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A GENERAL IBM 704 OR 7090 COMPUTER PROGRAM FOR COMPUTATION OF CHEMICAL EQUILIBRIUM COMPOSITIONS, ROCKET PERFORMANCE, AND CHAPMAN-JOUGUET DETONATIONS

SUPPLEMENT I - ASSIGNED AREA-RATIO PERFORMANCE

by Sanford Gordon and Frank J. Zeleznik
Lewis Research Center
Cleveland, Ohio

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • OCTOBER 1963

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SUMMARY

An addition to the computer program of NASA TN D-1454 is given that permits calculations of theoretical rocket performance for assigned area ratios. The use of thermodynamic derivatives to increase accuracy of interpolation in a specified range is discussed. A sample problem is included to illustrate the use of the program and to indicate the accuracy of the calculations.

INTRODUCTION

For various one-dimensional analyses involving rocket engines, theoretical performance data are often desired for specific area ratios. These data cannot be obtained in the same direct fashion as data for assigned pressure ratios (see ref. 1), inasmuch as area ratio is not a thermodynamic state function. However, by use of thermodynamic derivatives given in reference 2, data at assigned pressure ratios may be interpolated with excellent accuracy to give data for assigned area ratios.

This report presents an addition to the IBM 7090 program given in reference 1 to permit calculations at assigned area ratios. Several other minor modifications to the program were also made. These modifications are described under the sections "Optional Reading of Thermal Data From Cards," "H,P Problem (Combustion Properties Only)," "Specifying Reactants in Terms of Moles," and "Corrections to Reference 1."

SYMBOLS

A_t/w	nozzle throat area per unit mass flow rate, (sq in)(sec)/lb
a_n,b_n,c_n,d_n	polynomial coefficients

C_F thrust coefficient

c^* $32.174\ P_c A_t/w$, characteristic velocity, ft/sec

h enthalpy of reaction products per unit mass of reactant, cal/g

h_c combustion enthalpy of reaction products per unit mass of reactant, cal/g

I specific impulse with ambient and exit pressures equal, (lb force)(sec)/lb mass

I_{vac} specific impulse into vacuum (ambient pressure equal to zero), (lb force)(sec)/lb mass

M molecular weight

P_c chamber pressure, lb/sq in. abs

P_c/P ratio of chamber pressure to exit pressure

T temperature, $^{\circ}K$

x,y any function

ϵ ratio of exit area to throat area

INTERPOLATION OF PARAMETERS

Use of Derivatives for Interpolation

As indicated in reference 2, derivatives can be used to increase the accuracy of interpolation in a specified range. This is true because each derivative is approximately equivalent to having an additional point in the specified interval. For example, if only the functions are known at two points, only a linear interpolation equation is possible. However, if the first derivatives of these functions are also known at the two points, a cubic polynomial may be derived. With second derivatives also known at the two points, a quintic polynomial may be derived.

The general form of the equations used to determine the quintic polynomial coefficients a_n are

$$y = \sum_{n=0}^{5} a_n x^n \tag{1}$$

$$\frac{\partial y}{\partial x} = \sum_{n=0}^{4} (n + 1)(a_{n+1})x^n \tag{2}$$

$$\frac{\partial^2 y}{\partial x^2} = \sum_{n=0}^{3} (n + 1)(n + 2)(a_{n+2})x^n \tag{3}$$

The six coefficients a_n are determined by the solution of the six simultaneous equations obtained from equations (1), (2), and (3), where each equation is evaluated for two values of x. With coefficients determined, equation (1) is then used to obtain interpolated values of y for other values of x.

When second derivatives are not available, cubic polynomial coefficients $a_n (n = 0, 1, 2, 3)$ are obtained from equations (1) and (2) (with terms a_4 and a_5 omitted), where each equation is evaluated for two values of x.

Interpolation Equations

The equations used to obtain the interpolated parameters are as follows:

$$\ln \frac{P_c}{P} = \sum_{n=0}^{3} a_n (\ln \epsilon)^n \tag{4}$$

$$\ln T = \sum_{n=0}^{3} b_n \left[\ln\left(\frac{P_c}{P}\right)\right]^n \tag{5}$$

$$\ln M = \sum_{n=0}^{3} c_n \left[\ln\left(\frac{P_c}{P}\right)\right]^n \tag{6}$$

$$I^2 = \sum_{n=0}^{5} d_n \left[\ln\left(\frac{P_c}{P}\right)\right]^n \tag{7}$$

$$C_F = \frac{32.174\ I}{c^*} \tag{8}$$

$$I_{vac} = I + \frac{c^* \epsilon}{\frac{P_c}{P} 32.174} \tag{9}$$

$$h = h_c - \frac{I^2}{(294.98)^2} 1000 \tag{10}$$

Equations (4) to (7) are of the form of equation (1). In reference 2, the logarithmic form for the functions P_c/P, T, M, and ϵ and the form I^2 are shown to be preferable to the linear form for accuracy of interpolation. The coefficients in equations (4), (5), and (6) are determined by means of equations (1) and (2), and the coefficients in equation (7) by means of equations (1), (2) and (3), as described in the previous section. The order of calculation is, first, to interpolate a value of pressure ratio corresponding to an assigned are ratio by using equation (4). This interpolated value of pressure ratio is then used in equations (5), (6), and (7) to interpolate corresponding values of T, M and I. The interpolated values of P_c/P and I are then used in equations (8) to (10) together with the assigned value of ϵ and values of h_c and c^* known from the combustion and throat conditions to obtain corresponding interpolated values for C_F, I_{vac}, and h.

Accuracy of Interpolation

An indication of the accuracy of interpolation may be obtained from a sampl problem. It is expected that accuracy of interpolation should be least for thos propellants that have considerable dissociation of combustion products due to the effect of changing compositions during expansion. Therefore, a propellant that has a high combustion temperature, 4415° K, and consequently considerable dissociation was selected for the sample problem. The fuel is a 50-50 mixture b weight of hydrazine and unsymmetrical dimethyl hydrazine, and the oxidizer is fluorine. The propellant is at an oxidant-to-fuel weight ratio of 2.5 and a chamber pressure of 1000 pounds per square inch absolute. The same thermodynami data were used as for the sample problems of reference 1. The schedule of assigned area ratios selected is 2.5, 5, 10, 15, 25, 40, 50, 60, 100, 300, and 500 all on the divergent side of throat. The schedule of pressure ratios chosen to cover the range of these area ratios is 3, 10, 30, 100, 300, 1000, 3000, 10,000 and 30,000. The results are given in tables I and II. Table I contains the results for combustion, throat, and the schedule of assigned pressure ratios for equilibrium composition during expansion. Table II contains the interpolated values of table I data for the schedule of assigned area ratios.

To check the accuracy of the interpolated data, the interpolated pressure ratios of table II were read in as a new schedule of pressure ratios. The directly computed data for these pressure ratios are given in table III. A comparison of tables II and III shows that all the interpolated data except vacuum specific impulse, temperature, and molecular weight are correct to all figures tabulated for all the assigned area ratios. Vacuum specific impulse is correct

to all figures tabulated except for the area ratio of 60, where it is off by only one unit in the last place. Temperature and molecular weight are also correct to all figures tabulated for about half of the area ratios. For the other area ratios, molecular weight differs by 1 to 3 units in the fifth figure and temperature by 1 or 2 units in the fourth figure.

The same excellent accuracy of interpolation was obtained for several other problems checked. In general, it is felt that no closer spacing of initial pressures will be needed to obtain interpolated data that are good to about the same number of significant figures as tabulated in table I for the original data.

To check the accuracy obtainable with fewer initial pressure ratios, a check similar to that given in tables I, II, and III was made, except for starting with a short pressure ratio schedule of 10, 100, 1000, and 10,000 (besides combustion and throat). In this case, specific impulse was correct to all figures tabulated. Vacuum specific impulse was correct to all figures tabulated except for area ratios of 10 and 25, where it was off by 0.1 pound-second per pound. Temperature was off from 0° to 7° and molecular weight from 0 to 0.017. Other problems that were checked gave about the same results. Therefore, for many cases, the short pressure ratio schedule will also permit excellent accuracy of interpolation.

As expected, the same type of check for frozen composition performance gave even better interpolated results than the check for equilibrium composition performance due to the absence of the recombination effect on the data.

COMPUTER PROGRAM

In addition to the area-ratio-interpolation option, several modifications and corrections to the program of reference 1 are discussed in the following sections. Since the IBM 704 is no longer used at this Research Center, these changes to the program of reference 1 have been made for the IBM 7090 only, except for the few corrections to the IBM 704 program.

Area-Ratio Interpolation

In order to include the area-ratio-interpolation option in the program presented in reference 1, it was necessary to add the new routines SANFO, SET, MGAUS, and EXITT and also to make a few modifications in the existing routines MAIN PROGRAM, CORE5, PERPAR, and VAR. The FORTRAN listing of the IBM 7090 program containing these new routines and modifications is presented in appendix A. Those statements in the modified subroutines that differ from those of reference 1, to permit area-ratio interpolation, are indicated by the typed words "area ratio" that appear to the right of the statements.

Optional Reading of Thermal Data from Cards

In addition to the program input to be discussed in the section PROGRAM INPUT DATA, thermodynamic data must be supplied to the program. These data are

assumed to be available as a master data tape that must be loaded onto tape handler number four at the start of computation and unloaded when the computations have been completed. Since this master data tape is used for both reading and writing, it cannot be file-protected. Loading and unloading the data tape are time-consuming and costly. Unless a tape handler is available for the exclusive use of the thermodynamic data tape, it is more economical to make the data tape from binary cards than to stop the computer for loading and unloading the data tape. The following changes will permit operation in this fashion: For the IBM 7090 program, replace card number 123, page 87 of reference 1 (PAUSE 11111) with

```
        REWIND 4
5000    CALL BCREAD (DATA(44), DATA(1))
        DATA(23) = DATA(26)
        WRITE TAPE 4, (DATA(I), I = 1, 23)
        IF (MDATA(1)-MEND) 5000, 429, 5000
```

Also remove card number 332, page 88 of reference 1 (PAUSE 77777). The corresponding change for the IBM 704 program involves replacing card number 106, page 50 of reference 1 (PAUSE 11111) with

```
        REWIND 4
5000    CALL BCREAD (DATA(44), DATA(1))
        DATA (23) = DATA(26)
        WRITE TAPE 4, (DATA(I), I = 1, 23)
S       CLA DATA (1)
S       SUB END
S       TNZ*5000
```

and removing card number 432, page 53 of reference 1 (PAUSE 77777). If these changes are made, the master data tape is no longer needed but the equivalent binary cards must be available. These can be made from the master data tape.

These changes use the subroutine BCREAD (A,B). This subroutine is part of the computer system at Lewis and is given in appendix B. Its only function is to read the absolute binary cards punched by a companion subroutine BCDUMP (A,B), which is also given in appendix B. These subroutines are given in FAP, with the assembled binary equivalents appearing to the left of each instruction. The BCREAD subroutine is assembled on four binary cards, while BCDUMP is on seven binary cards.

In both subroutines the arguments A and B are the first and last words, respectively, to be read or punched, and the address of A must be less than or equal to the address of B. In FORTRAN, arrays are stored in reverse order. Therefore, in dumping or reading the array DATA (I), the last member of the array, DATA (44), is dumped or read first, since its address is the lowest of the entire array. Each binary card contains 22 words of information, and thus, since the data for each species require 23 words (see fig. 6 of ref. 1), two cards are required for each species. The second of each pair of cards contains the first 22 words. The first card of each pair contains the first three words of the record, for identification purposes, plus the 23rd word. These two

subroutines are not essential and can be replaced by any equivalent subroutines or sequence of instructions.

In the event thermal data are read in as binary cards, they are considered as part of the input and precede the input cards described in table V. The last pair of binary cards contains the word END in DATA (1).

H,P Problem (Combustion Properties Only)

A few modifications were made in the subroutines MAIN, CORE2, and HEAD in order to permit obtaining combustion properties for a series of pressures. These modifications are indicated in the program listings in appendix A by the letters "H,P" that appear to the right of the statements.

A sample output for an H,P type of problem is given in table IV. The same thermodynamic data were used as for the sample problems in reference 1. The input for the H,P problem is discussed under PROGRAM INPUT DATA.

While the program of reference 1 can produce the same type of combustion information when run as an H,S problem, data for only one assigned pressure rather than for a series of pressures can appear on the same output sheet. In addition, the H,P problem does not calculate throat data, as the H,S problem does, which are not needed when only combustion properties are desired.

Specifying Reactants in Terms of Moles

The subroutines MAIN, INPUT, OUT, and CORE5 and the format of the reactant card (card type 1, table V) were modified in order to permit the option of specifying either the number of moles or the relative weights of reactants. In the program of reference 1, only relative weights can be specified. The program modifications are indicated in the program listing in appendix A by the typed word "moles" appearing to the right of the appropriate statements.

The modifications to the reactant card format are discussed under PROGRAM INPUT DATA.

Shift Functions

To avoid a possible source of error in the use of the four shift functions ALSF(N,X), ARSF(N,X), LLSF(N,X), and LRSF(N,X) discussed on pages 24 and 25 of reference 1, it should be noted that these functions do not destroy the contents of the multiplier-quotient register C(MQ), although C(MQ) may be altered as a result of the shifting. This fact is used in some portions of the program to avoid storing C(MQ). Therefore, any routines written to replace these functions must not destroy C(MQ). Appendix D presents the FAP coding for an acceptable subprogram of the function type that can be used to replace the four shift functions.

Corrections to Reference 1

Equation (47) of reference 1 is given incorrectly. It should be

$$\mathcal{F}_c - \mathcal{F}_g \leq 0$$

Several errors in the IBM 7090 program appear in subroutines MAIN, CORE2, INPUT, and CORE4. In the program listing of these subroutines in appendix A, the corrected statements are indicated by the typed word "correction" that appears to the right of the statements.

The corrections to the IBM 704 program are given in appendix C.

PROGRAM INPUT DATA

Table V presents six types of input cards. Five of these types (1, 2, 3, 4, and 6) were discussed and given as table VIII in reference 1. The following sections discuss the changes in input for the area-ratio-interpolation option, the H,P problem, and the specification of reactants in terms of moles.

Input for Area Ratio Interpolation

The new type 5 card, the area-ratio schedule, permits area-ratio interpolation as an option. It should be noted that in the input of reference 1 only one blank card follows the schedule of P_c/P (or P or T). In the modified program presented herein, however, two blank cards follow the schedule of P_c/P (or P or T) if an area-ratio schedule is not included.

If the interpolation is for area ratios all on the divergent side of the nozzle, a maximum of 13 assigned area ratios is permitted. If interpolation is for area ratios all on the convergent side or on both sides of the throat, a maximum of only 12 assigned area ratios is possible, since a dummy area ratio of unity is needed. On the area ratio schedule cards, the convergent-side area ratios must be first, followed by unity, and then the divergent-side area ratios. If only divergent-side area ratios are desired, they need not be preceded by unity.

The schedule of assigned pressure ratios should be selected to cover the range of the area ratios desired. The pressure ratios, following combustion and throat, should be in ascending order. As in reference 1, 25 pressure ratios are still permitted if area ratio interpolation is not desired; however, only 11 pressure ratios in addition to combustion and throat are permitted when area-ratio interpolation is desired. As indicated in the section on "Accuracy of Interpolation", 11 pressure ratios will usually be more than sufficient.

Input for H,P Problem

The H,P problem is specified by the code H,P on the problem card (card type 3, table V). The rest of the input for the H,P problem is the same as for the

H,S problem except that in the former case the schedule cards (card type 4, table V) contain assigned pressures in atmospheres, whereas in the latter case the schedule cards contain assigned pressure ratios.

Input for Specifying Reactants in Terms of Moles

For the program of reference 1, columns 46 through 53 on the reactant card (card type 1, table IX, ref. 1) were reserved for specifying relative weights of propellants. This reactant card has been modified to reserve columns 46 through 52 for specifying relative weights or number of moles. If relative weights are being specified, column 53 is left blank. If the number of moles is being specified, the letter "M" (for moles) is keypunched into column 53. For each problem, either all of the reactants must be specified as moles or all of them must be specified as relative weights.

Two examples of reactant cards with the new format are given in table VI. When specifying the reactants in terms of moles, the first 30 columns for $\mathcal{R}$, O/F, and %F on the mixture card (card type 6, table V) may be left blank. In this event, the number of moles of fuel relative to oxidant is assumed by the program to be as given on the reactant cards. If, on the other hand, O/F, $\mathcal{R}$, or %F is specified on the mixture card, the number of moles of fuel relative to oxidant is adjusted accordingly.

AVAILABILITY OF PROGRAM

As indicated on page 25 of reference 1, the source program decks will be made available to qualified computing centers if a written request is addressed to the authors at the Lewis Research Center. The IBM 7090 program supplied will include the changes given in this report.

Lewis Research Center
National Aeronautics and Space Administration
Cleveland, Ohio, April 23, 1963

APPENDIX A

PROGRAM LISTING FOR IBM 7090

```
C     MAIN PROGRAM
C
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),   C(421)),   (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),  C(1359)),   (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),   (EN(90),   C(1471))
      EQUIVALENCE   (ISYS,     C(1472)),    (JEAN,     C(1473))
      EQUIVALENCE   (ACX,      C(1474)),    (ACF,     C(1475))
      EQUIVALENCE   (AMX,        C(1476)),    (AMF,      C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),    (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),   (DX(20),   C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),   (PROD(3),   C(1540))
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),   C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (OF,     C(1556)),     (FPCT,   C(1557))
      EQUIVALENCE   (EORAT,      C(1558))
      EQUIVALENCE (KODE,    C(1559)),    (KASE,       C(1560))
      EQUIVALENCE   (KONT,   C(1561)),    (NF,          C(1562))
      EQUIVALENCE   (NO,         C(1563)), (NE,         C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),    C(1785))
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),    C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LCRUM,      C(2323))
```

```
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))
      EQUIVALENCE   (L,          C(2325)), (L1,         C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,         C(2328))
      EQUIVALENCE   (N,          C(2329)), (IG,         C(2330))
      EQUIVALENCE   (IG1,        C(2331)), (IG2,        C(2332))
      EQUIVALENCE   (IG3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,       C(2335))
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,     C(2337))
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IERUZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),   C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE (KORE, C(8047))
      EQUIVALENCE(MT,DMT)
      EQUIVALENCE (HS,MHS),(TS,MTS),(PT,MPT),(TP,MTP),(DET,MDET)
      EQUIVALENCE (PROB,MPROB),(END,MEND)
      EQUIVALENCE (TMLM,MTMLM) , (BLK,MBLK)
      EQUIVALENCE(NAREA,C(10607))
      EQUIVALENCE(SAREA(1),C(10608)),(SAREA(13),C(10620))
      EQUIVALENCE  (IUNDER,C(10621))
      EQUIVALENCE  (IOVER,C(10622))
      EQUIVALENCE  (KSAN,C(10623))
      EQUIVALENCE  (WX,C(10624))
      EQUIVALENCE  (WF,C(10625))
      EQUIVALENCE (H P,MHP)
C
      DIMENSION SAREA(13)
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
C
C
B1    H S=307362606060
B     T S=637362606060
B     P T=477363606060
B     T P=637347606060
B     DET=242563456060
B     END=254524606060
B     BLK=000000000060
B     OMIT=464431636060
B     DMT=606060606060
B     H P=307347606060
C
C
C     READ IN INPUT DATA
C
      IF (ISYS-99) 401,403,401
  403 READ TAPE 3,(G(I),I=1,8044)
      REWIND 3
      IF (SENSE SWITCH 6) 651,719
  401 ISYS=99
      IERUZ=0
      PAUSE 11111
  429 CALL INPUT
      IF (L) 651,651,433
  433 WRITE OUTPUT TAPE 6,443, HX,VXPLS,VXMIN,HF,VFPLS,VFMIN
     1, (ELMT(I),BOX(I),BOF(I),I=1,L)
  443 FORMAT (10H10XIDANT  3E16.6/10H FUEL     3E16.6/(1H A6,2E20.8))
C
C     RIGHT ADJUST ELEMENT SYMBOLS
C
      DO 447 K=1,L
      TMLM = ELMT(K)
      ELMT(K) = ARSF(24, TMLM)
```

Area ratio

Moles

Moles

Moles

H,P

Area ratio

H,P

```
B     TMLM = ELMT(K) *000000000077
      IF (MTMLM-MBLK) 447,1447,447
 1447 TMLM = ELMT(K)
      ELMT(K) = ARSF(6, TMLM)
  447 CONTINUE
      IF(SYSTM(L+1))453,920,453
  920 IF (SYSTM(L)) 921,453,921
  921 DO 449 K=1,L
      DO 448 J=1,L
      IF (LLMT(K)-MTSYS(J)) 448,449,448
  448 CONTINUE
      GO TO 453
  449 CONTINUE
C
C     CANCEL ---OMITS---FROM PREVIOUS PROBLEM
C
  452 DO 1452 J=1,M
      COEFT1(1,J) = DMT
      COEFT2(1,J) = DMT
 1452 COEFT(1,J) = DMT
      IUSE=1
      GO TO 598
  453 DO 459 K=1,15
  459 SYSTM(K)=ELMT(K)
      CALL SEARCH
  598 IF (IUSE-2) 600,635,635
C
C     SET ARRAY  PROD  TO BYPASS ALL CONDENSED PHASES
C
  600 PROD(1)=0.0
      PROD(2)=0.0
      IF (M-35) 198,198,1198
 1198 IF (M-70) 199,199,1199
 1199 IF (M-90) 200,200,635
B198  PROD(2)=377777777777
B     PROD(3) = 377777777777
      TMP=PROD(2)
      PROD(1)=ARSF(M,TMP)
      GO TO 201
  199 M12 = M-35
B     PROD(3) = 377777777777
      TMP=PROD(3)
      PROD(2)=ARSF(M12,TMP)
      GO TO 201
  200 M12 = M-70
B     PROD(3) = 377777777777
      TMP=PROD(3)
      PROD(3)=ARSF(M12,TMP)
  201 IQ=L
      IQ1=IQ+1
      IQ2=IQ1+1
      IQ3=IQ2+1
      L1=IQ1
      M1=M+1
C
C     DETERMINE WHICH GASEOUS SPECIES SHOULD BE OMITTED FROM THE PROBLEM
C     AND WHICH CONDENSED SPECIES SHOULD BE USED IN THE FIRST ITERATION
C
  203 READ INPUT TAPE 7,204,(DATA(I),I=1,8)
  204 FORMAT (4(2A6,3X))
B     SJW=DATA(1)*(-DMT)
B     IF(SJW)207,220,207
  207 DO 213 K=1,4
      DO 211 J=1,N
      DO 208 I=2,3
      KK=2*K+I-3
B     SJW=DATA(KK)*(-COEFT2(I,J))
B     IF(SJW)211,208,211
  208 CONTINUE
      IF (J-M) 209,209,210
  209 CALL BYPASS (J,2)
11209 GO TO 213
  210 CALL BYPASS (J,3)
11210 GO TO 213
  211 CONTINUE
  213 CONTINUE
      GO TO 203
```

```
  220 CONTINUE
      DO 222 J=1,M
      CALL BYPASS(J,1)
      IF (IPROB - 2) 221,222,221
  221 COEFT1(1,J) = OMIT
      COEFT2(1,J)=OMIT
  222 CONTINUE
C
C     ARRANGE ANSWER REGION
C
      I=1
      DO 602 J=1,N
      ANS(I)=COEFT2(1,J)
      ANS(I+1)=COEFT2(2,J)
      ANS(I+2)=COEFT2(3,J)
      ANS(I+3) = 0.0
  602 I=I+4
      K=4*N
  605 I=K+34
      ANS(I)=ANS(K)
      K=K-1
      IF (K) 651,607,605
  607 DO 609 K=1,34
  609 ANS(K) = 0.0
      DO 1700  K= 1, 454
 1700 ANSLAB(K) = ANS(K)
      DO 1701 J = 1, 15
      DO 1701 K = 1, 90
 1701 COEFT(J,K) = COEFT1(J,K)
C
C     DETERMINE THE TYPE OF PROBLEM
C
  700 IFROZ=1
  701 READ INPUT TAPE 7,703,PROB,KASE
  703 FORMAT (A5,I5)
      IF (MPROB-MHS) 705,901,705
  901 IPROB=1
      GO TO 715
  705 IF (MPROB-MTS) 707,902,707
  902 IPROB=2
      GO TO 715
  707 IF (MPROB-MPT) 709,903,709
  903 IPROB=3
      GO TO 715
  709 IF (MPROB-MTP) 711,904,711
  904 IPROB=4
      GO TO 715
  711 IF (MPROB-MDET) 713,905,713
  905 IPROB=1
      IFROZ=-1
      GO TO 719
  713 IF (MPROB-MHP) 9001,9000,9001
 9000 IPROB=5
      GO TO 715
 9001 IF (MPROB-MT) 631,429,631
  715 DO 716 K=1,25
  716 PCP(K)=0.0
      I=5
 1716 READ INPUT TAPE 7,718,(G(K),K=1,5)
      IF(G(1))1719,1719,717
  717 DO 1717 K=1,5
      IK=I+K
 1717 PCP(IK)=G(K)
      I=I+5
      GO TO 1716
  718 FORMAT(5F10.2)
C
C     READ IN AREA RATIO SCHEDULE
C
 1719 IK = 1
 2013 READ INPUT TAPE 7,718,(G(K),K=1,5)
      IF (G(1)) 2001,2003,2001
 2001 DO 2002  I=1,5
      ANS(IK) = G(I)
 2002 IK = IK+1
      GO TO 2013
```

H,P

Area ratio

Area ratio

```
 2003 NAREA=0                                                          )
      IF(IK-1)2004,719,2004                                            |
 2004 IUNDER=0                                                         |
      DO 2005  I=1,13                                                  |
      IF(ANS(I))2011,2010,2011                                         |
 2011 IF (ANS(I) - 1.00001) 2006,2006,2007                             |
 2007 NAREA = NAREA+1                                                  }Area ratio
      SAREA (NAREA)=ANS(I)                                             |
      GO TO 2005                                                       |
 2006 IUNDER = NAREA                                                   |
 2005 CONTINUE                                                         |
 2010 IOVER=NAREA-IUNDER                                               |
C                                                                      |
C     DETERMINE THE ASSIGNED VALUES FOR THE PROBLEM                    )
C
  719 READ INPUT TAPE 7,721,EQRAT,O F,F PCT,PC,TC,KODE,IDEBUG
  721 FORMAT (5F10.2,I5,16X,I1)
      IF (EQRAT) 725,725,723
  723 O F=(-EQRAT*VFMIN-VFPLS)/(VXPLS+EQRAT*VXMIN)
      F PCT=100.0/(1.0+O F)
      GO TO 745
  725 IF (O F) 731,731,727
  727 F PCT=100.0/(1.0+O F)
  729 EQRAT=O F*VXMIN+VFMIN                                            Correction
      IF(EQRAT)9050,745,9050                                           Correction
 9050 EQRAT=ABSF((O F*VXPLS+VFPLS)/EQRAT)                              Correction
      GO TO 745
  731 IF(F PCT)9051,9051,733                                           )
 9051 IF (PC+TC)9052,700,9052                                          |
 9052 IF(KSAN)9053,700,9053                                            }Moles
 9053 O F=WX/WF                                                        |
      GO TO 727                                                        |
  733 O F=(100.0-F PCT)/F PCT
      IF (O F)   719,1733,729
 1733 IF (VFMIN) 729, 746,729
  745 IF (O F) 719,746,746
  746 DO 747 I=1,L
  747 BO(I)=(O F*BOX(I)+BOF(I))/(1.0+O F)
      IF (IPROB-1) 651,749,748
  748 IF (IPROB-5) 9002,749,651                                        H,P
 9002 HSUBO=0.0                                                        H,P
      GO TO 755
  749 HSUBO=(O F*HX+HF)/(1.0+O F)
  755 WRITE OUTPUT TAPE 6,760,KASE,PROB,O F,F PCT,EQRAT,PC,HSUBO,
     1 (BO(I),I=1,L)
  760 FORMAT (1H1I5,3X,A6/1H 4E17.8/(1H 7E17.8))
      HSUBO=HSUBO/1.98726
      DO 1771 I = 1, 454
 1771 ANS(I) = ANSLAB(I)
      RHO=RHOX+O F*RHOF
      IF (RHO) 772,772,771
  771 RHO=(1.0+O F)*RHOX*RHOF/RHO
  772 DO 1772 I = 1, 454
 1772 ANSLAB(I) = ANS(I)
  775 IF (IFRO7) 777,651,779
  777 CALL CORE4
      IF (KORE) 1,779,1
  779 CALL CORE2
      GO TO 1
C
C     ERROR PRINT OUT
C
  631 WRITE OUTPUT TAPE 6,633,PROB,KASE
  633 FORMAT (21H1THERE IS NO PROBLEM A6,2X,I5)
      GO TO 651
  635 WRITE OUTPUT TAPE 6,637
  637 FORMAT (47H1TROUBLE IN COMPILING MASTER THERMODYNAMIC TAPE)
      REWIND 4
  639 READ TAPE 4,(DATA(I),I=1,23)
      WRITE OUTPUT TAPE 6,640,(DATA(I),I=1,23)
  640 FORMAT (1H 3A6,2F10.1/(1H 2F8.1,7E14.6))
      IF (MDATA(1)-MEND) 639,900,639
  900 WRITE OUTPUT TAPE 6,643, ((COEFT1(K,J),K=1,14),J=1,N)
      WRITE OUTPUT TAPE 6,643, ((COEFT2(K,J),K=1,14),J=1,N)
  643 FORMAT (1H 3A6,2F15.2/2F8.1,7E12.4//)
  651 REWIND 4
      PAUSE 77777
```

```
      SUBROUTINE SEARCH                                                 0333
C                                                                       0334
C                                                                       0335
      COMMON C                                                          0336
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))        0337
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))        0338
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))        0339
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))        0340
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))        0341
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))        0342
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))        0343
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))        0344
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))        0345
      EQUIVALENCE   (RHO,        C(439))                                0346
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))        0347
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))        0348
      EQUIVALENCE   (T ETA,      C(445))                                0349
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))        0350
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))        0351
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))        0352
      EQUIVALENCE   (AW SIG,     C(453))                                0353
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))         0354
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))         0355
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))         0356
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))         0357
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))          0358
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))         0359
      EQUIVALENCE   (EN(1),   C(1382)),  (EN(90),   C(1471))            0360
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))        0361
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))         0362
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))       0363
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))        0364
      EQUIVALENCE   (COEFX(1),    C(1480)),  (COEFX(20),  C(1499))      0365
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),   C(1519))           0366
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))      0367
      EQUIVALENCE   (MMLA(1),   C(1520)),  (MMLA(18), C(1537))          0368
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),   C(1540))          0369
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),   C(1555))       0370
      EQUIVALENCE   (MISYS(1), C(1541)), (MISYS(15),  C(1555))          0371
      EQUIVALENCE   (OF,     C(1556)),    (FPCT,   C(1557))             0372
      EQUIVALENCE   (EQRAT,      C(1558))                               0373
      EQUIVALENCE (KODE,    C(1559)),   (KASE,      C(1560))            0374
      EQUIVALENCE   (KONT,   C(1561)),   (NF,         C(1562))          0375
      EQUIVALENCE   (NO,         C(1563)), (NE,        C(1564))         0376
      EQUIVALENCE   (NOEQ, C(1565))                                     0377
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),   C(1785))         0378
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),   C(1800))         0379
      EQUIVALENCE   (HX,         C(1801)), (HF,        C(1802))         0380
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,     C(1804))         0381
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,     C(1806))         0382
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))         0383
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))         0384
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),    C(2130))         0385
      EQUIVALENCE   (S(1),       C(2131)), (S(90),     C(2220))         0386
      EQUIVALENCE   (X(1),       C(2221)), (X(20),     C(2240))         0387
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))         0388
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),    C(2275))         0389
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,     C(2277))         0390
      EQUIVALENCE   (SO,         C(2278)), (T LN,      C(2279))         0391
      EQUIVALENCE   (T,          C(2280)), (AAY LN,    C(2281))         0392
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,     C(2283))         0393
      EQUIVALENCE   (HC,         C(2284)), (TC LN,     C(2285))         0394
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),   C(2310))         0395
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),  C(2313))         0396
      EQUIVALENCE   (PC,         C(2314)), (TC,        C(2315))         0397
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,     C(2317))         0398
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,     C(2319))         0399
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,     C(2321))         0400
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,     C(2323))         0401
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,     C(2324))         0402
      EQUIVALENCE   (L,          C(2325)), (L1,        C(2326))         0403
      EQUIVALENCE   (M,          C(2327)), (M1,        C(2328))         0404
      EQUIVALENCE   (N,          C(2329)), (IQ,        C(2330))         0405
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,       C(2332))         0406
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,      C(2335))         0408
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,      C(2334))         0407
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,    C(2337))         0409
```

```
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),   C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE (C12,MM),(E,ME),(END,MEND),(BLK,MBLK),(RPN,MRPN)
      EQUIVALENCE (GAS,MGAS),(SOL,MSOL),(BLIQ,MLIQ),(BLPN,MLPN)
      EQUIVALENCE (C10,MC10),(PLS,MPLS),(SYMBL,MBL),(BMIN,MMIN)
      EQUIVALENCE (TMP1, MTMP1)
C
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
      DIMENSION MMLA(18)
C
C
B     BLK=00C000C00060
B     RPN=00C000C00034
B     BLPN=000000C000074
B     GAS=00C000C00027
B     SOL=00C000C00062
B     BLIQ=000000C000043
B     PLS=00C000C00020
B     BMIN=000000C000040
B     E=0000C0000025
B     END=254524606060
B     C10=000000C00012
B     C12=000014C00000
B     CF10=000012000000
C
C
      KION=2
      DO 1 K=1,L
      IF (LLMT(K)-ME) 1,2,1
    1 CONTINUE
      GO TO 3
    2 KION=1
      TEMP=ELMT(K)
      ELMT(K)=ELMT(L)
      ELMT(L)=TEMP
    3 ISOL=0
      M=0
      DO 4 J=1,15
      DO 4 K=1,9C
      COEFT2(J,K) = 0.0
    4 COEFT1(J,K) = 0.0
      DO 6 J=1,1350
    6 A(J) = 0.0
      REWIND 4
    7 READ TAPE 4, (DATA(I),I=1,23)
      IF (MDATA(1)-MEND) 900,171,900
C
C     UNPACK THE BCD FORMULA FOR THE PRODUCT
C
  900 DO 16 I=1,2
   16 DATUM(I)=DATA(I)
      J=1
      I=1
   13 K=0
   17 TMP1 = DATUM(I)
      FORMLA(J) = ARSF(30,TMP1)
B     DATUM(I) = ALSF(600000C,TMP1)
      J=J+1
      IF (K-4) 925,925,21
  925 K = K+1
```

```
      GO TO 17
   21 IF(I-1) 926,926,25
  926 I=I+1
      GO TO 13
C
C     BEGIN SEARCH FOR FIRST NON BLANK ALPHANUMERIC CHARACTER
C
   25 J=12
   29 J=J
      IF (MMLA(J)-MBLK) 35,950,35
  950 IF (J-1) 30,30,951
  951 J = J-1
      GO TO 29
   30 WRITE OUTPUT TAPE 6,31,(DATA(I),I=1,3)
   31 FORMAT (14H THE FORMULA  3A6,33H  IS INCORRECT ON THE MASTER TAPE)
      GO TO 7
   35 IF (MMLA(J)-MRPN) 30,952,30
  952 J = J-1
      IF (MMLA(J)-MGAS) 953,39,953
  953 IF (MMLA(J)-MSOL) 954,41,954
  954 IF (MMLA(J)-MLIQ) 30,41,30
   39 ITYPE=1
      GO TO 47
   41 ITYPE=2
   47 J=J-1
      IF (MMLA(J)-MLPN) 30,955,30
  955 J=J-1
C
C     OBTAIN AND STORE THE FORMULA NUMBERS A(K,J)
C
      DO 48 K=1,15
   48 FORM(K)=0.0
   51 NLSW=1
      NUMB=0
   55 ICNT=0
   57 JCNT=J-ICNT
      IF (JCNT) 30,81,59
   59 IF (MMLA(JCNT) - MC10) 958,67,67
  958 GO TO (63,85),NLSW
   63 ICNT=ICNT+1
      GO TO 57
   67 GO TO (69,63),NLSW
   69 IF (ICNT) 959,330,959
  330 IF(KION-1)30,333,30
  333 NLSW=2
      GO TO 57
  959 IF (ICNT-2) 77,73,30
   73 NUMB = MMLA(J-1) * 10
   77 TMP1 = FORMLA(J)
      TMP1 = ALSF(18,TMP1)
B     TMP1 = TMP1 * 377777777777
B     TMP2 = FORMLA(J)*400000000000
B     TMP1 = TMP1+TMP2
      NUMB = NUMB+MTMP1
      VALUE = NUMB
      J=J-ICNT
      NLSW=2
      GO TO 55
   81 GO TO (30,85),NLSW
   85 IF (ICNT) 960,30,960
  960 SYMBL = 0.0
      IF(NUMB)86,95,86
   86 IF (ICNT-2) 93,89,30
   89 TMP1 = FORMLA(J-1)
      SYMBL = ALSF(6,TMP1)
   93 MBL = MBL + MMLA(J)
      GO TO 107
   95 IF(JCNT)30,30,96
   96 IF (MMLA(J)-MPLS) 97,970,97
  970 FORM(L)=-ICNT
      GO TO 109
   97 IF (MMLA(J)-MMIN) 107,975,107
  975 FORM(L)=ICNT
  101 GO TO 109
  107 DO 111 K=1,L
      IF (MBL-LLMT(K)) 111,105,111
  111 CONTINUE
```

```
      GO TO 7
  105 FORM(K)=VALUE
  109 J=J-ICNT
      IF (J) 30,121,51
  121 IF (ITYPE-1) 30,133,137
  133 M=M+1
      J=M
      GO TO 145
  137 J=90-ISOL
      ISOL=ISOL+1
  145 DO 147 K=1,L
      A(K,J)=FORM(K)
  147 CONTINUE
C
C     ARRANGE THERMODYNAMIC DATA IN CORE ORDERED BY INTERVAL
C
  151 IT=0
      TEMP = DATA(1)
      DATA(1) = DATA(3)
      DATA(3) = DATA(2)
      DATA(2) = TEMP
      DO 155 K=1,5
  155 COEFT1(K,J) = DATA(K)
      DO 159 K=6,14
      KIT= K+IT
  159 COEFT1(K,J) = DATA(KIT)
      IT=IT+9
      DO1955 K=1,5
 1955 COEFT2(K,J) = DATA(K)
      DO1959 K=6,14
      KIT = K+IT
 1959 COEFT2(K,J) = DATA(KIT)
      GO TO 7
C
C     GO TO NEXT MOLECULE
C
C
C     ELIMINATE GAP BETWEEN GASES AND CONDENSED PHASES
C
  171 N=M+ISOL
      IUSE=1
  173 IF (N-90) 175,225,181
  175 IF (ISOL) 177,225,184
  177 IUSE=2
      GO TO 225
  181 WRITE OUTPUT TAPE 6,182
  182 FORMAT (45H TOO MANY REACTION PRODUCTS FOUND ON THE TAPE)
      IUSE=2
      GO TO 225
  184 KK = 90-ISOL
      DO 186 J = 1, ISOL
      MJ = M+J
      KJ = KK + J
      DO 186 K = 1,15
  186 COEFT1(K,MJ) = COEFT1(K,KJ)
      DO 185 J = 1,ISOL
      MJ = M+J
      KJ = KK + J
      DO 185 K = 1,15
  185 COEFT2(K,MJ) = COEFT2(K,KJ)
      DO 219 J=1,ISOL
      MJ=M+J
      KJ = KK +J
      DO 217 K=1,15
      A(K,MJ) = A(K,KJ)
  217 CONTINUE
  219 CONTINUE
      GO TO 225
  225 RETURN
```

```
      SUBROUTINE BYPASS (J,IARG)
C
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),  (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),  (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),  (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),  (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),  (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),  (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),  (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),  (PI I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),  (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),  (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),  (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),  (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),   C(1382)),  (EN(90),   C(1471))
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),   C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),   C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),   C(1540))
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),   C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (OF,     C(1556)),     (FPCT,   C(1557))
      EQUIVALENCE   (FQRAT,      C(1558))
      EQUIVALENCE (KODF,    C(1559)),   (KASE,      C(1560))
      EQUIVALENCE   (KONT,   C(1561)),   (NF,         C(1562))
      EQUIVALENCE   (NO,         C(1563)), (NE,         C(1564))
      EQUIVALENCE   (NOFQ, C(1565))
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),   C(1785))
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),   C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))
      EQUIVALENCE   (L,          C(2325)), (L1,         C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,         C(2328))
      EQUIVALENCE   (N,          C(2329)), (IG,         C(2330))
      EQUIVALENCE   (IG1,        C(2331)), (IG2,        C(2332))
      EQUIVALENCE   (IG3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,       C(2335))
      EQUIVALENCE   (IADD,       C(2336)), (IINUMB,     C(2337))
```

```
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),   C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE (CONS,JFCONS),   (MTEMP, TEMP)
C
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
C
C
C     IARG=1 MEANS TEST ONLY, IARG=2 MEANS ELIMINATE A SPECIES, IARG=3
C     MEANS ADD ANOTHER SPECIES
C
B     CONS=1
      MLM=J
      IF (J-35) 2,2,102
  102 IF (J-70) 1,1,101
  101 K=3
      MLM=J-70
      GO TO 3
    1 K=2
      MLM=J-35
      GO TO 3
    2 K=1
    3 IF (IARG-2) 4,5,7
    4 IPROD=2
      KLM = 35-MLM
      TEMP = PROD(K)
      TEMP = LRSF(KLM,TEMP)
B     IF (TEMP*CONS) 12,10,12
   12 IPROD = 1
      GO TO 10
    5 KLM = 35 - MLM
      TEMP = PROD(K)
      TEMP = LRSF(KLM,TEMP)
B     IF (TEMP * CONS) 10,6,10
B6    TEMP = TEMP +1
B     PROD(K) = LLSF(KLM,TEMP)
      IF(M-J)11,10,10
   11 IQ3=IQ2
      IQ2=IQ1
      IQ1=IQ
      IQ =IQ-1
      GO TO 9
    7 KLM = 35 - MLM
      TEMP = PROD(K)
      TEMP = LRSF(KLM,TEMP)
B     IF (TEMP * 1) 110,10,110
  110 MTEMP=MTEMP-JFCONS
B     PROD(K) = LLSF(KLM, TEMP)
      IF(M-J)121,10,10
  121 IQ = IQ1
      IQ1=IQ2
      IQ2=IQ3
      IQ3=IQ3+1
    9 SENSE LIGHT 4
   10 RETURN
```

```
      SUBROUTINE INPUT
C
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),  (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),  (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),  (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),  (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),  (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),  (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),  (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),  (P1 I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),  (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),  (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),  (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),  (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),   C(1382)),  (EN(90),   C(1471))
      EQUIVALENCE   (ISYS,     C(1472)),   (JEAN,     C(1473))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,     C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,      C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,    C(1479))
      EQUIVALENCE   (COEFX(1),    C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),   C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),   C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),   C(1540))
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),   C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (DF,     C(1556)),    (FPCT,   C(1557))
      EQUIVALENCE   (ECRAT,      C(1558))
      EQUIVALENCE (KODE,    C(1559)),   (KASE,       C(1560))
      EQUIVALENCE   (KONT,   C(1561)),   (NF,         C(1562))
      EQUIVALENCE   (ND,         C(1563)), (NE,        C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE (KD, C(1763))
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),   C(1785))
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),   C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,        C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,     C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,     C(1806))
      EQUIVALENCE (TELMT(1), C(1807)), (TELMT(15), C(1821))
      EQUIVALENCE   (EN LN(1),  C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),  C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),    C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),     C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),     C(2240))
      EQUIVALENCE   (DELTA(1),  C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),    C(2275))
      EQUIVALENCE   (PC,         C(2276)), (HSUBO,     C(2277))
      EQUIVALENCE   (SC,         C(2278)), (T LN,      C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,    C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,     C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,     C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),   C(2310))
      EQUIVALENCE   (DATUM(1),  C(2311)), (DATUM(3),  C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,        C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,     C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,     C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,     C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,     C(2323))
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,     C(2324))
      EQUIVALENCE   (L,          C(2325)), (L1,        C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,        C(2328))
      EQUIVALENCE   (N,          C(2329)), (IG,        C(2330))
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,       C(2332))
```

```
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,       C(2335))
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,     C(2337))
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))
      EQUIVALENCE (MANAME(1),ANAME(1)),(MANAME(5),ANAME(5))
      EQUIVALENCE  (KSAN,C(10623))
      EQUIVALENCE  (WX,C(10624))
      EQUIVALENCE  (WF,C(10625))
      EQUIVALENCE (ASANN, MSANN)
      EQUIVALENCE (ASAN,MSAN)
C
      DIMENSION TELMT(15)
      DIMENSION   G(20,21),   A(15,46),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
      DIMENSION MANAME(5),     ANAME(5),      ANUM(5)
C
C
C  SUBROUTINE TO COMPUTE PROPELLANTS
B     ASANN = 446060606060
B     OX=466C6C6C6060
      IF(JEAN-222)51,50,51
   51 CALL BCREAD(ATOM(101,3),ATOM(1,1))
   50 DO 52 I=1,15
B     ELMT(I)=00C00
B     BOF(I)=000C00C0C000
B     BOX(I)=000C00000000
      DO 52 J=1,46
B     A(I,J)=000C00000000
   52 CONTINUE
      TOTAL=0.0
      NF=0
      NO=0
      NE=C
      WRITE OUTPUT TAPE 6,400
  400 FORMAT(8H1  INPUT//)
  100 READ INPUT TAPE 7,1,(ANAME(I),ANUM(I),I=1,5),PECWT,ASAN,ENTH,
     2DEN,TEMP,ETHR,DENS
    1 FORMAT(5(A2,F7.5),F7.5,A1,F9.5,A1,F8.5,A1,F8.5)
      IF(ANUM(1))99,200,99
   99 WRITE OUTPUT TAPE 6,402,(ANAME(I),ANUM(I),1=1,5),PECWT,ASAN,ENTH,
     1DEN,TEMP,ETHR,DENS
  402 FORMAT(1X,5(A2,1X,F7.4,2X),F8.4,2X,A1,2X,F9.2,2X,A1,2X,F8.3,2X,
     2A1,3X,F8.5)
      IF (MSAN - MSANN) 501,500,501
  500 KSANN = 1
      GO TO 502
  501 KSANN = 0
  502 DO 9 I=1,5
    9 TOTAL=TOTAL+ANUM(I)
      IF(ETHR-OX)11,10,11
   10 NO=NO+1
      KK=NO
      KKK=NO
      NN=31
      GO TO 12
   11 NF=NF+1
      KK=NF+15
      KKK=NF
      NN=32
   12 DO 98 J=1,5
      IF(ANUM(J)) 96,97,96
```

Moles

Moles

Moles

Moles

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```
   96 DO 31 I=1,15
      IF(ANAME(J)-ELMT(I)) 21,20,21
   20 NHUT=0
   33 KT=I
      GO TO 30
   21 IF(ELMT(I)) 31,22,31
   22 ELMT(I)=ANAME(J)
      NE=NE+1
      NHUT=1
      GO TO 33
   31 CONTINUE
   30 IF(NHUT)14,15,14
   14 DO 16 I=1,101
      IF (MATOM(I,1)-MANAME(J)) 16,17,16
   17 II=I
      GO TO 18
   16 CONTINUE
      WRITE OUTPUT TAPE 6,199
  199 FORMAT (32H0 THERE IS A BAD PROPELLANT CARD)
      L=-1
      RETURN
   18 A(NE,37)=ATOM(II,2)
      A(NE,38)=ATOM(II,3)
   15 A(KT,KK)=ANUM(J)
   98 CONTINUE
   97 A(KKK,NN)=ENTH
      A(KKK,NN+2)=PECWT
      A(KKK,NN+4)=DENS
      A(KKK,NN+10)=DEN
      A(KKK,NN+12)=TEMP
      A(KKK,NN+14)=ETHR
      GO TO 100
  200 IF(NE)202,201,202
  201 L=0
      RETURN
  202 JEAN=222
B     WX=000000000000
B     WF=000000000000
B     HX=000000000000
B     HF=000000000000
B     RHOX=000000000000
B     RHOF=000000000000
B     VXPLS=000000000000
B     VXMIN=000000000000
B     VFPLS=000000000000
B     VFMIN=000000000000
B     ACX=000000000000
B     ACF=000000000000
B     AMX=000000000000
B     AMF=000000000000
      KSAN=KSANN
      DO552 J=1,NO
      DO552 I=1,NE
  552 A(J,39)=A(J,39)+A(I ,37)*A(I ,J )
      DO 53 J=1,NF
      DO 53 I=1,NE
   53 A(J,40)=A(J,40)+A(I,37)*A(I,J+15)
      IF (KSAN) 9001,9000,9001
 9001 DO 9002  I=1,NO
      ANS(I)=A(I,33)
 9002 A(I,33)=A(I,33)*A(I,39)
      DO 9003  I=1,NF
      G(I)=A(I,34)
 9003 A(I,34)=A(I,34)*A(I,40)
 9000 CONTINUE
      IF (NO) 1000,1001,1000
 1000 DO 550 I=1,NO
   54 HX=HX+A(I,31)*A(I,33)/A(I,39)
  550 WX=WX+A(I,33)
 1001 IF (NF) 1002,1003,1002
 1002 DO 551 I=1,NF
   55 HF=HF+A(I,32)*A(I,34)/A(I,40)
  551 WF=WF+A(I,34)
 1003 IF (NO) 1004,1005,1004
 1004 DO 42 I=1,NO
      ACX=ACX+A(I,35)*A(I,33)/A(I,39)
   42 AMX=AMX+A(I,33)/A(I,39)
```

Moles

Moles

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      ACX=ACX/WX
      AMX=WX/AMX
 1005 IF (NF) 1006,1007,1006
 1006 DO 43 I=1,NF
      ACF=ACF+A(I,36)*A(I,34)/A(I,40)
   43 AMF=AMF+A(I,34)/A(I,40)
      ACF=ACF/WF
      AMF=WF/AMF
 1007 IF (WX) 1020,1021,1020
 1020 HX=HX/WX
 1021 IF (WF) 1022,1023,1022
 1022 HF =HF/WF
 1023 DO 60 I=1,NO
      IF(A(I,35))60,71,60
   60 RHOX=RHOX+A(I,33)/A(I,35)
      RHOX=WX/RHOX
   73 DO 61 I=1,NF
      IF(A(I,36))61,71,61
   61 RHOF=RHOF+A(I,34)/A(I,36)
      RHOF=WF/RHOF
      GO TO 74
   71 RHOX = 0.0
   72 RHOF = 0.0
   74 IF (NO) 1008,1009,1008
 1008 DO 57 I=1,NF
      DO 56 J=1,NO
   56 BOX(I)=BOX(I)+A(I,J)*A(J,33)/A(J,39)
   57 BOX(I)=BOX(I)/WX
 1009 IF (NF) 1010,1011,1010
 1010 DO 59 I=1,NF
      DO 58 J=1,NF
   58 BOF(I)=BOF(I)+A(I,J+15)*A(J,34)/A(J,40)
   59 BOF(I)=BOF(I)/WF
 1011 DO 62 I=1,NF
      IF(A(I,38))63,62,64
   64 VXPLS=VXPLS+BOX(I)*A(I,38)
   67 VFPLS=VFPLS+BOF(I)*A(I,38)
      GO TO 62
   63 VXMIN=VXMIN+BOX(I)*A(I,38)
   66 VFMIN=VFMIN+BOF(I)*A(I,38)
   62 CONTINUE
      IF (WX) 1030,1031,1030
 1030 DO 40 I=1,NO
   40 A(I,33)=A(I,33)/WX
 1031 IF(WF) 1040,1050,1040
 1040 DO 1041 I= 1,NF
 1041 A(I,34)=A(I,34)/WF
C
C     SAVE ELEMENT ARRAY FOR CORE 4
C
 1050 DO 2000 I=1,15
 2000 TELMT(I) = ELMT(I)
      L=NE
      TOTAL = MODF(TOTAL,1.0)
      IF(TOTAL)1142,1143,1142
 1142 KD=1
      GO TO 9050
 1143 KD=0
 9050 IF(KSAN)9011,9010,9011
 9011 DO 9012  I=1,NO
 9012 A(I,33)=ANS(I)
      DO 9013  I=1,NF
 9013 A(I,34)=G(I)
 9010 RETURN
```

Correction

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      SUBROUTINE  CORE2
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),   C(421)),   (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (MFORM(1),   C(1329)), (MFORM(15), C(1343))
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),    C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),    C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (OF,      C(1556)),    (FPCT,    C(1557))
      EQUIVALENCE   (FORAT,      C(1558))
      EQUIVALENCE (KODE,     C(1559)),   (KASL,       C(1560))
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE   (BCX(1),     C(1771)), (BCX(15),    C(1785))
      EQUIVALENCE   (BCF(1),     C(1786)), (BCF(15),    C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HO(1),      C(2041)), (HC(90),     C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))
      EQUIVALENCE   (MX(1),    C(2221)), (MX(20),     C(2240))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LCRUM,      C(2323))
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))
      EQUIVALENCE   (L,          C(2325)), (L1,         C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,         C(2328))
      EQUIVALENCE   (N,          C(2329)), (IQ,         C(2330))
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,        C(2332))
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,       C(2335))
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,     C(2337))
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      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IPROZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),   C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (MCOEFT(1),  C(6392)), (MCOEFT(1350),  C(7741))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE (KORE, C(8047))
      EQUIVALENCE (DLNT,LNT),(SUM,MSUM),(BLK,MBLK),(TMP,MTMP),(MT,BMT)
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),   C(1540))
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),      EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),       X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),     PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),    FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),    SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
      DIMENSION MX(20),MCOEFT(15,90)
      DIMENSION MFORM(15)
C
B1    BMT =606060606060
B     GAS =000000000027
B     BLK =000000000000
C
      K5=0
      REWIND 3
      NO EQ=0
      ITEST=M1
      SIZE=18.5
      TO=TC
  555 IF (IPROB-3) 557,563,9000
 9000 IF (IPROB-4) 565,565,9001
  557 PC = PC/14.696006
      PO=PC
 9001 IF(TO)559,559,561
  559 TC LN= 8.25
      GO TO 431
  561 TC LN=LOGF(TO)
      GO TO 431
  563 PO=PC
      GO TO 431
  565 T=TC
      PO=0.0
      T LN=LOGF(T)
C
C     START CALCULATION FOR NEW OVERALL COMPOSITION
C
  431 IADD=1
      IF (IPROZ) 1565,379,1432
 1565 IF (IUSE) 1432,1432,433
 1432 DO 432 K=1,N
      EN(K)=0.0
      EN LN(K)=0.0
  432 DEL N(K)=0.0
      AAY LN=5.0
  433 SENSE LIGHT 0
      IF (IPROB-2) 435,445,434
  434 IF (IPROB-4) 455,465,9002
 9002 IF (IPROB-5) 9003,9003,379
 9003 IF(IADD-25)9004,9004,231
 9004 IF(PCP(IADD))231,231,9005
 9005 PO=PCP(IADD)
      IF(IADD-1)9008,9006,9008
 9006 T LN=TC LN
 9008 SENSE LIGHT 1
      SENSE LIGHT 4
      K5=1
      IK5=IADD
      IPK5=IPROB
      IADD = 1
      IPROB=1
      GO TO 13
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H,P

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  435 IF (IADD-1) 379,436,441
  436 SENSE LIGHT 1
  437 T LN=TC LN
      ITROT=3
  438 IF (PCP(IADD)) 231,231,439
  439 SENSE LIGHT 4
      PO=PC/PCP(IADD)
      GO TO 13
  441 IF (IADD-25) 438,438,231
  445 IF (IADD-1) 379,447,441
  447 SENSE LIGHT 2
      GO TO 437
  455 IF (IADD-25) 459,459,231
  459 IF (PCP(IADD)) 231,231,460
  460 T=PCP(IADD)
      T LN= LOGF(T)
      GO TO 473
  465 IF (IADD-25) 469,469,231
  469 IF (PCP(IADD)) 231,231,470
  470 PO=PCP(IADD)
  473 SENSE LIGHT 2
      SENSE LIGHT 4
C
C     BEGIN CALCULATIONS FOR CURRENT POINT
C
   13 PO LN=LOGF(PO)
C
C     CHECK TEMPERATURE RANGE OF THERMODYNAMIC DATA
C
      IF (IPROB-2) 17,17,19
   17 T=EXPF(T LN)
   19 IF (COEFT(7,1)-T) 21,27,27
   21 IF (COEFT(7,1)-5000.0) 23,31,231
   23 DO 1123 K=1,15
      DO 1123 J = 1,90
 1123 COEFT(K,J)=COEFT1(K,J)
      SENSE LIGHT 4
      GO TO 19
   25 DO 1125 K = 1,15
      DO 1125 J = 1,90
 1125 COEFT(K,J)=COEFT2(K,J)
      SENSE LIGHT 4
      GO TO 19
   27 IF (T-COEFT(6,1)) 29,37,37
   29 IF (300.0-COEFT(6,1)) 25,31,231
   31 IF (SENSE LIGHT 4) 38,305
C
C     ELIMINATE THOSE SPECIES WHICH DO NOT HAVE DATA IN THIS INTERVAL
C
   37 IF (SENSE LIGHT 4 ) 38,142
   38 SENSE LIGHT 4
      DO 40 J=1,N
      IF (COEFT(8,J)) 40,39,40
   39 CALL BYPASS (J,2)
      EN LN(J)=0.0
      EN(J)=0.0
      DEL N(J)=0.0
   40 CONTINUE
C
C     BEGIN ITERATION FOR COMPOSITION
C
   42 IQ=IQ
      IQ1=IQ1
      IQ2=IQ2
      IQ3=IQ3
      ITNUMB=30
   43 DO 48 J=1,N
      CALL BYPASS (J,1)
      IF (IPROB-2) 48,45,49
   45 IF (EN LN(J)+SIZE-PO LN) 46,46,47
   46 EN(J)=0.0
      GO TO 48
   47 EN(J)=EXPF(EN LN(J))
   48 CONTINUE
      IF (IPROB-2) 49,49,51
   49 T=EXPF(T LN)
   51 AAY=EXPF(AAY LN)
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Correction

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C
C     CALCULATE HEAT CAPACITY, ENTHALPY AND ENTROPY
C
      IFIXT=3
      IF (SENSE LIGHT 2) 52,55
   52 SENSE LIGHT 2
      IF (SENSE LIGHT 4) 53,55
   53 SENSE LIGHT 4
      IFIXT=1
      IF (ITNUMB-30) 55,54,55
   54 IFIXT=2
   55 CPSUM=0.0
      DO 60 J=1,N
      CALL BYPASS (J,1)
      IF (IPROD-2) 60,56,60
   56 IF (IFIXT-2) 59,58,57
   57 CPSUM=CPSUM+((((COEFT(12,J)*T+COEFT(11,J))*T+COEFT(10,J))*T+COEFT(
     19,J))*T+COEFT(8,J))*EN(J)
   58 HO(J)=((((COEFT(12,J)/5.0)*T+COEFT(11,J)/4.0)*T+COEFT(10,J)/3.0)*T
     1+COEFT(9,J)/2.0)*T +COEFT(13,J)/T+COEFT(8,J)
   59 S(J)=((((COEFT(12,J)/4.0 )*T+COEFT(11,J)/3.0)*T+COEFT(10,J)/2.0)*T
     1+COEFT(9,J))*T+COEFT(8,J)*T LN+COEFT(14,J)-EN LN(J)
   60 CONTINUE
C
C     CONSTRUCT MATRIX AND SOLVE THE EQUATIONS
C
      CALL MATRIX
      IF (SENSE LIGHT 4) 61,171
   61 SENSE LIGHT 4
      CALL GAUSS
      IF (IDEBUG) 910,80,910
  910 DO 911 I=1,IMAT
  911 WRITE OUTPUT TAPE 6,912,(G(I,K),K=1,KMAT),DELTA(I)
      WRITE OUTPUT TAPE 6,912,(X(I),I=1,IMAT)
  912 FORMAT (8E14.6)
   80 IF (IDID-IMAT) 81,85,81
   81 IF (SIZE-18.5) 83,83,311
   83 SIZE=27.5
      GO TO 43
   85 ITNUMB=ITNUMB-1
      DO 87 K=1,IMAT
      IF (ABSF(DELTA(K))-0.5E-4) 87,87,88
   88 IF (SIZE-18.5) 83,83,315
   87 CONTINUE
C
C     OBTAIN CORRECTIONS TO THE ESTIMATES
C
      D LN T=X(IQ2)
   91 IF (IFIXT-2) 93,95,379
   93 D LN T=0.0
   95 DO  101 J=1,M
      CALL BYPASS (J,1)
      IF (IPROD-2) 96,97,96
   96 DEL N(J)=0.0
      GO TO 101
   97 DEL N(J)=HO(J)*D LN T-HO(J)+S(J)
      DO  99 K=1,L
   99 DEL N(J)=DEL N(J)+A(K,J)*X(K)
  101 CONTINUE
      IF (L-IQ) 103,109,109
  103 J=M1
      DO 107 K=L1,IQ
  104 CALL BYPASS (J,1)
      IF (IPROD-2) 105,106,105
  105 DEL N(J)=0.0
      J=J+1
      GO TO 104
  106 DEL N(J)=X(K)
      J=J+1
  107 CONTINUE
  109 AMBDA=1.0
      AMBDA1=1.0
      IF (ABSF(D LN T)-ABSF(X(IQ1))) 501,913,913
  501 SUM = ABSF(X(IQ1))
      GO TO 915
  913 SUM=ABSF(D LN T)
```

Correction
Correction
Correction

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  915 DO 917 J=1,M
      IF (EN(J)) 917,1915, 916
  916 SUM=MAX1F(DEL N(J),SUM)
      GO TO 917
 1915 IF (DEL N(J))  917,917,1917
 1917 SUM1=ABSF((PO LN-9.212-EN LN(J))/DEL N(J))
      AMBDA1=MIN1F(SUM1,AMBDA1)
  917 CONTINUE
      IF (SUM-2.0) 1110,1110,110
  110 AMBDA=2.0/SUM
 1110 AMBDA =MIN1F(AMBDA,AMBDA1)
  920 IF (IDEBUG) 921,111,921
  921 WRITE OUTPUT TAPE 6,923, T,P,AAY, AMBDA, ((COEFT(K,J),K=1,3),
     1  EN(J),EN LN(J),DEL N(J),HO(J),S(J),J=1,N)
  923 FORMAT (4E25.8/(1X,3A6,5E15.6))
C
C     APPLY CORRECTIONS TO THE ESTIMATES
C
  111 DO 113 J=1,M
  113 EN LN(J)=EN LN(J)+AMBDA*DEL N(J)
      IF (ICOND-2) 115,121,375
  115 DO 117 J=M1,N
  117 EN(J)=EN(J)+AMBDA*DEL N(J)
  121 T LN=T LN +AMBDA*D LN T
      AAY LN=AAY LN- AMBDA*X(IQ1)
      IF (SENSE SWITCH 6) 122,124
  122 IF (IDEBUG) 1122,123,1122
 1122 IDEBUG=0
      GO TO 231
  123 IDEBUG=1
C
C     TEST  FOR CONVERGENCE OF ITERATION
C
  124 IF (ITNUMB) 125,132,125
  125 IF (AMBDA-1.0) 43,1124,231
 1124 P=0.0
      DO 1126 J=1,M
      IF (EN LN(J)) 2125,1126,2125
 2125 P=P+EXPF(EN LN(J))
 1126 CONTINUE
      IF (ABSF((PO-P)/PO)-0.5E-5) 126,126,43
  126 SUM=P
      IF(ICOND-2)127,129,375
  127 DO 128 J=M1,N
  128 SUM=SUM+ABSF(EN(J))
  129 DO 130 J=1,N
      IF (J-M) 1129,1129,1130
 1129 IF (ABSF(EN(J)*DEL N(J)/SUM)-0.5E-5) 130,130,43
 1130 IF (ABSF(DEL N(J)/SUM)-0.5E-5) 130,130,43
  130 CONTINUE
  132 IF (SENSE LIGHT 4) 133,133
  133 GO TO 13
C
C     ELIMINATE THOSE SPECIES WITH NO DATA AT THIS TEMPERATURE, ADD
C     THOSE WITH DATA AT THIS TEMPERATURE
C
  142 DO 170 J=1,N
      IF (MCOEFT(1,J)-MT) 170,500,170
  500 IF (COEFT(5,J) + 150.0-T) 285,143,143
  143 IF (T-COEFT(4,J)+150.0) 295,144,144
  285 IF (5000.0-COEFT(5,J)) 144,144,301
  295 IF (COEFT(4,J)-300.0) 144,144,301
  144 IF (J-M) 145,145,146
  145 CALL BYPASS (J,3)
      GO TO 170
  301 CALL BYPASS (J,2)
      EN(J)=0.0
      EN LN(J)=0.0
      DEL N(J)=0.0
      GO TO 170
  146 IF (EN(J)) 147,148,170
  147 EN(J)=0.0
      DEL N(J)=0.0
      CALL BYPASS (J,2)
      GO TO 42
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C
C     SKIP CONDENSATION CHECK IF T IS HIGHER THAN MELTING POINT WHEN
C     TESTING SOLID, OR LOWER THAN MELTING POINT WHEN TESTING LIQUID
C
  148 IF (COEFT(4,J)-COEFT(5,J-1)) 150,149,150
  149 IF (COEFT(4,J)-T) 2153,170,170
 2153 IF (EN(J-1)) 170,153,2154
 2154 IF (COEFT(4,J)+150.0-T) 2155,2155,2157
 2155 EN(J)=EN(J-1)
      CALL BYPASS (J,3)
      J=J-1
      GO TO 3156
 2157 EN(J-1)=EN(J-1)/2.0
      EN(J)=EN(J-1)
      T LN=LOGF(COEFT(4,J))
      CALL BYPASS(J,3)
      GO TO 42
  150 IF (COEFT(5,J)-COEFT(4,J+1)) 153,151,153
  151 IF (T-COEFT(5,J)) 3153,170,170
 3153 IF (EN(J+1)) 170,153,3154
 3154 IF(T+150.0-COEFT(5,J)) 3155,3155,3157
 3155 EN(J)=EN(J+1)
      CALL BYPASS(J,3)
      J=J+1
 3156 CALL BYPASS(J,2)
      EN(J)=0.0
      DEL N(J)=0.0
      GO TO 42
 3157 EN(J+1)=EN(J+1)/2.0
      EN(J)=EN(J+1)
      T LN=LOGF(COEFT(5,J))
      CALL BYPASS(J,3)
      GO TO 42
C
C     CHECK FOR CONDENSATION
C     IF MORE THAN ONE CONDENSED PHASE OF ANY SPECIES CAN EXIST THE
C     PHASE STABLE AT THE HIGHER TEMPERATURE MUST PRECEED THAT STABLE AT
C     THE LOWER TEMPERATURE ON MASTER TAPE
C
  153 DO 155 K=2,3
      SUM=COEFT(K,J)
      DO 154 I=1,6
      TMP=ARSF(30,SUM)
B     SUM=ALSF(6000000,SUM)
      IF(MTMP-MBLK)  154,156,154
  154 CONTINUE
  155 CONTINUE
      K=3
      I=5
      GO TO 159
  156 I=I-2
      IF (I) 157,158,159
  157 K=2
      I=5
      GO TO 159
  158 K=2
      I=0
  159 FORM(2)=COEFT(2,J)
      FORM(3)=COEFT(3,J)
      I=6*I
      JJ=42-I
      I=I
      JJ=JJ
      SUM = FORM(K)
B     SUM = ARSF(JJ,SUM)
      MJJ=JJ-6
      TMLJ = FORM(K)
      TMLJ = LRSF(MJJ,TMLJ)
      MJJ=36-I
B     SUM1=LLSF(MJJ,GAS)
B     TEMP=LRSF(JJ,SUM1)
      MJJ=42-I
B     FORM(K)=LLSF(MJJ,SUM)
      DO 160 K=1,M
      IF (MFORM(2)-MCOEFT(2,K)) 160,1160,160
 1160 IF (MFORM(3)-MCOEFT(3,K)) 160,162,160
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  160 CONTINUE
      CALL BYPASS (J,3)
      GO TO 170
  162 CALL BYPASS (K,1)
      IF (IPROD-2) 170,163,170
  163 HO(J)=((((COEFT(12,J)/5.0)*T+COEFT(11,J)/4.0)*T+COEFT(10,J)/3.0)*T
     1+COEFT(9,J)/2.0)*T +COEFT(13,J)/T+COEFT(8,J)
      S(J)=((((COEFT(12,J)/4.0 )*T+COEFT(11,J)/3.0)*T+COEFT(10,J)/2.0)*T
     1+COEFT(9,J))*T+COEFT(8,J)*T LN+COEFT(14,J)
      IF (HO(J)-S(J)-HO(K)+S(K)-DEL N(K)) 164,164,170
  164 CALL BYPASS (J,3)
      EN(J)=0.0
      GO TO 42
  170 CONTINUE
C
C     IF COMPOSITION HAS BEEN CORRECTLY DETERMINED CALCULATE THE
C     EQUILIBRIUM PROPERTIES, OTHERWISE CONTINUE ITERATION
C
      IF(SENSE LIGHT 4) 1170,1172
 1170 SENSE LIGHT 4
      GO TO 42
 1172 IF (ITNUMB) 42,971,42
  971 WRITE OUTPUT TAPE 6,973,IADD
  973 FORMAT (70HL30 ITERATIONS DID NOT SATISFY CONVERGENCE REQUIREMENTS
     1 FOR THE POINT I5)
      GO TO 42
C
C     CALCULATE EQUILIBRIUM PROPERTIES
C
  171 DO 1171 I = 1,454
 1171 ANS(I) = ANSLAB(I)
      WTMOL=AAY/P
      HSUM=G(IQ2,IQ1)*T/AAY
      SSUM=0.0
      DO 183 J=1,N
      CALL BYPASS (J,1)
      IF (IPROD-2) 183,181,183
  181 SSUM=SSUM+S(J)*EN(J)
  183 CONTINUE
 1183 SSUM=SSUM/AAY
      IMAT=IMAT-1
      CALL GAUSS
      IF (IDID-IMAT) 172,174,172
  172 CPR=CPSUM/AAY
      GAMMA=CPR/(CPR-(1.0/WTMOL))
      DLMTP=0.0
      DLMPT=0.0
      GO TO 185
  174 DLMTP=X(IQ1)
      IF (ABSF(DLMTP)-27.5) 1174,1174,172
 1174 CPR=G(IQ2,IQ2)
      DO 175 J=1,IQ1
  175 CPR=CPR-G(IQ2,J)*X(J)
      CPR=CPR/AAY
 1175 IMAT=IMAT-1
      CALL GAUSS
      DLMPT=0.0
      DO 179 J=1,L
  179 DLMPT=DLMPT+G(IQ1,J)*X(J)
      DLMPT=(P-DLMPT)/DLMPT
      IF (DLMPT-27.5) 180,180,172
  180 GAMMA=1.0/(1.0+DLMPT-((1.0-DLMTP)**2)/(CPR*WTMOL))
      IF (GAMMA) 172,172,185
  185 IF (IPROB-2) 186,186,207
  186 IF (IALD-2) 187,191,197
  187 WTMOLC=WTMCL
      TC=T
      PC=P
      HC=HSUM
      SC=SSUM
  188 T PI=-DLMTP/(WTMOL*CPR)
      T ETA=1000.0/(CPR*TC*1.98726)
      T SIG=-(1.0-DLMTP)/(WTMOL*CPR)
      GO TO 207
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Correction

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C
C     CHECK FOR CONVERGENCE AT THROAT
C
  191 DHSTAR=HC-HSUM - (GAMMA*T/(2.0*WTMCL))
      IF (ABSF(DHSTAR/(HC-HSUM))-0.4E-4) 197,197,192
  192 IF(ITROT) 193,197,193
  193 PCP(2)=PCP(2)/(1.0+2.0*DHSTAR*WTMOL/(T*(GAMMA+1.0)))
      PO=PC/PCP(IADD)
      ITROT=ITROT-1
      IF (IDEBUG) 929,194,929
  929 WRITE OUTPUT TAPE 6,923,DHSTAR,HC,HSUM,PCP(IADD)
  194 SENSE LIGHT 4
      GO TO 13
C
C     CALCULATE PERFORMANCE PARAMETERS
C
  197 SP IMP=294.98*SQRTF((HC-HSUM)*1.98726E-3)
      RHOI=RHO*SP IMP
      SUM=T/(2.0*(HC-HSUM))
      PI I=SUM*(WTMOL-WTMOLC)/(WTMOL*WTMCLC)
      ETA I=SUM*(TC-T)/(TC*T*1.98726)*1000.0
      SIG I=SUM/WTMOL
      T PI=(((WTMOLC-WTMOL)/WTMOLC)-DLMTP)/(WTMOL*CPR)
      T ETA=1000.0/(CPR*TC*1.98726)
      T SIG=-(1.0-DLMTP)/(WTMOL*CPR)
      AW=(86.4579*T)/(AAY*14.696006*SP IMP)
      AW PI=- ((1.0-DLMTP)/(WTMOLC*CPR)+1.0/GAMMA+PI I)
      AW ETA=T ETA*(1.0-DLMTP)-ETA I
      AW SIG=1.0/GAMMA-SIG I
      IF (IADD-2) 203,201,203
  201 AWT=AW
      CSTAR=32.174*PC*14.696006*AWT
      CSTRPI=1.0+AW PI
      STR ETA=AW ETA
      STR SIG=0.0
      AWT PI=AW PI
      AWT ETA=AW ETA
      AW SIG=0.0
  203 CF=32.174*SP IMP/CSTAR
      ARATIO=AW/AWT
      VACI=SP IMP+P*14.696006*AW
      RHOVAC=RHO*VACI
      VMACH=SP IMP/SQRTF(86.4579*GAMMA*T/WTMCL)
      EP PI=AW PI-AWT PI
      EP ETA=AW ETA-AWT ETA
      EP SIG=AW SIG
  207 HSUM=HSUM*1.98726
      SSUM=SSUM*1.98726
      CP=CPR*1.98726
C
C     OBTAIN COMPOSITION IN MOLE FRACTIONS
C
      SUM=P
      IF (ICOND-2) 209,213,375
  209 DO 211 J=M1,N
  211 SUM=SUM+EN(J)
  213 DO 215 J=1,N
  215 ANS(4*J+34)=EN(J)/SUM
      IF (IPROB-2) 217,217,220
  217 ANS(1)=PCP(IADD)
  218 IF (IADD-2) 220,219,219
  219 ANS(15)=CSTAR
      ANS(24)=CSTRPI
      ANS(29)=STR ETA
      ANS(34)=STR SIG
  220 ANS(2)=P
      ANS(3)=T
      K=34+4*N
C
C     PRINT OUT THE CALCULATED ANSWERS
C
      IF (IDEBUG) 1221,222,1221
 1221 WRITE OUTPUT TAPE 6,221,(ANS(I),I=1,K)
  221 FORMAT (1H ////5E20.8/5E20.8/5E20.8/4E20.8/5E20.8/5E20.8/5E20.8///
     1 (3(7X,3A6,F8.5)))
      GO TO 9009
```

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  222 WRITE TAPE 3, (ANS(I), I=1,454)
      NO EQ=NO EQ+1
 9009 IF(K5)9007,2223,9007
 9007 IADD = IK5
      IPROB = IPK5
 2223 IF (IADD-2) 223,225,225
  223 IF (IPROB-2) 224,1224,1223
  224 IF (IPROB) 1223,1224,1224
 1224 PCP(2)=((GAMMA+1.0)/2.0)**(GAMMA/(GAMMA-1.0))
      T LN=T LN+LOGF(2.0/(GAMMA+1.0))
 1223 DO 1225 I = 1,484
 1225 ANSLAB(I) = ANS(I)
  225 IADD=IADD+1
      GO TO 433
C
  231 IF (NO EQ) 378,378,1231
 1231 IF (IPROB) 232,379,235
  232 IF (IADD-2) 378,233,378
  233 IF (IDEBUG) 378,234,378
  234 CALL  CORE4
      IF (KORE) 1234,1,1234
 1234 RETURN
  235 IF (IPROB-2) 237,237,239
  237  CALL CORE3
      RETURN
  239 WRITE TAPE 3,(G(I), I=1,8044)
      CALL CORE5
      RETURN
C
C     ERROR PRINT OUT
C
  305 WRITE OUTPUT TAPE 6,306,T,IADD
  306 FORMAT (17HLTHE TEMPERATURE=E12.4,34H K, IS OUT OF RANGE FOR THE P
     1OINT I5)
      IF (6000.0-T) 3 9,307,307
  307 IF (T-200.0) 1309,308,308
  308 GO TO 147
 1309 IF (IADD-1) 309,1310,309
 1310  IF (IPROB-2) 1311,309,309
 1311 IF (ITEST-N) 1312,1312,309
 1312 DO 1313 J=ITEST,N
      CALL BYPASS(J,1)
      IF (IPROB-2) 1315,1313,1313
 1313 CONTINUE
      GO TO 309
 1315 ITEST=J+1
      CALL BYPASS(J,3)
      GO TO 1376
  309 PCP(25)=PCP(IADD)
      IADD=25
      IF (SENSE LIGHT 4) 42,42
  311 WRITE OUTPUT TAPE 6,312,IMAT,IDID
  312 FORMAT (/15HITRIED TO SOLVE I3,22H EQUATIONS, ELIMINATED I3)
      SIZE=18.5
      GO TO 375
  315 WRITE OUTPUT TAPE 6,316,
  316 FORMAT (/47HIRESIDUALS FROM SUBROUTINE GAUSS EXCEED  0.5E-4)
      SIZE=18.5
  375 IF (IDEBUG) 231,377,231
  377 IDEBUG=1
 1376 IF(IPROB-3)1377,555,555
 1377 PC=PC*14.696006
      GO TO 555
  378 WRITE TAPE 3,(G(I),I=1,8044)
      BACKSPACE 3
      RETURN
  379 REWIND 4
      PAUSE 77777
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      SUBROUTINE  GAUSS
C
C
C     SUBROUTINE GAUSS SOLVES ANY LINEAR SET OF UP TO TWENTY EQUATIONS,
C     BY ITERATION IF NECESSARY
C
C     FORTRAN MONITOR UNDER NORMAL OPERATING CONDITIONS WILL TAKE CARE
C     OF OVER-UNDER FLOW
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),   C(421)),   (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,     C(1473))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,     C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,      C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),    C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),    C(1540))
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),    C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (OF,      C(1556)),    (FPCT,    C(1557))
      EQUIVALENCE   (FORAT,      C(1558))
      EQUIVALENCE (KODE,    C(1559)),    (KASE,       C(1560))
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE   (BCX(1),     C(1771)), (BCX(15),    C(1785))
      EQUIVALENCE   (BCF(1),     C(1786)), (BCF(15),    C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HC(1),      C(2041)), (HO(90),     C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BC(1),      C(2261)), (BO(15),     C(2275))
      EQUIVALENCE   (PC,         C(2276)), (HSUBO,      C(2277))
      EQUIVALENCE   (SC,         C(2278)), (T LN,       C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))
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      EQUIVALENCE   (L,          C(2325)), (L1,         C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,         C(2328))
      EQUIVALENCE   (N,          C(2329)), (IC,         C(2330))
      EQUIVALENCE   (IC1,        C(2331)), (IC2,        C(2332))
      EQUIVALENCE   (IC3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,       C(2335))
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,     C(2337))
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),  C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PRCD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
      DIMENSION  DRUM(20,21)
8     BIGNO=377777777777
      IDID=0
      DETN=0.0
      IF(IUSE) 80,80,81
   81 IUSE1=IUSE+1
      DO 1 K=1,IUSE
      X(K)=0.0
    1 DELTA(K)=0.0
      ITERA=0
      KAPUT=1
      DSUM1=BIGNO
C
C     SAVE MATRIX IN DRUM
C
      DO 82 ID=1,IUSE
      DO82  JN=1, IUSE1
   82 DRUM(ID,JN)=G(ID,JN)
C
C     BEGIN ELIMINATION OF NNTH VARIABLE
C
    6 DO 45 NN=1,IUSE
      IF (NN-IUSE) 8,83,8
  83  IF(G(NN,NN))31,23,31
C
C     SEARCH FOR MAXIMUM COEFFICIENT IN EACH ROW
C
    8 DO 16 I=NN,IUSE
      J=NN
      IF(G(I,J)) 99,14,99
  99  COEFX(I)=0.0
   10 J=J+1
      IF(IUSE1-J) 12,84,84
   84 IF( ABSF(G(I,J)) - ABSF(COEFX(I))) 10,100,100
  100 COEFX(I)=ABSF(G(I,J))
      GO TO 10
   12 COEFX(I)= ABSF(COEFX(I)/G(I,NN))
      GO TO 18
   14 COEFX(I)=BIGNO
   18 CONTINUE
   19 TEMP=BIGNO
      I=0
   20 DO 22 J=NN,IUSE
      IF (COEFX(J)-TEMP) 87,22,22
   87 TEMP=COEFX(J)
      I=J
   22 CONTINUE
      IF(I) 28,23,28
   23 IDID=NN-1
      GO TO 80
```

```
C
C     INDEX I LOCATES EQUATION TO BE USED FOR ELIMINATING THE NTH
C     VARIABLE FROM THE REMAINING EQUATIONS
C
C      INTERCHANGE EQUATIONS I AND NN
C
   28 IF(NN-1) 29,31,29
   29 DO 30 J=NN,IUSE1
      Z=G(I,J)
      G(I,J)=G(NN,J)
   30 G(NN,J)=Z
C
C     DIVIDE NTH ROW BY NTH DIAGONAL ELEMENT AND ELIMINATE THE NTH
C     VARIABLE FROM THE REMAINING EQUATIONS
C
   31 K = NN + 1
      DO 36 J = K, IUSE1
            IF(G(NN,NN)) 36, 23, 36
   36       G(NN,J) = G(NN,J) / G(NN,NN)
      IF(K-IUSE1) 88,45,88
   88 DO 44 I = K,IUSE
   40 DO 44 J = K, IUSE1
            G(I,J) = G(I,J) - G(I,NN)*G(NN,J)
   44 CONTINUE
   45 CONTINUE
C
C     BACKSOLVE FOR THE VARIABLES
C
  991 IDID = IUSE
      K = IUSE
   47 J = K + 1
      SUM = 0.
      IF(IUSE - J) 51,48,48
   48 DO 50 I = J,IUSE
   50       SUM = SUM + G(K,I)*DX(I)
   51 DX(K) = G(K,IUSE1) - SUM
      X(K) = X(K) + DX(K)
      K = K - 1
      IF (K) 47,151,47
  151 DO 90 ID = 1,IUSE
      DO 90 JD = 1, IUSE1
   90       G(ID,JD) = DRUM(ID,JD)
C
C     CALCULATE RESIDUALS (DELTA RIGHT HAND SIDE)
C
   52 DSUM = 0.
      DO 62 I = 1, IUSE
            SUM = 0.
            DO 56 J = 1, IUSE
   56             SUM = SUM + G(I,J)*X(J)
            DELTA(I) = G(I,IUSE1) - SUM
            IF(ABSF(G(I,IUSE1)) - 1.0) 62, 62, 60
   60       DELTA(I) = DELTA(I) / G(I,IUSE1)
   62       DSUM = ABSF(DELTA(I)) + DSUM
      GO TO(66,80), KAPUT
   66 IF(DSUM - DSUM1) 74,80,68
   68 KAPUT = 2
      DO 72 K = 1,IUSE
   72       X(K) = X(K) - DX(K)
      GO TO 52
   74 DSUM1 = DSUM
      ITERA = ITERA + 1
      IF(ITERA -  4) 92,80,92
   92 DO 78 I = 1,IUSE
            IF(ABSF(G(I,IUSE1)) - 1.0) 75,75,76
   75       G(I,IUSE1) = DELTA(I)
            GO TO 78
   76       G(I,IUSE1) = DELTA(I) * G(I,IUSE1)
   78       CONTINUE
      GO TO 6
   80 RETURN
```

```
      SUBROUTINE MATRIX
C
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),   C(421)),   (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (FLMT(1),    C(1344)),  (FLMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),   C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),   C(1540))
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),   C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (DF,     C(1556)),    (FPCT,   C(1557))
      EQUIVALENCE   (EQRAT,      C(1558))
      EQUIVALENCE (KODE,    C(1559)),    (KASE,       C(1560))
      EQUIVALENCE   (KONT,   C(1561)),    (NF,         C(1562))
      EQUIVALENCE   (ND,         C(1563)), (NE,         C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE   (BCX(1),     C(1771)), (BCX(15),    C(1785))
      EQUIVALENCE   (BCF(1),     C(1786)), (BCF(15),    C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HO(1),      C(2041)), (HC(90),     C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BC(1),      C(2261)), (BC(15),     C(2275))
      EQUIVALENCE   (PC,         C(2276)), (HSUBO,      C(2277))
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))
      EQUIVALENCE   (L,          C(2325)), (L1,         C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,         C(2328))
      EQUIVALENCE   (N,          C(2329)), (IC,         C(2330))
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,        C(2332))
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (ICSE,       C(2335))
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      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,     C(2337))
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),   C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),      EN LN(90)
      DIMENSION   DEL N(90),  HO(90),     S(90),       X(20)
      DIMENSION   DELTA(20),  BO(15),     PCP(25),     PRCD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   FLMT(15),   DATA(23),   DATUM(3),    FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),    SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
C
C
C     DETERMINE WHICH MATRIX IS TO BE SET UP
C     SENSE LIGHT        LIGHT ON                    LIGHT OFF
C          1         COMBUSTION TYPE             EXPANSION TYPE
C          2         ASSIGNED TEMPERATURE        UNASSIGNED TEMPERATURE
C          4         NOT CONVERGED               CONVERGED
C
      IQ1=IQ1
      IQ2=IQ2
      IQ3=IQ3
      IF (SENSE LIGHT 2) 1,4
    1 SENSE LIGHT 2
      IF (SENSE LIGHT 4) 2,3
    2 SENSE LIGHT 4
      IFIXT=1
      ISYM=IQ1
      GO TO 10
    3 IFIXT=2
      IHS=1
      ISYM=IQ2
      GO TO 10
    4 IFIXT=2
      IF (SENSE LIGHT 1) 5,6
    5 SENSE LIGHT 1
      IHS=1
      ISYM= IQ2
      GO TO 10
    6 IF (SENSE LIGHT 4) 7, 8
    7 SENSE LIGHT 4
      IHS=2
      ISYM=IQ1
      GO TO 10
    8 IHS=1
      ISYM=IQ2
C
C     CLEAR MATRIX STORAGES TO ZERO
C
   10 DO 212 I=1,IQ2
      DO 211 K=1,IQ3
      G(I,K)= 0.0
  211 CONTINUE
  212 CONTINUE
      ICOND=1
      IF (L-IQ) 14,213,14
  213 ICOND=2
C
C     BEGIN SET UP OF ITERATION MATRIX
C
   14 DO 65  J=1,M
      CALL BYPASS (J,1)
      IF (IPROD-2) 65,214,65
  214 IF (EN(J)) 65,65,12
C
C     CALCULATE THE ELEMENTS  R(I,K)
C
```

```
   12 DO 20  I=1, L
      IF (A(I,J)) 13,20,13
   13 TERM= A(I,J)*EN(J)
      DO 15  K=I, L
      G(I,K)= G(I,K) + A(K,J)*TERM
   15 CONTINUE
C
C     COMPLETE COLUMN  A FOR THE GAS MOLECULE
C
      G(I,IQ1)=G(I,IQ1)+TERM
   20 CONTINUE
      G(IQ1,IQ1)= G(IQ1,IQ1)+EN(J)
C
C     STATEMENT 24 IS FOR FIXED T, 30 IS FOR VARIABLE  T AND CONVERGED
C     FIXED T
C
   21 IF (IFIXT-2) 24,30,30
C
C     FOR ASSIGNED T BYPASS ENERGY ROW AND T COLUMN WHILE ITERATING
C
   24 TERM= (HO(J)-S(J))*EN(J)
      DO 25  I=1, L
      G(I,IQ2)=G(I,IQ2)+A(I,J)*TERM
   25 CONTINUE
      G(IQ1,IQ2)=G(IQ1,IQ2)+TERM
      GO TO 65
C
C     FILL IN TEMPERATURE COLUMN AND RIGHT HAND SIDE
C
   30 TERM=HO(J)*EN(J)
      DO 35 I=1,L
      G(I,IQ2)= G(I,IQ2)+A(I,J)*TERM
   35 CONTINUE
      G(IQ1,IQ2)= G(IQ1,IQ2)+TERM
      TERM1=(HO(J)-S(J))*EN(J)
      DO 40 I=1,L
      G(I,IQ3)= G(I,IQ3)+A(I,J)*TERM1
   40 CONTINUE
      G(IQ1,IQ3)=G(IQ1,IQ3)+TERM1
C
C     STATEMENT 50 IS FOR ENTHALPY , 55 IS FOR ENTROPY EQUATION
C
   45 IF (IHS-2) 50,55,55
   50 G(IQ2,IQ2)=G(IQ2,IQ2)+HO(J)*TERM
      G(IQ2,IQ3)=G(IQ2,IQ3)+HO(J)*TERM1
      GO TO 65
C
C     DURING EXPANSION THE ENTROPY ROW IS FILLED IN
C
   55 TERM=S(J)*EN(J)
      DO 60  K=1,L
   60 G(IQ2,K)= G(IQ2,K)+A(K,J)*TERM
      CONTINUE
      G(IQ2,IQ1)=G(IQ2,IQ1)+TERM
      G(IQ2,IQ2)=G(IQ2,IQ2)+HO(J)*TERM
      G(IQ2,IQ3)=G(IQ2,IQ3)+(HO(J)-S(J))*TERM
   65 CONTINUE
C
C     AT THIS POINT PROCESSING OF GASEOUS PRODUCTS HAS BEEN COMPLETED
C     AND CONDENSED PHASE PROCESSING IS BEGUN
C
C     STATEMENT 70 IS FOR CONDENSED PRODUCTS, 101 IS FOR NO CONDENSED
C
   66 IF (ICOND-2) 70,101,101
   70 K=L1
      DO 100 J= M1,N
      CALL BYPASS (J,1)
      IF (IPROD-2) 100,74,100
   74 DO 75  I=1,L
      G(I,K)=A(I,J)
   75 CONTINUE
C
C     STATEMENT 80 IS FOR FIXED T, 85 IS FOR VARIABLE T AND CONVERGED
C     FIXED T
C
      IF (IFIXT-2) 80,85,85
   80 G(K,IQ2)= HO(J)-S(J)
```

```
      GO TO 95
   85 G(K,IQ2)= HO(J)
      G(K,IQ3)= HO(J)-S(J)
C
C     STATEMENT 95 IS FOR ENTHALPY, STATEMENT 90 IS FOR ENTROPY EQUATION
C
      IF (IHS-2) 95,90,90
   90 G(IQ2,K)=S(J)
   95 K= K+1
  100 CONTINUE
C
C     REFLECT SYMMETRIC PORTIONS OF THE MATRIX BEFORE COMPLETING THE
C     CONDENSED PHASE CONTRIBUTIONS TO THE MATRIX
C
  101 DO 104 I=1,ISYM
      DO 102 J=I,ISYM
      G(J,I)=G(I,J)
  102 CONTINUE
  104 CONTINUE
C
C     THE ADDRESS OF THE NEXT INSTRUCTION IF SET DURING INITIALIZATION
C     STATEMENT 105 IS FOR CONDENSED,130  IS FOR NO CONDENSED
C
      IF (ICOND-2) 105,130,130
C
C     COMPLETE COLUMN A OF MATRIX
C
  105 DO 125 J=M1,N
      CALL BYPASS (J,1)
      IF (IPROD-2) 125,106,125
  106 DO 107 I=1,L
      G(I,IQ1)=G(I,IQ1)+A(I,J)*EN(J)
  107 CONTINUE
      IF (IFIXT-2) 125,109,109
  109 IF (IHS-2) 110,115,115
  110 G(IQ2,IQ1)= G(IQ2,IQ1)+HO(J)*EN(J)
      GO TO 125
  115 G(IQ2,IQ1)= G(IQ2,IQ1)+S(J)*EN(J)
  125 CONTINUE
  130 GO TO (131,133),IFIXT
  131 KMAT=IQ2
      GO TO 136
  133 KMAT=IQ3
  136 IMAT=KMAT-1
C
C     COMPLETE THE RIGHT HAND SIDE
C
      DO 145 I=1,IMAT
      G(I,KMAT)=G(I,KMAT)-G(I,IQ1)
  145 CONTINUE
      DO 150 I=1,L
      G(I,KMAT)= G(I,KMAT)+ AAY*BO(I)
  150 CONTINUE
      P= G(IQ1,IQ1)
  160 G(IQ1,KMAT) = G(IQ1,KMAT)+ PO
      G(IQ1,IQ1)=0.0
C
C     COMPLETE ENERGY ROW AND TEMPERATURE COLUMN
C
      IF (KMAT-IQ2) 165,185,165
  165 IF (IHS-2) 166,168,168
  166 ENERGY=AAY*(HSUBO/T)
      GO TO 169
  168 ENERGY= AAY*SO+PO-P
  169 G(IQ2,IQ3)=G(IQ2,IQ3)+ ENERGY
      G(IQ2,IQ2)= G(IQ2,IQ2)+CPSUM
  185 RETURN
```

```
      SUBROUTINE  CORE3
C
C     FROZEN COMPOSITION EXPANSION
C
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),   C(421)),   (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,        C(425))
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,          C(427))
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,       C(429))
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,      C(431))
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,      C(433))
      EQUIVALENCE   (VACI,       C(434)),   (CF,          C(436))
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,      C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),   (PI I,        C(441))
      EQUIVALENCE   (SP PI,      C(442)),   (AW PI,       C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,      C(447))
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,       C(450))
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,      C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),   C(1343))
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))
      EQUIVALENCE   (DATA(1),   C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),   C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),   C(1538)),  (PROD(3),   C(1540))
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),   C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (DF,     C(1556)),    (FPCT,   C(1557))
      EQUIVALENCE   (EQRAT,      C(1558))
      EQUIVALENCE (KODE,    C(1559)),   (KASE,      C(1560))
      EQUIVALENCE   (KONT,   C(1561)),   (NF,         C(1562))
      EQUIVALENCE   (NO,         C(1563)), (NE,        C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE  (NOFROZ,  C(1566))
      EQUIVALENCE   (BCX(1),     C(1771)), (BCX(15),   C(1785))
      EQUIVALENCE   (BCF(1),     C(1786)), (BCF(15),   C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,        C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,     C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,     C(1806))
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HS(1),      C(2041)), (HS(90),    C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),     C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),     C(2240))
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),    C(2275))
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,     C(2277))
      EQUIVALENCE   (SO,         C(2278)), (T LN,      C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,    C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,     C(2283))
      EQUIVALENCE   (HC,         C(2284)), (TC LN,     C(2285))
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),   C(2310))
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),  C(2313))
      EQUIVALENCE   (PC,         C(2314)), (TC,        C(2315))
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,     C(2317))
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,     C(2319))
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,     C(2321))
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,     C(2323))
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,     C(2324))
      EQUIVALENCE   (L,          C(2325)), (L1,        C(2326))
      EQUIVALENCE   (M,          C(2327)), (M1,        C(2328))
      EQUIVALENCE   (N,          C(2329)), (IC,        C(2330))
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      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,        C(2332))
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,       C(2335))
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,     C(2337))
      EQUIVALENCE   (ITAPE,      C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,     C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (A(1),       C(2342)),  (A(1350),   C(3691))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  H0(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  B0(15),     PCP(25),    PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
C
C
      NO FROZ=
      MISSED=0
      DO 1004 J = 1,454
 100  ANS(J) = ANSLAB(J)
      IADD=1
      ITROT=3
      ALPHA=0.
      DO 7 J=1,N
      EN(J)=ANS(4*J+34)
      IF (EN(J)) 6,6,15
    1 IF (J-M) 5,5,7
      EN LN(J)=LOGF(EN(J))
      ALPHA=ALPHA+EN(J)
      GO TO 7
      EN LN(J)=0.0
      EN(J)=0.
      CONTINUE
      WTMOLF=ALPHA*WTMOL
      PC=ANS(2)
      T LN=LOGF(ANS(3))
      HC=ANS(4)/1.98726
      SO= (ANS(5)*WTMOLF/1.98726)+ALPHA*LOGF(PC/ALPHA)
      DLMPT=0.
      DLMTP=0.
C
C     BEGIN CALCULATIONS FOR CURRENT POINT
C     CHECK TEMPERATURE RANGE OF THERMODYNAMIC DATA
C
      DO 1117 J=1,454
 111  ANSLAB(J)=ANS(J)
    1 T=EXPF(T LN)
    1 IF (COEFT(7,1)-T) 21,27,27
    2 IF (COEFT(7,1)-5000.0) 23,22,451
    2 IF (IADD-2) 51,31,31
    2 DO 1123 K = 1,15
      DO 1123 J = 1,90
 112  COEFT(K,J) = COEFT1(K,J)
      SENSE LIGHT 4
      GO TO 19
    2 DO 1125 K = 1,15
      DO 1125 J = 1,90
 112  COEFT(K,J)=COEFT2(K,J)
      SENSE LIGHT 4
      GO TO 19
    2 IF (T-COEFT(6,1)) 29,35,35
    2 IF (300.0-COEFT(6,1)) 25,22,451
    3 IF (SENSE LIGHT 4) 38,305
C
C     LEAVE FROZEN PROGRAM IF DATA FOR ANY SPECIES RUNS OUT
C
```

```
   35 IF (IADD-2) 51,37,37
   37 IF (SENSE LIGHT 4) 38,41
   38 SENSE LIGHT 4
      DO 40 J=1,N
      IF (COEFT(8,J)) 40,39,40
   39 IF (EN(J)) 40,40,309
   40 CONTINUE
      GO TO 49
   41 DO 44 J=1,N
      IF (EN(J)) 44,44,42
   42 IF (COEFT(5,J)+20.0-T) 285,43,43
   43 IF (T-COEFT(4,J)+20.0) 295,44,44
  285 IF (5000.0-COEFT(5,J)) 44,44,311
  295 IF (COEFT(4,J)-300.0) 44,44,311
   44 CONTINUE
C
C     BEGIN ITERATION
C
   49 PCP LN=LOGF(PCP(IADD))
   51 CPSUM=0.0
      T=EXPF(T LN)
      DO 60 J=1,N
      IF (EN(J)) 60,60,57
   57 CPSUM=CPSUM+((((COEFT(12,J)*T+COEFT(11,J))*T+COEFT(10,J))*T+COEFT(
     19,J))*T+COEFT(8,J))*EN(J)
   58 HO(J)=((((COEFT(12,J)/5.0)*T+COEFT(11,J)/4.0)*T+COEFT(10,J)/3.0)*T
     1+COEFT(9,J)/2.0)*T +COEFT(13,J)/T+COEFT(8,J)
   59 S(J)=((((COEFT(12,J)/4.0 )*T+COEFT(11,J)/3.0)*T+COEFT(10,J)/2.0)*T
     1 +COEFT(9,J))*T+COEFT(8,J)*T LN+COEFT(14,J)-CN LN(J)
   60 CONTINUE
      SUM H=0.0
      SUM S=0.0
      DO 63 J=1,N
      SUM H=SUM H+HO(J)*EN(J)
   63 SUM S=SUM S+S(J)*EN(J)
      IF (IADD-2) 81,65,65
   65 IF (SENSE LIGHT 4) 66,81
   66 SENSE LIGHT 4
   67 D LN T=(SUM S+(ALPHA*PCP LN)-SO)/CPSUM
C
C     CHECK CONVERGENCE OF THE ITERATION
C
      T LN=T LN-D LN T
      IF (ABSF(D LN T)-0.5E-4) 73,73,51
   73 IF (SENSE LIGHT 4) 17,17
   81 DO 1181 J = 1,454
 1181 ANS(J) = ANSLAB(J)
      SUM H=T*SUM H/WTMOLE
      CPR=CPSUM/WTMOLE
      GAMMA=CPR/(CPR-(1.0/WTMOL))
      IF (IADD-2) 209,191,197
C
C     CHECK FOR CONVERGENCE AT THROAT
C
  191 DHSTAR=HC-SUM H - (GAMMA*T/(2.0*WTMOL))
      IF (ABSF(DHSTAR/(HC-SUM H))-0.4E-4) 197,197,192
  192 IF (ITROT) 193,197,193
  193 PCP(2)=PCP(2)/(1.0+2.0*DHSTAR*WTMOL/(T*(GAMMA+1.0)))
      SENSE LIGHT 4
      ITROT=ITROT-1
      GO TO 49
C
C     CALCULATE PERFORMANCE PARAMETERS
C
  197 SP IMP=294.98*SQRTF((HC-SUM H)*1.98726E-3)
      P=PC/PCP(IADD)
      AW=(86.4579*T)/(P*WTMOL*14.696006*SP IMP)
      IF (IADD-2) 203,201,203
  201 AWT=AW
      CSTAR=32.174*PC*14.696006*AWT
  203 CF=32.174*SP IMP/CSTAR
      ARATIO=AW/AWT
      VACI=SP IMP+P*14.696006*AW
      VMACH=SP IMP/SQRTF(86.4579*GAMMA*T/WTMOL)
  207 ANS(2)=P
      ANS(3)=T
```

```
  209 FSUM=SUM H*1.98726
      CP=CPR*1.98726
      ANS(1)=PCP(IADD)
      ANS(15)=CSTAR
      WRITE TAPE 3,(ANS(I),I=1,454)
      NO FROZ=NO FROZ+1
      IF (MISSED) 451,223,451
  223 IADD=IADD+1
      IF (IADD-2) 1225,224,1225
  224 PCP(2)=((GAMMA+1.0)/2.0)**(GAMMA/(GAMMA-1.0))
      T LN=T LN+LOGF(2.0/(GAMMA+1.0))
 1225 IF (IADD-25) 225,225,451
  225 IF (PCP(IADD)) 451,451,227
  227 SENSE LIGHT 4
      GO TO 49
C
C     ERROR PRINT OUT
C
  305 WRITE OUTPUT TAPE 6,306,T,IADD
  306 FORMAT (17HLTHE TEMPERATURE=E12.4,26H K, IS OUT OF RANGE,POINT I5)
      IF (6000.0-T) 449,307,307
  307 IF (T-200.0) 449,308,308
  308 GO TO 41
  449 MISSED=1
      ITROT=0
      IF (SENSE LIGHT 4) 51,51
  451 WRITE TAPE 3, (G(I), I=1,8044)
      CALL CORE5
      RETURN
  309 WRITE OUTPUT TAPE 6,310,(COEFT(I,J),I=1,3),COEFT(6,J),COEFT(7,J)
  310 FORMAT (13H6THE SPECIES 3A6,29H HAS NO DATA IN THE INTERVAL 2F9.1)
      DO 1311 K = 1,15
      DO 1311 J = 1,90
 1311 COEFT(K,J) = COEFT1(K,J)
      GO TO 449
  311 WRITE OUTPUT TAPE 6,312, (COEFT(I,J),I=1,3),T
  312 FORMAT (13H6THE SPECIES 3A6,19H HAS NO DATA AT T= F9.1)
      GO TO 449
```

```
      SUBROUTINE  CORE4
C
C     CHAPMAN-JOUGUET DETONATIONS
C
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),   C(421)),   (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIC,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))
      EQUIVALENCE   (ISYS,      C(1472))
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),    C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),    C(1540))
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),    C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (OF,      C(1556)),     (FPCT,   C(1557))
      EQUIVALENCE   (OOF,      C(1556))
      EQUIVALENCE   (PERCF,     C(1557)),     (EQUIV,     C(1558))
      EQUIVALENCE   (EQRAT,      C(1558))
      EQUIVALENCE                          (KASE,       C(1560))
      EQUIVALENCE   (KONT,   C(1561)),    (NF,          C(1562))
      EQUIVALENCE   (NO,         C(1563)), (NE,         C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE   (NOFRCZ,     C(1566))
      EQUIVALENCE   (P1,        C(1567)),  (T1,         C(1568))
      EQUIVALENCE   (AM1,         C(1569)), (H1,        C(1570))
      EQUIVALENCE   (CON,        C(1571)), (ITR,        C(1572))
      EQUIVALENCE   (R,          C(1573)), (KCDE,       C(1574))
      EQUIVALENCE   (JEAN,       C(1575)), (GAMF,      C(1585))
      EQUIVALENCE   (A1,    C(1576)), (A2,   C(1577)),  (A3,   C(1578))
      EQUIVALENCE   (A4,   C(1579)),   (A5,   C(1580)),   (A6,  C(1581))
      EQUIVALENCE   (A7,  C(1582)),  (A8,  C(1583)),   (A9,   C(1584))
      EQUIVALENCE   (UUS,         C(1586)),     (US,  C(1587))
      EQUIVALENCE   (PPP,      C(1588)),      (TTT,     C(1589))
      EQUIVALENCE   (TE,      C(1590)),      (TEM,     C(1591))
      EQUIVALENCE   (AMD,      C(1592)),      (UD,    C(1593))
      EQUIVALENCE   (AMOL(1),   C(1594)),    (AMOL(105),   C(1698))
      EQUIVALENCE (KD, C(1763)), (II, C(1764))
      EQUIVALENCE (MM, C(1765)), (IN, C(8046))
      EQUIVALENCE (ME, C(1769)), (KORE, C(8047))
      EQUIVALENCE   (BCX(1),     C(1771)), (BCX(15),   C(1785))
      EQUIVALENCE   (BCF(1),     C(1786)), (BCF(15),   C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,        C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,     C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,     C(1806))
      EQUIVALENCE (ELMT(1), C(1807)), (ELMT(15), C(1821))
      EQUIVALENCE (LLMT(1), C(1807)), (LLMT(15), C(1821))
      EQUIVALENCE   (EN LN(1),  C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),  C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),    C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),     C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),     C(2240))
```

```
      EQUIVALENCE   (DELTA(1),  C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BC(1),     C(2261)), (BC(15),    C(2275))
      EQUIVALENCE   (PC,        C(2276)), (HSUBO,     C(2277))
      EQUIVALENCE   (SC,        C(2278)), (T LN,      C(2279))
      EQUIVALENCE   (T,         C(2280)), (AAY LN,    C(2281))
      EQUIVALENCE   (AAY,       C(2282)), (CPSUM,     C(2283))
      EQUIVALENCE   (HC,        C(2284)), (TC LN,     C(2285))
      EQUIVALENCE   (PCP(1),    C(2286)), (PCP(25),   C(2310))
      EQUIVALENCE   (DATUM(1),  C(2311)), (DATUM(3),  C(2313))
      EQUIVALENCE   (PC,        C(2314)), (TC,        C(2315))
      EQUIVALENCE   (IPROB,     C(2316)), (IFIXT,     C(2317))
      EQUIVALENCE   (IHS,       C(2318)), (ICOND,     C(2319))
      EQUIVALENCE   (ISYM,      C(2320)), (IPROD,     C(2321))
      EQUIVALENCE   (IDID,      C(2322)), (LDRUM,     C(2323))
      EQUIVALENCE   (IDRM,      C(2323)), (KDRUM,     C(2324))
      EQUIVALENCE   (L,         C(2325)), (L1,        C(2326))
      EQUIVALENCE   (M,         C(2327)), (M1,        C(2328))
      EQUIVALENCE   (N,         C(2329)), (IC,        C(2330))
      EQUIVALENCE   (IC1,       C(2331)), (IC2,       C(2332))
      EQUIVALENCE   (IC3,       C(2333)), (KMAT,      C(2334))
      EQUIVALENCE   (IMAT,      C(2335)), (ICSE,      C(2335))
      EQUIVALENCE   (IADD,      C(2336)), (ITNUMB,    C(2337))
      EQUIVALENCE   (ITAPE,     C(2338)), (P,         C(2339))
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,     C(2341))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE   (TITLE(1),     C(8055)), (TITLE(315), C(8369))
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))
C
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)
      DIMENSION   DEL N(90),  HC(90),     S(90),      X(20)
      DIMENSION   DELTA(20),  BC(15),     PCP(25),    PROD(3)
      DIMENSION   COEFX(20),  DX(20),     FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)
      DIMENSION   BCX(15),    BCF(15),    ANS(454),   SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
C
C
C   CORE LOAD 4   DETONATION VELOCITIES
      IF(JEAN-101)100,101,100
  100 WRITE OUTPUT TAPE 6,2
    2 FORMAT (38H1   DETONATION VELOCITY   CALCULATIONS)
      PPP=15.0
      CON=(ACF+CCF*ACX)/(1.0+OCF)
      AM1=AMX*AMF*(1.0+OCF)/(AMX+OCF*AMF)
      WRITE OUTPUT TAPE 6,102,KODE
  102 FORMAT (4X,5HKODE=I1)
      PCP(1)=1.0/PPP
      PCP(2)=0.0
      R=1.98726
      TTT=0.0
      H1=HSUBO*R
      P1=PC
      T1=TC
      TC=0.0
      PC=PC*14.696006
      ITR=0
      ICSE=0
      JEAN=101
   20 HSUBO=H1/R+.75*T1/AM1*PPP
   21 KORF  =0
      RETURN
  101 DO 1101 J= 1,454
 1101 ANS(J) = ANSLAB(J)
      GAM=GAMMA
      IF(KODE)91,92,91
   91 GAMMA=GAMMA*(1.0+DLMPT)
```

Correction

Correction

```
 92 PPP=ANS(2)/P1
    TTT=ANS(3)/T1
    E=PPP
    EE=TTT
    IF(ITR)201,200,201
200 TEMM=WTMOL/AM1
    II=0
    WRITE OUTPUT TAPE 6,203,II,PPP,TTT
    DO 202 II=1,7
    TEM=TEMM/TTT*GAMMA
    PPPP=(1.0+GAMMA)/(2.0*TEM)*
   2(1.0+SQRTF(1.0-4.0*TEM/(1.0+GAMMA)**2))
    TE=TEM/GAMMA*PPPP
    TTTT=EE-.75*R/(AM1*CP)*E+GAMMA*R/(2.*AM1*CP)*((TE**2-1.0)/TE)*PPPP
    WRITE OUTPUT TAPE 6,203,II,PPPP,TTTT
203 FORMAT(I5,2E20.8)
    IF(ABSF(PPPP-PPP)-.1)205,205,206
206 PPP=PPPP
    TTT=TTTT
202 CONTINUE
205 PCP(1)=T1*TTTT
    PC=P1*PPPP
    TC=0.0
    IPRCP=3
    ITR=1
    GAMMA=GAM
    GO TO 21
201 TEMM=PPP/TTT*WTMOL/AM1
    TEM=(1.0-GAMMA*(TEMM-1.0))
    A11=1.0/PPP-GAMMA*TEMM*(1.0+DLMPT)
    A12=GAMMA*TEMM*(1.0-DLMTP)
    A21=GAMMA/2.0*(DLMPT+TEMM**2*(2.0+DLMPT))-DLMTP
    HAL=GAMMA/2.0*(TEMM**2+1.0)
    A22=HAL*(DLMTP-1.0)-WTMOL*CP/R
    B1=1.0/PPP-TEM
    B2=WTMOL/(R*ANS(3))*(HSUM-H1)-GAMMA/2.0*(TEMM**2-1.0)
    ASSIGN 51 TO JJ
 50 EEM=A11*A22-A21*A12
    X1=(B1*A22-B2*A12)/EEM
    X2=(A11*B2-A21*B1)/EEM
    GO TO JJ,(51,52,53,       59)
 51 TE=ABSF(X1)
    TEM=ABSF(X2)
    IF(TE-.4)94,94,95
 94 IF(TEM-.4)96,96,95
 96 ALAM=1.0
    GO TO 97
 95 IF(TE-TEM)93,93,98
 93 HAL=TEM
    GO TO 99
 98 HAL=TE
 99 ALAM=.4/HAL
 97 PPPP=PPP*EXPF(X1*ALAM)
    TTTT=TTT*EXPF(X2*ALAM)
301 US=91.18496 *SQRTF(GAMMA*ANS(3)/WTMOL)
    UD=TEMM*US
    PCP(1)=T1*TTTT
    PC=P1*PPPP
    TC=0.0
    IPRCB=3
    TE=WTMOL/AM1
    TEM=PPPP/TTTT*TE
    E=X1**2+X2**2
    EE=SQRTF(E)
    WRITE OUTPUT TAPE 6,10,ITR
 10 FORMAT (21H0    ITERATION NUMBER=I2,10X,3HOLD,17X,3HNEW//)
    WRITE OUTPUT TAPE 6,30,PPP,PPPP,TTT,TTTT,TEMM,TEM,X1,X2,US,UD,E
   2,EE
 30 FORMAT(6X,4HP/P1,10X,1H=2E20.8/6X,4HT/T1,10X,1H=2E20.8/6X,8HRHO/RH
   101,6X,1H=2E20.8/6X,11HDEL LN P/P1,3X,1H=E20.8/6X,11HDEL LN T/T1,3X
   2,1H=E20.8/6X,2HUS,12X,1H=E20.8/6X,2HUD,12X,1H=E20.8/6X,1HE,13X,1H=
   3E20.8/6X,13HSQR ROOT OF E,1X,1H=E20.8)
    PPP=PPPP
    TTT=TTTT
    IF(ABSF(X1)-.5E-05)11,11,12
 11 IF(ABSF(X2)-.5E-05)13,13,12
```

```
 12 IF(ITR-10)14,13,13
 14 ITR=ITR+1
    GAMMA=GAM
    GO TO 21
 13 JEAN=10
    P=PPP*P1
    T=TTT*T1
    US=91.18496 *SQRTF(GAMMA*T/WTMOL)
    UD=TEM*US
    WRITE OUTPUT TAPE 6,31
 31 FORMAT (17H1   FINAL ANSWERS//)
    WRITE OUTPUT TAPE 6,32,PPP,TTT,TE,TEM,P,T,WTMOL,P1,T1,AM1,US,UD
   2,CON
 32 FORMAT (6X,4HP/P1,10X,1H=E20.8/6X,4HT/T1,10X,1H=E20.8/6X,4HM/M1,10
   2X,1H=E20.8/6X,8HRHO/RHO1,6X,1H=E20.8/6X,1HP,13X,1H=E20.8/6X,1HT,13
   3X,1H=E20.8/6X,1HM,13X,1H=E20.8/6X,2HP1,12X,1H=E20.8/6X,2HT1,12X,1H
   4=E20.8/6X,2HM1,12X,1H=E20.8/6X,2HUS,12X,1H=E20.8/6X,2HUD,12X,1H=E2
   5C.8/6X,2HCP,12X,1H=E20.8)
    IF(CON)41,40,41
 41 GAMF=CON/(CON-R/AM1)
    AMD=UD/(91.18496*SQRTF(GAMF*T1/AM1))
    WRITE OUTPUT TAPE 6,42,GAMF,AMD
 42 FORMAT (6X,7HGAMMA F,7X,1H=E20.8/6X,2HMD,12X,1H=E20.8)
    GO TO 150
 40 GAMF=0.0
    AMD=0.0
150 FEM=.5*(2.0+DLMPT)
    TEMM=.5*(DLMTP-1.0)
    WRITE OUTPUT TAPE 6,55
 55 FORMAT (17H0   DERIVATIVE OF,12X,4HLN P,13X,4HLN T,13X,5HLN UD/4X,
   22HBY)
    B1=1.0/PPP-GAMMA*TEM
    B2=GAMMA*  TEM**2
    ASSIGN 53 TO JJ
    GO TO 50
 53 CASE1=(FEM*X1+TEMM*X2-1.0)*UD
    X1=X1-1.0
    WRITE OUTPUT TAPE 6,81,X1,X2,CASE1
 81 FORMAT (6X,12HLNP1 AT T1,G,7X,1H=3E17.8)
    A1=X1
    A2=X2
    A3=CASE1
    B1=GAMMA*TEM
    B2=-B1*TEM-WTMOL*CON/R/TTT
    ASSIGN 59 TO JJ
    GO TO 50
 59 CASE4=(FEM*X1+TEMM*X2+1.0)*UD
    X2=X2-1.0
    WRITE OUTPUT TAPE 6,84,X1,X2,CASE4
 84 FORMAT(6X,16HLNT1 AT P1,H1,M1,3X,1H=3E17.8)
    A4=X1
    A5=X2
    A6=CASE4
    B1=0.0
    B2=-WTMOL/(R*T)
    ASSIGN 52 TO JJ
    GO TO 50
 52 X1=X1*1000.0
    X2=X2*1000.0
    CASE5=(FEM*X1+TEMM*X2)*UD
    WRITE OUTPUT TAPE 6,85,X1,X2,CASE5
 85 FORMAT (6X,20HH1    AT T1,P1,M1    =3E17.8)
    A7=X1
    A8=X2
    A9=CASE5
    GAMMA=GAM
    IPROB=1
    ULS=91.18496*SQRTF(GAMF*T1/AM1)
    WRITE TAPE 3,(G(I),I=1,8044)
    CALL OUT
    KORE=1
    RETURN
```

```
      SUBROUTINE OUT
C
      COMMON C
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))
      EQUIVALENCE   (HSUM,       C(424)),  (SSUM,       C(425))
      EQUIVALENCE   (WTMOL,      C(426)),  (CP,         C(427))
      EQUIVALENCE   (DLMPT,      C(428)),  (DLMTP,      C(429))
      EQUIVALENCE   (GAMMA,      C(430)),  (ARATIO,     C(431))
      EQUIVALENCE   (VMACH,      C(432)),  (SP IMP,     C(433))
      EQUIVALENCE   (VACI,       C(434)),  (CF,         C(436))
      EQUIVALENCE   (RHOI,       C(437)),  (RHOVAC,     C(438))
      EQUIVALENCE   (RHO,        C(439))
      EQUIVALENCE   (T PI,       C(440)),  (PI I,       C(441))
      EQUIVALENCE   (CP PI,      C(442)),  (AW PI,      C(443))
      EQUIVALENCE   (T ETA,      C(445))
      EQUIVALENCE   (ETA I,      C(446)),  (EP ETA,     C(447))
      EQUIVALENCE   (AW ETA,     C(448)),  (T SIG,      C(450))
      EQUIVALENCE   (SIG I,      C(451)),  (EP SIG,     C(452))
      EQUIVALENCE   (AW SIG,     C(453))
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),   C(1343))
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),   C(1381))
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23), C(1381))
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))
      EQUIVALENCE   (ISYS,       C(1472))
      EQUIVALENCE   (ACX,        C(1474)),   (ACF,      C(1475))
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,      C(1477))
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),    C(1519))
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),    C(1540))
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),    C(1555))
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))
      EQUIVALENCE   (OCF,      C(1556))
      EQUIVALENCE   (OF,      C(1556)),     (FPCT,   C(1557))
      EQUIVALENCE   (PERCF,    C(1557)),     (EQUIV,    C(1558))
      EQUIVALENCE   (EQRAT,      C(1558))
      EQUIVALENCE                          (KASE,       C(1560))
      EQUIVALENCE   (KCNT,   C(1561)),    (NF,          C(1562))
      EQUIVALENCE   (NC,         C(1563)), (NE,         C(1564))
      EQUIVALENCE   (NCEQ, C(1565))
      EQUIVALENCE   (NCFRCZ,     C(1566))
      EQUIVALENCE   (P1,        C(1567)),  (T1,         C(1568))
      EQUIVALENCE   (AM1,         C(1569)), (H1,        C(1570))
      EQUIVALENCE   (CON,        C(1571)), (ITR,        C(1572))
      EQUIVALENCE   (R,          C(1573)), (KCDE,       C(1574))
      EQUIVALENCE   (JBAR,       C(1575)), (GAMF,      C(1585))
      EQUIVALENCE   (A1,    C(1576)), (A2,    C(1577)),  (A3,    C(1578))
      EQUIVALENCE   (A4,    C(1579)),    (A5,    C(1580)),    (A6,  C(1581))
      EQUIVALENCE   (A7,  C(1582)),  (A8,  C(1583)),    (A9,    C(1584))
      EQUIVALENCE   (UCS,         C(1586)),     (US,  C(1587))
      EQUIVALENCE   (PPP,      C(1588)),      (TTT,     C(1589))
      EQUIVALENCE   (TE,      C(1590)),      (TEM,     C(1591))
      EQUIVALENCE   (AMD,      C(1592)),      (UD,    C(1593))
      EQUIVALENCE (KD, C(1763)), (II, C(1764))
      EQUIVALENCE (MM, C(1765)), (IN, C(8046))
      EQUIVALENCE (MF, C(1769))
      EQUIVALENCE   (BCX(1),     C(1771)), (BCX(15),    C(1785))
      EQUIVALENCE   (BCF(1),     C(1786)), (BCF(15),    C(1800))
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))
      EQUIVALENCE   (EN LN(1),  C(1861)), (EN LN(90), C(1950))
      EQUIVALENCE   (DEL N(1),  C(1951)), (DEL N(90), C(2040))
      EQUIVALENCE   (HC(1),      C(2041)), (HC(90),     C(2130))
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))
      EQUIVALENCE   (DELTA(1),  C(2241)), (DELTA(20), C(2260))
      EQUIVALENCE   (BC(1),      C(2261)), (BC(15),     C(2275))
      EQUIVALENCE   (PC,         C(2276)), (HSUBO,      C(2277))
      EQUIVALENCE   (SC,         C(2278)), (T LN,       C(2279))
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))
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```
      EQUIVALENCE   (HC,          C(2284)), (TC LN,      C(2285))
      EQUIVALENCE   (PCP(1),      C(2286)), (PCP(25),    C(2310))
      EQUIVALENCE   (DATUM(1),    C(2311)), (DATUM(3),   C(2313))
      EQUIVALENCE   (PC,          C(2314)), (TC,         C(2315))
      EQUIVALENCE   (IPRCB,       C(2316)), (IFIXT,      C(2317))
      EQUIVALENCE   (IPS,         C(2318)), (ICOND,      C(2319))
      EQUIVALENCE   (ISYM,        C(2320)), (IPROD,      C(2321))
      EQUIVALENCE   (IDID,        C(2322)), (LCRUM,      C(2323))
      EQUIVALENCE   (IDRM,        C(2323)), (KCRUM,      C(2324))
      EQUIVALENCE   (L,           C(2325)), (L1,         C(2326))
      EQUIVALENCE   (M,           C(2327)), (M1,         C(2328))
      EQUIVALENCE   (IG1,         C(2331)), (IG2,        C(2332))
      EQUIVALENCE   (N,           C(2329)), (IG,         C(2330))
      EQUIVALENCE   (IG3,         C(2333)), (KMAT,       C(2334))
      EQUIVALENCE   (IMAT,        C(2335)), (ILSE,       C(2335))
      EQUIVALENCE   (IADD,        C(2336)), (ITNUMB,     C(2337))
      EQUIVALENCE   (ITAPE,       C(2338)), (P,          C(2339))
      EQUIVALENCE   (IDEBUG,      C(2340)), (IFROZ,      C(2341))
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))
      EQUIVALENCE (ELMT(1), C(1807)), (ELMT(15), C(1821))
      EQUIVALENCE (LLMT(1), C(1807)), (LLMT(15), C(1821))
      EQUIVALENCE (AMOL(1), C(9268)), (AMOL(1170),  C(10437))
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))
      EQUIVALENCE (KSAN,C(10623))
C
      DIMENSION   G(20,21),                EN(90),      FN LN(90)
      DIMENSION   DEL N(90),  HC(90),      S(90),       X(20)
      DIMENSION   DELTA(20),  BC(15),      PCP(25),     PRCD(3)
      DIMENSION   COEFX(20),  DX(20),      FORM(15)
      DIMENSION COEFT1(15,90) , COEFT2(15,90)
      DIMENSION   ELMT(15),   DATA(23),    DATUM(3),    FORMLA(18)
      DIMENSION   BCX(15),    BOF(15),     ANS(454),    SYSTM(15)
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)
      DIMENSION   ANSLAB(454),   COEFT(15,90)
      DIMENSION   MATOM(101,3),     ATOM(101,3)
      DIMENSION TITLE(3,105),            A(15,46)
      DIMENSION AMOL(13,90)
C
C
    2 FORMAT (9HCCASE NO.I5,F8.2,F8.2)
    3 FORMAT (1HC,64X,52HWT FRACTION  ENTHALPY   STATE  TEMP    HEAT CAP
     2ACITY/25X,16HCHEMICAL FORMULA,24X,10H(SEE NOTE),4X,7HCAL/MOL,9X,
     35HDEG K,4X,13HCAL/MOL-DEG K)
    4 FORMAT (1HC,84X,46HWT FRACTION  ENTHALPY   STATE  TEMP       CP  /
     2         25X,16HCHEMICAL FORMULA,44X,10H(SEE NOTE),4X,7HCAL/MOL,
     3         10X,5HDEG K)
    5 FORMAT(1H+,63X,F9.5,F12.3,4X,A1,F10.2,F11.4)
    6 FORMAT(1H+,83X,F9.5,F12.3,4X,A1,F10.2,F11.4)
    7 FORMAT (1HC,30X,4HC/F=F9.6,15H, PERCENT FUEL=F8.4,20H, EQUIVALENCE
     1 RATIO=F7.4)
   20 FORMAT      (43X,46HDETONATION PROPERTIES OF AN IDEAL REACTING GAS)
   21 FORMAT (43X,45HCALCULATED USING SPECIFIC HEAT RATIO AS GAMMA)
   22 FORMAT (1HC,24HTHERMODYNAMIC PROPERITES/27X,12HUNBURNED GAS, 5X,10
     2HBURNED GAS)
   23 FORMAT (1X,6HP, ATM,20X,F12.5,3X,F12.5)
   24 FORMAT (1X,8HT, DEG K,18X,F12.2,3X,F12.1)
   25 FORMAT (1X,9HH, CAL/G ,17X,F12.1,3X,F12.1)
   26 FORMAT (1X,15HS, CAL/G-DEG K ,26X,F12.4)
   27 FORMAT (1X,11HM, MOL. WT.15X,F12.3,3X,F12.3)
   28 FORMAT (1X,16HCP, CAL/G-DEG K ,10X,F12.4,3X,F12.4)
   29 FORMAT (1X,12H(DLNM/DLNP)T,14X,F12.5,3X,F12.5)
   30 FORMAT (1X,12H(DLNM/DLNT)P,14X,F12.4,3X,F12.4)
   31 FORMAT (1X,5HGAMMA,21X,F12.4,3X,F12.4)
   32 FORMAT (1X,9HUS, M/SEC,17X,F12.1,3X,F12.1)
   33 FORMAT(1HC/1X,40HBURNED GAS COMPOSITION IN MOLE FRACTIONS//)
   34 FORMAT (1HC/1X,21HDETONATION PARAMETERS,
     22X,27H(UD IN M/SEC, H1 IN KCAL/G))
   35 FORMAT (1HC,4HP/P1,4X,1H=F7.3,5X,21H(DL(P/P1)/DLP1)T1,H1=F8.5,5X,1
     28H(DL(P/P1)/DLT1)P1=F8.5,5X,20H(DL(P/P1)/DH1)P1,T1=F8.5)
   36 FORMAT ( 1X,4HT/T1,4X,1H=F7.3,5X,21H(DL(T/T1)/DLP1)T1,H1=F8.5,5X,1
     18H(DL(T/T1)/DLT1)P1=F8.5,5X,20H(DL(T/T1)/DH1)P1,T1=F8.5)
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   37 FORMAT (1X,4HM/M1,4X,1H=F7.4)
   38 FORMAT (1X,9HRHO/RHO1=F7.4)
   39 FORMAT (1X,9HMACH NO.=F7.4)
   40 FORMAT (1X,9HUP       =F7.1,5X,16H(D UP/DLP1)T1,H1,4X,1H=F8.2,5X,13
     1H(D UP/DLT1)P14X,1H=F8.2,5X,15H(D UP/DH1)P1,T1,4X,1H=F8.2)
 1000 WRITE OUTPUT TAPE 6,18
   18 FORMAT (1H1)
  552 REWIND 3
  300 READ TAPE 3,(ANS(I),I=1,454)
      HAL=P1*14.696006
      I=1
      J=38
      DO 350 JJ=1,N
      AMOL(1,I)=ANS(J)
      J=J+4
  350 I=I+1
      WRITE OUTPUT TAPE 6,20
      IF(KODE)351,352,351
  351 WRITE OUTPUT TAPE 6,21
  352 CONTINUE
B     ZERO=0000000000000
  106 J=34
      DO 104 I=1,N
      DO 105 II=1,3
      KK=J+II
  105 TITLE(II,I)=ANS(KK)
  104 J=J+4
      ASSIGN 90 TO JEAN
   92 WRITE OUTPUT TAPE 6,2,KASE,HAL,TI
      GO TO JEAN,(90,91)
   90 IF (KD) 710, 700, 710
  700 IF (KSAN) 702,701,702
  701 WRITE OUTPUT TAPE 6,3
      GO TO 97
  702 WRITE OUTPUT TAPE 6,733
  733 FORMAT (1H0,64X,52H MOLES        ENTHALPY    STATE  TEMP     HEAT CAP
     2ACITY/25X,16HCHEMICAL FORMULA,24X,10H            ,4X,7HCAL/MOL,9X,
     35HDEG K,4X,13HCAL/MOL-DEG K)
      GO TO 97
  710 IF (KSAN) 712,711,712
  711 WRITE OUTPUT TAPE 6,4
      GO TO 97
  712 WRITE OUTPUT TAPE 6,744
  744 FORMAT (1H0,84X,46H MOLES        ENTHALPY    STATE  TEMP        CP  /
     2         25X,16HCHEMICAL FORMULA,44X,10H            ,4X,7HCAL/MOL,
     3         10X,5HDEG K)
   97 IF(NF)451,450,451
  451 DO 100 I=1,NF
      II=I
      MM=15
      CALL SPEC
      IF(KD)401,400,401
  400 WRITE OUTPUT TAPE 6,5,A(I,34),A(I,32),A(I,42),A(I,44),A(I,36)
      GO TO 100
  401 WRITE OUTPUT TAPE 6,6,A(I,34),A(I,32),A(I,42),A(I,44),A(I,36)
  100 CONTINUE
  450 IF(ND)453,452,453
  453 DO 101 I=1,ND
      II=I
      MM=0
      CALL SPEC
      IF(KD)411,410,411
  410 WRITE OUTPUT TAPE 6,5,A(I,33),A(I,31),A(I,41),A(I,43),A(I,35)
      GO TO 101
  411 WRITE OUTPUT TAPE 6,6,A(I,33),A(I,31),A(I,41),A(I,43),A(I,35)
  101 CONTINUE
  452 CONTINUE
      WRITE OUTPUT TAPE 6,7,COF,PERCF,EQUIV
      WRITE OUTPUT TAPE 6,22
      WRITE OUTPUT TAPE 6,23,P1,P
      WRITE OUTPUT TAPE 6,24,T1,T
      WRITE OUTPUT TAPE 6,25,H1,ANS(4)
      WRITE OUTPUT TAPE 6,26,ANS(5)
      WRITE OUTPUT TAPE 6,27,AM1,ANS(6)
      WRITE OUTPUT TAPE 6,28,CON,ANS(7)
      WRITE OUTPUT TAPE 6,29,ZERO,ANS(8)
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      WRITE OUTPUT TAPE 6,30,ZERO,ANS(9)
      WRITE OUTPUT TAPE 6,31,GAMF,ANS(10)
      WRITE OUTPUT TAPE6,32,LUS,US
      WRITE OUTPUT TAPE 6,33
      IN=1
      NE=2
      CALL COMP
      WRITE OUTPUT TAPE 6,34
      WRITE OUTPUT TAPE 6,35,PPP,A1,A4,A7
      WRITE OUTPUT TAPE 6,36,TTT,A2,A5,A8
      WRITE OUTPUT TAPE 6,40,UU,A3,A6,A9
      WRITE OUTPUT TAPE 6,37,TE
      WRITE OUTPUT TAPE 6,38,TEM
      WRITE OUTPUT TAPE 6,39,AMD
  207 WRITE OUTPUT TAPE 6,16
   16 FORMAT (1H0,30X,16HINPUT, G-ATOMS/G//)
      IF(NE-8)80,80,81
   80 KK=1
      KKK=NE
      LOOP=1
      GO TO 82
   81 KK=1
      KKK=8
      LOOP=2
   82 DO 85 J=1,LOOP
      WRITE OUTPUT TAPE 6,11,(ELMT(I),I=KK,KKK)
   11 FORMAT (11X,8(6X,A2,7X))
      WRITE OUTPUT TAPE 6,12,(BOF (I),I=KK,KKK)
   12 FORMAT (5H FUEL,6X,8E15.7)
      WRITE OUTPUT TAPE 6,13,(BOX (I),I=KK,KKK)
   13 FORMAT (8H OXIDANT,3X,8E15.7)
      WRITE OUTPUT TAPE 6,14,(BO  (I),I=KK,KKK)
   14 FORMAT (11H PROPELLANT,8E15.7)
      IF (LOOP-1) 86,85,86
   86 KK=9
      KKK=NE
      WRITE OUTPUT TAPE 6,15
   15 FORMAT(1H0)
   85 CONTINUE
      ASSIGN 91 TO JEAN
      GO TO 92
   91 IF (KSAN) 751,750,751
  750 WRITE OUTPUT TAPE 6,119
  119 FORMAT (8HONOTE.,2X,71HWEIGHT FRACTION OF FUEL IN TOTAL FUELS AND
     1OF OXIDANT IN TOTAL OXIDANTS)
  751 CONTINUE
      RETURN
```

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```
      SUBROUTINE ONCE (N,M)
C
C     OUTPUTS OOO PRODUCTS
C
C
      COMMON C
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))
      DIMENSION M(105),TITLE(3,105) ,TEM(10),FMT(3)
      WRITE OUTPUT TAPE 6,1
B     FMT(1)=7401302C736C
B     FMT(3)=21C6346C6060
B     TEM(1)=6C6C01677302
B     TEM(2)=6CC1046773C2
B     TEM(3)=6C0207677302
B     TEM(4)=6C04CC677302
B     TEM(5)=6C05C3677302
B     TEM(6)=6CC6C6677302
B     TEM(7)=6C07116773C2
B     TEM(8)=6C11C2677302
B     TEM(9)=C1CC05677302
B     TEM(10)=C1C11C677302
      K=0
      KK=10
      DO 10 I=1,N
      J=M(I)
```

```
      IF(I-KK) 20,20,21
   20 K=K+1
      GO TO 5
   21 K=1
      KK=KK+10
      WRITE OUTPUT TAPE 6,1
    1 FORMAT (1H )
    5 FMT(2)=TEM(K)
      WRITE OUTPUT TAPE 6,FMT,TITLE(2,J),TITLE(3,J)
   10 CONTINUE
      RETURN
```

```
      SUBROUTINE SPEC
C
C     OUTPUTS FUEL AND OXIDANT FROM SUBROUTINE INPUT
C
C
      COMMON C
      EQUIVALENCE (KONT, C(1763))
      EQUIVALENCE (I, C(1764)), (M,C(1765))
      EQUIVALENCE (A(1),  C(8578)),  (A(690),  C(9267))
      EQUIVALENCE (ELMT(1),  C(1807)), (ELMT(15),  C(1821))
      DIMENSION A(15,46),TEM(5),ANAME(5),ELMT(15)
      DIMENSION II(5)
   55 FORMAT (10X,4HFUEL)
   66 FORMAT (10X,7HOXIDANT)
      IF (M ) 2,1,2
    1 WRITE OUTPUT TAPE 6,66
      GO TO 3
    2 WRITE OUTPUT TAPE 6,55
    3 K=0
      DO 11 J=1,15
      KK=I+M
      IF(A(J,KK))12,11,12
   12 K=K+1
      TEM(K)=A(J,KK)
      ANAME(K)=ELMT(J)
      II(K)=TEM(K)
   11 CONTINUE
      IF(KONT)21,20,21
   20 WRITE OUTPUT TAPE 6,4,(ANAME(I),II(I),I=1,K)
    4 FORMAT(1H+,18X,5(A2,I2,5X))
      GO TO 13
   21 WRITE OUTPUT TAPE 6,5,(ANAME(I),TEM(I),I=1,K)
    5 FORMAT (1H+,18X,5(A2,F8.5,3X))
   13 RETURN
```

```
      SUBROUTINE COMP
C
C     OUTPUTS COMPOSITION
C
C
      COMMON C
      EQUIVALENCE (AMOL(1),  C(9268)),  (AMOL(1170),  C(10437))
      EQUIVALENCE (NANA, C(1768)), (IN, C(80461)
      EQUIVALENCE (MF, C(1769)), (N, C(2329))
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))
      EQUIVALENCE   (MTITLE(1), C(8055)),  (MTITLE(315),   C(8369))
      EQUIVALENCE (OMIT,MOMIT)
      DIMENSION                TITLE(3,105),IOMIT(105),ILESS(105)
      DIMENSION AMOL(13,90)
      DIMENSION FMT(4),TEM(4)
      DIMENSION MTITLE (3,105)
    1 FORMAT (1X,2A6,2X,13F9.5)
    3 FORMAT (1H0,   118HADDITIONAL PRODUCTS WHICH WERE CONSIDERED BUT W
     1HOSE MOLE FRACTIONS WERE LESS THAN 0.000005 FOR ALL ASSIGNED CONDI
     2TIONS//)
    4 FORMAT (1H0,    59HPRODUCTS WHICH WERE INTENTIONALLY OMITTED FROM
     1CALCULATIONS//)
P     OMIT=464431636060
B     TEM(1)=6060076773C2
B     TEM(2)=6003066773C2
B     TEM(3)=6006046773C2
B     TEM(4)=6011026773C2
B     FMT(1)=74013020736C
B     FMT(3)=210673261033
B     FMT(4)=053460606060
      K=0
      KK=4
      IOM=0
      ILE=0
      IF(MF-1)61,60,61
   61 WRITE OUTPUT TAPE 6,44
   60 II=0
      DO 9 I=1,N
      IF (MTITLE(1,I)-MOMIT) 10,100,10
  100 IOM=IOM+1
      IOMIT(IOM)=I
      GO TO 9
   10 DO 11 J=1,IN
      IF(AMOL(J,I)-.5E-05)11,12,12
   11 CONTINUE
      ILE=ILE+1
      ILESS(ILE)=I
      GO TO 9
   12 IF(MF-1)51,50,51
   50 WRITE OUTPUT TAPE 6,1 ,TITLE(2,I),TITLE(3,I),(AMOL(JJ,I),JJ=1,IN)
      GO TO 9
   51 II=II+1
      IF(II-KK)200,200,201
  200 K=K+1
      GO TO 5
  201 K=1
      KK=KK+4
      WRITE OUTPUT TAPE 6,44
   44 FORMAT (1H )
    5 FMT(2)=TEM(K)
      WRITE OUTPUT TAPE 6,FMT,TITLE(2,I),TITLE(3,I),AMOL(1,I)
    9 CONTINUE
      IF(ILE) 21,20,21
   21 WRITE OUTPUT TAPE 6,44
      WRITE OUTPUT TAPE 6,3
      CALL ONCE (ILE,ILESS)
   20 IF(IOM) 31,30,31
   31 WRITE OUTPUT TAPE 6,44
      WRITE OUTPUT TAPE 6,4
      CALL ONCE (IOM,IOMIT)
   30 RETURN
```

```
      SUBROUTINE  CORES
C
C     OUTPUT ROUTINE
C
C
      COMMON C
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),    C(874))
      EQUIVALENCE   (PERCF,    C(1557)),    (EQUIV,    C(1558))
      EQUIVALENCE   (DDF,      C(1556))
      EQUIVALENCE (KODE,     C(1559)),   (KASE,       C(1560))
      EQUIVALENCE   (KONT,   C(1561)),   (NF,         C(1562))
      EQUIVALENCE   (NC,        C(1563)), (NE,        C(1564))
      EQUIVALENCE   (NOEQ, C(1565))
      EQUIVALENCE   (NOFROZ,    C(1566))
      EQUIVALENCE (KO, C(1763)), (II, C(1764))
      EQUIVALENCE (MM, C(1765))
      EQUIVALENCE (LEN, C(1766)), (MAY, C(1767))
      EQUIVALENCE (NANA, C(1768)), (ME, C(1769))
      EQUIVALENCE (LOOP, C(1770)), (KTAPE, C(8045))
      EQUIVALENCE   (BOX(1),    C(1771)), (BOX(15),   C(1785))
      EQUIVALENCE   (BOF(1),    C(1786)), (BOF(15),   C(1800))
      EQUIVALENCE   (BO(1),     C(2261)), (BO(15),    C(2275))
      EQUIVALENCE   (IPROB,     C(2316)), (IFIXT,     C(2317))
      EQUIVALENCE   (N,         C(2329)), (IO,        C(2330))
      EQUIVALENCE (IN, C(8046))
      EQUIVALENCE (KK, C(8048)), (KKK, C(8049))
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))
      EQUIVALENCE (ELMT(1), C(1807)), (ELMT(15), C(1821))
      EQUIVALENCE (PAR(1),  C(8370)), (PAR(208),  C(8577))
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))
      EQUIVALENCE (AMOL(1),  C(9268)),  (AMOL(1170),  C(10437))
      EQUIVALENCE (DER(1), C(10438)),  (DER(169), C(10606))
      EQUIVALENCE(NAREA,C(10607))                                    Area ratio
      EQUIVALENCE(SAREA(1),C(10608)),(SAREA(13),C(10620))            Area ratio
      EQUIVALENCE (PC,C(2314)),  (HC,C(2284))                        Area ratio
      EQUIVALENCE (KSAM,C(10623))                                    Moles
      DIMENSION SAREA(13)                                            Area ratio
      DIMENSION         TITLE(3,105),PAR(13,16),DER(13,13),
     2              A(15,46),ELMT(15)
     3,ANS(454)
      DIMENSION BOX(15),BOF(15),BO(15)
      DIMENSION AMOL(13,90)
      DIMENSION          ASOL(13)
D     EXIT=2567316360C0
    2 FORMAT (9HCCASE NO.I5,F8.1,F7.3)
    3 FORMAT (1HC,64X,46HWT FRACTION  ENTHALPY   STATE  TEMP    DENSITY/
     225X,16HCHEMICAL FORMULA,24X,10H(SEE NOTE),4X,7HCAL/MOL,10X,
     35HDEG K,4X,4HG/CC)
    4 FORMAT (1HC,84X,46HWT FRACTION  ENTHALPY   STATE  TEMP    DENSITY/
     2         25X,16HCHEMICAL FORMULA,44X,10H(SEE NOTE),4X,7HCAL/MOL,
     3         8X,5HDEG K,4X,4HG/CC)
    5 FORMAT(1H+,63X,F9.5,F12.3,4X,A1,F10.2,F11.6)
    6 FORMAT(1H+,83X,F9.5,F12.3,4X,A1,F10.2,F11.6)
    7 FORMAT (1HC,30X,4HO/F=F9.6,15H, PERCENT FUEL=F8.4,20H, EQUIVALENCE
     1 RATIO=F7.4,10H, DENSITY=F7.4)
      DO 60 I=1,13
   60 ASOL(I)=EXIT
      IF(IPROB-2)550,550,551
  550 NANA=2
      GO TO 552
  551 NANA=1
  552 REWIND 3
      KANE = NANA
      DO 200 ME=1,KANE
      KTAPE=0
  300 READ TAPE 3, (ANS(I),I=1,454)
      KTAPE=KTAPE+1
      HAL=ANS(2)*14.696006
      HALL=ANS(19)
      IF(MM-11)202,201,202
  201 LEN=NOEQ
      GO TO 203
  202 LEN=NOFROZ
  203 IF(LEN-13)102,102,103
  102 KODE=0
      GO TO 106
```

```
  103 KCNT=0                                                            3224
      KCDE=13                                                           3225
  106 J=34                                                              3226
      DO 104 I=1,N                                                      3227
      DO 105 II=1,3                                                     3228
      KK=J+II                                                           3229
  105 TITLE(II,I)=ANS(KK)                                               3230
  104 J=J+4                                                             3231
      MAY=1                                                             3232
 1000 WRITE OUTPUT TAPE 6,18                                            3233
   18 FORMAT (1H1)                                                      3234
      CALL HEAD                                                         3235
      ASSIGN 2000 TO LENN                                                   Area ratio
 2002 ASSIGN 90 TO JEAN                                                     Area ratio
   92 WRITE OUTPUT TAPE 6,2,KASE,HAL,COF                                3237
      GO TO JEAN,(90,91)                                                3238
   90 IF (KB) 710, 900, 710
  900 IF(KSAN)902,901,902
  901 WRITE OUTPUT TAPE 6,3
      GO TO 97
  902 WRITE OUTPUT TAPE 6,733
  733 FORMAT (1H0,64X,46H MOLES        ENTHALPY   STATE  TEMP    DENSITY/
     225X,16HCHEMICAL FORMULA,24X,10H           ,4X,7HCAL/MOL,10X,
     35HDEG K,4X,4HG/CC)                                                    Moles
      GO TO 97
  710 IF (KSAN) 712,711,712
  711 WRITE OUTPUT TAPE 6,4
      GO TO 97
  712 WRITE OUTPUT TAPE 6,744
  744 FORMAT (1H0,84X,46H MOLES        ENTHALPY   STATE  TEMP    DENSITY/
     2         25X,16HCHEMICAL FORMULA,44X,10H           ,4X,7HCAL/MOL,
     3         8X,5HDEG K,4X,4HG/CC)
   97 IF(NF)351,350,351                                                 3243
  351 DO 100 I=1,NF                                                     3244
      II=I                                                              3245
      MM=15                                                             3246
      CALL SPEC                                                         3247
      IF(KB)401,400,401                                                 3248
  400 WRITE OUTPUT TAPE 6,5,A(I,34),A(I,32),A(I,42),A(I,44),A(I,36)     3249
      GO TO 100                                                         3250
  401 WRITE OUTPUT TAPE 6,6,A(I,34),A(I,32),A(I,42),A(I,44),A(I,36)     3251
  100 CONTINUE                                                          3252
  350 IF(NO)353,352,353                                                 3253
  353 DO 101 I=1,NO                                                     3254
      II=I                                                              3255
      MM=0                                                              3256
      CALL SPEC                                                         3257
      IF(KB)411,410,411                                                 3258
  410 WRITE OUTPUT TAPE 6,5,A(I,33),A(I,31),A(I,41),A(I,43),A(I,35)     3259
      GO TO 101                                                         3260
  411 WRITE OUTPUT TAPE 6,6,A(I,33),A(I,31),A(I,41),A(I,43),A(I,35)     3261
  101 CONTINUE                                                          3262
  352 CONTINUE                                                          3263
      WRITE OUTPUT TAPE 6,7,COF,PERCF,EQUIV,HALL                        3264
      GO TO LENN,(2000,2001)                                                Area ratio
 2000 IF(KCDE)51,50,51                                                      Area ratio
   50 IN=LEN                                                            3266
      GO TO 56                                                          3267
   51 IF(KCNT) 52,52,53                                                 3268
   52 IN=KCDE                                                           3269
      KCNT=1                                                            3270
      GO TO 56                                                          3271
   53 IN=LEN -13                                                        3272
      KCDE=0                                                            3273
   56 CALL READ                                                         3274
      IF(IPRCB-2)600,600,601                                            3275
  601 WRITE OUTPUT TAPE 6,602                                           3276
  602 FORMAT (37H0EQUILIBRIUM THERMODYNAMIC PROPERTIES)                 3277
      CALL PERPAR                                                       3278
      GO TO 206                                                         3279
  600 WRITE OUTPUT TAPE 6,8                                             3280
    8 FORMAT (11HOPARAMETERS)                                           3281
      IF(MAY-1)64,63,64                                                 3282
   63 KK=IN-2                                                           3283
      WRITE OUTPUT TAPE 6,61,(ASLL(I),I=1, KK)                          3284
```

```
 61 FORMAT (1HC,16X,7HCHAMBER,4X,7HTHROAT ,10(3X,A6),3X,A4)
    GO TO 65
 64 WRITE OUTPUT TAPE 6,66,(ASCL(I),I=1,IN)
 66 FORMAT (1HC,15X,13(3X,A6))
 65 CONTINUE
    CALL PERPAR
    IF(NE-1)206,205,206
205 WRITE OUTPUT TAPE 6,99
 99 FORMAT(1H )
    WRITE OUTPUT TAPE 6,9
  9 FORMAT (12HDERIVATIVES)
    IF(PAY-1) 503,502,503
503 CALL PERLER
    GO TO 504
502 CALL PERDEY
504 CONTINUE
206 WRITE OUTPUT TAPE 6,99
    WRITE OUTPUT TAPE 6,10
 10 FORMAT (15HMOLE FRACTIONS//)
    CALL COMP
    ASSIGN 3000 TO LENNA
207 WRITE OUTPUT TAPE 6,16
 16 FORMAT (1HC,30X,16HINPUT, G-ATOMS/G//)
    IF(NE-8)80,80,81
 80 KK=1
    KKK=NE
    LOOP=1
    GO TO 82
 81 KK=1
    KKK=8
    LOOP=2
 82 DO 85 J=1,LOOP
    WRITE OUTPUT TAPE 6,11,(ELMT(I),I=KK,KKK)
 11 FORMAT (11X,9(6X,A2,7X))
    WRITE OUTPUT TAPE 6,12,(BOF (I),I=KK,KKK)
 12 FORMAT (5H FUEL,6X,9E15.7)
    WRITE OUTPUT TAPE 6,13,(BOX (I),I=KK,KKK)
 13 FORMAT (8H OXIDANT,3X,8E15.7)
    WRITE OUTPUT TAPE 6,14,(BO  (I),I=KK,KKK)
 14 FORMAT (11H PROPELLANT,8E15.7)
    IF (LOOP-1) 86,85,86
 86 KK=9
    KKK=NE
    WRITE OUTPUT TAPE 6,15
 15 FORMAT(1HC)
 85 CONTINUE
    ASSIGN 91 TO JEAN
    GO TO 92
 91 IF (KSAN) 751,750,751
750 WRITE OUTPUT TAPE 6,119
119 FORMAT (6HCNOTE.,2X,71HWEIGHT FRACTION OF FUEL IN TOTAL FUELS AND
   1OF OXIDANT IN TOTAL OXIDANTS)
751 CONTINUE
    GO TO LENNA,(3000,3001)
3000 IF(KODE)96,95,96
 96 MAY=MAY+1
    GO TO 1000
 95 IF(IPROB-2)700,700,701
700 IF(NAREA)702,701,702
702 IF(LEN-4)701,703,703
703 CALL SANEO
    IF(IPROB-2)7000,7001,7001
7001 IF(ME-1)7003,7002,7003
7002 WRITE OUTPUT  TAPE 6,7005
7005 FORMAT (    25X,20HTHEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIB
    2RIUM COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERAT
    3URE/
    445X,24HFOR ASSIGNED AREA RATIOS)
    GO TO 5050
7003 WRITE OUTPUT TAPE 6,7006
7006 FORMAT (    25X,25HTHEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN
    2COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERATURE/
    345X,24HFOR ASSIGNED AREA RATIOS)
    GO TO 5050
7000 IF(ME-1)70,71,70
  70 WRITE OUTPUT TAPE 6,4000
```

Area ratio
Moles
Moles
Area ratio
Area ratio
Area ratio
Area ratio

```
 4000 FORMAT(1H1, 25X,75HTHEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN
     2COMPOSITION DURING EXPANSION/
     345X,24HFOR ASSIGNED AREA RATIOS)
      GO TO 5050
   71 WRITE OUTPUT TAPE 6,5000
 5000 FORMAT (1H1,25X,80HTHEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIB
     2RIUM COMPOSITION DURING EXPANSION/
     345X,24HFOR ASSIGNED AREA RATIOS)
 5050 CONTINUE
      ASSIGN 2001 TO LENN
      GO TO 2002
 2001 CALL EXITT
      ASSIGN 3001 TO LENNN
      GO TO 207
 3001 CONTINUE
  701 IF(NANA-1)208,200,208
  208 NANA=0
  200 CONTINUE
      RETURN
C
C
C
```

Area ratio

```
      SUBROUTINE HEAD
C
C     OUTPUTS PROPER HEADING ACCORDING TO PROBLEM NUMBER
C
C
      COMMON C
      EQUIVALENCE (IPROB, C(2316)), (ME, C(1769))
  100 FORMAT (     25X,80HTHEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIB
     2RIUM COMPOSITION DURING EXPANSION)
  200 FORMAT (     25X,75HTHEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN
     2COMPOSITION DURING EXPANSION)
  300 FORMAT (     25X,80HTHEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIB
     2RIUM COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERAT
     3URE)
  400 FORMAT (     25X,75HTHEORETICAL ROCKET PERFORMANCE ASSUMING FROZEN
     2COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERATURE)
  500 FORMAT (     25X,74HTHEORETICAL THERMODYNAMIC PROPERTIES AT ASSIGNE
     2D PRESSURE AND TEMPERATURES)
  600 FORMAT (     25X,74HTHEORETICAL THERMODYNAMIC PROPERTIES AT ASSIGNE
     2D TEMPERATURE AND PRESSURES)
      IF(IPROB-2)11,2,10
   10 IF (IPROB-4) 3,4,5
    5 WRITE OUTPUT TAPE 6,9000
 9000 FORMAT(25X, 47HTHEORETICAL THERMODYNAMIC COMBUSTION PROPERTIES)
      RETURN
    1 IF(ME-1)12,11,12
   11 WRITE OUTPUT TAPE 6,100
      RETURN
   12 WRITE OUTPUT TAPE 6,200
      RETURN
    2 IF(ME-1)14,13,14
   13 WRITE OUTPUT TAPE 6,300
      RETURN
   14 WRITE OUTPUT TAPE 6,400
      RETURN
    3 WRITE OUTPUT TAPE 6,500
      RETURN
    4 WRITE OUTPUT TAPE 6,600
      RETURN
C
C
C
```

H,P

```
      SUBROUTINE PERDER
C
C     OUTPUTS PERFORMANCE DERIVATIVES
C
C
      COMMON C
      EQUIVALENCE (IN, C(8046))
      EQUIVALENCE (PER(1), C(10438)),  (PER(169), C(10606))
      DIMENSION PER(13,13)
    1 FORMAT (15F8(DLI/DLPC)PC/P13F9.5)
    2 FORMAT (15F (DLT/DLPC)PC/P13F9.5)
    3 FORMAT (16F (DLAR/DLPC)PC/PF8.5,12F9.5)
    4 FORMAT (16F (DLCS/DLPC)PC/PF8.5,12F9.5)
    5 FORMAT (15F8(DLI/DHC)PC/P*13F9.5)
    6 FORMAT (15F (DLT/DHC)PC/P*13F9.5)
    7 FORMAT (16F (DLAR/DHC)PC/P*F8.5,12F9.5)
    8 FORMAT (16F (DLCS/DHC)PC/P*F8.5,12F9.5)
    9 FORMAT (16F *(HC IN KCAL/G))
   10 FORMAT (13F8(DLI/DLPCP)S,2X,13F9.5)
   11 FORMAT (13F (DLT/DLPCP)S,2X,13F9.5)
   12 FORMAT (15F (DLAR/DLPCP)S 13F9.5)
      WRITE OUTPUT TAPE 6,1,(PER(I,2),I=1,IN)
      WRITE OUTPUT TAPE 6,2,(PER(I,1),I=1,IN)
      WRITE OUTPUT TAPE 6,3,(PER(I,3),I=1,IN)
      WRITE OUTPUT TAPE 6,4,(PER(I,5),I=1,IN)
      WRITE OUTPUT TAPE 6,5,(PER(I,7),I=1,IN)
      WRITE OUTPUT TAPE 6,6,(PER(I,6),I=1,IN)
      WRITE OUTPUT TAPE 6,7,(PER(I,8),I=1,IN)
      WRITE OUTPUT TAPE 6,8,(PER(I,10),I=1,IN)
      WRITE OUTPUT TAPE 6,9
      WRITE OUTPUT TAPE 6,10,(PER(I,12),I=1,IN)
      WRITE OUTPUT TAPE 6,11,(PER(I,11),I=1,IN)
      WRITE OUTPUT TAPE 6,12,(PER(I,13),I=1,IN)
      RETURN
C
C
C
```

```
      SUBROUTINE PERDEY
C
C     OUTPUTS PERFORMANCE DERIVATIVES
C
C
      COMMON C
      EQUIVALENCE (IN, C(8046))
      EQUIVALENCE (PER(1), C(10438)),  (PER(169), C(10606))
      DIMENSION PER(13,13)
    1 FORMAT (15F8(DLI/DLPC)PC/P,9X,12F9.5)
    2 FORMAT (15F (DLT/DLPC)PC/P13F9.5)
    3 FORMAT (16F (DLAR/DLPC)PC/P,8X,12F9.5)
    4 FORMAT (16F (DLCS/DLPC)PC/P,8X,12F9.5)
    5 FORMAT (15F8(DLI/DHC)PC/P*,9X,12F9.5)
    6 FORMAT (15F (DLT/DHC)PC/P*13F9.5)
    7 FORMAT (16F (DLAR/DHC)PC/P*,8X,12F9.5)
    8 FORMAT (16F (DLCS/DHC)PC/P*,8X,12F9.5)
    9 FORMAT (16F *(HC IN KCAL/G))
   10 FORMAT (13F8(DLI/DLPCP)S,11X,12F9.5)
   11 FORMAT (13F (DLT/DLPCP)S,2X,13F9.5)
   12 FORMAT (15F (DLAR/DLPCP)S,9X,12F9.5)
      WRITE OUTPUT TAPE 6,1,(PER(I,2),I=2,IN)
      WRITE OUTPUT TAPE 6,2,(PER(I,1),I=1,IN)
      WRITE OUTPUT TAPE 6,3,(PER(I,3),I=2,IN)
      WRITE OUTPUT TAPE 6,4,(PER(I,5),I=2,IN)
      WRITE OUTPUT TAPE 6,5,(PER(I,7),I=2,IN)
      WRITE OUTPUT TAPE 6,6,(PER(I,6),I=1,IN)
      WRITE OUTPUT TAPE 6,7,(PER(I,8),I=2,IN)
      WRITE OUTPUT TAPE 6,8,(PER(I,10),I=2,IN)
      WRITE OUTPUT TAPE 6,9
      WRITE OUTPUT TAPE 6,10,(PER(I,12),I=2,IN)
      WRITE OUTPUT TAPE 6,11,(PER(I,11),I=1,IN)
      WRITE OUTPUT TAPE 6,12,(PER(I,13),I=2,IN)
      RETURN
C
C
C
```

```
      SUBROUTINE READ
C
C     SORTS WHAT IS ON TAPE 3
C
C
      COMMON C
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),    C(874))
      EQUIVALENCE (LEN, C(1766)), (MAY, C(1767))
      EQUIVALENCE (LCOP, C(1770)), (KTAPE, C(3045))
      EQUIVALENCE (IN, C(8046))
      EQUIVALENCE  (NN,   C(2329))
      EQUIVALENCE (PAR(1), C(8370)), (PAR(208), C(8577))
      EQUIVALENCE (AMOL(1),  C(9268)), (AMCL(1170), C(10437))
      EQUIVALENCE (DER(1), C(10438)),  (DER(169), C(10606))
      DIMENSION PAR(13,16),DER(13,13),              ANS(454)
      DIMENSION AMCL(13,90)
      DO 1 I=1,IN
      DO 2 J=1,16
    2 PAR(I,J)=ANS(J)
      N=1
      DO 3 J=20,32
      DER(I,N)=ANS(J)
    3 N=N+1
      N=1
      J=33
      DO 4 JJ=1,NN
      AMCL(I,N)=ANS(J)
      J=J+4
    4 N=N+1
      IF(KTAPE-LEN)100,1,100
  100 READ TAPE 3,(ANS(K),K=1,454)
      KTAPE=KTAPE+1
    1 CONTINUE
      RETURN
C
C
C
```

```
      SUBROUTINE PERPAR
C
C     OUTPUTS PERFORMANCE PARAMETERS
C
C
      COMMON C
      EQUIVALENCE (KODE, C(1768))
      EQUIVALENCE (IN, C(8046)),  (MAY, C(1767))
      EQUIVALENCE (PAR(1), C(8370)), (PAR(208), C(8577))
      DIMENSION PAR(13,16),NN(13)
   10 FORMAT (5H PC/P,10X)
   11 FORMAT (8H P, ATM ,7X)
   12 FORMAT (9H T, DEG K,6X,13I9)
   13 FORMAT (9H H, CAL/G,6X,13F9.1)
   14 FORMAT (15H S, CAL/(G)(K) 13F9.4)
   15 FORMAT (10HON, MOL WT,5X,13F9.3)
   16 FORMAT (11H (DLM/DLP)T,4X,13F9.5)
   17 FORMAT (11H (DLM/DLT)P,4X,13F9.4)
   18 FORMAT (15H CP, CAL/(G)(K)13F9.4)
   19 FORMAT (6H GAMMA,9X,13F9.4)
   20 FORMAT (12H MACH NUMBER,3X,13F9.3)
   21 FORMAT (15HCOSTAR, FT/SEC 13I9)
   22 FORMAT (3H CF,12X,13F9.3)
   23 FORMAT (6H AE/AT,9X,13F9.3)
   24 FORMAT (15H IVAC,LB-SEC/LB13F9.1)
   25 FORMAT (15H I, LB-SEC/LB  13F9.1)
      IF(KODE-1)2,1,2
    1 WRITE OUTPUT TAPE 6,111
  111 FORMAT (8HCP, ATM ,7X)
      GO TO 3
    2 WRITE OUTPUT TAPE 6,10
      CALL VAR(1,2)
      WRITE OUTPUT TAPE 6,11
```

Area ratio

```
    3 CALL VAR(2,2)                                                     3528 Area ratio
      DO 60 I=1,IN                                                      3529
   60 NN(I)=PAR(I,3)+.5                                                 3530
      WRITE OUTPUT TAPE 6,12,(NN(I),I=1,IN)                             3531
      WRITE OUTPUT TAPE 6,13,(PAR(I,4),I=1,IN)                          3532
      WRITE OUTPUT TAPE 6,14,(PAR(I,5),I=1,IN)                          3533
      WRITE OUTPUT TAPE 6,15,(PAR(I,6),I=1,IN)                          3534
      IF(KODE)6,5,6                                                     3535
    6 WRITE OUTPUT TAPE 6,16,(PAR(I,8),I=1,IN)                          3536
      WRITE OUTPUT TAPE 6,17,(PAR(I,9),I=1,IN)                          3537
    5 WRITE OUTPUT TAPE 6,18,(PAR(I,7),I=1,IN)                          3538
      WRITE OUTPUT TAPE 6,19,(PAR(I,10),I=1,IN)                         3539
      IF(KODE-1)41,40,41                                                3540
   40 RETURN                                                            3541
   41 WRITE OUTPUT TAPE 6,20,(PAR(I,12),I=1,IN)                         3542
      DO 61 I=1,IN                                                      3543
   61 NN(I)=PAR(I,15)+.5                                                3544
      IF (MAY-1) 51,50,51                                               3545
   50 WRITE OUTPUT TAPE 6,31,(NN(I),I=2,IN)                             3546
      WRITE OUTPUT TAPE 6,32,(PAR(I,16),I=2,IN)                         3547
      WRITE OUTPUT TAPE 6,33                                            3548
      CALL VAR(11,2)                                                    3549 Area ratio
      WRITE OUTPUT TAPE 6,34,(PAR(I,14),I=2,IN)                         3550
      WRITE OUTPUT TAPE 6,35,(PAR(I,13),I=2,IN)                         3551
   31 FORMAT (15HCOSTAR, FT/SEC ,9X,12I9)                               3552
   32 FORMAT (3H CF,21X,12F9.3)                                         3553
   33 FORMAT (6H AE/AT,18X,12F9.3)                                      3554
   34 FORMAT (15H IVAC,LB-SEC/LB,9X,12F9.1)                             3555
   35 FORMAT (15H I, LB-SEC/LB ,9X,12F9.1)                              3556
      RETURN                                                            3557
   51 WRITE OUTPUT TAPE 6,21,(NN(I),I=1,IN)                             3558
      WRITE OUTPUT TAPE 6,22,(PAR(I,16),I=1,IN)                         3559
      WRITE OUTPUT TAPE 6,23                                            3560
      CALL VAR(11,2)                                                    3561 Area ratio
      WRITE OUTPUT TAPE 6,24,(PAR(I,14),I=1,IN)                         3562
      WRITE OUTPUT TAPE 6,25,(PAR(I,13),I=1,IN)                         3563
      RETURN                                                            3564
C                                                                       3565
C                                                                       3566
C                                                                       3567


      SUBROUTINE VAR(INDEX,K1)                                          3568 Area ratio
C                                                                       3569
C     SPECIAL FORMAT FOR FO/P,P, AND AE/AT                              3570
C                                                                       3571
C                                                                       3572
      COMMON C                                                          3573
      EQUIVALENCE (IN, C(8046)), (MAY, C(1767))                         3574
      EQUIVALENCE (PAR(1), C(837C)), (PAR(208), C(8577))                3575
      DIMENSION FMT(3),PAR(13,16),TEM(4),AM(4),TEMM(13)                 3576
B     ZERO=113300346060                                                 3577
B     ONE=113301346060                                                  3578
B     TWO=113302346060                                                  3579
B     THR=113303346060                                                  3580
B     FR=113304346060                                                   3581
B     TEMM(1)=600104677326                                              3582
B     TEMM(2)=600203677326                                              3583
B     TEMM(3)=600302677326                                              3584
B     TEMM(4)=600401677326                                              3585
B     TEMM(5)=600500677326                                              3586
B     TEMM(6)=600511677326                                              3587
B     TEMM(7)=600610677326                                              3588
B     TEMM(8)=600707677326                                              3589
B     TEMM(9)=601006677326                                              3590
B     TEMM(10)=601105677326                                             3591
B     TEMM(11)=010004677326                                             3592
B     TEMM(12)=010103677326                                             3593
B     TEMM(13)=010202677326                                             3594
B     FMT(1)=740130207360                                               3595
      IF(K1-2)101,100,101                                                   Area ratio
  100 IF(INDEX-K1)1,2,3                                                     Area ratio
  101 IF(INDEX-K1)3,1,2                                                     Area ratio
    1 TEM(1)=1.0E04                                                     3597
      TEM(2)=1.0E05                                                     3598
      TEM(3)=1.0E06                                                     3599
```

```
      AM(1)=THR
      AM(2)=TWO
      AM(3)=ONE
      AM(4)=ZERO
      GO TO 4
    2 TEM(1)=1.0
      TEM(2)=10.0
      TEM(3)=100.0
      AM(1)=TEN
      AM(2)=THR
      AM(3)=TWO
      AM(4)=ONE
      GO TO 4
    3 TEM(1)=10.0
      TEM(2)=100.0
      TEM(3)=1000.0
      AM(1)=THR
      AM(2)=TWO
      AM(3)=ONE
      AM(4)=ZERO
    4 DO 5 I=1,IN
      IF (I-1) 53,50,53
   50 IF (MAY-1) 53,52,53
   52 IF(INDEX-11) 53,5,53
   53 CONTINUE
      FMI(2)=TEMM(I)
      DO 6 J=1,3
      IF(PAR(I,INDEX)-TEM(J))10,6,6
   10 FMI(3)=AM(J)
   11 WRITE OUTPUT TAPE 6,FMT,PAR(I,INDEX)
      GO TO 5
    6 CONTINUE
      FMI(3)=AM(4)
      WRITE OUTPUT TAPE 6,FMI,PAR(I,INDEX)
    5 CONTINUE
      RETURN
```

```
      SUBROUTINE SAREO
C
C     (USED FOR AREA RATIO INTERPOLATION ONLY)
C
C
      COMMON C
      EQUIVALENCE(SAREA(1),C(10608)),(SAREA(13),C(10620))
      EQUIVALENCE(NAREA,C(10697))
      EQUIVALENCE (PER(1), C(10438)),  (PER(169), C(10606))
      EQUIVALENCE (PAR(1),  C(8370)), (PAR(208),  C(8577))
      EQUIVALENCE (PC,C(2314)),  (HC,C(2284))
      EQUIVALENCE   (NOFC, C(1565))
      EQUIVALENCE (LEN,C(1766)), (MF,C(1769))
      EQUIVALENCE  (IN,C(8946))
      EQUIVALENCE  (IUNPER,C(10621))
      EQUIVALENCE  (IDVPR,C(10622))
      EQUIVALENCE(PCP(1),C(2296)),  (PCP(25),C(2310))
      DIMENSION PCP(25)
      DIMENSION PAR(13,16),PER(13,13),SAREA(13),TEM(13,10),SPEC(2)
      DIMENSION A(6,7)
      DIMENSION ANS(6)
      DIMENSION IMM(12)
      LEN=LEN
      NUNN=0
   80 NUN=0
      DO 82  I=3,LEN
      IF (PCP(I)-PCP(2))1 83, 83, 89
   89 NUNN=NUNN+1
      GO TO 82
   83 NUN=NUN+1
   82 CONTINUE
   81 IF (NUN) 85,84,85
   84 KOK=4
      GO TO 86
   85 KOK=4+NUN
      KOKK=KOK-2
   86 CONTINUE
   97 L=1
      DO 1 I=1,NAREA
      IF (I-IUNPER) 100,100,101
  100 IF(NUN-1)201,201,202
  201 L=L-1
      GO TO 1
  200 DO 22  J=4,KOKK
      IF (SAREA(I)-PAR(J,11)) 22,44,44
   44 IND=J-1
      GO TO 6
   22 CONTINUE
      IND=KOKK-1
      GO TO 6
  101 IF(NUNN-1)201,201,202
  202 DO 2  J=KOK,LEN
      IF(SAREA(I)-PAR(J,11)) 4,4,2
    4 IND=J-1
      GO TO 6
    2 CONTINUE
      IF(SAREA(I)-PAR(LEN,11)*3.0)91,90,90
   91 IND=LEN-1
    6 IF(MF-1)60,66,65
   65 K=IND
      DO 64 J=1,2
      PER(K,12)=1.98726*PAR(K,3)/(2.0*PAR(K,6)*(HC*1.98726-PAR(K,4)))
      PER(K,11)=-1.98726/(PAR(K,7)*PAR(K,6))
      PER(K,13)=1.0/PAR(K,10)-PER(K,12)
   64 K=K+1
      TEM(L,10)=PAR(1,6)
   66 SPEC(1)=1.0/PER(IND,13)
      SPEC(2)=1.0/PER(IND+1,13)
      CALL SET(PAR(IND,1),SPEC,PAR(IND,11),SAREA(I),TEM(L,5))
      CALL SET(PAR(IND,3),PER(IND,11),PAR(IND,1),TEM(L,5),TEM(L,7))
      IF(MF-1)70,71,70
   71 SPEC(1)=-PAR(IND,8)+PAR(IND,9)*PER(IND,11)
      SPEC(2)=-PAR(IND+1,8)+PAR(IND+1,9)*PER(IND+1,11)
      CALL SET(PAR(IND,6),SPEC,PAR(IND,1),TEM(L,5),TEM(L,10))
   70 K=IND
      DO 20 J=1,2
```

```
      A(J,7)=PAR(K,13)**2
      A(J+2,7)=2.0*A(J,7)*PER(K,12)
      A(J+4,7)=(1.0-PAR(K,10))/PAR(K,10)*A(J+2,7)
      A(J,1)=1.0
      A(J+2)=0.0
      A(J+4)=0.0
      A(J,2)=LOGE(PAR(K,1))
      A(J+2,2)=1.0
      A(J+4,2)=0.
      DO 50 M=3,6
      A(J,M)=A(J,2)**(M-1)
      A(J+2,M)=A(J,2)**(M-2)*FLOATF(M-1)
   50 A(J+4,M)=A(J+2,M)/A(J,2)*FLOATF(M-2)
   20 K=K+1
      CALL MGAUS(A,6,ANS)
      TEM(L,2)=ANS(1)
      SPEC=LOGE(TEM(L,5))
      DO 21 J=2,6
   21 TEM(L,2)=TEM(L,2)+ANS(J)*SPEC**(J-1)
      TEM(L,2)=1.99726*HC-1000.0*TEM(L,2)/294.99**2
      IF(TEM(L,2))90,90,23
   23 TEM(L,2)=SQRTF(TEM(L,2))
      IF(L-2)25,24,24
   24 IF(TEM(L,2)-TEM(L-1,2))90,25,25
   25 TEM(L,1)=TEM(L,2)+PAR(2,15)*SAREA(I)/(32.174*TEM(L,5))
      TEM(L,3)=PA2(2,15)
      TEM(L,4)=TEM(L,2)*32.174/TEM(L,3)
      TEM(L,6)=PC/TEM(L,5)
      TEM(L,9)=PAR(2,5)
      TERM(L)=SAREA(I)
    1 L=L+1
   90 L=L-1
      IN=L
      DO 30 I=1,IN
      PAR(I,1)=TERM(I)
      DO 30 J=2,11
   30 PAR(I,J)=TEM(I,J-1)
      RETURN
C
C
C


      SUBROUTINE SET(ONE,TWO,THREE,ARG,FAL)
C
C     (USED FOR AREA RATIO INTERPOLATION ONLY)
C     SETS UP ALL 4 BY 5 MATRICES
C
C
      DIMENSION A(6,7),ANS(6),ONE(2),TWO(2),THREE(2)
      DO 8 J=1,2
      A(J,5)=LOGE(ONE(J))
      A(J+2,5)=TWO(J)
    8 A(J,2)=LOGE(THREE(J))
      DO 1 I=1,2
      A(I,1)=1.0
      A(I+2,1)=0.0
      A(I+2,2)=1.0
      DO 1 J=2,3
      A(I,J+1)=A(I,2)**J
      A(I+2,J+1)=A(I,2)**(J-1)*FLOATF(J)
    1 CONTINUE
      CALL MGAUS(A,4,ANS)
      FAL=ANS(1)
      SUM=LOGE(ARG)
      DO 10 J=1,3
   10 FAL=FAL+SUM**J*(ANS(J+1))
      FAL=EXPF(FAL)
      RETURN
C
C
C
```

```
      SUBROUTINE RGAUS(A,N,ANS)
C
C     (USED FOR AREA RATIO INTERPOLATION ONLY)
C     SOLVES FOR INTERPOLATION COEFFICIENTS
C
C
      DIMENSION A(6,7),ANS(6)
      DO 1 I=1,N
    1 ANS(I)=0.0
      DO 10 I=1,N
      DO 9 J=I,N
      A(I,J+1)=A(I,J+1)/A(I,I)
      IF(I-N) 9,20,9
    9 CONTINUE
      K=I+1
      DO 8 II=K,N
      DO 8 JJ=I,N
    8 A(II,JJ+1)=-A(II,I)*A(I,JJ+1)+A(II,JJ+1)
   10 CONTINUE
   20 ANS(N)=A(I,J+1)
      IF(N-1)31,30,31
   30 RETURN
   31 J=N-1
      II=J
      DO 11 I=1,II
      K=J+1
      DO 12 M=1,I
      ANS(J)=ANS(K)*A(J,K)+ANS(J)
   12 K=K+1
      ANS(J)=A(J,K)-ANS(J)
   11 J=J-1
      RETURN
C
C
C
```

```
      SUBROUTINE EXIT
C
C     (USED FOR AREA RATIO INTERPOLATION ONLY)
C     OUTPUTS DATA FOR ASSIGNED AREA RATIOS
C
C
      COMMON C
      EQUIVALENCE (IN, C(8046)),  (MAY, C(1767))
      EQUIVALENCE (PAR(1), C(8370)), (PAR(208), C(8577))
      EQUIVALENCE (LEN,C(1766)), (ME,C(1769))
      DIMENSION PAR(13,16),NN(13)
C     MAY MUST EQUAL 2
C     IN MUST EQUAL NAREA
   20 WRITE OUTPUT TAPE 6,23
   23 FORMAT (6HCAR/AT,9X,13F9.3)
      CALL VAR(1,6)
      WRITE OUTPUT TAPE 6,24,(PAR(I,2),I=1,IN)
   24 FORMAT (15H IVAC,LB-SEC/LB13F9.1)
      WRITE OUTPUT TAPE 6,25,(PAR(I,3),I=1,IN)
   25 FORMAT (15H I, LB-SEC/LB  13F9.1)
      DO 61 I=1,IN
   61 NN(I)=PAR(I,4)+.5
   51 WRITE OUTPUT TAPE 6,21,(NN(I),I=1,IN)
   21 FORMAT (15H CSTAR, FT/SEC 13I9)
      WRITE OUTPUT TAPE 6,22,(PAR(I,5),I=1,IN)
   22 FORMAT (3H CF,12X,13F9.3)
    2 WRITE OUTPUT TAPE 6,10
   10 FORMAT (9HCPC/P,10X)
      CALL VAR(6,6)
      WRITE OUTPUT TAPE 6,11
   11 FORMAT (8H P, ATM ,7X)
      CALL VAR(7,6)
      DO 60 I=1,IN
   60 NN(I)=PAR(I,8)+.5
      WRITE OUTPUT TAPE 6,12,(NN(I),I=1,IN)
   12 FORMAT (9H T, DEG K,6X,13I9)
      WRITE OUTPUT TAPE 6,13,(PAR(I,9),I=1,IN)
   13 FORMAT (9H H, CAL/G,6X,13F9.1)
      WRITE OUTPUT TAPE 6,14,(PAR(I,10),I=1,IN)
   14 FORMAT (15H S, CAL/(G)(K) 13F9.4)
      WRITE OUTPUT TAPE 6,15,(PAR(I,11),I=1,IN)
   15 FORMAT (10H M, MOL WT,5X,13F9.3)
      RETURN
C
C
C
```

APPENDIX B

PROGRAM LISTING FOR BCREAD (A,B) AND BCDUMP (A,B)

```
BINARY CARD NO. BCREAD00
                    00006          ENTRY   BCREAD

     TRANSFER VECTOR

BINARY CARD NO. BCREAD01
    00000  254626266060      EOFF
    00001  665125515160      WRERR

    00002  0 00000 0 00000          PZE
    00003  0 00000 0 00000          PZE
    00004  0 00000 0 00000          PZE
    00005  222351252124             BCI     1,BCREAD
    00006 -0634 00 1 00002  BCREAD  SXD     *-4,1
    00007 -0634 00 2 00003          SXD     *-4,2
    00010 -0634 00 4 00004          SXD     *-4,4
    00011  0500 00 4 00002          CLA     2,4
    00012  0402 00 4 00001          SUP     1,4
    00013  0400 00 0 00045          ADD     ONE
    00014  0767 00 0 00022          ALS     18
    00015  0602 00 0 00051          SLW     I02
    00016  0500 00 4 00001          CLA     1,4
    00017 -0320 00 0 00044          ANA     MASKA
    00020 -0501 00 0 00051          ORA     I02
    00021 -0534 00 4 00045          LXD     ONE,4
    00022  0762 00 0 01222  READ    RTBA    2
    00023 -0734 00 1 00000          PDX     0,1

BINARY CARD NO. BCREAD02
    00024 -3 00026 1 00033          TXL     LESS22,1,22
    00025  0621 00 0 00047   GOOF   STA     I022
    00026  0540 00 0 00046          RCHA    I022-1
    00027  0074 00 2 00052          TSX     ERR,2
    00030  0400 00 0 00043          ADD     MINPLS
    00031 -0320 00 0 00042          ANA     MASR
    00032  0020 00 0 00022          TRA     READ
    00033  0601 00 0 00051  LESS22  STO     I02
    00034  0540 00 0 00050          RCHA    I01
    00035  0074 00 2 00052          TSX     ERR,2
    00036 -0534 00 1 00002          LXD     BCREAD-4,1
    00037 -0534 00 2 00003          LXD     BCREAD-3,2
    00040 -0534 00 4 00004          LXD     BCREAD-2,4
    00041  0020 00 4 00003          TRA     3,4
    00042 +077777777777     MASR    OCT     077777777777
    00043 +077752000026     MINPLS  OCT     077752000026
    00044 +000000777777     MASKA   OCT     000000777777
    00045 +000000000001     ONE     OCT     1
    00046 -2 00002 2 00000          IOSPN   0,0,2
    00047  3 00026 0 00000  I022    IORT    **,0,22

BINARY CARD NO. BCREAD03
    00050 -2 00002 2 00000  I01     IOSPN   0,0,2
    00051  0 00000 0 00000  I02     PZE
    00052  0060 00 0 00052  ERR     TCOA    *
    00053  0030 00 0 00056          TEFA    EOFT
    00054  0022 00 0 00061          TRCA    OUT
    00055  0020 00 2 00001          TRA     1,2
    00056  0500 00 0 00060  EOFT    CLA     BSR2
    00057  0074 00 4 00000          CALL    EOFF
    00060  0764 00 0 01202  BSR2    BSRA    2
    00061  1 00001 4 00062  OUT     TXI     *+1,4,1
    00062  0764 00 0 01202          BSRA    2
    00063 -3 00007 4 00022          TXL     READ,4,7
    00064  0 07400 4 00001  PRINT   CALL    WRERR,MESS
    00065  0 07400 0 00066
    00066  015125246445     MESS    BCI     4,1REDUNDANT A2 IN BCREAD
    00067  242145636021
    00070  026031456022
    00071  235125212460
                                    END
```

ASSEMBLY OF BCDUMP SUBROUTINE

```
BINARY CARD NO. BCDUMP00
                    00005          ENTRY    BCDUMP

      TRANSFER VECTOR

BINARY CARD NO. BCDUMP01
    00000  746325623460      (TES)

    00001  0 00000 0 00000          PZE
    00002  0 00000 0 00000          PZE
    00003  0 00000 0 00000          PZE
    00004  222324644447             BCD 1BCDUMP
    00005 -0634 00 1 00001  BCDUMP  SXD      *-4,1
    00006 -0634 00 2 00002          SXD      *-4,2
    00007 -0634 00 4 00003          SXD      *-4,4
    00010  0522 60 0 00000          XEC*     $(TES)
    00011 -0534 00 2 00123          LXD      B3,2
    00012 -3 77776 2 00020          TXL      *+6,2,-2
    00013  0500 00 0 00174          CLA      WTBA5
    00014  0601 00 0 00103          STO      DARN
    00015  0500 00 0 00175          CLA      RTDA5
    00016  0601 00 0 00170          STO      DARN2
    00017  0621 00 0 00165          STA      ERR
    00020 -0534 00 4 00003          LXD      BCDUMP-2,4
    00021  0500 00 0 00162          CLA      BITT
    00022  0622 00 0 00047          STD      CHAN
    00023  0621 00 0 00116          STA      LASTC

BINARY CARD NO. BCDUMP02
    00024  0500 00 4 00001          CLA      1,4
    00025  0734 00 2 00000   JAY    PAX      0,2
    00026  0402 00 4 00002          SUB      2,4
    00027  0734 00 4 00026   DM22   PAX      22,4
    00030  1 00001 4 00031          TXI      *+1,4,1
    00031  0534 00 1 00027          LXA      DM22,1
    00032  1 00500 1 00033          TXI      *+1,1,320
    00033 -0634 00 1 00126          SXD      WD1,1
    00034  0634 00 2 00126   LOOP   SXA      WD1,2
    00035  0534 00 1 00027          LXA      DM22,1
    00036  0600 00 1 00156   CLEAR  STZ      GP,1
    00037  2 00001 1 00036          TIX      CLEAR,1,1
    00040  0534 00 1 00027   MORE   LXA      DM22,1
    00041 -3 00026 4 00116          TXL      LASTC,4,22
    00042  0634 00 2 00043   STORE  SXA      *+1,2
    00043  0500 00 0 00000          CLA      **
    00044  0601 00 1 00156          STO      GP,1
    00045  1 00001 2 00046          TXI      *+1,2,1
    00046  1 77777 1 00047          TXI      *+1,1,-1
    00047  3 00000 1 00042   CHAN   TXH      STORE,1,0

BINARY CARD NO. BCDUMP03
    00050  0534 00 1 00116          LXA      LASTC,1
    00051  0500 00 0 00164          CLA      HUNBIT
    00052  0771 00 0 00001          ARS      1
    00053 -3 00143 1 00055          TXL      *+2,1,99
    00054  1 77634 1 00052          TXI      *-2,1,-100
    00055  0621 00 0 00157          STA      GP+1
    00056  0500 00 0 00162          CLA      BITT
    00057  0771 00 0 00001          ARS      1
    00060 -3 00011 1 00062          TXL      *+2,1,9
    00061  1 77766 1 00057          TXI      *-2,1,-10
    00062  0601 00 0 00160          STO      WORD3
    00063  0500 00 0 00163          CLA      BITU
    00064  0771 00 0 00001          ARS      1
    00065 -3 00000 1 00067          TXL      *+2,1,0
    00066  1 77777 1 00064          TXI      *-2,1,-1
    00067 -0602 00 0 00160          ORS      WORD3
    00070  0534 00 1 00116          LXA      LASTC,1
    00071  1 00001 1 00072          TXI      *+1,1,1
    00072 -3 01747 1 00074          TXL      *+2,1,999
    00073  0534 00 1 00162          LXA      BITT,1
```

```
BINARY CARD NO. BCDUMP04
    00074  0634 00 1 00116          SXA      LASTC,1
    00075  0534 00 1 00027          LXA      DM22,1
    00076 -0500 00 0 00126          CAL      WD1
    00077  0361 00 1 00156   ADD    ACL      GP,1
    00100  2 00001 1 00077          TIX      ADD,1,1
    00101  0602 00 0 00127          SLW      CKSUM
    00102  0534 00 1 00025          LXA      JAY,1
    00103  0766 00 0 01223   DARN   WTBA     3
    00104  0540 00 0 00161          RCHA     OUTPUT
    00105  0060 00 0 00105          TCDA     *
    00106  0022 00 0 00165          TRCA     ERR
    00107 -3 00026 4 00112          TXL      BACK,4,22
    00110  1 77752 4 00111          TXI      *+1,4,-22
    00111  0020 00 0 00034          TRA      LOOP
    00112 -0534 00 1 00001   BACK   LXD      BCDUMP-4,1
    00113 -0534 00 2 00002          LXD      BCDUMP-3,2
    00114 -0534 00 4 00003          LXD      BCDUMP-2,4
    00115  0020 00 4 00003          TRA      3,4
    00116 -0754 00 4 00000   LASTC  PXD      0,4
    00117  0402 00 0 00125          SUB      D22

BINARY CARD NO. BCDUMP05
    00120  0622 00 0 00047          STD      CHAN
    00121  1 00500 4 00122          TXI      *+1,4,320
    00122 -0634 00 4 00126          SXD      WD1,4
    00123  1 77300 4 00124          TXI *+1,4,-320
    00124  0020 00 0 00042          TRA      STORE
    00125 +000026000000      D22    OCT 26000000
    00126  0 00000 0 00000   WD1    PZE
    00127                    CKSUM  BSS      23

BINARY CARD NO. BCDUMP06
    00156 -020041004040      GP     OCT 420041004040
    00157 +104020400000             OCT 104020400000
    00160  0 00000 0 00000   WORD3  PZE
    00161  0 00033 0 00126  OUTPUT  IOCD     WD1,0,27
    00162 +200000000000      BITT   OCT 200000000000
    00163 +000020000000      BITU   OCT 20000000
    00164 +000000002000     HUNBIT  OCT 2000
    00165  0764 00 0 01203   ERR    BSRA     3
    00166  1 00001 1 00167          TXI      *+1,1,1
    00167 -3 00007 1 00103          TXL      DARN,1,7
    00170  0762 00 0 01203   DARN2  RTDA     3
    00171  0540 00 0 00173          RCHA     SKIP
    00172  0020 00 0 00102          TRA      DARN-1
    00173  0 00000 0 00000   SKIP   IOCD     0,0,0
    00174  0766 00 0 01225   WTBA5  WTBA     5
    00175  0762 00 0 01205   RTDA5  RTDA     5
                                    END
```

APPENDIX C

CORRECTIONS TO THE IBM 704 PROGRAM

On page 53, replace card number 0384, statement number 729 with:

```
 729    EQRAT = O F*VXMIN + VFMIN
        IF(EQRAT) 9050,745,9050
 9050   EQRAT = ABSF((O F*VXPLS + VFPLS)/EQRAT)
```

On page 61, insert the following statement between card numbers 1279 and 1280:

```
        DEL N(J) = 0.0
```

On page 62, replace card number 1418, statement number 1126 with:

```
        IF(EN LN(J))2125, 1126, 2125
2125    P = P + EXPF (EN LN(J))
1126    CONTINUE
```

Also, replace card numbers 1461, 1462, and 1463 containing statement numbers 149, 150, and 151, respectively, with:

```
 149    IF (COEFT(4,J)-T) 2153,170,170
2153    IF (EN(J-1)) 170,153,2154
2154    IF (COEFT(4,J)+100.0-T) 2155,2155,2157
2155    EN(J)=EN(J-1)
        CALL BYPASS (J,3)
        J=J-1
        GO TO 3156
2157    EN(J-1)=EN(J-1)/2.0
        EN(J)=EN(J-1)
        T LN=LOGF(COEFT(4,J))
        CALL BYPASS(J,3)
        GO TO 42
 150    IF (COEFT(5,J)-COEFT(4,J+1))153,151,153
 151    IF (T-COEFT(5,J)) 3153,170,170
3153    IF (EN(J+1)) 170,153,3154
3154    IF(T+100.0 -COEFT(5,J)) 3155,3155,3157
3155    EN(J)=EN(J+1)
        CALL BYPASS(J,3)
        J=J+1
3156    CALL BYPASS(J,2)
        EN(J)=0.0
        DEL N(J)= 0.0
        GO TO 42
3157    EN(J+1)=EN(J+1)/2.0
        EN(J)=EN(J+1)
        T LN=LOGF(COEFT(5,J))
        CALL BYPASS(J,3)
```

```
      GO TO 42
```

On page 63, replace card number 1529 with:

```
IF (HO(J) - S(J) - HO(K) + S(K) - DEL N(K)) 164, 164, 170
```

On page 64, replace card number 1709, statement number 309 with:

```
309   PCP(25) = PCP(IADD)
      IADD = 25
```

On page 73 following card number 2623, insert

```
      TC = 0.0
```

APPENDIX D

SHIFT FUNCTIONS

```
*         FAP
*         SHIFT FUNCTIONS
          COUNT   5
          LBL     SHIFT,N
          ENTRY   ALS
          ENTRY   ARS
          ENTRY   LLS
          ENTRY   LRS
          BCI     1,SHIFT
  ALS     ARS     18
          STA     *+3
          XCL
          LDQ     -1
          ALS     **
          STQ     -1
          TRA     1,4
  ARS     ARS     18
          STA     *+3
          XCL
          LDQ     -1
          ARS     **
          STQ     -1
          TRA     1,4
  LLS     ARS     18
          STA     *+3
          XCL
          LDQ     -1
          LLS     **
          STQ     -1
          TRA     1,4
  LRS     ARS     18
          STA     *+3
          XCL
          LDQ     -1
          LRS     **
          STQ     -1
          TRA     1,4
          END
```

REFERENCES

1. Zeleznik, Frank J., and Gordon, Sanford: A General IBM 704 or 7090 Computer Program for Computation of Chemical Equilibrium Compositions, Rocket Performance, and Chapman-Jouguet Detonations. NASA TN D-1454, 1962.

2. Gordon, Sanford, and Zeleznik, Frank J.: Thermodynamic Extrapolation of Rocket Performance Parameters. ARS Jour., vol. 12, no. 8, Aug. 1962, pp. 1195-1202.

TABLE I. - THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM COMPOSITION DURING EXPANSION AT ARBITRARILY ASSIGNED EXIT PRESSURE RATIOS

CASE NO. 122 1000.0 2.500

	CHEMICAL FORMULA	WT FRACTION (SEE NOTE)	ENTHALPY CAL/MOL	STATE	TEMP DEG K	DENSITY G/CC
FUEL	N 2 H 8 C 2	0.50000	12734.800	L	298.15	0.786100
FUEL	N 2 H 4	0.50000	12050.000	L	298.15	1.003900
OXIDANT	F 2	1.00000	-3030.892	L	85.24	1.54 000

O/F= 2.500000, PERCENT FUEL= 28.5714, EQUIVALENCE RATIO= 1.4859, DENSITY= 1.2692

PARAMETERS

	CHAMBER	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT
PC/P	1.000	1.750	3.000	10.000	30.000	100.000	300.000	1000.000	3000.000	10000.00	30000.00
P, ATM	68.05	38.89	22.68	6.805	2.268	0.6805	0.2268	0.0680	0.0227	0.0068	0.0023
T, DEG K	4416	4141	3897	3536	3181	2700	2222	1745	1353	1008	761
H, CAL/G	27.0	-203.3	-408.9	-825.1	-1160.1	-1476.4	-1713.6	-1922.2	-2069.9	-2193.0	-2277.3
S, CAL/(G)(K)	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353
M, MOL WT	20.488	20.774	21.067	21.672	22.150	22.483	22.691	22.791	22.796	22.796	22.796
(DLM/DLP)T	0.03415	0.02750	0.03768	0.02128	0.00973	0.00218	0.00289	0.00012	0.	-0.00000	0.
(DLM/DLT)P	-0.5392	-0.4567	-0.8183	-0.4988	-0.2470	-0.0528	-0.0645	-0.0038	-0.0001	-0.0000	-0.0000
CP, CAL/(G)(K)	1.4049	1.2047	2.2510	1.5840	1.0264	0.5416	0.5272	0.3927	0.3697	0.3477	0.3359
GAMMA	1.1654	1.1649	1.1122	1.1220	1.1444	1.2176	1.2277	1.2889	1.3130	1.3347	1.3505
MACH NUMBER	0.	1.000	1.460	2.164	2.696	3.216	3.817	4.469	5.204	6.154	7.171
CSTAR, FT/SEC		6846	6846	6846	6846	6846	6846	6846	6846	6846	6846
CF		0.665	0.915	1.280	1.510	1.700	1.829	1.935	2.007	2.065	2.104
AE/AT		1.000	1.158	2.434	5.446	13.49	30.68	75.53	169.3	408.6	908.9
IVAC,LB-SEC/LB		263.2	276.9	324.1	360.0	390.4	410.9	427.3	439.2	448.2	454.2
I, LB-SEC/LB ,		141.6	194.8	272.3	321.4	361.7	389.2	411.8	427.2	439.5	447.8

DERIVATIVES

(DLI/DLPC)PC/P		0.01280	0.01191	0.01099	0.00975	0.00773	0.00598	0.00439	0.00317	0.00223	0.00162
(DLT/DLPC)PC/P	0.04097	0.03505	0.03311	0.02553	0.01450	-0.00726	-0.00707	-0.02412	-0.02684	-0.02824	-0.02923
(DLAR/DLPC)PC/P		-0.	-0.00015	-0.00476	-0.01216	-0.02831	-0.02716	-0.03948	-0.04077	-0.04123	-0.04162
(DLCS/DLPC)PC/P		0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076
(DLI/DHC)PC/P*		0.13524	0.13488	0.11696	0.11782	0.12921	0.14273	0.15516	0.16541	0.17383	0.17959
(DLT/DHC)PC/P*	0.17353	0.18797	0.10060	0.14296	0.22061	0.41811	0.42957	0.57665	0.61922	0.65132	0.67420
(DLAR/DHC)PC/P*		0.	-0.09074	-0.04147	0.01848	0.17221	0.17573	0.28488	0.31506	0.33870	0.35582
(DLCS/DHC)PC/P*		0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879
*(HC IN KCAL/G)											
(DLI/DLPCP)S		0.85914	0.42165	0.19025	0.12020	0.07938	0.05592	0.03903	0.02812	0.01978	0.01440
(DLT/DLPCP)S	-0.11440	-0.11557	-0.07620	-0.08677	-0.10900	-0.17183	-0.17693	-0.22288	-0.23840	-0.25074	-0.25955
(DLAR/DLPCP)S,		0.	0.47748	0.70098	0.75361	0.74188	0.75864	0.73737	0.73348	0.72947	0.72605

MOLE FRACTIONS

C1(G)	0.00317	0.00226	0.00153	0.00052	0.00010	0.	0.	0.	0.	0.	0.
C2(G)	0.00275	0.00242	0.00195	0.00046	0.00006	0.	0.	0.	0.	0.	0.
C3(G)	0.00340	0.00431	0.00632	0.00189	0.00031	0.00001	0.	0.	0.	0.	0.
C1F1(G)	0.00693	0.00588	0.00480	0.00180	0.00052	0.00007	0.	0.	0.	0.	0.
C1F2(G)	0.00222	0.00230	0.00235	0.00103	0.00047	0.00034	0.00027	0.00001	0.	0.	0.
C1F3(G)	0.00031	0.00032	0.00034	0.00013	0.00007	0.00016	0.00104	0.00019	0.00001	0.	0.
C1F4(G)	0.00000	0.00001	0.00001	0.	0.	0.00002	0.00155	0.00367	0.00386	0.00386	0.00386
C1H1(G)	0.00031	0.00017	0.00009	0.00002	0.	0.	0.	0.	0.	0.	0.
C1H2(G)	0.00010	0.00006	0.00004	0.00001	0.	0.	0.	0.	0.	0.	0.
C1H3(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C2H2(G)	0.00277	0.00292	0.00281	0.00088	0.00018	0.	0.	0.	0.	0.	0.
C1N1(G)	0.04162	0.04023	0.03739	0.02026	0.00808	0.00106	0.00004	0.	0.	0.	0.
C2N2(G)	0.00102	0.00129	0.00156	0.00065	0.00022	0.00003	0.	0.	0.	0.	0.
F1(G)	0.08873	0.07404	0.06132	0.04409	0.02832	0.01555	0.00556	0.00018	0.	0.	0.
F2(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
H1(G)	0.03964	0.02858	0.02048	0.01385	0.00667	0.00075	0.00002	0.	0.	0.	0.
H2(G)	0.01075	0.00779	0.00544	0.00338	0.00156	0.00013	0.	0.	0.	0.	0.
H1C1N1(G)	0.01947	0.01963	0.01898	0.01058	0.00462	0.00059	0.00003	0.	0.	0.	0.
H1F1(G)	0.66918	0.69620	0.71795	0.72281	0.73522	0.74853	0.75650	0.76061	0.76074	0.76074	0.76074
N1(G)	0.00028	0.00015	0.00008	0.00003	0.00001	0.	0.	0.	0.	0.	0.
N2(G)	0.10830	0.11090	0.11380	0.12411	0.13254	0.13829	0.14030	0.14103	0.14111	0.14111	0.14111
N1F1(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
N1H1(G)	0.00005	0.00002	0.00001	0.	0.	0.	0.	0.	0.	0.	0.
C1(S)	0.	0.	0.06274	0.05345	0.08104	0.09445	0.09468	0.09426	0.09427	0.09429	0.09429

ADDITIONAL PRODUCTS WHICH WERE CONSIDERED BUT WHOSE MOLE FRACTIONS WERE LESS THAN 0.000005 FOR ALL ASSIGNED CONDITIONS

C1H4(G) C2H4(G) N1F2(G) N1F3(G) N2F2(G) N2F4(G) N1H3(G)

INPUT, G-ATOMS/G

	N	H	C	F
FUEL	0.4744158E-01	0.1289599E-00	0.1663838E-01	0.
OXIDANT	0.	0.	0.	0.5263158E-01
PROPELLANT	0.1366702E-01	0.3634569E-01	0.4754823E-02	0.3759398E-01

CASE NO. 122 1000.0 2.500

NOTE. WEIGHT FRACTIONS OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

TABLE II. - THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM COMPOSITION DURING EXPANSION FOR ASSIGNED AREA RATIOS

CASE NO. 122 1000.0 2.500

	CHEMICAL FORMULA			WT FRACTION (SEE NOTE)	ENTHALPY CAL/MOL	STATE	TEMP DEG K	DENSITY G/CC
FUEL	N 2	H 8	C 2	0.50000	12734.800	L	298.15	0.786100
FUEL	N 2	H 4		0.50000	12050.000	L	298.15	1.003600
OXIDANT	F 2			1.00000	-3030.892	L	85.24	1.540000

O/F= 2.500000, PERCENT FUEL= 28.5714, EQUIVALENCE RATIO= 1.4859, DENSITY= 1.2692

AE/AT	2.500	5.000	10.00	15.00	25.00	40.00	50.00	60.00	100.0	300.0	500.0
IVAC,LB-SEC/LB	325.5	356.7	381.3	393.4	406.3	416.5	420.8	424.0	432.2	445.4	449.9
I, LB-SEC/LB	274.2	316.9	349.6	365.7	383.1	396.5	402.2	406.6	417.7	435.6	441.8
CSTAR, FT/SEC	6846	6846	6846	6846	6846	6846	6846	6846	6846	6846	6846
CF	1.289	1.489	1.643	1.719	1.800	1.863	1.890	1.911	1.963	2.047	2.076
PC/P	10.385	26.779	67.007	115.336	228.715	426.098	573.718	732.716	1463.977	6550.052	13189.17
P, ATM	6.552	2.541	1.016	0.5900	0.2975	0.1597	0.1186	0.0929	0.0465	0.0104	0.0052
T, DEG K	3524	3220	2877	2634	2332	2083	1964	1867	1601	1119	940
H, CAL/G	-837.4	-1127.4	-1377.5	-1510.0	-1659.4	-1779.7	-1832.3	-1873.2	-1977.7	-2153.8	-2216.5
S, CAL/(G)(K)	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353
M, MOL WT	21.690	22.106	22.403	22.506	22.628	22.736	22.766	22.782	22.795	22.796	22.796

INPUT, G-ATOMS/G

	N	H	C	F
FUEL	0.4784158E-01	0.1289599E-00	0.1663838E-01	0.
OXIDANT	0.	0.	0.	0.5263158E-01
PROPELLANT	0.1366902E-01	0.3684569E-01	0.4753823E-02	0.3759398E-01

CASE NO. 122 1000.0 2.500

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

TABLE III. - THEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIBRIUM DECOMPOSITION DURING EXPANSION AT ASSIGNED EXIT PRESSURE

RATIOS TAKEN FROM TABLE II

CASE NO. 122 1000.0 2.500

	CHEMICAL FORMULA			WT FRACTION (SEE NOTE)	ENTHALPY CAL/MOL	STATE	TEMP DEG K	DENSITY G/CC
FUEL	N 2	H 8	C 2	0.50000	12734.800	L	298.15	0.786100
FUEL	N 2	H 4		0.50000	12050.000	L	298.15	1.003600
OXIDANT	F 2			1.00000	-3030.892	L	85.24	1.540000

O/F= 2.500000, PERCENT FUEL= 28.5714, EQUIVALENCE RATIO= 1.4859, DENSITY= 1.2692

PARAMETERS

	CHAMBER	THROAT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT	EXIT
PC/P	1.000	1.750	10.385	26.779	67.007	115.336	228.715	426.098	573.718	732.716	1463.977	6550.052	13189.17
P, ATM	68.05	38.89	6.552	2.541	1.016	0.5900	0.2975	0.1597	0.1186	0.0929	0.0465	0.0104	0.0052
T, DEG K	4416	4141	3524	3220	2877	2634	2330	2084	1965	1868	1600	1119	940
H, CAL/G	27.0	-203.3	-837.4	-1127.4	-1377.5	-1510.0	-1659.4	-1779.7	-1832.3	-1873.2	-1977.7	-2153.8	-2216.5
S, CAL/(G)(K)	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353	2.7353
M, MOL WT	20.488	20.794	21.690	22.106	22.405	22.504	22.625	22.738	22.769	22.783	22.795	22.796	22.796
(DLM/DLP)T	0.03415	0.02750	0.02083	0.01076	0.00373	0.00210	0.00357	0.00160	0.00077	0.00037	0.00003	0.00000	0.
(DLM/DLT)P	-0.5392	-0.4567	-0.4894	-0.2707	-0.0996	-0.0466	-0.0748	-0.0389	-0.0202	-0.0103	-0.0009	-0.0000	-0.0000
CP, CAL/(G)(K)	1.3049	1.2047	1.5637	1.0808	0.6727	0.5157	0.5431	0.4784	0.4375	0.4126	0.3794	0.3538	0.3442
GAMMA	1.1654	1.1633	1.1225	1.1410	1.1844	1.2277	1.2244	1.2431	1.2608	1.2745	1.2990	1.3270	1.3391
MACH NUMBER	0.	1.000	2.184	2.644	3.048	3.281	3.669	3.995	4.146	4.278	4.703	5.804	6.395
CSTAR, FT/SEC		6846	6846	6846	6846	6846	6846	6846	6846	6846	6846	6846	6846
CF		0.665	1.289	1.489	1.643	1.719	1.800	1.863	1.890	1.911	1.963	2.047	2.076
AE/AT		1.000	2.500	5.000	10.00	15.00	24.98	40.02	50.03	60.02	99.99	300.0	500.0
IVAC,LB-SEC/LB		263.2	325.5	356.7	381.3	393.4	406.3	416.5	420.8	424.1	432.2	445.4	449.9
I, LB-SEC/LB ,		141.6	274.2	316.9	349.6	365.7	383.1	396.5	402.2	406.6	417.7	435.6	441.8

DERIVATIVES

(DLI/DLPC)PC/P		0.01280	0.01095	0.00996	0.00850	0.00744	0.00633	0.00553	0.00513	0.00480	0.00392	0.00252	0.00206
(DLT/DLPC)PC/P	0.04007	0.03505	0.02524	0.01595	0.00080	-0.00886	-0.00477	-0.01295	-0.01817	-0.02149	-0.02565	-0.02775	-0.02852
(DLAR/DLPC)PC/P		-0.	-0.00495	-0.01115	-0.02211	-0.02957	-0.02578	-0.03136	-0.03521	-0.03765	-0.04038	-0.04104	-0.04134
(DLCS/DLPC)PC/P		0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076	0.01076
(DLI/DHC)PC/P*		0.13504	0.11682	0.11733	0.12405	0.13131	0.14007	0.14616	0.14923	0.15185	0.15902	0.17115	0.17544
(DLT/DHC)PC/P*	0.17353	0.18797	0.14481	0.20953	0.33665	0.43909	0.41697	0.47334	0.51759	0.54877	0.59682	0.64004	0.65785
(DLAR/DHC)PC/P*		0.	-0.03993	0.01013	0.10733	0.18947	0.16928	0.20680	0.24002	0.26378	0.29957	0.33010	0.34362
(DLCS/DHC)PC/P*		0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879	0.13879
*(HC IN KCAL/G)													
(DLI/DLPCP)S		0.85914	0.18678	0.12537	0.09086	0.07565	0.06067	0.05040	0.04613	0.04287	0.03480	0.02237	0.01826
(DLT/DLPCP)S	-0.11440	-0.11557	-0.08727	-0.10570	-0.14500	-0.17922	-0.17383	-0.18979	-0.20353	-0.21356	-0.22998	-0.24640	-0.25325
(DLAR/DLPCP)S,		0.	0.70406	0.75108	0.75344	0.73887	0.75606	0.75403	0.74700	0.74174	0.73503	0.73123	0.72849

MOLE FRACTIONS

C1(G)	0.00317	0.00226	0.00050	0.00013	0.00001	0.	0.	0.	0.	0.	0.	0.	0.
C2(G)	0.00275	0.00242	0.00046	0.00008	0.00001	0.	0.	0.	0.	0.	0.	0.	0.
C3(G)	0.00340	0.00491	0.00180	0.00040	0.00003	0.	0.	0.	0.	0.	0.	0.	0.
C1F1(G)	0.00693	0.00588	0.00174	0.00061	0.00015	0.00005	0.00001	0.	0.	0.	0.	0.	0.
C1F2(G)	0.00222	0.00230	0.00100	0.00051	0.00032	0.00037	0.00038	0.00013	0.00006	0.00002	0.	0.	0.
C1F3(G)	0.00031	0.00032	0.00013	0.00007	0.00008	0.00023	0.00096	0.00085	0.00058	0.00038	0.00007	0.	0.
C1F4(G)	0.	0.00001	0.	0.	0.	0.00004	0.00084	0.00248	0.00359	0.00343	0.00380	0.00386	0.00386
C1H1(G)	0.00030	0.00017	0.00002	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1H2(G)	0.00010	0.00006	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1H3(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C2H2(G)	0.00277	0.00292	0.00085	0.00022	0.00002	0.	0.	0.	0.	0.	0.	0.	0.
C1N1(G)	0.04162	0.04023	0.01977	0.00912	0.00255	0.00073	0.00010	0.00001	0.	0.	0.	0.	0.
C2N2(G)	0.00102	0.00129	0.00063	0.00025	0.00007	0.00002	0.	0.	0.	0.	0.	0.	0.
F1(G)	0.08873	0.07404	0.04354	0.02988	0.01875	0.01462	0.00843	0.00269	0.00121	0.00056	0.00003	0.	0.
F2(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
H1(G)	0.03864	0.02858	0.01361	0.00741	0.00212	0.00047	0.00005	0.00001	0.	0.	0.	0.	0.
H2(G)	0.01075	0.00779	0.00332	0.00174	0.00044	0.00008	0.00001	0.	0.	0.	0.	0.	0.
H1CIN1(G)	0.01947	0.01963	0.01035	0.00516	0.00152	0.00039	0.00005	0.00001	0.00001	0.	0.	0.	0.
H1F1(G)	0.66918	0.69620	0.72314	0.73374	0.74516	0.74942	0.75432	0.75869	0.75981	0.76032	0.76071	0.76074	0.76074
N1(G)	0.00028	0.00015	0.00003	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.
N2(G)	0.13839	0.11080	0.12442	0.13177	0.13696	0.13862	0.13986	0.14072	0.14094	0.14103	0.14110	0.14111	0.14111
N1F1(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
N1H1(G)	0.00005	0.00002	0.	0.	0.	0.00000	0.	0.	0.	0.	0.	0.	0.
C1(S)	0.	0.	0.05468	0.07891	0.09180	0.09495	0.09499	0.09440	0.09429	0.09426	0.09427	0.09429	0.09429

ADDITIONAL PRODUCTS WHICH WERE CONSIDERED BUT WHOSE MOLE FRACTIONS WERE LESS THAN 0.000005 FOR ALL ASSIGNED CONDITIONS

C1H4(G) C2H4(G) N1F2(G) N1F3(G) N2F2(G) N2F4(G) N1H3(G)

INPUT, G-ATOMS/G

	N	H	C	F
FUEL	0.4784158E-01	0.1289599E-00	0.1663838E-01	0.
OXIDANT	0.	0.	0.	0.5263158E-01
PROPELLANT	0.1366902E-01	0.3684569E-01	0.4753823E-02	0.3759398E-01

CASE NO. 122 1000.0 2.500

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

TABLE IV. - SAMPLE H,P PROBLEM

CASE NO. 122 1469.6 2.500

	CHEMICAL FORMULA	WT FRACTION (SEE NOTE)	ENTHALPY CAL/MOL	STATE	TEMP DEG K	DENSITY G/CC
FUEL	N 2 H 8 C 2	0.50000	12734.800	L	298.15	0.786100
FUEL	N 2 H 4	0.50000	12050.000	L	298.15	1.003600
OXIDANT	F 2	1.00000	-3030.892	L	85.24	1.540000

O/F= 2.500000, PERCENT FUEL= 28.5714, EQUIVALENCE RATIO= 1.4859, DENSITY= 1.2692

EQUILIBRIUM THERMODYNAMIC PROPERTIES

P, ATM	100.0	68.05	30.00	10.00	3.000	1.000	0.3000	0.1000	0.0300	0.0100
T, DEG K	4484	4416	4272	4082	3880	3706	3525	3371	3213	3078
H, CAL/G	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
S, CAL/(G)(K)	2.6981	2.7353	2.8151	2.9235	3.0438	3.1549	3.2781	3.3918	3.5175	3.6332
M, MOL WT	20.588	20.488	20.283	20.022	19.756	19.533	19.310	19.125	18.945	18.788
(DLM/DLP)T	0.03289	0.03415	0.03739	0.04216	0.04722	0.05161	0.05601	0.05966	0.06327	0.06625
(DLM/DLT)P	-0.5060	-0.5392	-0.6172	-0.7336	-0.8683	-0.9960	-1.1383	-1.2692	-1.4131	-1.5444
CP, CAL/(G)(K)	1.2346	1.3049	1.4747	1.7403	2.0771	2.4238	2.8454	3.2672	3.7690	4.2623
GAMMA	1.1690	1.1654	1.1579	1.1483	1.1387	1.1307	1.1228	1.1162	1.1097	1.1043

MOLE FRACTIONS

C1(G)	0.00289	0.00317	0.00376	0.00451	0.00525	0.00580	0.00627	0.00657	0.00677	0.00684
C2(G)	0.00261	0.00275	0.00300	0.00321	0.00330	0.00328	0.00316	0.00299	0.00277	0.00254
C3(G)	0.00314	0.00340	0.00393	0.00462	0.00535	0.00602	0.00674	0.00740	0.00812	0.00879
C1F1(G)	0.00727	0.00693	0.00617	0.00518	0.00419	0.00341	0.00270	0.00217	0.00169	0.00134
C1F2(G)	0.00266	0.00222	0.00151	0.00091	0.00052	0.00032	0.00019	0.00012	0.00007	0.00005
C1F3(G)	0.00044	0.00031	0.00014	0.00005	0.00002	0.00001	0.	0.	0.	0.
C1F4(G)	0.00001	0.	0.	0.	0.	0.	0.	0.	0.	0.
C1H1(G)	0.00032	0.00030	0.00026	0.00021	0.00015	0.00011	0.00007	0.00005	0.00003	0.00002
C1H2(G)	0.00011	0.00010	0.00007	0.00005	0.00003	0.00002	0.00001	0.00001	0.	0.
C1H3(G)	0.00001	0.00001	0.	0.	0.	0.	0.	0.	0.	0.
C2H2(G)	0.00306	0.00277	0.00223	0.00161	0.00109	0.00075	0.00049	0.00033	0.00021	0.00014
C1N1(G)	0.04049	0.04162	0.04362	0.04556	0.04685	0.04741	0.04750	0.04720	0.04654	0.04571
C2N2(G)	0.00116	0.00102	0.00076	0.00052	0.00034	0.00024	0.00016	0.00011	0.00007	0.00005
F1(G)	0.08561	0.08873	0.09496	0.10267	0.11051	0.11724	0.12425	0.13036	0.13677	0.14237
F2(G)	0.00001	0.00001	0.00001	0.	0.	0.	0.	0.	0.	0.
H1(G)	0.03520	0.03864	0.04641	0.05741	0.06960	0.08041	0.09163	0.10115	0.11075	0.11879
H2(G)	0.01081	0.01075	0.01049	0.00984	0.00881	0.00772	0.00649	0.00543	0.00438	0.00357
H1C1N1(G)	0.02062	0.01947	0.01712	0.01420	0.01138	0.00920	0.00721	0.00575	0.00446	0.00353
H1F1(G)	0.67442	0.66918	0.65792	0.64285	0.62692	0.61301	0.59859	0.58619	0.57343	0.56250
N1(G)	0.00028	0.00028	0.00027	0.00024	0.00021	0.00018	0.00014	0.00012	0.00009	0.00007
N2(G)	0.10883	0.10830	0.10734	0.10631	0.10546	0.10487	0.10438	0.10407	0.10383	0.10370
N1F1(G)	0.00001	0.00001	0.	0.	0.	0.	0.	0.	0.	0.
N1H1(G)	0.00006	0.00005	0.00003	0.00002	0.00001	0.00001	0.	0.	0.	0.

ADDITIONAL PRODUCTS WHICH WERE CONSIDERED BUT WHOSE MOLE FRACTIONS WERE LESS THAN 0.000005 FOR ALL ASSIGNED CONDITIONS

C1F4(G) C2H4(G) N1F2(G) N1F3(G) N2F2(G) N2F4(G) N1H3(G) C1(S)

INPUT, G-ATOMS/G

	N	H	C	F
FUEL	0.4784158E-01	0.1289509E-00	0.1663833E-01	0.
OXIDANT	0.	0.	0.	0.5263158E-01
PROPELLANT	0.1366932E-01	0.3684569E-01	0.4753823E-02	0.3759398E-01

CASE NO. 122 1469.6 2.500

NOTE. WEIGHT FRACTION OF FUEL IN TOTAL FUELS AND OF OXIDANT IN TOTAL OXIDANTS

TABLE V. - PROGRAM INPUT

Card type	Card name	Optional card?	Number of cards	Card format
1	Reactant	No	1 to 30 (1 to 15 oxidants) (1 to 15 fuels)	(5(A2,F7.5),F7.5,A1,F9.5,A1,F8.5,A1,F8.5)
	Blank	No	1	
2	Omit-Insert	Yes	Any	(4(2A6,3X))
	Blank	No	1	
3	Problem (H,S;T,S;T,P;P,T;H,P; or DETN, case)	No	1	(A5,I5)
[a]4	Schedule (of P_c/P, or P, or T)	No	1 to 5	(5F10.2)
	Blank[a]	No	1	
[a]5	Schedule of area ratios	Yes	1 to 3	(5F10.2)
	Blank[a]	No	1	
6	Mixture (ℝ, O/F, %F, P, T, code, debug)	No	Any	(5F10.2,I5,16X,I1)
	Blank[b]	No	1 to 3	

[a]For DETN problems, the schedule cards and the blank card that follows them must be omitted.

[b]There may be one, two, or three blank cards.
(1) One blank card: Program returns to read another sequence of cards starting with type 3.
(2) Two blank cards: Program returns to read another sequence of cards starting with type 1.
(3) Three blank cards: Program terminates.

TABLE VI. - EXAMPLES OF TYPICAL REACTANT CARDS

Reactant formula										Relative weights[a] or moles	Code for moles	Enthalpy, cal/mole	State	Temperature, °K	Fuel or oxidant	Density, g/cc, or heat capacity, cal/(mole)(°K)
Column																
1-2	3-9	10-11	12-18	19-20	21-27	28-29	30-36	37-38	39-45	46-52	53	54-62	63	64-71	72	73-80
N	2.	H	4.							0.5		12050.	L	298.15	F	1.0036
N	2.	H	8.	C	2.					.5		12734.8	L	298.15	F	0.7861
F	2.									1.		-3030.832	L	85.24	O	1.54
N	2.									0.780881	M	0.	G	298.15	O	
O	2.									.209495	M	0.	G	298.15	O	
AR	1.									.009324	M	0.	G	298.15	O	
C	1.	O	2.							.000300	M	-94051.8	G	298.15	O	
H	2.									2.	M	0.	G	298.15	F	

[a]Relative weight of fuel in total fuels or oxidant in total oxidants as designated in column 72.