01 CAL/GM-DEG K
       DENSITY =    ,183867-04 GM/CM3

    SPECIES   MOLE FR,          SPECIES   MOLE FR,          SPECIES   MOLE FR,
    C            ,24190+00      N             ,18255-01     O             ,59463+00
    E-           ,71047-01      CO            ,99231-03     N2            ,10300-05
    O2           ,12990-04      CN            ,46686-05     CO2           ,64047-08
    C2           ,15229-04      C3            ,11374-09     NO            ,52730-05
    O-           ,21292-04      C-            ,46660-05     CO+           ,43310-04
```

OUTPUT - SAMPLE PROBLEM 1

C+	,60727-01	N+	,48012-03	NO+	,33898-05
N2+	,17368-07	O+	,98187-02	CN+	,53057-06

TEMP= 10689,9990 DEG-K   PRES = 1,164 ATM   MOL WT = 13,5883874
ENTHALPY = ,1195115+05 CAL/GM   ENTROPY = ,41046+01 CAL/GM-DEG K
DENSITY = ,180313-04 GM/CM3

SPECIES	MOLE FR,	SPECIES	MOLE FR,	SPECIES	MOLE FR,
C	,23884+00	N	,18195-01	O	,59418+00
E-	,73900-0	CO	,90059-03	N2	,97432-06
O2	,12372-0.	CN	,43294-05	CO2	,55629-08
C2	,14144-04	C3	,97830-10	NO	,49544-05
O-	,21348-04	C-	,46467-05	CO+	,41699-04
C+	,62927-01	N+	,51154-03	NO+	,33112-05
N2+	,17269-07	O+	,10442-01	CN+	,52435-06

OUTPUT - SAMPLE PROBLEM 1

DELTA = 1.330000+00

NUMBER DENSITIES

O+	9.93+14	3.69+15	4.79+15	5.89+15	6.56+15	7.04+15	7.41+15	7.70+15	7.98+15	8.35+15
O	6.45+17	5.58+17	5.38+17	5.21+17	5.12+17	5.04+17	4.98+17	4.91+17	4.85+17	4.75+17
N+	4.33+13	1.74+14	2.29+14	2.84+14	3.18+14	3.43+14	3.61+14	3.76+14	3.90+14	4.09+14
N	2.06+16	1.73+16	1.66+16	1.60+16	1.57+16	1.55+16	1.53+16	1.51+16	1.49+16	1.45+16
C+	1.30+16	3.24+16	3.77+16	4.23+16	4.48+16	4.65+16	4.77+16	4.84+16	4.93+16	5.03+16
C	2.97+17	2.47+17	2.33+17	2.20+17	2.14+17	2.09+17	2.04+17	2.00+17	1.97+17	1.91+17
N2+	1.66+10	1.54+10	1.52+10	1.47+10	[illegible]	1.46+10	1.45+10	1.43+10	1.41+10	1.39+10
NO	3.81+13	1.02+13	7.79+12	6.25+12	5.56+12	5.12+12	4.80+12	4.53+12	4.28+12	3.96+12
O2	5.49+13	2.06+13	1.68+13	1.42+13	1.30+13	1.22+13	1.16+13	1.11+13	1.06+13	9.89+12
N2	1.91+13	2.87+12	1.96+12	1.44+12	1.22+12	1.09+12	9.99+11	9.26+11	8.61+11	7.79+11
CO	2.66+16	3.16+15	2.05+15	1.44+15	1.20+15	1.05+15	9.53+14	8.75+14	8.06+14	7.20+14
C2	1.12+14	3.23+13	2.42+13	1.90+13	1.66+13	1.51+13	1.41+13	1.32+13	1.24+13	1.13+13
CN	4.58+13	1.05+13	7.70+12	5.94+12	5.16+12	4.67+12	4.33+12	4.05+12	3.79+12	3.46+12
C-	2.69+12	3.73+12	3.85+12	3.90+12	3.91+12	3.90+12	[illegible]	3.84+12	3.79+12	3.71+12
O-	1.16+13	1.61+13	1.68+13	1.73+13	1.75+13	1.75+13	1.75+13	1.74+13	1.73+13	1.71+13
E-	1.50+16	3.63+16	4.27+16	4.85+16	5.17+16	5.39+16	5.55+16	5.67+16	5.77+16	5.91+16

OUTPUT - SAMPLE PROBLEM 1

CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX

NORMALIZED PATH LENGTH=	.00	.50-01	.13+00	.25+00	.38+00	.50+00	.63+00	.75+00	.88+00	.10+01
HV (EV)	GMINUS/GPLUS (WATTS/CM2-EV)									
.020	.00	.35+00	.15+01	.32+01	.43+01	.50+01	.54+01	.56+01	.57+01	.57+01
	.55+01	.55+01	.55+01	.56+01	.56+01	.55+01	.53+01	.47+01	.33+01	.00
.100	.00	.35+00	.17+01	.46+01	.80+01	.12+02	.15+02	.19+02	.23+02	.27+02
	.27+02	.27+02	.26+02	.23+02	.21+02	.17+02	.13+02	.92+01	[illegible]	.00
.200	.00	.34+00	.16+01	.45+01	.79+01	.12+02	.16+02	.20+02	.24+02	.29+02
	.28+02	.28+02	.27+02	.24+02	.21+02	.17+02	.13+02	.91+01	.47+01	.00
.500	.00	.30+00	.14+01	.40+01	.70+01	.10+02	.14+02	.18+02	.22+02	.26+02
	.26+02	.26+02	.24+02	.22+02	.19+02	.16+02	.12+02	.81+01	.41+01	.00
.600	.00	.28+00	.14+01	.38+01	.67+01	.10+02	.13+02	.17+02	.21+02	.25+02
	.25+02	.25+02	.23+02	.21+02	.18+02	.15+02	.11+02	.78+01	[illegible]	.00
.800	.00	.27+00	.13+01	.35+01	.61+01	.91+01	.12+02	.16+02	.19+02	.23+02
	.23+02	.22+02	.21+02	.19+02	.17+02	.14+02	.10+02	.71+01	.36+01	.00
1.000	.00	.25+00	.12+01	.32+01	.55+01	.82+01	.11+02	.14+02	.17+02	.21+02
	.21+02	.20+02	.19+02	.17+02	.15+02	.12+02	.94+01	.64+01	.33+01	.00
1.500	.00	.35+00	.14+01	.36+01	.61+01	.89+01	.12+02	.15+02	.18+02	.21+02
	.21+02	.21+02	.20+02	.18+02	.15+02	.12+02	.95+01	.65+01	.33+01	.00
2.000	.00	.37+[illegible]	.14+01	.34+01	.57+01	.83+01	.11+02	.14+02	.17+02	.20+02
	.20+02	.19+02	.18+02	.16+02	.14+02	.11+02	.86+01	.58+01	.29+01	.00
2.500	.00	.68+00	.18+01	.40+01	.64+01	.90+01	.12+02	.14+02	.17+02	.20+02
	.20+02	.19+02	.18+02	.16+02	.14+02	.11+02	.84+01	.57+01	.29+01	.00
2.750	.00	.47+00	.14+01	.33+01	.55+01	.78+01	.10+02	.13+02	.15+02	.18+02
	.18+02	.17+02	.16+02	.15+02	.12+02	.10+02	.77+01	.52+01	.26+01	.00
3.000	.00	.39+00	.13+01	.30+01	.50+01	.72+01	.95+01	.12+02	.14+02	.17+02
	.17+02	.16+02	.15+02	.14+02	.12+02	.94+01	.72+01	.49+01	.25+01	.00
3.250	.00	.50+00	.14+01	.33+01	.54+01	.76+01	.99+01	.12+02	.15+02	.17+02
	.17+02	.17+02	.16+02	.14+02	.12+02	.97+01	[illegible]	.50+01	.25+01	.00
3.500	.00	.67+00	.19+01	.43+01	.70+01	.98+01	.13+02	.16+02	.19+02	.22+02
	.22+02	.21+02	.20+02	.18+02	.15+02	.12+02	.93+01	.62+01	.31+01	.00
3.750	.00	.61+00	.18+01	.41+01	.67+01	.94+01	.12+02	.15+02	.18+02	.21+02
	.21+02	.21+02	.19+02	.17+02	.15+02	.12+02	.89+01	.60+01	.30+01	.00
4.000	.00	.48+00	.15+01	.34+01	.56+01	.79+01	.10+02	.13+02	.15+02	.18+02
	.18+02	.18+02	.17+02	.15+02	.12+02	.10+02	.76+01	.51+01	.26+01	.00
4.500	.00	.38+00	.12+01	.28+01	.47+01	.67+01	.88+01	.11+02	.13+02	.16+02
	.16+02	.15+02	.14+02	.13+02	.11+02	.88+01	.67+01	.45+01	.23+01	.00
5.000	.00	.33+00	.93+00	.21+01	.35+01	.50+01	.66+01	.82+01	.98+01	.12+02
	.12+02	.11+02	.11+02	.94+01	.80+01	.65+01	.50+01	.34+01	.17+01	.00
6.000	.00	.60+00	.11+01	.20+01	.29+01	.39+01	.49+01	.59+01	.69+01	.80+01
	.80+01	.74+01	.69+01	.60+01	.51+01	.41+01	.31+01	.21+01	.11+01	.00
7.000	.00	.12+01	.17+01	.23+01	.28+01	.33+01	.39+01	.44+01	.50+01	.55+01
	.55+01	.43+01	.38+01	.32+01	.27+01	.22+01	.16+01	.11+01	.54+00	.00
8.000	.00	.83+01	.14+02	[illegible]	.30+02	.37+02	.44+02	.50+02	.56+02	.62+02
	.61+02	.54+02	.48+02	.40+02	.32+02	.25+02	.19+02	.12+02	.59+01	.00
8.500	.00	.48+01	.85+01	.14+02	.18+02	.23+02	.27+02	.31+02	.34+02	.38+02
	.37+02	.33+02	.30+02	.25+02	.20+02	.16+02	.12+02	.76+01	.37+01	.00
8.520	.00	.53+01	.11+02	.20+02	.29+02	.38+02	.47+02	.56+02	.66+02	.75+02
	.73+02	.69+02	[illegible]	.56+02	.47+02	.38+02	.29+02	.19+02	.98+01	.00
8.980	.00	.13+01	.32+01	.71+01	.11+02	.16+02	.20+02	.25+02	.30+02	.35+02
	.34+02	.33+02	.32+02	.28+02	.24+02	.20+02	.15+02	.10+02	.52+01	.00
9.000	.00	.12+01	.31+01	.68+01	.11+02	.15+02	.20+02	.24+02	.29+02	.34+02
	.33+02	.33+02	.31+02	.27+02	.23+02	.19+02	.15+02	.99+01	.50+01	.00
9.190	.00	.63+00	.20+01	.48+01	.83+01	.11+02	.15+02	.19+02	.23+02	.27+02

OUTPUT - SAMPLE PROBLEM 1

	.26+02	.26+02	.25+02	.22+02	.19+02	.15+02	.12+02	.80+01	.41+01	.00
9.210	.00	.59+00	.19+01	.46+01	.77+01	.11+02	.15+02	.18+02	.22+02	.26+02
	.26+02	.25+02	.24+02	.21+02	.16+02	.15+02	.12+02	.79+01	[illegible]	.00
9.990	.00	.15+00	.73+00	.20+01	.35+01	.52+01	.70+01	.89+01	.11+02	.13+02
	.13+02	.13+02	.12+02	.11+02	.94+01	.76+01	[illegible]	[illegible]	.21+01	.00
10.010	.00	.36+01	.16+02	.39+02	.63+02	.87+02	.11+03	.13+03	.15+03	.17+03
	.14+03	.15+03	.15+03	.15+03	.13+03	.12+03	.97+02	.71+02	.39+02	.00
10.790	.00	.17+01	.77+01	.20+02	.33+02	.45+02	.57+02	.69+02	.79+02	.90+02
	.75+02	.73+02	.79+02	.77+02	.71+02	.55+02	.52+02	.36+02	.21+02	.00
10.810	.00	.17+01	.76+01	[illegible]	.22+02	.45+02	.57+02	.68+02	.79+02	.89+02
	.74+02	.77+02	.78+02	.76+02	.71+02	.62+02	.51+02	.37+02	.20+02	.00
11.000	.00	.14+01	.60+01	.16+02	.27+02	.38+02	.48+02	.58+02	.67+02	.75+02
	.63+02	.66+02	.66+02	.65+02	.60+02	.56+02	.44+02	.32+02	.18+02	.00
11.250	.00	.11+01	.51+01	.13+02	.22+02	.31+02	.39+02	.47+02	.54+02	.61+02
	.51+02	.53+02	.54+02	.53+02	[illegible]	.43+02	.35+02	.26+02	.14+02	.00
11.270	.00	.65+01	.23+02	.45+02	.62+02	.74+02	.83+02	.90+02	.96+02	.10+03
	.43+02	.57+02	.67+02	.78+02	.85+02	.89+02	.85+02	[illegible]	.55+02	.00
11.990	.00	.31+01	.12+02	.24+02	.33+02	.40+02	.45+02	.49+02	.52+02	.56+02
	.23+02	.30+02	.36+02	.42+02	.46+02	.48+02	.48+02	.44+02	.31+02	.00
12.010	.00	.31+01	.12+02	.24+02	.33+02	.39+02	.44+02	.48+02	.52+02	.55+02
	.22+02	.30+02	.35+02	.41+02	.45+02	.45+02	.48+02	.43+02	.31+02	.00
12.180	.00	.26+01	.99+01	.20+02	.28+02	.34+02	.38+02	.42+02	.45+02	.46+02
	.19+02	.25+02	.30+02	.36+02	.39+02	.41+02	.41+02	.37+02	.27+02	.00
12.230	.00	.25+01	.97+01	.20+02	.28+02	.33+02	.38+02	.41+02	.44+02	.47+02
	.19+02	.25+02	.30+02	.35+02	.39+02	.41+02	.40+02	.37+02	.26+02	.00
12.980	.00	.12+01	.47+01	.98+01	.14+02	.17+02	.19+02	.21+02	.22+02	.24+02
	.91+01	.12+02	.15+02	.18+02	.20+02	.21+02	.21+02	.19+02	.15+02	.00
13.000	.00	.11+01	.46+01	.95+01	.14+02	.16+02	.19+02	.21+02	.22+02	.24+02
	.90+01	.12+02	.15+02	.17+02	.19+02	.20+02	.20+02	.19+02	.15+02	.00
13.390	.00	.77+00	.32+01	.67+01	.95+01	.12+02	.13+02	.15+02	.16+02	.17+02
	.63+01	.85+01	.10+02	.12+02	.14+02	.14+02	.15+02	.13+02	.94+01	.00
13.410	.00	.12+01	.44+01	.82+01	.11+02	.13+02	.14+02	.15+02	.16+02	.17+02
	.64+01	.71+01	.91+01	.12+02	.13+02	.14+02	.15+02	.15+02	.13+02	.00
13.590	.00	.10+01	.37+01	.69+01	.91+01	.11+02	.12+02	.13+02	.14+02	.15+02
	.37+01	.60+01	.77+01	.98+01	.11+02	.12+02	.13+02	.13+02	.11+02	.00
13.610	.00	.98+00	.36+01	.68+01	.90+01	.11+02	.12+02	.13+02	.14+02	.14+02
	.36+01	.59+01	.76+01	.96+01	.11+02	.12+02	.13+02	.13+02	.11+02	.00
14.290	.00	.50+00	.19+01	.36+01	.48+01	.57+01	.64+01	.69+01	.75+01	.80+01
	.19+01	.31+01	.41+01	.52+01	.60+01	.66+01	.70+01	.71+01	.60+01	.00
14.310	.00	.49+00	.19+01	.35+01	.48+01	.56+01	.63+01	.68+01	.73+01	.79+01
	.18+01	.31+01	.40+01	.51+01	.59+01	.65+01	.69+01	.70+01	.59+01	.00
14.550	.00	.39+00	.15+01	.29+01	.38+01	.45+01	.51+01	.55+01	.59+01	.64+01
	.14+01	.24+01	.32+01	.41+01	.47+01	.52+01	.56+01	.57+01	.48+01	.00
15.000	.00	.24+00	.97+00	.19+01	.25+01	.30+01	.34+01	.37+01	.40+01	.43+01
	.94+00	.16+01	.21+01	.27+01	.32+01	.35+01	.37+01	.38+01	.32+01	.00

FREQUENCY INTEGRATED VALUES

.00	.23+02	.66+02	.14+03	.20+03	.26+03	.32+03	.38+03	.43+03	.48+03
.38+03	.39+03	.39+03	.38+03	.35+03	.32+03	.27+03	.21+03	.13+03	.00

OUTPUT - SAMPLE PROBLEM 1

LINE RADIATION

NORMALIZED DIST = .00 .50-01 .13+00 .25+00 .38+00 .50+00 .63+00 .75+00 .88+00 .10+01

POSITIVE AND NEGATIVE CONTRIBUTIONS (WATTS/CM2)

GROUP NO.	FREQUENCY (EV)	.00	.50-01	.13+00	.25+00	.38+00	.50+00	.63+00	.75+00	.88+00	.10+01
1	.690	.21+02	.20+02	.19+02	.17+02	.15+02	.12+02	.94+01	.64+01	.33+01	.31-03
		.24-03	.38+00	.14+01	.36+01	.61+01	.88+01	.12+02	.15+02	.18+02	.21+02
2	.890	.14+02	.14+02	.13+02	.12+02	.10+02	.88+01	.69+01	.48+01	.26+01	.11-03
		.92-04	.37+00	.13+01	.31+01	.49+01	.68+01	.86+01	.10+02	.12+02	.14+02
3	1.050	.62+02	.62+02	.60+02	.55+02	.49+02	.42+02	.34+02	.24+02	.14+02	.92-04
		.12-03	.26+01	.72+01	.15+02	.24+02	.33+02	.41+02	.49+02	.56+02	.64+02
4	1.290	.36+02	.36+02	.36+02	.34+02	.31+02	.28+02	.23+02	.18+02	.11+02	.61-04
		.31-04	.22+01	.60+01	.11+02	.17+02	.21+02	.26+02	.30+02	.34+02	.38+02
5	1.460	.18+02	.18+02	.18+02	.17+02	.15+02	.14+02	.12+02	.89+01	.55+01	.15-03
		.12-03	.94+00	.26+01	.52+01	.77+01	.10+02	.12+02	.15+02	.17+02	.19+02
6	1.850	.59+01	.59+01	.56+01	.50+01	.43+01	.35+01	.27+01	.18+01	.93+00	.98-03
		.24-03	.83-01	.30+00	.96+00	.17+01	.24+01	.33+01	.41+01	.50+01	.59+01
7	2.850	.10+01	.10+01	.98+00	.88+00	.77+00	.63+00	.49+00	.33+00	.17+00	.44-02
		.20-02	.14-01	.56-01	.15+00	.27+00	.40+00	.55+00	.70+00	.85+00	.10+01
8	3.700	.12+01	.12+01	.11+01	.10+01	.90+00	.74+00	.58+00	.40+00	.20+00	.61-03
		.92-04	.11-01	.53-01	.16+00	.29+00	.44+00	.61+00	.79+00	.98+00	.12+01
9	5.000	.67+02	.67+02	.65+02	.60+02	.53+02	.45+02	.36+02	.26+02	.15+02	.73-03
		.12-03	.26+01	.63+01	.14+02	.22+02	.31+02	.41+02	.50+02	.60+02	.70+02
10	7.110	.14+03	.16+03	.16+03	.16+03	.15+03	.14+03	.12+03	.98+02	.69+02	.29-03
		.42-04	.19+02	.34+02	.60+02	.85+02	.11+03	.13+03	.15+03	.17+03	.19+03
11	8.400	.26+02	.29+02	.30+02	.30+02	.29+02	.27+02	.24+02	.20+02	.15+02	.23-04
		.38-05	.33+01	.67+01	.12+02	.16+02	.21+02	.25+02	.29+02	.32+02	.36+02
12	9.400	.90+02	.96+02	.98+02	.97+02	.91+02	.83+02	.71+02	.56+02	.36+02	.38-04
		.29-05	.58+01	.15+02	.31+02	.47+02	.62+02	.76+02	.90+02	.10+03	.11+03
13	10.070	.94+00	.62+01	.10+02	.16+02	.21+02	.24+02	.27+02	.25+02	.25+02	.76-05
		.60-06	.41+01	.10+02	.17+02	.20+02	.22+02	.23+02	.24+02	.23+02	.23+02
14	10.620	.40+00	.43+01	.77+01	.12+02	.16+02	.19+02	.21+02	.21+02	.17+02	.38-05
		.18-06	.22+01	.69+01	.12+02	.15+02	.17+02	.18+02	.18+02	.18+02	.17+02
15	11.200	.62-01	.36+01	.64+01	.10+02	.13+02	.15+02	.17+02	.17+02	.13+02	.38-05
		.24-06	.18+01	.55+01	.98-01	.12+02	.14+02	.15+02	.15+02	.15+02	.15+02
16	11.900	-.44+00	-.31+00	-.25+00	-.15+00	-.63-01	.72-01	.29+00	.64+00	.10+01	.14-05
		.60-07	.21+00	.37+00	.43+00	.38+00	.31+00	.25+00	.21+00	.18+00	.19+00
17	12.410	-.32+00	-.22+00	-.17+00	-.11+00	-.53-01	.34-01	.18+00	.40+00	.69+00	.95-06
		.45-07	.17+00	.26+00	.28+00	.25+00	.21+00	.17+00	.14+00	.12+00	.13+00

18	13.040	-.18+00	-.13+00	-.10+00	-.65-01	-.31-01	.20-01	.10+00	.23+00	.38+00	.48-06
		.15-07	.88-01	.14+00	.15+00	.14+00	.12+00	.19+00	.83-01	.73-01	.77-01
19	13.580	-.40-01	-.26-01	-.21-01	-.15-01	-.12-01	-.79-02	-.26-03	.21-01	.76-01	.18-06
		.75-08	.27-01	.34-01	.29-01	.21-01	.16-01	.13-01	.11-01	.10-01	.12-01
20	14.200	-.47-01	-.28-01	-.23-01	-.17-01	-.13-01	-.80-02	.22-02	.50-01	.91-01	.24-06
		.56-08	.21-01	.36-01	.33-01	.25-01	.19-01	.15-01	.13-01	.11-01	.13-01
TOTAL POS=		.49+03	.52+03	.53+03	.52+03	.50+03	.46+03	.40+03	.35+03	.23+03	.78-02
TOTAL NEG=		.31-02	.46+02	.11+03	.20+03	.28+03	.36+03	.43+03	.50+03	.56+03	.63+03

OUTPUT - SAMPLE PROBLEM 1

4.2 SAMPLE PROBLEM 2

This sample problem is identical to the first sample problem, except that the results are presented in the extensive output format. The input data decks are identical except for the following changes:

Sample Problem 1	Sample Problem 2
KR(17) = 0	KR(17) = 1
NIC = 10	NIC = 1
NICN(I) = 1,2,3,...10	NICN(L)= 1

which must be made to implement this option. The first set of continuum output includes black body emissive powers (B), continuum absorption coefficients (FMU) and optical depths of the 60 degree ray (TAU) as a function of frequency (HV) and for each spatial point across the layer. The second set of continuum output summarizes the flux values at the spatial position ($y/\delta = 0$) specified for print-out. The next set of output data gives the line transport at the spatial point specified for print-out. Finally, a line radiation summary is presented. Recall that the spectral flux presented in this output block is an artifice, defined as the frequency integrated flux assigned to the line group divided by the frequency increment assigned to the line group.

EXTENSIVE CONTINUUM OUTPUT:

HV= .200000-01

B	.466485+01	.529298+01	.543542+01	.555330+01	.561660+01
	.565972+01	.569137+01	.571647+01	.573994+01	.577105+01
FMU	.216425+00	.110055+01	.148328+01	.186654+01	.209869+01
	.226313+01	.238522+01	.247597+01	.255880+01	.266415+01
TAU	.000000	.723035-01	.255841+00	.554469+00	.658466+00
	.724809+00	.772610+00	.808079+00	.836955+00	.868198+00

HV= .100000+00

B	.110457+03	.126141+03	.129698+03	.132642+03	.134223+03
	.135300+03	.136090+03	.136717+03	.137303+03	.138080+03
FMU	.887824-02	.448675-01	.603988-01	.759347-01	.853381-01
	.919952-01	.969357-01	.100606+00	.103954+00	.108210+00
TAU	.000000	.295447-02	.104237-01	.225670-01	.267812-01
	.294678-01	.314026-01	.328375-01	.340050-01	.352676-01

HV= .200000+00

B	.412280+03	.474766+03	.488946+03	.500083+03	.50·?85+03
	.511282+03	.514434+03	.516935+03	.519272+03	.5·2371+03
FMU	.229096-02	.114849-01	.154369-01	.193844-01	.217714-01
	.234601-01	.247127-01	.255424-01	.264901-01	.275670-01
TAU	.000000	.758529-03	.266605-02	.576415-02	.683447-02
	.751624-02	.800692-02	.837058-02	.866626-02	.898580-02

HV= .500000+00

B	.207499+04	.245487+04	.254143+04	.261315+04	.265170+04
	.267796+04	.269725+04	.271255+04	.272686+04	.274583+04
FMU	.402925-03	.96821-02	.263254-02	.329312-02	.369136-02
	.397248-02	.418063-02	.433471-02	.447497-02	.465274-02

MANY PAGES OF OUTPUT HAVE

BEEN OMITTED

CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX

Y/DELTA= .00

HV (EV)	QMINUS (WATTS/ CM2 EV)	PARTIAL SPECTRAL INTEGRAL OF QMINUS (WATTS/CM2)	NORMALIZED QMINUS CONTRIBUTION (PERCENT TOTAL)	QPLUS (WATTS/ CM2 EV)	PARTIAL SPECTRAL INTEGRAL OF QPLUS (WATTS/CM2)	NORMALIZED QPLUS CONTRIBUTION (PERCENT TOTAL)
.020	.000	.000	.000	.546+01	.000	.000
.100	.000	.000	.000	.272+02	.131+01	.343-02
.200	.000	.000	.000	.285+02	.409+01	.107-01
.500	.000	.000	.000	.259+02	.123+02	.321-01
.600	.000	.000	.000	.248+02	.140+02	.368-01
.800	.000	.000	.000	.227+02	.195+02	.512-01
1.000	.000	.000	.000	.205+02	.239+02	.626-01
1.500	.000	.000	.000	.214+02	.343+02	.901-01
2.000	.000	.000	.000	.195+02	.446+02	.117+00
2.500	.000	.000	.000	.201+02	.545+02	.143+00
2.750	.000	.000	.000	.179+02	.592+02	.155+00
3.000	.000	.000	.000	.166+02	.635+02	.167+00
3.250	.000	.000	.000	.173+02	.678+02	.178+00
3.500	.000	.000	.000	.220+02	.727+02	.191+00
3.750	.000	.000	.000	.212+02	.781+02	.205+00
4.000	.000	.000	.000	.180+02	.830+02	.218+00
4.500	.000	.000	.000	.155+02	.914+02	.240+00
5.000	.000	.000	.000	.115+02	.982+02	.257+00
6.000	.000	.000	.000	.801+01	.106+03	.283+00
7.000	.000	.000	.000	.549+01	.115+03	.301+00
8.000	.000	.000	.000	.607+02	.148+03	.387+00
8.500	.000	.000	.000	.374+02	.172+03	.452+00
8.520	.000	.000	.000	.727+02	.173+03	.455+00
8.980	.000	.000	.000	.345+02	.198+03	.519+00
9.000	.000	.000	.000	.335+02	.199+03	.521+00
9.190	.000	.000	.000	.262+02	.204+03	.535+00
9.210	.000	.000	.000	.256+02	.205+03	.537+00
9.990	.000	.000	.000	.127+02	.220+03	.576+00
10.010	.000	.000	.000	.143+03	.221+03	.581+00
10.790	.000	.000	.000	.747+02	.306+03	.803+00
10.810	.000	.000	.000	.737+02	.308+03	.807+00
11.000	.000	.000	.000	.628+02	.321+03	.841+00
11.250	.000	.000	.000	.508+02	.335+03	.876+00
11.270	.000	.000	.000	.430+02	.336+03	.880+00
11.990	.000	.000	.000	.225+02	.359+03	.942+00
12.010	.000	.000	.000	.221+02	.360+03	.943+00
12.180	.000	.000	.000	.189+02	.363+03	.953+00
12.200	.000	.000	.000	.186+02	.364+03	.954+00
12.980	.000	.000	.000	.912+01	.375+03	.982+00
13.000	.000	.000	.000	.895+01	.375+03	.982+00
13.390	.000	.000	.000	.625+01	.378+03	.990+00
13.410	.000	.000	.000	.440+01	.378+03	.990+00
13.590	.000	.000	.000	.370+01	.378+03	.992+00
13.610	.000	.000	.000	.363+01	.379+03	.993+00
14.290	.000	.000	.000	.188+01	.380+03	.997+00
14.310	.000	.000	.000	.185+01	.380+03	.998+00
14.550	.000	.000	.000	.145+01	.381+03	.999+00
15.000	.000	.000	.000	.944+00	.381+03	.100+01

```
                                   LINE TRANSPORT QUANTITIES AT YY =  .000
LINE GROUP NO. 1
   PATH LENGTH
  (NORMALIZED)        .00      .50-01   .13+00   .25+00   .38+00   .50+00   .63+00   .75+00   .88+00   .10+01

CONTM. ABSORPTION
COEFF.  (1/CM)        .22-03   .11-02   .14-02   .18-02   .20-02   .22-02   .23-02   .23-02   .24-02   .25-02

B.B.EMISSIVE POWER
(WATTS/CM2-EV)        .34+04   .41+04   .43+04   .44+04   .45+04   .45+04   .46+04   .46+04   .46+04   .47+04

                  POS. CONTM FLUX=   .24+02 NEG. CONTM FLUX=   .00    BOTH IN WATTS/CM2-EV

                                           ABSORPTION COEFFICIENTS,   (1/CM)
 FREQUENCY                                      CPTICAL DEPTHS,AND
                                                     FLUXES
  .60000              .43-03   .15-02   .19-02   .23-02   .25-02   .27-02   .28-02   .29-02   .30-02   .30-02
                      .00      .12-03   .34-03   .70-03   .80-03   .87-03   .91-03   .94-03   .97-03   .10-02
                  POSITIVE SPECTRAL FLUX=   .30+02 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68417              .84-03   .30-02   .39-02   .49-02   .56-02   .60-02   .63-02   .66-02   .68-02   .71-02
                      .00      .22-03   .68-03   .15-02   .17-02   .19-02   .21-02   .21-02   .22-02   .23-02
                  POSITIVE SPECTRAL FLUX=   .66+02 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68441              .92-03   .36-02   .49-02   .63-02   .72-02   .78-02   .83-02   .86-02   .89-02   .93-02
                      .00      .26-03   .85-03   .19-02   .22-02   .25-02   .27-02   .28-02   .29-02   .30-02
                  POSITIVE SPECTRAL FLUX=   .86+02 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68459              .10-02   .47-02   .66-02   .86-02   .99-02   .11-01   .12-01   .12-01   .13-01   .13-01
                      .00      .32-03   .11-02   .25-02   .31-02   .35-02   .37-02   .39-02   .41-02   .43-02
                  POSITIVE SPECTRAL FLUX=   .12+03 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68473              .12-02   .67-02   .98-02   .13-01   .15-01   .17-01   .18-01   .19-01   .20-01   .21-01
                      .00      .43-03   .16-02   .38-02   .47-02   .53-02   .58-02   .62-02   .65-02   .68-02
                  POSITIVE SPECTRAL FLUX=   .18+03 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68483              .16-02   .11-01   .17-01   .23-01   .27-01   .30-01   .33-01   .34-01   .36-01   .38-01
                      .00      .67-03   .28-02   .67-02   .84-02   .96-02   .10-01   .11-01   .12-01   .12-01
                  POSITIVE SPECTRAL FLUX=   .32+03 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68490              .28-02   .25-01   .37-01   .51-01   .59-01   .65-01   .69-01   .73-01   .76-01   .80-01
                      .00      .14-02   .61-02   .14-01   .18-01   .21-01   .22-01   .24-01   .25-01   .26-01
                  POSITIVE SPECTRAL FLUX=   .66+03 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV

  .68496              .97-02   .73-01   .99-01   .12+00   .14+00   .14+00   .15+00   .16+00   .16+00   .17+00
                      .00      .42-02   .17-01   .37-01   .43-01   .47-01   .49-01   .51-01   .53-01   .54-01
                  POSITIVE SPECTRAL FLUX=   .13+04 NEGATIVE SPECTRAL FLUX=   .00    BOTH IN W/CM2-EV
```

SELECTED OUTPUT - SAMPLE PROBLED 2

GROUP 1 (CONTINUED).

```
.68500      .71-01   .15+00   .17+00   .19+00   .20+00   .21+00   .21+00    .22+00   .22+00   .23+00
            .00      .14-01   .32-01   .60-01   .65-01   .63-01   .70-01    .72-01   .73-01   .74-01
          POSITIVE SPECTRAL FLUX=  .18+04 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68504      .98-02   .73-01   .99-01   .12+00   .14+00   .15+00   .15+00    .16+00   .16+00   .17+00
            .00      .42-02   .17-01   .37-01   .43-01   .47-01   .50-01    .52-01   .53-01   .55-01
          POSITIVE SPECTRAL FLUX=  .14+04 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68509      .32-02   .28-01   .41-01   .55-01   .65-01   .71-01   .76-01    .80-01   .83-01   .87-01
            .00      .15-02   .68-02   .15-01   .20-01   .23-01   .24-01    .26-01   .27-01   .28-01
          POSITIVE SPECTRAL FLUX=  .72+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68516      .21-02   .15-01   .23-01   .31-01   .36-01   .39-01   .42-01    .44-01   .46-01   .49-01
            .00      .89-03   .37-02   .83-02   .11-01   .12-01   .14-01    .14-01   .15-01   .16-01
          POSITIVE SPECTRAL FLUX=  .41+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68524      .20-02   .12-01   .17-01   .23-01   .26-01   .29-01   .31-01    .32-01   .33-01   .35-01
            .00      .74-03   .29-02   .66-02   .81-02   .92-02   .99-02    .10-01   .11-01   .11-01
          POSITIVE SPECTRAL FLUX=  .31+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68534      .22-02   .13-01   .18-01   .23-01   .26-01   .28-01   .30-01    .31-01   .32-01   .33-01
            .00      .80-03   .30-02   .67-02   .81-02   .90-02   .96-02    .10-01   .10-01   .11-01
          POSITIVE SPECTRAL FLUX=  .30+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68547      .31-02   .18-01   .24-01   .30-01   .34-01   .37-01   .38-01    .40-01   .41-01   .42-01
            .00      .11-02   .41-02   .90-02   .11-01   .12-01   .12-01    .13-01   .13-01   .14-01
          POSITIVE SPECTRAL FLUX=  .39+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68563      .67-02   .37-01   .48-01   .59-01   .64-01   .68-01   .71-01    .73-01   .74-01   .76-01
            .00      .23-02   .84-02   .13-01   .20-01   .22-01   .23-01    .24-01   .24-01   .25-01
          POSITIVE SPECTRAL FLUX=  .69+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68563      .67-02   .37-01   .48-01   .59-01   .64-01   .68-01   .71-01    .73-01   .74-01   .76-01
            .00      .23-02   .84-02   .13-01   .20-01   .22-01   .23-01    .24-01   .24-01   .25-01
          POSITIVE SPECTRAL FLUX=  .69+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV

.68567      .88-02   .47-01   .60-01   .72-01   .78-01   .83-01   .85-01    .87-01   .89-01   .90-01
            .00      .30-02   .11-01   .22-01   .25-01   .27-01   .28-01    .29-01   .29-01   .30-01
          POSITIVE SPECTRAL FLUX=  .83+03 NEGATIVE SPECTRAL FLUX=   .00     BOTH IN W/CM2-EV
```

SELECTED OUTPUT - SAMPLE PROBLEM 2

MANY PAGES OF OUTPUT HAVE

BEEN OMITTED

LINE RADIATION SUMMARY

GROUP NO.	BOUNDARIES NEG. (EV)	POS. (EV)	POS CONTRIBUTION SPECT. W/CM2-EV	TOTAL W/CM2	NEG CONTRIBUTION SPECT. W/CM2-EV	TOTAL W/CM2
1	.6000+00	.8000+00	.1026+03	.2052+02	.1221-02	.2441-03
2	.8100+00	.9500+00	.9781+02	.1369+02	.6539-03	.9155-04
3	.9600+00	.1200+01	.2597+03	.6232+02	.5086-03	.1221-03
4	.1200+01	.1400+01	.1812+03	.3624+02	.1526-03	.3052-04
5	.1400+01	.1600+01	.9057+02	.1811+02	.6104-03	.1221-03
6	.1620+01	.2400+01	.7618+01	.5942+01	.3130-03	.2441-03
7	.2400+01	.3500+01	.9344+00	.1028+01	.1776-02	.1953-02
8	.3400+01	.4000+01	.1971+01	.1183+01	.1526-03	.9155-04
9	.4000+01	.6000+01	.3333+02	.6666+02	.6104-04	.1221-03
10	.6200+01	.8000+01	.8030+02	.1445+03	.2331-04	.4196-04
11	.8000+01	.9000+01	.2551+02	.2551+02	.3815-05	.3815-05
12	.8800+01	.1000+02	.7497+02	.8997+02	.2384-05	.2861-05
13	.9700+01	.1045+02	.1258+01	.9438+00	.7947-06	.5960-06
14	.1045+02	.1080+02	.1147+01	.4013+00	.5109-06	.1788-06
15	.1080+02	.1170+02	.6857-01	.6172-01	.2649-06	.2384-06
16	.1170+02	.1210+02	-.1088+01	-.4352+00	.1490-06	.5960-07
17	.1210+02	.1280+02	-.4507+00	-.3155+00	.6386-07	.4470-07
18	.1280+02	.1340+02	-.2985+00	-.1791+00	.2484-07	.1490-07
19	.1340+02	.1380+02	-.1012+00	-.4046-01	.1863-07	.7451-08
20	.1380+02	.1450+02	-.6754-01	-.4728-01	.7983-08	.5588-08
		TOTALS =		.4861+03		.3071-02

SAMPLE OUTPUT - SAMPLE PROBLEM 2

4.3 SAMPLE PROBLEM 3

This sample problem is identical to Sample Problem 2, except the wavelength was selected for the independent output variable in place of the frequency. Note that wavelength begins with a maximum value then decreases. The input deck is identical to that used for Sample Case 2 except for the following change.

Sample Problem 2	Sample Problem 3
KR(8) = 0	KR(8) = 1

CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX

Y/DELTA= .00

LAMDA (MU)	QMINUS (WATTS/ CM2 MU)	PARTIAL SPECTRAL INTEGRAL OF QMINUS (WATTS/CM2)	NORMALIZED QMINUS CONTRIBUTION (PERCENT TOTAL)	QPLUS (WATTS/ CM2 MU)	PARTIAL SPECTRAL INTEGRAL OF QPLUS (WATTS/CM2)	NORMALIZED QPLUS CONTRIBUTION (PERCENT TOTAL)
.0827	.000	.000	.000	.171+03	.000	.000
.0852	.000	.000	.000	.247+03	.535+00	.140-02
.0867	.000	.000	.000	.305+03	.929+00	.244-02
.0868	.000	.000	.000	.310+03	.967+00	.253-02
.0911	.000	.000	.000	.543+03	.282+01	.738-02
.0912	.000	.000	.000	.551+03	.289+01	.757-02
.0925	.000	.000	.000	.638+03	.362+01	.946-02
.0926	.000	.000	.000	.904+03	.372+01	.976-02
.0954	.000	.000	.000	.122+04	.667+01	.175-01
.0955	.000	.000	.000	.124+04	.686+01	.180-01
.1016	.000	.000	.000	.223+04	.175+02	.458-01
.1018	.000	.000	.000	.227+04	.178+02	.466-01
.1032	.000	.000	.000	.257+04	.213+02	.559-01
.1034	.000	.000	.000	.261+04	.218+02	.571-01
.1100	.000	.000	.000	.440+04	.449+02	.118+00
.1102	.000	.000	.000	.519+04	.459+02	.120+00
.1127	.000	.000	.000	.613+04	.600+02	.157+00
.1147	.000	.000	.000	.695+04	.730+02	.191+00
.1149	.000	.000	.000	.702+04	.745+02	.195+00
.1239	.000	.000	.000	.115+05	.158+03	.413+00
.1241	.000	.000	.000	.102+04	.159+03	.417+00
.1346	.000	.000	.000	.175+04	.174+03	.455+00
.1349	.000	.000	.000	.179+04	.174+03	.457+00
.1378	.000	.000	.000	.219+04	.180+03	.472+00
.1381	.000	.000	.000	.224+04	.181+03	.473+00
.1455	.000	.000	.000	.426+04	.205+03	.537+00
.1459	.000	.000	.000	.218+04	.206+03	.540+00
.1550	.000	.000	.000	.313+04	.230+03	.603+00
.1771	.000	.000	.000	.217+03	.267+03	.700+00
.2067	.000	.000	.000	.232+03	.274+03	.718+00
.2480	.000	.000	.000	.233+03	.283+03	.743+00
.2756	.000	.000	.000	.254+03	.290+03	.761+00
.3100	.000	.000	.000	.232+03	.298+03	.783+00
.3307	.000	.000	.000	.240+03	.303+03	.795+00
.3543	.000	.000	.000	.218+03	.309+03	.810+00
.3815	.000	.000	.000	.147+03	.314+03	.823+00
.4133	.000	.000	.000	.121+03	.318+03	.834+00
.4509	.000	.000	.000	.109+03	.322+03	.845+00
.4[illegible]0	.000	.000	.000	.101+03	.327+03	.858+00
.6200	.000	.000	.000	.630+02	.337+03	.884+00
.8267	.000	.000	.000	.388+02	.348+03	.912+00
1.2400	.000	.000	.000	.166+02	.359+03	.942+00
1.5500	.000	.000	.000	.117+02	.364+03	.953+00
2.0667	.000	.000	.000	.721+01	.368+03	.966+00
2.4800	.000	.000	.000	.522+01	.371+03	.973+00
6.2000	.000	.000	.000	.919+00	.382+03	.100+01
12.4000	.000	.000	.000	.219+00	.386+03	.101+01
62.0000	.000	.000	.000	.176-02	.391+03	.103+01

LINE TRANSPORT QUANTITIES AT YY = .000

LINE GROUP NO. 1										
PATH LENGTH (NORMALIZED)	.00	.50-01	.13+00	.25+00	.38+00	.50+00	.63+00	.75+00	.88+00	.10+01
CONTN. ABSORPTION COEFF. (1/CM)	.22-03	.11-02	.14-02	.18-02	.20-02	.22-02	.23-02	.23-02	.24-02	.25-02
B.B.EMISSIVE POWER (WATTS/CM2-MU)	.13+04	.16+04	.16+04	.17+04	.17+04	.17+04	.18+04	.18+04	.18+04	.18+04

POS. CONTN FLUX= .92+01 NEG. CONTN FLUX= .00 BOTH IN WATTS/CM2-MU

WAVE LENGTH	ABSORPTION COEFFICIENTS, (1/CM) OPTICAL DEPTHS, AND FLUXES									
2.06667	.43-03	.15-02	.19-02	.23-02	.25-02	.27-02	.28-02	.29-02	.30-02	.30-02
	.00	.12-03	.34-03	.70-03	.80-03	.87-03	.91-03	.94-03	.97-03	.10-02
	POSITIVE SPECTRAL FLUX= .87+01 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81241	.84-03	.30-02	.39-02	.49-02	.56-02	.60-02	.63-02	.66-02	.68-02	.71-02
	.00	.22-03	.60-03	.15-02	.17-02	.19-02	.21-02	.21-02	.22-02	.23-02
	POSITIVE SPECTRAL FLUX= .25+02 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81177	.92-03	.36-02	.49-02	.63-02	.72-02	.78-02	.83-02	.86-02	.89-02	.93-02
	.00	.26-03	.85-03	.19-02	.22-02	.25-02	.27-02	.28-02	.29-02	.30-02
	POSITIVE SPECTRAL FLUX= .32+02 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81129	.10-02	.47-02	.66-02	.86-02	.99-02	.11-01	.12-01	.12-01	.13-01	.13-01
	.00	.32-03	.11-02	.25-02	.31-02	.35-02	.37-02	.39-02	.41-02	.43-02
	POSITIVE SPECTRAL FLUX= .45+02 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81094	.12-02	.67-02	[illegible]	.13-01	.15-01	.17-01	.18-01	.19-01	.20-01	.21-01
	.00	.43-03	.16-02	.38-02	.47-02	.53-02	.58-02	.62-02	.65-02	.68-02
	POSITIVE SPECTRAL FLUX= .69+02 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81067	.16-02	.11-01	.17-01	.23-01	.27-01	.30-01	.33-01	.34-01	.36-01	.38-01
	.00	.67-03	.28-02	.67-02	.84-02	.96-02	.10-01	.11-01	.12-01	.12-01
	POSITIVE SPECTRAL FLUX= .12+03 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81047	.28-02	.25-01	.37-01	.51-01	.59-01	.65-01	.69-01	.73-01	.76-01	.80-01
	.00	.14-02	.61-02	.14-01	.18-01	.21-01	.22-01	.24-01	.25-01	.26-01
	POSITIVE SPECTRAL FLUX= .25+03 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									
1.81033	.97-02	.73-01	.99-01	.12+00	.14+00	.14+00	.15+00	.16+00	.16+00	.17+00
	.00	.42-02	.17-01	.37-01	.43-01	.47-01	.49-01	.51-01	.53-01	.54-01
	POSITIVE SPECTRAL FLUX= .51+03 NEGATIVE SPECTRAL FLUX= .00 BOTH IN W/CM2-MU									

SELECTED OUTPUT - SAMPLE PROBLEM 3

```
GROUP   1 (CONTINUED)-

1,81022      ,71-01  ,15+00  ,17+00  ,19+00  ,20+00  ,21+00  ,21+00  ,22+00  ,22+00  ,27+00
             ,00     ,14-01  ,32-01  ,60-01  ,65-01  ,68-01  ,70-01  ,72-01  ,73-01  ,74-01
          POSITIVE SPECTRAL FLUX=  ,69+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,81011      ,98-02  ,73-01  ,99-01  ,12+00  ,14+00  ,15+00  ,15+00  ,16+00  ,16+00  ,17+00
             ,00     ,42-02  ,17-01  ,37-01  ,43-01  ,47-01  ,50-01  ,52-01  ,53-01  ,55-01
          POSITIVE SPECTRAL FLUX=  ,51+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80997      ,32-02  ,26-01  ,41-01  ,56-01  ,65-01  ,71-01  ,76-01  ,80-01  ,83-01  ,87-01
             ,00     ,15-02  ,68-02  ,16-01  ,20-01  ,23-01  ,24-01  ,26-01  ,27-01  ,28-01
          POSITIVE SPECTRAL FLUX=  ,27+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80980      ,21-02  ,15-01  ,23-01  ,31-01  ,36-01  ,39-01  ,42-01  ,44-01  ,46-01  ,49-01
             ,00     ,89-03  ,37-02  ,88-02  ,11-01  ,12-01  ,14-01  ,14-01  ,15-01  ,16-01
          POSITIVE SPECTRAL FLUX=  ,16+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80959      ,20-02  ,12-01  ,17-01  ,23-01  ,26-01  ,29-01  ,31-01  ,32-01  ,33-01  ,35-01
             ,00     ,74-03  ,29-02  ,66-02  ,81-02  ,92-02  ,99-02  ,10-01  ,11-01  ,11-01
          POSITIVE SPECTRAL FLUX=  ,12+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80932      ,22-02  ,13-01  ,18-01  ,23-01  ,26-01  ,28-01  ,30-01  ,31-01  ,32-01  ,33-01
             ,00     ,80-03  ,30-02  ,67-02  ,81-02  ,90-02  ,96-02  ,10-01  ,10-01  ,11-01
          POSITIVE SPECTRAL FLUX=  ,11+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80898      ,31-02  ,18-01  ,24-01  ,30-01  ,34-01  ,37-01  ,38-01  ,40-01  ,41-01  ,42-01
             ,00     ,11-02  ,41-02  ,90-02  ,11-01  ,12-01  ,12-01  ,13-01  ,13-01  ,14-01
          POSITIVE S°ECTRAL FLUX=  ,15+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80856      ,67-02  ,37-01  ,48-01  ,59-01  ,64-01  ,68-01  ,71-01  ,73-01  ,74-01  ,76-01
             ,00     ,23-02  ,84-02  ,18-01  ,20-01  ,22-01  ,23-01  ,24-01  ,24-01  ,25-01
          POSITIVE SPECTRAL FLUX=  ,26+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80856      ,67-02  ,37-01  ,48-01  ,59-01  ,64-01  ,68-01  ,71-01  ,73-01  ,74-01  ,76-01
             ,00     ,23-02  ,84-02  ,18-01  ,20-01  ,22-01  ,23-01  ,24-01  ,24-01  ,25-01
          POSITIVE SPECTRAL FLUX=  ,26+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU

1,80845      ,88-02  ,47-01  ,60-01  ,72-01  ,78-01  ,83-01  ,85-01  ,87-01  ,89-01  ,90-01
             ,00     ,30-02  ,11-01  ,22-01  ,25-01  ,27-01  ,28-01  ,29-01  ,29-01  ,30-01
          POSITIVE SPECTRAL FLUX=  ,31+03 NEGATIVE SPECTRAL FLUX=  ,00   BOTH IN W/CM2-MU
```

MANY PAGES OF OUTPUT HAVE

BEEN OMITTED

4.4 SAMPLE PROBLEM 4

This sample problem is also identical to the first sample problem, except that the equivalent width approximation was employed and only some (six) of the spatial points were selected for output. The input data decks are identical except for the following changes:

Sample Problem 1	Sample Problem 4
KR(4) = 0	KR(4) = 3
NIC = 10	NIC = 6
NICN(I) = 1,2,3, ...10	NICN(I) = 1,3,4,6,8,10

which must be made to implement these options. The computing time requirements are summarized in Table 4.1, below for a UNIVAC 1108 machine.

TABLE 4.1
COMPUTING TIMES

Computation	Time (Sec)	
	Sample Case 1	Sample Case 4
Chemistry	3.994	3.994
Continuum Radiation	3.782	3.782
Line Radiation	82.343	7.082
Total	90.119	14.858

CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX

NORMALIZED PATH LENGTH= .000, .125+00, .250+00, .500+00, .750+00, .100+01

QMINUS/QPLUS (WATTS/CM2-EV)

HV (EV)	.000		.125+00		.250+00		.500+00		.750+00		.100+01	
.020	.00	.55+01	.15+01	.55+01	.32+01	.56+01	.50+01	.55+01	.56+01	.47+01	.57+01	.00
.100	.00	.27+02	.17+01	.26+02	.46+01	.23+02	.12+02	.17+02	.19+02	.92+01	.27+02	.00
.200	.00	.28+02	.16+01	.27+02	.45+01	.24+02	.12+02	.17+02	.20+02	.91+01	.29+02	.00
.500	.00	.26+02	.14+01	.24+02	.40+01	.22+02	.10+02	.16+02	.18+02	.81+01	.26+02	.00
.600	.00	.25+02	.14+01	.23+02	.38+01	.21+02	.10+02	.15+02	.17+02	.78+01	.25+02	.00
.800	.00	.23+02	.13+01	.21+02	.35+01	.19+02	.91+01	.14+02	.16+02	.71+01	.23+02	.00
1.000	.00	.21+02	.12+01	.19+02	.32+01	.17+02	.85+01	.12+02	.14+02	.64+01	.21+02	.00
1.500	.00	.21+02	.14+01	.20+02	.36+01	.15+02	.89+01	.12+02	.15+02	.65+01	.21+02	.00
2.000	.00	.20+02	.14+01	.18+02	.34+01	.16+02	.85+01	.11+02	.14+02	.59+01	.20+02	.00
2.500	.00	.20+02	.18+01	.18+02	.40+01	.16+02	.90+01	.11+02	.14+02	.57+01	.20+02	.00
2.750	.00	.18+02	.14+01	.16+02	.33+01	.15+02	.78+01	.10+02	.13+02	.52+01	.18+02	.00
3.000	.00	.17+02	.13+01	.15+02	.30+01	.14+02	.72+01	.94+01	.12+02	.49+01	.17+02	.00
3.250	.00	.17+02	.14+01	.16+02	.35+01	.14+02	.76+01	.97+01	.12+02	.50+01	.17+02	.00
3.500	.00	.22+02	.19+01	.20+02	.43+01	.18+02	.95+01	.12+02	.16+02	.62+01	.22+02	.00
3.750	.00	.21+02	.18+01	.19+02	[illegible]	.17+02	.94+01	.12+02	.15+02	.60+01	.21+02	.00
4.000	.00	.18+02	.15+01	.17+02	.34+01	.15+02	.79+01	.10+02	.13+02	.51+01	.18+02	.00
4.500	.00	.16+02	.12+01	.14+02	.28+01	.13+02	.67+01	.88+01	.11+02	.45+01	.16+02	.00
5.000	.00	.12+02	.95+00	.11+02	.21+01	.94+01	.50+01	.65+01	.82+01	.34+01	.12+02	.00
6.000	.00	.80+01	.11+01	.69+01	.20+01	.60+01	.39+01	.41+01	.59+01	.21+01	.80+01	.00
7.000	.00	.55+01	.17+01	.38+01	.23+01	.32+01	.33+01	.22+01	.44+01	.11+01	.55+01	.00
8.000	.00	.61+02	.14+02	.46+02	.23+02	.40+02	.37+02	.25+02	.50+02	.12+02	.62+02	.00
8.500	.00	.37+02	.85+01	.30+02	.14+02	.25+02	.23+02	.16+02	.31+02	.75+01	.38+02	.00
8.520	.00	.73+02	.11+02	.64+02	.20+02	.56+02	.38+02	.38+ 2	.56+02	.19+02	.75+02	.00
8.980	.00	.34+02	.32+01	.32+02	.71+01	.28+02	.16+02	.20+02	.25+02	.10+02	.35+02	.00
9.000	.00	.33+02	.31+01	.31+02	.68+01	.27+02	.15+02	.19+02	.24+02	.99+01	.33+02	.00
9.190	.00	.26+02	.20+01	.25+02	.48+01	.22+02	.11+02	.15+02	.19+02	.80+01	.27+02	.00
9.210	.00	.26+02	.19+01	.24+02	.46+01	.21+02	.11+02	.15+02	.18+02	.79+01	.26+02	.00
9.990	.00	.13+02	.73+00	.12+02	.20+01	.11+02	.52+01	.78+01	.89+01	.41+01	.13+02	.00
10.010	.00	.14+03	.16+02	.15+03	.39+02	.15+03	.87+02	.12+03	.13+03	.71+02	.17+03	.00
10.790	.00	.75+02	.77+01	.79+02	.20+02	.77+02	.45+02	.63+02	.69+02	.38+02	.90+02	.00
10.810	.00	.74+02	.76+01	.78+02	.19+02	.76+02	.45+02	.62+02	.68+02	.37+02	.89+02	.00
11.000	.00	.63+02	.64+01	.66+02	.16+02	.65+02	.38+02	.53+02	.58+02	.32+02	.76+02	.00
11.250	.00	.51+02	.51+01	.54+02	.13+02	.53+02	.31+02	.43+02	.47+02	.26+02	.61+02	.00
11.270	.00	.43+02	.23+02	.67+02	.45+02	.78+02	.74+02	.89+02	.90+02	.80+02	.10+03	.00
11.990	.00	.23+02	.12+02	.36+02	.24+02	.42+02	.40+02	.48+02	.49+02	.44+02	.56+02	.00
12.010	.00	.22+02	.12+02	.35+02	.24+02	.41+02	.39+02	.48+02	.48+02	.45+02	.55+02	.00
12.180	.00	.19+02	.99+01	.30+02	.20+02	.36+02	.34+02	.41+02	.42+02	.37+02	.46+02	.00
12.200	.00	.19+02	.97+01	.30+02	.20+02	.35+02	.33+02	.41+02	.41+02	.37+02	.47+02	.00
12.930	.00	.91+01	.47+01	.15+02	.98+01	.18+02	.17+02	.21+02	.21+02	.19+02	.24+02	.00
13.000	.00	.90+01	.46+01	.15+02	.96+01	.17+02	.16+02	.20+02	.21+02	.19+02	.24+02	.00
13.390	.00	.65+01	.32+01	.10+02	.67+01	.12+02	.12+02	.14+02	.15+02	.13+02	.17+02	.00
13.410	.00	.44+01	.44+01	.91+01	.82+01	.12+02	.13+02	.14+02	.15+	.15+02	.17+02	.00
13.590	.00	.37+01	.37+01	.77+01	.69+01	.98+01	.11+02	.12+02	.13+	.13+02	.15+02	.00
13.610	.00	.76+01	.36+01	.76+01	.68+01	.96+01	.11+02	.12+02	.13+02	.13+02	.14+02	.00
14.290	.00	.19+01	.19+01	.41+01	.36+01	.52+01	.57+01	.66+01	.69+01	.71+01	.80+01	.00
14.310	.00	.18+01	.19+01	.40+01	.36+01	.51+01	[illegible]	.65+01	.68+01	.70+01	.79+01	.00
14.550	.00	.14+01	.15+01	.32+01	.29+01	.41+01	[illegible]	.52+01	.55+01	.57+01	.64+01	.00
15.000	.00	.94+00	.97+00	.21+01	.19+01	.27+01	.30+01	.35+01	.37+01	.38+01	.43+01	.00

FREQUENCY INTEGRATED VALUES

.00	.38+03	.66+02	.39+03	.14+03	.38+03	.26+03	.32+03	.38+03	.21+03	.48+03	.00

SELECTED OUTPUT - SAMPLE PROBLEM 4

LINE RADIATION

NORMALIZED DIST =		.00	.13+00	.25+00	.50+00	.75+00	.10+01
GROUP NO.	FREQUENCY (EV)	POSITIVE AND NEGATIVE CONTRIBUTIONS (WATTS/CM2)					
1	.690	.33+02	.31+02	.27+02	.19+02	.10+02	.76-05
		.76-05	.24+01	.61+01	.15+02	.24+02	.33+02
2	.890	.13+02	.12+02	.11+02	.82+01	.46+01	.15-04
		.15-04	.12+01	.29+01	.64+01	.98+01	.13+02
3	1.050	.65+02	.63+02	.58+02	.44+02	.25+02	.31-04
		.00	.70+01	.16+02	.34+02	.51+02	.67+02
4	1 290	.37+02	.37+02	.35+02	.28+02	.18+02	.00
		.15-04	.53+01	.11+02	.21+02	.30+02	.39+02
5	1.460	.17+02	.17+02	.16+02	.13+02	.85+01	.31-04
		.00	.23+01	.49+01	.99+01	.14+02	.18+02
6	1.850	.54+01	.50+01	.45+01	.32+01	.16+01	.37-03
		.31-03	.33+00	.88+00	.22+01	.37+01	.54+01
7	2.850	.84+00	.79+00	.71+00	.51+00	.26+00	.49-03
		.24-03	.45-01	.13+00	.33+00	.57+00	.84+00
8	3.700	.54+00	.51+00	.45+00	.33+00	.17+00	.00
		.00	.28-01	.79-01	.21+00	.37+00	.54+00
9	5.000	.14+02	.15+02	.15+02	.13+02	.94+01	.00
		.00	.32+01	.58+01	.10+02	.14+02	.17+02
10	7.110	.15+03	.17+03	.16+03	.14+03	.10+03	.61-04
		.15-04	.31+02	.59+02	.11+03	.15+03	.19+03
11	8.400	.29+02	.32+02	.31+02	.27+02	.20+02	.31-04
		.38-05	.52+01	.10+02	.20+02	.29+02	.37+02
12	9.400	.11+03	.12+03	.11+03	.94+02	.61+02	.76-05
		.48-06	.15+02	.32+02	.65+02	.10+03	.13+03
13	10.070	.14+02	.27+02	.35+02	.43+02	.43+02	.95-05
		.48-06	.13+02	.22+02	.32+02	.34+02	.33+02
14	10.620	.68+01	.11+02	.12+02	.12+02	.12+02	.75-06
		.12-06	.46+01	.55+01	.51+01	.44+01	.37+01
15	11.200	.11+02	.24+02	.30+02	.37+02	.31+02	-.95-06
		-.60-07	.81+01	.16+02	.25+02	.28+02	.24+02
16	11.900	-.37+00	-.19+00	-.12+00	.11+00	.65+00	.00
		.00	.21+00	.14+00	.42-01	.12-01	.50-02
17	12.410	-.24+00	-.13+00	-.81-01	.59-01	.44+00	.20-06
		.15-07	.21+00	.24+00	.19+00	.11+00	.36-01
18	13.040	-.14+00	-.75-01	-.48-01	[illegible]-01	.24+00	.00
		.00	.12+00	.13+00	.11+00	.60-01	.19-01
19	13.580	-.28-01	-.13-01	-.11-01	-.55-02	.24-01	.00
		-.19-08	.26-01	.20-01	.62-02	.63-03	.47-04
20	14.200	-.36-01	-.19-01	-.16-01	-.91-02	.25-01	.60-07
		.00	.30-01	.25-01	.75-02	.60-03	.43-04
TOTAL POS=		.51+03	.56+03	.55+03	.48+03	.35+03	.10-02
TOTAL NEG=		.61-03	.99+02	.19+03	.36+03	.49+03	.61+03

SELECTED OUTPUT - SAMPLE PROBLEM 4

4.5 SAMPLE PROBLEM 5

This sample problem was selected to illustrate the use of the IZZ=1 option in calculating transport in the hydrogen rich atmospheres. A complete input deck is presented for the C-H-O-N elemental system and for a uniform slab at 10000 °K and 1 atmosphere pressure. The continuum absorption coefficients with and without the addition of the far wings of the hydrogen lines are shown in Figure 4.1. For this case, the effect can be appreciable. Note that only the true continuum exists within the frequency increments defining those line groups which contain the special hydrogen lines (there are two such line groups which are adjacent in the region of 2 ev).

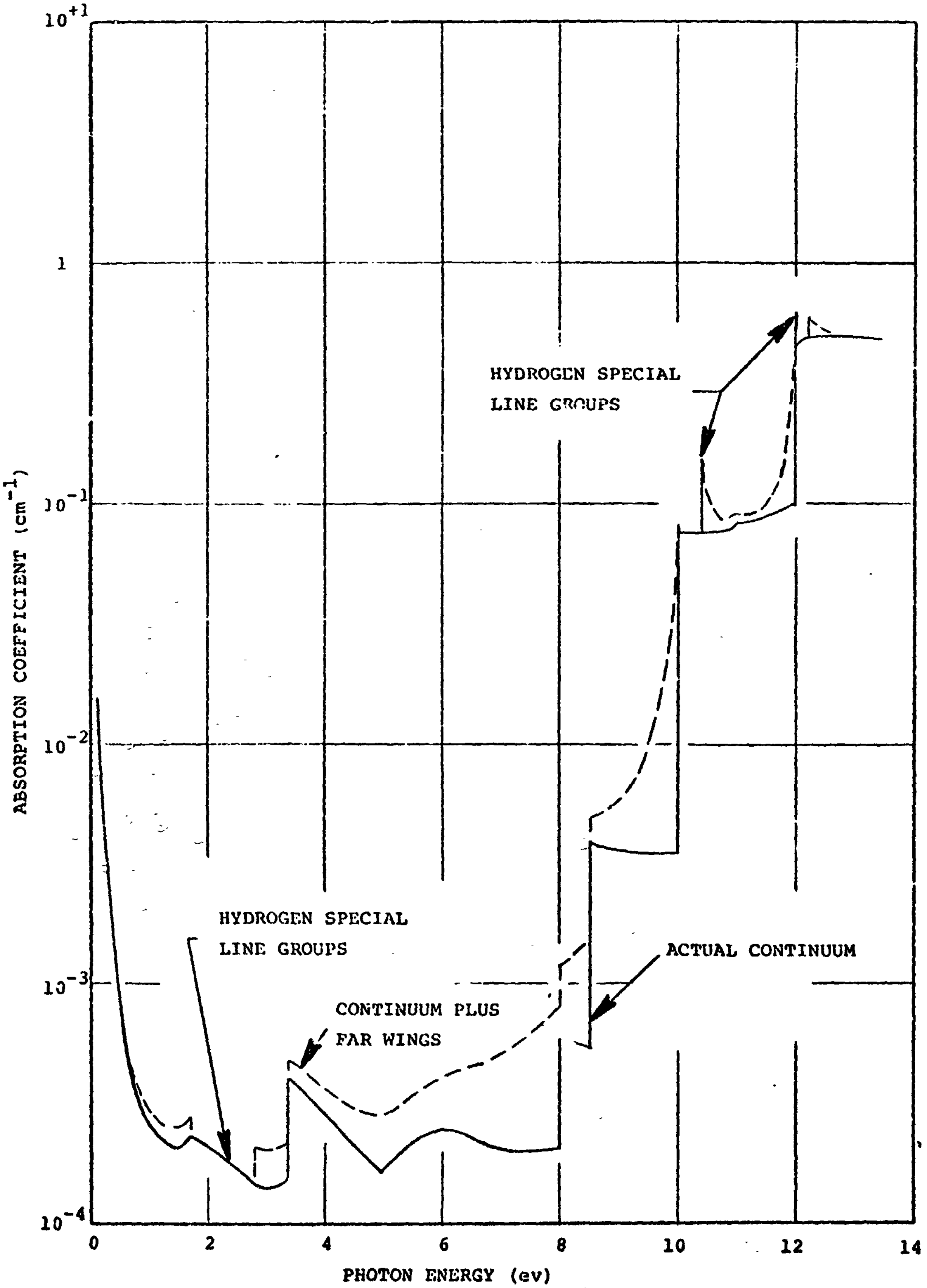


FIGURE 4.1 EFFECT OF HYDROGEN FAR WINGS ON THE CONTINUUM

```
20    4    1
  8     1 2.         35.146       GILMORE                                         O+
  4.        10.       6.        12.       19.        18.       54.       90.
 0.         3.3250    5.0171    10.6594   20.5797    23.135    25.938    28.833
20.
  1.        .76       .62       .55       .55        .85       1.42      2.
  8   2   1 1.       13.614       GILMORE                                         O
 9.         5.        19.       5.        3.         15.       9.        40.
 .0096      1.967     4.169     9.116     9.519      10.74     10.99     12.09
 4.4        8000.     .1915     1.0737-04
 1.         .71       .51       .34       .21        .27       .58       1.05
        O GROUND STATE                                           13.4         1
  O GD STATE      4.03      4.29      4.16      6.9       9.0       10.       10.
  O GD STATE      3.0
        O EXCITED STATE                                          4.22         4
 O EX STATE     6.5       5.929     5.433     4.672     4.215     4.062     4.215
 O EX STATE     4.215
  7  1  12.          29.605       GILMORE                                         N+
  9.        5.        1.        5.        15.        12.       30.       60.
 .011       1.6959    4.0528    5.8035    11.4366    18.4801   20.9555   23.2704
18.
  1.        .76       .62       .55       .55        .85       1.42      2.
  N+ GD STATE (ESTIMATE)                                         29.6         1
 N+ GD STATE      5.        5.        5.        5.        5.        5.        5.
 N+ GD STATE      5.        5.        5.        5.        5.        5.        5.
  7  3  11.          14.54        GILMORE                                         N
  4.        10.       6.        18.       54.        90.       1.
     0.         2.380     3.576     10.45     11.88      13.       14.
  4.        8000.     .657      2.80  -05
  1.        .67       .45       .26       .22        .41       .9        1.6
     N GROUND STATE                                              14.5         1
  N GD STATE      7.86      8.10      9.16      15.15     16.8      16.1      16.1
  N GD STATE      8.
 N 1ST EX STATE     2.38333E 00   8.33333E-01   1.32530E 05   1.20000E 01   2
 N 1ST EX STATE  6.4       6.4       6.4       6.4       6.4       6.4       6.4
 N 1ST EX STATE  6.4
 N 2ND EX STATE     2.48333E 00   1.50000E 00   1.17314E 05   1.06000E 01   3
11 1 2121 1 213118.645E 008.541E 008.005E 006.842E 005.375E 005.120E 003.189E 00
11 1 2121 1 213127.417E-011.357E-011.321E-022.633E-038.432E-043.475E-042.376E-04
  6  1  1  2.        24.376            WILSON AND NICOLET                         C+
 6.         12.       19.       2.        6.
 0.         5.32      9.28      11.95     13.7
 12.47
  1.        .76       .62       .55       .55        .85       1.42      2.
        C+ 1ST EXCITED ST                                        19.03        2
 C+ 1ST EX ST     5.2       5.2       5.2       5.2       5.2       5.2       5.2
 C+ 1ST EX ST     5.2
  6  3  1  1.         11.26        WILSON AND NICOLET                             C
 9.         5.        1.        5.        12.        15.       36.
 0.         1.2639    2.75      4.1825    7.5351     7.9461    8.6442
 3.78       4000.     .727      1.925 -05
 1.         .64       .42       .3        .33        .68       1.17      1.6
        C GROUND STATE                                           11.26        1
  C GD STATE      11.       11.       11.       10.4      9.55      8.7       7.85
  C GD STATE      4.5
  C FIRST EXCITED STATE                                          10.0         2
 C 1ST EX STATE   17.       17.       17.       17.       16.       14.       4.0
 C 1ST EX STATE   .2
   C SECOND EXCITED STATE                                        8.51         3
 C 2ND EX STATE   22.       22.       22.       22.       22.       22.       22.
 C 2ND EX STATE   22.
  1  3  1  1.        13.595            WEN                                        H
 2.         8.        18.       32.       50.
  0.000     10.19189  12.07926  12.7399   13.04568
```

```
.855
 1.          1.         1.         1.          1.          1.          1.          1.
                                                                        13.38        1
H GD STATE                                                               
H GD STATE      8.3078    6.6925    5.4699    3.7906    2.7339    2.0362     1.557
H GD STATE      .535                                                 3.4           2
H 1ST EX ST
H 1ST EX ST     15.822    7.300     3.9493    1.5346    .7487     .4197      .2584
H 1ST EX ST     .0465                                                1.6           3
H 2ND EX ST
H 2ND EX ST     19.932    4.646     1.75      .465      .166      .0923      .0523
H 2ND EX ST     .0061

N2+ NO  O2  N2  CO  H2  C2  CN  C-  H-  C3  OSI O-
N2+ NO  O2  N2  CO  H2  C2  CN  C-  H-  C3  O-
  .1  0  +00    0.81  +00    0.96  +00    0.12  +01    0.14  +01    0.184 +01
 2.2            2.8           4.6           8.0            8.8           9.7
 10.00          10.2          10.8          11.7           12.00         12.1
 12.8           13.04
  0.80  +00     0.95  +00     0.12  +01     0.14  +01  1.84          2.2
  2.8           3.8           8.0           9.0            10.00         10.2
  10.4          10.8          11.7          12.1           12.2          12.8
 13.30          14.5
 .69            .87           1.05          1.29           1.6           1.888
 2.5            3.4           7.11          8.4            9.4           10.
  10.2          10.5          11.2          11.9           12.08         12.4
 13.0           13.5
 6 71317
 9 610 6 9 1 1 7 910 9 7-11112 7 1 9 6 8
                                      1.23160     .1090+05    -.0000     -.0000
H        5   36.0000      .16620      1.03800     .4147+04    -.0000     -.0000
H        4   25.0000      .30600       .17930     .8800+04    -.0000     -.000
H        4   36.0000      .47220       .84210     .1267+04    -.0000     -.0000
H        3   16.0000      .66110       .1960      .1100-20    6.
O        8     .46        .685         .04400     .3210-20    3.
C        6     .3930      .68590      0.1597      .1870-19    6.          .
N        6    .25         0.669        .20800     .6390-17    4.0000
C        7     .1340      .71000      0.0149      .4460-20                .
N        5    .25         0.7525       .08080     .4120-20    3.
C        6     .3540      .84400       .06870     .1080-20    - 0000     -.0000
C        5     .4570      .85200      0.0366      .3800-20    4           .
N        5    .25         0.875        .1570      .3670-20
O        7     .46        .884        0.00647     .7390-21                .
N        4    .25         0.9158      0.0253      .3870-19    2.          .
N        6    .25         0.9304      0.0262      .3870-19    4.          .
N        6    .25         0.965        .15060     .3368+04    -.0000     -.0000
H        3   25.0000      .96710       .0805      .3090-19    2.
O        8     .46        .991         .03290     .2050-18    4.
C        7     .6120     1.01900      0.0735      .3310-20    7.          .
N        5    .25        1.0355        .10080     .3200-20    8.
C        6     .3540     1.08280       .7490      .3440-20
O        7     .46       1.098         .2010      .3670-20
O        6     .46       1.132         .05584     .8019+09    -.0000     -.00
H        3   36.0000     1.13330       .47400     .1080-20    -.0000     -.0000
C        5     .4020     1.16300       .02850     .2620-20    -.0000     -.0000
C        6     .3610     1.22400      0.118       .3120-20    3.          .
N        5    .25        1.2610       0.1833      .9840-21                .
N        4    .25        1.3190        .20600     .1380-20    3.
C        5     .3470     1.32600       .9130      .3420-20
O        6     .46       1.338        0.0387      .2920-20                .
N        5    .25        1.3677       0.256       .8240-21    3.          .
N        4    .25        1.4380        .9500      .8650-21
O        5     .46       1.467         .04050     .2180-20    -.0000     -.0000
C        5     .2910     1.48700      0.0030      .2950-19                .
N        5    .25        1.5527       1.0300      .7090-21
O        4     .46       1.594
```


INPUT - SAMPLE PROBLEM 5

N	6	.25	1.6630	0.0923	.9580-21		
O	7	.46	1.767	.0226	.2750-19	3.	
C	6	.3760	1.81400	.00390	.3500-19	5.	
N	5	.25	1.8357	0.00566	.2930-19	5.	.
H	2	.0000	1.88800	.64070	.0000	-.0000	-.0000
H	2	.0000	2.54900	.11930	.0000	-.0000	-.0000
H	2	25.0000	2.85590	.04467	.3157+04	-.0000	-.0000
N	4	.25	2.925	0.0070	.1060-19	3.	.
O	5	.46	3.000	.0100	.8100-20	2.	
H	2	36.0000	3.02210	.02209	.7808+04	-.0000	-.0000
O	4	.46	3.167	.00826	.5200-20		
N	4	.25	3.4729	0.00861	.4520-19	3.	.
O	4	.46	3.711	.0143	.1100-19		
C	3	.3150	5.66250	.06760	.1130-20	-.0000	-.0000
C	2	.3150	6.42450	.07290	.1130-20	-.0000	-.0000
C	3	.3390	7.61300	.01410	.5000-20	-.0000	-.0000
C	3	.3610	7.07800	.07480	.2620-20	-.0000	-.0000
N	3	.25	07.111	0.0634	.9120-21		.
C	1	.3230	7.46100	.10500	.8730-21	-.0000	-.0000
C	3	.3260	7.71700	.00534	.2200-19	-.0000	-.0000
C	3	.6260	7.72100	.03670	.1090-18	-.0000	-.0000
C	1	.9570	7.94700	.28300	.2060-21	-.0000	-.0000
C	3	.8600	8.03000	.00457	.6900-18	-.0000	-.0000
C	3	.7520	8.15100	.01160	.1300-17	-.0000	-.0000
C	3	.3300	8.20300	.00147	.1190-18	-.0000	-.0000
C	3	.2690	8.39200	.00831	.5350-17	-.0000	-.0000
N	2	.25	8.3021	0.0740	.9120-21		.
C	2	.4770	8.36800	.01100	.2140-20	-.0000	-.0000
C	3	.8380	8.37700	.00501	.6770-17	-.0000	-.0000
C	2	.3390	8.43300	.01420	.5000-20	-.0000	-.0000
C	2	.3790	8.47400	.06250	.2480-20	-.0000	-.0000
N	3	.25	08.701	0.0435	.6610-21		.
C	2	.62	9.135	.04146	.9796-19		
N	3	.25	09.301	0.0166	.4400-20		.
C	1	1.0650	9.35200	.20300	.5570-22	-.0000	-.0000
N	3	.25	09.394	0.0119	.2290-20		.
C	2	.8190	9.45000	.02180	.6900-18	-.0000	-.00
N	3	.25	09.460	0.0360	.3360-20		.
O	1	.46	9.501	.0471	.5480-21		
C	2	.75	9.612	.01283	.1168-17		
C	1	.342	9.697	.0233	.4568-20		
C	1	.3720	9.70900	.07670	.2350-20	-.0000	-.000
C	2	.2890	9.72200	.06810	.5380-17	-.0000	-.0000
C	2	.8480	9.79700	.00408	.6770-17	-.0000	-.000
C	1	.3200	9.83400	.02600	.2930-20	-.0000	-.0000
N	2	.25	09.973	0.0890	.6610-21		.
N	3	.25	10.102	0.0374	.2930-19		.
O	3	.46	10.182	.1510	.6530-21		
H	1	.0000	10.19600	.41620	.0000	-.0000	-.0000
N	1	.25	10.332	0.1840	.6210-21		.
C	1	.3260	10.40100	.00719	.2200-19	-.0000	-.0000
C	1	.6260	10.40500	.04950	.1090-18	-.0000	-.000
N	3	.25	10.418	0.0225	.5320-19		.
N	2	.25	10.493	0.0187	.4460-19		.
N	3	.25	10.585	0.0131	.7960-19		.
N	2	.25	10.619	0.0533	.3120-20		.
N	3	.25	10.682	0.00819	.2680-18		.
C	1	.8190	10.71400	.02980	.6900-16	-.0000	-.0000
N	3	.25	10.757	0.00518	.4370-18		.
O	2	.46	10.761	.1200	.6530-21		
C	2	-.6480	10.87300	.70500	.6300-20	-.0000	-.0000
C	1	.7530	10.87500	.01550	.1300-17	-.0000	-.0000
C	1	.3310	10.88700	.00195	.1190-18	-.0000	-.0000
N	1	.25	10.927	0.4540	.1610-22		.

INPUT - SAMPLE PROBLEM 5

```
C          1     .3280     10.91600       .01100     .2530-18    -.0000      -.0000
O          3     .46       11.667         .0185      .3670-20
 +                H8 d       H0  00       H09 59     H 770 17    -.0000      -H000
N          3    .25          11.200       0.0200     .4460-20                .
N          2    .25          11.293       0.0418     .2930-19                .
N          3    .25          11.310       0.0254     .3230-20                .
N          7    .25          11.424       0.2260     .1430-22                .
N          2    .25          11.609       0.0250     .5320-19                .
N          2    .25          11.776       0.0220     .7960-19                .
O          3     .46       11.856         .0049      .1450-19
O          1     .46       11.852         .0199      .3670-20
N          2    .25          11.874       0.0091     .2660-18                .
N          2    .25          11.948       0.00575    .4370-18                .
N          3    .25          12.020       0.0269     .2990-19                .
O          1     .46       12.067         .0218      .3440-20
H          1     .0000     12.08400       .07910     .0000       -.0000      -.0000
O          3     .46       12.160         .0019      .1280-19
C          3     .1610     12.18190      1.05000     .1590-21    -.0000      -.0000
N          3    .25          12.316       0.0156     .6960-19                .
O          2    .46        12.404         .0461      .6530-21
N          2    .25          12.419       0.0574     .3900-20                .
N          2    .25          12.511       0.0279     .3370-20                .
O          1     .46       12.521         .0775      .6330-21
O          1     .46       12.651         .00524     .1450-19
H          1    16.0000    12.74600       .02899     .1025+04    -.0000      -.0000
N          1    .25          12.877       0.0230     .4460-20                .
N          1    .25          13.004       0.1320     .2940-20                .
H          1    25.0000    13.05230       .01394     .3126+04    -.0000      -.0000
C          1    -.4220     13.11900       .37900     .1010-20    -.0000      -.0000
N          2    .25          13.190       0.0489     .2990-19                .
H          1    36.0000    13.21820       .00780     .7777+04    -.0000      -.0000
N          2    .25          13.506       0.0291     .6960-18                .
N          7    .25          13.543       0.1610     .9500-23                .
C          2     .1610     13.60100       .29500     .1590-21    -.0000      -.0000
N          1    .25          13.677       0.0957     .2930-19                .
N          1    .25          13.793       0.0584     .5320-19                .
N          1    .25          14.100       0.0342     .7960-19                .
N          1    .25          14.257       0.0212     .2680-18                .
N          1    .25          14.332       0.0138     .4370-18                .
 50
 0.02         0.1          0.2          0.5          0.8          1.00
 1.50         1.839        1.841        2.2          2.799        2.805
 3.10         3.40         3.70         4.00         4.50         5.00
 6.00         7.00         8.00         8.50         8.52         8.98
 9.00         9.19         9.21         9.99         10.01        10.395
 10.405       10.79        10.81        11.00        11.25        11.27
 11.995       12.005       12.195       12.201       12.98        13.00
 13.39        13.41        13.59        13.61        14.29        14.31
 14.55        15.00
1100001001000000000  SAMPLE CASE 5
0110000000
  5
  1HYDROGEN     1.008
  6 CARBON      12.011
  7 NITROGEN    14.006
  8 OXYGEN      16.0
 99 ELECTRON     0.00055
  1006                                          JANAF 03/61            C
 170886+6 135500+5 444433+1 226125-3 409830+6 492870+2  500. 3000.1   0.C
 170886+6 135500+5 412212+1 261908-3 262886+7 492870+2 3000. 5000.1   0.C
  1007                                          JANAF 03/61            N
 112965+6 134370+5 486944+1 363516-4 958460+5 480900+2  500. 3000.1   0.N
 112965+6 134370+5 420957+1 240844-3-417273+6 480900+2 3000. 5000.1   0.N
  1008                                          JANAF 06/62            O
```

```
595590+5 135220+5 497228+1 300768-5 154749+5 590960+2  500. 3000.1   0.0
595590+5 135220+5 657489+1-224260-3-891782+7 590960+2 3000. 5000.1   0.0
 1  1                                     A542-15-E 15.0ATM HURSE 8NOV71H
516309+5 134229+5 492412+1 122761-4 108948+5 388619+2  500.10000.1  -0.H
516309+5-388429+5-720490+1 962631-3 462559+0 256360+210000.30000.1  -0.H
 1  5  1  8                               JANAF 9-30-65               CO
-264169+5 223569+5 308732+1 281527-3-332124+6 653699+2   500  30001  -0CO
-264169+5 223569+5 865923+1 552009-4-124951+7 653699+2  3000  60001  -0CO
 2  7                                     JANAF 9-30-65               N2
     0+0 221649+5 793097+1 319647-3-314295+6 637650+2   500  30001  -0N2
     0+0 221649+5 878236+1 68 830-4-119252+7 637650+2  3000  60001  -0N2
 2  8                                     JANAF 9-30-65               O2
     0+0 234459+5 808690+1 497028-3-242932+6 679729+2   500  30001  -0O2
     0+0 234459+5 100924+2 636677-4-659192+7 679729+2  3000  60001  -0O2
 1  6  1  7                               JANAF 12-31-66              CN
110999+6 232479+5 706816+1 994584-3-107243+6 669760+2   500  30001  -0CN
110999+6 232479+5 126220+2-176667-3-184660+8 669760+2  3000  60001  -0CN
 1  6  2  8                               JANAF 9-30-65              CO2
-940539+5 365349+5 135296+2 479623-3-865470+6 798480+2   500  30001 -0CO2
-940539+5 365349+5 144584+2 170547-3-130622+7 798480+2  3000  60001 -0CO2
 2  6                                       JANAF 12/69     KS        C2
200223+6 246779+5 776830+1 671194-3 208014+6 685590+2   300  30001  10C2
200223+6 246779+5 843360+1 447514-3 259636+6 685590+2  3000  60001  10C2
 3  6                                       JANAF 12/69     KS        C3
195999+6 309579+5 990626+1 976478-3-168299+6 812359+2   500  30001  10C3
195999+6 309579+5 129505+2 166609-3-510560+7 812359+2  3000  60001  10C3
 4006                                     JANAF 12/60                 C4
242321+6 511230+5 205903+2 623436-4-257763+7 986760+2  500. 3000.1  0.C4
242321+6 511230+5 210714+2-434895-4-401939+7 986760+2 3000. 5000.1  0.C4
 5006                                     JANAF 12/60                 C5
242374+6 656230+5 264706+2 806528-4-337125+7 111641+3  500. 3000.1  0.C5
242374+6 656230+5 271156+2-580271-4-543165+7 111641+3 3000. 5000.1  0.C5
 2001                                     JANAF 03/61                 H2
000000-0 212100+5 711953+1 621950-3-712694+6 464650+2  500. 3000.1  0.H2
000000-0 212100+5 601794+1 589854-3 265106+7 484650+2 3000. 5000.1  0.H2
 1  1  1  6                               JANAF 12-31-67              CH
141999+6 234649+5 770879+1 742295-3-366107+6 622730+2   500  30001  -0CH
141999+6 234649+5 957141+1 114436-3-177529+6 622730+2  3000  60001  -0CH
 2001 01 06                               JANAF 12/62                CH2
950000+5 329960+5 132894+2 413822-3-290273+7 684940+2  500. 3000.1 0.CH2
950000+5 329960+5 140728+2 132150-3-239493+7 684940+2 3000. 5000.1 0.CH2
 3001 01 06                               JANAF 12/62                CH3
319400+5 434190+5 162763+2 401025-3-461203+7 786040+2  500. 3000.1 0.CH3
319400+5 434190+5 204899+2-198026-3-114692+8 786040+2 3000. 5000.1 0.CH3
 1  1  2  6                               JANAF 3-31-67              C2H
113999+6 356029+5 116307+2 125237-2-574681+6 773270+2   500  30001 -0C2H
113999+6 356029+5 181256+2-233191-3-189185+8 773270+2  3000  60001 -0C2H
 10 1  3  6                               DUFF BAUER 6/61            C3H
127703+6 489620+5 174464+2 508379-3-311933+7 928820+2  500. 3000.1 0.C3H
127703+6 489620+5 199582+2 245687-3-632510+6 928820+2 3000. 5000.1 0.C3H
 10 1  4  6                               DUFF BAUER 6/61            C4H
155196+6 645030+5 252172+2 574336-3-339547+7 113166+3  500. 3000.1 0.C4H
155196+6 645030+5 249358+2 402513-3 377676+7 113166+3 3000. 5000.1 0.C4H
 10 1  6  6                               DUFF BAUER 6/61            C6H
213164+6 942310+5 374677+2 420482-3-474514+7 148238+3  500. 3000.1 0.C6H
213164+6 942310+5 351470+2 661760-3 962699+7 148238+3 3000. 5000.1 0.C6H
 1007 01 08                               JANAF 06/63                 NO
215800+5 227000+5 877623+1 899031-4-789656+6 688490+2  500. 3000.1  0.NO
215800+5 227000+5 916260+1 657885-5-212519+7 688490+2 3000. 5000.1  0.NO
 1 99                                     JANAF 3-31-65               E-
     0+0 134229+5 496800+1 000000-0-700991-3 164589+2   500  30001  -0E-
     0+0 134229+5 496799+1 000000-0 216503-0 164589+2  3000  60001  -0E-
 1  8  1 99                               JANAF 6-30-65               O-
242999+5 134819+5 497058+1-566327-6 190609+5 492849+2   500  30001  -0O-
```


INPUT - SAMPLE PROBLEM 5

```
 242999+5 134819+5 496540+1 402556-6 389305+5 492649+2  3000  60001    -OO-
  1  6  1 99  0  0   0   0   0   0   5   0   0  OJANAF TAPE 7/71  9/65    C-
 140499+6 134412+5 492461+1 271340-4 955979+4 476326+2  500. 2500.1  -0.C-
 140499+6 134276+5 277636+1 523408-3 566164+7 476277+2 2500. 6000.1  -0.C-
  1  1  1 99                                JANAF 9-30-65                H-
 331999+5 134229+5 496800+1 000000-0-700991-3 374849+2   500  30001   - H-
 331999+5 134229+5 496799+1 000000-0 216505-0 374849+2  3000  60001   -OH-
  1  1 -1 99                                JANAF 6-30-66                H+
 367185+6 134229+5 496800+1 000000-0-700991-3 374820+2   500  30001   -OH+
 367185+6 134229+5 496799+1 000000-0 216505-0 374820+2  3000  60001   -OH+
  1  6  1  8 -1 99                         CONVAIR ZPH-122 12/61          CO+
+294283+6+243830+5+893619+1+376000-4-150900+7+666595+22000. 10000.1       CO+
+294283+6+243830+5+893619+1+376000-4-150900+7+666595+22000. 10000.1       CO+
  1  6 -1 99                               CONVAIR ZPH-122 12/61          C+
+426985+6+150120+5+489657+1+180700-4+340000+5+484232+22000. 10000.1       C+
+426985+6+150120+5+489657+1+180700-4+340000+5+484232+22000. 10000.1       C+
  1  7 -1 99                               CONVAIR ZPH-122 12/61          N+
+446641+6+151310+5+501751+1+617100-4-184100+7+496847+22000. 10000.1       N+
+446641+6+151310+5+501751+1+617100-4-184100+7+496847+22000. 10000.1       N+
  1  7  1  8 -1 99                           JANAF 6-30-66                NO+
 236659+6 221499+5 792263+1 320385-3-313165+6 653320+2   500  30001   -ONO+
 236659+6 221499+5 892153+1 385863-4-169555+7 653320+2  3000  60001   -ONO+
  2  7 -1 99                               CONVAIR ZPH-122 12/61          N2+
+357258+6+251470+5+136506+2-327940-3-225630+8+656601+22000. 1    0.1      N2+
+357258+6+251470+5+136508+2-327940-3-225630+6+656601+22000. 10000.1       N2+
  1  8 -1 99                               CONVAIR ZPH-122 12/61          O+
+371999+6+149290+5+336271+1+306710-3+590200+7+484849+22000. 10000.1       O+
+371999+6+149290+5+336271+1+306710-3+590200+7+484849+22000. 10000.1       O+
  1  6  1  7 -1 99                             JANAF 6/69      KS         CN+
 429399+6 238859+5 811795+1 517816-3-138643+6 702739+2   300  30001   -OCN+
 429399+6 238859+5 102410+2-992334-5-494752+7 702739+2  3000  60001   -OCN+

 10
  1  2  3  4  5  6  7  8  9 10
 10 10
 0.          .65          .125         .250          .375          .500
 .625        .750         .875         1.000
  1.0        1.0          10000.

 .25        .25        .25        .25
 1.
```

INPUT - SAMPLE PROBLEM 5

					DECK A						
GROUP	HV	HV+	HV-	N	NAME	K(I)	HV(I)	F(I)	GAM(I)	EXPN(I)	NOL
1	.690	.800	.100	9	H	53	.166	1.23+00	1.09+04	3.60+01	1.
					H	52	.306	1.04+00	4.15+03	2.50+01	1.
					H	52	.472	1.79-01	8.80+03	3.60+01	1.
					H	51	.661	8.42-01	1.27+03	1.60+01	1.
					O	16	.685	1.96-01	1.10-21	4.60-01	6.
					C	46	.686	4.40-02	3.21-21	3.93-01	3.
					N	30	.689	1.69-01	1.87-20	2.50-01	6.
					C	47	.710	2.08-01	6.39-10	1.34-01	4.
					N	29	.752	1.49-02	4.46-21	2.50-01	1.
2	.890	.950	.810	6	C	46	.844	8.08-02	4.12-21	3.54-01	3.
					C	45	.852	6.67-02	1.08-21	4.57-01	1.
					N	29	.875	3.60-02	3.30-21	2.50-01	4.
					O	15	.884	1.57-01	3.67-21	4.60-01	1.
					N	28	.916	8.40-03	7.00-18	2.50-01	1.
					N	30	.939	2.53-02	3.87-20	2.50-01	2.
3	1.050	1.200	.960	10	N	30	.965	2.62-02	5.67-20	2.50-01	4.
					H	51	.967	1.51-01	3.37+03	2.50+01	1.
					O	16	.991	8.05-02	3.09-20	4.60-01	2.
					C	47	1.019	3.29-02	2.05-19	6.12-01	4.
					N	29	1.036	7.35-02	3.31-21	2.50-01	7.
					C	46	1.083	1.01-01	3.20-21	3.54-01	8.
					O	15	1.098	7.49-01	3.44-21	4.60-01	1.
					O	14	1.132	2.01-0[illegible]	3.67-21	4.60-01	1.
					H	51	1.133	5.58-0[illegible]	2.02+03	3.60+01	1.
					C	45	1.165	4.74-0[illegible]	1.06-21	4.02-01	1.
4	1.290	1.400	1.200	6	C	46	1.224	2.85-0[illegible]	2.62-21	3.61-01	1.
					N	29	1.261	1.18-01	3.12-21	2.50-01	3.
					N	28	1.319	1.[illegible]3-01	9.84-22	2.50-01	1.
					C	45	1.326	2.66-01	1.30-21	3.47-01	3.
					O	14	1.358	9.13-01	3.42-21	4.60-01	1.
					N	29	1.368	3.87-02	2.92-21	2.50-01	1.
5	1.600	1.840	1.400	9	N	28	1.438	2.56-01	6.24-22	2.50-01	3.
					O	13	1.467	9.50-01	8.65-22	4.60-01	1.
					C	45	1.487	4.05-02	2.10-21	2.91-01	1.
					N	29	1.553	3.00-03	2.93-20	2.50-01	1.
					O	12	1.594	1.03+00	7.09-22	4.60-01	1.
					N	28	1.663	9.23-02	9.58-22	2.50-01	1.
					O	15	1.767	2.26-02	2.75-20	4.60-01	3.
					C	46	1.814	3.90-03	3.50-20	3.78-01	5.
					N	29	1.836	5.60-03	6.00-16	2.[illegible]-01	5.
6	1.8[illegible]	2.200	1.840	1	H	50	1.888	6.41-01	0.00	0.00	1.
7	2.500	2.800	2.200	1	H	50	2.549	1.19-01	0.00	0.00	1.
8	3.400	3.800	2.800	7	H	50	2.856	4.47-02	3.16+03	2.50+01	1.
					N	28	2.925	7.00-03	1.06-20	2.50-01	3.
					O	13	3.000	1.00-02	8.10-21	4.60-01	2.
					H	50	3.022	2.21-02	7.81+03	3.60+01	1.
					O	12	3.147	8.26-03	5.20-21	4.60-01	1.
					N	28	3.472	6.60-03	1.00-16	2.50-01	3.
					O	12	3.711	1.43-02	1.10-20	4.60-01	1.
9	7.110	8.000	4.800	9	C	43	5.002	6.76-02	1.13-21	3.15-01	1.
					C	42	6.424	7.29-02	1.13-21	3.15-01	1.
					C	43	7.013	1.41-02	5.00-21	3.39-01	1.
					C	43	7.078	7.48-02	2.62-21	3.61-01	1.
					N	27	7.111	6.34-02	9.12-22	2.50-01	1.
					C	41	7.481	1.05-01	8.73-22	3.23-01	1.
					C	43	7.717	5.34-03	2.20-20	3.26-01	1.

OUTPUT - SAMPLE PROBLEM 5

					C	43	7.721	3.67-02	1.09-19	6.26-01	1.
					C	41	7.947	2.83-01	2.08-22	9.57-01	1.
10	8.400	9.000	8.000	10	C	43	8.030	4.57-03	6.90-19	3.40-01	1.
					C	43	8.195	1.16-02	1.30-18	7.52-01	1.
					C	43	8.203	1.47-03	1.19-19	3.30-01	1.
					C	43	8.302	8.31-03	5.36-18	2.89-01	1.
					N	26	8.302	7.40-02	9.12-22	2.50-01	1.
					C	42	8.368	1.10-02	2.14-21	4.77-01	1.
					C	43	8.377	5.01-03	6.77-18	8.46-01	1.
					C	42	8.433	1.42-02	5.00-21	3.39-01	1.
					C	42	8.474	6.25-02	2.46-21	3.79-01	1.
					N	27	8.781	4.35-02	6.61-22	2.50-01	1.
11	9.400	10.000	8.800	9	C	42	9.139	4.15-02	9.80-20	6.20-01	1.
					N	27	9.301	1.66-02	4.46-21	2.50-01	1.
					C	41	9.332	2.03-01	5.57-23	1.06+00	1.
					N	27	9.394	1.17-02	2.29-21	2.50-01	1.
					C	42	9.450	2.16-02	6.90-19	8.19-01	1.
					N	27	9.460	3.60-02	3.36-21	2.50-01	1.
					O	9	9.501	4.71-02	5.46-22	4.60-01	1.
					C	42	9.612	1.20-02	1.17-18	7.50-01	1.
					C	41	9.697	2.33-02	4.57-21	3.42-01	1.
12	10.000	10.200	9.700	7	C	41	9.709	7.67-02	2.55-21	3.72-01	1.
					C	42	9.722	8.10-03	5.36-18	2.89-01	1.
					C	42	9.797	4.89-03	6.77-18	8.48-01	1.
					C	41	9.834	2.60-02	2.93-21	3.20-01	1.
					N	26	9.973	8.90-02	6.61-22	2.50-01	1.
					N	27	10.102	3.74-02	2.93-20	2.50-01	1.
					O	11	10.182	1.51-01	6.53-22	4.60-01	1.
13	10.200	10.400	10.000	1	H	49	10.196	4.16-01	0.00	0.00	1.
14	10.500	10.800	10.200	11	N	25	10.332	1.84-01	6.21-22	2.50-01	1.
					C	41	10.401	7.19-03	2.20-20	3.26-01	1.
					C	41	10.405	4.95-02	1.09-19	6.26-01	1.
					N	27	10.418	2.25-02	5.32-20	2.50-01	1.
					N	26	10.493	1.87-02	4.46-20	2.50-01	1.
					N	27	10.585	1.31-02	7.96-20	2.50-01	1.
					N	26	10.619	5.33-02	3.12-21	2.50-01	1.
					N	27	10.682	8.16-03	9.00-15	2.50-01	1.
					C	41	10.714	2.96-02	5.90-19	8.19-01	1.
					N	27	10.757	5.10-03	8.00-15	2.50-01	1.
					O	10	10.761	1.20-01	6.53-22	4.60-01	1.
15	11.200	11.700	10.800	12	C	42	10.873	7.05-01	6.30-21	-6.48-01	1.
					C	41	10.875	1.55-02	1.30-18	7.53-01	1.
					C	41	10.887	1.95-03	1.19-19	3.31-01	1.
					N	25	10.927	4.54-01	1.61-23	2.50-01	1.
					C	41	10.986	1.10-02	2.53-19	3.26-01	1.
					O	11	11.007	1.85-02	3.67-21	4.60-01	1.
					C	41	11.061	6.59-03	6.77-18	8.48-01	1.
					N	27	11.200	2.00-02	4.46-21	2.50-01	1.
					N	26	11.293	4.15-02	2.93-20	2.50-01	1.
					N	27	11.310	2.54-02	3.23-21	2.50-01	1.
					N	31	11.424	2.26-01	1.43-23	2.50-01	1.
					N	26	11.609	2.50-02	5.32-20	2.50-01	1.
16	11.900	12.100	11.700	7	N	26	11.776	2.20-02	7.96-20	2.50-01	1.
					O	11	11.806	4.90-03	1.45-20	4.60-01	1.
					O	9	11.852	1.99-02	3.67-21	4.60-01	1.
					N	26	11.874	9.10-03	2.68-19	2.50-01	1.
					N	26	11.948	5.70-03	5.00-15	2.50-01	1.
					N	27	12.000	2.69-02	2.99-20	2.50-01	1.
					O	9	12.067	2.18-02	3.44-21	4.60-01	1.
17	12.080	12.200	12.000	1	H	49	12.084	7.91-02	0.00	0.00	1.

OUTPUT - SAMPLE PROBLEM 5

18	12,400	12,600	12,100	9	O	11	12,160	1,90-03	1.28-20	4,60-01	1,
					C	43	12,181	1,05+00	1.59-22	1.61-01	1,
					N	27	12.316	1.56-02	6.96-20	2.50-01	1.
					O	10	12,404	[illegible].61-02	6.53-22	4,60-01	1,
					N	26	12,414	5.74-02	3.90-21	2,50-01	1,
					N	26	12.511	2.79-02	3.37-21	2.50-01	1,
					O	9	12.521	7,75-02	6.33-22	4,60-01	1,
					O	9	12,651	5.24-03	1.45-20	4.60-01	1,
					H	49	12.746	2.90-02	1.02+03	1,60+01	1,
19	13,000	13.300	12,800	6	N	25	12,877	2.30-02	4.46-21	2,50-01	1.
					N	25	13,004	1.32-01	2.94-21	2.50-01	1.
					H	49	13,052	1.39-02	3,13+03	2,50+01	1,
					C	41	13,119	3,79-01	1.01-21	-4,22-01	1,
					N	26	13.190	4.89-02	2.99-20	2.50-01	1.
					H	49	13.218	7,80-03	7.76+03	3.60+01	1,
20	13,500	14,500	13,040	8	N	26	13,508	2.91-02	6.96-19	2,50-01	1,
					N	31	13.5[illegible]5	1.61-01	9.50-24	2.50-01	1,
					C	42	13.601	2,95-01	1,59-22	1,61-01	1.
					N	25	13.677	9.57-02	2.93-20	2.50-01	1.
					N	25	13,993	5.84-02	5.32-20	2.50-01	1,
					N	25	14,160	3,42-02	7.96-20	2.50-01	1.
					N	25	14,257	2,12-02	2,68-19	2,50-01	1,
					N	25	14,332	1.38-02	4.37-19	2.50-01	1.

OUTPUT - SAMPLE PROBLEM 5

CASE - SAMPLE CASE 5

RADIATION CONTROL NUMBERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0

CHEMISTRY CONTROL NUMBERS	1	2	3	4	5	6	7	8	9	10
	0	1	1	0	0	0	0	0	0	0

FLOW CONTROL NUMBERS	1	2	3	4	5	6	7	8	9	10
	2	3	0	0	0	0	1	2	0	1

RADIATIVE BOUNDARY CONDITIONS

CONTINUUM

FREQ. (EV)	WAVE LENGTH (A)	EMITTANCE WALL	EMITTANCE /OUTER BOUND.	TRANSMITTANCE WALL	TRANSMITTANCE /OUTER BOUND.
.020	.620+06	1.000	.000	.000	1.000
.100	.124+06	1.000	.000	.000	1.000
.200	.620+05	1.000	.000	.000	1.000
.500	.248+05	1.000	.000	.000	1.000
.800	.155+05	1.000	.000	.000	1.000
1.000	.124+05	1.000	.000	.000	1.000
1.500	.827+04	1.000	.000	.000	1.000
1.839	.674+04	1.000	.000	.000	1.000
1.841	.674+04	1.000	.000	.000	1.000
2.200	.564+04	1.000	.000	.000	1.000
2.799	.443+04	1.000	.000	.000	1.000
2.805	.442+04	1.000	.000	.000	1.000
3.100	.400+04	1.000	.000	.000	1.000
3.400	.365+04	1.000	.000	.000	1.000
3.700	.335+04	1.000	.000	.000	1.000
4.000	.310+04	1.000	.000	.000	1.000
4.500	.276+04	1.000	.000	.000	1.000
5.000	.248+04	1.000	.000	.000	1.000
6.000	.207+04	1.000	.000	.000	1.000
7.000	.177+04	1.000	.000	.000	1.000
8.000	.155+04	1.000	.000	.000	1.000
8.500	.146+04	1.000	.000	.000	1.000
8.520	.146+04	1.000	.000	.000	1.000
8.940	.139+04	1.000	.000	.000	1.000
9.000	.138+04	1.000	.000	.000	1.000
9.190	.135+04	1.000	.000	.000	1.000
9.210	.135+04	1.000	.000	.000	1.000
9.990	.124+04	1.000	.000	.000	1.000
10.010	.124+04	1.000	.000	.000	1.000
10.395	.119+04	1.000	.000	.000	1.000
10.405	.119+04	1.000	.000	.000	1.000
10.790	.115+04	1.000	.000	.000	1.000
10.810	.115+04	1.000	.000	.000	1.000
11.000	.113+04	1.000	.000	.000	1.000
11.250	.110+04	1.000	.000	.000	1.000
11.270	.110+04	1.000	.000	.000	1.000
11.995	.103+04	1.000	.000	.000	1.000
12.005	.103+04	1.000	.000	.000	1.000
12.195	.102+04	1.000	.000	.000	1.000
12.201	.102+04	1.000	.000	.000	1.000
12.980	.955+03	1.000	.000	.000	1.000

LINE GROUPS

FREQ. (EV)	WAVE LENGTH (A)	EMITTANCE WALL	EMITTANCE /OUTER BOUND.	TRANSMITTANCE WALL	TRANSMITTANCE /OUTER BOUND.
.690	.180+05	1.000	.000	.000	1.000
.890	.139+05	1.000	.000	.000	1.000
1.050	.118+05	1.000	.000	.000	1.000
1.290	.961+04	1.000	.000	.000	1.000
1.600	.775+04	1.000	.000	.000	1.000
1.888	.657+04	1.000	.000	.000	1.000
2.500	.496+04	1.000	.000	.000	1.000
3.400	.365+04	1.000	.000	.000	1.000
7.110	.174+04	1.000	.000	.000	1.000
8.400	.148+04	1.000	.000	.000	1.000
9.400	.132+04	1.000	.000	.000	1.000
10.000	.124+04	1.000	.000	.000	1.000
10.200	.122+04	1.000	.000	.000	1.000
10.500	.118+04	1.000	.000	.000	1.000
11.200	.111+04	1.000	.000	.000	1.000
11.900	.104+04	1.000	.000	.000	1.000
12.085	.103+04	1.000	.000	.000	1.000
12.400	.100+04	1.000	.000	.000	1.000
13.000	.954+03	1.000	.000	.000	1.000
13.500	.919+03	1.000	.000	.000	1.000

OUTPUT - SAMPLE PROBLEM 5

13.000	.954+03	1.000	.000	.000	1.000
13.390	.926+03	1.000	.000	.000	1.000
13.410	.925+03	1.000	.000	.000	1.000
13.590	.912+03	1.000	.000	.000	1.000
13.610	.911+03	1.000	.000	.000	1.000
14.290	.868+03	1.000	.000	.000	1.000
14.310	.867+03	1.000	.000	.000	1.000
14.550	.852+03	1.000	.000	.000	1.000
15.000	.827+03	1.000	.000	.000	1.000

OUTPUT - SAMPLE PROBLEM 5

THERMODYNAMIC STATES ACROSS THE LAYER -STARTING WITH WALL

TEMP= 9999.9988 DEG-K PRES = 1.000 ATM MOL WT = 3.2118372
ENTHALPY = .3719076+05 CAL/GM ENTROPY = .14894+02 CAL/GM-DEG K
DENSITY = .391415-05 GM/CM3

SPECIES	MOLE FR.	SPECIES	MOLE FR.	SPECIES	MOLE FR.
C	.51760-01	N	.55935-01	O	.49376-01
H	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24986-09	C3H	.13391-14	C4H	.43718-19
C6H	.25875-29	NO	.18674-05	O-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

TEMP= 9999.9989 DEG-K PRES = 1.000 ATM MOL WT = 3.2118372
ENTHALPY = .3719076+05 CAL/GM ENTROPY = .14894+02 CAL/GM-DEG K
DENSITY = .391415-05 GM/CM3

SPECIES	MOLE FR	SPECIES	MOLE FR.	SPECIES	MOLE FR.
C	.51760-01	N	.55935-01	O	.49376-01
H	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24986-09	C3H	.13391-14	C4H	.43718-19
C6H	.25875-29	NO	.18674-05	O-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

TEMP= 9999.9989 DEG-K PRES = 1.000 ATM MOL WT = 3.2118372
ENTHALPY = .3719076+05 CAL/GM ENTROPY = .14894+02 CAL/GM-DEG K
DENSITY = .391415-05 GM/CM3

SPECIES	MOLE FR.	SPECIES	MOLE FR.	SPECIES	MOLE FR.
C	.51760-01	N	.55935-01	O	.49376-01
H	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24986-09	C3H	.13391-14	C4H	.43718-19
C6H	.25875-29	NO	.18674-05	O-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

```
TEMP=   9999.9989 DEG-K      PRES =     1.000 ATM      MOL WT =  3.2118372
 ENTHALPY =    .3719076+05 CAL/GM    ENTROPY =    .14894+02 CAL/GM-DEG K
 DENSITY =    .391415-05 GM/CM3

SPECIES   MOLE FR.        SPECIES   MOLE FR.        SPECIES   MOLE FR.
C           .51760-01     N           .55935-01     O           .49376-01
H           .78444+00     E-          .29181-01     CO          .33809-04
N2          .17790-04     O2          .10748-06     CN          .45027-05
CO2         .21634-10     C2          .92152-06     C3          .23320-11
C4          .75405-17     C5          .25426-22     H2          .57358-04
CH          .55564-05     CH2         .48835-10     CH3         .70213-14
C2H         .24486-09     C3H         .13391-14     C4H         .43718-19
C6H         .25875-29     NO          .18674-05     O-          .79025-06
C-          .43832-06     H-          .40578-05     H+          .12026-01
CO+         .13777-05     C+          .15044-01     N+          .13424-02
NO+         .15589-05     N2+         .23644-06     O+          .76975-03
CN+         .49469-06

TEMP=   9999.9989 DEG-K      PRES =     1.000 ATM      MOL WT =  3.2118372
 ENTHALPY =    .3719076+05 CAL/GM    ENTROPY =    .14894+02 CAL/GM-DEG K
 DENSITY =    .391415-05 GM/CM3

SPECIES   MOLE FR.        SPECIES   MOLE FR.        SPECIES   MOLE FR.
C           .51760-01     N           .55935-01     O           .49376-01
H           .78444+00     E-          .29181-01     CO          .33809-04
N2          .17790-04     O2          .10748-06     CN          .45027-05
CO2         .21634-10     C2          .92152-06     C3          .23320-11
C4          .75405-17     C5          .25426-22     H2          .57358-04
CH          .55564-05     CH2         .48835-10     CH3         .70213-14
C2H         .24486-09     C3H         .13391-14     C4H         .43718-19
C6H         .25875-29     NO          .18674-05     O-          .79025-06
C-          .43832-06     H-          .40578-05     H+          .12026-01
CO+         .13777-05     C+          .15044-01     N+          .13424-02
NO+         .15589-05     N2+         .23644-06     O+          .76975-03
CN+         .49469-06

TEMP=   9999.9989 DEG-K      PRES =     1.000 ATM      MOL WT =  3.2118372
 ENTHALPY =    .3719076+05 CAL/GM    ENTROPY =    .14894+02 CAL/GM-DEG K
 DENSITY =    .391415-05 GM/CM3

SPECIES   MOLE FR.        SPECIES   MOLE FR.        SPECIES   MOLE FR.
C           .51760-01     N           .55935-01     O           .49376-01
H           .78444+00     E-          .29181-01     CO          .33809-04
N2          .17790-04     O2          .10748-06     CN          .45027-05
CO2         .21634-10     C2          .92152-06     C3          .23320-11
C4          .75405-17     C5          .25426-22     H2          .57358-04
CH          .55564-05     CH2         .48835-10     CH3         .70213-14
C2H         .24486-09     C3H         .13391-14     C4H         .43718-19
C6H         .25875-29     NO          .18674-05     O-          .79025-06
C-          .43832-06     H-          .40578-05     H+          .12026-01
CO+         .13777-05     C+          .15044-01     N+          .13424-02
NO+         .15589-05     N2+         .23644-06     O+          .76975-03
CN+         .49469-06

TEMP=   9999.9989 DEG-K      PRES =     1.000 ATM      MOL WT =  3.2118372
 ENTHALPY =    .3719076+05 CAL/GM    ENTROPY =    .14894+02 CAL/GM-DEG K
 DENSITY =    .391415-05 GM/CM3

SPECIES   MOLE FR.        SPECIES   MOLE FR.        SPECIES   MOLE FR.
C           .51760-01     N           .55935-01     O           .49376-01
```

OUTPUT - SAMPLE PROBLEM 5

N	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24486-09	C3H	.13391-14	C4H	.43718-19
C6H	.25875-29	NO	.18674-05	O-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

TEMP= 9999.9989 DEG-K PRES = 1.000 ATM MOL WT = 3.2118372
ENTHALPY = .3719076+05 CAL/GM ENTROPY = .14894+02 CAL/GM-DEG K
DENSITY = .391415-05 GM/CM3

SPECIES	MOLE FR.	SPECIES	MOLE FR.	SPECIES	MOLE FR.
C	.51760-01	N	.55935-01	O	.49376-01
H	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24486-09	C3H	.13391-14	C4H	.43718-19
C6H	.25875-29	NO	.18674-05	O-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

TEMP= 9999.9989 DEG-K PRES = 1.000 ATM MOL WT = 3.2118372
ENTHALPY = .3719076+05 CAL/GM ENTROPY = .14894+02 CAL/GM-DEG K
DENSITY = .391415-05 GM/CM3

SPECIES	MOLE FR.	SPECIES	MOLE FR.	SPECIES	MOLE FR.
C	.51760-01	N	.55935-01	O	.49376-01
H	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24486-09	C3H	.13391-14	C4H	.43718-19
C6H	.25875-29	NO	.18674-05	O-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

TEMP= 9999.9989 DEG-K PRES = 1.000 ATM MOL WT = 3.2118372
ENTHALPY = .3719076+05 CAL/GM ENTROPY = .14894+02 CAL/GM-DEG K
DENSITY = .391415-05 GM/CM3

SPECIES	MOLE FR.	SPECIES	MOLE FR.	SPECIES	MOLE FR.
C	.51760-01	N	.55935-01	O	.49376-01
H	.78444+00	E-	.29181-01	CO	.33809-04
N2	.17790-04	O2	.10748-06	CN	.45027-05
CO2	.21634-10	C2	.92152-06	C3	.23320-11
C4	.75405-17	C5	.25426-22	H2	.57358-04
CH	.55564-05	CH2	.48835-10	CH3	.70213-14
C2H	.24486-09	C3H	.13391-14	C4H	.43718-19

OUTPUT - SAMPLE PROBLEM 5

C6H	.25675-29	NO	.18674-05	C-	.79025-06
C-	.43832-06	H-	.40578-05	H+	.12026-01
CO+	.13777-05	C+	.15044-01	N+	.13424-02
NO+	.15589-05	N2+	.23644-06	O+	.76975-03
CN+	.49469-06				

OUTPUT - SAMPLE PROBLEM 5

DELTA = 1,000000+00

NUMBER DENSITIES

O+	5.65+14	5.65+14	5.65+14	5.65+14	5.65+14	5.65+14	5.65+14	5.65+14	5.65+14	5.65+14
O	3.62+16	3.62+16	3.62+16	3.62+16	3.62+16	3.62+16	3.62+16	3.62+16	3.62+16	3.62+16
N+	9.85+14	9.85+14	9.85+14	9.85+14	9.85+14	9.85+14	9.85+14	9.85+14	9.85+14	9.85+14
N	4.11+16	4.11+16	4.11+16	4.11+16	4.11+16	4.11+16	4.11+16	4.11+16	4.11+16	4.11+16
C+	1.10+16	1.10+16	1.10+16	1.10+16	1.10+16	1.10+16	1.10+16	1.10+16	1.10+16	1.10+16
C	3.80+16	3.80+16	3.80+16	3.80+16	3.80+16	3.80+16	3.80+16	3.80+16	3.80+16	3.80+16
H	5.76+17	5.76+17	5.76+17	5.76+17	5.76+17	5.76+17	5.76+17	5.76+17	5.76+17	5.76+17
N2+	1.74+11	1.74+11	1.74+11	1.74+11	1.74+11	1.74+11	1.74+11	1.74+11	1.74+11	1.74+11
NO	1.37+12	1.37+12	1.37+12	1.37+12	1.37+12	1.37+12	1.37+12	1.37+12	1.37+12	1.37+12
O2	7.69+10	7.69+10	7.69+10	7.69+10	7.69+10	7.69+10	7.69+10	7.69+10	7.69+10	7.69+10
N2	1.31+13	1.31+13	1.31+13	1.31+13	1.31+13	1.31+13	1.31+13	1.31+13	1.31+13	1.31+13
CO	2.48+13	2.48+13	2.48+13	2.48+13	2.48+13	2.48+13	2.48+13	2.48+13	2.48+13	2.48+13
H2	4.21+13	4.21+13	4.21+13	4.21+13	4.21+13	4.21+13	4.21+13	4.21+13	4.21+13	4.21+13
C2	6.76+11	6.76+11	6.76+11	6.76+11	6.76+11	6.76+11	6.76+11	6.76+11	6.76+11	6.76+11
CN	3.30+12	3.30+12	3.30+12	3.30+12	3.30+12	3.30+12	3.30+12	3.30+12	3.30+12	3.30+12
C-	3.22+11	3.22+11	3.22+11	3.22+11	3.22+11	3.22+11	3.22+11	3.22+11	3.22+11	3.22+11
H-	2.98+12	2.98+12	2.98+12	2.98+12	2.98+12	2.98+12	2.98+12	2.98+12	2.98+12	2.98+12
C3	1.71+06	1.71+06	1.71+06	1.71+06	1.71+06	1.71+06	1.71+06	1.71+06	1.71+06	1.71+06
O-	5.80+11	5.80+11	5.80+11	5.80+11	5.80+11	5.80+11	5.80+11	5.80+11	5.80+11	5.80+11
E-	2.14+16	2.14+16	2.14+16	2.14+16	2.14+16	2.14+16	2.14+16	2.14+16	2.14+16	2.14+16

OUTPUT - SAMPLE PROBLEM 5

CONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX

UMINUS/UPLUS
(WATTS/CM2-EV)

NORMALIZED PATH LENGTHS / HV (EV)	.00	.50-01	.13+00	.25+00	.38+00	.50+00	.63+00	.75+00	.88+00	.10+01
.020	.00	.20+00	.48+00	.91+00	.13+01	.17+01	.20+01	.23+01	.26+01	.28+01
	.28+01	.27+01	.26+01	.23+01	.20+01	.17+01	.13+01	.91+00	.48+00	.00
.300	.00	.20+00	.49+00	.98+00	.15+01	.19+01	.24+01	.29+01	.34+01	.39+01
	.39+01	.37+01	.34+01	.29+01	.24+01	.19+01	.15+01	.98+00	.49+00	.00
.200	.00	.19+00	.48+00	.97+00	.14+01	.19+01	.24+01	.29+01	.34+01	.39+01
	.39+01	.37+01	.34+01	.29+01	.24+01	.19+01	.14+01	.97+00	.48+00	.00
.500	.00	.19+00	.47+00	.94+00	.14+01	.19+01	.23+01	.28+01	.33+01	.38+01
	.38+01	.36+01	.33+01	.28+01	.23+01	.19+01	.14+01	.94+00	.47+00	.00
.800	.00	.20+00	.50+00	.99+00	.15+01	.20+01	.25+01	.30+01	.35+01	.40+01
	.40+01	.38+01	.35+01	.30+01	.25+01	.20+01	.15+01	.99+00	.49+00	.00
1.000	.00	.21+00	.53+00	.11+01	.16+01	.21+01	.27+01	.32+01	.37+01	.43+01
	.43+01	.41+01	.37+01	.32+01	.27+01	.21+01	.16+01	.11+01	.53+00	.00
1.500	.00	.28+00	.71+00	.14+01	.21+01	.28+01	.35+01	.42+01	.49+01	.56+01
	.56+01	.54+01	.49+01	.42+01	.35+01	.28+01	.21+01	.14+01	.71+00	.00
1.839	.00	.37+00	.93+00	.19+01	.28+01	.37+01	.46+01	.56+01	.65+01	.74+01
	.74+01	.71+01	.65+01	.56+01	.46+01	.37+01	.28+01	.19+01	.93+00	.00
1.841	.00	.31+00	.77+00	.15+01	.23+01	.31+01	.39+01	.46+01	.54+01	.62+01
	.62+01	.59+01	.54+01	.46+01	.39+01	.31+01	.23+01	.15+01	.77+00	.00
2.200	.00	.27+00	.69+00	.14+01	.21+01	.27+01	.34+01	.41+01	.48+01	.55+01
	.55+01	.52+01	.48+01	.41+01	.34+01	.27+01	.21+01	.14+01	.68+00	.00
2.799	.00	.20+00	.50+00	.10+01	.15+01	.20+01	.25+01	.30+01	.35+01	.40+01
	.40+01	.38+01	.35+01	.30+01	.25+01	.20+01	.15+01	.10+01	.50+00	.00
2.805	.00	.29+00	.72+00	.14+01	.22+01	.29+01	.36+01	.43+01	.50+01	.57+01
	.57+01	.55+01	.50+01	.43+01	.36+01	.29+01	.22+01	.14+01	.72+00	.00
3.100	.00	.27+00	.68+00	.14+01	.20+01	.27+01	.34+01	.41+01	.48+01	.55+01
	.55+01	.52+01	.48+01	.41+01	.34+01	.27+01	.20+01	.14+01	.68+00	.00
3.400	.00	.58+00	.15+01	.29+01	.44+01	.58+01	.73+01	.88+01	.10+02	.12+02
	.12+02	.11+02	.10+02	.87+01	.73+01	.58+01	.44+01	.29+01	.15+01	.00
3.700	.00	.48+00	.12+01	.24+01	.36+01	.48+01	.60+01	.72+01	.84+01	.95+01
	.95+01	.91+01	.84+01	.72+01	.60+01	.48+01	.36+01	.24+01	.12+01	.00
4.000	.00	.37+00	.92+00	.18+01	.28+01	.37+01	.46+01	.55+01	.64+01	.74+01
	.74+01	.70+01	.64+01	.55+01	.46+01	.37+01	.28+01	.18+01	.92+00	.00
4.500	.00	.24+00	.60+00	.12+01	.18+01	.24+01	.30+01	.36+01	.42+01	.48+01
	.48+01	.46+01	.42+01	.36+01	.30+01	.24+01	.18+01	.12+01	.60+00	.00
5.000	.00	.17+00	.43+00	.86+00	.13+01	.17+01	.21+01	.26+01	.30+01	.34+01
	.34+01	.33+01	.30+01	.26+01	.21+01	.17+01	.13+01	.86+00	.43+00	.00
6.000	.00	.14+00	.35+00	.69+00	.10+01	.14+01	.17+01	.21+01	.24+01	.28+01
	.28+01	.26+01	.24+01	.21+01	.17+01	.14+01	.10+01	.69+00	.35+00	.00
7.000	.00	.81-01	.20+00	.40+00	.60+00	.81+00	.10+01	.12+01	.14+01	.16+01
	.16+01	.15+01	.14+01	.12+01	.10+01	.81+00	.60+00	.40+00	.20+00	.00
8.000	.00	.91-01	.23+00	.45+00	.68+00	.91+00	.11+01	.14+01	.16+01	.18+01
	.18+01	.17+01	.16+01	.14+01	.11+01	.91+00	.68+00	.45+00	.23+00	.00
8.500	.00	.79-01	.20+00	.40+00	.59+00	.79+00	.99+00	.12+01	.14+01	.16+01
	.16+01	.15+01	.14+01	.12+01	.99+00	.79+00	.59+00	.40+00	.20+00	.00
8.520	.00	.25+00	.61+00	.12+01	.18+01	.24+01	.31+01	.37+01	.43+01	.49+01
	.49+01	.46+01	.43+01	.37+01	.31+01	.24+01	.18+01	.12+01	.61+00	.00
8.980	.00	.19+00	.48+00	.95+00	.14+01	.19+01	.24+01	.29+01	.33+01	.38+01
	.38+01	.36+01	.33+01	.29+01	.24+01	.19+01	.14+01	.95+00	.48+00	.00
9.000	.00	.19+00	.47+00	.95+00	.14+01	.19+01	.24+01	.28+01	.33+01	.38+01
	.38+01	.36+01	.33+01	.28+01	.24+01	.19+01	.14+01	.95+00	.47+00	.00
9.190	.00	.19+00	.46+00	.92+00	+01	.18+01	.23+01	.28+01	.32+01	.37+01

OUTPUT - SAMPLE PROBLEM 5

```
                .37+01  .35+01  .32+01  .28+01  .23+01  .18+01  .14+01  .92+00  .46+00  .00
  9.210   .00       .19+00  .46+00  .93+00  .14+01  .18+01  .23+01  .28+01  .32+01  .37+01
                .37+01  .35+01  .32+01  .28+01  .23+01  .18+01  .14+01  .93+00  .46+00  .00
  9.990   .00       .12+01  .29+01  .57+01  .85+01  .11+02  .14+02  .16+02  .19+02  .22+02
                .22+02  .21+02  .17+02  .16+02  .14+02  .11+02  .85+01  .57+01  .29+01  .00
 10.010   .00       .11+01  .27+01  .54+01  .80+01  .11+02  .13+02  .15+02  .18+02  .20+02
                .20+02  .19+02  .18+02  .15+02  .13+02  .11+02  .80+01  .54+01  .27+01  .00
 10.395   .00       .78+00  .19+01  .38+01  .57+01  .75+01  .93+01  .11+02  .13+02  .15+02
                .15+02  .14+02  .13+02  .11+02  .93+01  .75+01  .57+01  .38+01  .19+01  .00
 10.405   .00       .15+01  .38+01  .74+01  .11+02  .14+02  .17+02  .21+02  .24+02  .26+02
                .26+02  .25+02  .24+02  .21+02  .17+02  .14+02  .11+02  .74+01  .38+01  .00
 10.790   .00       .62+00  .15+01  .30+01  .45+01  .59+01  .73+01  .87+01  .10+02  .11+02
                .11+02  .11+02  .10+02  .87+01  .73+01  .59+01  .45+01  .30+01  .15+01  .00
 10.910   .00       .65+00  .16+01  .32+01  .47+01  .62+01  .77+01  .92+01  .11+02  .12+02
                .12+02  .11+02  .11+02  .92+01  .77+01  .62+01  .47+01  .32+01  .16+01  .00
 11.000   .00       .53+00  .13+01  .26+01  .39+01  .51+01  .63+01  .75+01  .87+01  .98+01
                .98+01  .93+01  .87+01  .75+01  .63+01  .51+01  .39+01  .26+01  .13+01  .00
 11.250   .00       .42+00  .10+01  .21+01  .31+01  .40+01  .50+01  .59+01  .68+01  .77+01
                .77+01  .7 +01  .60+01  .59+01  .50+01  .40+01  .31+01  .21+01  .10+01  .00
 11.270   .00       .21+01  .51+01  .96+01  .14+02  .17+02  .21+02  .23+02  .26+02  .28+02
                .28+02  .27+02  .26+02  .23+02  .21+02  .17+02  .14+02  .96+01  .51+01  .00
 11.995   .00       .15+01  .35+01  .66+01  .92+01  .11+02  .13+02  .15+02  .16+02  .18+02
                .18+02  .17+02  .16+02  .15+02  .13+02  .11+02  .92+01  .66+01  .35+01  .00
 12.005   .00       .12+01  .28+01  .53+01  .74+01  .94+01  .11+02  .13+02  .14+02  .15+02
                .15+02  .15+02  .14+02  .13+02  .11+02  .94+01  .74+01  .53+01  .28+01  .00
 12.195   .00       .97+00  .23+01  .44+01  .63+01  .79+01  .93+01  .11+02  .12+02  .13+02
                .13+02  .12+02  .12+02  .11+02  .93+01  .79+01  .63+01  .44+01  .23+01  .00
 12.201   .00       .12+01  .28+01  .52+01  .72+01  .90+01  .11+02  .12+02  .13+02  .14+02
                .14+02  .14+02  .13+02  .12+02  .11+02  .90+01  .72+01  .52+01  .28+01  .00
 12.980   .00       .47+00  .11+01  .21+01  .30+01  .38+01  .45+01  .52+01  .57+01  .62+01
                .62+01  .60+01  .57+01  .52+01  .45+01  .38+01  .30+01  .21+01  .11+01  .00
 13.000   .00       .46+00  .11+01  .21+01  .30+01  .38+01  .44+01  .51+01  .56+01  .61+01
                .61+01  .59+01  .56+01  .51+01  .44+01  .38+01  .30+01  .21+01  .11+01  .00
 13.390   .00       .28+01  .50+01  .63+01  .67+01  .67+01  .68+01  .68+01  .68+01  .68+01
                .68+01  .68+01  .68+01  .68+01  .68+01  .67+01  .67+01  .63+01  .50+01  .00
 13.410   .00       .23+01  .49+01  .62+01  .65+01  .66+01  .66+01  .67+01  .67+01  .67+01
                .67+01  .67+01  .67+01  .67+01  .66+01  .66+01  .65+01  .62+01  .49+01  .00
 13.590   .00       .23+01  .41+01  .52+01  .55+01  .56+01  .56+01  .56+01  .56+01  .56+01
                .56+01  .56+01  .56+01  .56+01  .56+01  .56+01  .55+01  .52+01  .41+01  .00
 13.610   .00       .22+01  .40+01  .51+01  .54+01  .55+01  .55+01  .55+01  .55+01  .55+01
                .55+01  .55+01  .55+01  .55+01  .55+01  .55+01  .54+01  .51+01  .40+01  .00
 14.290   .00       .11+01  .20+01  .26+01  .28+01  .29+01  .29+01  .29+01  .29+01  .29+01
                .29+01  .29+01  .29+01  .29+01  .29+01  .29+01  .28+01  .26+01  .20+01  .00
 14.310   .00       .10+01  .19+01  .26+01  .28+01  .28+01  .28+01  .28+01  .28+01  .28+01
                .28+01  .28+01  .28+01  .28+01  .28+01  .28+01  .26+01  .26+01  .19+01  .00
 14.550   .00       .84+00  .16+01  .20+01  .22+01  .22+01  .23+01  .23+01  .23+01  .23+01
                .23+01  .23+01  .23+01  .23+01  .23+01  .22+01  .22+01  .20+01  .16+01  .00
 15.000   .00       .51+00  .97+00  .13+01  .14+01  .15+01  .15+01  .15+01  .15+01  .15+01
                .15+01  .15+01  .15+01  .15+01  .15+01  .15+01  .14+01  .13+01  .97+00  .00


                              FREQUENCY INTEGRATED VALUES

          .00       .86+01  .19+02  .34+02  .48+02  .60+02  .72+02  .83+02  .94+02  .10+03
                .10+03  .10+03  .94+02  .83+02  .72+02  .60+02  .48+02  .34+02  .14+02  .00
```

OUTPUT - SAMPLE PROBLEM 5

LINE RADIATION

POSITIVE AND NEGATIVE CONTRIBUTIONS (WATTS/CM2)

GROUP NO.	FREQUENCY (EV)	NORMALIZED DIST = .00	.50-01	.13+00	.25+00	.38+00	.50+00	.63+00	.75+00	.88+00	.10+01
1	.690	.49+01	.47+01	.43+01	.37+01	.31+01	.25+01	.19+01	.12+01	.62+00	.15-03
			.18-03	.25+00	.62+00	.12+01	.19+01	.25+01	.31+01	.37+01	.43+01	.49+01
2	.890	.20+01	.19+01	.18+01	.15+01	.13+01	.10+01	.78+00	.52+00	.26+00	.76-04
			.76-04	.11+00	.26+00	.52+00	.78+00	.10+01	.13+01	.15+01	.18+01	.20+01
3	1,050	.10+02	.98+01	.91+01	.80+01	.68+01	.56+01	.43+01	.30+01	.16+01	.92-04
			.18-03	.66+00	.16+01	.30+01	.43+01	.56+01	.68+01	.80+01	.91+01	.10+02
4	1,290	.56+01	.54+01	.51+01	.46+01	.40+01	.34+01	.27+01	.19+01	.10+01	.31-04
			.31-04	.42+00	.10+01	.19+01	.27+01	.34+01	.40+01	.46+01	.51+01	.56+01
5	1,600	.59+01	.57+01	.52+01	.46+01	.38+01	.31+01	.24+01	.16+01	.81+00	.27-03
			.21-03	.33+00	.81+00	.16+01	.24+01	.31+01	.38+01	.46+01	.52+01	.59+01
6	1,888	.45+02	.43+02	.40+02	.35+02	.29+02	.24+02	.18+02	.12+02	.62+01	.12-03
			.12-03	.25+01	.62+01	.12+02	.18+02	.24+02	.29+02	.35+02	.40+02	.45+02
7	2,500	.81+01	.77+01	.71+01	.61+01	.51+01	.41+01	.31+01	.21+01	.10+01	.37-03
			.37-03	.41+00	.10+01	.21+01	.31+01	.41+01	.51+01	.61+01	.71+01	.81+01
8	3,400	.30+01	.28+01	.26+01	.22+01	.18+01	.15+01	.11+01	.74+00	.37+00	.15-02
			.1[illegible]-02	.15+00	.37+00	.74+00	.11+01	.15+01	.18+01	.22+01	.26+01	.30+01
9	7,110	.31+02	.30+02	.29+02	.26+[illegible]2	.24+02	.21+02	.10+02	.15+02	.99+01	.69-04
			.69-04	.64+01	.99+01	.15+02	.18+02	.21+02	.24+02	.26+02	.29+02	.31+02
10	8,400	.89+01	.88+01	.05+01	.81+01	.76+01	.70+01	.64+01	.57+01	.48+01	.15-04
			.15-04	.39+01	.48+01	.57+01	.64+01	.70+01	.76+01	.81+01	.85+01	.89+01
11	9,400	.15+02	.14+02	.14+02	.12+02	.11+02	.93+01	.76+01	.56+01	.34+01	.13-04
			.17-04	.18+01	.34+01	.56+01	.76+01	.93+01	.11+02	.12+02	.14+02	.15+02
12	10,000	.33+01	.33+01	.32+01	.30+01	.27+01	.25+01	.2[illegible]+01	.17+01	.12+01	.17-05
			.14-05	.74+00	.12+01	.17+01	.21+01	.25+01	.27+01	.30+01	.32+01	.33+01
13	10,200	.13+02	.13+02	.12+02	.12+02	.11+02	.10+02	.92+01	.77+01	.57+01	.14-05
			.95-06	.41+01	.57+01	.77+01	.92+01	.1[illegible]+02	.11+02	.12+02	.12+02	.13+02
14	10,500	.13+02	.13+02	.13+02	.12+02	.11+02	.10+02	.89+01	.71+01	.46+01	.38-05
			.38-05	.25+01	.46+01	.71+01	.89+01	.10+02	.11+02	.12+02	.13+02	.13+02
15	11,200	.67+01	.65+01	.63+01	.59+01	.54+01	.48+01	.40+01	.31+01	.19+01	.17-05
			.19-05	.94+00	.19+01	.31+01	.40+01	.48+01	.54+01	.59+01	.63+01	.67+01
16	11,900	.42+00	.42+00	.43+00	.44+00	.44+00	.43+00	.39+00	.33+00	.23+00	.48-06
			.48-06	.13+00	.23+00	.33+00	.39+00	.43+00	.44+00	.44+00	.43+00	.42+00
17	12,080	.12+01	.12+01	.13+01	.13+01	.14+01	.15+01	.15+01	.15+01	.13+01	.12-06
			.18-06	.91+00	.13+01	.15+01	.15+01	.15+01	.14+01	.13+01	.13+01	.12+01

18	12,800	.81+00	.36-06	.84+00	.55+00	.87+00	.80+00	.93+00	.97+00	.95+00	.10+01	.10+01	.10+01	.10+01	.98+00	.97+00	.93+00	.80+00	.87+00	.30-06	.81+00
19	13,000	.10+01	.18-06	.10+01	.69+00	.11+01	.10+01	.12+01	.13+01	.12+01	.13+01	.13+01	.13+01	.13+01	.12+01	.13+01	.12+01	.10+01	.11+01	.18-06	.10+01
20	13,500	.40-04	.48-06	.67-04	.16+00	.14-03	.12+00	.49-03	.51-01	.17-02	.10-01	.55-02	.55-02	.18-01	.17-02	.51-01	.49-03	.12+00	.14-03	.48-06	.40-04
TOTAL POS=		.18+03		.17+03		.16+03		.15+03		.13+03		.11+03		.95+02		.73+02		.47+02		.27-02	
TOTAL NEG=			.25-02		.28+02		.47+02		.73+02		.95+02		.11+03		.13+03		.15+03		.16+03		.18+03

OUTPUT - SAMPLE PROBLEM 5

4.6 SAMPLE PROBLEM 6

This sample problem is identical to the fifth sample except that the equivalent width approximation is employed. The input decks are identical except for the following change:

Sample Problem 5	Sample Problem 6
KR(4)=0	KR(4)=3

which must be made to implement the equivalent width option. The computing time requirements are summarized in Table 4.2, below for a UNIVAC 1108 machine.

TABLE 4.2

COMPUTING TIMES

Computation	Time (sec)	
	Sample Case 5	Sample Case 6
Chemistry	6.411	6.354
Continuum Radiation	5.786	5.713
Line Radiation	110.446	9.452
Total	122.643	21.519

LINE RADIATION

GROUP NO.	FREQUENCY (EV)	NORMALIZED DIST = .00	.50-01	.13+00	.25+00	.38+00	.50+00	.63+00	.75+00	.88+00	.10+01
		POSITIVE AND NEGATIVE CONTRIBUTIONS (WATTS/CM2)									
1	.690	.69+01	.65+01	.60+01	.52+01	.43+01	.35+01	.26+01	.17+01	.86+00	.31-04
		.31-04	.35+00	.86+00	.17+01	.26+01	.35+01	.43+01	.52+01	.60+01	.69+01
2	.890	.15+01	.14+01	.13+01	.12+01	.97+00	.79+00	.60+00	.40+00	.20+00	.76-05
		.15-04	.82-01	.20+00	.40+00	.60+00	.79+00	.97+00	.12+01	.13+01	.15+01
3	1.050	.90+01	.86+01	.80+01	.70+01	.60+01	.49+01	.38+01	.26+01	.14+01	.31-04
		.31-04	.58+00	.14+01	.26+01	.38+01	.49+01	.60+01	.70+01	.80+01	.90+01
4	1.2	.56+01	.54+01	.51+01	.45+01	.40+01	.33+01	.27+01	.19+01	.10+01	.15-04
		.15-04	.42+00	.10+01	.19+01	.27+01	.33+01	.40+01	.45+01	.51+01	.56+01
5	1.600	.33+01	.32+01	.29+01	.26+01	.22+01	.18+01	.14+01	.95+00	.49+00	.18-03
		.18-03	.20+00	.49+00	.95+00	.14+01	.18+01	.22+01	.26+01	.29+01	.33+01
6	1.888	.45+02	.43+02	.40+02	.35+02	.29+02	.24+02	.18+02	.12+02	.62+01	.12-03
		.12-03	.25+01	.62+01	.12+02	.18+02	.24+02	.29+02	.35+02	.40+02	.45+02
7	2.500	.81+01	.77+01	.71+01	.61+01	.51+01	.41+01	.31+01	.21+01	.10+01	.37-03
		.37-03	.41+00	.10+01	.21+01	.31+01	.41+01	.51+01	.61+01	.71+01	.81+01
8	3.400	.31+01	.29+01	.27+01	.23+01	.19+01	.15+01	.11+01	.77+00	.38+00	.12-03
		.12-03	.15+00	.38+00	.77+00	.11+01	.15+01	.19+01	.23+01	.27+01	.31+01
9	7.110	.30+02	.29+02	.28+02	.26+02	.23+02	.21+02	.18+02	.14+02	.99+01	-.61-04
		.00	.61+01	.99+01	.14+02	.18+02	.21+02	.23+02	.26+02	.28+02	.30+02
10	8.400	.64+01	.62+01	.59+01	.55+01	.49+01	.44+01	.38+01	.30+01	.21+01	.15-04
		.15-04	.13+01	.21+01	.30+01	.38+01	.44+01	.49+01	.55+01	.59+01	.64+01
11	9.400	.16+02	.15+02	.14+02	.13+02	.11+02	.95+01	.78+01	.58+01	.35+01	.38-05
		.38-05	.17+01	.35+01	.58+01	.78+01	.95+01	.1[illegible]+02	.13+02	.14+02	.16+02
12	10.000	.45+01	.44+01	.42+01	.39+01	.35+01	.31+01	.26+01	.21+01	.14+01	.95-06
		.19-05	.80+00	.14+01	.21+01	.26+01	.31+01	.35+01	.38+01	.42+01	.45+01
13	10.200	.13+02	.13+02	.12+02	.12+02	.11+02	.10+02	.92+01	.77+01	.57+01	.14-05
		.95-06	.41+01	.57+01	.77+01	.92+01	.10+02	.11+02	.12+02	.12+02	.13+02
14	10.500	.60+01	.60+01	.59+01	.59+01	.58+01	.57+01	.55+01	.50+01	.43+01	.95-06
		.95-06	.25+01	.43+01	.49+01	.52+01	.53+01	.54+01	.53+01	.52+01	.52+01
15	11.200	.96+01	.94+01	.89+01	.82+01	.73+01	.63+01	.52+01	.38+01	.22+01	.00
		.00	.10+01	.22+01	.38+01	.52+01	.63+01	.73+01	.82+01	.89+01	.96+01
16	11.900	.33+00	.33+00	.32+00	.32+00	.31+00	.30+00	.28+00	.25+00	.19+00	.00
		-.12-06	.12+00	.18+00	.22+00	.23+00	.23+00	.22+00	.21+00	.20+00	.19+00
17	12.080	.12+01	.12+01	.13+01	.13+01	.14+01	.15+01	.15+01	.15+01	.13+01	.12-06
		.18-06	.91+00	.13+01	.15+01	.15+01	.15+01	.14+01	.13+01	.13+01	.12+01

SELECTED OUTPUT - SAMPLE PROBLEM 6

18	12.800	.11+01	.12-06	.11+01	.60+00	.11+01	.88+00	.12+01	.11+01	.12+01	.12+01	.12+01	.12+01	.12+01	.12+01	.11+01	.12+01	.88+00	.11+01	.12-06	.11+01
19	13.000	.14+01	.12-06	.14+01	.72+00	.14+01	.11+01	.15+01	.14+01	.16+01	.15+01	.16+01	.15+01	.15+01	.15+01	.14+01	.14+01	.11+01	.13+01	.12-06	.12+01
20	13.500	.43-04	.12-06	.71-04	.15+00	.15-03	.13+00	.51-03	.53-01	.17-02	.18-01	.57-02	.57-02	.18-01	.17-02	.53-01	.51-03	.15+00	.15-03	.12-06	.43-04
TOTAL POS=		.17+03		.17+03		.16+03		.14+03		.13+03		.11+03		.90+02		.69+02		.44+02		.78-03	
TOTAL NEG=			.91-03		.25+02		.44+02		.68+02		.89+02		.11+03		.12+03		.14+03		.16+03		.17+03

SELECTED OUTPUT - SAMPLE PROBLEM 6

SECTION 5

OPERATING PROCEDURES

This program is written in FORTRAN V source language. It has been run in the UNIVAC 1108, the CDC 6400, 6600 and 7600. It easily fits within the 66K core capacity of the 1108 computer; consequently, an overlay procedure is usually not required for uncoupled applications. When the program is to be used as a subroutine in coupled flow-field applications, an efficient overlay is easily devised, as shown in Figure 5-1.

Card input is on unit M and output is on unit N where M and N are defined as 5 and 6 in the main routine. No scratch tapes or other input/output devices are needed.

A control deck setup is shown in Figure 5-2 for the UNIVAC 1108. Compiled decks are often obtained from tape storage as shown in the figure. Drum storage is also commonly used for this machine and would require a deck setup which is quite similiar to that shown.

A control deck setup for the CDC 6600 is shown in Figure 5-3. In this case the compiled decks are obtained from files. Again, the deck setup, for tape input is quite similiar to that shown.

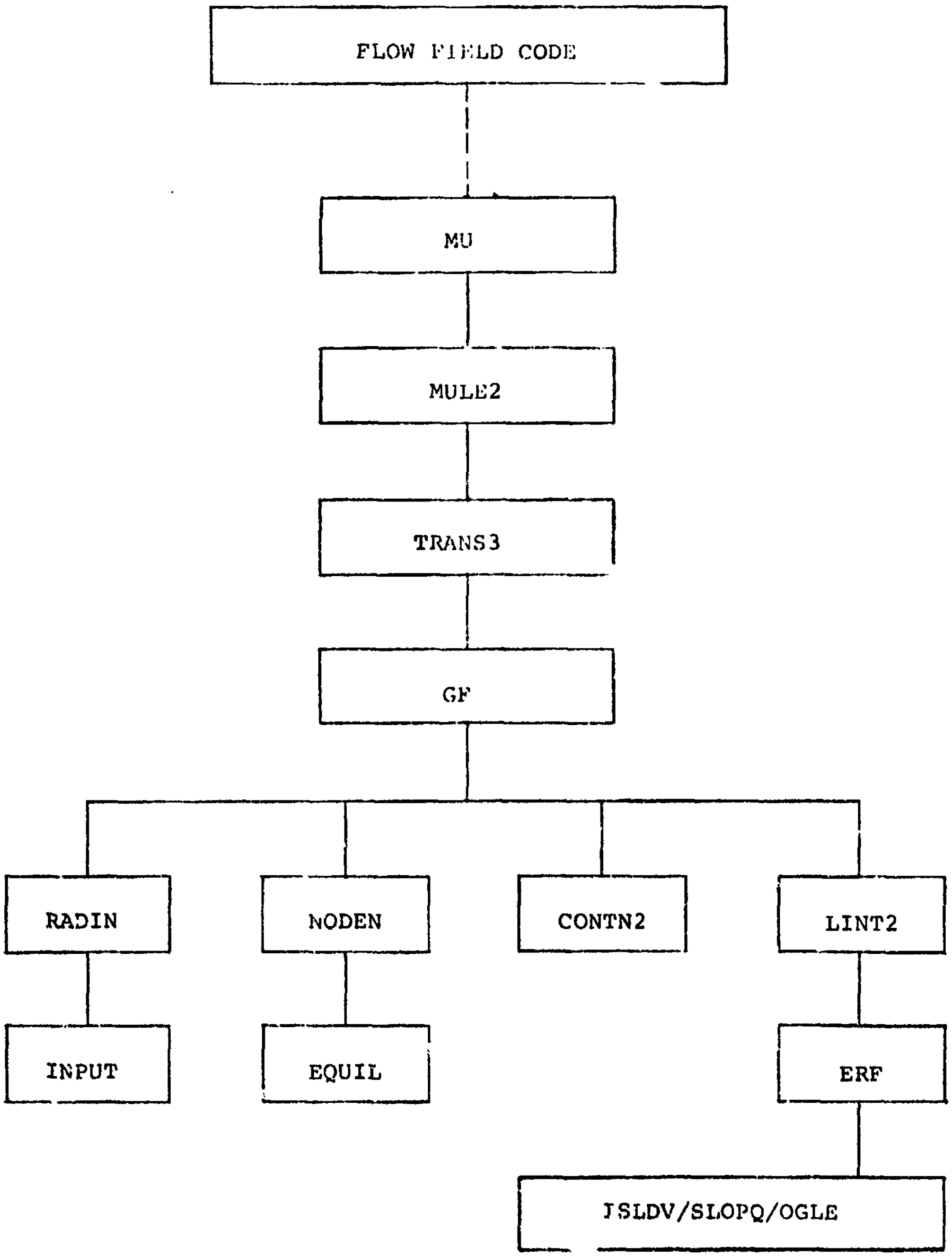


FIGURE 5.1 TYPICAL OVERLAY FOR FLOW FIELD COUPLING

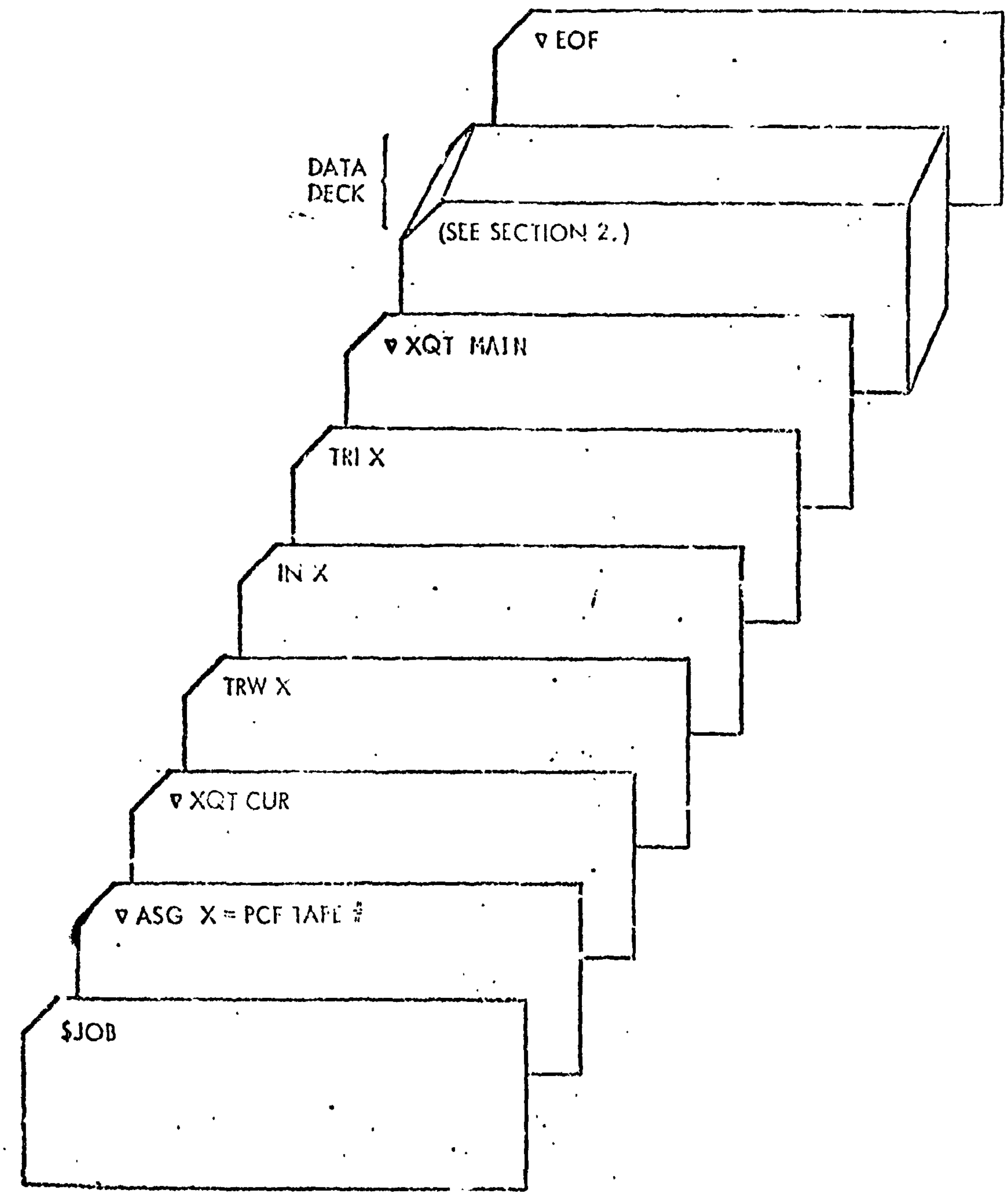


FIGURE 5.2 CONTROL DECK SETUP FOR THE UNIVAC 1103 COMPUTER

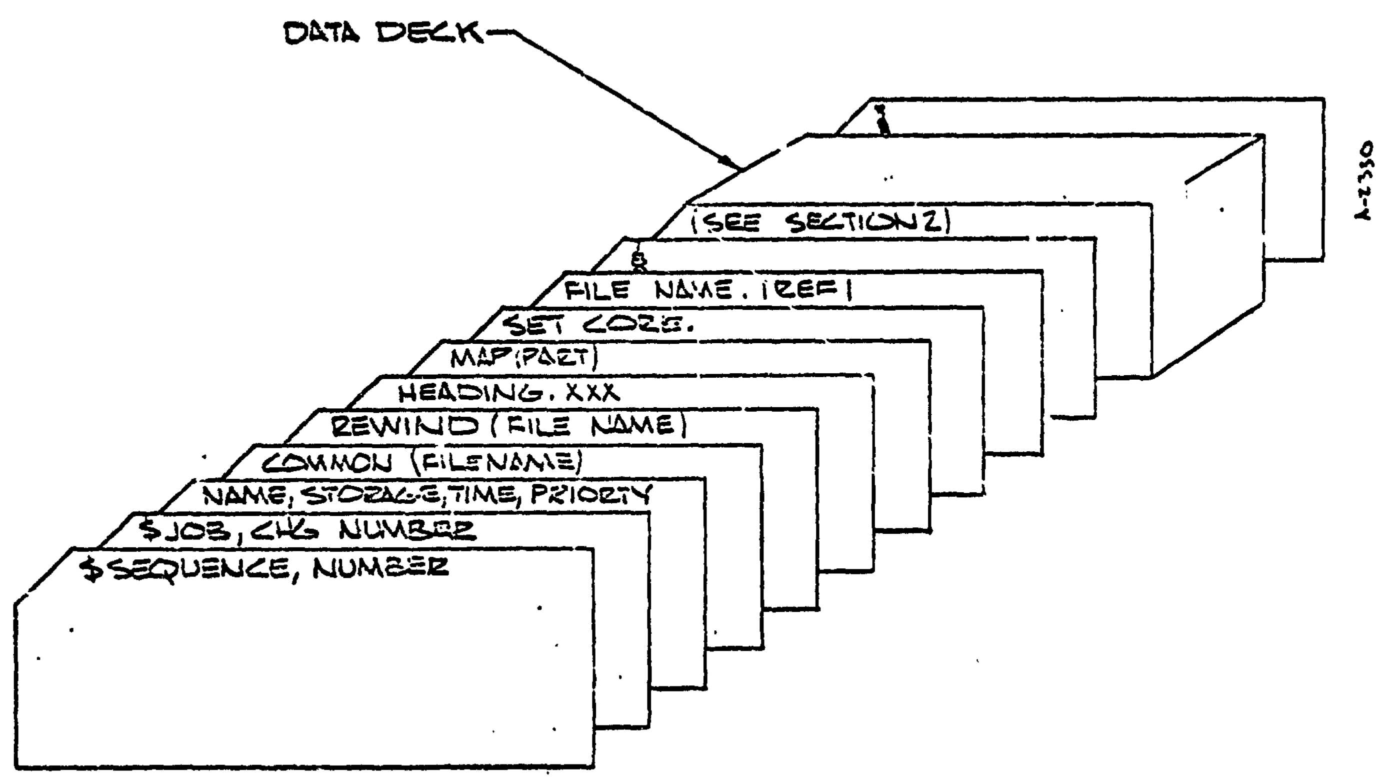


FIGURE 5.3 CONTROL DECK SETUP FOR THE CDC 6600 COMPUTER

SECTION 6

ERROR MESSAGES

This program has a number of internal consistency checks which must be satisfied before it will allow calculations to proceed. In addition, there are a number of internal iterative calculations which must be successfully completed before the program will allow the calculations to proceed. Whenever the program encounters an inconsistency or is unable to obtain an iterative solution, it will print out an error message and execute a program stop. Each of the error messages is presented on the following pages, accompanied by the name of the subroutine which prints it out plus a descriptive comment. These should enable the user to correct many of the more common mistakes which the author has encountered in the use of the program.

```
ERROR MESSAGE
   BAD MOLE CALL
SUBROUTINE
   MOLE2
COMMENT
   THE INDEX IN THE MOLE2 CALL LIST HAS BEEN ASSIGNED AN
   INAPPROPRIATE VALUE.

ERROR MESSAGE
   BAD PHASE NUMBERING FOR (NAME)
SUBROUTINE
   INPUT
COMMENT
   THE NAMED SPECIE HAS A BAD THERMOCHEMISTRY CARD.

ERROR MESSAGE
   CHEMISTRY FAILED TO CONVERGE
SUBROUTINE
   EQUIL
COMMENT
   THE PRIMARY ITERATION LOOP IN THE CHEMISTRY CALCULATION FAILED TO
   CONVERGE.

ERROR MESSAGE
   ****CONTINUUM FREQ AT E9.3 IS OUT OF SEQUENCE****
SUBROUTINE
   RADIN
COMMENT
   THE CONTINUUM FREQUENCY POINTS OBTAINED FROM INPUT ARE NOT
   IN SEQUENTIAL ORDER.

ERROR MESSAGE
   DATA DECK HAS I3 ELEMENTS,LIMIT IS 6
SUBROUTINE
   EQUIL
COMMENT
   THE NUMBER OF BASE SPECIES (OR ELEMENTS) INPUT TO THE
   CHEMISTRY CALCULATION EXCEEDS THE DIMENSION LIMIT.

ERROR MESSAGE
   DATA DECK HAS I3 INDIVIDUAL LEVELS-DIMENSION LIMIT OF 30
SUBROUTINE
   RADIN
COMMENT
   THE NUMBER OF INDIVIDUAL RADIATING LEVELS INPUT TO THE
   RADIATION CALCULATION EXCEEDS THE DIMENSION LIMIT.

ERROR MESSAGE
   DATA DECK HAS I3 LINES, LIMIT IS 200
SUBROUTINE
   RADIN
COMMENT
   THE NUMBER OF SPECTRAL LINES INPUT TO THE RADIATION CALCULATION
   EXCEEDS THE DIMENSION LIMIT.

ERROR MESSAGE
   DATA DECK HAS I3 RADIATING SPECIES-DIMENSION LIMIT OF 30
SUBROUTINE
   RADIN
COMMENT
   THE NUMBER OF SPECIES IN THE RADIATING SPECIES ARRAY
   EXCEEDS THE DIMENSION LIMIT.  THE ARRAY INCLUDES ALL THE
   SPECIES WITH CONTINUUM DATA INPUT PLUS ALL THE SPECIES WITH
   MOLECULAR RADIATION INPUT TO THIS DECK PLUS ELECTRONS.
```

```
ERROR MESSAGE
   DATA DECK HAS 13 SPECIES-LIMIT IS 40
SUBROUTINE
   ERJIL
COMMENT
   THERE ARE TOO MANY SPECIES INPUT TO THE CHEMISTRY
   CALCULATION.

ERROR MESSAGE
   ***EXTEND CONTINUUM FREQ RANGE****
SUBROUTINE
   DADIN
COMMENT
   YOU HAVE ACTIVATED THE OPTION WHICH REQUIRES THAT THE
   CODE CHECK THE ADEQUACY OF THE CONTINUUM FREQUENCY GRID.
   IT CHECKED THE GRID AND FOUND, FOR YOUR PROBLEM, THAT IT
   SHOULD EXTEND TO HIGHER FREQUENCIES.

ERROR MESSAGE
   FREQUENCY GRID ITERATION DID NOT CONVERGE
SUBROUTINE
   FREQ
COMMENT
   SUBROUTINE FREQ WAS UNABLE TO OBTAIN A LINE FREQUENCY GRID.

ERROR MESSAGE
   GROUP 13 HAS 13 LINES-LIMIT IS 13.
SUBROUTINE
   RADIN
COMMENT
   THERE ARE TOO MANY LINES ASSIGNED TO THE NAMED LINE GROUP.

ERROR MESSAGE
   ****KG(1)=2 CANNOT BE USED HERE****
   DADIN
COMMENT
   YOU CANNOT REQUIRE THAT THE CODE PROCEED WITHOUT A CHEMISTRY
   SOLUTION UNLESS YOU GIVE IT A TEMPERATURE TO WORK WITH.

ERROR MESSAGE
   ****LINE CENTER FREQ AT E9.3 IS OUT OF SEQUENCE****
SUBROUTINE
   RADIN
COMMENT
   THE LINES IN THE INPUT DECK ARE NOT PROPERLY ORDERED.

ERROR MESSAGE
   ****LINE CENTER OUT OF GROUP FREQUENCY RANGE****
SUBROUTINE
   RADIN
COMMENT
   A LINE HAS BEEN ASSIGNED TO A GROUP WHERE THE CENTER
   FREQUENCY OF THE LINE FALLS OUTSIDE OF THE BOUNDS OF THE
   GROUP.

ERROR MESSAGE
   ****NICH(1) MUST EQ.1 FOR REFLECTING WALLS****
SUBROUTINE
   DADIN
COMMENT
   THIS IS A REQUIREMENT OF THE CODE.
```

ERROR MESSAGE
THE IA INDEX INDICATES A SPECIAL HYDROGEN LINE IN GROUP I3 NONE
WAS FOUND
SUBROUTINE
MULE2
COMMENT
SOMETHING IS WRONG WITH YOUR LINE ASSIGNMENTS IN THE INPUT DECK.

ERROR MESSAGE
THERE ARE TOO MANY SPECIAL HYDROGEN LINES IN ONE OF THE LINE GROUPS
SUBROUTINE
MULE2
COMMENT
YOU MAY ASSIGN A MAXIMUM OF ONE SPECIAL HYDROGEN LINE PER GROUP.

ERROR MESSAGE
WITH I77=1, YOUR FRVC VALUES MUST RESOLVE (WITHIN .1
EV) THE BOUNDARIES OF THOSE GROUPS WITH SPECIAL H LINES.
SUBROUTINE
RADIN
COMMENT
VIEW THE BOUNDARIES OF THE GROUPS CONTAINING SPECIAL H LINES
AS POINTS WHERE THE CONTINUUM UNDERGOES DISCONTINUOUS CHANGES.
WHEN TWO ADJACENT LINE GROUPS HAVE A COMMON BOUNDARY AND EACH
GROUP CONTAINS ONLY A SPECIAL H LINE, THIS RULE DOES NOT APPLY
TO THE COMMON BOUNDARY.

ERROR MESSAGE
YOU HAVE SELECTED (NAME) AS RADIATING SPECIE BUT DID NOT INPUT
THERMO DATA FOR IT.
SUBROUTINE
RADIN
COMMENT
YOUR RADIATION AND CHEMISTRY INPUT DECKS ARE NOT CONSISTENT.

ERROR MESSAGE
YOU ARE TRYING TO CONSIDER I3 NONMOLECULAR RADIATING SPECIES.
THIS EXCEEDS THE DIMENSION LIMIT OF 20.
SUBROUTINE
RADIN
COMMENT
YOU HAVE INPUT TOO MANY SPECIES IN THE CONTINUUM RADIATION
INPUT.

ERROR MESSAGE
YOUR DATA DECK IS INCONSISTENT. LINES WERE ASSIGNED TO SPECIES
A4 BUT NOT CONTINUUM DATA.
SUBROUTINE
RADIN
COMMENT
YOUR DATA IN THE RADIATION DATA DECK IS NOT SELF-CONSISTENT.

SECTION 7

CODE DESCRIPTION

7.1 OVERVIEW

The RAD/EQUIL code performs four nearly autonomous functions. These are the following:

1. It obtains basic radiation property data, viz. frequency grid, line group properties and absorption coefficient data.
2. It obtains the properties of the radiating layer, viz. its size, spatial grid, radiation boundary conditions and thermodynamic property distribution across the layer.
3. It calculates continuum transport.
4. It calculates line transport.

The code performs these functions through the use of three primary computational modules. A complete listing is given in the appendix.

The first module performs function 2. with Subroutines NODEN (calculates partition functions and number densities) and EQUIL (obtains iterative solutions to the equilibrium chemistry relations and, when required, the shock jump conditions) being the primary computational elements. When the RAD/EQUIL program is to be used by itself, Subroutine DADIN is used to read in the remaining data required to define the properties of the layer and also to drive the calculations. When the RAD/EQUIL program is to be employed as a subprogram to a flow field procedure, DADIN is usually eliminated, with its functions being performed by the flow field code.

The second module calculates continuum transport and is driven by Subroutine CONTN2. Its most important elements are Subroutines MU (calculates continuum absorption coefficients), TRANS3 (calculates optical depths and spectral fluxes or intensities) and CONTN2 (drives the calculation and performs frequency integration to obtain total transport quantities). When the IZZ = 1 option is employed, the far wings of the special hydrogen lines are treated as continuum components. The necessary absorption coefficients are obrained from Subroutines MULE2 and GF.

The third module calculates the line correction to be added to the continuum transport and is driven by Subroutine LINT2. Its most important elements are Subroutine FREQ (sets up the nodal grid in frequency), ISLDV/SLOPQ/OGLE (performs integrations and interpolations within FREQ), MU (calculates continuum components of the absorption coefficients), MULE2 (calculates line component of the absorption coefficients), GF (provides interpolations for MULE2), TRANS3 (calculates optical depths and spectral fluxes or intensities) and LINT2 (drives the calculation and performs a frequency integration to obtain transport quantities). The line corrections are obtained by taking the difference between the combined (line + continuum) transport quantities and they continuum transport quantities evaluted at the "average" frequency of the line group. This calculation is also done in Subroutine LINT2.

7.2 PRIMARY SCRATCH ARRAY

A large array named AM (123 x 123) appears in common NONCOM. Numerous smaller arrays are equivalenced into this array throughout the program, as shown in Figure 7-1. While the AM array must be available during the execution of the RAD/EQUIL program, only temporary data is stored within it, so that the core space can be released at the end of each radiation transport calculation and used for other purposes.

7.3 SUBPROGRAM DESCRIPTIONS

<u>CONTN2</u>

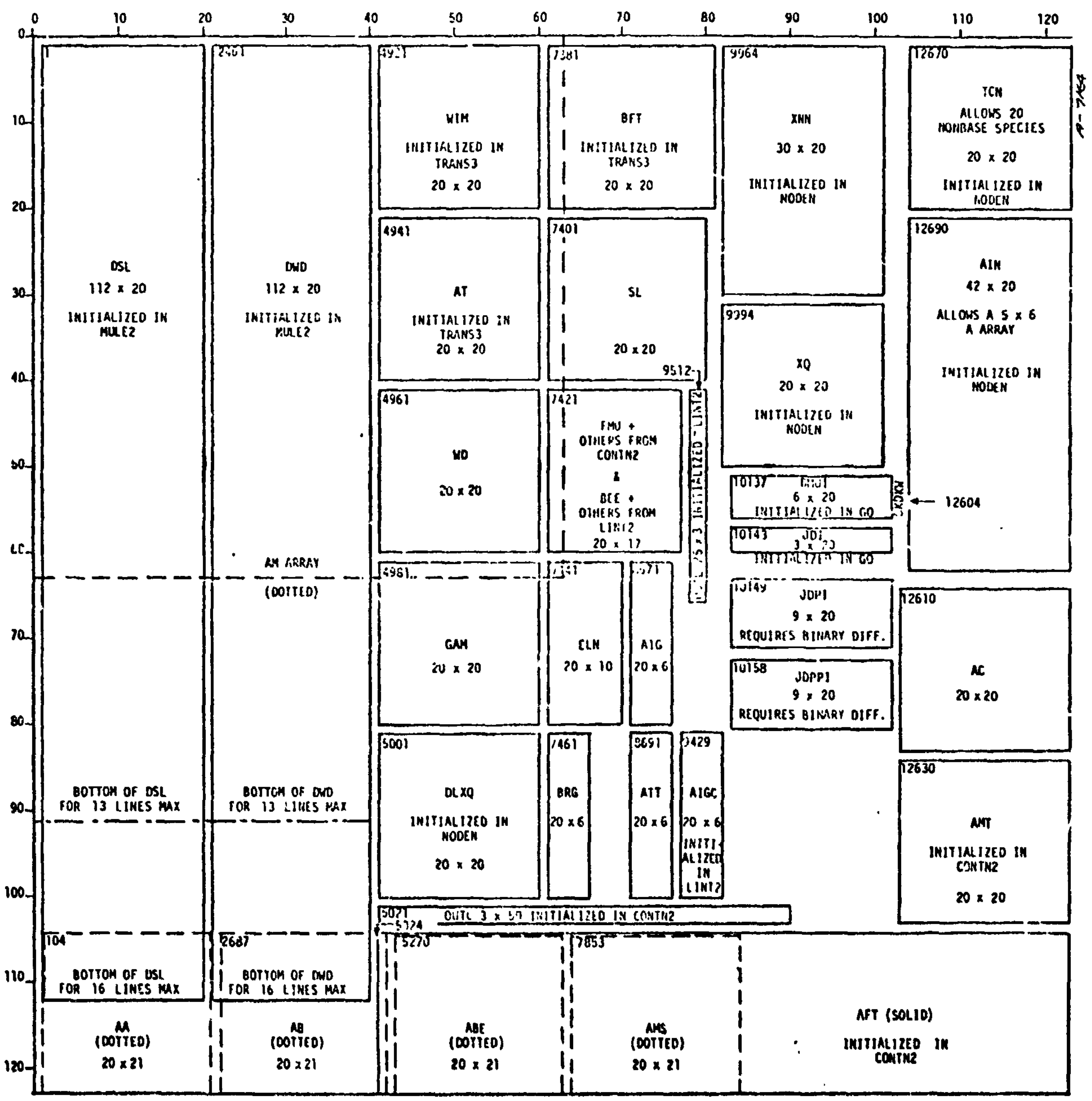
This subroutine organizes and drives the continuum calculation and integrates the spectral transport quantities to obtain frequency integrated totals. When IZZ = 1, subroutine MULE2 is called to include the far wing contributions of the special hydrogen lines.

<u>DADIN</u>

This subroutine reads in case data, viz. that data which defines the thermodynamic state of the slab or ray being considered. It also checks the frequency grid (when appropriate) and performs the shock wave standoff distance calculation (when appropriate) and drives the chemistry calculation for the program when it is not used as a subprogram.

<u>EQUIL</u>

This subroutine obtains an iterative solution to the equations governing chemical equilibrium. When required, the shock jump relations can be solved as part of the system in place of the relations assigning the energy and pressure of the system.


DSL
112 x 20
INITIALIZED IN MULE2
DWD
112 x 20
INITIALIZED IN MULE2
WIM
INITIALIZED IN TRANS3
20 x 20
BFT
INITIALIZED IN TRANS3
20 x 20
XNN
30 x 20
INITIALIZED IN NODEN
TCN
ALLOWS 20 NONBASE SPECIES
20 x 20
INITIALIZED IN NODEN
AT
INITIALIZED IN TRANS3
20 x 20
SL
20 x 20
AIN
42 x 20
ALLOWS A 5 x 6 A ARRAY
INITIALIZED IN NODEN
XQ
20 x 20
INITIALIZED IN NODEN
WD
20 x 20
FMU + OTHERS FROM CONTN2
&
BEE + OTHERS FROM LINT2
20 x 17
INITIALIZED - LINT2
12604
AM ARRAY
(DOTTED)
GAM
20 x 20
ELN
20 x 10
AIG
20 x 6
JDPI
9 x 20
REQUIRES BINARY DIFF.
JDPPI
9 x 20
REQUIRES BINARY DIFF.
AC
20 x 20
BOTTOM OF DSL FOR 13 LINES MAX
BOTTOM OF DWD FOR 13 LINES MAX
DLXQ
INITIALIZED IN NODEN
20 x 20
BRG
20 x 6
ATT
20 x 6
AIGC
20 x 6
INITIALIZED IN LINT2
ANT
INITIALIZED IN CONTN2
20 x 20
INITIALIZED IN CONTN2
BOTTOM OF DSL FOR 16 LINES MAX
BOTTOM OF DWD FOR 16 LINES MAX
AA
(DOTTED)
20 x 21
AB
(DOTTED)
20 x 21
ABE
(DOTTED)
20 x 21
AMS
(DOTTED)
20 x 21
AFT (SOLID)
INITIALIZED IN CONTN2

ERF

This logical function evaluates the error function.

FREQ

This subroutine calculates the nodal points in frequency used in the finite difference evaluation of the line transport equations.

GF

This subroutine performs interpolations as a special service to Subroutine MULE2.

INPUT

This subroutine reads in the chemistry input package.

ISLDV

This is a general service subroutine. It is essentially the same as SLOPQ except that the logarithms of the dependent variables are fitted to obtain the slopes and integrals rather than the dependent variables directly. The resulting slopes and integrals are those of the function, however.

LINT2

This subroutine organizes and drives the line calculation and integrates the spectral transport quantities to obtain frequency integrated totals. It has separate logical blocks to perform finite difference calculations and/or equivalent width calculations.

MAIN

This is the main program. It defines the input/output devices and drives the calculation when the code is used alone.

MU

This subroutine evaluates the continuum components of the absorption coefficients. Three general classes of absorbing transitions are considered - Biberman and Norman, individual cross sections and molecular species. The first two classes of transitions can be activated, modified or eliminated in a general manner through the normal program input; whereas modifications to the molecular species transitions require modifications to the source deck.

MULE2

This subroutine calculates the line components of the absorption coefficients. There are two logical blocks contained within the subroutine. When the first logical block is entered, the subroutine calculates line strengths and the parts of the line shapes which are not functions of frequency and stores them for subsequent use. When the second logical block is entered, the frequency part of the absorption coefficient is calculated, allowing the final result to be returned to the calling program.

NODEN

This subroutine calculates the number densities and the partition functions of the radiating species.

SUBROUTINE OGLE

This is a general service subroutine. Given a single function of an independent variable, it will obtain intermediate points by cubic interpolation.

SUBROUTINE RADIN

This subroutine reads in data decks A and B, identifies the species in the various arrays, tests the data deck for self-consistency, sets up the flags which will be used in the calculational subroutines, and writes out the output block defining the radiation boundary conditions.

SLOPQ

This is a general service subroutine. Given a single function of an independent variable, it will calculate slopes and/or integrals of the function. Cubics are used as interpolation functions.

TRANS3

This subroutine evaluates the spectral transport quantities using the finite difference relations. The quantities evaluated include optical depths and positive and negative fluxes (or intensities).

SECTION 8

FORTRAN VARIABLES LIST

Two lists of Fortran variables are given. The first was selected from those variables which appear in the primary logical blocks of the program. The second list represents the scratch arrays which includes many variables used to form the influence coefficients for coupling to flow field codes which employ the Newton-Raphson procedure. In both cases the following format is used:

Variable Name	Variable Use	Variable Location

where the Variable Location is described by either L Name (local variable in Subroutine "Name"), or by C Namel (common variable in Common Block Namel), or by ALL which means that the variable has the given meaning whenever it appears.

PRECEDING PAGE BLANK NOT FILMED

A(N,NN)	PARTIAL DERIVATIVE OF EQUATION N WRT VARIABLE NN. USED IN CHEMISTRY ITERATION	C EQTCOM
ACH		L MULE2
ACM	NUMBER DENSITY OF C-	L MU
ACN	NUMBER DENSITY OF CN	L MU
ACO	NUMBER DENSITY OF CO	L MU
AC2	NUMBER DENSITY OF C2	L MU
AC3	NUMBER DENSITY OF C3	L MU
AETA	FIRST HALF OF A TWO PART ALPHANUMERIC NAME OF THE SPECIES IN THE RADIATING SPECIES ARRAY	C CONTM
AHM	NUMBER DENSITY OF H-	L MU
AHV	WALL EMITTANCE FOR THE CONTINUUM RADIATION	C RAD
AHVL	WALL EMITTANCE FOR THE LINE RADIATION	C RAD
AH2	NUMBER DENSITY OF H2	L MU
AL	CONSTANTS ASSIGNED TO EACH OF SPECIAL H LINES	L FREQ
ALF	COORDINATE STRETCHING PRARMETER (NOT ACTIVE)	L CONTN2
ALPH	NORMALIZED FREQUENCY USED AS INDEPENDENT FREQUENCY VARIABLE TO DEFINE LYMAN ALPHA LINE	L MULE2
ALPHI	GRAM ATOMS PER UNIT MASS OF AN ELEMENT	L EQUIL
AM	PRIMARY SCRATCH ARRAY	C NONCOM
ANO	NUMBER DENSITY OF NO	L MU
AN2	NUMBER DENSITY OF N2	L MU
AN2P	NUMBER DENSITY OF N2+	L MU
AOM	NUMBER DENSITY OF O-	L MU
AO2	NUMBER DENSITY OF O2	L MU
ASIO	NUMBER DENSITY OF SIO	L MU
AQ	PHOTON ENERGY NORMALIZED BY KT	L CONTN2
AQ	PHOTON ENERGY NORMALIZED BY KT	L LINT2
ATA	NOT ACTIVE	C EQPCOM
ATB	NOT ACTIVE	C EQPCOM
ATC	NOT ACTIVE	C EQPCOM
A0-A5	COEFFICIENTS USED TO EVALUATE THE EXPONENTIAL INTEGRAL	L MULE2
B	LINE SHAPE FUNCTION (AS IT APPEARS IN EQUATION 42 OF REF. 1)	L MULE

BEE	PLANCK FUNCTION FOR INTENSITY CALCULATIONS, BLACK BODY EMISSIVE POWER FOR FLUX CALCULATIONS	L CONTN2
BEE	PLANCK FUNCTION FOR INTENSITY CALCULATIONS, BLACK BODY EMISSIVE POWER FOR FLUX CALCULATIONS	L LINT2
BEEOB	BEE EVALUATED AT OUTER BOUNDARY	L CONTN2
BEEOB	BEE EVALUATED AT OUTER BOUNDARY	L LINT2
BEEW	BEE EVALUATED AT THE WALL	L CONTN2
BEEW	BEE EVALUATED AT THE WALL	L LINT2
BETA	ALPHANUMERIC NAMES OF ATOMIC AND IONIC RADIATING SPECIES	L DADIN
BETA	NORMALIZED FREQUENCY USED AS INDEPENDENT FREQUENCY VARIABLE TO DEFINE LYMAN BETA LINE	L MULF2
BETB	SECOND HALF OF A TWO PART ALPHANUMERIC NAME OF THE SPECIES IN THE RADIATING SPECIES ARRAY	C CONTM
BRACE	NOT ACTIVE	L EQUIL
C(K)	GRAM ATOMS OF ELEMENT K IN A MOLECULE.	L INPUT
CASE	ALPHANUMERIC NAME OF CASE BEING RUN	C RAD
CB	LOCALLY DEFINED VARIABLE	L MULF2
CC3	NOT ACTIVE	L LINT2
CEP	FREQUENCIES OF 0,1,2,3,4,6,8,10 EV WHERE THE LOW FREQUENCY THEORY OF BIBERMAN AND NORMAN IS EVALUATED	L MU
COEFA	CORRECTION COEFFICIENT FROM INPUT	L MU
COEFB	CORRECTION COEFFICIENT FROM INPUT	L MU
CFIL	TOTAL DISTANCE IN FREQUENCY SPACE COVERED BY LINES (SUMMED OVER LINE GROUP)	L FREQ
CFIL	TOTAL DISTANCE IN FREQUENCY SPACE COVERED BY LINES (SUMMED OVER LINE GROUP)	L LINT
CP	SAME AS CPF	C EQTCOM
CPE	EQUILIBRIUM SPECIFIC HEAT OF SYSTEM	L EQUIL
CPF	FROZEN SPECIFIC HEAT FOR EACH SPECIE CAL/MOLE DEG.K	C EQTCOM
CPG	FROZEN SPECIFIC HEAT OF SYSTEM * PH PRODUCT	C EQTCOM
CPP	DERIVATIVE OF MOLAR CP OF EACH SPECIE WRT TEMPERATURE	L EQUIL
CS	CONTINUUM CROSS SECTIONS FROM BIBERMANS THEORY OBTAINED BY INTERPOLATING BETWEEN CSS VALUES WHICH WERE INPUT	L MU
CSS	CONTINUUM CROSS SECTIONS*10**18 AT FIXED FREQUENCIES . OBTAINED FROM INPUT	L MU
C1	C1=6.29E-20	L MU
C1	=1 FOR UNIFORM CONDITIONS, NOT=1 FOR NONUNIFORM CONDITIONS	C RAD

C2	= DELTA FOR INTENSITY CALCULATION, = 2*DELTA FOR FLUX CALCULATION	C RAD
C2COS	NOT ACTIVE	L LINT2
C2CO	NOT ACTIVE	L LINT2
C2OD	NOT ACTIVE	L LINT2
C3	=0 IF A FULL SET OF NEW DATA IS TO BE READ, NOT =0, IF ONLY THERMODYNAMIC AND PATH LENGTH DATA IS TO BE READ IN	C RAD
C4	=0 WHEN A NEW CASE FOLLOWS, =1 FOR LAST CASE	C RAD
DAMP	DAMPING FACTOR	L EQUIL
DBN	CONTRIBUTION TO THE ABSORPTION FROM THE BIBERMAN AND NORMAN TRANSITIONS.	L MU
DCN	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM CN	L MU
DCO	CONTRIBUTION TO ABSORPTION COEFFICIENT FROM CO	L MU
DC2	CONTRIBUTION TO ABSORPTION COEFFICIENT FROM C2	L MU
DC3	CONTRIBUTION TO ABSORPTION COEFFICIENT FROM C3	L MU
DEL	NORMALIZED FREQUENCY USED AS INDEPENDENT FREQUENCY VARIABLE TO DEFINE BALMER ALPHA LINE	L MULE2
DELTA	PATH LENGTH PARAMETER DESCRIBED IN THE INPUT SECTION	C RAD
DLN	LOCALLY DEFINED VARIABLE	L MULE2
DH2	CONTRIBUTION TO ABSORPTION COEFFICIENT FROM H2	L MU
DIM	THE DIFFERENCE BETWEEN FIIMT AND THE CORRESPONDING CONTINUUM FLUX (OR INTENSITY)	L LINT2
DIP	THE DIFFERENCE BETWEEN FIIPT AND THE CORRESPONDING CONTINUUM FLUX (OR INTENSITY)	L LINT2
DIS	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM INDIVIDUAL LEVELS (PHOTOIONIZATION)	L MU
DIV	ROW NORMALIZING FACTOR IN GAUSSIAN ELIMINATION.	L RERAY
DIVC	PRODUCT OF 'DIV' AND ELEMENT OF ROW.	L RERAY
DNO	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM NO	L MU
DN2	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM N2	L MU
DN2P	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM N2+	L MU
DOM	LOG OF MOLE FRACTION OF EACH SPECIE	L EQUIL
DSIO	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM SIO	L MU
DSK	PARTIAL DERIVATIVE OF EQUATION WRT THE GROWTH FACTOR Z (EQ 23 IN AEROTHERM REPORT 73-85.)...USED IN NEWTON RAPHSON ITERATION TO ESTABLISH LINE GROUP FREQUENCIES	L FREQ

DUB2		L INPUT
DUB3	LOCALLY INPUT VARIABLES, IF NON-ZERO ASSIGNED TO FITMOL,	L INPUT
DUB4	BASMOL, SIGMA AND EPOVRK, RESPECTIVELY	L INPUT
DUB5		L INPUT
DUD	LOCALLY DEFINED VARIABLE	L EQUIL
DUM	LOCALLY DEFINED VARIABLE	ALL
DXY(I,J)	PARTIAL DERIVATIVES OF THERMODYNAMIC VARIABLES I WRT THERMODYNAMIC VARIABLES J, WHERE THE VARIABLES IN THE I SET ARE LNT,LNPM,LNP1,LNP2,LNP3,....ALL PARTIAL PRESSURE OF ALL (NOT JUST BASE) SPECIES. THE J VARIABLES ARE H,P,K1,K2,K3,...ELEMENTAL MASS FRACTIONS.	L EQUIL
DY	DY(I) = YY(I+1)-YY(I)	L CONTN2
DY	NOT ACTIVE	C EQTCOM
E(N)	ERRORS IN CHEMISTRY EQUATIONS (MASS BALANCE ERRORS FOR N EQUAL TO OR LESS THAN IS*, EQUILIBRIUM ERRORS FOR N GREATER THAN IS*, WHERE IS* IS NUMBER OF ELEMENTS INCLUDING ELECTRON)	C EQTCOM
EB	NOT ACTIVE	C EQTCOM
EE	FIXED ARRAY OF FREQUENCIES MEASURED FROM THE PHOTOIONIZATION THRESHOLDS...0,1,2,4,6,8,10,20,	L MU
EFF		L MULE2
EL	NOT ACTIVE	C EQTCOM
EMSB	NOT CURRENTLY USED	L DADIN
EMSBL	NOT CURRENTLY USED	L DADIN
EMSH	SAME AS AHV	L DADIN
EMSHL	SAME AS AHVL	L DADIN
EMT	NEGATIVE EMISSIVITY OF THE LAYER (EQUATION 65 OF REF. 1)	L TRANS
ENL	MAXIMUM MASS BALANCE ERROR	
EPC	LOCALLY DEFINED VARIABLE	L MU
EPS	ELECTRONIC ENERGY LEVEL (EV)	C RAD
ERF	ERROR FUNCTION	FUNCTION
EXP	EXPONENTIAL FUNCTION	FUNCTION
EXPN	TEMPERATURN EXPONENT FOR STARK BROADENING (FROM INPUT)	C LINE
E1	EXPONENTIAL INTEGRAL	L MULE2
E10	E10= .4342944823	L MULE2
FAMUA	FIRST HALF OF ALPHANUMERIC NAME OF EQUILIBRIUM SPECIES	C EQPCOM

FAMOB	SECOND HALF OF ALPHANUMERIC NAME OF EQUILIBRIUM SPECIES	C EQPCOM
FF	F NUMBER OF INDIVIDUAL LINE IF AN UNLUMPED LOWER LEVEL IS USED, OTHERWISE IT = G(I)*F/GEE(L) WHERE G(I) IS THE STATISTICAL WT OF THE ABSORBING LEVEL AND GEE(L) IS THE STATISTICAL WT OF THE COMBINED LEVEL USED IN THE CALCULATION	C RAD
FHV	MEAN FREQUENCY OF LINE GROUP	C RAD
FHVC	FREQUENCY OF A CONTINUUM SPECTRAL POINT	C RAD
FHVM	LOWER FREQUENCY LIMIT OF LINE GROUP	C RAD
FHVP	UPPER FREQUENCY LIMIT OF LINE GROUP	C RAD
FHVS	VALUES OF LINE FREQUENCIES WITHIN LINE GROUPS	L FREQ
FHVS	VALUES OF LINE FREQUENCIES WITHIN LINE GROUPS	L LINT2
FHVSIN	FHVSIN = 1./FHVS	L MULE2
FHVS2	FHVS2 = FHVS*FHVS	L MULE2
FIIM	INTEGRAL OVER THE SPECTRUM OF THE FLUX (OR INTENSITY) DIRECTED AWAY FROM THE WALL	L CONTN2
FIIMT	THE TOTAL (LINE AND CONTINUUM) FLUX (OR INTENSITY) ASSIGNED TO A PARTICULAR LINE GROUP AND DIRECTED AWAY FROM THE WALL	L LINT2
FIIP	INTEGRAL OVER THE SPECTRUM OF THE FLUX (OR INTENSITY) DIRECTED TOWARD THE WALL	L CONTN2
FIIPT	THE TOTAL (LINE AND CONTINUUM) FLUX (OR INTENSITY) ASSIGNED TO A PARTICULAR LINE GROUP AND DIRECTED TOWARD THE WALL	L LINT2
FIM	DIFFERENCE BETWEEN THE CONTINUUM SPECTRAL FLUX (OR INTENSITY) DIRECTED AWAY FROM THE WALL AND BEE	L CONTN2
FIM	DIFFERENCE BETWEEN THE CONTINUUM SPECTRAL FLUX (OR INTENSITY) DIRECTED AWAY FROM THE WALL AND BEE	L LINT2
FIMI	NOT ACTIVE	C RAD
FIMO	THE SPECTRAL INTEGRAL OF BEE FROM 0 TO THE CURRENT FREQUENCY (USED IN CONTN2)	C RAD
FIP	DIFFERENCE BETWEEN THE CONTINUUM SPECTRAL FLUX (OR INTENSITY) DIRECTED TOWARD THE WALL AND BEE	L CONTN2
FIP	DIFFERENCE BETWEEN THE CONTINUUM SPECTRAL FLUX (OR INTENSITY) DIRECTED TOWARD THE WALL AND BEE	L LINT2
FIPI	NOT ACTIVE	C RAD
FIPO	NOT ACTIVE	L CONTN2
FL1	=1 FOR INTENSITY CALC., =2 FOR FLUX CALC	C RAD
FL2	SAME AS FL1	C RAD
FLG	=0 FOR NORMAL PRINT-OUT, NOT=0 FOR EXTENSIVE PRINT-OUT	C RAD

FLG1	=0 FOR INTENSITY CALC, NOT=0 FOR FLUX CALC	C RAD
FMU	CONTINUUM ABSORPTION COEFFICIENT (1/CM) OR MASS ABSORPTION COEFFICIENT(KR(13) GE 3)	L CONTN2
FMU	CONTINUUM ABSORPTION COEFFICIENT (1/CM) OR MASS ABSORPTION COEFFICIENT(KR(13) GE 3)	L LINT2
FR	SPECIES MOLE FRACTION	C AM
FRM	THE SAME AS FIM	L CONTN
FX	GROWTH FACT Z GIVEN IN EQ 23 OF AEROTHERM REPORT 73-65	L FREQ
F0	F0= (1.2528E-9)*(NE**.6666666667), WHERE NE = NO DENSITY OF ELECTRONS	L MULE2
F0INV	F0INV=1./F0	L MULE2
F2	LOCALLY DEFINED ARRAY	L MULE2
GAM	ISENTROPIC EXPONENT,	L EQUIL
GAM	LORENTZ HALF WIDTH AT HALF INTENSITY (CREATED IN MULE2, BUT EQUIVALENCED INTO THE AM SCRATCH ARRAY)	
GAMJJI	GAMJJI = GAM(JJ,I)	L MULE2
GAMP	HALF LINE BREDTH PER ELECTRON AT 10,000 DEG K	C RAD
GAMPS	LINE HALH WIDTH VALUE USED TO ESTABLISH FREQUENCY GRID	L FREQ
GAR	LINE STRETCHING PARAMETER (DEFINED BY EQ. 71, REF 1)	L FREQ
GEE	STATISTICAL WEIGHTS OF ABSORBING (LOWER) LEVELS	C RAD
GEG		L MULE2
GG	NOT ACTIVE	L EQUIL
GIL	FUNCTION USED IN EVALUATION OF HALF WIDTH OF SPECIAL H LINES	L FREQ
GMAX	NU MAX AS DEFINED BY EQ 23 OF AEROTHERM REPORT 73-85	L FREQ
GOR	FREQUENCY INCREMENT BETWEEN LINE CENTER AND ADJACENT NODE	L FREQ
GUP	A COEFFICIENT FOR RESONANCE BROADENING FROM HUNT AND SIBULKIN	C LINE
H	SYSTEM ENTHALPY CAL/GM	L EQUIL
HCH	CHAMBER (OR STAGNATION) ENTHALPY	L EQUIL
HEAD	ALPHANUMERIC HEADINGS FOR PRINT OUT PURPOSES	L LINT2
HH	ENTHALPY OF MIXTURE (BTU/LB)	C RADCOM
HI	MOLAR ENTHALPY FOR EACH SPECIE	C EQTCOM
HOS	PM* ENTHALPY (OR ENTROPY) FOR EACH SPECIE	L EQUIL
HS	ENTHALPY UPSTREAM OF SHOCKWAVE (BTU/LB)	C RADCOM

HTM	HTM(1)=1.8,HTM(2)=1.,HTM(I)=HTM(I-2)	L EQUIL
HV	CONTINUUM FREQUENCY POINT	L MU
HVD	LOCALLY DEFINED VARIABLE	L MU
HVG	TRANSITION FREQUENCY BETWEEN BIBERMAN AND NORMANS TWO LOW FREQUENCY FORMULAS, FROM INPUT.	L MU
HVL	FREQUENCY OF AN INDIVIDUAL LINE CENTER	C LINE
HVT	PHOTOIONIZATION THRESHOLD FREQUENCIES FROM INPUT	L MU
HV3	HV3=HV*HV*HV	L MU
I	INDEX USED FOR MANY ARRAYS	
IA	LINE GROUP INDEX FOR SPECIAL H LINES AS DESCRIBED IN THE INPUT SECTION	C LINE
IC(K)	NEGATIVE INDEX OF ELEMENT CORRESPONDING TO KTH BASE SPECIES	L INPUT
ICH	ICH IS THE INDEX OF THE SPECIE IN THE CHEMISTRY ARRAY WHICH HAS AN INDEX JI IN THE ARRAY OF RADIATING SPECIES	L MU
ICON	WHEN ICON=0, CHEMISTRY ITERATION IS CONVERGED, WHEN ICON =1,CHEMISTRY ITERATION IS IN PROGRESS	L EQUIL
IDX	CORE PACKING INDEX TO CONVERT 3-D ARRAY TO 2-D ARRAY	L LINT2
IE	INDEX ON LINES STARTING WITH FIRST LINE IN DECK	L LINT2
IEND	LOCALLY DEFINED INDEX	L MULE2
IG	ELIMINATION INDEX IN BASE SPECIES-ELEMENT CORRESPONDENCE LOGIC.	L INPUT
II	LOCALLY DEFINED VARIABLE	ALL
IIL	INDEX ON THE GROUND STATES OF THE LEVELS WITH INDIVIDUAL PHOTOIONIZATION CROSS SECTIONS ASSIGNED. FOR EXAMPLE, LET JJ=IIL(1) , THEN THE ABSORBING LEVEL FOR THE FIRST PHOTOIONIZATION TRANSITION HAS AN ENERGY OF EPS(JJ), A STATISTICAL WEIGHT OF GEE(JJ), ETC.	C CONTM
IIS	INDEX ON MOLECULAR SPECIES CONTRIBUTION. IF IIS(1)=0 THE CONTRIBUTION FOR THE FIRST MOLECULAR SPECIES BUILT INTO MU (E.G. N2+) IS NOT INCLUDED,IF IIS(1)=1, IT IS INCLUDED. IIS(2) APPLIES TO THE SECOND MOLECULAR SPECIE,ETC.	C CONTM
IJ	INDEX ON THE STORED VALUES OF XI USED AS CORRECTIONS IN THE BIBERMAN AND NORMAN FORMULAS	L MU
IK	INDEX ON THE ABSORBING LEVEL FOR THE LINE TRANSITION	L MULE2
ILK	THE LINE TRANSITION IS ASSIGNED TO THE ILK TH SPECIE IN THE RADIATING SPECIES ARRAY	L MULE2
IM(K)	ROW AND COLUMN INDEX IN INVERSION OF CIJ TO UM	L INPUT
IMI	LOCAL INDEX	L INPUT

IMJ	LOCAL INDEX	L INPUT
IML	LOCAL INDEX	L INPUT
IND	SPACE INDEX	L EQUIL
INDSHL	INDEX ON THE SPECIAL H LINES RELATIVE TO THE START OF THE DECK, IF JJ= INDSHL(1), THE FIRST SPECIAL H LINE IS THE JJ TH MEMBER OF THE LINES IN THE DATA DECK, INDSHL(2) REFERS TO THE SECOND SPECIAL H LINE,ETC,	C LINE
IOBN	INDEX ON THE RADIATING SPECIES WHICH ARE TO BE ASSIGNED CONTRIBUTIONS FROM THE LOW FREQUENCY BIBERMAN AND NORMAN FORMULAS, IF JJ= IOBN(1), THEN THE FIRST SPECIES ASSIGNED A BIBERMAN AND NORMAN COMPONENT HAS A Z VALUE OF Z(JJ), IOBN(2) REFERS TO THE SECOND SPECIE TO BE ASSIGNED A BIBERMAN AND NORMAN COMPONENT,ETC,	C CONTM
IOPT	IOPT=0 FOR FIRST EQUIL CALL SO THAT ITERATIVE VALUES WILL BE INITIALIZED	C SAVE
IOSL	NOT ACTIVE	L LINT2
IP		L EQUIL
IS	NUMBER OF BASE SPECIES IN CHEMISTRY SOLUTION	ALL
IS	THIS IS THE FIRST MEMBER OF A FAMILY INDEX IN SUBROUTINE MU. THUS JJ=IS(1) INDICATES THAT THE JJ TH MEMBER OF THE RADIATING SPECIES STARTS THE FIRST FAMILY. IS(2) REFERS TO THE SPECIE WHICH STARTS THE SECOND FAMILY,ETC,	C CONTM
ISDUM	ISDUM=IS	L LINT2
ISM	ISM=IS-1	ALL
ISM1	ISM1=IS-1	L EQUIL
ISM2	ISM2=IS-2	L EQUIL
ISP	ISP=IS+1	ALL
ISPL	IF ISPL=1, MULE2 WILL LOOK THROUGH THE LINES IN THE ADJACENT LINE GROUP FOR A SPECIAL H LINE. IF THERE IS ONE THERE, IT WILL INCLUDE ITS CONTRIBUTION IN THE LINE ABSORPTION COEFFICIENT. IF ISPL=0,NO SEARCH WILL BE MADE,	L MULE2
ISP2	ISP2=IS+2	ALL
ISP3	ISP3=IS+3	L EQUIL
ISS	THIS IS THE AN INDEX ON THE SPECIES WHICH HAVE INDIVIDUAL PHOTOIONIZATION TRANSITIONS, IF JJ=ISS(1), THEN THE FIRST SPECIE WITH AN INDIVIDUAL PHOTOIONIZATION TRANSITION IS THE JJ TH MEMBER OF THE RADIATING SPECIES, ISS(2) REFERS TO THE SECOND SPECIES WITH AN INDIVIDUAL PHOTOIONIZATION TRANSITION ASSIGNED,ETC,	C CONTM
ISTART	LOCALLY DEFINED INDEX	L MULE2
ISX	LOCALLY DEFINED INDEX	L MULE2
ISXP	ISXP=ISX+1	L MULE2

ISO	ISO=IS	ALL
ITER	COUNTER FOR CHEMISTRY ITERATION	L EQUIL
IX	DEBUG FLAG,	L RERAY
IY	INDEX ON SPACE NODE WHERE OUTPUT IS TO BE PRINTED	L CONTN2
IY	INDEX ON SPACE NODE WHERE OUTPUT IS TO BE PRINTED	L LINT2
IZZ	INDEX WHICH DETERMINES THE METHOD USED TO HANDLE THE FAR WINGS OF H LINES	C CONTM
I2	I2=IS+2	L EQUIL
J	LOCAL INDEX	L EQUIL
J	LOCAL INDEX	L INPUT
JDUM	LINE INDEX	L MULE2
JHOLD	INDEX ON THE SPECIAL H LINE OUTSIDE THE GROUP	L MULE2
JHV	COUNTER USED IN CALCULATION OF MEAN OPACITIES- ACTIVE ONLY WHEN KR(1)=3	L MU
JI	INDEX ON MEMBERS OF THE RADIATING SPECIES ARRAY	L MU
JIS	THIS INDEX GIVES THE CORRESPONDANCE BETWEEN THE SPECIES IN THE RADIATING SPECIES ARRAY AND THE SPECIES IN THE CHEMISTRY ARRAY. IF JJ=JIS(1), THE FIRST SPECIE IN THE RADIATING SPECIES ARRAY IS THE SAME AS THE JJ TH SPECIE IN THE CHEMISTRY ARRAY. JIS(2) REFERS TO THE SECOND SPECIE IN THE RADIATING SPECIES ARRAY,	C CONTM
JJ7	JJ7=(JJ-1)*7, WHERE JJ IS THE INDEX ON THE SPECIAL H LINES (1 TO 4)	L MULE2
JLV	LOCALLY DEFINED INDEX	L MULE2
JM	J-1, WHERE 'J' IS BASE SPECIES COUNT,	L INPUT
JMP	VARIABLE STATEMENT NUMBER FOR FORTRAN TRANSFERS	L MULE2
JP	LOCALLY DEFINED VARIABLE	L EQUIL
JS		L EQUIL
JS	LINE INDEX COUNTING FROM FIRST LINE IN GROUP	L LINT2
JS	LINE INDEX COUNTING FROM FIRST LINE IN GROUP	L MULE2
JT	LOCAL INDEX	L EQUIL
JV	LOCALLY DEFINED INDEX	L MULE2
JVV	LOCALLY DEFINED INDEX	L MULE2
K	LINE GROUP INDEX	L LINT2
KK	LOCAL INDEX	L INPUT
KPHA(N)	PHASE INDEX FOR A SPECIES, 1=GAS, 2=SOLID, 3=LIQUID,	L INPUT

KF	FLOW CONTROL NUMBERS	C INTCOM
KGP	INDEX ON CURRENT LINE GROUP USED IN SUBROUTINE MULE2	C LINE
KGPT	INDEX ON THE LINE GROUPS ADJACENT (AND BELOW IN FREQUENCY) TO THE LINE GROUPS WITH THE SPECIAL H LINES	L MULE2
KOUT	OUTPUT UNIT	C EQPCOM
KQ	CHEMISTRY CONTROL NUMBERS	L DADIN
KR	RADIATION CONTROL NUMBERS	C INTCOM
KS	INDEX ON FIRST LINE IN GROUP TO BE CONSIDERED	L MULE2
K1	INDEX ON FIRST LINE IN GROUP TRANSMITTED THROUGH COMMON	C LINE
K2	INDEX ON LAST LINE IN GROUP TRANSMITTED THROUGH COMMON	C LINE
L	INDEX ON SUBGROUP FREQUENCIES COUNTING FROM THE START OF THE LINE GROUP	L LINT2
L(N)	INDEX ON COLUMNS DURING INVERSION	L RERAY
LC	LINE COUNT INDEX (FOR OUTPUT PURPOSES ONLY)	L LINT2
LDEX	NOT ACTIVE	ALL
LK	SUBGROUP FREQUENCY INDEX COUNTING FROM THE START OF EACH LINE	L LINT2
LL	LOCALLY DEFINED INDEX	ALL
LL(N)	ROW INDEX OF PIVOT FOR NTH COLUMN	L RERAY
LLA	WHEN LLA=3, FREQUENCY APPEARS IN OUTPUT HEADINGS. WHEN LLA=5, WAVE LENGTH APPEARS IN OUTPUT HEADINGS.	L LINT2
LLB	WHEN LLB=7, UNITS OF (EV) ARE PRINTED OUT. WHEN LLB=8, UNITS OF (MU) ARE PRINTED OUT.	L LINT2
LLC	WHEN LLC=13, FLUX UNITS ARE PRINTED OUT. WHEN LLC=14, INTENSITY UNITS ARE PRINTED OUT.	L LINT2
LLL	WHEN LLL=11, UNITS FOR THE ORDINARY ABSORPTION COEFFICIENT ARE PRINTED OUT. WHEN LLL=9, UNITS FOR THE MASS ABSORPTION COEFFICIENT ARE PRINTED OUT.	L LINT2
LLL(N)	COLUMN INDEX OF PIVOT FOR NTH ROW	L RERAY
LS	INDEX USED TO REARRANGE COLUMNS IN RERAY (SEE LAR)	L RERAY
LY	INDEX ON SUBGROUP FREQUENCIES COUNTING FROM FIRST +- +--0	L FREQ
M	DESIGNATES INPUT UNIT (E.G., TAPE)	C INTCOM
M	LOCAL INDEX	L INPUT
MODE	UNSUBSCRIPTED VALUE OF KQ(1)	C EQTCOM
MPJ	LOCALLY DEFINED INDEX	L LINT2
N	TOTAL NUMBER OF SPECIES IN CHEMISTRY SYSTEM	C EQPCOM

N	DESIGNATES OUTPUT UNIT (E.G., TAPE)	C INTCOM
NAES	NUMBER OF ATOMIC ELECTRONIC LEVELS (SUM OVER ALL SPECIES)	C RAD
NBLP	NUMBER OF SPATIAL NODES ACROSS THE BOUNDARY LAYER (NOT NECESSARILY EQUAL TO NY)	C RAD
NCRC	NOT ACTIVE	C CONTM
ND	INDEX ON GROUND LEVEL OF TRANSITION	C RAD
NF	INDEX WHICH RECORDS WHICH OF THE SPECIAL H LINES IS PRESENT IN THE CURRENT GROUP. NF=1 FOR LYMAN ALPHA, 2 FOR LYMAN BETA, ETC.	L MULE2
NFK	NUMBER OF SUBGROUP FREQUENCIES PER LINE = 2*NFK+1 EXCEPT FOR FIRST AND LAST LINE IN GROUP.	L FREQ
NHLINE	SAME AS NF EXCEPT THAT IT IS NOT SUBSCRIPTED	L MULE2
NHV	NUMBER OF LINE GROUPS	C RAD
NHYDR	ALPHANUMERIC NAME FOR H	L MULE2
NI	YY INDEX WHERE LINE COORDINATES ARE EVALUATED	C LINE
NIC	NUMBER OF SPATIAL POINTS WHERE TRANSPORT IS PRINTED OUT	C RAD
NICN	SPACE INDICIES WHERE TRANSPORT IS PRINTED OUT	C RAD
NID	NID = THE LINE CENTER FREQUENCIES OF THE SPECIAL H LINES MULTIPLIED BY 1000 AND CONVERTED TO A FIXED POINT VARIABLE	L MULE2
NIHVC	TOTAL NUMBER OF CONTINUUM SPECTRAL POINTS	C RAD
NIK	INDEX ON THE SUBGROUP FREQUENCY COUNTING FROM THE THE START OF THE LINE	L FREQ
NIKP	NIKP=NIK+1	L FREQ
NIL	NUMBER OF INDIVIDUAL PHOTOIONIZATION TRANSITIONS ASSIGNED TO DATA DECK	C CONTM
NK	THE NUMBER OF FREQUENCY POINTS ASSIGNED TO EACH LINE EQUALS 2*NK+1	L FREQ
NLG	THE SAME AS FLG EXCEPT THAT IT IS A FIXED POINT VARIABLE	L CONTN2
NLG	THE SAME AS FLG EXCEPT THAT IT IS A FIXED POINT VARIABLE	L LINT2
NLG1	THE SAME AS FLG1 EXCEPT THAT IT IS A FIXED POINT VARIABLE	L CONTN2
NLG1	THE SAME AS FLG1 EXCEPT THAT IT IS A FIXED POINT VARIABLE	L LINT2
NM	NUMBER OF ROWS LESS ONE	L RERAY
NN	NUMBER BY WHICH COLUMNS EXCEED ROWS IN PRINCIPAL ARRAY	L RERAY
NNN	NUMBER OF COLUMN VECTORS IN SECONDARY ARRAY	L RERAY
NOL	SAME AS XNOL	OUTPUT
NP	NUMBER OF COLUMNS IN PRIMARY ARRAY.	L RERAY

NPPL	NUMBER OF FREQUENCY POINTS PER LINE (SET TO 15) EXCEPT FOR FIRST AND LAST LINE IN EACH GROUP WHICH HAVE ONE EXTRA.	L LINT2
NSBN	NUMBER OF BIBERMAN AND NORMAN SPECIES ASSIGNED TO DATA DECK	C CONTM
NSHV	NUMBER OF FREQUENCY POINTS PER LINE GROUP	L LINT2
NSL	NUMBER OF STRONG LINES IN GROUP (SET TO NUMBER OF LINES IN GROUP IN THIS VERSION)	L LINT2
NSPEC	NUMBER OF SPECIES CONSIDERED IN CHEMISTRY CALCULATION	C EQPCOM
NSP2	NSP2=N+2	L EQUIL
NST1	NUMBER OF ATOMIC AND IONIC SPECIES ASSIGNED TO THE RADIATING SPECIES ARRAY-DOES NOT INCLUDE MOLECULES OR ELECTRONS,OR NEGATIVE IONS IF THEIR CONTRIBUTIONS TO THE ABSORPTION COEFFICIENTS ARE BUILT INTO SUBROUTINE MU	C CONTM
NT	TOTAL NUMBER OF RADIATING SPECIES IN THE RADIATING SPECIES ARRAY	C CONTM
NU	NUMBER OF LINES IN EACH LINE GROUP	C RAD
NXI	NUMBER OF SPECIAL H LINES	C LINE
NY	NUMBER OF Y/DELTA POINTS	C RAD
NYM	NYM=NY-1	ALL
NYP	NYP=NY+1	ALL
OTI	OPTICALLY THIN FLUX ASSIGNED TO LINE /FREQUENCY INCREMENT ASSIGNED TO LINE (PART OF EQUIVALENT WIDTH LOGIC)	L LINT2
OUTC	NOT ACTIVE	ALL
OUTL	NOT ACTIVE	ALL
P	SYSTEM PRESSURE	C EQTCOM
PC		L EQUIL
PCP	LOCALLY DEFINED VARIABLE	L EQUIL
PH		L EQUIL
PHT	LOCALLY DEFINED VARIABLE	L EQUIL
PLN	LOG OF SYSTEM PRESSURE	L EQUIL
PLP	LOG OF PARTIAL PRESSURE OF EACH SPECIE	L EQUIL
PM	PRESSURE MOLECULAR WEIGHT PRODUCT	C EQTCOM
PO	LOCALLY DEFINED VARIABLE	L EQUIL
POP	POP*TEMPERATURE = KT(EV)	C RAD
PP	PARTIAL PRESSURE OF THE SPECIES	C EQTCOM
PPTC		L EQUIL

PR	SYSTEM PRESSURE (ATM)	L EQUIL
PRES	PRESSURE (ATM)	C RAD
PT	LOCALLY DEFINED VARIABLE	L EQUIL
PTAU		L EQUIL
PTC	LOCALLY DEFINED VARIABLE	L EQUIL
PTH		L EQUIL
PWDH	LOCALLY DEFINED VARIABLE	L MULE2
QR	NET RADIATIVE FLUX(BTU/FT2-SEC)	L MAIN
R		L MULE2
RA(N)	HEAT OF FORMATION OF MOLECULE AT 298 DEG K FROM JANAF BASE STATE, CAL/MOLE, N=1 OR 2 FOR LOW AND HIGH TEMPERATURE RANGES, RESPECTIVELY.	L INPUT
RB		C EQPCOM
RC(J,N)	CURVE FIT CONSTANT FOR THERMODYNAMIC DATA (THE QUANTITY F3 DISCUSSED IN GROUP 4 OF INPUT INSTRUCTIONS), N=1 OR 2 FOR LOW AND HIGH TEMPERATURE RANGES,RESPECTIVEL	C EQPCOM
RD(J,N)	CURVE FIT CONSTANT FOR THERMODYNAMIC DATA (THE QUANTITY F4 DISCUSSED IN GROUP 4 OF INPUT INSTRUCTIONS), N=1 OR 2 FOR LOW AND HIGH TEMPERATURE RANGES,RESPECTIVELY	C EQPCOM
RE(J,N)	CURVE FIT CONSTANT FOR THERMODYNAMIC DATA (THE QUANTITY F5 DISCUSSED IN GROUP 4 OF INPUT INSTRUCTIONS), N=1 OR 2 FOR LOW AND HIGH TEMPERATURE RANGES,RESPECTIVELY.	C EQPCOM
RF		C EQPCOM
RFACT	RAD FLUX PRINTED = RAD FLUX ACTUAL / RFACT ... USED AS A CONVERGANCE AID FOR FLOW FIELD COUPLED CALCULATIONS	C RAD
RHO	LOCALLY DEFINED VARIABLE	L EQUIL
RHS		L EQUIL
RT		L EQUIL
S	AN ARRAY USED FOR LOCAL STORAGE IN MANY SUBROUTINES	
S		L EQUIL
S(N)	LARGEST CONTRIBUTION TO TERM IN N TH COLUMN	L RERAY
SA1		L EQUIL
SB		C EQTCOM
SB(J)	ENTROPY,	C EQTCOM
SHA	LINE SHAPE FOR THE INNER REGION OF THE BALMER ALPHA LINE	L MULE2
SHAS	DERIVATIVE OF SHA WRT DEL	L MULE2
SHB	LINE SHAPE FOR THE INNER REGION OF THE BALMER BETA LINE	L MULE2

SHB	LINE SHAPE FOR THE INNER REGION OF THE BALMER BETA LINE	L MULE2
SHBS	DERIVATIVE OF SHB WRT XI	L MULE2
SHI	SAME AS HS EXCEPT FOR UNITS	L EQUIL
SK	ERROR IN THE FREQUENCY GRID FORMULA (EQ 23 OF AEROTHERM REPORT 73-65) AS USED IN NEWTON RAPHSON ITERATION.	L FREQ
SL	LINE STRENGTH CALCULATED IN MULE2 BUT EQUIVALENCED INTO THE AM ARRARY	
SLA	LINE SHAPE FOR THE INNER REGION OF THE LYMAN ALPH LINE	L MULE2
SLAS	DERIVATIVE OF SLA WRT ALPH	L MULE2
SLB	LINE SHAPE FOR THE INNER REGION OF THE LYMAN BETA LINE	L MULE2
SLBS	DERIVATIVE OF SLB WRT BETA	L MULE2
SLI	STRONG LINE FLUX ASSIGNED TO LINE/ FREQUENCY INCREMENT ASSIGNED TO LINE ..(PART OF EQUIVALENT WIDTH LOGIC)	L LINT2
SLJJI	SLJJI=SL(JJ,I)	L MULE2
SM	MAXIMUM ALLOWED FREQUENCY INCREMENT FROM LINE CENTER IN LOW FREQUENCY DIRECTION. USED TO PLACE MOST REMOTE SUBGROUP FREQUENCY POINT ASSIGNED TO THE LINE	L FREQ
SMD	FREQUENCY INCREMENT ASSIGNED TO XDOL LINES WITH AVERAGED PROPERTIES...(PART OF EQUIVALENT WIDTH APPROXIMATION)	L LINT2
SMZ	FREQUENCY INCREMENT ASSIGNED TO LINE...(PART OF EQUIVALENT WIDTH APPROXIMATION)	L LINT2
SP		C EQPCOM
SP	MAXIMUM ALLOWED FREQUENCY INCREMENT FROM LINE CENTER IN HIGH FREQUENCY DIRECTION. USED TO PLACE MOST REMOTE SUBGROUP FREQUENCY POINT ASSIGNED TO THE LINE	L FREQ
SP	ELEMENTAL MASS FRACTIONS	C RADCOM
SP1	PRESSURE UPSTREAM OF SHOCKWAVE (ATM)	C RADCOM
SQRTF0	SQRTF0= F0**.5	L MULE2
SQRWDH	SQRWDH=WDH**.5	L MULE2
SR1	DENSITY UPSTREAM OF SHOCKWAVE (LB/CUBIC FT)	C RADCOM
SS	LOCALLY DEFINED VARIABLE	L SLOPQ
SUMH	LOCALLY DEFINED VARIABLE	L EQUIL
SUMP	LOCALLY DEFINED VARIABLE	L EQUIL
SUMS	LOCALLY DEFINED VARIABLE	L EQUIL
SUMT	LOCALLY DEFINED VARIABLE	L EQUIL
SVA		C EQTCOM
SVB		C EQTCOM

SVC		C EQTCOM
SVD		C EQTCOM
SV1	VELOCITY UPSTREAM OF SHOCKWAVE ([illegible])	
S1	AN ARRAY USED FOR LOCAL STORAGE IN MANY SUBROUTINES	
S1	THE LINE ABSORPTION COEFFICIENT, INCLUDING THE CONTRI- BUTIONS DUE TO OVERLAPPING [illegible], AND ACCOUNTING FOR IN- DUCED EMISSION	L MULE
S2	AN ARRAY USED FOR LOCAL STORAGE IN MANY SUBROUTINES	
S3	BETA PARAMETER FOR EQUIVALENT WIDTH DEFINED BY EQ 40 OF AEROTHERM REPORT 73-85	L LINT2
T	TEMPERATURE DEG,K	C EQPCOM
TA	(HALF) HALF WIDTH FOR COMMON H LINES = TA* TB	L MULE2
TAU	CONTINUUM OPTICAL DEPTH ALONG THE RAY FOR INTENSITY CALCULATION, ALONG THE 60 DEG RAY FOR FLUX CALCULATION	C CONTN
TAU		L EQUIL
TAU	CONTINUUM OPTICAL DEPTH ALONG THE RAY FOR INTENSITY CALCULATION, ALONG THE 60 DEG RAY FOR FLUX CALCULATION	C LINT2
TAU(K,KK)	INTERMEDIATE ARRAY USED IN FORMING UM	L INPUT
TAUC	OPTICAL DEPTH AT THE LINE CENTER FOR INTENSITY CALCU- LATION, TWICE THAT FOR A FLUX CALCULATION	L FREQ
TAUT	TOTAL (LINE AND CONTINUUM) OPTICAL DEPTH FOR INTENSITY CALCULATION, TWICE THAT FOR A FLUX CALCULATION	L LINT
TB	(HALF) HALF WIDTH FOR COMMON H LINES = TA* TB	L MULE2
TC		C EQTCOM
TEE	TEMPERATURE (DEG. K)	C RAD
TERM1	FLUX (OR INTENSITY) COMPONENT DUE TO GAS PHASE EMISSION (PART OF EQUIVALENT WIDTH LOGIC),	L LINT2
TERM2	CONTINUUM CORRECTION (POSITIVE DIRECTION), ABSORPTION OF THE WALL EMISSION BY GAS PHASE LINES (NEGATIVE DIRECTION) ....PART OF EQUIVALENT WIDTH LOGIC	L LINT2
TERM3	CONTINUUM CORRECTION TO FLUX (OR INTENSITY) IN NEGATIVE DIRECTION...PART OF EQUIVALENT WIDTH LOGIC	L LINT2
TERM4	GAS PHASE ABSORPTION OF LINE COMPONENT REFLECTED OFF WALL	L LINT2
TEST	LOCALLY DEFINED VARIABLE	L EQUIL
THETA	ANGLE OF SHOCKWAVE	C RADCOM
TLCM	LINE CORRECTION TO FLUX (OR INTENSITY) AWAY FROM WALL	C LINE
TLCP	LINE CORRECTION TO FLUX (OR INTENSITY) TOWARD WALL	C LINE
TMSW	TRANSMITTANCE OF WALL AT CONTINUUM FREQUENCIES	C RAD

TMSWL	TRANSMITTANCE OF WALL AT AVERAGE FREQUENCIES OF LINE GROUPS	C RAD
TMU	TOTAL (LINE AND CONTINUUM) ABSORPTION COEFFICIENT	L LINT2
TOB	EFFECTIVE BRIGHTNESS TEMPERATURE (DEG,K) OF THE OUTER BOUNDARY	I RAD
TS	PHASE CHANGE TEMPERATURE,	L INPUT
TSAVE		L EQUIL
TSQ		L EQUIL
TSQ	TSQ = TEE*TEE	L MULE2
TT	TEMPERATURE (DEG. R)	C RADCOM
TTHRES	THRESHOLD TEMPERATURE FROM INPUT	C CONTM
TU(J,N)	UPPER TEMPERATURE OF TEMPERATURE RANGE FOR INPUTTING THERMODYNAMIC PROPERTY DATA FOR SPECIES J, N=1 OR 2 FOR LOWER AND UPPER TEMPERATURE RANGES, RESPECTIVELY	C EQPCOM
TW	WALL TEMPERATURE (DEG, K)	C RAD
T1	TEMPERATURE IN UNITS OF KT(EV)	L CONTN2
T1	TEMPERATURE IN UNITS OF KT(EV)	L LINT2
T1	TEMPERATURE IN UNITS OF KT(EV)	L MU
T1	TEMPERATURE IN EV (KT)	L MULE2
T2	KT IN ERGS	L MULE2
T3	TEE/10000	L MULE2
UGH	NORMALIZING FACTOR IN GAUSSIAN ELIMINATION,	L INPUT
UH(K,KK)	MOLECULES OF BASE SPECIES K IN ELEMENT KK	L INPUT
V	LOCALLY DEFINED VARIABLE	ALL
VA	LOCALLY DEFINED VARIABLE	L INPUT
VB	LOCALLY DEFINED VARIABLES	L INPUT
VC	LOCALLY DEFINED VARIABLES	L INPUT
VD	LOCALLY DEFINED VARIABLES	L INPUT
VE	LOCALLY DEFINED VARIABLES	L INPUT
VEE		L MULE2
VINT	P * 10**(-6)	L INPUT
VMW	MEAN MOLECULAR WEIGHT OF MIXTURE	C RADCOM
VN(J)	PARTIAL PRESSURE	C EQPCOM
VNU(J,K)	STOICHIOMETRIC COEFFICIENT ON K TH BASE SPECIES IN FORMA-	C EQPCOM

	T.ON OF J TH SPECIES	
V1	LOCALLY DEFINED VARIABLE	ALL
V2	LOCALLY DEFINED VARIABLE	ALL
V3	LOCALLY DEFINED VARIABLE	ALL
V4	LOCALLY DEFINED VARIABLE	ALL
V5-V15	LOCALLY DEFINED VARIABLES	ALL
W	PARAMETER IN LINE SHAPE OF SPECIAL H LINES	L MULE2
WALLF	LINE COMPONENT OF THE SPECTRAL FLUX AT WALL	L LINT2
WALLW	WIDTH (IN EV) OF THE LINE COMPONENT AT WALL	L LINT2
WD	DOPPLER HALF WIDTH AT HALF INTENSITY	L MULE2
WDH	NORMALIZED VALUE OF CURRENT FREQUENCY	L MULE2
WDHSQ	WDHSQ=WDH*WDH	L MULE2
WM	MOLECULAR WEIGHT OF MIXTURE	C EQPCOM
WT	MOLECULAR WEIGHT AS SUMMED.	L INPUT
WTM(J)	MOLECULAR WEIGHT OF SPECIES J	C EQPCOM
X	EQUIVALENT WIDTH PARAMETER DEFINED BY EQ 39 OF AEROTHERM REPORT 73-85,	L LINT2
X		L EQUIL
XAPNU	CONTINUUM ABSORPTION COEFFICIENT ORRECTED FOR INDUCED EMISSION	L MU
XCM	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM C-	L MU
XD	LOCALLY DEFINED VARIABLE	L SLOPQ
XF	GROWTH FACTOR FOR LINE FREQUENCY NODES (DEFINED BY EQUATIONS 69 AND 70 OF REF 1)	L FREQ
XHM	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM H-	L MU
XI	NORMALIZED FREQUENCY USED AS INDEPENDENT FREQUENCY VARIABLE TO DEFINE BALMER BETA LINE	L MULE2
XIM	DIFFERENCE BETWEEN SPECTRAL FLUX (OR INTENSITY) AWAY FROM THE WALL AND BEE	L LINT2
XI[illegible]	FLUX (OR INTENSITY) BOUNDARY CONDITION AT WALL	L LINT2
XIN	TEMPERATURE INDEPENDENT FUNCTION USED IN THE EVALUATION OF THE CO CONTRIBUTION TO THE ABSORPTION COEFFICIENT,	L MU
XION	IONIZATION ENERGY OF THE SPECIE(EV) FROM INPUT	C CONTM
XIP	DIFFERENCE BETWEEN FLUX (OR INTENSITY) TOWARD THE WALL AND BEE	L LINT2
XIPOB	FLUX (OR INTENSITY) BOUNDARY CONDITION AT OUTER BOUNDAR O	L J+NT2

XIS	STORED VALUE OF THE BIBERMAN AND NORMAN XI CORRECTION FACTOR,FROM INPUT	C CONTM
XJW	CONTINUUM FLUX (OR INTENSITY) LEAVING WALL AND INCLUDING REFLECTED AND EMITTED COMPONENTS	L CONTN2
XJWL	LINE FLUX (OR INTENSITY) LEAVING WALL AND INCLUDING REFLECTED AND EMITTED COMPONENTS	L CONTN2
XLAM	WAVE LENGTH (MICRONS)	L MU
XLANR	LADENBURG-REICHE FUNCTION	L LINT2
XMOL	=1 MOLECULAR CONTRIBUTIONS TO THE ABSORPTION COEFF ARE INCLUDED, =0 THEY ARE NOT INCLUDED	C RAD
XNOL	WEIGHT FACTOR TO BE APPLIED TO THE CONTRIBUTION OF A LINE TO ACCOUNT FOR THE CONTRIBUTIONS OF OTHER LINES WITH IDENTICAL PROPERTIES, WHICH ARE ALSO WITHIN THE LINE GROUP	C LINE
XNN	NUMBER DENSITIES OF RADIATING SPECIES	C LINE
XOM	CONTRIBUTION TO THE ABSORPTION COEFFICIENT FROM O-	L MU
XOT	LOCALLY DEFINED VARIABLE	L SLOPQ
XOTT	LOCALLY DEFINED VARIABLE	L SLOPQ
XP	NUMBER DENSITY OF ABSORBING LEVEL OF LINE TRANSITION	L MULE2
XQ	ELECTRONIC PARTITION FUNCTION	C AM
XTO	LOCALLY DEFINED VARIABLE	L SLOPQ
XTT	LOCALLY DEFINED VARIABLE	L SLOPQ
XX	H*NU/KT	L MU
XXN	NUMBER DENSITIES OF RADIATING SPECIES (DUPLICATE MEANING)	C LINE
Y	NOT ACTIVE	C EQPCOM
YC	INITIAL VALUE OF Y(J)	L INPUT
YINT	ALOG(VINT)	L INPUT
YS	LOCALLY DEFINED VARIABLE	L SLOPQ
YW	NOT ACTIVE	C EQPCOM
YY	VALUES OF Y/DELTA POINTS	C RAD
Z	CHARGE ON THE RESIDUAL ION,FROM INPUT	C CONTM
Z2	Z*Z	L MU

SECTION 9

REFERENCES

1. Nicolet, W. E., "Advanced Methods for Calculating Radiation Transport in Ablation-Product Contaminated Boundary Layers," NASA CR-1656, Aerotherm Corporation, Mountain View, California, September 1970.
2. Nicolet, W. E., "User's Manual for the Generalized Radiation Transfer Code (RAD/EQUIL)," UM-69-9, Aerotherm Corporation, Mountain View, California, October 1, 1969.
3. Nicolet, W. E., "Rapid Methods for Calculating Radiation Transport in the Entry Environment," Report 73-85, Aerotherm Division, Acurex Corporation, Mountain View, California, November 26, 1973.
4. Moore, C. E., "Atomic Energy Levels, NBS Circular 467, June 15, 1969.

PRECEDING PAGE BLANK NOT FILMED

APPENDIX

PROGRAM LISTING

PRECEDING PAGE BLANK NOT FILMED

```
      SUBROUTINE CONTN2
C
      COMMON/CONTM/ZZAZ(910),IZZ
C
      COMMON/EQPCOM/SPZZ(281),ISDUM,SPZ2(70),PDUM,SPZ3(480),TDUM,
     1 SPZ4(248),VN(60),VNU(60,8)
C
      COMMON/INTCOM/KR(20),KO(10),KF(10),M,N
C
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25),        NXI,IA(9) RADINU
     1,NI,YNOL(200),GUP(200),EXPN(200) ,XR(20),MUG,INDSHL(12)
     2,S(200),S1(200),S2(25)
C
      COMMON/NONCOM/AM(123,123)
C
      COMMON/OUTCOM/LDEX(3)
C
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(160),FF(200), RAD
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GEE(160),               NAES,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHVC,NHV,NU(25),NY,PRES(20),TEE(20),WOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),TMSW(50),TMSWL(25),TW,TOB ,
     5NRAD,RFACT,POP
C
      DIMENSION FMU(20),TAU(20),BFE(20),EM(20),EP(20),FIM(20),FIP(20),FIRADCL02
     1MO(20),FIPU(20),FIIM(20),FIIP(20),DY(20)
C
      DIMENSION OUTC(123,1),OUTL(123,1)
      DIMENSION HEAD(6)
C
      DIMENSION
     1         DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2         WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123,1) ,
     3         DLXQ(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4         SL(123,1) , BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5         TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6         XNN(123,1) , XQ(123,1)
C
      EQUIVALENCE
     1         (DSL(1),AM(1)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2         (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3         (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXQ(1),AM(5001)),
     4         (AFT(1),AM(5024)) , (ABE(1),AM(5270)) , (BFT(1),AM(7381)),
     5         (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
     6         (ATT(1),AM(8691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7         (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
     8         (XQ(1),AM(10004))
     9             ,(OUTC(1),AM(5021)),(OUTL(1),AM(9512))
C
      EQUIVALENCE (FMU(1),AM(7421)),(TAU(1), AM(7544)),(BEE(1),AM(7667))
     1            ,(EM(1),AM(7790)),(EP(1),AM(7913)),(FIM(1),AM(8036)),
     2           (FIP(1),AM(8159)),(FIMO(1),AM(8282)),(FIPU(1),AM(8405))
C
      EQUIVALENCE (FIIM(1),FIMI(1)),(FIIP(1),FIPI(1))
      EQUIVALENCE (DY(1),EM(1))
      DATA HEAD/6H  HV  ,6HLAMDA ,6H (EV) ,6H (MU) ,3H EV,3H MU/
```

PRECEDING PAGE BLANK NOT FILMED

```
100 FORMAT(4H0FMU,/,(5E20.6))
101 FORMAT(2H0B,/,(5E20.6))
102 FORMAT(4H0TAU,/,(5E20.6))
103 FORMAT(//1X,4HHV= ,E14.6)
108 FORMAT (2X,F10.3,  13E9.2)
109 FORMAT (2X,F10.3,4X,  13E9.2)
110 FORMAT (2X,F10.3,6(E10.2,  E9.2))
111 FORMAT(1H1,41X,43HCONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX,/,   CONTN08
   1,56X,8HY/DELTA=  E9.2)                                              CO
112 FORMAT(1H0,A6,3X, 6HIMINUS,6X,16HPARTIAL SPECTRAL,4X,
   117HNORMALIZED IMINUS,3X,5HIPLUS,6X,16HPARTIAL SPECTRAL,3X,          CONTN09
   216HNORMALIZED IPLUS,/,1H ,A6,11H (WATTS/CM2,3X,
   318HINTEGRAL OF IMINUS,6X,12HCONTRIBUTION,3X,10H(WATTS/CM2,3X,
   417HINTEGRAL OF IPLUS,5X,12HCONTRIBUTION,/,9X,4HSTER,A3,1H),4X,
   516H(WATTS/CM2-STER),6X,15H(PERCENT TOTAL),3X,4HSTER,A3,1H),4X,
   616H(WATTS/CM2-STER),5X,15H(PERCENT TOTAL))
113 FORMAT(F8.4,  E10.3,  E16.3,  E21.3,  E14.3,  E17.3,  E20.3)       CONT
114 FORMAT(1H0, A6,3X,6HQMINUS,6X,16HPARTIAL SPECTRAL,4X,              CONTN09
   117HNORMALIZED QMINUS,3X,5HQPLUS,6X,16HPARTIAL SPECTRAL,3X,          CONTN09
   216HNORMALIZED QPLUS,/,1H ,A6, 9H  (WATTS/,5X,
   318HINTEGRAL OF QMINUS,6X,12HCONTRIBUTION,4X,7H(WATTS/,5X,           CONTN10
   417HINTEGRAL OF QPLUS,5X,12HCONTRIBUTION,/,10X,3HCM2,A3,1H),7X,
   511H(WATTS/CM2),8X,15H(PERCENT TOTAL),4X,3HCM2,A3,1H),7X,
   611H(WATTS/CM2),7X,15H(PERCENT TOTAL))
125 FORMAT(1H1,41X,48HCONTINUUM CONTRIBUTION TO THE SPECTRAL INTENSITYRADCL035
   1,///,1X,11HNORMALIZED ,/1X,12HPATH LENGTH=,E13.3,5E19.3)            RADCL036
225 FORMAT(1X,/,                                              5X,2HHV,  RADCL037
   251X,12HIMINUS/IPLUS,/,4X,4H(EV),47X,19H(WATTS/CM2-EV-STER)          RADCL038
   2,/,12X,115HI-----------------I-----------------I-----------------RADCL039
   3--I-----------------I-----------------I-----------------I ,)        RADCL040
126 FORMAT(1H1,41X,48HCONTINUUM CONTRIBUTION TO THE SPECTRAL INTENSITYRADCL041
   1,///,1X,11HNORMALIZED ,/1X,12HPATH LENGTH=,1X,13E9.2)               RADCL042
226 FORMAT(1X,/,                                           5X,2HHV,     RADCL043
   251X,12HIMINUS/IPLUS,/,4X,4H(EV),47X,19H(WATTS/CM2-EV-STER),/)       RADCL044
130 FORMAT(//,51X,27HFREQUENCY INTEGRATED VALUES,//,12X,6(E10.2,  E9.2
   1))
131 FORMAT (//,51X,27HFREQUENCY INTEGRATED VALUES,//,12X,  13E9.2)       RADCL0
132 FORMAT (16X,  13E9.2)
135 FORMAT(1H1,41X,43HCONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX       RADCL048
   1,///,1X,11HNORMALIZED ,/1X,12HPATH LENGTH=,E13.3,5E19.3)            RADCL049
235 FORMAT(1X,/,                                              5X,2HHV,  RADCL050
   251X,12HQMINUS/QPLUS,/,4X,4H(EV),49X,14H(WATTS/CM2-EV)               RADCL051
   2,/,12X,115HI-----------------I-----------------I-----------------RADCL052
   3--I-----------------I-----------------I-----------------I ,)        RADCL053
136 FORMAT(1H1,41X,43HCONTINUUM CONTRIBUTION TO THE SPECTRAL FLUX       RADCL054
   1,///,1X,11HNORMALIZED ,/1X,12HPATH LENGTH=,1X,13E9.2)               RADCL055
236 FORMAT( 1X,/,                                          5X,2HHV,     RADCL056
   251X,12HQMINUS/QPLUS,/,4X,4H(EV),49X,14H(WATTS/CM2-EV),/)            RADCL057
1225 FORMAT(1X,/,                                             5X,2HWL,  RADCL058
   251X,12HIMINUS/IPLUS,/,4X,4H( A),47X,19H(WATTS/CM2- A-STER)          RADCL059
   2,/,12X,115HI-----------------I-----------------I-----------------RADCL060
   3--I-----------------I-----------------I-----------------I ,)        RADCL061
1226 FORMAT(1X,/,                                          5X,2HWL,     RADCL062
   251X,12HIMINUS/IPLUS,/,4X,4H( A),47X,19H(WATTS/CM2- A-STER),/)       RADCL063
1235 FORMAT(1X,/,                                             5X,2HWL,  RADCL064
   251X,12HQMINUS/QPLUS,/,4X,4H( A),49X,14H(WATTS/CM2- A)               RADCL065
   2,/,12X,115HI-----------------I-----------------I-----------------RADCL066
   3--I-----------------I-----------------I-----------------I ,)        RADCL067
1236 FORMAT( 1X,/,                                         5X,2HWL,     RADCL068
   251X,12HQMINUS/QPLUS,/,4X,4H( A),49X,14H(WATTS/CM2- A),/)            RADCL069
1333 FORMAT(2X,1H )
1334 FORMAT(   1P11E12.5)
1336 FORMAT(3X,1P6E15.6)
5110 FORMAT(1H1,41X,48HCONTINUUM CONTRIBUTION TO THE SPECTRAL INTENSITYCONTN08
```

```
     1,/,56X,8HY/DELTA=  E9.2)
5125 FORMAT(1H1,/2X,27HEXTENSIVE CONTINUUM OUTPUT*)
     ISO = ISDUM
     ISP = ISO + 1
     ISP2 = ISO + 2
     NLG = FLG + .00001
     NLG1 = FLG1 + .00001
     LDEX(1)=NICN(1)
     LDEX(3)=NICN(1)
     IF(KR(14).NE.2) ALF=1.
     POP = 8.61705E-05
     IF(KR(17).EQ.2) GO TO 76
     IF(NLG.EQ.1) GO TO 5776
     DO 120 LL=1,NIC
     IY = NICN(LL)
 120 S(LL) = YY(IY)
     IF (KR(1)) 80,81,80
  81 IF(NIC.GT.6) GO TO 75
     WRITE (N,125) (S(LL),LL=1,NIC)
     IF(KR(8)) 31,31,30
  31 WRITE(N,225)
     GO TO 76
  30 WRITE(N,1225)
     GO TO 76
  75 WRITE (N,126) (S(LL),LL=1,NIC)
     IF(KR(8)) 32,32,33
  32 WRITE(N,226)
     GO TO 76
  33 WRITE(N,1226)
     GO TO 76
  80 IF (NIC.GT.6) GO TO 85
     WRITE (N,135) (S(LL),LL=1,NIC)
     IF(KR(8)) 34,34,35
  34 WRITE(N,235)
     GO TO 76
  35 WRITE(N,1235)
     GO TO 76
  85 WRITE (N,136) (S(LL),LL=1,NIC)
     IF(KR(8)) 36,36,37
  36 WRITE(N,236)
     GO TO 76
  37 WRITE( N,1236)
     GO TO 76
5776 WRITE(N,5125)
  76 CONTINUE
     IF(KR(11).NE.3) GO TO 779
     NYM = NY-1
     DO 780 I=1,NYM
 780 DY(I) = (YY(I+1) - YY(I)) * C2
 779 CONTINUE
     DO 1 LL=1,NIC
     FIIM(LL)=0.
   1 FIIP(LL)=0.
     NYP = NY+1
     ISM = ISO-1
     DO 3010 I=1,NY
     DO 3010 J=1,NYP
     AMT(I,J) = 0.
     KK = J-NYP
     DO 3010 JJ=1,ISM
     KK = KK + NYP
3010 AFT(I,KK) = 0.
C    FAR WINGS OF HYDROGEN LINES
     IF(IZZ.NE.1) GO TO 785
```

```
      K1=1
      K2=NX1
      CALL MULE2(V,-3,1)
  785 CONTINUE
C
C     START PRIMARY LOOP
C
      DO 50 K=1,NIHVC
      CALL MU(FHVC(K),FMU)
      IF(IZZ.NE.1) GO TO 786
      DO 787 I=1,NXI
      J=IA(I)
      IF(FHVC(K) .GT. FHVP(J)) GO TO 787
      IF(FHVC(K) .LT. FHVM(J)) GO TO 787
      GO TO 786
  787 CONTINUE
      CALL MULE2(FHVC(K),3,1)
      DO 788 I=1,NY
  788 FMU(I)=FMU(I)+S1(I)
  786 CONTINUE
      BEEW = 0.
      BEEOB = 0.
      IF(TW) 400,400,4108
 4108 T1 = TW * POP
      AQ = FHVC(K) / T1
      IF(AQ.GE.85.)GO TO 400
      BEEW = 5040.*FHVC(K)**3/(EXP(AQ)-1.)
  400 IF(TOB) 600,600,6108
 6108 T1 = TOB*POP
      AQ = FHVC(K) / T1
      IF(AQ.GE.85.) GO TO 600
      BEEOB = 5040.*FHVC(K)**3/(EXP(AQ)-1.)
  600 IF(NLG1.EQ.0) GO TO 625
      BEEW = 3.1416*BEEW
      BEEOB = 3.1416*BEEOB
  625 FIP(NY) = 0.
      IF(KR(5).GT.5) FIP(NY) = BEEOB
      FIM(1) = AHV(K) * BEEW
      DO 38 I=1,NY
      FMU(I) = FMU(I) + 1.E-30
      T1=TEE(I)*POP
      BEE(I)=0.
      AQ=FHVC(K)/T1
      IF(AQ-85.) 2,3,3
    3 V=EXP(-AQ+80.)
      BEE(I) = (5040.*V*FHVC(K)**3)/5.539E+34
      IF(BEE(I).LT.1.E-34) BEE(I) = 1.E-34
      ATT(I,1) = BEE(I) * AQ
      ATT(I,1) = 0.
      GO TO 38
    2 V = EXP(AQ)
      V1 = V - 1.
      BEE(I) = 5040.*FHVC(K)**3/V1
      ATT(I,1) = BEE(I)/V1*V*AQ
      IF(NLG1)  16,38,16
   16 BEE(I)=3.1416*BEE(I)
      ATT(I,1) = 3.1416 * ATT(I,1)
   38 CONTINUE
      S(1) = 1.-AHV(K) - TMSW(K)
      S(2) = AHV(K)
      IF(KR(5)-2) 2740,2740,2742
 2740 FIM(1) = S(2) * BEEW
      GO TO 2741
 2742 FIM(1) = S(2) * BEE(1)
```

```
      IF(KR(5)-6) 2741,2743,2743
 2741 FIP(NY) = 0.
      S(3) =-1.
      GO TO 2750
 2743 FIP(NY) = BEE(NY)
      S(3) = 0.
 2750 CONTINUE
      CALL TRANS3(NY,DY,NIC,NICN,ALF,BEE,FMU,S,S1,S2,TAU,FIM,FIP)
  782 CONTINUE
      IF(KR(6).EQ.0) GO TO 2755
      FIP(1)=TMSW(K)*FIP(1)-BEE(1)*(1.-TMSW(K))
 2755 CONTINUE
      DO 300 I=1,NY
      IF(I.EQ.LDEX(1))OUTC(1,K)=FIP(I)+BEE(I)
      IF(I.EQ.LDEX(2)) OUTC(2,K) = FIP(I) + BEE(I)
      IF(I.EQ.LDEX(3)) OUTC(3,K) = FIM(I) + BEE(I)
      V = ATT(I,1)
      DO 300 J=1,ISP
      IDX = 8*(J-1) + 1
  300 ATT(I,J) = V * AIN(IDX,I)
      IF(KR(17).EQ.2) GO TO 89
      IF(NLG.EQ.1) GO TO 5289
      IF(KR(8)-1) 60,61,60
   61 V1 = 12400./FHVC(K)
      DO 65 LL=1,NIC
      IY=NICN(LL)
      S(LL)=(FIM(IY)+BEE(IY))/V1*FHVC(K)
   65 S1(LL)=(FIP(IY)+BEE(IY))/V1*FHVC(K)
      IF(NIC.GT.6) GO TO 68
      WRITE(N,110) V1,(S(LL),S1(LL),LL=1,NIC)
      GO TO 89
   68 WRITE(N,108) V1,(S(LL),LL=1,NIC)
      WRITE(N,132) (S1(LL), LL=1,NIC )
      WRITE(N,1333)
   60 CONTINUE
      DO 95 LL=1,NIC
      IY=NICN(LL)
      S(LL)=FIM(IY)+BEE(IY)
      S1(LL)=FIP(IY)+BEE(IY)
      IF(KR(8).NE.2) GO TO 95
      S(LL) = FIM(IY)
      S1(LL) = FIP(IY)
   95 CONTINUE
      IF (NIC.GT.6) GO TO 88
      WRITE (N,110) FHVC(K),(  S(LL), S1(LL),LL=1,NIC)
      GO TO 89
   88 WRITE (N,108) FHVC(K), (  S(LL),        LL=1,NIC)
      WRITE(N,132) ( S1(LL),LL=1,NIC)
      GO TO 89
 5289 WRITE(N,103) FHVC(K)
      WRITE(N,101) (BEE(I),I=1,NY)
      WRITE(N,100) (FMU(I),I=1,NY)
      WRITE(N,102)  (TAU(I),I=1,NY)
   89 CONTINUE
      NYP = NY + 1
      IF(K-1) 1326,1326,1327
 1326 V1 = FHVC(K+1) - FHVC(K)
      GO TO 1329
 1327 IF(K-NIHVC) 1328,1330,1330
 1330 V1 = FHVC(K) - FHVC(K-1)
      GO TO 1329
 1328 V1 = FHVC(K+1) - FHVC(K-1)
 1329 V1=V1/2.
      DO 91 LL=1,NY
```

```
      FIIM(LL) = FIIM(LL) + V1*FIM(LL)
      FIIP(LL) = FIIP(LL) + V1*FIP(LL)
   51 FIMO(LL) = FIMO(LL)+V1*BEE(LL)
C      RABLE PACKAGE
C
      CC3 = 1.
C
   91 NYM = NY - 1
      C38 = .8805*CC3/RFACT
      V3 = V1* C38
      V1 = V3*C2
      IIC = 0
      DO 1325 I=1,NY
      MPJ = 2
      DO 1470 J=1,NYM
      MPJ = MPJ+1
 1470 AMT(I,MPJ) = AMT(I,MPJ) + WIM(I,J)*V1
      MPJ = 0
      DO 1325 KK=1,ISO
      IF(KK.EQ.2) GO TO 1325
      MPJ=MPJ+1
      DO 1319 J=1,NY
      MPJ=MPJ+1
      V=BFT(I,J)*AIG(J,KK)+AT(I,J)*ATT(J,KK)
      AFT(I,MPJ) = AFT(I,MPJ) + V * V3
 1319 CONTINUE
 1325 CONTINUE
   50 CONTINUE
C
C
C      SUMMARY OUTPUT PACKAGE
C
      IF(KR(17).EQ.2) GO TO 123
      V3=0.
      V4=0.
      IF(NLG.EQ.1) GO TO 5123
      DO 96 LL=1,NIC
      IY=NICN(LL)
      S(LL) = FIIM(IY)+FIMO(IY)
      S1(LL) = FIIP(IY)+FIMO(IY)
      IF(KR(8).NE.2) GO TO 96
      S(LL) = FIIM(IY)
      S1(LL) = FIIP(IY)
   96 CONTINUE
      WRITE(N,1333)
      IF (NIC.GT.6) GO TO 122
      WRITE (N,130)  (   S(LL),   S1(LL),LL=1,NIC)
      GO TO 123
  122 WRITE (N,131) (   S(LL),LL=1,NIC)
      WRITE (N,132) (  S1(LL),LL=1,NIC)
      GO TO 123
 5123 IY=NICN(1)
      YDELT=YY(IY)
      IF(NLG1.NE.0) GO TO 560
      WRITE(N,5110) YDELT
      IF(KR(8))  920,920,626
  920 WRITE(N,112) HEAD(1),HEAD(3),HEAD(5),HEAD(5)
      GO TO 561
  626 WRITE(N,112) HEAD(2),HEAD(4),HEAD(6),HEAD(6)
      GO TO 610
  560 WRITE(N,111) YDELT
      IF(KR(8)) 666,666,667
  666 WRITE(N,114) HEAD(1),HEAD(3),HEAD(5),HEAD(5)
  561 V=0.
```

```
      V1=0.
      V2=0.
      DO 62 I=1,NIHVC
      V1=V1+(OUTC(1,I)+V3)*V
      V2=V2+(OUTC(3,I)+V4)*V
      V3=OUTC(1,I)
      V4=OUTC(3,I)
      V=(FHVC(I+1)-FHVC(I))/2.
      QQ1=V1/(FIIP(IY)+FIMO(IY))
      QQ2=V2/(FIIM(IY)+FIMO(IY))
   62 WRITE(N,113)FHVC(I),OUTC(3,I),V2,QQ2,OUTC(1,I),V1,QQ1
      GO TO 123
  667 WRITE(N,114) HEAD(2),HEAD(4),HEAD(6),HEAD(6)
  610 V=0.
      V1=0.
      V2=0.
      V5=1.24/FHVC(NIHVC)
      DO 620 I=1,NIHVC
      IR=NIHVC-I+1
      S(IY)=OUTC(1,IR)/V5*FHVC(IR)
      S1(IY)=OUTC(3,IR)/V5*FHVC(IR)
      V1=V1+(S(IY)+V3)*V
      V2=V2+(S1(IY)+V4)*V
      V3=S(IY)
      V4=S1(IY)
      V6=1.24/FHVC(IR-1)
      V=(V6-V5)/2.
      QQ1=V1/(FIIP(IY)+FIMO(IY))
      QQ2=V2/(FIIM(IY)+FIMO(IY))
      WRITE(N,113)V5,S1(IY),V2,QQ2, S(IY),V1,QQ1
  620 V5=V6
  123 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE DADIN                                                  DADIN00
C.....SUPPLIES THERMODYNAMIC ,PATH LENGTH AND OTHER DATA                DADIN00
      INTEGER FAMOA,FAMOB
      COMMON/CONTH/NCRC(20),NSBN,Z(20),HVG(30),KS(20),IIS(16),NIL,
     1              HVT(30)       ,CSS(240),IIL(30),ISS(30)   ,IOBN(20),
     2               XION(30),BETA(30),BETB(30),NST1,NT,XIS(240),JIS(30),
     3              TTHRES(30),COEFA(30),COEFB(30),IZZ
C
      COMMON/INTCOM/KR(20),KQ(10),KF(10),M,N
C
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25),           NXI,IA(9) RADIN0
     1,NI,XNOL(200),GUP(200),EXPN(200),XR(20)
                                                                        DADIN01
C
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(160),FF(200), RAC
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GEF(160),               NAES,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHVC,NHV,NU(25),NY,PRES(20),TEE(20),WOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),THSW(50),THSWL(25),TW,TOB ,
     5NRAD,RFACT,POP
C
      COMMON/PRPCOM/SPIZ(20),RHO(20)
      COMMON/NONCOM/AM(123,123)
      COMMON/EQTCOM/ZUG1(8),AA,ZUG2(853)                                DADIN01
      COMMON/EQPCOM/FSC1(181),ISC0(60),FSC2(24),ISC1(16),IS,            DADIN01
     1                ISC2(70),P,FSC3( 480),T,FPSC3(788),
     2                ISC3(4),FSC4,ISC4,FSC5(181),ISP2,FAMOA(60),FAMOB(60)DADIN01
     3               ,ISP,NSPEC,FSC6(3),KIN,KOUT,KKR(20)
      COMMON /RADCOM/            TT(20),VMW(20),MH(20),SP(1,20,8)       DADIN00
     1                  ,THETA,SV1,SP1,SR1,HS
      DIMENSION FR(123,1)
      EQUIVALENCE (FR(1),AM(43))                                        DADIN02
  100 FORMAT(6E12,1)
  102 FORMAT(1E12,4)                                                    DADIN02
  103 FORMAT(5I3)                                                       DADIN02
  115 FORMAT(24I3)                                                      DADIN01
  225 FORMAT(8E10,3)
  226 FORMAT(6E12,4)
  227 FORMAT(10I1,I10,5E10,3)
  625 FORMAT(,/,47H ****NICN(1) MUST EQ,1 FOR REFLECTING WALLS****)
                                                                        DADIN02
 4010 FORMAT(35H****EXTEND CONTINUUM FREQ RANGE****)                    DADIN02
 4004 FORMAT(20I1,15A4)                                                 DADIN02
 4008 FORMAT(35H****KQ(1)=2 CANNOT BE USED HERE****)
 7005 FORMAT(2A4,2X,7E10,2/(8E10,2))
 7006 FORMAT(2A4,2X,7E10,2)
      ISM1=IS-1                                                         DADIN04
   85 IF(C1-1,)  80,79,80
C     ******************************************************************
C                                                                       DADIN04
C                                                                       DADIN04
C     UNIFORM CONDITIONS                                                DADIN04
C
C     ******************************************************************
   79 IF(KR(7)-1) 681,682,682
  681 READ(M,226) DELTA
      GO TO 683
  682 READ(M,226) DELTA,PRES(1),TEE(1),SLOPE,V
      IF(KR(7),EQ,2) RHO(1) = V
  683 READ(M,226) TW,TOB
```

```
C                                                                     DADIN09
C     READ MASS FRACTIONS OF BASE SPECIES
C                                                                     DADIN09
      IF(KR(7)-1) 365,321,322
  321 READ(M,225) (SP(1,1,I),I=1,ISM1)                                DADIN09
      GO TO 340                                                       DADIN09
C     OR MOLE FRACTIONS OF RADIATING SPECIES
  322 READ(M,115)NSPEC
      DO 700 J=1,NSPEC
  700 READ(M,7006) FAMOA(J),FAMOB(J),FR(J,1)
      IF(KQ(1)-2) 345,346,345                                         DADIN09
  346 WRITE(N,4008)                                                   DADIN09
      STOP                                                            DADIN10
  345 GO TO 341                                                       DADIN10
  340 IF(KQ(1).EQ.0) TT(1) = 1.8*TEE(1)
      IF(KQ(1).EQ.2) HH(1)=TEE(1)                                     DADIN10
      IF(KR(5)-3) 636,637,637
  637 TW = TEE(1)
      TOB = TEE(NY)
  636 CONTINUE
      IF(KR(2).EQ.2) PRES(1) = P
  341 DO 81 I=1,NY                                                    DADIN10
      HH(I) = HH(1)                                                   DADIN11
      PRES(I)=PRES(1)                                                 DADIN04
      TEE(I)=TEE(1)
      RHO(I) = RHO(1)
      DO 5581 J=1,ISM1
 5581 SP(1,I,J)=SP(1,1,J)
      IF(KR(7).NE.2) GO TO 81
      DO 82 J=1,NSPEC
   82 FR(J,I)=FR(J,1)                                                 DADIN05
   81 CONTINUE                                                        DADIN05
C     CHECK FREQUENCY GRID
      IF( KR(9).EQ.1) GO TO 365                                       DADIN11
      V1 = FHVC(NIHVC)/(12.*8.62E-5)                                  DADIN11
      V2 = AMAX1(TW,TOB,TEE(1))
      IF(KQ(1).NE.0)V2=AMAX1(TW,TOB,TT(1)/1.8)
      IF(V1-V2) 360,365,365
  360 WRITE(N,4010)                                                   DADIN11
      STOP                                                            DADIN1.
  365 CONTINUE                                                        DADIN11
C
C     STANDOFF DISTANCE CALCULATION
C
      C4 = KR(13)
      IF(KR(13).GT.2) KR(13)=KR(13) - 3
      IF(KR(13).EQ.0) GO TO 86                                        DADIN11
      SDR = SR1/P*T/VMW(1)*1.3146                                     DADIN12
      IF(ABS(SLOPE).LT. 1.E-8) SLOPE=1./(1.+SQRT(8./3.*SDR))
      DELTA = SDR*SLOPE*DELTA
      IF(KR(13).EQ.2) DELTA = 30.48*DELTA                             DADIN12
      GO TO 86                                                        DADIN05
C     *****************************************************************
C                                                                     DADIN05
C     NONUNIFORM CONDITIONS INPUT                                     DADIN05
C                                                                     DADIN05
C     *****************************************************************
C     INPUT DELTA                                                     DADIN05
C                                                                     DADIN05
   80 READ(M,102) DELTA                                               DADIN06
C                                                                     DADIN06
C     READ PRESSURES                                                  DADIN06
C                                                                     DADIN06
      IF(KR(7).EQ.0) GO TO 689
```

```
      READ(M,226)(PRES(I),I=1,NY)                                       DADIN06
C                                                                       DADIN06
C     READ TEMPEATURE                                                   DADIN06
C
      READ(M,226)(TEE(I),I=1,NY)                                        DADIN06
      IF(KR(7).NE.2.OR.KR(13).LE.2)  GO TO 689
      READ(M,226) (RHO(I),I=1,NY)
  689 CONTINUE
      READ(M,226) TW,TOB                                                DADIN12
C                                                                       DADIN06
C                                                                       DADIN12
C     READ MASS FRACTIONS OF BASE SPECIES
C                                                                       DADIN12
      IF( KR(7)-1) 86,521,522                                           DADIN12
  521 DO 325 I=1,NY                                                     DADIN12
  325 READ(M,225) (SP(1,I,J),J=1,IGM1)                                  DADIN12
      GO TO 540                                                         DADIN13
  522 READ(M,115) NSPEC
      DO 710 J=1,NSPEC
  710 READ(M,7005) FAMOA(J),FAMOB(J),(FR(J,I),I=1,NY)
      IF(KQ(1)*2) 545,546,545                                           DADIN13
  546 WRITE(N,4008)                                                     DADIN13
      STOP                                                              DADIN13
  545 GO TO 541                                                         DADIN13
C                                                                       DADIN13
  540 CONTINUE
C                                                                       DADIN14
  541 IF(KR(5) - 3) 638,639,639
  639 TW = TEE(1)
      TOB = TEE(NY)
  638 CONTINUE
C     ********************************************************************
C     END OF DATA CHECK
C     ********************************************************************
C                                                                       DADIN07
C     IF C4=0, AN ADDITIONAL CASE FOLLOWS                               DADIN07
   86 READ(M,226) C4                                                    DADIN07
      IF(NICN(1).EQ.1.OR.KR(5).LT.2) GO TO 640
      WRITE(N,625)
      STOP
  640 CONTINUE
C                                                                       DADIN07
C                                                                       DADIN11
      RETURN                                                            DADIN14
      END                                                               DADIN14
```

```
      SUBROUTINE EQUIL(KQ,IND,PR)
      INTEGER FAMOA,FAMOB
C
      COMMON /RADCOM/          TT(20),VMW(20),HH(20),SP(2,20,8)        DADI
     1                  ,THETA,SV1,SP1,SR1,HS
C
      COMMON /EQPCOM/ RB(60,2),FF(60),FFA,IFC(60),ATA(8),ATB(8),WAT(8), EQUIL00
     1                KAT(8),IR(8),IS,KR(10),LAMI(60),P,RC(60,2),        EQUIL00
     2                RD(60,2),RE(60,2),RF(60,2),T,TK(8,8),TQ(8,8),     EQUIL00
     3                TU(60,2),PF(60),VNU(60,8),L2,L3,ITFF,KR2,HCH,NCV, EQUIL01
     4                WM,WTM(60),Y(60),YW(60),ISP2,FAMOA(60),FAMOB(60), EQUIL01
     5                ISP,N,W(3),KIN,KOUT,KKR(20),ATC(8),GG(60)         EQUIL01
C
      COMMON /EQTCOM/ SIP,HIP,EL,ENL,FLIQ,CPR,IRE,IER,PM,ITS,IN,IL,IT,  EQUIL01
     1                MODE,HMELT,SMELT,TMAX,TMIN,MELT,SUMN,SUML,IB(9),  EQUIL01
     2                EB(8),FBL(8),A(14,14),B(14),I4(60),ALP(8),FNU(8), EQUIL01
     3                GAMH(8),GAMF(8),JC,HG,SLAM(8),CPG,DY(60),CP(60),  EQUIL01
     4               HI(60),SB(60),TC(60),VLNK(60),E(60),TTMIN,TTMAX,   EQUIL01
     5                PNUS(8),WS,WSS,ISPO,BC(8),BLNK(8),BY(8),IHC(8),   EQUIL01
     6                B1,KKJ,SVA,SVB,SVC,SVD,SUMC,FFF,RV,CMF,EP,IFCJC,  EQUIL02
     7                WIG,WIL,JJ(8),BE(8),LEF(6)                        EQUIL02
C
      COMMON/NONCOM/AM(123,123)
C
      COMMON/SAVE/IOPT,PO
      DIMENSION KQ(1)
      DIMENSION DXY(123,1)  ,FR(123,1)
      DIMENSION DLCPF(60)
      DIMENSION RHS(32),        PLP(30),        PPTC(30),
     1 HOS(30),
     2 X(30),          ALPHI(8)
      DIMENSION FKXX(8,8,8),FKDX(8,8),BRACE(8,8),  CPF(60),
     1 TAU(30),CPP(30),DCP(30),PTAU(30),PC(30),PH(30),PTH(30)
      DIMENSION HTM(32)
      EQUIVALENCE (NSPEC,N),(CP(1),CPF(1)),           (PLP(1),Y(1)),
     1            (PPTC(1),YW(1)),(HOS(1),GG(1)),(X(1),VLNK(1)),
     2            (TAU(1),DY(1))
      EQUIVALENCE (RHS(1),AM(1)),(CPP(1),AM(124)),(DCP(1),AM(247)),
     1            (PTAU(1),AM(370)),(PC(1),AM(493)),(PH(1),AM(616)),
     2            (PTH(1),AM(739)),(HTM(1),AM(862)),(DXY(1),AM(1477)),
     3            (FR(1),AM(43?)),(FKXX(1),AM(2461)),(FKDX(1),AM(3076)),
     4            (BRACE(1),AM(3198)),(DLCPF(1),AM(3321))
  200 FORMAT(I1,E9.4,4E10.4)
  201 FORMAT(4H1 P=E12.4,10X,2HS=E12.4,10X4HVKT=3E12.4)
  202 FORMAT(4H1 P=E12.4,10X,2HH=E12.4,10X4HVKT=3E12.4)
  203 FORMAT(I2,7E14.5)
  204 FORMAT(6E9.6,6XF6.0)
  246 FORMAT(//5X,14HDATA DECK HAS ,I3,20H SPECIES-LIMIT IS 40,//)
  248 FORMAT(//5X14HDATA DECK HAS ,I3,21H ELEMENTS, LIMIT IS 6//)
C
C     THIS CODE COMES TO YOU COURTESY OF AEROTHERM,.,WEN,RMK,MG
C
C     THIS VERSION CAN CONSIDER 40 SPECIES
C
      IF(IOPT.NE.0) GO TO 99
      PO=7.
      IF(NSPEC.LE.40) GO TO 244
      WRITE(N,246)NSPEC
      STOP
  244 CONTINUE
      IF(IS.LE.6) GO TO 249
      WRITE(N,248) IS
      STOP
```

```
 249 CONTINUE
     DO 2 I=1,NSPEC
     V=NSPEC
     PP(I) = PR/V
     PLP(I) = ALOG(PP(I))
     DO 2 J=1,2
     RF(I,J)=RF(I,J)/1,9869
   2 CONTINUE
     IOPT = 2
  99 CONTINUE
C
     MODE=KQ(1)
     ISP2 = IS+2
     ISP3 = IS + 3
     NSP2 = NSPEC + 2
     ISM1 = IS - 1
     HTM(1) = 1,8
     HTM(2) = 1,0
     DO 300 I=1,IS
 300 ALPHI(I) = SP(1,IND,I)/WTM(I)
     ISM2 = IS-2
     ALPHI(ISM1) = 1,
     DO 600 I=1,ISM2
 600 ALPHI(ISM1) = ALPHI(ISM1)-SP(1,IND,I)
     ALPHI(ISM1)=ALPHI(ISM1)/WTM(ISM1)
     IF(KQ(5),NE,1) GO TO 4675
     SA1=THETA/57,29577
     SH1=HS/1,8
     SVA=(1,3146*SR1*SV1*COS(SA1))**2/90108,
     SVB=SVA*2,/1,9869
     SVC=(SV1*COS(SA1))**2/90108,+SH1
     SVD=SH1+SVB/(1,3146*SR1)
4675 CONTINUE
     P=PR
     H=HH(IND)/1,8
     T= TT(IND)/1,8
     TSAVE=T
     WM = VMW(IND)
     PLN= ALOG(P)
     PTEST=P*(EXP(-4,))
     PO= ALOG (P/PO)
     I2 = ISP2
     DO 3 I=1,NSPEC
     HTM(I+2) = WTM(I)
     PLP(I) = -30,
     IF(FR(I,IND)) 22,22,23
  23 PLP(I) = ALOG(FR(I,IND))      +PO
  22 CONTINUE
     PP(I)= EXP (PLP (I))
   3 CONTINUE
     PO=P
     PM=WM*P
     ITER=1
  30 CONTINUE
     CPG=0,
     VA=ALOG(T/3000,)/1,9869
     VB=T-3000,
     VC=(T+3000,)/2,
     VD=T*3000,
     VE=VC/(VD*VD)
     VF=VB/1,9869
     RT=1,9869*T
     TSQ=T*T
     SUMP=0,
```

```
      DO 1 I=1,NSPEC
      J=2
      IF(T.LT.TU(I,1)) J=1
      CPF(I)=RC(I,J)+T*RD(I,J)+RE(I,J)/TSQ
      DLCPF(I)=(T*RD(I,J)-2.*RE(I,J)/TSQ)/CPF(I)
      HI(I)=RB(I,J)+VB*(RC(I,J)+RD(I,J)*VC+RE(I,J)/VD)
      SB(I)=RF(I,J)+RC(I,J)*VA+VF*(RD(I,J)+RE(I,J)*VE)-PLP(I)
      CPG=CPG + PP (I)*CPF(I)
      SUMP=SUMP+PP(I)
      TC(I)=-HI(I)/RT
      E(I)=TC(I)+SB(I)
    1 CONTINUE
      DO 302 I=ISP,NSPEC
      DO 302 J=1,IS
      TC(I) = TC(I) - VNU(I,J) * TC(J)
  302 E(I) = E(I)-VNU(I,J) * E(J)
      SUMS=0.
      SUMH=0.
      IF(MODE .NE.0) GO TO 412
      SUMT=0.
      DO 620 I=1,NSPEC
      HOS(I) = WTH(I)*PP(I)
  620 SUMT = SUMT+HOS(I)
      V=T/TSAVE*PM
      RHS(1) = V-SUMT
      A(1,1) = -V
      A(1,2) = -V
      GO TO 6
  412 CONTINUE
      IF(MODE .NE.3) GO TO 4
      DO 5 I=1,NSPEC
      HOS(I)=SB(I)*PP(I)-PP(I)
      SUMS=SUMS +HOS(I)
    5 CONTINUE
      A(1,1)=CPG/1.9869
      A(1,2)=-PM*S
      RHS(1)=PM*S-SUMS-SUMP
      GO TO 6
    4 DO 7 I=1,NSPEC
      HOS(I)=HI(I)*PP(I)
      SUMH=SUMH+HOS(I)
    7 CONTINUE
      IF(KQ(5)-1)406,408,406
  406 A(1,2)=-PM*H
      A(1,1)=CPG*T
      RHS(1)=PM*H-SUMH
    6 RHS(2)=P-SUMP
      GO TO 410
  408 P=SUMP
      A(1,2)=-PM*SVC-SVA*TSQ/PM
      A(1,1)=CPG*T+2.*SVA*TSQ/PM
      RHS(1)=PM*SVC-SUMH-SVA*TSQ/PM
      RHS(2)=SVD-SUMP-SVB*T/PM
  410 CONTINUE
      DO 304 I=1,IS
      E(I) = PM * ALPHI(I) - PP(I)
      DO 304 J=ISP,NSPEC
  304 E(I) = E(I) - VNU(J,I) * PP(J)
      ICON=1
      TEST = ABS(E(IS))
      DO 305 I=1,ISM1
      V = PM*ALPHI(I) *.0001
      V1 = 1.E-10
      V = AMAX1(V,V1)
```

```
      IF(ABS(E(I))-V)305,305,10
  305 TEST = TEST + ABS(E(I))
      DO 16 I=ISP,NSPEC
      IF (ABS(E(I))-.001) 16,16,10
   16 CONTINUE
      IF( MODE.EQ.0) GO TO 416
      IF (ABS(RHS(1)*T/A(1,1)).GT. 0.1) GO TO 10
  416 IF (ABS(RHS(2))/P.GT. 0.00001) GO TO 10
      IF(TEST/PM .GT. .00001) GO TO 10
      IF(ABS(E(IS))/AMAX1(PP(IS),ABS(ALPHI(IS))) .GT. 0.00001) GO TO 10
      ICON = 0
   10 A(2,1)=0.
      IF(KQ(5).EQ.1) A(2,1)=SVB*T/PM
      DO 8 I=ISP,NSPEC
      A(1,1)=A(1,1)-HOS(I)*TC(I)
      PPTC(I)=PP(I)*TC(I)
      A(2,1)=A(2,1)-PPTC(I)
    8 CONTINUE
      A(2,2) = 0.
      IF(KQ(5).EQ.1) A(2,2)=-SVB*T/PM
      DO 312 I=3,ISP2
      A(I,1) = 0.
      A(I,2) = -PM*ALPHI(I-2)
      A(1,I) = HOS(I-2)
      A(2,I) = PP(I-2)
      DO 316 K=3,ISP2
  316 A(I,K) = 0.
      A(I,I) = PP(I-2)
      DO 314 J=ISP,NSPEC
      A(I,1) = A(I,1)-VNU(J,I-2)*PPTC(J)
      A(1,I) = A(1,I) + VNU(J,I-2) * HOS(J)
      A(2,I) = A(2,I) + VNU(J,I-2) * PP(J)
      DO 314 K=3,ISP2
  314 A(I,K) = A(I,K) + VNU(J,I-2)*VNU(J,K-2) * PP(J)
  312 CONTINUE
  803 FORMAT(2X,8E14.6)
      DO 9 I=ISP,NSPEC
      RHS(1)=RHS(1)-HOS(I)*E(I)
      PPTC(I)=PP(I)*E(I)
      RHS(2)=RHS(2)-PPTC(I)
    9 CONTINUE
      DO 306 I=3,ISP2
      RHS(I) = E(I-2)
      DO 306 J=ISP,NSPEC
  306 RHS(I) = RHS(I) - VNU(J,I-2) * PPTC(J)
      DO 318 I=1,ISP2
  318 A(I,ISP3) = RHS(I)
      JP=1
      DO 32 I=1,I2
      DUM=A(I,I)
      A(I,I)=1.
      IP=I+1
      JP=JP+ICON
      DO 31 J=JP,ISP3
   31 A(I,J)=A(I,J)/DUM
      IF(IP.GT.I2)GO TO 33
      DO 32 K=IP,I2
      DUM= (K,I)
      A(K,I)=0.
      DO 32 J=JP,ISP3
   32 A(K,J)=A(K,J)-DUM*A(I,J)
   33 IF(ICON.EQ.0) GO TO 36
      IP=ISP3
      DO 35 I=1,ISP
```

```
      IP=IP-1
      DO 35 J=IP,I2
   35 A(IP-1,ISP3) = A(IP-1,ISP3) - A(IP-1,J) * A(J,ISP3)
      GO TO 38
   36 DO 37 I=1,ISP
      DO 37J=1,I
      DUM=A(J,I+1)
      A(J,I+1)=0.
      DO 37 L=1,ISP3
   37 A(J,L)=A(J,L)-DUM*A(I+1,L)
   38 CONTINUE
      DO 320 I=1,ISP2
  320 RHS(I) = A(I,ISP3)
      DO 308 I=ISP3,NSP2
      RHS(I) = E(I-2) - TC(I-2) * RHS(1)
      DO 308 J=3,ISP2
  308 RHS(I) = RHS(I) + VNU(I-2,J-2) * RHS(J)
      DAMP=1.
      DO 15 I=1,NSPEC
      DOM= PLP(I)-PLN
      IF( RHS(I+2)) 20,15,18
   18 DUM=(4.+4.*DOM)/(3.-DOM)
      GO TO 13
   20 DUM=(3.*DOM-4.)/(4.+DOM)
      IF(DUM) 13,15,15
   13 CONTINUE
   19 DAMP=AMIN1(DAMP,(DUM-DOM)/RHS(I+2))
   15 CONTINUE
      DAMP=AMIN1(DAMP,0.4/AMAX1(ABS(RHS(1)),ABS(RHS(2)),.4))
      IF (DAMP .GT..99) GO TO 21
      DO 27 I=1,NSP2
   27 RHS(I)=DAMP*RHS(I)
   21 DO 28 I=1,NSPEC
      PLP(I)= PLP(I)+RHS(I+2)
      PP(I)=EXP (PLP(I))
   28 CONTINUE
      T=T/(1.-RHS(1))
      PM=PM+RHS(2)*PM
      ITER=ITER+1
      IF(ITER.LT.50) GO TO 6642
      WRITE(6,6680)
 6680 FORMAT(//5X,28HCHEMISTRY FAILED TO CONVERGE//)
      WRITE(6,6681)IND,HH(IND),PR,SP(1,IND,1),SP(1,IND,2),SP(1,IND,3),
     1 SP(1,IND,4)
 6681 FORMAT(1X,15HI,H,P,K1,K2,....,2X,I3,2X,6E12.3)
      STOP
 6642 CONTINUE
      IF (ICON.GT.0) GO TO 30                                          C
      ALF=A(2,1)/A(1,1)
      CPE=1.9869/(A(1,1)*PM)
      IF(IOPT.EQ.2) CPE=CPE/RT
      WM=PM/P
      VMW(IND) = WM
      TT(IND) = 1.8*T
      RHO=PM/T/82.057
      S=0.
      H=0.
      DO 17 I=1,NSPEC
      S=S+SB(I)*PP(I)
      H=H+PP(I)*HI(I)
      X(I)=PP(I)/P
      FR(I,IND) = X(I)
   17 CONTINUE
      H=H/PM
```

```
      S=S/PM
      S=S*1,9869
      IF(KQ(5),EQ,1) GO TO 52
      IF( MODE,NE,2) GO TO 52
      GO TO 53
   52 WH(IND) = 1,8*H
   53 CONTINUE
      IF(MODE,EQ,2) GO TO 426
      MODE=2
      GO TO 30
  426 CONTINUE
      IF(KQ(7),EQ,9) GO TO 3650
C
C
 1902 WRITE(KOUT, 42)T,P,WM                                             EQUIL37
      WRITE(KOUT,48)H,S,RHO
      WRITE(KOUT,2032)(FAMOA(I),FAMOB(I), X(I),I=1,NSPEC)
 2032 FORMAT(/3(5X7HSPECIES3X8HMOLE FR,2X)/(5X2A4,E12,5,5X2A4,E12,5,5X2AEQUIL41
     14,E12,5))                                                         EQUIL41
   42 FORMAT(/9X5HTEMP=,F12,4,17H DEG-K     PRES =F9,3,17H ATM     MOL WEQUIL05
     1T =F11,7)                                                         EQUIL05
   48 FORMAT(10X10HENTHALPY =E14,7,20H CAL/GM    ENTROPY =E12,5,13H CAL/EQUIL06
     1GM-DEG K/10X 9HDENSITY =E13,6, 8H GM/CM3 )
 3650 CONTINUE
      DO 310 I=ISP,NSPEC
      DCP(I) = CPF(I)
      DO 310 J=1,IS
  310 DCP(I) = DCP(I)-VNU(I,J) * CPF(J)
      PTC=0,
      PCP=0,
      PHT=0,
      PT=0,
      DO 100 J=1,NSPEC
      K=2
      IF(TU(J,1),GT,T)K=1
      CPP(J)=RD(J,K)-2,/T**3*RE(J,K)
      PCP=PP(J)*CPP(J)+PCP
      PH(J)=PP(J)*HI(J)
      PTH(J)=T*CPF(J)*PP(J)
      IF(J,LE,IS)GO TO 100
      TAU(J)=TC(J)*TC(J)+TC(J)+DCP(J)/1,9869
      PTAU(J)=PP(J)*TAU(J)
      PTC=PP(J)*TC(J)*CPF(J)+PTC
      PHT=PP(J)*HI(J)*TAU(J)+PHT
      PT=PP(J)*TAU(J)+PT
      PC(J)=PP(J)*TC(J)
      PTH(J)=PTH(J)-HI(J)*TC(J)*PP(J)
  100 CONTINUE
      DO 125I=1,ISP2
      DXY(I,2)=A(I,2)
      DXY(I,1)=A(I,1)*PM
      DO 125 J= 3,ISP2                                                  C
  125 DXY(I,J)=A(I,J)*PM
      DO 176 IM=ISP,NSPEC
      DO 176 JS=1,ISP2
      DUD=-TC(IM)*DXY(1,JS)
      DO 171 IP=1,IS
  171 DUD=DUD+VNU(IM,IP)*DXY(IP+2,JS)
  176 DXY(IM+2,JS)=DUD
      DO 197 K=1,NSP2
      DO 189 J=1,ISP2
  189 DXY(K,J) = DXY(K,J)/HTM(J)
C     FOLLOWING ACTIVE ONLY WHEN ISM1 ELEMENT OBTAINED BY DIFFERENC
      IF(KQ(6),EQ,1) GO TO 197
```

```
      RMMG=1.                                                           INPUT06
      IF (KR(2)) 334,334,321                                            INPUT06
  321 READ(KIN,301) IO,IS,FFAR,DUB2,DUB3,DUB4,DUB5,DUB6,DUB7,DUB8
      IF (IO.NE.0) KR(3)=6                                              INPUT06
      IF (DUB2.GT.0.) FITMOL=DUB2                                       INPUT06
      IF (DUB3.GT.0.) BASMOL=DUB3                                       INPUT06
      IF (DUB4.GT.0.) SIGMA=DUB4                                        INPUT06
      IF (DUB5.GT.0.) EPOVRK=DUB5                                       INPUT06
      IF (DUB6.GT.0.) GGA =DUB6                                         INPUT06
      IF (DUB7.GT.0.) FITGMW=DUB7                                       INPUT07
      IF(FFAR) 3213,3212,3211                                           INPUT07
 3213 FFA=0.                                                            INPUT07
      GO TO 3212                                                        INPUT07
 3211 FFA=FFAR                                                          INPUT07
 3212 CONTINUE                                                          INPUT07
      JAT(8)=0                                                          INPUT07
      IX=3                                                              INPUT07
      IF (IS-10) 311,311,399                                            INPUT07
  311 READ(KIN,304) (KAT(J), ATA(J), ATB(J), ATC(J), WAT(J), (TK(J,I),  INPUT07
     1  I=1,7),J=1,IS)                                                  INPUT08
      DO 327 K=1,7                                                      INPUT08
      VA=0.                                                             INPUT08
      DO 322 J=1,IS                                                     INPUT08
      IF(KAT(J)-99) 3111,325,3111                                       INPUT08
 3111 IF(TK(J,K)) 324,322,325                                           INPUT08
  324 VA=VA-TK(J,K)                                                     INPUT08
      TK(J,K)=-TK(J,K)/WAT(J)                                           INPUT08
      GO TO 322                                                         INPUT08
  325 VA=VA+TK(J,K)*WAT(J)                                              INPUT08
  322 CONTINUE                                                          INPUT09
      IF(VA) 326,327,326                                                INPUT09
  326 DO 323 J=1,IS                                                     INPUT09
  323 TK(J,K)=TK(J,K)/VA                                                INPUT09
  327 CONTINUE                                                          INPUT09
      ISP=IS 1                                                          INPUT10
      IF(KR(3)) 399,399,334                                             INPUT10
  334 TFMAX=0.                                                          INPUT10
      AAA=0.                                                            INPUT10
      N=0                                                               INPUT10
      II=ISP                                                            INPUT10
      J=1                                                               INPUT10
  342 READ(KIN,306)(ALPT(K),JAT(K),K=1,7),SORCE,AMOA,AMOB               INPUT10
      IF(ALPT(1)) 3421,399,3420                                         INPUT10
 3420 IF(JAT(1)) 344,3421,344                                           INPUT10
 3421 NFF=ABS(ALPT(1))                                                  INPUT11
      READ(KIN,3021)(NFIA(I),NFIB(I),FFIN(I),I=1,NFF)                   INPUT11
      GO TO 342                                                         INPUT11
  344 DO 345 K=1,IS                                                     INPUT11
  345 C(K)=0.                                                           INPUT11
      DO 349 I=1,7                                                      INPUT11
      IF(JAT(I)) 346,349,346                                            INPUT11
  346 DO 347 K=1,IS                                                     INPUT11
      IF(JAT(I)-KAT(K)) 347,348,347                                     INPUT11
  347 CONTINUE                                                          INPUT11
      READ(KIN,303)                                                     INPUT12
      GO TO 342                                                         INPUT12
  348 C(K)=ALPT(I)                                                      INPUT12
  349 CONTINUE                                                          INPUT12
      WT=0.                                                             INPUT12
      L=1
```

```
      LAMKK=0                                                         INPUT12
      DO 388 I=1,IS                                                   INPUT12
      IF(C(I)) 387,388,387                                            INPUT12
  387 LAMKK=LAMKK+L                                                   INPUT12
      WT=WT+C(I) * WAT(I)                                             INPUT12
  388 L=L+L                                                           INPUT13
      IF(J-IS) 360,360,369                                            INPUT13
  360 JM=J-1                                                          INPUT13
      DO 3601 L=1,IS                                                  INPUT13
 3601 CIJ(L,J)=C(L)                                                   INPUT13
      LAMI(J) = LAMKK                                                 INPUT13
      IF (JM) 320,320,313                                             INPUT13
  313 DO 314 L=1,JM                                                   INPUT13
      IML=IM(L)                                                       INPUT13
      UGH=C(IML)                                                      INPUT13
      UM(L,J)=0.                                                      INPUT14
      IF(UGH) 353,314,353                                             INPUT14
  353 DO 393 I=1,L                                                    INPUT14
  393 UM(I,J)=UM(I,J)-UM(I,L)*UGH                                     INPUT14
      DO 394 I=IML,IS                                                 INPUT14
  394 C(I)=C(I)-TAU(I,L)*UGH                                          INPUT14
  314 UM(J,L)=0.                                                      INPUT14
  320 DO 316 I=1,IS                                                   INPUT14
      IF(ABS (C(I))-.001)316,316,317                                  INPUT14
  316 TAU(I,J)=0.                                                     INPUT14
      DO 396 I=1,JM                                                   INPUT15
  396 VKU(II,I)=-UM(I,J)                                              INPUT15
      DO 397 I=J,IS                                                   INPUT15
  397 VKU(II,I)=0.                                                    INPUT15
      LAMI(II)=LAMKK                                                  INPUT15
      GO TO 370                                                       INPUT15
  317 IM(J)=I                                                         INPUT15
      UM(J,J)=1.                                                      INPUT15
      DO 398 L=1,J                                                    INPUT15
  398 UM(L,J)=UM(L,J)/C(I)                                            INPUT15
      DO 328 L=I,IS                                                   INPUT16
  328 TAU(L,J)=C(L)/C(I)                                              INPUT16
      YC=YINT                                                         INPUT16
      KK=J                                                            INPUT16
      J=J+1                                                           INPUT16
      IF(J-IS) 372,372,329                                            INPUT16
  329 DO 330 L=2,IS                                                   INPUT16
      JM=ISP-L                                                        INPUT16
      IMJ=IM(JM+1)                                                    INPUT16
      DO 330 K=1,JM                                                   INPUT16
      UGH=TAU(IMJ,K)                                                  INPUT17
      DO 330 I=1,IS                                                   INPUT17
  330 UM(I,K)=UM(I,K)-UGH*UM(I,JM+1)                                  INPUT17
      DO 333 I=1,IS                                                   INPUT17
  337 IMI=IM(I)                                                       INPUT17
      IF(IMI-I) 336,333,336                                           INPUT17
  336 DO 338 K=1,IS                                                   INPUT17
      V=UM(K,IMI)                                                     INPUT17
      UM(K,IMI)=UM(K,I)                                               INPUT17
  338 UM(K,I)=V                                                       INPUT17
      IM(I)=IM(IMI)                                                   INPUT18
      IM(IMI)=IMI                                                     INPUT18
      GO TO 337                                                       INPUT18
  333 CONTINUE                                                        INPUT18
C-----ELEMENT -- BASE GAS CORRESPONDENCE                               INPUT18
```

```
C      INITIALIZE ROW AND COLUMN SUMS                                  INPUT18
       IG=IS                                                           INPUT18
       DO 401 I=1,IS                                                   INPUT18
       IR(I)=-1                                                        INPUT18
   401 IC(I)=-1                                                        INPUT18
C      EVALUATE INITIAL SUMS                                           INPUT19
       LAMD=1                                                          INPUT19
       DO 402 I=1,IS                                                   INPUT19
       DO 403 J=1,IS                                                   INPUT19
       LIM(I,J)=MOD(LAMI(J)/LAMD,2)                                    INPUT19
       IC(J) = IC(J) + LIM(I,J)                                        INPUT19
   403 IR(I)= IR(I) + LIM(I,J)                                         INPUT19
   402 LAMD=LAMD+LAMD                                                  INPUT19
C      CHECK FOR ZEROS                                                 INPUT19
   426 IZ=0                                                            INPUT19
   404 DO 412 I=1,IS
       IF(IC(I)-IZ) 408,405,408                                        INPUT20
   405 DO 406 J=1,IS                                                   INPUT20
       IF(LIM(J,I)) 407,406,407                                        INPUT20
   406 CONTINUE                                                        INPUT20
   407 IC(I)=-J                                                        INPUT20
       IR(J)=-I                                                        INPUT20
       DO 428 K=1,IS                                                   INPUT20
       LIM(J,I)=0                                                      INPUT20
       IF(LIM(J,K)) 425,427,425                                        INPUT20
   425 IC(K)=IC(K)-1                                                   INPUT20
       LIM(J,K)=0                                                      INPUT21
   427 IF(LIM(K,I)) 422,428,422                                        INPUT21
   422 LIM(K,I)=0                                                      INPUT21
       IR(K)=IR(K)-1                                                   INPUT21
   428 CONTINUE                                                        INPUT21
       GO TO 413                                                       INPUT21
   408 IF(IR(I)-IZ)  412,409,412                                       INPUT21
   409 DO 410 J=1,IS                                                   INPUT21
       IF(LIM(I,J)) 411,410,411                                        INPUT21
   411 IC(J)=-I                                                        INPUT21
       IR(I)=-J                                                        INPUT22
       LIM(I,J)=0                                                      INPUT22
       GO TO 4101                                                      INPUT22
   410 CONTINUE                                                        INPUT22
  4101 DO 430 K=1,IS                                                   INPUT22
       IF(LIM(K,J))424,429,424                                         INPUT22
   424 IR(K)=IR(K)-1                                                   INPUT22
       LIM(K,J)=0                                                      INPUT22
   429 IF(LIM(I,K)) 423,430,423                                        INPUT22
   423 LIM(I,K)=0                                                      INPUT22
       IC(K)=IC(K)-1                                                   INPUT23
   430 CONTINUE                                                        INPUT23
       GO TO 413                                                       INPUT23
   412 CONTINUE                                                        INPUT23
       IZ=IZ+1                                                         INPUT23
       GO TO 404                                                       INPUT23
   413 IG=IG-1                                                         INPUT23
       J=IS+1                                                          INPUT23
       IF(IG) 414,414,426                                              INPUT23
   414 IF(KP(3)-3) 372,372,415                                         INPUT23
   415 FAMDA(IS)=AMDA                                                  INPUT24
       FAMDB(IS)=AMDB                                                  INPUT24
       DO 416 I=1,IS                                                   INPUT24
       K=-IR(I)                                                        INPUT24
```

```
      IC(I)=FAMOA(K)                                                    INPUT24
  416 IM(I)=FAMOB(K)                                                    INPUT24
 417  FORMAT(///5X9HELEMENT  ,18A4)                                     INPUT24
  418 FORMAT( 5X9HBASE SP    6(4X2A4))                                  INPUT24
      GO TO 372                                                         INPUT24
  369 DO 361 L=1,IS                                                     INPUT24
      VNU(II,L)=0.                                                      INPUT25
      DO 361 I=1,IS                                                     INPUT25
  361 VNU(II,L)=VNU(II,L)+C(I)*UM(L,I)                                  INPUT25
      LAMI(II)=LAMKK                                                    INPUT25
  370 KK=II                                                             INPUT25
      II=II+1                                                           INPUT25
      YC= 0.                                                            INPUT25
 372  READ(KIN,302) (RA(K),RB(KK,K), RC(KK,K), RD(KK,K), RE(KK,K),      INPUT25
     1RF(KK,K), ZIGEPS(K), TU(KK,K),KPHA(K),K=1,2)                      INPUT25
      IF(KPHA(1)-KPHA(2)) 3733,3736,3734                                INPUT25
 3733 IF(KPHA(1)+KPHA(2)-5) 3734,3737,3734                              INPUT26
 3734 WRITE(KOUT,3735) AMOA,AMOB                                        INPUT26
 3735 FORMAT(////25H BAD PHASE NUMBERING FOR 2A4)                       INPUT26
      STOP                                                              INPUT26
 3736 IF(KPHA(1)-1) 3734,3727,3728                                      INPUT26
 3737 TU(KK,1)=-TU(KK,1)                                                INPUT26
 3728 FF(KK) = 1.E+10                                                   INPUT26
      GG(KK) = 1.E+10                                                   INPUT26
      GO TO 3729                                                        INPUT26
 3727 FF(KK)=(WT/FITMOL) **FFA                                          INPUT26
      IFMET(KK)=2                                                       INPUT27
      GG(KK) = -1.                                                      INPUT27
 3729 IF(NFF) 3726,3449,3730                                            INPUT27
 3730 DO 3723 I=1,NFF                                                   INPUT27
      IF(NFIA(I)-AMOA) 3723,3724,3723                                   INPUT27
 3724 IF(NFIB(I)-AMOB) 3723,3720,3723                                   INPUT27
 3720 IF(FFIN(I)-100.) 3725,3731,3731                                   INPUT27
 3725 IF (FFIN(I)) 3480,3480,3481                                       INPUT27
 3480 GG(KK) = -FFIN(I)                                                 INPUT27
      IGMET(KK)=1                                                       INPUT27
      GO TO 3723                                                        INPUT28
 3481 FF(KK) = FFIN(I)                                                  INPUT28
      IFMET(KK)=1                                                       INPUT28
      GO TO 3723                                                        INPUT28
 3731 TF(KK)=FFIN(I)                                                    INPUT28
 3723 CONTINUE                                                          INPUT28
      IF (GG(KK)) 3449,3449,3455                                        INPUT28
 3449 IF (ZIGEPS(1)-100.) 3453,3452,3452                                INPUT28
 3453 IF   (ZIGEPS(1)) 3452,3452,3441                                   INPUT28
 3441 IF (ZIGEPS(2)) 3452,3452,3443                                     INPUT28
 3443 GG(KK) = ZIGEPS(1)/SIGMA   *   (ZIGEPS(2)/EPOVRK)**.0795    *     INPUT29
     1  (WT/MASMOL)**.25                                                INPUT29
      IGMET(KK)=3                                                       INPUT29
      GO TO 3455                                                        INPUT29
 3452 IF (KPHA(1)-1)3456,3457,3456                                      INPUT29
 3456 GG(KK) = 1.E+10                                                   INPUT29
      GO TO 3455                                                        INPUT29
 3457 GG(KK) = (WT/FITGMW)**GGA                                         INPUT29
      IGMET(KK)=2                                                       INPUT29
 3455 CONTINUE                                                          INPUT29
 3726 IF(KR(3)-6) 3722,3721,3722                                        INPUT30
 3721 WRITE(KOUT,306)(ALPT(K),JAT(K), K=1,7), SORCE,AMOA,AMOB           INPUT30
      WRITE(KOUT,3020)(RA(K), RB(KK,K), RC(KK,K), RD(KK,K), RE(KK,K),   INPUT30
     1RF(KK,K),ZIGEPS(K),TU(KK,K),KPHA(K),K=1,2)                        INPUT30
```

```
 3722 FAMOA(KK)=AMOA                                                    INPUT30
      FAMOB(KK)=AMOB                                                    INPUT30
      WTM(KK)=WT                                                        INPUT30
      RB(KK,1)= RB(KK,1) + RA(1)                                        INPUT30
      RB(KK,2) = RB(KK,2) + RA(2)                                       INPUT31
      N=N+1                                                             INPUT31
      IF(KPHA(1)-1)3734,362,364                                         INPUT31
  364 IFC(KK)=-1                                                        INPUT31
      VN(KK)=0.                                                         INPUT31
      Y(KK)=YC                                                          INPUT31
      IF(TF(KK)-TFMAX) 342,342,371                                      INPUT31
  371 TFMAX=TF(KK)                                                      INPUT31
      GO TO 342                                                         INPUT31
  362 IFC(KK)=0                                                         INPUT31
      VN(KK)=VINT                                                       INPUT32
      Y(KK)=YINT                                                        INPUT32
      GO TO 342                                                         INPUT32
  399 CONTINUE
C     WRITE (KOUT,418) (IC(I),IM(I),I=1,IS)                             INPUT32
 5001 CONTINUE
      DO 375 L=1,8                                                      INPUT35
      DO 375 I=1,IS                                                     INPUT35
      TQ(I,L)=0.                                                        INPUT35
      DO 375 K=1,IS                                                     INPUT35
  375 TQ(I,L)=TQ(I,L)+UM(I,K)*TK(K,L)                                   INPUT35
 3752 VN(N+1)=0.                                                        INPUT39
      IFC(N+1)=-1                                                       INPUT39
      WTM(N+1)=-1.                                                      INPUT39
      FAMOA(N+1)=CHAR                                                   INPUT39
      FAMOB(N+1)=BLANK                                                  INPUT40
      TF(N+1)=50000.                                                    INPUT40
      IF(DUBB.GT.0.) TF(N+1) = DUBB                                     INPUT40
      RETURN                                                            INPUT40
      END                                                               INPUT40
```

```
      SUBROUTINE ISLDV (N,X,Y,SR,R,NO)                                  ISLDV00
      DIMENSION X(1),Y(1),SR(1),R(1)                                    ISLDV00
      DIMENSION YY(5)                                                   ISLDV00
      DIMENSION XX(6),SLR(25),YL(25)                                    ISLDV00
      DO 1 I=1,N                                                        ISLDV00
    1 YL(I)=ALOG(Y(I))                                                  ISLDV00
      CALL SLOPH(N,X,YL,SLR,R)                                          ISLDV00
      DO 2 I=1,N                                                        ISLDV00
    2 SR(I)=Y(I)*SLR(I)                                                 ISLDV01
      DO 3 I=2,N                                                        ISLDV01
      XI=I                                                              ISL4V0
      XD=X(I)-X(I-1)                                                    ISLDV01
      YS=Y(I)+Y(I-1)                                                    ISLDV01
      SD=SR(I)-SR(I-1)                                                  ISLDV01
      YD=Y(I)-Y(I-1)                                                    ISLDV01
      YDER=YD/XD                                                        ISLDV01
      Y2DER=SD/XD                                                       ISLDV01
      T2=ABS(XD*YDER)                                                   ISLDV01
      T3 = ABS(Y2DER*XD/2.*XD)                                          ISLDV00
      TS = ABS(Y(I-1)) + T2                                             ISLDV02
      IF(T3-0.15*TS) 4,4,5                                              ISLDV02
    4 R(I) = R(I-1)+XD/2.*(YS-XD/6.*SD)                                 ISLDV02
      GO TO 3                                                           ISLDV02
    5 YY(1)=ALOG(Y(I-1))                                                ISLDV02
      RR=0.0                                                            ISLDV02
      XX(1)=X(I-1)                                                      ISLDV02
      DO 8 J=2,5                                                        ISLDV02
    8 XX(J)=XX(J-1)+XD/4.                                               ISLDV02
      CALL OGLE(5,XX,YY,N,X,YL,SLR)                                     ISLDV03
      IF(NO-1) 9,9,10                                                   ISLDV03
   10 YMAX=YY(1)                                                        ISLDV03
      YMIN=YY(5)                                                        ISLDV03
      IF(YY(5)-YY(1)) 11,11,12                                          ISLDV03
   11 YMAX=YY(5)                                                        ISLDV03
      YMIN=YY(1)                                                        ISLDV03
   12 DO 13 J=1,5                                                       ISLDV03
      IF(YY(J)-YMAX) 14,14,15                                           ISLDV03
   14 IF(YY(J)-YMIN) 15,13,13                                           ISLDV03
   13 CONTINUE                                                          ISLDV04
      GO TO 9                                                           ISLDV04
   15 SSR=(YY(5)-YY(1))/XD                                              ISLDV04
      T4=ABS(2.*SSR*XD/(YY(5)+YY(1)))                                   ISLDV04
      IF(T4-.00001) 19,18,18                                            ISLDV04
   19 RR=0.5*XD*(EXP(YY(5))+EXP(YY(1)))                                 ISLDV04
      GO TO 17                                                          ISLDV04
   18 RR=(EXP(YY(5))/SSR)*(1.-EXP(-SSR*XD))                             ISLDV04
   17 R(I) = R(I-1)+RR                                                  ISLDV04
      GO TO 3                                                           ISLDV04
    9 DO 6 J=2,5                                                        ISLDV05
      SSR=(YY(J)-YY(J-1))/(XD/4.)                                       ISLDV05
    6 RR=RR+(EXP(YY(J))/SSR)*(1.-EXP(-SSR*XD/4.))                       ISLDV05
      R(I)=R(I-1)+RR                                                    ISLDV05
    3 CONTINUE                                                          ISLDV05
      RETURN                                                            ISLDV05
      END                                                               ISLDV05
```

```
      SUBROUTINE LINT2                                                  RADCL28
C
      COMMON/CONTM/NCRC(20)                                             RADCL29
C
      COMMON/EQPCOM/SPZZ(281),ISDUM,SPZ2(70),PDUM,SPZ3(480),TDUM,
     1 SPZ4(248),VN(60),VNU(60,8)
C
      COMMON/INTCOM/KR(20),KQ(10),KF(10),M,N
C
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25),          NXI,IA(9) RADINO
     1,NI,XNOL(200),GUP(200),EXPN(200),XR(20),K ,INDSHL(12)
     2,S(200),S1(200),S2(25)
C
      COMMON/NONCOM/AM(123,123)
C
      COMMON/OUTCOM/LDEX(3)
C
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(160),FF(200), RAD
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GEE(160),             NAES,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHVC,NHV,NU(25),NY,PRES(20),TEE(20),KOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),THSW(50),THSWL(25),TW,TOB
     5,NRAD,RFACT,POP
C
      DIMENSION XXN(123,1)
      DIMENSION OUTC(123,1),OUTL(123,1)
      DIMENSION BEE(20),FHVS(200),FIIMT(20),FIIPT(20),FIM(20),FIMT(20),FRADCL29
     1IP(20),FIPT( 20),FMU(20)        ,TAU(20),TAUT(20),TMU(20),DIP(20), RADCL30
     2DIM(20)               ,XIMO(20),XIPO(20),IOSL(20),XIM(20),XIP(20) RADCL30
      DIMENSION SMD(25)
      DIMENSION DY(20)
      DIMENSION HEAD(17)
      DIMENSION S8(20),S5(20),S6(20)
      DIMENSION S7(20)
      DIMENSION S9(20)
      EQUIVALENCE (XXN,XNN)
C
C
      DIMENSION
     1        DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2        WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123,1) ,
     3        DLXQ(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4        SL(123,1) , BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5        TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6        XNN(123,1) , XQ(123,1) ,AIGC(123,1)
C
      EQUIVALENCE
     1        (DSL(1),AM(1)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2        (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3        (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXQ(1),AM(5001)),
     4        (AFT(1),AM(5024)) , (ABE(1),AM(5270)) , (BFT(1),AM(7381)),
     5        (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
     6        (ATT(1),AM(8691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7        (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
```

```
     8         (XQ(1),AM(10004)),(AIGC(1),AM(9429))
     9            ,(OUTC(1),AM(5021)),(OUTL(1),AM(9512))
C
      EQUIVALENCE  (BEE(1),AM(8528)),(FIIMT(1),AM(8651)),(FIIPT(1),AM(
     1               8774)),(FIM(1),AM(8897)),(FIMT(1),AM(9020)),(FIPT(1)
     2               ,AM(9143)),(FMU(1),AM(9266)),(TAU(1),AM(9389))
      DATA HEAD/3H-EV,3H-MU,6H FREQU,6HENCY  ,6HWAVE L,6HENGTH ,4H(EV),
     14H(MU),6H (FT3/,6HLB-CM),6H  (1/C,6HM)    ,6H)      ,6H-STER),5HW/C
     2M2,5H     ,5H-STER/
 1000 FORMAT(1H1,38X,34HLINE TRANSPORT QUANTITIES AT YY = ,F5.3)
 1001 FORMAT(15H LINE GROUP NO.,I2)
 1010 FORMAT(15H    PATH LENGTH/15H   (NORMALIZED),6X,  10E9.2/(25X,
     110E9.2))
 1020 FORMAT(18H CONTM. ABSORPTION/ 7H COFFF.,2A6,2X  ,     10E9.2/(25X,
     1      10E9.2))
 1021 FORMAT(19H    PLANCK FUNCTION/16H (WATTS/CM2-STER,A3,2H) , 10E9.2/LINT 09
     1 (25X,     10E9.2))
 1030 FORMAT(19H B.B.EMISSIVE POWER/11H (WATTS/CM2,A3,1H),6X,    10E9.2/L9NT 09
     1(25X,10E9.2))
 1031 FORMAT(1H )
 1032 FORMAT(22X,16HPOS. CONTM FLUX=  E9.2,1X,16HNEG. CONTM FLUX=  E9.2,LINT 10
     11X,17HBOTH IN WATTS/CM2,A3)
 1040 FORMAT(46X,24HABSORPTION COEFFICIENTS,,1X,2A6     /2X,2A6,38X18HOP
     1TICAL DEPTHS,AND/58X,6HFLUXES)
 1041 FORMAT(22X,23HPOSITIVE SPECTRAL FLUX=  E9.2,1X,23HNEGATIVE SPECTRALINT 16
     1L FLUX=  E9.2,1X,13HBOTH IN W/CM2,A3)
 1042 FORMAT(22X,24HPOS. SPECTRAL INTENSITY=  E9.2,1X,24HNEG. SPECTRAL ILINT 16
     1NTENSITY=  E9.2,1X,13HBOTH IN W/CM2,A3,5H-STER)
 1045 FORMAT(2X,F8.5,11X,  10E9.2/(25X,     10E9.2))
 1046 FORMAT(21X,  10E9.2/(25X,     10E9.2))
 1047 FORMAT(1H )
 1050 FORMAT(1H1,///52X,22HLINE RADIATION SUMMARY//)
 1051 FORMAT(22X,77H  GROUP          BOUNDARIES              POS CONTRIBUTIO
     1N         NEG CONTRIBUTION/
     222X,77H   NO.        NEG.          POS.         SPECT.       TOTAL
     3 SPECT.        TOTAL)
 1052 FORMAT(24X,I3,2X,6E12.4)
 1053 FORMAT(35X,A4,8X,A4,6X,A5,A3,5X,A5,6X,A5,A3,5X,A5/58X,A5,7X,A5,7X,
     1A5,7X,A5)
 1054 FORMAT(/52X,8HTOTALS =,5X,E12.4,12X,E12.4)
 1090 FORMAT(I4,F12.3,3X,10E10.2)
 1091 FORMAT(19X,10E10.2)
 1092 FORMAT(3X,10HTOTAL POS=,6X,10E10.2/(19X,10E10.2))                 RADCL30
 1093 FORMAT(3X,10HTOTAL NEG=,12X,10E10.2/(25X,10E10.2))
 1094 FORMAT(25X,10E10.2)
 1095 FORMAT(1H )
 2010 FORMAT(1H1/57X,14HLINE RADIATION)                                 RADCL30
 2020 FORMAT(/,10H NORMALIZED DIST =,1X,10E10.2/(19X,10E10.2))
 2030 FORMAT(/,6H GROUP,3X,  2A6,30X     ,12HPOSITIVE AND/2X,3HNO.,6X, RADCL30
     1 A4  ,40X,22HNEGATIVE CONTRIBUTIONS/58X,10H(WATTS/CM2,A6)          RADCL30
 2045 FORMAT(2X,F8.5,11X,  10E9.2)
 2046 FORMAT(21X,  10E9.2)
 2094 FORMAT(6H GROUP,2X,2A6,       2X,16HNEG CONTRIBUTION,2X,16HPOS COLINT 25
     1NTRIBUTION/2X,3HNO.,6X,A4    ,12X,5HW/CM2,13X5HW/CM2)
 3018 FORMAT(1H1,/10X,6HGROUP ,I3,13H (CONTINUED)-,//)
 3040 FORMAT(46X,24HABSORPTION COEFFICIENTS,,1X,6H(1/CM)/52X,18HOPTICAL LINT 11
     1DEPTHS,AND/56X,11HINTENSITIES)                                    LINT 12
 3072 FORMAT(22X,16HPOS. CONTM INTS=  E9.2,1X,16HNEG. CONTM INTS=  E9.2,LINT 10
     11X,22HBOTH IN WATTS/CM2-STER,A3)
      ISO = ISDUM
      ISP = ISO + 1
      ISP2 = ISO + 2
      LDEX(1)=NICN(1)
      LDEX(3)=NICN(1)
```

```
      NLG1=FLG1+.00001
      NLG=FLG+.00001
      LLLL=1
      LLA=3
      LLB=7
      LLC=13
      IF(KR(8).NE.1) GO TO 53
      LLLL=2
      LLA=5
      LLB=8
   53 IF(NLG1.EQ.0) LLC=14
      LLL=11
      IF(KR(13).GE.3) LLL=9
      IF(KR(14).NE.2) ALF = 1.
C
      CC3 = 1.
C
      IF(KR(17).NE.0) GO TO 115
      DO 120 LL=1,NIC                                                   RADCL31
      IY=NICN(LL)                                                       RADCL31
  120 S(LL) = YY(IY)                                                    RADCL31
      WRITE(N,2010)                                                     RADCL31
      WRITE(N,2020) ( S(J),J=1,NIC)                                     RADCL31
      WRITE(N,2030 )  HEAD(LLA),HEAD(LLA+1),HEAD(LLB),HEAD(LLC)         RADCL31
  115 XK=NY                                                             RADCL31
      NYP = NY + 1
      NYM = NY-1
      DO 780 I=1,NYM
  780 DY(I) = (YY(I+1) - YY(I)) * C2
      DO 30 LL=1,NY
      XIP(LL) = 0.                                                      RADCL31
      XIM(LL) = 0.                                                      RADCL32
      FIPT(LL) = 0.                                                     RADCL32
      FIMT(LL) = 0.                                                     RADCL32
      FIIMT(LL) = 0.                                                    RADCL32
      FIIPT(LL) = 0.                                                    RADCL32
      TLCM(LL)=0.                                                       RADCL32
   30 TLCP(LL)=0.                                                       RADCL32
      NYP = NY+1
      ISM = ISO-1
      DO 3010 I=1,NY
      DO 3010 J=1,NYP
      AMT(I,J) = 0.
      KK = J-NYP
      DO 3010 JJ=1,ISM
      KK = KK + NYP
 3010 AFT(I,KK) = 0.
C     FAR WINGS OF HYDROGEN LINES
      IF(IZZ.NE.1) GO TO 3097
      K1=1
      K2=NXI
      CALL MULE2(V,-3,1)
 3097 CONTINUE
      ISPECS=1
      K2=0                                                              RADCL32
      C2COS = SQRT(6.28318*C2) /89.8053
C     *****************************************************************
C     *                                                               *
C     *                    LOOP ON LINE GROUPS                        *
C     *                                                               *
C     *****************************************************************
      DO 50 K=1,NHV                                                     RADCL32
      K1=K2+1                                                           RADCL32
      K2=K2+NU(K)                                                       RADCL33
```

```
      NSL = NU(K)                                                        RADCL33
      ISPEC=0
      IF(K.NE.IA(ISPECS)) GO TO 3100
      ISPEC=1
      ISPECS=ISPECS+1
 3100 CONTINUE
      CALL MU(FHV(K),FMU)
      IF(IZZ.NE.1) GO TO 3101
      IF(ISPEC.EQ.1) GO TO 3101
      CALL MULE2(FHV(K),3,1)
      DO 3102 I=1,NY
 3102 FMU(K)=FMU(K)+S1(I)
 3101 CONTINUE
      BEEW = 0.
      BEEOB = 0.
      XJW = 0.
      FIP(NY) = 0.
      IF(TW) 200,200,2108
 2108 T1 = TW * POP
      AQ =  FHV(K) / T1
      BEEW = 5040.* FHV(K)**3/(EXP(AQ)-1.)
      IF(NLG1.NE.0) BEEW = 3.1416*BEEW
      XJW = AHVL(K) * BEEW
  200 IF(TOB) 600,600,6108
 6108 T1 = TOB*8.62E-05
      AQ =  FHV(K) / T1
      BEEOB = 5040.*FHV(K)**3/(EXP(AQ)-1.)
      IF(NLG1.NE.0) BEEOB = 3.1416*BEEOB
  600 IF(KR(5).GT.5) FIP(NY) = BEEOB
      FIM(1) = AHVL(K)*BEEW
   40 DO 10 I=1,NY                                                       RADCL33
      DO 22 J=1,ISO
   22 AIGC(I,J) = AIG(I,J)
      T1=TEE(I)*POP
      FMU(I) = FMU(I) + 1.E-30
      BEE(I)=0.                                                          RADCL33
      AQ=FHV(K)/T1
      V = EXP(AQ)
      V1 = V - 1.
      BEE(I) = 5040.* FHV(K)**3/V1
      ATT(I,1) = BEE(I)/V1*V*AQ
      IF(NLG1) 16,10,16
   16 BEE(I)=3.1416*BEE(I)
      ATT(I,1) = 3.1416 * ATT(I,1)
   10 CONTINUE
      S(1) = 1.-AHVL(K) -TMSWL(K)
      S(2) = AHVL(K)
      S(3) = -1.
      XIMW = FIM(1)
      XIPOB = FIP(NY)
      CALL TRANS3(NY,DY,NIC,NICN,ALF,BEE,FMU,S,S1,S2,TAU,FIM,FIP)
      IF(KR(6).EQ.1)FIP(1)=TMSWL(K)*FIP(1)-BEE(1)*(1.-TMSWL(K))
      DO 300 I=1,NY
      XIM(I)=S(I)
      V = ATT(I,1)
      DO 300 J=1,ISP
      IDX = 8*(J-1) + 1
  300 ATT(I,J) = V * AIN(IDX,I)
      CALL MULE2(FHVS,1,1)
      IF(ISPEC.EQ.1) GO TO 60
      IF(KR(4)-3) 60,65,60
   60 CALL FREQ(K,NSHV,FHVS,CFIL)
      GO TO 7000
   65 CFIL = FHVP(K)-FHVM(K)
```

```
      V = 0.
      DO 1500 I=1,NSL
      S(I) = SQRT(SL(I,NI)/SL(1,NI)*GAM(I,NI)/GAM(1,NI))
 1500 V = V+S(I)
      SMD(1) = CFIL/V
      DO 1505 I=1,NSL
 1505 SMD(I) = SMD(1)*S(I)
      S8(1) = 1.
      S5(1) = FIM(1)+BEE(1)
      DO 1506 I=2,NY
      S5(I)=FIM(I)+BEE(I)
      S8(I)=S8(I-1)*XIM(I)
      S2(I-1)=FIP(I-1)+BEE(I-1)
      S6(I) = DY(I-1)/8064.98*BEE(I)
      V1 = BEE(I)/BEE(I-1)-1.
      IF(ABS(V1).GT. .01) GO TO 585
      S1(I)=BEE(I-1)*(1.+V1*(.5+V1/24.*(V1-2.)))
      GO TO 1506
  585 S1(I)=BEE(I-1)*V1/ALOG(V1+1.)
 1506 CONTINUE                                                                C
C                                                )I(8S,)1-I(2S,)I(1S )1994,6(ETIRW 6051
 7000 CONTINUE
      V1 = -CFIL*.8805*CC3/RFACT
      DO 6325 I=1,NY
      MPJ = 2
      DO 1470 J=1,NYM
      MPJ = MPJ+1
 1470 AMT(I,MPJ) = AMT(I,MPJ) + WIM(I,J)*V1*FL1
      MPJ = 0
      DO 6325 KK=1,IS0
      IF(KK.EQ.2) GO TO 6325
      MPJ = MPJ+1
      DO 6324 J=1,NY
      MPJ = MPJ+1
      V = BFT(I,J) * AIG(J,KK)+AT(I,J)*ATT(J,KK)
 6324 AFT(I,MPJ) = AFT(I,MPJ) + V*V1
 6325 CONTINUE
      IF(NLG-1) 61,308,61
C
C     OUTPUT LOGIC BLOCK FOR EXTENSIVE OUTPUT OPTION
C
  308 CONTINUE
      IY=NICN(1)
      YDELT=YY(IY)
      WRITE(N,1000) YDELT
      LC=0
  601 WRITE(N,1001) K
      LC=LC+1
      WRITE(N,1010) (YY(I),I=1,NY)
      LC=LC+2
      WRITE(N,1020) HEAD(LLL),HEAD(LLL+1),(FMU(I),I=1,NY)
      LC=LC+2
      IF(NLG1.EQ.0) GO TO 125
  604 IF(KR(8)) 4575,4575,4576
 4575 WRITE(N,1030) HEAD(1),(BEE(I),I=1,NY)
      GO TO 1022
 4576 DO 4574 I=1,NY
 4574 S2(I) =  BEE(I)/1.24 * FHV(K)*FHV(K)
      WRITE(N,1030) HEAD(2),(S2(I),I=1,NY)
      GO TO 1022
  125 IF(KR(8)) 4610,4610,1999
 4610 WRITE(N,1021) HEAD(1),(BEE(I),I=1,NY)
      GO TO 1022
 1999 DO 4810 I=1,NY
```

```
4010 S2(I) = BEE(I)/1.24   *FHV(K)*FHV(K)
     WRITE(N,1021) HEAD(2),(S2(I),I=1,NY)
1022 CONTINUE
     LC=LC+2
     LL=1
     IF(KR(8).EQ.1)LL=2
     IF(KR(8).EQ.2) GO TO 4719
     V3=FIP(IY)+BEE(IY)
     V2 = FIM(IY)+BEE(IY)
     IF(KR(8).EQ.1) GO TO 4771
     IF(NLG1.EQ.0) GO TO 3070
     GO TO 4718
4719 V3=FIP(IY)
     V2=FIM(IY)
     IF(NLG1.EQ.0) GO TO 3070
     GO TO 4718
4771 V1=1.24/FHV(K)
     V3=V3/V1*FHV(K)
     V2=V2/V1*FHV(K)
     IF(NLG1.EQ.0) GO TO 3070
4718 WRITE(N,1032)V3,V2,HEAD(LL)
     GO TO 4721
3070 WRITE(N,3072) V3,V2,HEAD(LL)
4721 CONTINUE
     LC=LC+1
     WRITE(N,1031)
     IF(NLG1.EQ.0 ) GO TO 3076
 605 WRITE(N,1040)     HEAD(LLL),HEAD(LLL+1) ,HEAD(LLA),HEAD(LLA+1)
     GO TO 3077
3076 WRITE(N,3040)
3077 CONTINUE
     LC=LC+6
  61 CONTINUE
C
C     *****************************************************************
C     *              LOOP ON LINES                                    *
C     *****************************************************************
C
     L=0
     DO 6500 JS = 1,NSL                                          RADCL34
     IDSL(JS) = JS                                               RADCL34
     IE = K1 - 1 + IDSL(JS)                                      RADCL34
     V4 = XNUL(IE)*.44025*CC3/RFACT
     IF(ISPEC.EQ.1) GO TO 80
     IF(KR(4)-3) 80,85,80
C
C     FINITE DIFFERENCE CALCULATION
C
  80 DUM = 0.
     LK=0
     NPPL=15
     IF(JS.EQ.1)NPPL=16
     IF(JS.EQ.NSL) NPPL=16
     IF(NSL.EQ.1) NPPL=17
6501 LK=LK+1
     L=L+1
     XJWL = XJW
     CALL MULE2(FHVS(L),2,JS)
     DO 501 I=1,NY                                               RADCL35
     DO  23 J=1,IS0
  23 AIG(I,J) = AIG(I,J)+AIGC(I,J)
 501 TMU(I)=S1(I) + FMU(I)                                       RADCL35
     S(1) = 1.-AHVL(K) -TMSWL(K)
     S(2) = AHVL(K)
```

```
      S(3) = -1.
      XIM(1) = XIMW
      XIP(NY) = XIPOB
      CALL  TRANS3(NY,DY,NIC,NICN,ALF,BEE,TMU,S,S1,S2,TAUT,XIM ,XIP )
      IF(KR(6).EQ.1)XIP(1)=TMSWL(K)*XIP(1)-BEE(1)*(1.-TMSWL(K))
      DO 302 LL=1,NY
      FIMT(LL)=FIMT(LL)+(XIM(LL)+XIMO(LL))    *DUM                     RADCL35
      FIPT(LL)=FIPT(LL)+(XIP(LL)+XIPO(LL))    *DUM                     RADCL35
  160 XIMO(LL)=XIM(LL)                                                 RADCL35
  302 XIPO(LL) = XIP(LL)                                               RADCL36
C
C     PRINT OUT PACKAGE FOR SUBGROUP FREQUENCIES
C
      IF(NLG.NE.1) GO TO 352
      LL=1
      IY=NICN(1)
      V1=FHVS(L)
      IF(KR(8).NE.1) GO TO 4475
      LL=2
      V1=1.24/FHVS(L)
 4475 IF(NY.GT.10) GO TO 6890
      WRITE(N,2045) V1,(TMU(I),I=1,NY)
      WRITE(N,2046)     (TAUT(I),I=1,NY)
      GO TO 6891
 6890 WRITE(N,1045) V1,(TMU(I),I=1,NY)
      WRITE(N,1046)     (TAUT(I),I=1,NY)
 6891 CONTINUE
      IF(KR(8).EQ.2) GO TO 4455
      V3 = XIP(IY) + BEE(IY)
      V2 = XIM(IY) + BEE(IY)
      IF(KR(8).EQ.1) GO TO 4450
      IF(NLG1.EQ.0) GO TO 606
      GO TO 613
 4455 V3=XIP(IY)
      V2 = XIM(IY)
      IF(NLG1.EQ.0) GO TO 606
      GO TO 613
 4450 V3=V3/V1*FHVS(L)
      V2 = V2/V1*FHVS(L)
      IF(NLG1.EQ.0) GO TO 606
  613 WRITE(N,1041) V3,V2,HEAD(LL)
      GO TO 608
  606 WRITE(N,1042) V3,V2,HEAD(LL)
  608 WRITE(N,1047)
      LC=LC+4
      IF(LC.LT.45) GO TO 352
      WRITE(N,3018)K
      LC=5
  352 CONTINUE
C
C
      IF(LK-1) 1326,1326,1327
 1326 V1 =(FHVS(L+1)-FHVS(L))*V4
      GO TO 1329
 1327 IF(LK-NPPL) 1328,1330,1330
 1330 V1 =(FHVS(L)-FHVS(L-1))*V4
      GO TO 1329
 1328 V1 =(FHVS(L+1)-FHVS(L-1))*V4
 1329 CONTINUE
      DO 2325 I=1,NY
      MPJ = 2
      DO 1475 J=1,NYM
      MPJ = MPJ + 1
 1475 AMT(I,MPJ) = AMT(I,MPJ) + WIM(I,J)*V1*FL1
```

```
      MPJ = 0
      DO 2325 KK=1,ISO
      IF(KK.EQ.2) GO TO 2325
      MPJ = MPJ+1
      DO 2324 J=1,NY
      MPJ = MPJ+1
      V = BFT(I,J)*AIG(J,KK)+AT(I,J)*ATT(J,KK)
 2324 AFT(I,MPJ) = AFT(I,MPJ) + V * V1
 2325 CONTINUE
      DUM=(FHVS(L+1) - FHVS(L))/2.
      IF(LK.LT.NPPL) GO TO 6501
      GO TO 70
C
C     EFFECTIVE WIDTH CALCULATION
C
C     CURTIS GODSON MODEL
   85 I=NY
      SMZ = SMD(JS)/XNOL(I.1)
C     S IS THE INTEGRAL OF THE LINE STRENGTH*WIDTH OVER SPACE
      S(1) = 0.
      S9(1) = 0.
      S7(1) = 0.
      V5 = 0.
      SL(JS,1) = SL(JS,1)+1.E-35
      V7 = GAM(JS,1)*SL(JS,1)/8064.98
      DO 610 J=2,NY
      SL(JS,J)=SL(JS,J)+1.E-35
      V=GAM(JS,J)*SL(JS,J)/8064.98
      V1 = V/V7-1.
      IF(ABS(V1).GT. .01) GO TO 576
      S(J) = S(J-1)+V7*DY(J-1)*(1.+V1*(.5+V1/24.*(V1-2.)))
      GO TO 612
  576 S(J)=S(J-1)+V7*DY(J-1)/ALOG(V/V7)*V1
  612 V7=V
      V2 = SL(JS,J)/SL(JS,J-1)
      V1 = V2-1.
      IF(ABS(V1).GT. .01) GO TO 526
      V5=V5+SL(JS,J-1)*DY(J-1)*(1.+V1*(.5+V1/24.*(V1-2.)))
      GO TO 615
  526 V5=V5+SL(JS,J-1)*DY(J-1)*V1/ALOG(V2)
  615 S9(J)=V5*S8(J) /8064.98
      S7(J) = 2.*SQRT(S(J))
  610 CONTINUE
      C2OD=C2/SMZ/8064.998
      C2CO = C2COS/SMZ
      V5 = 0.
      EX = 1.
      FIPT(NY) = -BEE(NY) *SMZ
      V2 = 0.
      V3 = 0.
C     POSITIVE FLUX
      DO 365 I1=2,NY
      V3 = 0.
      V5 = 0.
      DO 2365 J=I,NY
      V4=V5
      V5 = 2.*SQRT(S(J)-S(I-1))*S8(J)
 2365 V3=V3+(V5-V4)*S1(J)
      SLI=V3/SMZ/S8(I-1)
      V2 = V2+S1(I)*(S9(I)-S9(I-1))
      OTI=(V2+S9(I-1)*S2(I-1))/SMZ/S8(I-1)
  350 I=I-1
      X = .63662*(OTI/SLI)**2
      S3=OTI/BEE(NI)/X
```

```
      IF(X.GE. 4.0)GO TO 361
      IF(S3.GE.4.0/X) GO TO 361
      IF(X.LE. 0.05) GO TO 362
      IF(S3.GT. 1.0) GO TO 362
C     ISOLATED LINE
C              NOTE..XLANR IS LADENBURG-REICHE FUNCTION
      XLANR = X    /(1.+(1.57079* X    )**1.25)**.4
      V = S3*SMZ*XLANR
      GO TO 360
C     STRONG LINE ELSASSER BAND MODEL
  361 V4 = S3    *SQRT( X    /2.)
      V=ERF(V4)*SMZ
      GO TO 360
C     WEAK LINE MODEL (NOT LINEAR)--AFTER PLASS
  362 V=(1.-EXP(-S3*X))*SMZ
  360 TERM1=BEE(N1)*V
      TERM2=FIP(I)*SMZ
      FIPT(I)=TERM1+TERM2
 4991 FORMAT(5X,1P7E15.5)
  365 CONTINUE
  523 FORMAT(2X,2I3,1P7E12.4)
C                  )YN,SJ(MAG,)YN,SJ(LS,)YN(TPIF,)1(THIF,)1(LEB )885,6(ETIRW
      V9=1.-AMVL(K)-TMSAL(K)
      WALLW = 0.
      WALLF = 0.
      IF(ABS(FIP(1)).LT.1.E-33) GO TO 26
      WALLW=-TERM1/(X/(1.+X)*FIP(1))
      WALLW = AMIN1(WALLW,SMZ)
      WALLF = TERM1/WALLW
   26 V3 = 0.
      V5 = SQRT(GAM(JS,1)*SL(JS,1)    *YY(1))
      V7=0.
      V8=0.
      V14 = 1.
      V15 = 0.
      FIMT(1)=V9*(FIPT(1)+BEE(1)*SMZ)+SMZ*(AMVL(K)*BEEW-BEE(1))
 3949 FORMAT(10X,3I3,1P5E12.4)
C     NEGATIVE FLUX
      DO 375 II=2,NY
      V5=0.
      V1=0.
      JJ=II
      DO 2375 J=2,II
      V4=V5
      V5 = 2.*SQRT(S(II)-S(JJ-1))/S8(JJ-1)
      V1 = V1+S1(JJ)*(V5-V4)
C                          )1-JJ(8S,)1-JJ(S,)II(S,1V,5V,JJ,J,II )9493,6(ETIRW
 2375 JJ=JJ-1
      SLI = V1*S8(II)/SMZ
      SLI=S8(II)/SMZ*(V1-S5(1)*S7(II)+WALLF*(WALLW-AMIN1(WALLW,S7(II)))*
     1 V9)
      V4 = V14
      V14 = 1./S8(II)
      V8 = V8+S1(II)*(V14-V4)
      V4 = V15
      V7 = S9(II)*V14
      V15 = V7*V14
      V3 = V3+S1(II)*(V15-V4)
      OTI = S8(II)/SMZ*(V3-V7*V8)
      X = .63662*(OTI/SLI)**2
      V4 = WALLW * S8(II)
      OTI =OTI-(S5(1)*S9(II)-V9*WALLF*(V4-AMIN1(V4,S9(II))))/SMZ
            V2 = BEE(II)-V9*WALLF*S5(1)
            V5 = S8(II)/SMZ*WALLF*WALLW*V9
```

```
              V6 = BEE(II)-S5(1)
              V  = OTI*V5
              V10 = SLI-V5
      IF(S7(II) .GT. WALLW) GO TO 700
      IF(S9(II) .GT.    V4) GO TO 750
C
C     CASE 1
C
              X = .63662*(V /V10)**2
              S3 = V /(V2*S8(II)*X)
              GO TO 400
C
C     CASE 2
C
  750         X = .63662*(OTI/V10*V2/V6)**2
              S3 = OTI/(V6*S8(II)*X)
              GO TO 400
C
  700 IF(S9(II) .GT.    V4) GO TO 775
C
C     CASE 3
C
              X = .63662*(V /SLI*V6/V2)**2
              S3 = V /(V2*S8(II)*X)
              GO TO 400
C
C     CASE 4
C
  775         X = .63662*(OTI/SLI)**2
              S3 = OTI/(V2*S8(II)*X)
  400 CONTINUE
      IF(X.GE. 4.) GO TO 371
      IF(S3.GE. 4./X) GO TO 371
      IF(X.LE. 0.05) GO TO 372
      IF(S3.GT. 1.0) GO TO 372
C     ISOLATED LINE
      XLANR =    X      /(1.+(1.57079*   X      )**1.25)**.4
      V2= S3*SMZ*XLANR
      GO TO 370
C     STRONG LINE ELSASSER BAND MODEL
  371 V4 = S3      *SQRT(   X      /2.)
      V2 = SMZ*ERF(V4)
      GO TO 370
C     WEAK LINE MODEL (NOT LINEAR)--AFTER PLASS
  372 V2=(1.-EXP(-S3*X))*SMZ
  370 CONTINUE
 1370 TERM1 = V2*BEE(II)*S8(II)
      TERM2 = -S5(1)*V2*S8(II)
      TERM3 = FIM(II)*SMZ
      TERM4 = V9*WALLF*S8(II)*(WALLW-AMIN1(WALLW,V2))
      FIMT(II) = TERM1+TERM2+TERM3+TERM4
  375 CONTINUE
C
C     END OF EQUIVALENT WIDTH CALCULATION
C
   70 DO 500 LL=1,NY                                                  RADCL36
      FIIMT(LL) = FIIMT(LL) + XNOL(IE) * FIMT(LL)                     RADCL36
      FIIPT(LL) = FIIPT(LL) + XNOL(IE) * FIPT(LL)                     RADCL36
      FIMT(LL) = 0.                                                   RADCL36
  500 FIPT(LL) = 0.                                                   RADCL36
 6500 CONTINUE
C
      DO 303 LL=1,NY
      DIP(LL) = FIIPT(LL) - FIP(LL) * CFIL                            RADCL36
```

```
      DIM(LL) = FIIMT(LL) - FIM(LL) * CFIL                              RADCL37
      FIIPT(LL) = 0.                                                    RADCL37
      FIIMT(LL) = 0.                                                    RADCL37
      TLCP(LL)=TLCP(LL)+DIP(LL)                                         RADCL37
  303 TLCM(LL)=TLCM(LL)+DIM(LL)                                         RADCL37
      V1 = FHVP(K)-FHVM(K)-CFIL
      DO 250 I=1,NY
      IF(I.EQ.LDEX(1)) OUTL(K,1) = DIP(I)
      IF(I.EQ.LDEX(2)) OUTL(K,2) = DIP(I)
      IF(I.EQ.LDEX(3)) OUTL(K,3) = DIM(I)
  250 CONTINUE
      IF(NLG.EQ.1) GO TO 50
      IF(KR(17).EQ.2) GO TO 50
      I=MINO(NIC,10)
      DO 51 LL=1,NIC
      IY=NICN(LL)
      S(LL)=DIP(IY)
   51 S1(LL)=DIM(IY)
      WRITE(N,1090)K,FHV(K),(  S(LL),LL=1,I)
      IF(NIC.GT.10) WRITE(N,1091)(  S(LL),LL=11,NIC)
      WRITE(N,1094) ( S1(LL),LL=1,NIC)
      WRITE(N,1095)
   50 CONTINUE                                                          RADCL37
C
      IF(KR(17).EQ.2) RETURN
      IF(NLG.EQ.1) GO TO 7020
      DO 52 LL=1,NIC
      IY=NICN(LL)
      S(LL)=TLCP(IY)
   52 S1(LL)=TLCM(IY)
      WRITE(N,1092) (   S(LL),LL=1,NIC)
      WRITE(N,1093) (  S1(LL),LL=1,NIC)
      GO TO 7021
 7020 WRITE(N,1050)
      WRITE(N,1051)
      WRITE(N,1053)HEAD(LLB),HEAD(LLB),HEAD(15),HEAD(LLLL),HEAD(15),
     1 HEAD(15),HEAD(LLLL),HEAD(15),HEAD(LLC+3),HEAD(LLC+3),HEAD(LLC+3),
     2HEAD(LLC+3)
      V=0.
      V1=0.
      DO 7017 I=1,NHV
      IF(KR(8).NE.1) GO TO 7018
      V5=1.24/FHVP(I)
      V6=1.24/FHVM(I)
      GO TO 7019
 7018 V5=FHVM(I)
      V6=FHVP(I)
 7019 V3=OUTL(I,1)/(V6-V5)
      V4=OUTL(I,3)/(V6-V5)
      V=V+OUTL(I,1)
      V1=V1+OUTL(I,3)
 7017 WRITE(N,1052)I,V5,V6,V3,OUTL(I,1),V4,OUTL(I,3)
      WRITE(N,1054) V,V1
 7021 RETURN                                                            RADCL38
      END
```

```
      PROGRAM MAIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      COMMON/NONCOM/AM(123,123)
      COMMON/INTCOM/KR(20),KQ(10),KF(10),M,N
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25),            NXI,IA(9) RADINO
     1,N1,XMOL(200),GUP(200),EXPN(200) ,XR(20)
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(160),FF(200), RAD
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GFF(160),                    NAES,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHV(,NHV,NU(25),NY,PRES(20),TFF(20),WOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),TMSW(50),TMSWL(25),TW,TOB ,
     5NRAD,RFACT,POP
      COMMON/RADCOM/             TT(20),VMW(20),HH(20),SP(1,20,8)
     1                ,THETA,SV1,SP1,SR1,HS
      COMMON/EQPCOM/SPZ/(81),IS,SPZ2(70),F,SPZ3(480),T,SPZ4(248),VN(60)
     1                ,VNU(60,8),SPZ5(187),IUP2,FAMDA(60),FAMOB(60),IUP1
     2                ,NS,FSC6(3),KIN,KOUT,KKR(20),FSC7(68)
      COMMON/PRPCOM/PA(20),RHO(20),SC(20),CAPC(20),QR(20) ,XMUI(20)
     1    ,XLEHO(20)
      DIMENSION FR(123,1)
      EQUIVALENCE (FR(1),AM(43))
  224 FORMAT(A6)
  225 FORMAT(8E10.3)
  226 FORMAT(3I2)
  227 FORMAT(8E10.0)
  228 FORMAT(3I2,E14.6,3F10.3,10X,A6)
      KIN=5
      KOUT = 6
      M=5
      N=6
      C4=1.
      RFACT = 1.
      DO 5000 J=1,20
      VMW(J) = 20.
      TT(J) = 3000.
      DO 5000 I=1,30
 5000 FR(I,J) = .0333333333
      T= 3000.
      CALL RADIN
   77 CALL DADIN
      C2 = FL1*DELTA
      NOP=2
      CALL NODEN(NOP)
      CALL CONTN2
      DO 2 I=1,NY
      TLCM(I)=0.
    2 TLCP(I)=0.
      IF(KR(4).NE.2) CALL LINT2
C     EVALUATE NET FLUX (OR INTENSITIES) IN BTU/FT2-SEC (-STER)
      DO 1 I=1,NY
    1 QR(I)=.8805*(FIPI(I)-FIMI(I)+TLCP(I)-TLCM(I))
      IF(C4) 18,77,18
   18 CONTINUE
      STOP
      END
```

```
      SUBROUTINE MU(HV,XAPNU)
C
      INTEGER BETA,BETB
C
      COMMON/CONTM/NCRC(20),NSBN,Z(20),HVG(30),KS(20),IIS(16),NIL,
     1               HVT(30)       ,CSS(240),IIL(30),ISS(30)   ,IOBN(20),
     2               XION(30),BETA(30),BETB(30),NST1,NT,XIS(240),JIS(30),
     3               TTHRES(30),COEFA(30),COEFB(30),IZZ
C
      COMMON/EOPCOM/SPZZ(281),ISDUM,SPZ2(70),PDUM,SPZ3(480),TDUM,
     1 SPZ4(240),VN(60),VNU(60,8)
C
      COMMON/INTCOM/KR(20),KQ(10),KF (10),M,N
C
      COMMON/LINE/S6(896),XI(200),C3(200),S7(25)
C
      COMMON/NONCOM/AM(123,123)                                       RBL
C
      COMMON/PRPCOM/PR(20),RHO(20),SC(20),CAPC(20),QR(20)
C
      COMMON/RAD/ S1(81),EPS(160),S2(225),FHVC(50),SS30(304),
     2  GEE(160)                  ,NAES,S3(227),NIHVC,SS40(26)
     3                         ,NY,PRES(20),TEE(20),S4(25) ,XMOL,
     4 YDELT,YY(20),S5(92)
     5,NRAD,RFACT,POP
C
C
      DIMENSION                LE(8),XKT(1)
      DIMENSION IS(20)
      DIMENSION RM(3),RK(3),A(3),B(3),C(3)
      DIMENSION T( 1),XAPNU(1,1)
      DIMENSION CEP(8)
      DIMENSION XAPO(15)
C
C
      DIMENSION
     1          DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2          WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123,1) ,
     3          DLXQ(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4          SL(123,1) , BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5          TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6          XNN(123,1) , XQ(123,1)
C
      EQUIVALENCE
     1          (DSL(1),AM(1)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2          (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3          (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXQ(1),AM(5001)),
     4          (AFT(1),AM(5024)) , (ABE(1),AM(5270)) , (BFT(1),AM(7381)),
     5          (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
     6          (ATT(1),AM(8691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7          (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
```

```
     8          (XQ(1),AM(10004))
C
      EQUIVALENCE (KS(1),IS(1))
C
      DATA RM/,82,,82,,90/
      DATA RK/,75,2,3,6,/
      DATA A/-,147,-,120,-,117/
      DATA B/,2515,,600,1,170/
      DATA C/-,078,0,,0,/
      DATA EE/0,,1,,2,,4,,6,,8,,10,,20,/
      DATA CEP/0,,1,,2,,3,,4,,6,,8,,10,/
      ALOGT(Q)=ALOG10(Q)
C
      L=1
      RY = 13,595
      ISO = ISDUM
      ISP = ISO + 1
      ISP2 = ISO + 2
      DO 380 I=1,NY
  380 XAPNU(I,L) = 0,
      C1 = 6,292E-20
      JHV = 1
  350 HV3 = HV*HV*HV
      PI = 3,1416
      SQA=7,25E-16
      XLAM=1,24/HV
      XIN = 0,
      V = HV/,431
      IF(V,GT,84,) GO TO 3520
      V = EXP(V)
      XIN = (1,492E+05)*(1,-1,/V)/((XLAM**5)*(V-1,))
 3520 CONTINUE
      DNO=0,
      DN2P=0,
C
C     LOW FREQUENCY B-F AND F-F CONTRIBUTIONS FOR ATOMS AND IONS---
C     -------FROM BIBERMAN AND NORMAN
C
      IF(NSBN,EQ,0) GO TO 935
      IJ = 0
      DO 62 II=1,NSBN
      I2 = IOBN(II)
      Z2 = Z(I2)*Z(I2)
      EP = HV/Z2
      DO 777 K=2,8
      IF(EP-CEP(K)) 774,774,777
  777 CONTINUE
      XI(II) = XIS(IJ+K)
      GO TO 773
  774 XI(II)=XIS(IJ+K-1)+(XIS(IJ+K)-XIS(IJ+K-1))/(CEP(K)-CEP(K-1))
     1    *(EP-CEP(K-1))
  773 IJ=IJ+8
   62 CONTINUE
  935 CONTINUE
C
C     SET UP FOR CONTRIBUTIONS FROM INDIVIDUAL LEVELS
C
      IJ = 0
      IF(NIL,EQ,0) GO TO 835
      DO 35 IN=1,NIL
      V=HV-HVT(IN)
      IF(V) 9195,37,37
 9195 CS(IN) = 0,
      GO TO 73
```

```
   37 DO 77 K=2,8
      IF(V-EE(K)) 74,74,77
   77 CONTINUE
      CS(IN) = CSS(IJ+8) * 1.E-18
      GO TO 73
   74 CS(IN)=(CSS(IJ+K-1)+(CSS(IJ+K)-CSS(IJ+K-1))/(EE(K)-EE(K-1))
     1    *(V-EE(K-1)))    *1.E-18
   73 IJ = IJ + 8
   35 CONTINUE
  835 CONTINUE
C
C
C      START SPATIAL LOOP
C
C
      DO 38 I=1,NY
      DO 880 J=1,ISP2
  880 BRG(I,J) = 0.
      T(L) = TEE(I)
      XKT(L)=TEE(I)*POP
      T1 = XKT(L)
      XX=HV/XKT(L)
      V = EXP(-XX)
      EPC = 1.- V
      DLEPC = -V*XX/EPC
      DBN = 0.
      JK = 1
      IF(NSBN.EQ.0) GO TO 825
      DO 60 II=1,NSBN
      I2 = IOBN(II)
      ICH = JIS(I2)
      Z2 = Z(I2) * Z(I2)
      V = AMIN1(HV,HVG(II))
      V2 = 1.
      IF(T(L) .GE. TTHRES(II)) V2=COEFA(II)+COEFB(II)*T(L)
 7260 CONTINUE
      V5 = (V-XION(I2))/T1
      IF(I2.EQ.IS(JK) ) GO TO 700
      V4 = XNN(I2,I)*2.*XQ(I2-1,I)/XQ(I2,I) *TEE(I)/HV3*Z2*XI(II)*
     1    (EXP(V5)*C1) *V2
      BRG(I,1) = BRG(I,1) - V4*( V5 + DLXQ(I2,I) - DLXQ(I2-1,I) )
      GO TO 4004
  700 V4 = XNN(I2,I) * TEE(I)/HV3*Z2*XI(II)*(EXP(V5)*C1) *V2
      BRG(I,1) = BRG(I,1) - V4 * V5
      JK = JK + 1
 4004 DBN = DBN + V4
      IF(ICH.GT.ISO) GO TO 4001
C     BASE SPECIES CONTRIBUTION
      BRG(I,ICH+2) = BRG(I,ICH+2) + V4
      GO TO 60
C     NON BASE SPECIES
 4001 DO 4005 IAB = 1,ISO
 4005 BRG(I,IAB+2) = BRG(I,IAB+2) + V4*VNU(ICH,IAB)
      BRG(I,1) = BRG(I,1) + V4*TCN(ICH-ISO,I)
   60 CONTINUE
C
  825 CONTINUE
C     CONTRIBUTIONS FROM INDIVIDUAL LEVELS
C
      DIS = 0.
      IF(NIL.EQ.0) GO TO 845
      DO 440 IN=1,NIL
      JJ = IIL(IN)
      JJJ = ISS(IN)
```

```
      ICH = JIS(JJJ)
      V0 = -EPS(JJ)/XKT(L)
      V = CS(IN) * XNN(JJJ,I)
      V1 = GFL(JJ)/XQ(JJJ,I)
      V2 = EXP(V0)
      V3 = V*V1*V2
      DIS = DIS + V3
      BRG(I,1) = BRG(1,1) - V3*(1.+V0 + DLXQ(JJJ,I) )
      IF(ICH.GT.ISO) GO TO 4010
C     BASE SPECIES CONTRIBUTIONS
      BRG(I,ICH+2) = BRG(I,ICH+2) + V3
      GO TO 440
 4010 DO 4011 IAB = 1,ISO
 4011 BRG(I,IAB+2) = BRG(I,IAB+2) + V3*VNU(ICH,IAB)
      BRG(I,1) = BRG(I,1) + V3*TCN(ICH-ISO,I)
  440 CONTINUE
  845 CONTINUE
C
C     CONTRIBUTIONS FOR INDIVIDUAL MOLECULAR BAND SYSTEMS
C
C     NOTE MAX TEMPERATURE LIMIT FOR MOLECULAR CURVE FITS
      T(L) = AMIN1(T(L),15000.)
      XKT(L) = AMIN1(XKT(L),1.293)
      JI = NST1+1
      IF(IIS(1)) 3075,3075,7001
 7001 AN2P = XNN(JI,I)
      JI = JI + 1
C.....N2+ CONTRIBUTION FROM BIBERMAN AND MN.
  602 IF(HV-2.23) 3075,3074,3074
 3074 IF(HV-4.46) 3073,3073,3075
 3073 IF(HV-3.35) 3084,3084,3083
 3084 DN2P=(AN2P*1.E-18)*10.**(-11.576+6.77*HV-0.91*HV**2)
      GO TO 3075
 3083 DN2P=(AN2P*1.E-19)*10.**(-49.086+0.51623E-02*T(L)-0.23577E-06*T(L)
     1**2+HV*(30.616-0.30289E-02*T(L)+0.13644E-06*T(L)**2)+(HV**2)*(-4.5
     26684+0.43903E-03*T(L)-0.19543E-07*T(L)**2))
 3075 CONTINUE
      IF(IIS(2)) 2525,2525,7003
 7003 ANO = XNN(JI,I)
      JI = JI + 1
C.....NO ULTRAVIOLET CONTRIBUTION FROM BIBERMAN AND MNATSAKANYAN
  606 IF(HV-13.5) 2511,2511,2525
 2511 IF(HV-5.0) 2520,2520,2513
 2513 IF(HV-6.65)2514,2515,2515
 2514 DNO=(ANO*1.E-18)*10.0**(-4.2673+HV*0.68267)
      GO TO 2525
 2515 IF(HV-10.) 2517,2517,2516
 2517 DNO=ANO*1.9E-18
      GO TO 2525
 2516 DNO=(ANO*1.E-18)*(89.75-19.125*HV+1.033*HV**2)
      GO TO 2525
C.....NO VISIBLE CONTRIBUTION FROM BIBERMAN AND MNATSAKANYN
 2520 IF(HV-2.7) 2525,2521,2521
 2521 DNO=(ANO*1.E-18)*10.**(-3.4820-0.11509E-02*T(L)+0.15999E-06*T(L)**
     12+HV*(-2.3744+0.10952E-02*T(L)-0.10099E-06*T(L)**2)+(HV**2)*(0.575
     249-0.17249E-03*T(L)+0.13874E-07*T(L)**2))
 2525 CONTINUE
C     OXYGEN MOLECULAR CONTRIBUTION
   17 DO2=0.0
      IF(IIS(3)) 18,18,7005
 7005 AO2 = XNN(JI,I)
      JI = JI + 1
  613 IF(HV-3.) 18,1305,1305
 1305 IF(HV-7.) 1301,207,207
```

```
  207 IF(HV-9.2) 208,208,18
  208 DO2=AO2*400,0*SQRT(TANH(0,0975/XKT(L)))*EXP(-TANH(0,195/(2,0*
     1XKT(L)))*((HV-8,76)/0,805)**2)/2,687E+19
      GO TO 18
C,....SHUMAN-RUNGE BANDS FROM BIBERMAN AND MNATSAKYN
 1301 DO2=(AO2*1,E-18)*10,**(-23,413+0,40509E-02*T(L)-0,24545E-06*T(L)**
     12+HV*(6,2102-0,10559E-02*T(L)+0,65192E-07*T(L)**2)+(HV**2)*(-0,416
     253+0,71490E-04*T(L)-0.47115E-08*T(L)**2))
C      NITROGEN MOLECULAR CONTRIBUTION
   18 DN2=0.0
      IF(IIS(4)) 2010,2010,7007
 7007 AN2 = XNN(JI,I)
      JI = JI + 1
  614 IF(HV-6,5) 2550,209,209
  209 IF(HV-12,77)210,210,2010
  210 IF(HV-10,5)211,211,212
C,....N2 BIRGE HOPFIELD DATA FROM APPLETON AND STEINBERG FOR HV LARGER
C      THAN 10.5 EV - AND FROM ALLEN ET, AL, FOR HV LESS THAN 10,5 EV
  211 DN2=(AN2/2,52E+19)*EXP(2,3026*(-14,871-0,39586E-03*T(L)+0,86911E-0
     17*T(L)**2+HV*(-0.99225E-01+0.61168E-03*T(L)-0.41260E-07*T(L)**2)
     2+(HV**2)*(0,12305-0,48332E-04*T(L)+0,28353E-08*T(L)**2)))
      GO TO 2010
  212 DN2=(AN2/2.52E+19)*EXP(2,3026*(-39,306+0,71761E-02*T(L)-0,46157E-0
     16*T(L)**2+HV*(4,1032-0,76919E-03*T(L)+0.52442E-07*T(L)**2)+(HV**2)
     2*(-0,56701E-01+0.16228E-04*T(L)-0,12761E-08*T(L)**2)))
      GO TO 2010
C,....N2 LOW FREQUENCY BANDS (1+ AND 2+) FROM BIBERMAN AND MN,
 2550 IF(HV-4,5) 2551,2551,2010
 2551 IF(HV-0,75) 2010,2552,2552
 2552 DN2=8,E-20*AN2*10,**(-1,+2,78*HV-0,819*HV**2-2,696/XKT(L))+2,E-17
     1*AN2*10,**(-17,14+8,93*HV-1,132*HV**2-3,26/XKT(L))
C      CO CONTRIBUTION
C,....CO FITS CHECKED AGAINST WOODWARDS DATA JAN-68
 2010 DCO=0,0
      IF(IIS(5)) 118,118,7009
 7009 ACO = XNN(JI,I)
      JI = JI + 1
  615 IF(HV-4.27) 118,220,220
  220 IF(HV-10,6) 221,221,118
  221 IF(HV-7,75) 2000,2000,2001
 2000 XIG=1,492E+05*(1,-EXP(-HV/XKT(L)))/((XLAM**5)*(EXP(HV/XKT(L))-1,))
      ARG=-17,09+1,375E-03*T(L)-,051E-06*T(L)**2+XLAM*(-66,94+11,76E-03*
     1T(L)-0,767E-06*T(L)**2)
      DCO=ACO*EXP(2,30259*ARG)/XIG
      GO TO 118
 2001 DCO=ACO*EXP(-2,30259*(127,2-1436,*XLAM+4620,*(XLAM**2)))/XIN
C      HYDROGEN MOLECULAR CONTRIBUTION
C,....H2 LYMAN AND WERNER CONTRIBUTIONS FROM WEISNER
  118 DH2=0,0
      IF (IIS(6)) 2538,2538,7011
 7011 AH2=XNN(JI,I)
      ICH=JIS(JI)
      JI = JI + 1
  616 IF(HV-3,65) 2538,222,222
  222 IF(HV-25,)223,223,2538
  223 IF(HV-15,50) 1023,124,124
 1023 IF(HV-10,) 2530,2531,2531
 2531 IF (T(L),GE,3000,) GO TO 9125
      DH2=(AH2*1,E-18)*10.**(-120,73+0,17515E-01*T(L)-0,87076E-06*T(L)**
     12+HV*(17,526-0,24654E-02*T(L)+0,12097E-06*T(L)**2)+(HV**2)*(-0,625
     227+0,86154E-04*T(L)-0.41002E-08*T(L)**2))
      DDDLT=DH2*(T(L)*(0,17515E-01-1,74152E-06*T(L)+HV*(-0,24654E-02
     1      +0,24194E-06*T(L))+(HV**2)*(0,86154E-04-0,83604E-08*T(L)))
     2 *2,30259-1,0)
```

```
      GO TO 119
 9125 DH2=(AH2*1.E-19)*10.**(11.513+0.15839E-03*T(L)-0.11789E-06*T(L)**2
     1+HV*(-1.2534-0.13165E-05*T(L)+0.31267E-07*T(L)**2)+(HV**2)*(0.3294
     11E-01+0.89272E-05*T(L)-0.17775E-08*T(L)**2)) +DH2
      DDDLT=DH2*(T(L)*(0.15839E-03-0.23578E-06*T(L)+HV*(-0.13165E-03
     1 +0.62534E-07*T(L))+(HV**2)*(0.89272E-05-0.35550E-08*T(L)))
     2 *2.30259-1.0)
      GO TO 119
 2530 IF(HV-6.2) 2532,2533,2533
 2533 DH2=AH2*2.5E-18
      DDDLT=-DH2
      GO TO 119
 2532 IF(HV-5.3) 2534,2534,2535
 2535 DH2=(AH2*1.E-18)*10.0**(-207.78+0.55206E-01*T(L)-0.44098E-05*T(L)*
     1*2+HV*(66.917-0.17948E-01*T(L)+0.14473E-05*T(L)**2)+(HV**2)*(-5.37
     267+0.14587E-02*T(L)-0.11872E-06*T(L)**2))
      DDDLT=DH2*(T(L)*(0.55206E-01-0.88196E-05*T(L)+HV*(-0.17948E-01
     1 +0.28946E-05*T(L))+(HV**2)*(0.14587E-02-0.23744E-06*T(L)))
     2 *2.30259-1.0)
      GO TO 119
 2534 DH2=(AH2*1.E-18)*10.0**(-5.2820-0.27812E-02*T(L)+0.20715E-06*T(L)*
     1*2+HV*(-5.1687+0.24948E-02*T(L)-0.16031E-06*T(L)**2)+(HV**2)*(0.96
     2364-0.34072E-03*T(L)+0.21180E-07*T(L)**2))
      DDDLT=DH2*(T(L)*(-0.27812E-02+0.41430E-06*T(L)+HV*(0.24948E-02
     1 -0.32062E-06*T(L))+(HV**2)*(-0.34072E-03+0.42360E-07*T(L)))
     2*2.30259-1.0)
      GO TO 119
  124 DH2=AH2*10.0**(-17.19+0.062*(HV-16.0))
      DDDLT=-DH2
  119 BRG(I,1)=BRG(I,1)+DDDLT*XMOL
      IF (ICH.GT.ISO) GO TO 2536
      BRG(I,ICH+2)=BRG(I,ICH+2)+DH2*XMOL
      GO TO 2538
 2536 DO 2537 IAB=1,ISO
 2537 BRG(I,IAB+2)=BRG(I,IAB+2)+DH2*VNU(ICH,IAB)*XMOL
      BRG(I,1)=BRG(I,1)+DH2*TCN(ICH-ISO,I)*XMOL
 2538 CONTINUE
C     CARBON MOLECULAR CONTRIBUTION
      DC2=0.0
      IF (IIS(7)) 1303,1303,7013
 7013 AC2 = XNN(JI,I)
      ICH=JIS(JI)
      JI = JI + 1
  617 IF(HV-1.8) 1303,224,224
  224 IF(HV-6.0) 225,225,1303
C.....FREYMARK
  225 DC2=AC2*(                                    +10.0**(-25.41+1.96*HV
     1-0.096*HV**2))
      IF (HV-5.35) 125,126,126
C.....FOX-HERTZBERG
  125 DC2=DC2+AC2*10.0**(-27.04+4.245*HV-0.4804*HV**2)
      DDDLT=-DC2
      IF(HV-3.) 1300,120,120
C.....SWAN
 1300 DC2ST= +(1.E-14*AC2)*10.**(-51.144+0.59285E-02*T(L)-0.4322E-06*T(L
     1)**2+HV*(40.864-0.47230E-02*T(L)+0.35379E-06*T(L)**2)+(HV**2)*(-8.
     20892+0.95369E-03*T(L)-0.73682E-07*T(L)**2))
      DDDLT=DDDLT+DC2ST*(T(L)*(0.59285E-02-0.8644E-06*T(L)+HV*(-.47230E-
     102+0.70758E-06*T(L))+(HV**2)*(0.95369E-03-1.47364E-07*T(L)))
     2 *2.30259-1.0)
      DC2=DC2+DC2ST
      GO TO 120
C.....MULLIKAN
  126 DC2=DC2+AC2*10.**(-16.7+2.*(5.35-HV))
```

```
      DDDLT=-DC2
  120 BRG(I,1)=BRG(I,1)+DDDLT*XMOL
      IF (ICH.GT.ISO) GO TO 1310
      BRG(I,ICH+2)=BRG(I,ICH+2)+DC2*XMOL
      GO TO 1303
 1310 DO 1302 IAB=1,ISO
 1302 BRG(I,IAB+2)=BRG(I,IAB+2)+DC2*VNU(ICH,IAB)*XMOL
      BRG(I,1)=BRG(I,1)+DC2*TCN(ICH-ISO,1)*XMOL
 1303 CONTINUE
C     CN CONTRIBUTION
      DCN=0.0
      IF(IIS(8)) 7004,7004,7015
 7015 ACN = XNN(JI,1)
      JI = JI+1
  618 IF(HV-0.8) 121,226,226
  226 IF(HV-6.)  1227,1227,121
 1227 DCN=(ACN*1.E-19)*10.**(-1.3962+0.19982E-03*T(L)-0.10678E-07*T(L)**
     12+HV*(6.6871-0.10144E-02*T(L)+0.60781E-07*T(L)**2)+(HV**2)*(-2.909
     27+0.45612E-03*T(L)-0.26433E-07*T(L)**2))
      IF(HV-2.) 121,1228,1228
 1228 DCN=DCN+ACN*10.**(-41.46+13.76*HV-1.946*HV**2)
  121 DC=0.
 7004 CONTINUE
C     NEGATIVE ION CONTRIBUTIONS                                        MU   06
C.....C- CONTRIBUTION FROM SEMAN AND BRANSCOMB                           THIN
      XCM = 0.
      IF (IIS(9)) 6605,6605,3701
 3701 ACM= XNN(JI,I)
      ICH=JIS(JI)
      JI = JI+1
 6601 IF(HV-1.25) 6600,6602,6602                                         THIN
 6602 XCM = XCM + ACM * 1.4E-17
      BRG(I,1)=BRG(I,1)-XCM
      IF (ICH.GT.ISO) GO TO 6603
      BRG(I,ICH+2)=BRG(I,ICH+2)+XCM
      GO TO 6605
 6603 DO 6604 IAB=1,ISO
 6604 BRG(I,IAB+2)=BRG(I,IAB+2)+XCM*VNU(ICH,IAB)
      BRG(I,1)=BRG(I,1)+XCM*TCN(ICH-ISO,1)
 6605 CONTINUE
 6600 CONTINUE                                                           THIN
C.....H- CONTRIBUTION FROM CHANDRASEKHAR AND ELBERT                     MU   06
 3700 XHM = 0.
      IF (IIS(10)) 6506,6506,3703
 3703 AHM = XNN(JI,I)
      ICH=JIS(JI)
      JI = JI+1
  604 IF(HV-13.6) 2500,2500,2502                                        MU   06
 2500 IF(HV-0.75) 2502,2501,2501
 2501 IF(HV-1.3) 6500,6500,6501
 6500 XHM = (AHM*1.E-17)*(-4.51+7.15*HV)                                MU   07
      GO TO 6508
 6501 IF(HV-6.) 6502,6502,6503                                          MU   07
 6502 XHM = (AHM*1.E-17)*(6.765-1.7*HV+0.1258*HV**2.)                   MU   07
      GO TO 6508
 6503 XHM = (AHM*1.E-17)*(3.5-0.535*HV+0.0225*HV**2.)                   MU   07
 6508 CONTINUE
      BRG(I,1)=BRG(I,1)-XHM
      IF (ICH.GT.ISO) GO TO 6504
      BRG(I,ICH+2)=BRG(I,ICH+2)+XHM
      GO TO 6506
 6504 DO 6505 IAB=1,ISO
 6505 BRG(I,IAB+2)=BRG(I,IAB+2)+XHM*VNU(ICH,IAB)
      BRG(I,1)=BRG(I,1)+XHM*TCN(ICH-ISO,I)
```

```
 6506 CONTINUE
 2502 CONTINUE
C      C3 CONTRIBUTION
C
 3702 DC3 = 0.
      IF (IIS(11)) 6512,6512,3706
 3706 IF(HV-3.5) 3710,3710,3705
 3710 IF(HV-2.8) 3705,3711,3711
 3711 AC3 = XNN(JI,I)
      ICH=JIS(JI)
      JI = JI+1
 3712 CONTINUE
      DC3 = DC3 + AC3*3.E-17
      BRG(I,1)=BRG(I,1)-DC3
      IF (ICH.GT.ISO) GO TO 6510
      BRG(I,ICH+2)=BRG(I,ICH+2)+DC3*XMOL
      GO TO 6512
 6510 DO 6511 IAB=1,ISO
 6511 BRG(I,IAB+2)=BRG(I,IAB+2)+DC3*VNU(ICH,IAB)*XMOL
      BRG(I,1)=BRG(I,1)+DC3*TCN(ICH-ISO,I)*XMOL
 6512 CONTINUE
 3705 CONTINUE
C
C      SIO MOLECULAR CONTRIBUTION   X(SIGMA)-A(PI) TRANSITION  MBG12/72
C      MINUS 18.0 HAS BEEN ADDED TO THE COEFFICIENTS OF THE FIT TO LOG MU
C      TO CORRECT FOR THE NORMALIZATION AND DOES NOT APPEAR AS A SEPARATE
C      FACTOR IN DSIO
      DSIO=0.0
      IF(IIS(12))1799,1799,1701
 1701 ASIO=XNN(JI,I)
      ICH=JIS(JI)
      JI=JI+1
      TTM=T(L)
      IF(T(L).GT.8000.0) T(L)=8000.0
 1710 IF(HV-4.1)1799,1711,1711
 1711 IF(HV-6.2)1712,1712,1799
 1712 IF(HV-4.62)1720,1720,1713
 1713 IF(HV-4.85)1721,1721,1714
 1714 IF(HV-4.95)1722,1722,1715
 1715 IF(HV-5.70)1723,1723,1724
 1720 DSIO=ASIO*10.0**(-218.64478+0.048960962*T(L)-0.32952003E-05*T(L)**
     12+HV*(89.065844-0.022532897*T(L)+0.15528148E-05*T(L)**2)+
     2(HV**2)*(-9.9303105+0.26042766E-02*T(L)-0.18307631E-06*T(L)**2))
C      DDDLT IS THE DERIVATIVE OF DSIO WITH RESPECT TO NATURAL LOG OF T
      DDDLT=DSIO*(T(L)*(0.048960962-0.65904006E-05*T(L)+
     1HV*(-0.022532897+0.31056296E-05*T(L))+
     2(HV**2)*(0.26042766E-02-0.36615262 -06*T(L)))*2.302585093-1.0)
      GO TO 1750
 1721 DSIO=ASIO*10.0**(4011.5523-1.6253812*T(L)+0.14197259E-03*T(L)**2+
     1HV*(-1723.0218+0.69542522*T(L)-0.60703645E-04*T(L)**2)+
     2(HV**2)*(184.10876-0.074353818*T(L)+0.64864507E-05*T(L)**2))
      DDDLT=DSIO*(T(L)*(-1.6253812+0.28394518E-03*T(L)+
     1HV*(0.69542522-1.21407290E-04*T(L))+
     2(HV**2)*(-0.074353818+1.29729014E-05*T(L)))*2.302585093-1.0)
      GO TO 1750
 1722 DSIO=ASIO*10.0**(13711.552-5.2261407*T(L)+0.43743603E-03*T(L)**2+
     1HV*(-5560.8074+2.1160029*T(L)-0.17711999E-03*T(L)**2)+
     2(HV**2)*(563.03368-0.21417920*T(L)+0.17928935E-04*T(L)**2))
      DDDLT=DSIO*(T(L)*(-5.2261407+0.87487206E-03*T(L)+
     1HV*(2.1160029-0.35423998E-03*T(L))+
     2(HV**2)*(-0.21417920+0.35857870E-04*T(L)))*2.302585093-1.0)
      GO TO 1750
 1723 DSIO=ASIO*10.0**(63.966757-0.045491754*T(L)+0.38947047E-05*T(L)**2
     1+HV*(-33.362126+0.017452372*T(L)-0.14786126E-05*T(L)**2)+
```

```
    2(HV**2)*(3.3654929-0.16630653E-02*T(L)+0.13958678E-06*T(L)**2))
     DDDLT=DSIO*(T(L)*(-0.045491754+0.77894094E-05*T(L)+
    1HV*(0.017452372-0.29572252E-05*T(L))+
    2(HV**2)*(-0.16630653E-02+0.27917356E-06*T(L)))*2.302585093-1.0)
     GO TO 1750
1724 DSIO=ASIO*10.0**(-692.95285+0.15277203*T(L)-0.11407575E-04*T(L)**2
    1+HV*(230.38067-0.051035522*T(L)+0.37860043E-05*T(L)**2)+
    2(HV**2)*(-19.609401+0.42505144E-02*T(L)-0.31308440E-06*T(L)**2))
     DDDLT=DSIO*(T(L)*(0.15277203-0.22815150E-04*T(L)+
    1HV*(-0.051035522+0.75720086E-05*T(L))+
    2(HV**2)*(0.42505144E-02-0.62616880E-06*T(L)))*2.302585093-1.0)
C     DDDLT=-DSIO IF MU IS HELD CONSTANT WITH RESPECT TO TEMPERATURE
1750 IF(TTM.GT.8000.0) DDDLT=-DSIO
     BRG(I,1)=BRG(I,1)+DDDLT*XMOL
     IF(ICH.GT.ISO) GO TO 1770
     BRG(I,ICH+2)=BRG(I,ICH+2)+DSIO*XMOL
     GO TO 1799
1770 DO 1775 IAB=1,ISO
1775 BRG(I,IAB+2)=BRG(I,IAB+2)+DSIO*VNU(ICH,IAB)*XMOL
     BRG(I,1)=BRG(I,1)+DSIO*TCN(ICH-ISO,I)*XMOL
1799 CONTINUE
C.....O- CONTRIBUTION FROM CHURCHILL,ARMSTRONG AND MUELLER
     XOM=0.0
     IF(IIS(13))2510,2510,7017
7017 AOM=XNN(JI,I)
     ICH=JIS(JI)
     JI=JI+1
 605 IF(HV-11.) 2503,2503,2510
2503 IF(HV-1.5) 2510,2504,2504
2504 IF(HV-3.5) 2505,2506,2506
2505 XOM=AOM*6.2E-18
     GO TO 7025
2506 IF(HV-5.7) 2507,2507,2508
2507 XOM=AOM*1.E-18*(16.16-0.818*HV)
     GO TO 7025
2508 XOM=AOM*1.E-18*(15.58-0.453*HV)
C.....WITH NO TEMPERATURE DEPENDENCE, D(XOM)/DLNT=-XOM
7025 BRG(I,1)=BRG(I,1)-XOM
     IF (ICH.GT.ISO) GO TO 7019
     BRG(I,ICH+2)=BRG(I,ICH+2)+XOM
     GO TO 2510
7019 DO 7021 IAB=1,ISO
7021 BRG(I,IAB+2)=BRG(I,IAB+2)+XOM*VNU(ICH,IAB)
     BRG(I,1)=BRG(I,1)+XOM*TCN(ICH-ISO,I)
2510 CONTINUE
     IF(KR(1).EQ.3) GO TO 360
     XAPNU(I,L)=EPC*(DBN + DIS + XCM + XHM + XOM
    1     +XMOL*(DCO+DH2+DC2+DCN+DO2+DN2+DNO+DN2P+DC3+DSIO))
     DO 7020 JIJ=1,ISP2
7020 BRG(I,JIJ) = EPC*BRG(I,JIJ)
     BRG(I,1) = BRG(I,1) + DLEPC*XAPNU(I,L)
     IF(KR(13).EQ.3) XAPNU(I,L) = XAPNU(I,L) / RHO(I)
     GO TO 38
 360 V = 0.
     IF(XX.LT.85.) V = 5040.*HV3/(EXP(XX)-1.)
     V = V/EPC*XX/TEE(I)
     V1 = V/(  EPC * (DBN + DIS + XCM + XHM + XOM
    1     +XMOL*(DCO+DH2+DC2+DCN+DO2+DN2+DNO+DN2P+DC3+DSIO))
     IF(JHV.EQ.1) GOTO  323
     XAPNU(I,L) = XAPNU(I,L) + .5*HVD*(V1+XAPO(I))
 323 XAPO(I) = V1
  38 CONTINUE
     IF(KR(1)-3) 355,341,355
 341 IF(JHV-NIHVC) 346,347,347
```

```
  346 JHV = JHV + 1
      HVD = FHVC(JHV)-FHVC(JHV-1)
      HV = FHVC(JHV)
      GO TO 350
  347 DO 382 I=1,NY
      V = TEE(I)*TEE(I)* TEE(I)
      V = V * 7.2189E-12
  382 XAPNU(I,L) = XAPNU(I,L)/V
  355 CONTINUE
      DO 4500 I=1,NY
      AIG(I,1) = 0.
      AIG(I,2) = 0.
      DO 4600 JJ=1,ISP2
      AIG(I,1) = AIG(I,1) + BRG(I,JJ) * AIN(JJ,I)
      AIG(I,2) = AIG(I,2) + BRG(I,JJ) * AIN(JJ+8,I)
 4600 CONTINUE
      DO 4700 II=3,ISP
      AIG(I,II) = 0.
      DO 4650 JJ=1,ISP2
      IDX = 8*(II-1) +JJ
      AIG(I,II) = AIG(I,II) + BRG(I,JJ) * AIN(IDX,I)
 4650 CONTINUE
 4700 CONTINUE
 4500 CONTINUE
      IF(KR(13).NE.3) GO TO 4660
      DO 4655 I=1,NY
      DO 4655 J=1,ISP2
      IDX1 = 8*(J-1) + 2
      IDX2 = 8*(J-1) + 1
      AIG(I,J) = AIG(I,J)/RHO(I) - XAPNU(I,L)*(AIN(IDX1,I)-AIN(IDX2,I) )
 4655 CONTINUE
 4660 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE MULE2(FHVS,IDX,JS)
      INTEGER AFTA,FAMOA
C
C
      COMMON/CONTH/NCRC(20),NSRN,Z(20),HVG(30),KA(20),IIS(16),NIL,
     1             HVT(30),CSS(240),IIL(30),ISS(30),IOHN(20),
     1             XION(30),AETA(30),BETB(30),NST1,NT,XIS(240),JIS(30),
     3             THRES(30),COEFA(30),COEFB(30),IZZ
C
      COMMON/EQPCOM/SPZZ(281),I9,SPZ2(71)  ,SPZ3(481)  ,SPZ4(308),
     1              VNU(60,8),SPZ5(187),I9P2,FAMOA(60),FAMOB(60),I9P,
     2             NICK
C
      COMMON/EQTCOM/SPZ7(6),AA,SPZ8(37),A(14,14),SPZ9(357),TC(60)
C
      COMMON/INTCOM/KR(20),KO(10),KV(10),M,N
C
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25),          NXI,IA(9) RADINO
     1,NI,XNOL(200),GUP(200),FXPN(200),XR(20) ,KGP,INDSHL(12)
     2,S(200),S1(20 ),S2(25)
C
      COMMON/NONCOM/AM(123,123)
C
      COMMON/PRPCOM/PR(20),RHO(20),SC(20),CAPC(20),GR(20)
C
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(160),FF(200), RAD
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GCE(160),               NAES,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHVC,NHV,NU(25),NY,PRES(20),TFE(20),WOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),THSW(50),THSWL(25),TW,TOB
     5,NRAD,PFACT,F
C
      DIMENSION ALFA(8),BETA(8),DEL(8),XI(8),SLA(8),SLB(8),SHA(8),SHB(8)MULE 01
     1,SLAS(8),SLBS(8),SHAS(8),SHBS(8)
      DIMENSION SORTEG(2 )
      DIMENSION GEG(7),FFF(7)
      DIMENSION DR(20,2),DW(20,2)
      DIMENSION NHYDR(1)
      DIMENSIONNF(20),   W(20),            R(20),V1(20)
      DIMENSION FOINV(20),F2(20)
C
      DIMENSION
     1         DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2         WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123,1) ,
     3         DLXO(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4         SL(123,1) , BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5         TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6         XNN(123,1) , XQ(123,1)
C
      EQUIVALENCE
     1         (DSL(1),AM(1)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2         (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3         (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXO(1),AM(5001)),
     4         (AFT(1),AM(5024)) , (ABE(1),AM(5270)) , (BFT(1),AM(7381)),
     5         (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
     6         (ATT(1),AM(8691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7         (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
     8         (XQ(1),AM(10004))
C
C
      DATA(ALPH(J),J=1,8)/0.,1.E-4,2.E-4,4.E-4,8.E-4,1.2E-3,1.6E-3,2.8E-MULE 01
     13/                                                               MULE 01
      DATA(BETA(J),J=1,8)/0.,5.E-4,1.E-3,2.E-3,3.E-3,5.E-3,7.E-3,1.E-2/ MULE 01
```

```
                                                                    MULE 01
      DATA(DEL(J),J=1,8)/0.,.02,.04,.08,.12,.16,.2,.24/             MULE 02
      DATA(XI(J),J=1,8)/0.,.025,.05,.1,.15,.2,.25,.3/               MULE 02
      DATA(SLA(J),J=1,8)/3.362,3.114,2.748,2.301,2.000,1.778,1.580,1.146MULE 02
     1/                                                             MULE 02
      DATA(SLB(J),J=1,8)/1.886,2.187,2.248,2.000,1.716,1.228,0.903,0.491MULE 02
     1/                                                             MULE 02
      DATA(SHA(J),J=1,8)/1.231,.806,.512,.079,-.244,-.522,-.732,-.921/ MULE 02
      DATA(SHB(J),J=1,8)/.492,.7,.623,.267,-.06,-.337,-.537,-.721/  MULE 02
      DATA(SLAS(J),J=1,8)/-1.890E+03,-3.692E+03,-3.337E+03,-1.404E+03, MULE 02
     1-4.141E+02,-5.086E+02,-4.633E+02,-2.616E+02/                  MULE 02
      DATA(SLBS(J),J=1,8)/2.419E+02,3.036E+02,-8.766E+01,-3.309E+02, MULE 03
     1-2.820E+02,-1.990E+02,-1.570E+02,-1.222E+02/                  MULE 03
      DATA(SHAS(J),J=1,8)/-.245E+2,-.169E+2,-.126E+2,-.894E+1,-.738E+1,-MULE 03
     1.602E+1,-.469E+1,-.446E+1/                                    MULE 03
      DATA(SHBS(J),J=1,8)/.140E+2,.443E+00,-.626E+1,-.762E+1,-.615E+1,-.MULE 03
     1468E+1,-.353E+1,-.352E+1/                                     MULE 03
C     DATA (XR(J),J=1,7)/23.2518E-24,26.5584E-24,19.9370E-24,1.67338E-24MULE 03
C    1,23.2518E-24,26.5584E-24,19.9370E-24/                         MULE 03
      DATA NHYDR/4HH   /
  129 FORMAT(//,16H  BAD MULE CALL //)
  277 FORMAT(//,68H THERE ARE TOO MANY SPECIAL HYDROGEN LINES IN ONE OF
     1THE LINE GROUPS,//)
  278 FORMAT(//,5X,56HTHE IA INDEX INDICATES A SPECIAL HYDROGEN LINE IN
     1GROUP ,I3,15H,NONE WAS FOUND//)
C
C     CYCLE TIME THROUGH FIRST ENTRY = .0476 SEC FOR NY=15 AND NO H LINES
C     CYCLE TIME THROUGH SECOND ENTRY = .00634 FORNY=15 AND NO H LINES OR
C     DOPPLER EFFECT
C     IN BOTH CASES 10 LINES WERE ASSUMED IN THE LINE GROUP
C
      M=5
      KIN=5
      KOUT=6
      ISO = 19
      ISP = ISO + 1
      ISP2 = ISO + 2
      ISX=1
      ISXP=2                                                        MULE 04
C     START LOOP ON INDIVIDUAL LINES
      IF(IDX-1) 126,127,126
  126 IF(IDX.EQ.-3) GO TO 127
      KS=K1+JS-1
      KF=KS
      JJ=JS-1
      GO TO 5479
C
C     ENTRY AT THIS POINT CALCULATES LINE STRENGTHS AND PORTIONS OF THE
C     INFLUENCE COEFFICIENTS WHICH ARE NOT FUNCTIONS OF FREQUENCY
C
  127 JJ = 0
      KS=K1
      KF=K2
 5479 CONTINUE
      DO 4420 I=1,112
      DO 4420 J=1,20
      DSL(I,J) = 0.
 4420 DWD (I,J) = 0.
       ISPL = 0
      IF(IZZ.EQ. ) GO TO 2960
      IF(NXI) 2960,2960,2961
 2961 DO 2962 I=1,NXI
      KGPT = IA(I)-1
      IF(KGP-KGPT) 2962,2963,2962
 2962 CONTINUE
```

```
      GO TO 2960
 2963 ISPL = 1
      KF = KF+1
 2960 CONTINUE
C
C
      DO 250 JDUM=KS,KF
      J=JDUM
      IF(J-KF) 2965,2964,2965
 2964 IF(ISPL-1) 2965,2966,2965
 2966 IEND=KF+ND(KGPT+1)-1
      DO 2967 JV=KF,IEND
      ILK = (ND(JV)+7)/8
      IF(ALTA(ILK),NE, NHYDR(1) ,OR, EXPN(JV) ,GE, 0,1) GO TO 2967
      J = JV
      JHOLD = JV
      GO TO 2965
 2967 CONTINUE
      WRITE(N,278) KGPT
      STOP
 2965 CONTINUE
      JJ = JJ + 1
      IF(IDX,EQ,-3) J=INDSHL(JJ)
      DO 3840 I=1,NY
      DO 3840 JV=1,ISP2
 3840 BRG(I,JV) = 0,
      NF(JJ) = 0
C                                                                       MULE 08
C     STATEMENT 6 COMPLETES THE INDEXING OPERATION,  CALCULATE THE      MULE 08
C     LEVEL POPULATIONS,                                                MULE 08
C                                                                       MULE 08
   10 ILK = (ND(J)+7)/8
      IK = ND(J)
      ICH = JIS(ILK)
      IF(ILK) 666,666,667
  666 WRITE(N,766)
  766 FORMAT(//2X,10HMULE2 STOP//)
      STOP
  667 DO 50 I=1,NY
      T2=TEE(I)*1,38047E-16                                             MULE 04
      T1=TEE(I)*POP
      T3 = TEE(I)/10000,                                                MULE 04
      XP = XNN(ILK,I)*EXP(-EPS(IK)/T1)/XQ(ILK,I)*GEE(IK)
      S2(I) = XP
C                                                                       MULE 08
C     CALCULATE LINE STRENGTHS USING INPUTTED F-VALUES                  MULE 08
C                                                                       MULE 09
      V0 = -HVL(J)/T1
      V = EXP(V0)
      V3 = 1,-V
   14 SL(JJ,I) = 3,1416*2,8183E-13*FF(J)*XP*V3
      BRG(I,1)=BRG(I,1)-SL(JJ,I)*(1,+DLXQ(ILK,I)-EPS( IK)/T1-V/V3*V0)
      IF(ICH,GT,ISO) GO TO 4010
      BRG(I,ICH+2) = SL(JJ,I)
      GO TO 440
 4010 DO 4011 IAB = 1,ISO
 4011 BRG(I,IAB+2)=BRG(I,IAB+2)+SL(JJ,I)*VNU(ICH,IAB)
      BRG(I,1) = BRG(I,1)+SL(JJ,I)*TCN(ICH-ISO,I)
  440 CONTINUE
      IF(KR(13),EQ,3)SL(JJ,I)=SL(JJ,I)/RHO(I)
C
C     CREATE THE INFLUENCE COEFFICIENTS FOR LINE STRENGTH WRT PRIMARY VARIABLES
C
      DO 4600 JVV=1,ISP
```

```
      JLV=JVV+(JJ-1)*7
      ISTART=8*(JVV-1)+1
      IEND=ISTART+ISP
      JAV=0
      DO 4600 JV=ISTART,IEND
      JAV=JAV+1
      DSL(JLV,I)=DSL(JLV,I)+BRG(I,JAV)*AIN(JV,I)
 4600 CONTINUE
      S1(I) = SL(JJ,I)
C
C     SPECIAL TREATMENT FOR HYDROGEN LINES --LINE WIDTHS
C     GO TO 21 IF HYDROGEN LINE
C
      IF (AETA(ILK).NE.NHYDR(1)) GO TO 20
   21 CONTINUE
C
C     HYDROGEN LINES ARE DIVIDED INTO TWO GROUPS, THE FOUR SPECIAL LINES
C     LYMAN ALPHA AND BETA AND BALMER ALPHA AND BETA ARE CALLLED SPECIAL LINES
C     ALL OTHER HYDROGEN LINES ARE CONSIDERED COMMON LINES
C
      V1(I) = XNN(NT,I)**.6666667
      F0=V1(I)*1.2528E-9
      SQRTF0(I)=SQRT(F0)
      F0INV(I)=1.0/F0
      V1(I)=9.696E+12/V1(I)
      E10 = .4342944823
      IF (EXPN(J).LT.0.1) GO TO 32
C
CC    BEGIN COMMON LINE LINE WIDTH LOGIC
C
      SQNU=EXPN(J)
      SQNUNL=GAMP(J)
      TA=5.79E+21*XNN(NT,I)*SQNUNL/SQRT(TEE(I))
      V11= SQNU/(16.E+12)*SQNU/TEE(I)*XNN(NT,I)/TEE(I)                  C
      V2 = V11*V11
      V3 = V11*V2
      V4 = V2*V2
      V5 = V2*V3
      IF(V11-1.) 80,82,82
   80 A0 = -.57721566
      A1 = .99999193
      A2=-.24991055
      A3 = .05519968
      A4 = -.00976004
      A5 = .00107857
      E1 = -ALOG(V11)+A0+A1*V11+A2*V2+A3*V3+A4*V4+A5*V5
      DE1DX=-1./V11+A1+2.*A2*V11+3.*A3*V2+4.*A4*V3+5.*A5*V4
      GO TO 85
   82 A1 = 2.334733
      A2 = .250621
      A3 = 3.330657
      A4 = 1.681534
      V6 = EXP(-V11)/V11
      V7 = V2+A1*V11 + A2
      V8 = V2 + A3 * V11 + A4
      E1 = V6 * V7 / V8
      DE1DX = -E1*(1.+1./V11)+V6*(2.*V11+A1-V7*(2.*V11+A3)/V8)/V8
   85 TB=E1/4.60518
      GAM(JJ,I)=TA*TB
      BRG(I,1) = -GAM(JJ,I)*(1.5+3./E1*DE1DX*V11)
      BRG(I,ISP2) = GAM(JJ,I)*(1.+V11/E1*DE1DX)
      GO TO 33
   32 CONTINUE
C
```

```
C     BEGIN SPECIAL HYDROGEN LINE LOGIC
C
      TSQ=TEE(I)*TEE(I)
      X10=ALOG10(XNN(NT,I))
      NID = 1000. * (HVL(J) + 0.0001)
C
C     LYMAN ALPHA
C
      IF(NID-10196) 23,22,23                                          MULE 09
   22 NF(JJ) = 1
      CALL GF (ALPH,SLA,SLAS,GLG,EFF)
      TA=7.692-5.126E-4*TEE(I)+1.345E-8*TSQ
      TB=-0.4127+2.907E-5*TEE(I)-7.65E-10*TSQ
      R(I)=TA+X10*TB
      TD=TB*E10
      DR(I,1)=TA-7.692+X10*(TB+0.4127)-TD
      DR(I,2)=TD
      CB=3.4E-6
      GO TO 50
C
C     LYMAN BETA
C
   23 IF(NID-12084) 31,30,31                                          MULE 10
   30 NF(JJ) = 2
      CALL GF (BETA,SLB,SLBS,GFG,EFF)
      TA=12.95-8.07E-4*TEE(I)+2.06E-8*TSQ
      TB=-0.7175+4.7675E-5*TEE(I)-1.23E-9*TSQ
      W(I)=TA+X10*TB
      TD=TB*E10
      DW(I,1)=TA-12.95+X10*(TB+0.7175)-TD
      DW(I,2)=TD
      CB=1.78E-5
      GO TO 50
C
C     BALMER ALPHA
C
   31 IF(NID-1888) 47,46,47                                           MULE 1
   46 NF(JJ) = 3
      CALL GF (DEL ,SHA,SHAS,GLG,EFF)
      TA=1.5702*(20000./TEE(I))**0.52
      TB=0.1183*(10000./TEE(I))**0.578
      R(I)=TA-X10*TB
      DR(I,1)=-0.52*TA+TB*(0.578*X10+E10)
      DR(I,2)=-TB*E10
      CB=1.3E-3
      GO TO 50
C
C     BALMER BETA
C
   47 IF(NID-2549) 49,48,49                                           MULE 13
   48 NF(JJ) = 4
      CALL GF (XI  ,SHB,SHBS,GEG,EFF)
      TA=2.17*(10000./TEE(I))**0.339
      TB=0.115*(10000./TEE(I))**0.333
      W(I)=TA-X10*TB
      DW(I,1)=-0.339*TA+TB*(0.333*X10+E10)
      DW(I,2)=-TB*E10
      CB=3.37E-3
      GO TO 50
   49 CONTINUE
   20 CONTINUE                                                        MULE 14
C
C     GAMMA  (LINE WIDTH) CALCULATION FOR ALL NON HYDROGEN LINES
C
```

```
      DO 4601 JV=1,ISP2
 4601 BRG(I,JV) = 0.
      GAM(JJ,I)=GAMP(J)*XNN(NT,I)*T3**EXPN(J)
      S(I)=GAM(JJ,I)
      BRG(I,1)=BRG(I,1)+S(I)*(-1.+EXPN(J))
      BRG(I,ISP2)=S(I)
   33 NF(JJ)=0
C
C     LINE WIDTH INFLUENCE COEFFICIENTS FOR ALL LINES EXCEPT SPECIAL HYDROGEN
C     DWD ARRAY IS WRT    PRIMARY VARIABLES
C
      DO 9600 JVV=1,ISP
      JLV=JVV+(JJ-1)*7
      ISTART=8*(JVV-1)+1
      IEND=ISTART+ISP
      JAV=1
      DO 9600 JV=ISTART,IEND,ISP
      DWD(JLV,I)=DWD(JLV,I)+BRG(I,JAV)*AIN(JV,I)
      JAV=JAV+ISP
 9600 CONTINUE
      IF(GUP(J).LT.1) GO TO 200                                        MULE100
      A1R = 0.175*GEE( IK)*FF(J)/HVL(J)*SQRT(GEE( IK)/GUP(J))            MULE1
      GAM(JJ,I) = GAM(JJ,I) + XP*A1R/2.687E+19
       S(I) = GAM(JJ,I)
  200 WD(JJ,I)=HVL(J)*SQRT(2.*0.69315*T2/XR(ILK))/2.99776E+10
   50 CONTINUE
      IF(KR(13).NE.3) GO TO 4660
      DO 4655  I=1,NY
      JAV=7*(JJ-1)
      DO 4655 JV=1,ISP
      IDX1=8*(JV-1)+2
      IDX2=IDX1-1
      JAV=JAV+1
      DSL(JAV,I)=DSL(JAV,I)/RHO(I)+SL(JJ,I)*(AIN(IDX2,I)-AIN(IDX1,I))
 4655 CONTINUE
 4660 CONTINUE
  250 CONTINUE
      RETURN
  128 CONTINUE
C
C     THE FOLLOWING BLOCK CALCULATES THE ABSOPRTION COEFFICIENTS AND ITS
C     DERIVATIVES WRT THE PRIMARY VARIABLES BY ADDING THE FREQUENCY DEPENDENCE
C     TERMS TO THE LINE STRENGTH AND INFLUENCE COEFFICIENT TERMS CALCULATED IN
C     THE FIRST CALL OF MULE2
C
      DO 3079  K80=1,ISP
      DO 3079 I=1,NY
 3079 AIG(I,K80) = 0.
      FHVS2=FHVS*FHVS
      FHVSIN=1.0/FHVS
      V7=1.537/FHVS2
      DO 350 I=1,NY
      F2(I)=V7*FOINV(I)
  350 S1(I)=0.0
      JJ=0
C
C     LOOP ON THE INDIVIDUAL LINES
C
      DO 550 JDUM=KS,KF
      J= JDUM
      IF(ISPL)195,195,196
  196 IF(J-KF)195,197,195
  197 J=JHOLD
  195 CONTINUE
```

```
      JJ = JJ + 1
      IF(IDX,EQ.3) J=INDSHL(JJ)
      JJ7=(JJ-1)*7
      V2 = (FHVS - HVL(J))**2
      PWDH = ABS(FHVSIN-1.0/HVL(J))
      ASSIGN 351 TO JMP
      NHLINE=NF(JJ)
      IF (NHLINE.EQ,0) ASSIGN 65 TO JMP
C
C     LOOP ON SPACE
C
      DO 550 I=1,NY
      SLJJ1=SL(JJ,I)
      GO TO JMP,(65,351)
C
C     SPECIAL HYDROGEN LINES
C     CORE REGION
C
  351 WDH = V1(I) * PWDH
      GO TO (130,132,134,136),NHLINE
C
C    LYMAN ALPHA
C
  130 IF (WDH-0.0028) 140,141,141
  140 VEE=WDH-ALPH(ISX)
  154 IF (VEE) 150,151,151
  151 IF (WDH-ALPH(ISXP)) 152,152,153
  150 ISXP=ISX
      ISX=ISX-1
      GO TO 140
  153 ISX=ISXP
      ISXP=ISXP+1
      GO TO 140
  152 ACH=(EFF(ISX)*(WDH-ALPH(ISXP))+GEG(ISX))*VEE
      V3=ACH+SLAS(ISX)
      DSDA=(ACH+V3+EFF(ISX)*VEE*VEE)
      B=V3*VEE+SLA(ISX)
      GO TO 147
C
C    LYMAN BETA
C
  132 IF (WDH-0,01) 142,191,191
  142 VEE=WDH-BETA(ISX)
  164 IF (VEE) 160,161,161
  161 IF (WDH-BETA(ISXP)) 162,162,163
  160 ISXP=ISX
      ISX=ISX-1
      GO TO 142
  163 ISX=ISXP
      ISXP=ISXP+1
      GO TO 142
  162 ACH=(EFF(ISX)*(WDH-BETA(ISXP))+GLG(ISX))*VEE
      V3=ACH+SLBS(ISX)
      DSDA=(ACH+V3+EFF(ISX)*VEE*VEE)
      B=V3*VEE+SLB(ISX)
      GO TO 147
C
C    BALMER ALPHA
C
  134 IF (WDH-0,24) 144,141,141
  144 VEE=WDH-DEL (ISX)
  174 IF (VEE) 170,171,171
  171 IF (WDH- DEL(ISXP)) 172,172,173
  170 ISXP=ISX
```

```
      ISX=ISX-1
      GO TO 144
  173 ISX=ISXP
      ISXP=ISXP+1
      GO TO 144
  172 ACH=(EFF(ISX)*(WDH- GEL(ISXP))+GEG(ISX))*VEE
      V3=ACH+SHAS(ISX)
      DSDA=(ACH+V3+EFF(ISX)*VEE*VEE)
      B=V3*VEE+SHA(ISX)
      GO TO 147
C
C     BALMER BETA
C
  136 IF (WDH-0.3) 146,191,191
  146 VEE=WDH-  XI(ISX)
  184 IF (VEE) 180,181,181
  181 IF (WDH-  XI(ISXP)) 182,182,183
  180 ISXP=ISX
      ISX=ISX-1
      GO TO 146
  183 ISX=ISXP
      ISXP=ISXP+1
      GO TO 146
  182 ACH=(EFF(ISX)*(WDH-  XI(ISXP))+GEG(ISX))*VEE
      V3=ACH+SHBS(ISX)
      DSDA=(ACH+V3+EFF(ISX)*VEE*VEE)
      B=V3*VEE+SHB(ISX)
  147 CONTINUE
      B=10.**B
      DSKDA=B*DSDA*2.30258
      B=B*F2(I)
      DBDLNT=0.6666667*(B+WDH*DSKDA*F2(I))
      DBDLNP=-DBDLNT
      GO TO 148
C
C     SPECIAL HYDROGEN LINES
C     WING REGION
C
  191 V = W(I)
      V0 = DW(I,1)
      V6 = DW(I,2)
      GO TO 192
  141 V= R(I)
      V0 = DR(I,1)
      V6 = DR(I,2)
  192 WDHSQ=WDH*WDH
      SQRWDH=SQRT(WDH)
      B=(CB*(1.0+  V *SQRWDH*SQRTF0(I))/(WDHSQ*SQRWDH))*F2(I)
      TB=CB*V7/WDHSQ/SQRTF0(I)
      DBDLNT=-B+TB*V0
      DBDLNP=+B+TB*V6
  148 CONTINUE
C
C      CALCULATION OF ABSORPTION COEFF AND DERIVATIVE WRT PRIMARY VARIABLES FOR
C      SPECIAL HYDROGEN LINES ONLY
C
      DO 66 JVV=1,ISP
      JLV=JVV+JJ7
      ISTART=3*(JVV-1)+1
      IEND=ISTART+ISP
      DBDX     =DBDLNT*AIN(ISTART,I)+DBDLNP*AIN(IEND,I)
   66 AIG(I,JVV)=B*DSL(JLV,I)+SLJJI   *DBDX     +AIG(I,JVV)
      S2(I) = SLJJI * B
      GO TO 67
```

```
   65 CONTINUE
C
C      CALCULATION OF ABSORPTION COEFF AND DERIVATIVE WRT PRIMARY VARIABLES FOR
C      ALL LINES EXCEPT SPECIAL HYDROGEN
C
      JLV=JJ7
      GAMJJI=GAM(JJ,I)
      V4=GAMJJI*GAMJJI
      V5=V4-V2
      V6=V4+V2
      DEN=25336.92*V6
      B=GAMJJI/DEN
      DO 549 JV=1,ISP
      JLV=JLV+1
      AIG(I,JV)=(DSL(JLV,I)*SLJJI *DWD(JLV,I)*(V5/(V6*GAMJJI)))*B
     1  +AIG(I,JV)
  549 CONTINUE
      S2(I) = SLJJI * B
   67 CONTINUE
      S1(I) = S1(I) +S2(I)
  550 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE NODEN(NOP)
C     ...OBTIANS SPECIES NUMBER DENSITIES FOR EACH SPATIAL STATION       NODEN003
C     DIMENSIONED FOR 40 SPECIES
      INTEGER FAMDA,FAMDB,       BETA,BETB
C                                                                        NODEN012
      COMMON/CONTM/NCRC(20),NSBN,Z(20),HVG(30),KS(20),IIS(16),NIL,
     1              HVT(30)      ,CSS(240),IIL(30),ISS(30)   ,IOBN(20),
     2               XION(30),BETA(30),BETB(30),NST1,NT,XIS(240),IN(30)
C
      COMMON/COPCOM/SPZZ(281),IS,SPZ2(70),P,SPZ3(480),T,SPZ4(308),
     1               VNU(60,8),SPZ5(187),ISP2,FAMDA(60),FAMDB(60),ISP,
     2               NSPEC,FSC6(3),KIN,KOUT,KKR(20),FSC7(68)
C
      COMMON/EQTCOM/SPZ7(6),AA,SPZ8(37),A(14,14),SPZ9(357),TC(60),
     1              SXZ10(203)
C
      COMMON/INTCOM/KR(20),KQ(10),KF(10),M,N
C
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25)             ,NXI,IA(9) RADIN0
     1,NI,XNOL(200),GUP(200),EXPN(200)
C
      COMMON/NONCOM/AM(123,123)
C
      COMMON/PRPCOM/PR(20),RHO(20),SC(20),CAPC(20),QR(20),XMUI(20)
C
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(160),FF(200), RAD
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GEL(160),             NALS,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHVC,NHV,NU(25),NY,PRES(20),TFE(20),VOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),TMSW(50),TMSWL(25),TW,IOB
C                                                                        NODEN002
      COMMON /RADCOM/          TT(20),VMW(20),HG(20),SP(1,20,8)          DADIN00
     1                  ,THETA,SV1,SP1,SR1,HS,HP(20)
C
      DIMENSION KCNT(3)
C                                                                        NODEN018
      DIMENSION
     1        DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2        WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123,1) ,
     3        DLXQ(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4        SL(123,1) , BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5        TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6        XNN(123,1) , XQ(123,1)
C
      DIMENSION FR(123,1)
C
      EQUIVALENCE
     1        (DSL(1),AM(1)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2        (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3        (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXQ(1),AM(5001)),
     4        (AFT(1),AM(5024)) , (ABE(1),AM(5270)) , (BFT(1),AM(7381)),
     5        (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
     6        (ATT(1),AM(.691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7        (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
     8        (XQ(1),AM(1000
      EQUIVALENCE (FR(1),AM(
 1050 FORMAT(2X,2A4,2X,1P13E9.2/(12X,1P13E9.2))
 1060 FORMAT(1H /48X,16HNUMBER DENSITIES/)
 1070 FORMAT(1H1,///45X,8HDELTA = ,1PE14.6,/)
 1216 FORMAT(1H1,//10X,58H THERMODYNAMIC STATES ACROSS THE LAYER -STARTI
     1NG WITH WALL//)
C
C     DO EDGE CALCULATION
C
```

```
      IF(NOP.GT.1) GO TO 120
      CALL EQUIL(KQ,NY  ,PRES(  NY))
      RHO(NY) = AA/(1.3146*T)
      KCNT(1) = 1
      KCNT(2) = 2
      KCNT(3) = 0
      EFLD = 0.
      CALL GO(KCNT,  NY,PRES(  NY))
      RETURN
  120 CONTINUE
C
C
C     DO THERMODYNAMIC STATE CALCULATION
C
C
      IF(KR(17).NE.2) WRITE(N,1216)
      NF= 1
      DO 87 I=1,NY
      IF(KQ(1).EQ.0) TT(I) = 1.8*TEE(I)
      IF(KQ(1).EQ.2 .AND. NF .EQ. 0) HH(I) = TEE(I)
      CALL EQUIL(KQ,I,PRES(I))
C     SET UP TCN AND ACN ARRAYS FOR CORRECTION COEFFICIENTS
      NNBS = NSPEC - IS
      RHO(I) = AA/(1.3146*T)
      DO 625 J=1,NNBS
  625 TCN(J,I) = -TC(J+IS)
      DO 630 II=1,ISP2
      DO 630 JJ=1,ISP
      IDX = 8*(JJ-1) + II
  630 AIN(IDX,I) = A(II,JJ)
      TEE(I) = TT(I)/1.8
      IF(KR(14) .GT. 0) CALL GO(KCNT,I,PRES(I))
   87 CONTINUE
C
C     CALCULATE ELECTRONIC PARTITION FUNCTIONS FOR ATOMS AND IONS
C
  445 DO 500 I=1,NY
      T1 = TEE(I)*8.62E-5
      IRK = 0
      NCES=0
  450 IRK=IRK+1
      NICE = 0
      XQ(IRK,I)=0.
      DLXQ(IRK,I) = 0.
  475 NCES=NCES+1
      NICE=NICE+1
      V = EPS(NCES)/T1
      V1 = GEE(NCES)*EXP(-V)
      XQ(IRK,I) = XQ(IRK,I) + V1
      DLXQ(IRK,I) = DLXQ(IRK,I) + V1 * V
      IF(NCES .EQ. NAES) GO TO 7500
  455 IF(NICE .EQ. 8) GO TO 7450
  476 GO TO 475
 7450 DLXQ(IRK,I) = DLXQ(IRK,I)/XQ(IRK,I)
      GO TO 450
 7500 DLXQ(IRK,I) = DLXQ(IRK,I)/XQ(IRK,I)
  500 CONTINUE
C
C     START LOOP ON SPATIAL GRID POINTS                                 NODEN025
C                                                                       NODEN026
      DO 20 I=1,NY                                                      NODEN027
      PRESS=PRES(I)
      DO 19 J=1,NT                                                      NODEN029
      IJ=IV(J)
```

```
      IF (IJ.EQ.0) GO TO 18                                              NODEN020
      XNN(J,I)=7.3398E21*PRESS*FP(IJ,I)/TEE(I)                           NODEN030
      GO TO 19                                                           NODEN021
   18 XNN(J,I)=0.                                                        NODEN022
   19 CONTINUE                                                           NODEN031
   20 CONTINUE                                                           NODEN032
      IF(KR(17).EQ.2) GO TO 75
      WRITE(N,1070)DELTA
      WRITE(N,1060)                                                      NODEN033
      DO 50 J=1,NT
   50 WRITE(N,1050) BETA(J),BETB(J),(XNN(J,I),I=1,NY)
   75 RETURN
      END                                                                NODEN064
```

```
      SUBROUTINE OGLE(N,XAM,PRM,NUMX,X,P,EM)
      DIMENSION XAM(1),X(1),P(1),EM(1),PRM(1)
      XDIF=X(NUMX)-X(1)
      IS=1
    2 DO 600 J=1,N
      XA=XAM(J)
      IO=1
      IT=1
   61 IF(XDIF) 72,60,71
   71 IF(XA-X(IS)) 62,63,64
   72 IF(X(IS)-XA) 62,63,64
   62 IF(IS-1)671,671,68
   68 IS=IS-1
      IT=2
      GO TO (61,66),IO
  672 IS=NUMX
  671 I=IS
      H=0.
      DPDI=EM(I)
      GO TO 67
   63 PR=P(IS)
      DPDI=EM(IS)
      GO TO 601
   64 IS=IS+1
      IF(IS-NUMX)69,69 ,672
   69 IO=2
      GO TO (61,65),IT
   65 IS=IS-1
   66 I=IS
      G=(((P(I+1)-P(I))/(X(I+1)-X(I)))-EM(I))/(X(I+1)-X(I))
      F=(((EM(I+1)-EM(I))/(X(I+1)-X(I)))-2.*G)/(X(I+1)-X(I))
      H=(F*(XA-X(I+1))+G)*(XA-X(I))
      DPDI=(H+H+EM(I)+F*(XA-X(I))*(XA-X(I)))
   67 PR=(H+EM(I))*(XA-X(I))+P(I)
  601 CONTINUE
      PRM(J)=PR
  600 CONTINUE
   50 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE RADIN
      INTEGER BETA,BETB,BA,BB,BL,BM,BLINE
      INTEGER  FAMOA,FAMOB
      DIMENSION BLINE(10),JLINE(10)
C
      COMMON/CONTM/NCRC(20),NSBN,Z(20),HVG(30),KS(20),IIS(16),NIL,
     1            HVT(30)       ,CSS(240),IIL(30),ISS(30)  ,IOBN(20),
     2            XION(30),BETA(30),BETB(30),NST1,NT,XIS(240),K4(30),
     3            TTHRES(30),COEFA(30),COEFB(30),IZZ
C
      COMMON/DIFCOM/INDX1(66),INDX2(66),OA1(66),OA2(66),OA3(66),OB1(66),
     1             OB2(66),OB3(66),OC1(66),OC2(66),OC3(66),AC1(66),
     2             AC2(66),AC3(66),AD1(66),AD2(66),AD3(66),AE1(66),
     3             AE2(66),AE3(66),MINTA(15),MINTB(15),JCS(15),NUP
     4             ,NDIM ,XMM(66),TRNS(5)
C
C
      COMMON/INTCOM/KR(20),KQ(10),KF(10),M,N
C
      COMMON/EQPCOM/SPZZ(281),IS,SPZ2(70),P,SPZ3(480),T,SPZ4(308),
     1             VNU(60,8),SPXX(7),WT(60),SPZ5(120),ISP2,FAMOA(60)
     2             ,FAMOB(60),ISP,NSPEC,FSC6(3),KIN,KOUT
C
      COMMON/LINE/HVL(200),K1,K2,TLCM(25),TLCP(25),          NXI,IA(9) RADIN0
     1,NI,XNOL(200),GUP(200),EXPN(200) ,XK(20),MUG,INDSHL(12)
C
      COMMON/NONCOM/AM(123,123)
C
      COMMON/OUTCOM/LDEX(3)
C
      COMMON/PRPCOM/PR(20),RHO(20),SC(20),CAPC(20),QR(20) ,XMUI(20)
C
      COMMON/RAD/AHV(50),AHVL(25),C1,C2,C3,C4,C5,DELTA,EPS(16),FF(200), RAD
     1FHV(25),FHVC(50),FHVM(25),FHVP(25),FIMI(25),FIPI(25),FL1,FL2,FLG, RAD
     2FLG1,GAMP(200),GEE(160),              NAES,NBLP,ND(200),NIC,NICN(2 RAD
     35),NIHVC,NHV,NU(25),NY,PRES(20),TEE(20),WOL(25),XMOL,
     4 YDELT,YY(20),CASE(15),THSW(50),THSWL(25),TW,TOB
C
C
      COMMON /RADCOM/           TT(20),VMW(20),HH(20),SP(1,20,8)         DADIN00
     1          ,THETA,SV1,SP1,SR1,HS                                    EQUIL00
C
      COMMON/TNPT/XN(11),XM(11),OMEG(11,11,1),DOMEG(11,11,1)
     1            ,FOMEG(11,11,1),IESPV,XKT,IESPF,A(11,11)
C
C
      DIMENSION BA(16),BB(16),NFLCT(2)
      DIMENSION OUTC(123,1),OUTL(123,1)
      DIMENSION         EMSW(50),EMSWL(25)
C
      DIMENSION
```

```
     1          DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2          WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123,1) ,
     3          DLXQ(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4          SL(123,1)   BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5          TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6          XNN(123,1) , XQ(123,1)
C
      EQUIVALENCE
     1          (DSL(1),AM(.)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2          (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3          (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXQ(1),AM(5001)),
     4          (AFT(1),AM(5024)) , (ABF(1),AM(5270)) , (BFT(1),AM(7381)),
     5          (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
                (ATT(1),AM(8691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7          (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
     8          (XQ(1),AM(10004))
     9              ,(OUTC(1),AM(5021)),(OUTL(1),AM(9512))
C                                                                        DADIN014
C                                                                        DADIN015
      EQUIVALENCE (EMSW(1),AHV(1)),(EMSHL(1),AHVL(1))                    DADIN016
-
      DATA NELCT/4HE=  ,4H    /
      DATA NHYDR/4HH   /
C
  100 FORMAT(6E12.1)
  101 FORMAT(40I2)
  102 FORMAT (2A4,I2,F10.4,2E12.1,3E12.2)                                DADIN022
  103 FORMAT(5I3)
  115 FORMAT(24I3)
  120 FORMAT(1H1,60X,8H DECK A ,/)
  121 FORMAT(6H GROUP,8X,2HHV,12X,3HHV+,11X,3HHV=,10X,1HN,
     168H     NAME      K(I)       HV(I)       F(I)          GAM(I)       EXPN(I)
     2  NOL,/)
  122 FORMAT(I4,F12.3,2F14.3,I12,3X,A4,I8,F11.3,1PE11.2,1P2E12.2,0PF6.0)
  124 FORMAT(56X,3X,A4,I8,F11.3,1PE11.2,1PE12.2,1PE12.2,0PF6.0)          DADIN018
  225 FORMAT(8E10.3)
  226 FORMAT(6E12.4)
  227 FORMAT(5E12.8)
  597 FORMAT(//109H WITH IZZ=1, YOUR FHVC VALUES MUST RESOLVE (WITHIN .1
     1 EV) THE BOUNDARIES OF THOSE GROUPS WITH SPECIAL H LINES//)
  600 FORMAT(3I3,E11.3,E10.3,40X,2A4)
  610 FORMAT(8E10.3)
  620 FORMAT(20A4)
  901 FORMAT(I2,2X,I2,2X,I2,2X,I2)
                                                                         DADIN023
 1080 FORMAT(1H1,/,
     1        32X,7HCASE = ,15A4,//,8X,65HRADIATION CONTROL NUMBERS  1  2DADIN024
     1  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20,//,33X,20I3DADIN025
                                                                         DADIN026
     2/,33X,20I3)
 1085 FORMAT(//8X,55HCHEMISTRY CONTROL NUMBERS  1  2  3  4  5  6  7  8  DADIN027
     19 10,8X,50HFLOW CONTROL NUMBERS  1  2  3  4  5  6  7  8  9 10/33X,
     110I3,28X,10I3)
 1090 FORMAT(//50X,29HRADIATIVE BOUNDARY CONDITIONS//,130H    ----------DADIN029
     1--------------CONTINUUM----------------------    ---------------DADIN030
     2------------LINE GROUPS----------------------      ,/,130H      DADIN031
     3    WAVE            EMITTANCE               TRANSMITTANCE          WDADIN032
     4AVE            EMITTANCE             TRANSMITTANCE           ,/,130h   DADIN033
     5 FREQ,  LENGTH   WALL /OUTER BOUND,   WALL /OUTER BOUND,       FREDADIN034
     6Q,  LENGTH   WALL /OUTER BOUND,   WALL /OUTER BOUND,         ,/,130DADIN035
                                                                         DADIN036
     7H     (EV)     (A)                                                ,DADIN037
     8  (EV)     (A)                                                     DADIN038
     9 )
 1095 FORMAT(F10.3,E10.3,F8.3,F10.3,F11.3,F10.3,F12.3,E10.3 ,F8.3,F10.3 DADIN039
                                                                         DADIN040
     1,F11.3,F10.3)                                                      DADIN041
 1098 FORMAT(F10.3,E10.3,F8.3,F10.3,F11.3,F10.3)
```


C 2

```
1099 FORMAT(6X,F10.3,E10.3,F8.3,F10.3,F11.3,F10.3)                      DADIN042
1967 FORMAT (1H1)
2000 FORMAT(//5X,52HKQ(5) MUST EQ 1 AND KR(2) MUST EQ 2 WHEN KF(1) EQS
    11//)
4000 FORMAT(23H***LINE CENTER FREQ AT ,F9.3,23H IS OUT OF SEQUENCE****)RADIN00
4001 FORMAT(21H***CONTINUM FREQ AT ,L?.3,23H IS OUT OF SEQUENCE****)  RADIN01
                                                                       DADIN020
4004 FORMAT(20I1,15A4)                                                 DADIN022
4010 FORMAT(35H****EXTEND CONTINUUM FREQ RANGE****)
4227 FORMAT(10I1,6E10.3)
5001 FORMAT(4A4,3X,I1,6E10.3)
5002 FORMAT(20X,6E10.3)
5003 FORMAT(/2X,67H ELECTRONS WERE NOT INCLUDED IN THE DIFFUSIVE TRANSP
    1ORT PROPS - BAD/)
5004 FORMAT(8E10.3)
5430 FORMAT(/5X,10H YOU HAVE ,I3,71H  SPECIES IN YOUR DIFFUSIVE TRNSPRT
    1 MDL.  PGM IS DIMENSIONED FOR 11,MAX,//)
8500 FORMAT(59X,F14.5,I3)
8501 FORMAT(2X,2I3,1P4E14.6)
8503 FORMAT(5X,2A4,2X,I3)
8505 FORMAT(//5X,14HDATA DECK HAS ,I3,40H RADIATING SPECIES-DIMENSION L
    1IMIT OF 30)
8506 FORMAT(//5X,14HDATA DECK HAS ,I3,40H INDIVIDUAL LEVELS-DIMENSION L
    1IMIT OF 30)
8520 FORMAT(6X,2I3,1P4E14.6)
9500 FORMAT(17X,7E9.2)
9600 FORMAT(//2X,26HYOU ARE TRYING TO CONSIDER,I3,2Y,71H NONMOLECULAR,R
    1ADIATING SPECIES. THIS EXCEEDS THE DIMENSION LIMIT OF 20/)
9610 FORMAT(//2X,65HYOUR DECK A DATA IS INCONSISTENT.  LINES WERE ASSIG
    1NED TO SPECIES,2X,A4,2X,23H BUT NOT CONTINUUM DATA//)
9611 FORMAT(//2X,17HYOU HAVE SELECTED,2X,2A4,2X,56HAS RADIATING SPECIE
    1BUT DID NOT INPUT THERMO DATA FOR IT//)
9612 FORMAT(//16H  DATA DECK HAS ,I3,20H LINES, LIMIT IS 200//)
9613 FORMAT(//7H GROUP ,I3,5H HAS ,I3,16H LINES-LIMIT IS ,I3//)
C
C*****************************************************************************
C
C     INPUT DECK A
C
C*****************************************************************************
      J = 0
      II = 0
      IATO = 0
      NIL = 0
      NSBN = 0
      III= 0
      UMASS = 1.660434E-24
      READ(M,90  NHV,NXI,IZZ,NOUT
      IF(NOUT.GT.0) GO TO 800
      DO 900 I=1,3.
      IZ = I
      READ(M,6  ) IAT,NN    ,NBN    ,Z(IZ),XION(IZ),BETA(IZ),BETB(IZ)
      IF(IAT.EQ.0) GO TO 200
      NSBN = NSBN + NBN
 7115 IF(NBN.EQ.1) IOBN(NSBN) = I
      READ(M,610) (GEE(II+JJJ),JJJ=1,8)
      READ(M,610) (EPS(II+JJJ),JJJ=1,8)
      IF(NBN.EQ.0) GO TO 325
      READ(M,610) HVG(NSBN),TTHRES(NSBN),COEFA(NSBN),COEFB(NSBN)
      IF(TTHRES(NSBN).GE. .10) GO TO 3228
      COEFA(NSBN)=1.
      COEFB(NSBN)=0.
 3228 CONTINUE
      ITEMP=8*(NSBN-1)
      READ(M,610)(XIS(ITEMP+JJJ),JJJ=1,8)
```

```
  325 IF(NN,EQ,0) GO TO 345
      DO 360 N1=1,NN
      NIL = NIL +1
      ISS(NIL) = I
      READ(M,8500) HVT(NIL),LEV
      IIL(NIL) = II+LEV
      READ(M,9500) ( CSS(III+J2),J2=1,8)
  360 III=III + 8
  345 CONTINUE
      IF(IA),EQ,IATO) GO TO 50
      J=J+1
      KS(J) = I
   50 IATO = IAT
      II = II + 8
  900 CONTINUE
  200 CONTINUE
      NAES = II
      NSRS = J
      NST1 = IZ-1
      IF(NST1 ,LE, 20) GO TO 228
      WRITE(N,9600) NST1
      STOP
  228 CONTINUE
      READ(M,620) BA
      READ(M,620) BB
      NT = NST1
      DO 75 I=1,16
      IF(BA(I),EQ,NELCT(2)) GO TO 133
      DO 65 II=1,16
      IF(BA(I),NE,BB(II)) GO TO 65
      IIS(I) = 1
      NT = NT+1
      BETA(NT)=BA(I)
      BETB(NT) = NELCT(2)
      GO TO 75
   65 CONTINUE
  133 IIS(I) = 0
   75 CONTINUE
      NT = NT+1
      BETA(NT) = NELCT(1)
      BETB(NT) = NELCT(2)
      IF(NT ,LE, 30) GO TO 229
      WRITE(N,8505) NT
      STOP
  229 CONTINUE
      IF(NIL ,LE, 30) GO TO 230
      WRITE(N,8506)NIL
      STOP
  230 CONTINUE
      READ(M,226) (FHVM(I),I=1,NHV)
      READ(M,226) (FHVP(I),I=1,NHV)
      READ(M,226) (FHV(I),I=1,NHV)
      IF(NXI) 80,80,81
   81 READ(M,101) (IA(I),I=1,NXI)
   80 READ(M,101)  (  NU(I),I=1,NHV)
      IS=0
      DO 1 I=1,NHV
      IF(NU(I) ,LE, 12) GO TO 1
      IF(NU(I) ,EQ, 13) GO TO 87
      K=13
   89 WRITE(N,9613) I,NU(I),K
      STOP
   87 IF(IZZ,EQ,1) GO TO 1
      K=12
```

```
      DO 88 J=1,NXI
      IDUM=IA(J)-1
      IF(I.EQ.IDUM) GO TO 89
   88 CONTINUE
    1 IS=IS+NU(I)
      IF(IS.LE.200) GO TO 86
      WRITE(N,9612)IS
      STOP
   86 CONTINUE
      KLINE=1
      IC1 = 1
      DO 450 I=1,IS
      READ (M,102)  BL    ,BM    ,ND(I),EXPN(I),HVL(I),FF(I),GAMP(I),
     1 XNOL(I),GUP(I)
      IF(BL .NE. NHYDR .OR. EXPN(I) .GE. 0.1) GO TO 422
      INDSHL(IC1) = I
      IC1 = IC1 + 1
  422 CONTINUE
      DO 420 KK=1,KLINE
      K = KK
      IF (BL.EQ.BLINE(K)) GO TO 490
  420 CONTINUE
      BLINE(K)=BL
      KLINE=KLINE+1
  425 CONTINUE
      DO 430 JJ=1,30
      J=JJ
      IF (BLINE(K).NE.BETA(J)) GO TO 430
      GO TO 435
  430 CONTINUE
      WRITE(N,9610) BLINE(K)
      STOP
  435 JLINE(K)=J
  490 ND(I)=(JLINE(K)-1)*8+ND(I)
  450 CONTINUE
C
      IF(IS.EQ.1) GO TO 613
      DO 413 I=1,IS
      NOL =  XNOL(I) + .001
      IF(NOL .EQ. 0) XNOL(I) = 1.
  413 CONTINUE
      DO 513 I=2,IS
      IF(HVL(I)-HVL(I-1)) 514,514,513
  514 WRITE(N,4000) HVL(I)
      STOP
  513 CONTINUE
  613 CONTINUE
      READ(M,115) NIHVC
      READ(M,100) (FHVC(I),I=1,NIHVC)
      DO 580 I=2,NIHVC
      IF(FHVC(I)-FHVC(I-1)) 582,582,580
  582 WRITE(N,4001) FHVC(I)
      STOP
  580 CONTINUE
      IF(IZZ.NE.1) GO TO 590
      IF(NXI.EQ.0) GO TO 590
      DO 591 I=1,NXI
      K=IA(I)
      IF(I.EQ.1) GO TO 595
      KK=IA(I-1)
      V=FHVM(K)-FHVP(KK)
      IF(V .LT. 0.1) GO TO 670
  595 CONTINUE
      DO 592 J=1,NIHVC
```

```
      V=FHVM(K)-FHVC(J)
      IF(V.LE.0.) GO TO 592
      IF(V .LT. .1) GO TO 593
  592 CONTINUE
      GO TO 680
  593 CONTINUE
      DO 594 J=1,NIHVC
      V= FHVC(J)-FHVM(K)
      IF(V.LE.0.) GO TO 594
      IF(V.LT. .1) GO TO 670
  594 CONTINUE
  680 WRITE(N,597)
      STOP
  670 IF(I.EQ.NXI) GO TO 655
      KK=IA(I+1)
      V=-FHVP(K)+FHVM(KK)
      IF(V.LT. 0.1) GO TO 591
  655 CONTINUE
      DO 692 J=1,NIHVC
      V=FHVC(J)-FHVP(K)
      IF(V.LE.0.) GO TO 692
      IF(V.LT..1) GO TO 693
  692 CONTINUE
      GO TO 680
  693 CONTINUE
      DO 685 J=1,NIHVC
      V=FHVP(K)-FHVC(J)
      IF(V.LE.0.) GO TO 685
      IF(V.LT. .1) GO TO 591
  685 CONTINUE
      GO TO 680
  591 CONTINUE
  590 CONTINUE
C
      WRITE (N,1967)
      WRITE (N,120)
      WRITE (N,121)
      IC1=0
      DO 30 I=1,NHV
      IC2 = IC1 + NU(I)
      IC1= IC1+1
      NAMX = (ND(IC1)+7)/8
      WRITE(N,122) I,FHV(I),FHVP(I),FHVM(I),NU(I),
     1 BETA(NAMX),ND(IC1),HVL(IC1),FF(IC1),GAMP(IC1),EXPN(IC1),XNOL(IC1)
      IF(IC1.EQ.IC2) GO TO 30
      IC3=IC1+1
      DO 25 J=IC3,IC2
      NAMX = (ND(J)+7)/8
   25 WRITE(N,124)  BETA(NAMX),ND(J),HVL(J),FF(J),GAMP(J),EXPN(J),
     1 XNOL(J)
   30 IC1=IC2
C***************************************************************************
C
C     INPUT DECK B
C
C***************************************************************************
  800 READ(M,4004)  KR,CASE                                           DADIN046
      DO 1902 III=1,10
 1902 KF(III)=0
      KF(1)=2
      KF(2)=3
      KF(7)=1
      KF(8)=2
      KF(10)=1
```

```
      IF(KR(1).NE.6) GO TO 8180
C     CALL BURCS
      STOP
 8180 CONTINUE
      READ(M,4227)(KQ(I),I=1,10),DUM,THETA,SV1,SP1,SR1,HS
      NF = 0
      NUG = 0
      IF(KR(12).NE.4) GO TO 520
      KR12=4
      KR(12)=0
  520 CONTINUE
C                                                                       DADIN048
      IF(KF(1)-1) 156,157,156
  157 IF(KQ(5).NE.1) GO TO 158
      IF(KR(2).NE.2) GO TO 158
      GO TO 156
  158 WRITE(N,2000)
      STOP
  156 CONTINUE
      IF( KR(7)-1) 161,159,161                                          DADIN049
  159 IF( KR(12)-1) 160,161,160                                         DADIN050
  160 CALL INPUT                                                        DADIN051
C                                                                       NODEN018
C     ESTABLISH IDENTITY OF EACH SPECIES                                NODEN019
C
      DO 6800 J=1,NT
      K4(J)=0
      DO 6802 I=1,NSPEC
       IF(FAMOA(I).NE.BETA(J).OR.FAMOB(I).NE.BETB(J))GO TO 6802
      K4(J)=I
      GO TO 6800
 6802 CONTINUE
      WRITE(N,9611) BETA(J),BETB(J)
      STOP
 6800 CONTINUE
      DO 3919 J=1,20
      IJ = K4(J)
 3919 XR(J) = UMASS * WTH(IJ)
      IF(KR12.EQ.4) GO TO 161
      IF(KR(14).EQ.0) GO TO 161
C
C     READ AND MAKE SENSE OF THE TRANSPORT PROPERTY DATA
C
C
C     READ TRANSITION TEMPERATURES
      READ(KIN,5004) (TRNS(I),I=1,5)
      DO 4950 I=2,5
      IF(TRNS(I) .LE. 0.) TRNS(I) = 100000.
 4950 CONTINUE
C
C     MAKE ICLMB=1 FOR COLLISIONS OF THE TYPE---A+-E- AND A+-A+
C     MAKE ICLMB=2 FOR COLLISIONS OF THE TYPE---A+-A++
C     MAKE ICLMB=3 FOR COLLISIONS OF THE TYPE---A++ - A++
      IESPV = IS
      NUP = 0
      II = 0
      DO 5100 I=1,66
      READ(KIN,5001)
      READ(KIN,5001)MOA,MOB,MOC,MOD,ICLMB    ,OA1(I),OB1(I),OC1(I),
     1              AC1(I),AD1(I),AE1(I)
      IF(MOA.EQ.NELCT(2)) GO TO 5200
      IF(ICLMB.EQ.1) OA1(I)=-990.
      IF(ICLMB.EQ.2) OA1(I) = -1090.
      IF(ICLMB.EQ.3) OA1(I)=-1190.
```

```
      READ(KIN,5002) OA2(I),OB2(I),OC2(I),AC2(I),AD2(I),AE2(I)
      IF(ICLMB,EQ,1) OA2(I)=-990,
      READ(KIN,5002) OA3(I),OB3(I),OC3(I),AC3(I),AD3(I),AE3(I)
      IF(ICLMB,EQ,1) OA3(I)=-990,
      II=II+1
      JJ=0
 5000 JJ=JJ+1
      IF(MOA,EQ,MINTA(JJ),AND,MOB,EQ,MINTB(JJ))GO TO 5010
      IF(JJ,LT,NUP) GO TO 5000
      NUP = NUP + 1
      JJ = NUP
      MINTA(NUP) = MOA
      MINTB(NUP) = MOB
 5010 INDX1(I) = JJ
      JJ = 0
 5020 JJ = JJ + 1
      IF(MOC,EQ,MINTA(JJ),AND,MOD,EQ,MINTB(JJ))GO TO 5030
      IF(JJ,LT,NUP) GO TO 5020
      NUP = NUP + 1
      JJ = NUP
      MINTA(NUP) = MOC
      MINTB(NUP) = MOD
 5030 INDX2(I) = JJ
 5100 CONTINUE
 5200 IF(NUP,LT,1) GO TO 5280
      DO 5250 J=1,NUP
      JCS(J) = 0
      DO 5225 I=1,NSPEC
      IF(FAMOA(I),NE,MINTA(J),OR,FAMOB(I),NE,MINTB(J)) GO TO 5225
      JCS(J) = I
      GO TO 5250
 5225 CONTINUE
 5250 CONTINUE
 5280 CONTINUE
      NDINT = II
      DO 5290 I=1,NDINT
      I1 = INDX1(I)
      I2 = INDX2(I)
      I1C = JCS(I1)
      I2C = JCS(I2)
      XMM(I) = WTM(I1C)*WTM(I2C)/(WTM(I1C)+WTM(I2C))
 5290 XMM(I)=SQRT(2,*XMM(I)/3,14159)
      IESPF=0
      DO 5230 I=1,NUP
      IF(MINTA(I),EQ,NELCT(1)) IESPF=I
 5230 CONTINUE
      IF(IESPF,NE,0) GO TO 5224
      WRITE(KOUT,5003)
      STOP
 5224 CONTINUE
      IF(NUP   ,LE,11) GO TO 5229
      WRITE(KOUT,5430) NUP
      STOP
 5229 CONTINUE
C
C
C
  161 IF( KR(2)-1) 162,163,163                                          DADIN052
  162 C1 = 0,                                                           DADIN053
      GO TO  164                                                        DADIN054
  163 C1 = 1,                                                           DADIN055
  164 IF( KR(10)-1) 165,166,165                                         DADIN056
  166 C3 = 0,                                                           DADIN057
      GO TO 167                                                         DADIN058
```

```
  165 C3 = 1.                                                           DADIN059
  167 IF( KR(1) -1) 169,168,169                                         DADIN060
  168 FL1 = 2.                                                          DADIN061
      FL2 = 2.                                                          DADIN062
      GO TO 190                                                         DADIN063
  169 FL1 = 1.                                                          DADIN064
      FL2 = 1.                                                          DADIN065
  190 IF( KR(17) -1) 170,171,170                                        DADIN066
  171 FLG = 1.                                                          DADIN067
      GO TO 172                                                         DADIN068
  170 FLG = 0.                                                          DADIN069
  172 FLG1 = FL1-1                                                      DADIN070
      IF( KR(3)-1) 174,173,174                                          DADIN071
  173 XMOL = 0.                                                         DADIN072
      GO TO 176                                                         DADIN073
  174 XMOL = 1.                                                         DADIN074
  176 CONTINUE                                                          DADIN075
      ISM1 = IS - 1                                                     DADIN077
   76 IF(C3) 85,77,85                                                   DADIN029
C     INPUT INDICES FOR Y VALUE CALCULATIONS                            DADIN030
C                                                                       DADIN031
   77 IF(KR(10).EQ.2) GO TO 180
      READ(M,115) NIC
      READ(M,115) (NICN(I),I=1,NIC)                                     DADIN033
      READ(M,103) NY,NI,LDEX(1),LDEX(2),LDEX(3)
      READ(M,226) (YY(I),I=1,NY)
      GO TO 181
  180 READ(M,103) LDEX(1),LDEX(2),LDEX(3)
  181 CONTINUE
C     INPUT TRANSMISSION FACTORS FOR CONTM AND LINE CALCULATIONS        DADIN037
C                                                                       DADIN038
      IF(KR(5).EQ.3.OR.KR(5).EQ.6)GO TO 441
      IF(KR(5).EQ.4.OR.KR(5).EQ.7) GO TO 440
      IF(KR(5).EQ.5.OR.KR(5).EQ.8) GO TO 442
      IF( KR(5)-1) 440,440,441                                          DADIN079
  441 READ(M,100) (AHV(I),I=1,NIHVC)                                    DADIN080
      READ (M,100) (AHVL(I),I=1,NHV)                                    DADIN040
      READ(M,100) (TMSW(I),I=1,NIHVC)                                   DADIN081
      READ(M,100) (TMSWL(I),I=1,NHV)                                    DADIN082
      GOTO 85                                                           DADIN083
  440 DO 355 I=1,NIHVC                                                  DADIN084
      TMSW(I) = 0.                                                      DADIN085
  355 AHV(I) = 1.                                                       DADIN086
      DO 456 I=1,NHV                                                    DADIN087
      TMSWL(I) = 0.                                                     DADIN088
  456 AHVL(I) = 1.                                                      DADIN089
      GO TO 85
  442 DO 443 I=1,NIHVC
      TMSW(I) = 1.
  443 AHV(I) = 0.
      DO 444 I=1,NHV
      TMSWL(I) = 1.
  444 AHVL(I) = 0.
   85 CONTINUE
  541 IF( KR(9).EQ.1) GO TO 565                                         DADIN143
      V1 = FHVC(NIHVC)/(12.*8.62E-5)                                    DADIN144
      DO 560 I=1,NY                                                     DADIN145
      IF(V1-TEE(I)) 559,560,560                                         DADIN146
  559 WRITE(N,4010)                                                     DADIN147
      STOP                                                              DADIN148
  560 CONTINUE                                                          DADIN149
      IF(V1-TW)1559,569,569                                             DADIN001
  569 IF(V1-TOB) 1559,565,565                                           DADIN002
 1559 WRITE(N,4010)                                                     DADIN003
```

```
      STOP                                                              DADIN004
  565 CONTINUE                                                          DADIN152
  505 NW=MAX0(NHV,NIHVC)                                                DADIN098
C     WRITE OUT TRANSMISSION FACTORS
      WRITE(N,1080) CASE,KR
      WRITE(N,1085) (KR(I),I=1,10),KF
      IF(C4.GT.2.01) KR(13) = 3
      WRITE(N,1090)                                                     DADIN155
      DO 750 I=1,NW
      IF(NHV.GE.I) GO TO 51                                             DADIN157
      V1 = 12400./FHVC(I)                                               DADIN158
      IF(KR(5)-5) 1520,1520,1521
 1520 EMSB = 0.
      TMSB = 1.                                                         DADIN160
      GO TO 1525
 1521 EMSB = 1.
      TMSB = 0.
 1525 CONTINUE
      WRITE(N,1098) FHVC(I),V1,EMSW(I),EMSB    ,TMSW(I),TMSB            DADIN161
      GO TO 750
   51 IF(NIHVC.GE.I) GO TO 52                                           DADIN163
      V2 = 12400./FHV(I)                                                DADIN164
      IF(KR(5)-5) 1522,1522,1523
 1522 EMSBL = 0.
      TMSBL = 1.                                                        DADIN166
      GO TO 1526
 1523 EMSBL = 1.
      TMSBL = 0.
 1526 CONTINUE
      WRITE(N,1099) FHV(I),V2,EMSWL(I),EMSBL    ,TMSWL(I),TMSBL         DADIN167
      GO TO 750
   52 V1 = 12400./FHVC(I)                                               DADIN169
      V2 = 12400./FHV(I)                                                DADIN170
      IF(KR(5)-5) 1524,1524,1527
 1524 EMSB = 0.
      TMSB = 1.                                                         DADIN172
      EMSBL = 0.                                                        DADIN173
      TMSBL = 1.
      GO TO 1529
 1527 EMSB = 1.
      TMSB = 0.
      EMSBL = 1.
      TMSBL = 0.
 1529 CONTINUE
      WRITE(N,1095)FHVC(I),V1,EMSW(I),EMSB    ,TMSW(I),TMSB    ,FHV(I), DADIN175
     1             V2,EMSWL(I),EMSBL    ,TMSWL(I),TMSBL                 DADIN176
  750 CONTINUE                                                          DADIN177
      RETURN                                                            DADIN148
      END                                                               DADIN149
```

```
      SUBROUTINE SLOPQ(N,X,Y,S,Z)                                        SLOPQ00
      DIMENSION X(1),Y(1),S(1),Z(1)                                      SLOPQ00
      IF(N-1) 9,9,8                                                      SLOPQ00
    8 S(2)=(Y(2)-Y(1))/(X(2)-X(1))                                       SLOPQ00
      S(1)=S(2)                                                          SLOPQ00
      QC=S(2)                                                            SLOPQ00
      DO 7 I=1,N                                                         SLOPQ00
      IF(I+1-N)2,1,6                                                     SLOPQ00
    1 QB=QC                                                              SLOPQ01
      IF (I-2)7,6,5                                                      SLOPQ01
    2 XOT=X(I)-X(I+1)                                                    SLOPQ01
      XTT=X(I+1)-X(I+2)                                                  SLOPQ01
      XTO=X(I+2)-X(I)                                                    SLOPQ01
      AA=Y(I)/(XOT*XTO)                                                  SLOPQ01
      XOTT=XOT*XTT                                                       SLOPQ01
      AB=Y(I+1)/XOTT                                                     SLOPQ01
      AC=Y(I+2)/(XTT*XTO)                                                SLOPQ01
      AAA=AA*XTT                                                         SLOPQ01
      ABB=AB*XTO                                                         SLOPQ02
      ACC=AC*XOT                                                         SLOPQ02
      QA=QC                                                              SLOPQ02
      QB=S(I)                                                            SLOPQ02
      QC=S(I+1)                                                          SLOPQ02
      S(I)=AA*(XTO-XOT)+ABB-ACC                                          SLOPQ02
      S(I+1)=AB*(XOT-XTT)+ACC-AAA                                        SLOPQ02
      S(I+2)=AC*(XTT-XTO)+AAA-ABB                                        SLOPQ02
    3 IF(I-2)7,5,4                                                       SLOPQ02
    4 S(I)=(S(I)+QA)/2.                                                  SLOPQ02
    5 S(I)=(S(I)+QB)/2.                                                  SLOPQ03
    6 XD=X(I)-X(I-1)                                                     SLOPQ03
      YS=Y(I)+Y(I-1)                                                     SLOPQ03
      SD=S(I)-S(I-1)                                                     SLOPQ03
      SS=S(I)                                                            SLOPQ03
      Z(I)=Z(I-1)+XD/2.*(YS-XD/6.*SD)                                    SLOPQ03
      S(I)=SS                                                            SLOPQ03
    7 CONTINUE                                                           SLOPQ03
    9 RETURN                                                             SLOPQ03
      END                                                                SLOPQ03
```

```
      SUBROUTINETRANS3(NY,DY,NIC,NICN,ALF,BFE,TMU,EX,DM,BP,TAUT,FIM,FIP)
      COMMON/NONCOM/AM(123,123)
      DIMENSION EX(1),DM(1),BP(1),DY(1),BFE(1),TMU(1),TAUT(1),NICN(1),
     1          FIM(1),FIP(1)
      DIMENSION ELN(20),FPTAU(20),FMTAU(20),FPE(20),FME(20),FPEZ(20),
     1          FMEZ(20), VBM(20),VAM(20),VCM(20),DP(20)
C
      DIMENSION
     1         DSL(123,1) , DA(123,1) , DWD(123,1) , AB(123,1) ,
     2         WIM(123,1) , AT(123,1) , WD(123,1) , GAM(123, ) ,
     3         DLXQ(123,1) , AFT(123,1) , ABE(123,1) , BFT(123,1) ,
     4         SL(123,1) , BRG(123,1) , AIG(123,1) , ATT(123,1) ,
     5         TCN(123,1) , AIN(123,1) , AC(123,1) , AMT(123,1) ,
     6         XNN(123,1) , XQ(123,1)
C
      EQUIVALENCE
     1         (DSL(1),AM(1)) , (DA(1),AM(104)) , (DWD(1),AM(2461)) ,
     2         (AB(1),AM(2687)) , (WIM(1),AM(4921)) , (AT(1),AM(4941)) ,
     3         (WD(1),AM(4961)) , (GAM(1),AM(4981)) , (DLXQ(1),AM(5001)),
     4         (AFT(1),AM(5024)) , (ABE(1),AM(5270)) , (BFT(1),AM(7381)),
     5         (SL(1),AM(7401)) , (BRG(1),AM(7461)) , (AIG(1),AM(8671)) ,
     6         (ATT(1),AM(8691)) , (TCN(1),AM(10147)),(AIN(1),AM(12670)),
     7         (AC(1),AM(12610)) ,(AMT(1),AM(12630)) , (XNN(1),AM(9964)),
     8         (XQ(1),AM(10004))
C
      EQUIVALENCE (ELN(1),AM(7441)),(FPTAU(1),AM(7564)),(FMTAU(1),
     1            AM(7687)),(FME(1),AM(7810)),(FPEZ(1),AM(7933)),
     2            (FMEZ(1),AM(8056)),(VBM(1),AM(8179)),(VAM(1),AM(8302)),
     3            (VCM(1),AM(8425)),(FPE(1),AM(8548))
C     NOTE THAT THE PARTIAL DERIVATIVES (NOT THE FLUX) ARE CORRECT ONLY
C     WHEN THE FLUX EMITTED FROM THE WALL EQUALS WALLE*BEE(1)--I,E,  THE
C     TEMPERATURES MUST BE CONTINUOUS
C
      WALLR = EX(1)
      WALLE = EX(2)
      EBCD = EX(3)
      DO 25 J=1,NY
      BFT(NY,J) = 0,
      BFT(J,NYP) = 0,
      AT(NY,J) = 0,
      DO 25 I=1,NY
   25 WIM(I,J) = 0,
      NYP = NY + 1                                                      DERS
      NYM = NY - 1
C      CALCULATE OPTICAL DEPTHS
      EX(1) = 1,
      TAUT(1) = 0,
      DO 1 I=2,NY
      V = TMU(I)/TMU(I-1)
      V1=V-1,
      DYAL=DY(I-1)*ALF
      IF(ABS(V1),GT,0,01) GO  TO 2
      TAUT(I)=(1,+V1*(0,5+V1/24,*(V1-2,)))*DYAL*TMU(I-1)
      DM(I)=DYAL*(0,5-V1/8,*(1,33333333-V1))
      DP(I-1)=DYAL*(0,5+V1/24,*(4,-V1))
      GO TO 1
    2 V3=ALOG(V)
      V32 = V3 * V3                                                     DERS
      TAUT(I)=V1/V3*TMU(I-1)*DYAL
      DM(I)=DYAL*(V3-V1/V)/V32
      DP(I-1)=DYAL*(V1-V3)/V32
    1 CONTINUE
C*****CALCULATE TRANSPORT INTEGRALS AND DERIVITVES
```

```
      I=NY
      IF(ABS((FIP(I)-BEE(I))/(FIP(I)+BEE(I))),LE,,000001)FIP(I)=BEE(I)
      FIP(I)=FIP(I)-BEE(I)
      DO 31 II=2,NY
      EX(I)=EXP(-TAUT(I))
      ELN(I)=ALOG(BEE(I)/BEE(I-1))
      DEN=TAUT(I)-ELN(I)
      DUM=ELN(I)
      VUM=(BEE(I-1)-BEE(I)*EX(I))/DEN
      FIP(I-1)=FIP(I)*EX(I)+VUM*DUM
      FPTAU(I-1)=-FIP(I-1)+(DUM*BEE(I-1)-VUM*ELN(I))/DEN
      FPE(I-1)=(DUM-TAUT(I)/BEE(I-1)*VUM)/DEN
      FPEZ(I-1)=(VUM/BEE(I)*TAUT(I)-EX(I)*DUM)/DEN
   31 I=I-1
      FIM(1)=(FIP(1)+BEE(1))*WALLR+FIM(1)-BEE(1)
      DO 30 I=2,NY
      DEN=ELN(I)+TAUT(I)
      DUM=-ELN(I)
      VUM=(BEE(I)-BEE(I-1)*EX(I))/DEN
      FIM(I)=FIM(I-1)*EX(I)+VUM*DUM
      FMTAU(I)=-FIM(I)+(VUM*ELN(I)+DUM*BEE(I))/DEN
      FME(I)=(DUM-VUM/BEE(I)*TAUT(I))/DEN
   30 FMEZ(I)=(VUM/BEE(I-1)*TAUT(I)-EX(I)*DUM)/DEN
      DO 32 J=1,NYP
      VBM(J)=0,
   32 VAM(J)=0,
      VAM(NY) = EBCD
      AT(NY,NY) = EBCD
      I=NY
      DO 37 II=2,NY
      DO 36 J=I,NY
      VAM(J)=VAM(J)*EX(I)
   36 VBM(J)=VBM(J)*EX(I)
      VBM(NYP)=VBM(NYP)*EX(I)+FPTAU(I-1)/ALF*TAUT(I)
      VBM(I)=VBM(I)+FPTAU(I-1)*DM(I)
      VBM(I-1)=VBM(I-1)+FPTAU(I-1)*DP(I-1)
      VAM(I)=VAM(I)+FPEZ(I-1)
      VAM(I-1)=VAM I-1)+FPE(I-1)
      I=I-1
      IP2=I+2
      IP1=I+1
      DUM = FPTAU(I)/DY(I)*TAUT(IP1)
      V=1,
      III=I
      DO 45 IZ=II,NY
      WIM(III,I) = V*DUM
      V = V*EX(III)
   45 III=III-1
      V = -WALLR*WIM(1,I)
      WIM(IP1,I)=-FMTAU(IP1)/DY(I)*TAUT(IP1)
      DO 46 IZ=1,IP1
      V=V*EX(IZ)
   46 WIM(IZ,I) = WIM(IZ,I) + V
      IF(IP2,GT,NY) GO TO 48
      DO 47 IZ=IP2,NY
   47 WIM(IZ,I) = WIM(IZ-1,I)*EX(IZ)
   48 BFT(I,NYP)=VBM(NYP)
      DO 37 J=1,NY
      BFT(I,J)=VBM(J)
   37 AT(I,J)=VAM(J)
      DO 35 J=1,NYP
      VBM(J)=VBM(J)*WALLR
   35 VAM(J)=VAM(J)*WALLR
      VAM(1)=VAM(1)+WALLE-1,+WALLR
```

```
      DO 34 I=1,NY
      IF(I.EQ.1) GO TO 335
      IM=NY
      IF(WALLR.LE.0.) IM=I-1
      DO 33 J=1,IM
      VAM(J)=VAM(J)*EX(I)
   33 VBM(J)=VBM(J)*EX(I)
      VBM(NYP)=VBM(NYP)*EX(I)+FMTAU(I)/ALF*TAUT(I)
      VBM(I-1)=VBM(I-1)+FMTAU(I)*DP(I-1)
      VBM(I)=VBM(I)+FMTAU(I)*DM(I)
      VAM(I-1)=VAM(I-1)+FMEZ(I)
      VAM(I)=VAM(I)+FME(I)
      BFT(I,NYP)=-VBM(NYP)+BFT(I,NYP)
  335 DO 34 J=1,NY
      BFT(I,J)=-VBM(J)+BFT(I,J)
   34 AT(I,J)=-VAM(J)+AT(I,J)
      RETURN
      END
```