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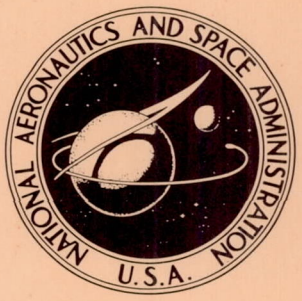

NASA TN D-1737

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

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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, ^oK

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

$$y = \sum_{n=0}^{5} a_n x^n \qquad (1)$$

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

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

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 area 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 sample problem. It is expected that accuracy of interpolation should be least for those 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 by 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 thermodynamic 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 $\mathscr{R}$, 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, $\mathscr{R}$, 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                                                                0001
C                                                                                 0002
C                                                                                 0003
      COMMON C                                                                    0004
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))                 0005
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))                 0006
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))                 0007
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))                 0008
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))                 0009
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))                 0010
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))                 0011
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))                 0012
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))                 0013
      EQUIVALENCE   (RHO,        C(439))                                          0014
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))                 0015
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))                 0016
      EQUIVALENCE   (T ETA,      C(445))                                          0017
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))                 0018
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))                 0019
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))                 0020
      EQUIVALENCE   (AW SIG,     C(453))                                          0021
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))                  0022
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),    C(1343))                0023
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15),   C(1358))                0024
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15),   C(1358))                0025
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),    C(1381))                0026
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23), C(1381))                0027
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),      C(1471))                0028
      EQUIVALENCE   (ISYS,       C(1472)),   (JEAN,      C(1473))                0029
      EQUIVALENCE   (ACX,        C(1474)),   (ACF,      C(1475))                 0030
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))                0031
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,      C(1479))                0032
      EQUIVALENCE   (COEFX(1),     C(1480)), (COEFX(20),  C(1499))                0033
      EQUIVALENCE   (DX(1),    C(1500)),   (DX(20),    C(1519))                  0034
      EQUIVALENCE   (FORMLA(1),  C(1520)), (FORMLA(18),  C(1537))                0035
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))                  0036
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),    C(1540))                  0037
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),   C(1555))              0038
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))                   0039
      EQUIVALENCE   (OF,      C(1556)),     (FPCT,   C(1557))                    0040
      EQUIVALENCE   (EQRAT,      C(1558))                                         0041
      EQUIVALENCE (KODE,     C(1559)),    (KASE,       C(1560))                0042
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))               0043
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))               0044
      EQUIVALENCE   (NOEQ, C(1565))                                              0045
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),    C(1785))                0046
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),    C(1800))                0047
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))                0048
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))                0049
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))                0050
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))                  0051
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))                  0052
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))                0053
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))                0054
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))                0055
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))                  0056
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))                0057
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))                0058
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))                0059
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))                0060
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))                0061
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))                0062
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))                0063
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))                0064
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))                0065
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))                0066
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))                0067
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))                0068
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))                0069
```

```
      EQUIVALENCE   (IDRM,      C(2323)), (KDRUM,     C(2324))          0070
      EQUIVALENCE   (L,         C(2325)), (L1,        C(2326))          0071
      EQUIVALENCE   (M,         C(2327)), (M1,        C(2328))          0072
      EQUIVALENCE   (N,         C(2329)), (IQ,        C(2330))          0073
      EQUIVALENCE   (IQ1,       C(2331)), (IQ2,       C(2332))          0074
      EQUIVALENCE   (IQ3,       C(2333)), (KMAT,      C(2334))          0075
      EQUIVALENCE   (IMAT,      C(2335)), (IUSE,      C(2335))          0076
      EQUIVALENCE   (IADD,      C(2336)), (ITNUMB,    C(2337))          0077
      EQUIVALENCE   (ITAPE,     C(2338)), (P,         C(2339))          0078
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,     C(2341))          0079
      EQUIVALENCE   (A(1),      C(2342)),  (A(1350),  C(3691))          0080
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))      0081
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))       0082
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))       0083
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))           0084
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))        0085
      EQUIVALENCE (KORE, C(8047))                                       0086
      EQUIVALENCE(MT,DMT)                                               0087
      EQUIVALENCE (HS,MHS),(TS,MTS),(PT,MPT),(TP,MTP),(DET,MDET)        0088
      EQUIVALENCE (PROB,MPROB),(END,MEND)                               0089
      EQUIVALENCE (TMLM,MTMLM) , (BLK,MBLK)                             0090
      EQUIVALENCE(NAREA,C(10607))                                       }
      EQUIVALENCE(SAREA(1),C(10608)),(SAREA(13),C(10620))               } Area ratio
      EQUIVALENCE  (IUNDER,C(10621))                                    }
      EQUIVALENCE  (IOVER,C(10622))                                     }
      EQUIVALENCE  (KSAN,C(10623))                                      Moles
      EQUIVALENCE  (WX,C(10624))                                        Moles
      EQUIVALENCE  (WF,C(10625))                                        Moles
      EQUIVALENCE (H P,MHP)                                             H,P
C                                                                       0091
      DIMENSION SAREA(13)                                               Area ratio
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)         0092
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)             0093
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)           0094
      DIMENSION   COEFX(20),  DX(20),     FORM(15)                      0095
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                           0096
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)        0097
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)         0098
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                            0099
      DIMENSION   ANSLAB(454),   COEFT(15,90)                           0100
      DIMENSION   MATOM(101,3),     ATOM(101,3)                         0101
C                                                                       0102
C                                                                       0103
B1    H S=307362606060                                                  0104
B     T S=637362606060                                                  0105
B     P T=477363606060                                                  0106
B     T P=637347606060                                                  0107
B     DET=242563456060                                                  0108
B     END=254524606060                                                  0109
B     BLK=000000C00060                                                  0110
B     OMIT=464431636060                                                 0111
B     DMT=606060606060                                                  0112
B     H P=307347606060                                                  H,P
C                                                                       0113
C                                                                       0114
C     READ IN INPUT DATA                                                0115
C                                                                       0116
      IF (ISYS-99) 401,403,401                                          0117
  403 READ TAPE 3,(G(I),I=1,8044)                                       0118
      REWIND 3                                                          0119
      IF (SENSE SWITCH 6) 651,719                                       0120
  401 ISYS=99                                                           0121
      IFROZ=0                                                           0122
      PAUSE 11111                                                       0123
  429 CALL INPUT                                                        0124
      IF (L) 651,651,433                                                0125
  433 WRITE OUTPUT TAPE 6,443, HX,VXPLS,VXMIN,HF,VFPLS,VFMIN            0126
     1, (ELMT(I),BOX(I),BOF(I),I=1,L)                                   0127
  443 FORMAT (10H1OXIDANT  3E16.6/10H FUEL     3E16.6/(1H A6,2E20.8))   0128
C                                                                       0129
C     RIGHT ADJUST ELEMENT SYMBOLS                                      0130
C                                                                       0131
      DO 447 K=1,L                                                      0132
      TMLM = ELMT(K)                                                    0133
      ELMT(K) = ARSF(24, TMLM)                                          0134
```

```
B       TMLM = ELMT(K) *000000000077                                          0135
        IF (MTMLM-MBLK) 447,1447,447                                          0136
 1447   TMLM = ELMT(K)                                                        0137
        ELMT(K) = ARSF(6, TMLM)                                               0138
  447   CONTINUE                                                              0139
        IF(SYSTM(L+1))453,920,453                                             0140
  920   IF (SYSTM(L)) 921,453,921                                             0141
  921   DO 449 K=1,L                                                          0142
        DO 448 J=1,L                                                          0143
        IF (LLMT(K)-MTSYS(J)) 448,449,448                                     0144
  448   CONTINUE                                                              0145
        GO TO 453                                                             0146
  449   CONTINUE                                                              0147
C                                                                             0148
C       CANCEL ---OMITS---FROM PREVIOUS PROBLEM                               0149
C                                                                             0150
  452   DO 1452 J=1,M                                                         0151
        COEFT1(1,J) = DMT                                                     0152
        COEFT2(1,J) = DMT                                                     0153
 1452   COEFT(1,J) = DMT                                                      0154
        IUSE=1                                                                0155
        GO TO 598                                                             0156
  453   DO 459 K=1,15                                                         0157
  459   SYSTM(K)=ELMT(K)                                                      0158
        CALL SEARCH                                                           0159
  598   IF (IUSE-2) 600,635,635                                               0160
C                                                                             0161
C       SET ARRAY  PROD  TO BYPASS ALL CONDENSED PHASES                       0162
C                                                                             0163
  600   PROD(1)=0.0                                                           0164
        PROD(2)=0.0                                                           0165
        IF (M-35) 198,198,1198                                                0166
 1198   IF (M-70) 199,199,1199                                                0167
 1199   IF (M-90) 200,200,635                                                 0168
B198    PROD(2)=377777777777                                                  0169
B       PROD(3) = 377777777777                                                0170
        TMP=PROD(2)                                                           0171
        PROD(1)=ARSF(M,TMP)                                                   0172
        GO TO 201                                                             0173
  199   M12 = M-35                                                            0174
B       PROD(3) = 377777777777                                                0175
        TMP=PROD(3)                                                           0176
        PROD(2)=ARSF(M12,TMP)                                                 0177
        GO TO 201                                                             0178
  200   M12 = M-70                                                            0179
B       PROD(3) = 377777777777                                                0180
        TMP=PROD(3)                                                           0181
        PROD(3)=ARSF(M12,TMP)                                                 0182
  201   IQ=L                                                                  0183
        IQ1=IQ+1                                                              0184
        IQ2=IQ1+1                                                             0185
        IQ3=IQ2+1                                                             0186
        L1=IQ1                                                                0187
        M1=M+1                                                                0188
C                                                                             0189
C       DETERMINE WHICH GASEOUS SPECIES SHOULD BE OMITTED FROM THE PROBLEM    0190
C       AND WHICH CONDENSED SPECIES SHOULD BE USED IN THE FIRST ITERATION     0191
C                                                                             0192
  203   READ INPUT TAPE 7,204,(DATA(I),I=1,8)                                0193
  204   FORMAT (4(2A6,3X))                                                   0194
B       SJW=DATA(1)*(-DMT)                                                    0195
B       IF(SJW)207,220,207                                                    0196
  207   DO 213 K=1,4                                                          0197
        DO 211 J=1,N                                                          0198
        DO 208 I=2,3                                                          0199
        KK=2*K+I-3                                                            0200
B       SJW=DATA(KK)*(-COEFT2(I,J))                                           0201
B       IF(SJW)211,208,211                                                    0202
  208   CONTINUE                                                              0203
        IF (J-M) 209,209,210                                                  0204
  209   CALL BYPASS (J,2)                                                     0205
11209   GO TO 213                                                             0206
  210   CALL BYPASS (J,3)                                                     0207
11210   GO TO 213                                                             0208
  211   CONTINUE                                                              0209
  213   CONTINUE                                                              0210
        GO TO 203                                                             0211
```

```
  220 CONTINUE                                                          0212
      DO 222 J=1,M                                                      0213
      CALL BYPASS(J,1)                                                  0214
      IF (IPROD - 2) 221,222,221                                        0215
  221 COEFT1(1,J) = OMIT                                                0216
      COEFT2(1,J)=OMIT                                                  0217
  222 CONTINUE                                                          0218
C                                                                       0219
C     ARRANGE ANSWER REGION                                             0220
C                                                                       0221
      I=1                                                               0222
      DO 602 J=1,N                                                      0223
      ANS(I)=COEFT2(1,J)                                                0224
      ANS(I+1)=COEFT2(2,J)                                              0225
      ANS(I+2)=COEFT2(3,J)                                              0226
      ANS(I+3) = 0.0                                                    0227
  602 I=I+4                                                             0228
      K=4*N                                                             0229
  605 I=K+34                                                            0230
      ANS(I)=ANS(K)                                                     0231
      K=K-1                                                             0232
      IF (K) 651,607,605                                                0233
  607 DO 609 K=1,34                                                     0234
  609 ANS(K) = 0.0                                                      0235
      DO 1700  K= 1, 454                                                0236
 1700 ANSLAB(K) = ANS(K)                                                0237
      DO 1701 J = 1, 15                                                 0238
      DO 1701 K = 1, 90                                                 0239
 1701 COEFT(J,K) = COEFT1(J,K)                                          0240
C                                                                       0241
C     DETERMINE THE TYPE OF PROBLEM                                     0242
C                                                                       0243
  700 IFROZ=1                                                           0244
  701 READ INPUT TAPE 7,703,PROB,KASE                                   0245
  703 FORMAT (A5,I5)                                                    0246
      IF (MPROB-MHS) 705,901,705                                        0247
  901 IPROB=1                                                           0248
      GO TO 715                                                         0249
  705 IF (MPROB-MTS) 707,902,707                                        0250
  902 IPROB=2                                                           0251
      GO TO 715                                                         0252
  707 IF (MPROB-MPT) 709,903,709                                        0253
  903 IPROB=3                                                           0254
      GO TO 715                                                         0255
  709 IF (MPROB-MTP) 711,904,711                                        0256
  904 IPROB=4                                                           0257
      GO TO 715                                                         0258
  711 IF (MPROB-MDET) 713,905,713                                       0259
  905 IPROB=1                                                           0260
      IFROZ=-1                                                          0261
      GO TO 719                                                         0262
  713 IF (MPROB-MHP) 9001,9000,9001                                     }
 9000 IPROB=5                                                           } H,P
      GO TO 715                                                         }
 9001 IF (MPROB-MT) 631,429,631                                         0264
  715 DO 716 K=1,25                                                     0265
  716 PCP(K)=0.0                                                        0266
      I=0                                                               0267
 1716 READ INPUT TAPE 7,718,(G(K),K=1,5)                                    Area ratio
      IF(G(1))1719,1719,717                                             0269
  717 DO 1717 K=1,5                                                     0270
      IK=I+K                                                            0271
 1717 PCP(IK)=G(K)                                                      0272
      I=I+5                                                             0273
      GO TO 1716                                                        0274
  718 FORMAT(5F10.2)                                                    0275
C                                                                       }
C     READ IN AREA RATIO SCHEDULE                                       }
C                                                                       }
 1719 IK = 1                                                            }
 2013 READ INPUT TAPE 7,718,(G(K),K=1,5)                                } Area ratio
      IF (G(1)) 2001,2003,2001                                          }
 2001 DO 2002  I=1,5                                                    }
      ANS(IK) = G(I)                                                    }
 2002 IK = IK+1                                                         }
      GO TO 2013                                                        }
```

```
 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                          0276
C                                                                            0277
  719 READ INPUT TAPE 7,721,EQRAT,O F,F PCT,PC,TC,KODE,IDEBUG                0278
  721 FORMAT (5F10.2,I5,16X,I1)                                              0279
      IF (EQRAT) 725,725,723                                                 0280
  723 O F=(-EQRAT*VFMIN-VFPLS)/(VXPLS+EQRAT*VXMIN)                           0281
      F PCT=100.0/(1.0+O F)                                                  0282
      GO TO 745                                                              0283
  725 IF (O F) 731,731,727                                                   0284
  727 F PCT=100.0/(1.0+O F)                                                  0285
  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                                                              0287
  731 IF(F PCT)9051,9051,733                                                     )
 9051 IF (PC+TC)9052,700,9052                                                    ) Moles
 9052 IF(KSAN)9053,700,9053                                                      )
 9053 O F=WX/WF                                                                  )
      GO TO 727                                                                  )
  733 O F=(100.0-F PCT)/F PCT                                                2289
      IF (O F)   719,1733,729                                                2290
 1733 IF (VFMIN) 729, 746,729                                                2291
  745 IF (O F) 719,746,746                                                   2292
  746 DO 747 I=1,L                                                           2293
  747 BO(I)=(O F*BOX(I)+BOF(I))/(1.0+O F)                                    2294
      IF (IPROB-1) 651,749,748                                               2295
  748 IF (IPROB-5) 9002,749,651                                                  H,P
 9002 HSUBO=0.0                                                                  H,P
      GO TO 755                                                              2297
  749 HSUBO=(O F*HX+HF)/(1.0+O F)                                            2298
  755 WRITE OUTPUT TAPE 6,760,KASE,PROB,O F,F PCT,EQRAT,PC,HSUBO,            2299
     1 (BO(I),I=1,L)                                                         2300
  760 FORMAT (1H1I5,3X,A6/1H 4E17.8/(1H 7E17.8))                             2301
      HSUBO=HSUBO/1.98726                                                    2302
      DO 1771 I = 1, 454                                                     2303
 1771 ANS(I) = ANSLAB(I)                                                     2304
      RHO=RHOX+O F*RHOF                                                      2305
      IF (RHO) 772,772,771                                                   2306
  771 RHO=(1.0+O F)*RHOX*RHOF/RHO                                            2307
  772 DO 1772 I = 1, 454                                                     2308
 1772 ANSLAB(I) = ANS(I)                                                     2309
  775 IF (IFROZ) 777,651,779                                                 2310
  777 CALL CORE4                                                             2311
      IF (KORE) 1,779,1                                                      2312
  779 CALL CORE2                                                             2313
      GO TO 1                                                                2314
C                                                                            2315
C     ERROR PRINT OUT                                                        2316
C                                                                            2317
  631 WRITE OUTPUT TAPE 6,633,PROB,KASE                                      2318
  633 FORMAT (21H1THERE IS NO PROBLEM A6,2X,I5)                              2319
      GO TO 651                                                              2320
  635 WRITE OUTPUT TAPE 6,637                                                2321
  637 FORMAT (47H1TROUBLE IN COMPILING MASTER THERMODYNAMIC TAPE)             2322
      REWIND 4                                                               2323
  639 READ TAPE 4,(DATA(I),I=1,23)                                           2324
      WRITE OUTPUT TAPE 6,640,(DATA(I),I=1,23)                               2325
  640 FORMAT (1H 3A6,2F10.1/(1H 2F8.1,7E14.6))                               2326
      IF (MDATA(1)-MEND) 639,900,639                                         2327
  900 WRITE OUTPUT TAPE 6,643, ((COEFT1(K,J),K=1,14),J=1,N)                  2328
      WRITE OUTPUT TAPE 6,643, ((COEFT2(K,J),K=1,14),J=1,N)                  2329
  643 FORMAT (1H 3A6,2F15.2/2F8.1,7E12.4//)                                  2330
  651 REWIND 4                                                               2331
      PAUSE 77777                                                            2332
```

```
      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   (MTSYS(1), C(1541)), (MTSYS(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
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      EQUIVALENCE   (ITAPE,     C(2338)), (P,         C(2339))          0410
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,     C(2341))          0411
      EQUIVALENCE   (A(1),      C(2342)),  (A(1350),  C(3691))          0412
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))      0413
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))       0414
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))       0415
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))           0416
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))        0417
      EQUIVALENCE (C12,MM),(E,ME),(END,MEND),(BLK,MBLK),(RPN,MRPN)      0418
      EQUIVALENCE (GAS,MGAS),(SOL,MSOL),(BLIQ,MLIQ),(BLPN,MLPN)         0419
      EQUIVALENCE (C10,MC10),(PLS,MPLS),(SYMBL,MBL),(BMIN,MMIN)         0420
      EQUIVALENCE (TMP1, MTMP1)                                         0421
C                                                                       0422
C                                                                       0423
      DIMENSION   G(20,21),   A(15,90),   EN(90),     EN LN(90)         0424
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)             0425
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)           0426
      DIMENSION   COEFX(20),  DX(20),     FORM(15)                      0427
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                           0428
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)        0429
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)         0430
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                            0431
      DIMENSION   ANSLAB(454),   COEFT(15,90)                           0432
      DIMENSION   MATOM(101,3),     ATOM(101,3)                         0433
      DIMENSION MMLA(18)                                                0434
C                                                                       0435
C                                                                       0436
B     BLK=000000000060                                                  0437
B     RPN=000000000034                                                  0438
B     BLPN=000000000074                                                 0439
B     GAS=000000000027                                                  0440
B     SOL=000000000062                                                  0441
B     BLIQ=000000000043                                                 0442
B     PLS=000000000020                                                  0443
B     BMIN=000000000040                                                 0444
B     E=000000000025                                                    0445
B     END=254524606060                                                  0446
B     C10=000000000012                                                  0447
B     C12=000014000000                                                  0448
B     CF10=000012000000                                                 0449
C                                                                       0450
C                                                                       0451
      KION=2                                                            0452
      DO 1 K=1,L                                                        0453
      IF (LLMT(K)-ME) 1,2,1                                             0454
    1 CONTINUE                                                          0455
      GO TO 3                                                           0456
    2 KION=1                                                            0457
      TEMP=ELMT(K)                                                      0458
      ELMT(K)=ELMT(L)                                                   0459
      ELMT(L)=TEMP                                                      0460
    3 ISOL=0                                                            0461
      M=0                                                               0462
      DO 4 J=1,15                                                       0463
      DO 4 K=1,90                                                       0464
      COEFT2(J,K) = 0.0                                                 0465
    4 COEFT1(J,K) = 0.0                                                 0466
      DO 6 J=1,1350                                                     0467
    6 A(J) = 0.0                                                        0468
      REWIND 4                                                          0469
    7 READ TAPE 4, (DATA(I),I=1,23)                                     0470
      IF (MDATA(1)-MEND) 900,171,900                                    0471
C                                                                       0472
C     UNPACK THE BCD FORMULA FOR THE PRODUCT                            0473
C                                                                       0474
  900 DO 16 I=1,2                                                       0475
   16 DATUM(I)=DATA(I)                                                  0476
      J=1                                                               0477
      I=1                                                               0478
   13 K=0                                                               0479
   17 TMP1 = DATUM(I)                                                   0480
      FORMLA(J) = ARSF(30,TMP1)                                         0481
B     DATUM(I) = ALSF(6000000,TMP1)                                     0482
      J=J+1                                                             0483
      IF (K-4) 925,925,21                                               0484
  925 K = K+1                                                           0485
```

```
      GO TO 17                                                                0486
   21 IF(I-1) 926,926,25                                                      0487
  926 I=I+1                                                                   0488
      GO TO 13                                                                0489
C                                                                             0490
C     BEGIN SEARCH FOR FIRST NON BLANK ALPHANUMERIC CHARACTER                 0491
C                                                                             0492
   25 J=12                                                                    0493
   29 J=J                                                                     0494
      IF (MMLA(J)-MBLK) 35,950,35                                             0495
  950 IF (J-1) 30,30,951                                                      0496
  951 J = J-1                                                                 0497
      GO TO 29                                                                0498
   30 WRITE OUTPUT TAPE 6,31,(DATA(I),I=1,3)                                  0499
   31 FORMAT (14H THE FORMULA  3A6,33H  IS INCORRECT ON THE MASTER TAPE)       0500
      GO TO 7                                                                 0501
   35 IF (MMLA(J)-MRPN) 30,952,30                                             0502
  952 J = J-1                                                                 0503
      IF (MMLA(J)-MGAS) 953,39,953                                            0504
  953 IF (MMLA(J)-MSOL) 954,41,954                                            0505
  954 IF (MMLA(J)-MLIQ) 30,41,30                                              0506
   39 ITYPE=1                                                                 0507
      GO TO 47                                                                0508
   41 ITYPE=2                                                                 0509
   47 J=J-1                                                                   0510
      IF (MMLA(J)-MLPN) 30,955,30                                             0511
  955 J=J-1                                                                   0512
C                                                                             0513
C     OBTAIN AND STORE THE FORMULA NUMBERS A(K,J)                             0514
C                                                                             0515
      DO 48 K=1,15                                                            0516
   48 FORM(K)=0.0                                                             0517
   51 NLSW=1                                                                  0518
      NUMB=0                                                                  0519
   55 ICNT=0                                                                  0520
   57 JCNT=J-ICNT                                                             0521
      IF (JCNT) 30,81,59                                                      0522
   59 IF (MMLA(JCNT) - MC10) 958,67,67                                        0523
  958 GO TO (63,85),NLSW                                                      0524
   63 ICNT=ICNT+1                                                             0525
      GO TO 57                                                                0526
   67 GO TO (69,63),NLSW                                                      0527
   69 IF (ICNT) 959,330,959                                                   0528
  330 IF(KION-1)30,333,30                                                     0529
  333 NLSW=2                                                                  0530
      GO TO 57                                                                0531
  959 IF (ICNT-2) 77,73,30                                                    0532
   73 NUMB = MMLA(J-1) * 10                                                   0533
   77 TMP1 = FORMLA(J)                                                        0534
      TMP1 = ALSF(18,TMP1)                                                    0535
B     TMP1 = TMP1 * 377777777777                                              0536
B     TMP2 = FORMLA(J)*400000000000                                           0537
B     TMP1 = TMP1+TMP2                                                        0538
      NUMB = NUMB+MTMP1                                                       0539
      VALUE = NUMB                                                            0540
      J=J-ICNT                                                                0541
      NLSW=2                                                                  0542
      GO TO 55                                                                0543
   81 GO TO (30,85),NLSW                                                      0544
   85 IF (ICNT) 960,30,960                                                    0545
  960 SYMBL = 0.0                                                             0546
      IF(NUMB)86,95,86                                                        0547
   86 IF (ICNT-2) 93,89,30                                                    0548
   89 TMP1 = FORMLA(J-1)                                                      0549
      SYMBL = ALSF(6,TMP1)                                                    0550
   93 MBL = MBL + MMLA(J)                                                     0551
      GO TO 107                                                               0552
   95 IF(JCNT)30,30,96                                                        0553
   96 IF (MMLA(J)-MPLS) 97,970,97                                             0554
  970 FORM(L)=-ICNT                                                           0555
      GO TO 109                                                               0556
   97 IF (MMLA(J)-MMIN) 107,975,107                                           0557
  975 FORM(L)=ICNT                                                            0558
  101 GO TO 109                                                               0559
  107 DO 111 K=1,L                                                            0560
      IF (MBL-LLMT(K)) 111,105,111                                            0561
  111 CONTINUE                                                                0562
```

```
      GO TO 7                                                          0563
  105 FORM(K)=VALUE                                                    0564
  109 J=J-ICNT                                                         0565
      IF (J) 30,121,51                                                 0566
  121 IF (ITYPE-1) 30,133,137                                          0567
  133 M=M+1                                                            0568
      J=M                                                              0569
      GO TO 145                                                        0570
  137 J=90-ISOL                                                        0571
      ISOL=ISOL+1                                                      0572
  145 DO 147 K=1,L                                                     0573
      A(K,J)=FORM(K)                                                   0574
  147 CONTINUE                                                         0575
C                                                                      0576
C     ARRANGE THERMODYNAMIC DATA IN CORE ORDERED BY INTERVAL           0577
C                                                                      0578
  151 IT=0                                                             0579
      TEMP = DATA(1)                                                   0580
      DATA(1) = DATA(3)                                                0581
      DATA(3) = DATA(2)                                                0582
      DATA(2) = TEMP                                                   0583
      DO 155 K=1,5                                                     0584
  155 COEFT1(K,J) = DATA(K)                                            0585
      DO 159 K=6,14                                                    0586
      KIT= K+IT                                                        0587
  159 COEFT1(K,J) = DATA(KIT)                                          0588
      IT=IT+9                                                          0589
      DO1955 K=1,5                                                     0590
 1955 COEFT2(K,J) = DATA(K)                                            0591
      DO1959 K=6,14                                                    0592
      KIT = K+IT                                                       0593
 1959 COEFT2(K,J) = DATA(KIT)                                          0594
      GO TO 7                                                          0595
C                                                                      0596
C     GO TO NEXT MOLECULE                                              0597
C                                                                      0598
C                                                                      0599
C     ELIMINATE GAP BETWEEN GASES AND CONDENSED PHASES                 0600
C                                                                      0601
  171 N=M+ISOL                                                         0602
      IUSE=1                                                           0603
  173 IF (N-90) 175,225,181                                            0604
  175 IF (ISOL) 177,225,184                                            0605
  177 IUSE=2                                                           0606
      GO TO 225                                                        0607
  181 WRITE OUTPUT TAPE 6,182                                          0608
  182 FORMAT (45H TOO MANY REACTION PRODUCTS FOUND ON THE TAPE)         0609
      IUSE=2                                                           0610
      GO TO 225                                                        0611
  184 KK = 90-ISOL                                                     0612
      DO 186 J = 1, ISOL                                               0613
      MJ = M+J                                                         0614
      KJ = KK + J                                                      0615
      DO 186 K = 1,15                                                  0616
  186 COEFT1(K,MJ) = COEFT1(K,KJ)                                      0617
      DO 185 J = 1,ISOL                                                0618
      MJ = M+J                                                         0619
      KJ = KK + J                                                      0620
      DO 185 K = 1,15                                                  0621
  185 COEFT2(K,MJ) = COEFT2(K,KJ)                                      0622
      DO 219 J=1,ISOL                                                  0623
      MJ=M+J                                                           0624
      KJ = KK +J                                                       0625
      DO 217 K=1,15                                                    0626
      A(K,MJ) = A(K,KJ)                                                0627
  217 CONTINUE                                                         0628
  219 CONTINUE                                                         0629
      GO TO 225                                                        0630
  225 RETURN                                                           0631
```

```
      SUBROUTINE BYPASS (J,IARG)                                        0632
C                                                                       0633
C                                                                       0634
      COMMON C                                                          0635
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))       0636
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))       0637
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))       0638
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))       0639
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))       0640
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))       0641
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))       0642
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))       0643
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))       0644
      EQUIVALENCE   (RHO,        C(439))                               0645
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))       0646
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))       0647
      EQUIVALENCE   (T ETA,      C(445))                               0648
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))       0649
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))       0650
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))       0651
      EQUIVALENCE   (AW SIG,     C(453))                               0652
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))        0653
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),    C(1343))      0654
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15),   C(1358))      0655
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15),   C(1358))      0656
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),   C(1381))      0657
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23), C(1381))      0658
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),     C(1471))      0659
      EQUIVALENCE   (ISYS,       C(1472)),   (JEAN,      C(1473))      0660
      EQUIVALENCE   (ACX,        C(1474)),   (ACF,       C(1475))      0661
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))      0662
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,      C(1479))      0663
      EQUIVALENCE   (COEFX(1),     C(1480)), (COEFX(20),  C(1499))      0664
      EQUIVALENCE   (DX(1),    C(1500)),  (DX(20),     C(1519))      0665
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))    0666
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18),  C(1537))      0667
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),    C(1540))      0668
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),   C(1555))    0669
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))        0670
      EQUIVALENCE   (OF,      C(1556)),    (FPCT,    C(1557))         0671
      EQUIVALENCE   (EQRAT,      C(1558))                              0672
      EQUIVALENCE (KODE,     C(1559)),    (KASE,       C(1560))      0673
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))     0674
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))     0675
      EQUIVALENCE   (NOEQ, C(1565))                                   0676
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),     C(1785))     0677
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),     C(1800))     0678
      EQUIVALENCE   (HX,         C(1801)), (HF,          C(1802))     0679
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,       C(1804))     0680
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,       C(1806))     0681
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90),  C(1950))      0682
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90),  C(2040))      0683
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),      C(2130))     0684
      EQUIVALENCE   (S(1),       C(2131)), (S(90),       C(2220))     0685
      EQUIVALENCE   (X(1),       C(2221)), (X(20),       C(2240))     0686
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20),  C(2260))      0687
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),      C(2275))     0688
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,       C(2277))     0689
      EQUIVALENCE   (SO,         C(2278)), (T LN,        C(2279))     0690
      EQUIVALENCE   (T,          C(2280)), (AAY LN,      C(2281))     0691
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,       C(2283))     0692
      EQUIVALENCE   (HC,         C(2284)), (TC LN,       C(2285))     0693
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),     C(2310))     0694
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),    C(2313))     0695
      EQUIVALENCE   (PC,         C(2314)), (TC,          C(2315))     0696
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,       C(2317))     0697
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,       C(2319))     0698
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,       C(2321))     0699
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,       C(2323))     0700
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,       C(2324))     0701
      EQUIVALENCE   (L,          C(2325)), (L1,          C(2326))     0702
      EQUIVALENCE   (M,          C(2327)), (M1,          C(2328))     0703
      EQUIVALENCE   (N,          C(2329)), (IQ,          C(2330))     0704
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,         C(2332))     0705
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,        C(2334))     0706
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,        C(2335))     0707
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,      C(2337))     0708
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      EQUIVALENCE   (ITAPE,     C(2338)), (P,         C(2339))          0709
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,     C(2341))          0710
      EQUIVALENCE   (A(1),      C(2342)),  (A(1350),  C(3691))          0711
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))      0712
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))       0713
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))       0714
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))           0715
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))        0716
      EQUIVALENCE (CONS,JFCONS),   (MTEMP, TEMP)                        0717
C                                                                       0718
C                                                                       0719
      DIMENSION   G(20,21),   A(15,90),   EN(90),      EN LN(90)        0720
      DIMENSION   DEL N(90),  HO(90),     S(90),       X(20)            0721
      DIMENSION   DELTA(20),  BO(15),     PCP(25),     PROD(3)          0722
      DIMENSION   COEFX(20),  DX(20),     FORM(15)                      0723
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                           0724
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),    FORMLA(18)       0725
      DIMENSION   BOX(15),    BOF(15),    ANS(454),    SYSTM(15)        0726
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                            0727
      DIMENSION   ANSLAB(454),   COEFT(15,90)                           0728
      DIMENSION   MATOM(101,3),     ATOM(101,3)                         0729
C                                                                       0730
C                                                                       0731
C     IARG=1 MEANS TEST ONLY, IARG=2 MEANS ELIMINATE A SPECIES, IARG=3  0732
C     MEANS ADD ANOTHER SPECIES                                         0733
C                                                                       0734
B     CONS=1                                                            0735
      MLM=J                                                             0736
      IF (J-35) 2,2,102                                                 0737
  102 IF (J-70) 1,1,101                                                 0738
  101 K=3                                                               0739
      MLM=J-70                                                          0740
      GO TO 3                                                           0741
    1 K=2                                                               0742
      MLM=J-35                                                          0743
      GO TO 3                                                           0744
    2 K=1                                                               0745
    3 IF (IARG-2) 4,5,7                                                 0746
    4 IPROD=2                                                           0747
      KLM = 35-MLM                                                      0748
      TEMP = PROD(K)                                                    0749
      TEMP = LRSF(KLM,TEMP)                                             0750
B     IF (TEMP*CONS) 12,10,12                                           0751
   12 IPROD = 1                                                         0752
      GO TO 10                                                          0753
    5 KLM = 35 - MLM                                                    0754
      TEMP = PROD(K)                                                    0755
      TEMP = LRSF(KLM,TEMP)                                             0756
B     IF (TEMP * CONS) 10,6,10                                          0757
B6    TEMP = TEMP +1                                                    0758
B     PROD(K) = LLSF(KLM,TEMP)                                          0759
      IF(M-J)11,10,10                                                   0760
   11 IQ3=IQ2                                                           0761
      IQ2=IQ1                                                           0762
      IQ1=IQ                                                            0763
      IQ =IQ-1                                                          0764
      GO TO 9                                                           0765
    7 KLM = 35 - MLM                                                    0766
      TEMP = PROD(K)                                                    0767
      TEMP = LRSF(KLM,TEMP)                                             0768
B     IF (TEMP * 1) 110,10,110                                          0769
  110 MTEMP=MTEMP-JFCONS                                                0770
B     PROD(K) = LLSF(KLM, TEMP)                                         0771
      IF(M-J)121,10,10                                                  0772
  121 IQ = IQ1                                                          0773
      IQ1=IQ2                                                           0774
      IQ2=IQ3                                                           0775
      IQ3=IQ3+1                                                         0776
    9 SENSE LIGHT 4                                                     0777
   10 RETURN                                                            0778
```

```
      SUBROUTINE INPUT                                                  0779
C                                                                       0780
C                                                                       0781
      COMMON C                                                          0782
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))       0783
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))       0784
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))       0785
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))       0786
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))       0787
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))       0788
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))       0789
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))       0790
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))       0791
      EQUIVALENCE   (RHO,        C(439))                               0792
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))       0793
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))       0794
      EQUIVALENCE   (T ETA,      C(445))                               0795
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))       0796
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))       0797
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))       0798
      EQUIVALENCE   (AW SIG,     C(453))                               0799
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))        0800
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),   C(1343))       0801
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))        0802
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))        0803
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),   C(1381))       0804
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23), C(1381))      0805
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))       0806
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))      0807
      EQUIVALENCE   (ACX,        C(1474)),   (ACF,      C(1475))      0808
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))     0809
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,     C(1479))      0810
      EQUIVALENCE   (COEFX(1),    C(1480)), (COEFX(20),  C(1499))      0811
      EQUIVALENCE   (DX(1),     C(1500)),  (DX(20),    C(1519))       0812
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))    0813
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))       0814
      EQUIVALENCE   (PROD(1),   C(1538)),  (PROD(3),    C(1540))     0815
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),    C(1555))  0816
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))        0817
      EQUIVALENCE   (OF,      C(1556)),    (FPCT,    C(1557))        0818
      EQUIVALENCE   (EQRAT,      C(1558))                              0819
      EQUIVALENCE (KODE,     C(1559)),    (KASE,       C(1560))      0820
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))     0821
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))     0822
      EQUIVALENCE   (NOEQ, C(1565))                                   0823
      EQUIVALENCE (KD, C(1763))                                       0824
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),    C(1785))      0825
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),    C(1800))      0826
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))      0827
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))      0828
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))      0829
      EQUIVALENCE (TELMT(1), C(1807)), (TELMT(15), C(1821))           0830
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))       0831
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))       0832
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))      0833
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))      0834
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))      0835
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))       0836
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))      0837
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))      0838
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))      0839
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))      0840
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))      0841
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))      0842
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))      0843
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))      0844
      EQUIVALENCE   (PC,         C(2314)), (TC,         C(2315))      0845
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))      0846
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))      0847
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))      0848
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))      0849
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))      0850
      EQUIVALENCE   (L,          C(2325)), (L1,         C(2326))      0851
      EQUIVALENCE   (M,          C(2327)), (M1,         C(2328))      0852
      EQUIVALENCE   (N,          C(2329)), (IQ,         C(2330))      0853
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,        C(2332))      0854
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      EQUIVALENCE    (IQ3,       C(2333)), (KMAT,      C(2334))          0855
      EQUIVALENCE    (IMAT,      C(2335)), (IUSE,      C(2335))          0856
      EQUIVALENCE    (IADD,      C(2336)), (ITNUMB,    C(2337))          0857
      EQUIVALENCE    (ITAPE,     C(2338)), (P,         C(2339))          0858
      EQUIVALENCE    (IDEBUG,    C(2340)), (IFROZ,     C(2341))          0859
      EQUIVALENCE    (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))      0860
      EQUIVALENCE    (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))       0861
      EQUIVALENCE    (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))       0862
      EQUIVALENCE    (ATOM(1),  C(7742)), (ATOM(303), C(8044))           0863
      EQUIVALENCE    (MATOM(1),  C(7742)), (MATOM(303),  C(8044))        0864
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))                     0865
      EQUIVALENCE (MANAME(1),ANAME(1)),(MANAME(5),ANAME(5))              0866
      EQUIVALENCE  (KSAN,C(10623))
      EQUIVALENCE  (WX,C(10624))
      EQUIVALENCE  (WF,C(10625))                                          } Moles
      EQUIVALENCE (ASANN, MSANN)
      EQUIVALENCE (ASAN,MSAN)
C                                                                        0867
      DIMENSION TELMT(15)                                                0868
      DIMENSION   G(20,21),   A(15,46),   EN(90),     EN LN(90)          0869
      DIMENSION   DEL N(90),  HO(90),     S(90),      X(20)              0870
      DIMENSION   DELTA(20),  BO(15),     PCP(25),    PROD(3)            0871
      DIMENSION   COEFX(20),  DX(20),     FORM(15)                       0872
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                            0873
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),   FORMLA(18)         0874
      DIMENSION   BOX(15),    BOF(15),    ANS(454),   SYSTM(15)          0875
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                             0876
      DIMENSION   ANSLAB(454),   COEFT(15,90)                            0877
      DIMENSION   MATOM(101,3),     ATOM(101,3)                          0878
      DIMENSION MANAME(5),     ANAME(5),      ANUM(5)                    0879
C                                                                        0880
C                                                                        0881
C  SUBROUTINE TO COMPUTE PROPELLANTS                                     0882
B     ASANN = 446060606060                                                Moles
B     OX=466C606C6060                                                    0883
      IF(JEAN-222)51,50,51                                               0884
   51 CALL BCREAD(ATOM(101,3),ATOM(1,1))                                 0885
   50 DO 52 I=1,15                                                       0886
B     ELMT(I)=00C00                                                      0887
B     BOF(I)=000000000000                                                0888
B     BOX(I)=000C00000000                                                0889
      DO 52 J=1,46                                                       0890
B     A(I,J)=000000000000                                                0891
   52 CONTINUE                                                           0892
      TOTAL=0.0                                                          0893
      NF=0                                                               0894
      NO=0                                                               0895
      NE=C                                                               0896
      WRITE OUTPUT TAPE 6,400                                            0897
  400 FORMAT(8H1  INPUT//)                                               0898
  100 READ INPUT TAPE 7,1,(ANAME(I),ANUM(I),I=1,5),PECWT,ASAN,ENTH,       Moles
     2DEN,TEMP,ETHR,DENS                                                 0900
    1 FORMAT(5(A2,F7.5),F7.5,A1,F9.5,A1,F8.5,A1,F8.5)                     Moles
      IF(ANUM(1))99,200,99                                               0902
   99 WRITE OUTPUT TAPE 6,402,(ANAME(I),ANUM(I),I=1,5),PECWT,ASAN,ENTH,    Moles
     1DEN,TEMP,ETHR,DENS                                                  Moles
  402 FORMAT(1X,5(A2,1X,F7.4,2X),F8.4,2X,A1,2X,F9.2,2X,A1,2X,F8.3,2X,     Moles
     2A1,3X,F8.5)                                                        0906
      IF (MSAN - MSANN) 501,500,501
  500 KSANN = 1                                                           } Moles
      GO TO 502
  501 KSANN = 0
  502 DO 9 I=1,5
    9 TOTAL=TOTAL+ANUM(I)                                                0908
      IF(ETHR-OX)11,10,11                                                0909
   10 NO=NO+1                                                            0910
      KK=NO                                                              0911
      KKK=NO                                                             0912
      NN=31                                                              0913
      GO TO 12                                                           0914
   11 NF=NF+1                                                            0915
      KK=NF+15                                                           0916
      KKK=NF                                                             0917
      NN=32                                                              0918
   12 DO 98 J=1,5                                                        0919
      IF(ANUM(J)) 96,97,96                                               0920
```

```
   96 DO 31 I=1,15                                                      0921
      IF(ANAME(J)-ELMT(I)) 21,20,21                                     0922
   20 NHUT=0                                                            0923
   33 KT=I                                                              0924
      GO TO 30                                                          0925
   21 IF(ELMT(I)) 31,22,31                                              0926
   22 ELMT(I)=ANAME(J)                                                  0927
      NE=NE+1                                                           0928
      NHUT=1                                                            0929
      GO TO 33                                                          0930
   31 CONTINUE                                                          0931
   30 IF(NHUT)14,15,14                                                  0932
   14 DO 16 I=1,101                                                     0933
      IF (MATOM(I,1)-MANAME(J)) 16,17,16                                0934
   17 II=I                                                              0935
      GO TO 18                                                          0936
   16 CONTINUE                                                          0937
      WRITE OUTPUT TAPE 6,199                                           0938
  199 FORMAT (32H0 THERE IS A BAD PROPELLANT CARD)                      0939
      L=-1                                                              0940
      RETURN                                                            0941
   18 A(NE,37)=ATOM(II,2)                                               0942
      A(NE,38)=ATOM(II,3)                                               0943
   15 A(KT,KK)=ANUM(J)                                                  0944
   98 CONTINUE                                                          0945
   97 A(KKK,NN)=ENTH                                                    0946
      A(KKK,NN+2)=PECWT                                                 0947
      A(KKK,NN+4)=DENS                                                  0948
      A(KKK,NN+10)=DEN                                                  0949
      A(KKK,NN+12)=TEMP                                                 0950
      A(KKK,NN+14)=ETHR                                                 0951
      GO TO 100                                                         0952
  200 IF(NE)202,201,202                                                 0953
  201 L=0                                                               0954
      RETURN                                                            0955
  202 JEAN=222                                                          0956
B     WX=000000000000                                                   0957
B     WF=000000000000                                                   0958
B     HX=000000000000                                                   0959
B     HF=000000000000                                                   0960
B     RHOX=000000000000                                                 0961
B     RHOF=000000000000                                                 0962
B     VXPLS=000000000000                                                0963
B     VXMIN=000000000000                                                0964
B     VFPLS=000000000000                                                0965
B     VFMIN=000000000000                                                0966
B     ACX=000000000000                                                  0967
B     ACF=000000000000                                                  0968
B     AMX=000000000000                                                  0969
B     AMF=000000000000                                                  0970
      KSAN=KSANN                                                          Moles
      DO552 J=1,NO                                                      0971
      DO552 I=1,NE                                                      0972
  552 A(J,39)=A(J,39)+A(I ,37)*A(I ,J )                                 0973
      DO 53 J=1,NF                                                      0974
      DO 53 I=1,NE                                                      0975
   53 A(J,40)=A(J,40)+A(I,37)*A(I,J+15)                                 0976
      IF (KSAN) 9001,9000,9001                                            )
 9001 DO 9002  I=1,NO                                                     )
      ANS(I)=A(I,33)                                                      )Moles
 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                                                          0977
      IF (NO) 1000,1001,1000                                            0978
 1000 DO 550 I=1,NO                                                     0979
   54 HX=HX+A(I,31)*A(I,33)/A(I,39)                                     0980
  550 WX=WX+A(I,33)                                                     0981
 1001 IF (NF) 1002,1003,1002                                            0982
 1002 DO 551 I=1,NF                                                     0983
   55 HF=HF+A(I,32)*A(I,34)/A(I,40)                                     0984
  551 WF=WF+A(I,34)                                                     0985
 1003 IF (NO) 1004,1005,1004                                            0986
 1004 DO 42 I=1,NO                                                      0987
      ACX=ACX+A(I,35)*A(I,33)/A(I,39)                                   0988
   42 AMX=AMX+A(I,33)/A(I,39)
```

```
      ACX=ACX/WX                                                        0989
      AMX=WX/AMX                                                        0990
 1005 IF (NF) 1006,1007,1006                                            0991
 1006 DO 43 I=1,NF                                                      0992
      ACF=ACF+A(I,36)*A(I,34)/A(I,40)                                   0993
   43 AMF=AMF+A(I,34)/A(I,40)                                           0994
      ACF=ACF/WF                                                        0995
      AMF=WF/AMF                                                        0996
 1007 IF (WX) 1020,1021,1020                                            0997
 1020 HX=HX/WX                                                          0998
 1021 IF (WF) 1022,1023,1022                                            0999
 1022 HF =HF/WF                                                         1000
 1023 DO 60 I=1,NO                                                      1001
      IF(A(I,35))60,71,60                                               1002
   60 RHOX=RHOX+A(I,33)/A(I,35)                                         1003
      RHOX=WX/RHOX                                                      1004
   73 DO 61 I=1,NF                                                      1005
      IF(A(I,36))61,71,61                                               1006
   61 RHOF=RHOF+A(I,34)/A(I,36)                                         1007
      RHOF=WF/RHOF                                                      1008
      GO TO 74                                                          1009
   71 RHOX = 0.0                                                        1010
   72 RHOF = 0.0                                                        1011
   74 IF (NO) 1008,1009,1008                                            1012
 1008 DO 57 I=1,NE                                                      1013
      DO 56 J=1,NO                                                      1014
   56 BOX(I)=BOX(I)+A(I,J)*A(J,33)/A(J,39)                              1015
   57 BOX(I)=BOX(I)/WX                                                  1016
 1009 IF (NF) 1010,1011,1010                                            1017
 1010 DO 59 I=1,NE                                                      1018
      DO 58 J=1,NF                                                      1019
   58 BOF(I)=BOF(I)+A(I,J+15)*A(J,34)/A(J,40)                           1020
   59 BOF(I)=BOF(I)/WF                                                  1021
 1011 DO 62 I=1,NE                                                      1022
      IF(A(I,38))63,62,64                                               1023
   64 VXPLS=VXPLS+BOX(I)*A(I,38)                                        1024
   67 VFPLS=VFPLS+BOF(I)*A(I,38)                                        1025
      GO TO 62                                                          1026
   63 VXMIN=VXMIN+BOX(I)*A(I,38)                                        1027
   66 VFMIN=VFMIN+BOF(I)*A(I,38)                                        1028
   62 CONTINUE                                                          1029
      IF (WX) 1030,1031,1030                                            1030
 1030 DO 40 I=1,NO                                                      1031
   40 A(I,33)=A(I,33)/WX                                                1032
 1031 IF(WF) 1040,1050,1040                                             1033 Correction
 1040 DO 1041 I= 1,NF                                                   1034
 1041 A(I,34)=A(I,34)/WF                                                1035
C                                                                       1036
C     SAVE ELEMENT ARRAY FOR CORE 4                                     1037
C                                                                       1038
 1050 DO 2000 I=1,15                                                    1039 Correction
 2000 TELMT(I) = ELMT(I)                                                1040
      L=NE                                                              1041
      TOTAL = MODF(TOTAL,1.0)                                           1042
      IF(TOTAL)1142,1143,1142                                           1043
 1142 KD=1                                                              1044
      GO TO 9050                                                            Moles
 1143 KD=0                                                              1046
 9050 IF(KSAN)9011,9010,9011                                                 )
 9011 DO 9012  I=1,NO                                                        )
 9012 A(I,33)=ANS(I)                                                         )Moles
      DO 9013  I=1,NF                                                        )
 9013 A(I,34)=G(I)                                                           )
 9010 RETURN
```

```
      SUBROUTINE  CORE2                                                     1048
C                                                                           1049
      COMMON C                                                              1050
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))          1051
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))          1052
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))          1053
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))          1054
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))          1055
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))          1056
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))          1057
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))          1058
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))          1059
      EQUIVALENCE   (RHO,        C(439))                                    1060
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))          1061
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))          1062
      EQUIVALENCE   (T ETA,      C(445))                                    1063
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))          1064
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))          1065
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))          1066
      EQUIVALENCE   (AW SIG,     C(453))                                    1067
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))           1068
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),    C(1343))         1069
      EQUIVALENCE   (MFORM(1),   C(1329)), (MFORM(15),   C(1343))         1070
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15),   C(1358))         1071
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15),   C(1358))         1072
      EQUIVALENCE   (DATA(1),   C(1359)),  (DATA(23),    C(1381))         1073
      EQUIVALENCE   (MDATA(1),   C(1359)),  (MDATA(23),  C(1381))         1074
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),     C(1471))          1075
      EQUIVALENCE   (ISYS,       C(1472)),   (JEAN,      C(1473))         1076
      EQUIVALENCE   (ACX,        C(1474)),   (ACF,       C(1475))         1077
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))         1078
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,      C(1479))         1079
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))        1080
      EQUIVALENCE   (DX(1),     C(1500)),  (DX(20),     C(1519))         1081
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))        1082
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18),   C(1537))         1083
      EQUIVALENCE   (SYSTM(1),   C(1541)),  (SYSTM(15),    C(1555))       1084
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))           1085
      EQUIVALENCE   (OF,      C(1556)),    (FPCT,    C(1557))            1086
      EQUIVALENCE   (EQRAT,      C(1558))                                   1087
      EQUIVALENCE (KODE,     C(1559)),    (KASE,       C(1560))          1088
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))        1089
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))         1090
      EQUIVALENCE   (NOEQ, C(1565))                                       1091
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),     C(1785))         1092
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),     C(1800))         1093
      EQUIVALENCE   (HX,         C(1801)), (HF,          C(1802))         1094
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,       C(1804))         1095
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,       C(1806))         1096
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90),  C(1950))          1097
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90),  C(2040))          1098
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),      C(2130))         1099
      EQUIVALENCE   (S(1),       C(2131)), (S(90),       C(2220))         1100
      EQUIVALENCE   (MX(1),     C(2221)), (MX(20),     C(2240))           1101
      EQUIVALENCE   (X(1),       C(2221)), (X(20),       C(2240))         1102
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20),  C(2260))          1103
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),      C(2275))         1104
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,       C(2277))         1105
      EQUIVALENCE   (SO,         C(2278)), (T LN,        C(2279))         1106
      EQUIVALENCE   (T,          C(2280)), (AAY LN,      C(2281))         1107
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,       C(2283))         1108
      EQUIVALENCE   (HC,         C(2284)), (TC LN,       C(2285))         1109
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),     C(2310))         1110
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),    C(2313))         1111
      EQUIVALENCE   (PC,         C(2314)), (TC,          C(2315))         1112
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,       C(2317))         1113
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,       C(2319))         1114
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,       C(2321))         1115
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,       C(2323))         1116
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,       C(2324))         1117
      EQUIVALENCE   (L,          C(2325)), (L1,          C(2326))         1118
      EQUIVALENCE   (M,          C(2327)), (M1,          C(2328))         1119
      EQUIVALENCE   (N,          C(2329)), (IQ,          C(2330))         1120
      EQUIVALENCE   (IQ1,        C(2331)), (IQ2,         C(2332))         1121
      EQUIVALENCE   (IQ3,        C(2333)), (KMAT,        C(2334))         1122
      EQUIVALENCE   (IMAT,       C(2335)), (IUSE,        C(2335))         1123
      EQUIVALENCE   (IADD,       C(2336)), (ITNUMB,      C(2337))         1124
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      EQUIVALENCE   (ITAPE,     C(2338)), (P,          C(2339))              1125
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,      C(2341))              1126
      EQUIVALENCE   (A(1),      C(2342)),  (A(1350),   C(3691))              1127
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))           1128
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))           1129
      EQUIVALENCE   (MCOEFT(1),  C(6392)), (MCOEFT(1350),  C(7741))         1130
      EQUIVALENCE   (COEFT(1),   C(6392)),  (COEFT(1350), C(7741))          1131
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))               1132
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))            1133
      EQUIVALENCE (KORE, C(8047))                                           1134
      EQUIVALENCE (DLNT,LNT),(SUM,MSUM),(BLK,MBLK),(TMP,MTMP),(MI,BMT)      1135
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),   C(1540))              1136
C                                                                           1137
      DIMENSION   G(20,21),   A(15,90),   EN(90),      EN LN(90)            1138
      DIMENSION   DEL N(90),  HO(90),     S(90),       X(20)                1139
      DIMENSION   DELTA(20),  BO(15),     PCP(25),     PROD(3)              1140
      DIMENSION   COEFX(20),  DX(20),     FORM(15)                          1141
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                               1142
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),    FORMLA(18)           1143
      DIMENSION   BOX(15),    BOF(15),    ANS(454),    SYSTM(15)            1144
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                                1145
      DIMENSION   ANSLAB(454),   COEFT(15,90)                               1146
      DIMENSION   MATOM(101,3),     ATOM(101,3)                             1147
      DIMENSION MX(20),MCOEFT(15,90)                                        1148
      DIMENSION MFORM(15)                                                   1149
C                                                                           1150
B1    BMT =606060606060                                                     1151
B     GAS =000000000027                                                     1152
B     BLK =000000000060                                                     1153
C                                                                           1154
      K5=0                                                          H,P
      REWIND 3                                                      1155
      NO EQ=0                                                       1156
      ITEST=M1                                                      1157
      SIZE=18.5                                                     1158
      TO=TC                                                           Correction
  555 IF (IPROB-3) 557,563,9000                                       H,P
 9000 IF (IPROB-4) 565,565,9001                                       H,P
  557 PC = PC/14.696006                                             1160
      PO=PC                                                         1161
 9001 IF(TO)559,559,561                                               Correction
  559 TC LN= 8.25                                                   1163
      GO TO 431                                                     1164
  561 TC LN=LOGF(TO)                                                  Correction
      GO TO 431                                                     1166
  563 PO=PC                                                         1167
      GO TO 431                                                     1168
  565 T=TC                                                          1169
      PO=0.0                                                        1170
      T LN=LOGF(T)                                                  1171
C                                                                   1172
C     START CALCULATION FOR NEW OVERALL COMPOSITION                 1173
C                                                                   1174
  431 IADD=1                                                        1175
      IF (IFROZ) 1565,379,1432                                      1176
 1565 IF (IUSE) 1432,1432,433                                       1177
 1432 DO 432 K=1,N                                                  1178
      EN(K)=0.0                                                     1179
      EN LN(K)=0.0                                                  1180
  432 DEL N(K)=0.0                                                  1181
      AAY LN=5.0                                                    1182
  433 SENSE LIGHT 0                                                 1183
      IF (IPROB-2) 435,445,434                                      1184
  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                                                      } H,P
 9008 SENSE LIGHT 1                                                   }
      SENSE LIGHT 4                                                   }
      K5=1                                                            }
      IK5=IADD                                                        }
      IPK5=IPROB                                                      }
      IADD = 1                                                        }
      IPROB=1                                                         }
      GO TO 13                                                        }
```

```
  435 IF (IADD-1) 379,436,441                                                    1186
  436 SENSE LIGHT 1                                                              1187
  437 T LN=TC LN                                                                 1188
      ITROT=3                                                                    1189
  438 IF (PCP(IADD)) 231,231,439                                                 1190
  439 SENSE LIGHT 4                                                              1191
      PO=PC/PCP(IADD)                                                            1192
      GO TO 13                                                                   1193
  441 IF (IADD-25) 438,438,231                                                   1194
  445 IF (IADD-1) 379,447,441                                                    1195
  447 SENSE LIGHT 2                                                              1196
      GO TO 437                                                                  1197
  455 IF (IADD-25) 459,459,231                                                   1198
  459 IF (PCP(IADD)) 231,231,460                                                 1199
  460 T=PCP(IADD)                                                                1200
      T LN= LOGF(T)                                                              1201
      GO TO 473                                                                  1202
  465 IF (IADD-25) 469,469,231                                                   1203
  469 IF (PCP(IADD)) 231,231,470                                                 1204
  470 PO=PCP(IADD)                                                               1205
  473 SENSE LIGHT 2                                                              1206
      SENSE LIGHT 4                                                              1207
C                                                                                1208
C     BEGIN CALCULATIONS FOR CURRENT POINT                                       1209
C                                                                                1210
   13 PO LN=LOGF(PO)                                                             1211
C                                                                                1212
C     CHECK TEMPERATURE RANGE OF THERMODYNAMIC DATA                              1213
C                                                                                1214
      IF (IPROB-2) 17,17,19                                                      1215
   17 T=EXPF(T LN)                                                               1216
   19 IF (COEFT(7,1)-T) 21,27,27                                                 1217
   21 IF (COEFT(7,1)-5000.0) 23,31,231                                           1218
   23 DO 1123 K=1,15                                                             1219
      DO 1123 J = 1,90                                                           1220
 1123 COEFT(K,J)=COEFT1(K,J)                                                     1221
      SENSE LIGHT 4                                                              1222
      GO TO 19                                                                   1223
   25 DO 1125 K = 1,15                                                           1224
      DO 1125 J = 1,90                                                           1225
 1125 COEFT(K,J)=COEFT2(K,J)                                                     1226
      SENSE LIGHT 4                                                              1227
      GO TO 19                                                                   1228
   27 IF (T-COEFT(6,1)) 29,37,37                                                 1229
   29 IF (300.0-COEFT(6,1)) 25,31,231                                            1230
   31 IF (SENSE LIGHT 4) 38,305                                                  1231
C                                                                                1232
C     ELIMINATE THOSE SPECIES WHICH DO NOT HAVE DATA IN THIS INTERVAL            1233
C                                                                                1234
   37 IF (SENSE LIGHT 4 ) 38,142                                                 1235
   38 SENSE LIGHT 4                                                              1236
      DO 40 J=1,N                                                                1237
      IF (COEFT(8,J)) 40,39,40                                                   1238
   39 CALL BYPASS (J,2)                                                          1239
      EN LN(J)=0.0                                                               1240
      EN(J)=0.0                                                                  1241
      DEL N(J)=0.0                                                                     Correction
   40 CONTINUE                                                                   1242
C                                                                                1243
C     BEGIN ITERATION FOR COMPOSITION                                            1244
C                                                                                1245
   42 IQ=IQ                                                                      1246
      IQ1=IQ1                                                                    1247
      IQ2=IQ2                                                                    1248
      IQ3=IQ3                                                                    1249
      ITNUMB=30                                                                  1250
   43 DO 48 J=1,N                                                                1251
      CALL BYPASS (J,1)                                                          1252
      IF (IPROD-2) 48,45,48                                                      1253
   45 IF (EN LN(J)+SIZE-PO LN) 46,46,47                                          1254
   46 EN(J)=0.0                                                                  1255
      GO TO 48                                                                   1256
   47 EN(J)=EXPF(EN LN(J))                                                       1257
   48 CONTINUE                                                                   1258
      IF (IPROB-2) 49,49,51                                                      1259
   49 T=EXPF(T LN)                                                               1260
   51 AAY=EXPF(AAY LN)                                                           1261
```

```
C
C      CALCULATE HEAT CAPACITY, ENTHALPY AND ENTROPY                                                    1262
C                                                                                                       1263
                                                                                                        1264
       IFIXT=3                                                                                          1265
       IF (SENSE LIGHT 2) 52,55                                                                         1266
    52 SENSE LIGHT 2                                                                                    1267
       IF (SENSE LIGHT 4) 53,55                                                                         1268
    53 SENSE LIGHT 4                                                                                    1269
       IFIXT=1                                                                                          1270
       IF (ITNUMB-30) 55,54,55                                                                          1271
    54 IFIXT=2                                                                                          1272
    55 CPSUM=0.0                                                                                        1273
       DO 60 J=1,N                                                                                      1274
       CALL BYPASS (J,1)                                                                                1275
       IF (IPROD-2) 60,56,60                                                                            1276
    56 IF (IFIXT-2) 59,58,57                                                                            1277
    57 CPSUM=CPSUM+((((COEFT(12,J)*T+COEFT(11,J))*T+COEFT(10,J))*T+COEFT(                               1278
      19,J))*T+COEFT(8,J))*EN(J)                                                                        1279
    58 HO(J)=((((COEFT(12,J)/5.0)*T+COEFT(11,J)/4.0)*T+COEFT(10,J)/3.0)*T                               1280
      1+COEFT(9,J)/2.0)*T +COEFT(13,J)/T+COEFT(8,J)                                                     1281
    59 S(J)=((((COEFT(12,J)/4.0 )*T+COEFT(11,J)/3.0)*T+COEFT(10,J)/2.0)*T                               1282
      1+COEFT(9,J))*T+COEFT(8,J)*T LN+COEFT(14,J)-EN LN(J)                                              1283
    60 CONTINUE                                                                                         1284
C                                                                                                       1285
C      CONSTRUCT MATRIX AND SOLVE THE EQUATIONS                                                         1286
C                                                                                                       1287
       CALL MATRIX                                                                                      1288
       IF (SENSE LIGHT 4) 61,171                                                                        1289
    61 SENSE LIGHT 4                                                                                    1290
       CALL GAUSS                                                                                       1291
       IF (IDEBUG) 910,80,910                                                                           1292
   910 DO 911 I=1,IMAT                                                                                  1293
   911 WRITE OUTPUT TAPE 6,912,(G(I,K),K=1,KMAT),DELTA(I)                                               1294
       WRITE OUTPUT TAPE 6,912,(X(I),I=1,IMAT)                                                          1295
   912 FORMAT (8E14.6)                                                                                  1296
    80 IF (IDID-IMAT) 81,85,81                                                                          1297
    81 IF (SIZE-18.5) 83,83,311                                                                         1298
    83 SIZE=27.5                                                                                        1299
       GO TO 43                                                                                         1300
    85 ITNUMB=ITNUMB-1                                                                                  1301
       DO 87 K=1,IMAT                                                                                   1302
       IF (ABSF(DELTA(K))-0.5E-4) 87,87,88                                                                  Correction
    88 IF (SIZE-18.5) 83,83,315                                                                             Correction
    87 CONTINUE                                                                                         1304
C                                                                                                       1305
C      OBTAIN CORRECTIONS TO THE ESTIMATES                                                              1306
C                                                                                                       1307
       D LN T=X(IQ2)                                                                                    1308
    91 IF (IFIXT-2) 93,95,379                                                                           1309
    93 D LN T=0.0                                                                                       1310
    95 DO  101 J=1,M                                                                                    1311
       CALL BYPASS (J,1)                                                                                1312
       IF (IPROD-2) 96,97,96                                                                            1313
    96 DEL N(J)=0.0                                                                                     1314
       GO TO 101                                                                                        1315
    97 DEL N(J)=HO(J)*D LN T-HO(J)+S(J)                                                                 1316
       DO  99 K=1,L                                                                                     1317
    99 DEL N(J)=DEL N(J)+A(K,J)*X(K)                                                                    1318
   101 CONTINUE                                                                                         1319
       IF (L-IQ) 103,109,109                                                                            1320
   103 J=M1                                                                                             1321
       DO 107 K=L1,IQ                                                                                   1322
   104 CALL BYPASS (J,1)                                                                                1323
       IF (IPROD-2) 105,106,105                                                                         1324
   105 DEL N(J)=0.0                                                                                     1325
       J=J+1                                                                                            1326
       GO TO 104                                                                                        1327
   106 DEL N(J)=X(K)                                                                                    1328
       J=J+1                                                                                            1329
   107 CONTINUE                                                                                         1330
   109 AMBDA=1.0                                                                                        1331
       AMBDA1=1.0                                                                                       1332
       IF (ABSF(D LN T)-ABSF(X(IQ1))) 501,913,913                                                       1333 Correction
   501 SUM = ABSF(X(IQ1))                                                                               1334
       GO TO 915                                                                                        1335
   913 SUM=ABSF(D LN T)                                                                                 1336
```

```
  915 DO 917 J=1,M                                                          1337
      IF (EN(J)) 917,1915, 916                                              1338
  916 SUM=MAX1F(DEL N(J),SUM)                                               1339
      GO TO 917                                                             1340
 1915 IF (DEL N(J))  917,917,1917                                           1341 Correction
 1917 SUM1=ABSF((PO LN-9.212-EN LN(J))/DEL N(J))                            1342
      AMBDA1=MIN1F(SUM1,AMBDA1)                                             1343
  917 CONTINUE                                                              1344
      IF (SUM-2.0) 1110,1110,110                                            1345
  110 AMBDA=2.0/SUM                                                         1346
 1110 AMBDA =MIN1F(AMBDA,AMBDA1)                                            1347
  920 IF (IDEBUG) 921,111,921                                               1348
  921 WRITE OUTPUT TAPE 6,923, T,P,AAY, AMBDA, ((COEFT(K,J),K=1,3),         1349
     1  EN(J),EN LN(J),DEL N(J),HO(J),S(J),J=1,N)                           1350
  923 FORMAT (4E25.8/(1X,3A6,5E15.6))                                       1351
C                                                                           1352
C     APPLY CORRECTIONS TO THE ESTIMATES                                    1353
C                                                                           1354
  111 DO 113 J=1,M                                                          1355
  113 EN LN(J)=EN LN(J)+AMBDA*DEL N(J)                                      1356
      IF (ICOND-2) 115,121,375                                              1357
  115 DO 117 J=M1,N                                                         1358
  117 EN(J)=EN(J)+AMBDA*DEL N(J)                                            1359
  121 T LN=T LN +AMBDA*D LN T                                               1360
      AAY LN=AAY LN- AMBDA*X(IQ1)                                           1361
      IF (SENSE SWITCH 6) 122,124                                           1362
  122 IF (IDEBUG) 1122,123,1122                                             1363
 1122 IDEBUG=0                                                              1364
      GO TO 231                                                             1365
  123 IDEBUG=1                                                              1366
C                                                                           1367
C     TEST  FOR CONVERGENCE OF ITERATION                                    1368
C                                                                           1369
  124 IF (ITNUMB) 125,132,125                                               1370
  125 IF (AMBDA-1.0) 43,1124,231                                            1371
 1124 P=0.0                                                                 1372
      DO 1126 J=1,M                                                         1373
      IF (EN LN(J)) 2125,1126,2125                                              Correction
 2125 P=P+EXPF(EN LN(J))                                                        Correction
 1126 CONTINUE                                                                  Correction
      IF (ABSF((PO-P)/PO)-0.5E-5) 126,126,43                                1375
  126 SUM=P                                                                 1376
      IF(ICOND-2)127,129,375                                                1377
  127 DO 128 J=M1,N                                                         1378
  128 SUM=SUM+ABSF(EN(J))                                                   1379
  129 DO 130 J=1,N                                                          1380
      IF (J-M) 1129,1129,1130                                               1381
 1129 IF (ABSF(EN(J)*DEL N(J)/SUM)-0.5E-5) 130,130,43                       1382
 1130 IF (ABSF(DEL N(J)/SUM)-0.5E-5) 130,130,43                             1383
  130 CONTINUE                                                              1384
  132 IF (SENSE LIGHT 4) 133,133                                            1385
  133 GO TO 13                                                              1386
C                                                                           1387
C     ELIMINATE THOSE SPECIES WITH NO DATA AT THIS TEMPERATURE, ADD         1388
C     THOSE WITH DATA AT THIS TEMPERATURE                                   1389
C                                                                           1390
  142 DO 170 J=1,N                                                          1391
      IF (MCOEFT(1,J)-MT) 170,500,170                                       1392
  500 IF (COEFT(5,J) + 150.0-T) 285,143,143                                 1393 Correction
  143 IF (T-COEFT(4,J)+150.0) 295,144,144                                   1394 Correction
  285 IF (5000.0-COEFT(5,J)) 144,144,301                                    1395
  295 IF (COEFT(4,J)-300.0) 144,144,301                                     1396
  144 IF (J-M) 145,145,146                                                  1397
  145 CALL BYPASS (J,3)                                                     1398
      GO TO 170                                                             1399
  301 CALL BYPASS (J,2)                                                     1400
      EN(J)=0.0                                                             1401
      EN LN(J)=0.0                                                          1402
      DEL N(J)=0.0                                                          1403
      GO TO 170                                                             1404
  146 IF (EN(J)) 147,148,170                                                1405
  147 EN(J)=0.0                                                             1406
      DEL N(J)=0.0                                                          1407
      CALL BYPASS (J,2)                                                     1408
      GO TO 42                                                              1409
```

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C                                                                       1410
C     SKIP CONDENSATION CHECK IF T IS HIGHER THAN MELTING POINT WHEN     1411
C     TESTING SOLID, OR LOWER THAN MELTING POINT WHEN TESTING LIQUID     1412
C                                                                       1413
  148 IF (COEFT(4,J)-COEFT(5,J-1)) 150,149,150                          1414
  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                                                                       1418
C     CHECK FOR CONDENSATION                                            1419
C     IF MORE THAN ONE CONDENSED PHASE OF ANY SPECIES CAN EXIST THE     1420
C     PHASE STABLE AT THE HIGHER TEMPERATURE MUST PRECEED THAT STABLE AT 1421
C     THE LOWER TEMPERATURE ON MASTER TAPE                              1422
C                                                                       1423
  153 DO 155 K=2,3                                                      1424
      SUM=COEFT(K,J)                                                    1425
      DO 154 I=1,6                                                      1426
      TMP=ARSF(30,SUM)                                                  1427
B     SUM=ALSF(6000000,SUM)                                             1428
      IF(MTMP-MBLK)  154,156,154                                        1429
  154 CONTINUE                                                          1430
  155 CONTINUE                                                          1431
      K=3                                                               1432
      I=5                                                               1433
      GO TO 159                                                         1434
  156 I=I-2                                                             1435
      IF (I) 157,158,159                                                1436
  157 K=2                                                               1437
      I=5                                                               1438
      GO TO 159                                                         1439
  158 K=2                                                               1440
      I=6                                                               1441
  159 FORM(2)=COEFT(2,J)                                                1442
      FORM(3)=COEFT(3,J)                                                1443
      I=6*I                                                             1444
      JJ=42-I                                                           1445
      I=I                                                               1446
      JJ=JJ                                                             1447
      SUM = FORM(K)                                                     1448
B     SUM = ARSF(JJ,SUM)                                                1449
      MJJ=JJ-6                                                          1450
      TMLJ = FORM(K)                                                    1451
      TMLJ = LRSF(MJJ,TMLJ)                                             1452
      MJJ=36-I                                                          1453
B     SUM1=LLSF(MJJ,GAS)                                                1454
B     TEMP=LRSF(JJ,SUM1)                                                1455
      MJJ=42-I                                                          1456
B     FORM(K)=LLSF(MJJ,SUM)                                             1457
      DO 160 K=1,M                                                      1458
      IF (MFORM(2)-MCOEFT(2,K)) 160,1160,160                            1459
 1160 IF (MFORM(3)-MCOEFT(3,K)) 160,162,160                             1460
```

Correction

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  160 CONTINUE                                                                  1461
      CALL BYPASS (J,3)                                                         1462
      GO TO 170                                                                 1463
  162 CALL BYPASS (K,1)                                                         1464
      IF (IPROD-2) 170,163,170                                                  1465
  163 HO(J)=((((COEFT(12,J)/5.0)*T+COEFT(11,J)/4.0)*T+COEFT(10,J)/3.0)*T        1466
     1+COEFT(9,J)/2.0)*T +COEFT(13,J)/T+COEFT(8,J)                              1467
      S(J)=((((COEFT(12,J)/4.0 )*T+COEFT(11,J)/3.0)*T+COEFT(10,J)/2.0)*T        1468
     1+COEFT(9,J))*T+COEFT(8,J)*T LN+COEFT(14,J)                                1469
      IF (HO(J)-S(J)-HO(K)+S(K)-DEL N(K)) 164,164,170                           1470 Correction
  164 CALL BYPASS (J,3)                                                         1471
      EN(J)=0.0                                                                 1472
      GO TO 42                                                                  1473
  170 CONTINUE                                                                  1474
C                                                                               1475
C     IF COMPOSITION HAS BEEN CORRECTLY DETERMINED CALCULATE THE                1476
C     EQUILIBRIUM PROPERTIES, OTHERWISE CONTINUE ITERATION                      1477
C                                                                               1478
      IF(SENSE LIGHT 4) 1170,1172                                               1479
 1170 SENSE LIGHT 4                                                             1480
      GO TO 42                                                                  1481
 1172 IF (ITNUMB) 42,971,42                                                     1482
  971 WRITE OUTPUT TAPE 6,973,IADD                                              1483
  973 FORMAT (70HL30 ITERATIONS DID NOT SATISFY CONVERGENCE REQUIREMENTS        1484
     1 FOR THE PCINT I5)                                                        1485
      GO TO 42                                                                  1486
C                                                                               1487
C     CALCULATE EQUILIBRIUM PROPERTIES                                          1488
C                                                                               1489
  171 DO 1171 I = 1,454                                                         1490
 1171 ANS(I) = ANSLAB(I)                                                        1491
      WTMOL=AAY/P                                                               1492
      HSUM=G(IQ2,IQ1)*T/AAY                                                     1493
      SSUM=0.0                                                                  1494
      DO 183 J=1,N                                                              1495
      CALL BYPASS (J,1)                                                         1496
      IF (IPROD-2) 183,181,183                                                  1497
  181 SSUM=SSUM+S(J)*EN(J)                                                      1498
  183 CONTINUE                                                                  1499
 1183 SSUM=SSUM/AAY                                                             1500
      IMAT=IMAT-1                                                               1501
      CALL GAUSS                                                                1502
      IF (IDID-IMAT) 172,174,172                                                1503
  172 CPR=CPSUM/AAY                                                             1504
      GAMMA=CPR/(CPR-(1.0/WTMOL))                                               1505
      DLMTP=0.0                                                                 1506
      DLMPT=0.0                                                                 1507
      GO TO 185                                                                 1508
  174 DLMTP=X(IQ1)                                                              1509
      IF (ABSF(DLMTP)-27.5) 1174,1174,172                                       1510
 1174 CPR=G(IQ2,IQ2)                                                            1511
      DO 175 J=1,IQ1                                                            1512
  175 CPR=CPR-G(IQ2,J)*X(J)                                                     1513
      CPR=CPR/AAY                                                               1514
 1175 IMAT=IMAT-1                                                               1515
      CALL GAUSS                                                                1516
      DLMPT=0.0                                                                 1517
      DO 179 J=1,L                                                              1518
  179 DLMPT=DLMPT+G(IQ1,J)*X(J)                                                 1519
      DLMPT=(P-DLMPT)/DLMPT                                                     1520
      IF (DLMPT-27.5) 180,180,172                                               1521
  180 GAMMA=1.0/(1.0+DLMPT-((1.0-DLMTP)**2)/(CPR*WTMOL))                        1522
      IF (GAMMA) 172,172,185                                                    1523
  185 IF (IPROB-2) 186,186,207                                                  1524
  186 IF (IADD-2) 187,191,197                                                   1525
  187 WTMOLC=WTMOL                                                              1526
      TC=T                                                                      1527
      PC=P                                                                      1528
      HC=HSUM                                                                   1529
      SO=SSUM                                                                   1530
  188 T PI=-DLMTP/(WTMOL*CPR)                                                   1531
      T ETA=1000.0/(CPR*TC*1.98726)                                             1532
      T SIG=-(1.0-DLMTP)/(WTMOL*CPR)                                            1533
      GO TO 207                                                                 1534
```

```
C                                                                       1535
C     CHECK FOR CONVERGENCE AT THROAT                                   1536
C                                                                       1537
  191 DHSTAR=HC-HSUM - (GAMMA*T/(2.0*WTMOL))                            1538
      IF (ABSF(DHSTAR/(HC-HSUM))-0.4E-4) 197,197,192                    1539
  192 IF(ITROT) 193,197,193                                             1540
  193 PCP(2)=PCP(2)/(1.0+2.0*DHSTAR*WTMOL/(T*(GAMMA+1.0)))              1541
      PO=PC/PCP(IADD)                                                   1542
      ITROT=ITROT-1                                                     1543
      IF (IDEBUG) 929,194,929                                           1544
  929 WRITE OUTPUT TAPE 6,923,DHSTAR,HC,HSUM,PCP(IADD)                  1545
  194 SENSE LIGHT 4                                                     1546
      GO TO 13                                                          1547
C                                                                       1548
C     CALCULATE PERFORMANCE PARAMETERS                                  1549
C                                                                       1550
  197 SP IMP=294.98*SQRTF((HC-HSUM)*1.98726E-3)                         1551
      RHOI=RHO*SP IMP                                                   1552
      SUM=T/(2.0*(HC-HSUM))                                             1553
      PI I=SUM*(WTMOL-WTMOLC)/(WTMOL*WTMOLC)                            1554
      ETA I=SUM*(TC-T)/(TC*T*1.98726)*1000.0                            1555
      SIG I=SUM/WTMOL                                                   1556
      T PI=(((WTMOLC-WTMOL)/WTMOLC)-DLMTP)/(WTMOL*CPR)                  1557
      T ETA=1000.0/(CPR*TC*1.98726)                                     1558
      T SIG=-(1.0-DLMTP)/(WTMOL*CPR)                                    1559
      AW=(86.4579*T)/(AAY*14.696006*SP IMP)                             1560
      AW PI=- ((1.0-DLMTP)/(WTMOLC*CPR)+1.0/GAMMA+PI I)                 1561
      AW ETA=T ETA*(1.0-DLMTP)-ETA I                                    1562
      AW SIG=1.0/GAMMA-SIG I                                            1563
      IF (IADD-2) 203,201,203                                           1564
  201 AWT=AW                                                            1565
      CSTAR=32.174*PC*14.696006*AWT                                     1566
      CSTRPI=1.0+AW PI                                                  1567
      STR ETA=AW ETA                                                    1568
      STR SIG=0.0                                                       1569
      AWT PI=AW PI                                                      1570
      AWT ETA=AW ETA                                                    1571
      AW SIG=0.0                                                        1572
  203 CF=32.174*SP IMP/CSTAR                                            1573
      ARATIO=AW/AWT                                                     1574
      VACI=SP IMP+P*14.696006*AW                                        1575
      RHOVAC=RHO*VACI                                                   1576
      VMACH=SP IMP/SQRTF(86.4579*GAMMA*T/WTMOL)                         1577
      EP PI=AW PI-AWT PI                                                1578
      EP ETA=AW ETA-AWT ETA                                             1579
      EP SIG=AW SIG                                                     1580
  207 HSUM=HSUM*1.98726                                                 1581
      SSUM=SSUM*1.98726                                                 1582
      CP=CPR*1.98726                                                    1583
C                                                                       1584
C     OBTAIN COMPOSITION IN MOLE FRACTIONS                              1585
C                                                                       1586
      SUM=P                                                             1587
      IF (ICOND-2) 209,213,375                                          1588
  209 DO 211 J=M1,N                                                     1589
  211 SUM=SUM+EN(J)                                                     1590
  213 DO 215 J=1,N                                                      1591
  215 ANS(4*J+34)=EN(J)/SUM                                             1592
      IF (IPROB-2) 217,217,220                                          1593
  217 ANS(1)=PCP(IADD)                                                  1594
  218 IF (IADD-2) 220,219,219                                           1595
  219 ANS(15)=CSTAR                                                     1596
      ANS(24)=CSTRPI                                                    1597
      ANS(29)=STR ETA                                                   1598
      ANS(34)=STR SIG                                                   1599
  220 ANS(2)=P                                                          1600
      ANS(3)=T                                                          1601
      K=34+4*N                                                          1602
C                                                                       1603
C     PRINT OUT THE CALCULATED ANSWERS                                  1604
C                                                                       1605
      IF (IDEBUG) 1221,222,1221                                         1606
 1221 WRITE OUTPUT TAPE 6,221,(ANS(I),I=1,K)                            1607
  221 FORMAT (1H ////5E20.8/5E20.8/5E20.8/4E20.8/5E20.8/5E20.8/5E20.8///1608
     1 (3(7X,3A6,F8.5)))                                                1609
      GO TO 9009                                                          H,P
```

```
  222 WRITE TAPE 3, (ANS(I), I=1,454)                                    1611
      NO EQ=NO EQ+1                                                      1612
 9009 IF(K5)9007,2223,9007                                                    H,P
 9007 IADD = IK5                                                              H,P
      IPROB = IPK5                                                            H,P
 2223 IF (IADD-2) 223,225,225                                            1613
  223 IF (IPROB-2) 224,1224,1223                                         1614
  224 IF (IFROZ) 1223,1224,1224                                          1615
 1224 PCP(2)=((GAMMA+1.0)/2.C)**(GAMMA/(GAMMA-1.0))                      1616
      T LN=T LN+LOGF(2.0/(GAMMA+1.0))                                    1617
 1223 DO 1225 I = 1,454                                                  1618
 1225 ANSLAB(I) = ANS(I)                                                 1619
  225 IADD=IADD+1                                                        1620
      GO TO 433                                                          1621
C                                                                        1622
  231 IF (NO EQ) 378,378,1231                                            1623
 1231 IF (IFROZ) 232,379,235                                             1624
  232 IF (IADD-2) 378,233,378                                            1625
  233 IF (IDEBUG) 378,234,378                                            1626
  234 CALL  CORE4                                                        1627
      IF (KORE) 1234,1,1234                                              1628
 1234 RETURN                                                             1629
  235 IF (IPROB-2) 237,237,239                                           1630
  237  CALL CORE3                                                        1631
      RETURN                                                             1632
  239 WRITE TAPE 3,(G(I), I=1,8044)                                      1633
      CALL CORE5                                                         1634
      RETURN                                                             1635
C                                                                        1636
C     ERROR PRINT OUT                                                    1637
C                                                                        1638
  305 WRITE OUTPUT TAPE 6,306,T,IADD                                     1639
  306 FORMAT (17HLTHE TEMPERATURE=E12.4,34H K, IS OUT OF RANGE FOR THE P 1640
     1OINT I5)                                                           1641
      IF (6000.0-T) 309,307,307                                          1642
  307 IF (T-200.C) 1309,308,308                                          1643
  308 GO TO 142                                                          1644
 1309 IF (IADD-1) 309,1310,309                                           1645
 1310 IF (IPROB-2) 1311,309,309                                          1646
 1311 IF (ITEST-N) 1312,1312,309                                         1647
 1312 DO 1313 J=ITEST,N                                                  1648
      CALL BYPASS(J,1)                                                   1649
      IF (IPROD-2) 1315,1313,1313                                        1650
 1313 CONTINUE                                                           1651
      GO TO 309                                                          1652
 1315 ITEST=J+1                                                          1653
      CALL BYPASS(J,3)                                                   1654
      GO TO 1376                                                         1655 H,P
  309 PCP(25)=PCP(IADD)                                                       Correction
      IADD=25                                                                 Correction
      IF (SENSE LIGHT 4) 42,42                                           1657
  311 WRITE OUTPUT TAPE 6,312,IMAT,IDID                                  1658
  312 FORMAT (/15H1TRIED TO SOLVE I3,22H EQUATIONS, ELIMINATED I3)       1659
      SIZE=18.5                                                               Correction
      GO TO 375                                                          1660
  315 WRITE OUTPUT TAPE 6,316,                                           1661
  316 FORMAT (/47H1RESIDUALS FROM SUBROUTINE GAUSS EXCEED  0.5E-4)       1662
      SIZE=18.5                                                               Correction
  375 IF (IDEBUG) 231,377,231                                            1663
  377 IDEBUG=1                                                           1664
 1376 IF(IPROB-3)1377,555,555                                            1665 H,P
 1377 PC=PC*14.696006                                                    1666
      GO TO 555                                                          1667
  378 WRITE TAPE 3,(G(I),I=1,8044)                                       1668
      BACKSPACE 3                                                        1669
      RETURN                                                             1670
  379 REWIND 4                                                           1671
      PAUSE 77777                                                        1672
```

```
      SUBROUTINE  GAUSS                                                      1673
C                                                                            1674
C                                                                            1675
C     SUBROUTINE GAUSS SOLVES ANY LINEAR SET OF UP TO TWENTY EQUATIONS,      1676
C     BY ITERATION IF NECESSARY                                              1677
C                                                                            1678
C     FORTRAN MONITOR UNDER NORMAL OPERATING CONDITIONS WILL TAKE CARE       1679
C     OF OVER-UNDER FLOW                                                     1680
C                                                                            1681
      COMMON C                                                               1682
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))            1683
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),     C(874))            1684
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))            1685
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))            1686
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))            1687
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))            1688
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))            1689
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))            1690
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))            1691
      EQUIVALENCE   (RHO,        C(439))                                     1692
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))            1693
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))            1694
      EQUIVALENCE   (T ETA,      C(445))                                     1695
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))            1696
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))            1697
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))            1698
      EQUIVALENCE   (AW SIG,     C(453))                                     1699
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))            1700
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))            1701
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))            1702
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))            1703
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))            1704
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))           1705
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))            1706
      EQUIVALENCE   (ISYS,       C(1472)),   (JEAN,      C(1473))          1707
      EQUIVALENCE   (ACX,        C(1474)),   (ACF,      C(1475))           1708
      EQUIVALENCE   (AMX,         C(1476)),   (AMF,       C(1477))         1709
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,      C(1479))          1710
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))         1711
      EQUIVALENCE   (DX(1),     C(1500)),   (DX(20),    C(1519))           1712
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))         1713
      EQUIVALENCE   (MMLA(1),    C(1520)),  (MMLA(18), C(1537))            1714
      EQUIVALENCE   (PROD(1),  C(1538)),  (PROD(3),    C(1540))           1715
      EQUIVALENCE   (SYSTM(1),  C(1541)),  (SYSTM(15),    C(1555))        1716
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))            1717
      EQUIVALENCE   (OF,      C(1556)),    (FPCT,    C(1557))             1718
      EQUIVALENCE   (EQRAT,      C(1558))                                  1719
      EQUIVALENCE (KODE,     C(1559)),    (KASE,        C(1560))         1720
      EQUIVALENCE   (KONT,   C(1561)),    (NF,          C(1562))         1721
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))         1722
      EQUIVALENCE   (NOEQ, C(1565))                                       1723
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),    C(1785))          1724
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),    C(1800))          1725
      EQUIVALENCE   (HX,         C(1801)), (HF,          C(1802))         1726
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))          1727
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))          1728
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))           1729
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))           1730
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))          1731
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))          1732
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))          1733
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))           1734
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))          1735
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))          1736
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))          1737
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))          1738
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))          1739
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))          1740
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))          1741
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))          1742
      EQUIVALENCE   (PC,         C(2314)), (TC,          C(2315))         1743
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))          1744
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))          1745
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))          1746
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))          1747
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))          1748
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      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))
      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)
      DIMENSION  DRUM(20,21)
B     BIGNO=377777777777
      IDID=0
      DETN=0.0
      IF(IUSE) 8C,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 18 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                                                                       1825
C      INDEX I LOCATES EQUATION TO BE USED FOR ELIMINATING THE NTH      1826
C      VARIABLE FROM THE REMAINING EQUATIONS                            1827
C                                                                       1828
C       INTERCHANGE EQUATIONS I AND NN                                  1829
C                                                                       1830
   28 IF(NN-I) 29,31,29                                                 1831
   29 DO 30 J=NN,IUSE1                                                  1832
      Z=G(I,J)                                                          1833
      G(I,J)=G(NN,J)                                                    1834
   30 G(NN,J)=Z                                                         1835
C                                                                       1836
C      DIVIDE NTH ROW BY NTH DIAGONAL ELEMENT AND ELIMINATE THE NTH     1837
C      VARIABLE FROM THE REMAINING EQUATIONS                            1838
C                                                                       1839
   31 K = NN + 1                                                        1840
      DO 36 J = K, IUSE1                                                1841
           IF(G(NN,NN)) 36, 23, 36                                      1842
   36      G(NN,J) = G(NN,J) / G(NN,NN)                                 1843
      IF(K-IUSE1) 88,45,88                                              1844
   88 DO 44 I = K,IUSE                                                  1845
   40 DO 44 J = K, IUSE1                                                1846
           G(I,J) = G(I,J) - G(I,NN)*G(NN,J)                            1847
   44 CONTINUE                                                          1848
   45 CONTINUE                                                          1849
C                                                                       1850
C      BACKSOLVE FOR THE VARIABLES                                      1851
C                                                                       1852
  991 IDID = IUSE                                                       1853
      K = IUSE                                                          1854
   47 J = K + 1                                                         1855
      SUM = 0.                                                          1856
      IF(IUSE - J) 51,48,48                                             1857
   48 DO 50 I = J,IUSE                                                  1858
   50      SUM = SUM + G(K,I)*DX(I)                                     1859
   51 DX(K) = G(K,IUSE1) - SUM                                          1860
      X(K) = X(K) + DX(K)                                               1861
      K = K - 1                                                         1862
      IF (K) 47,151,47                                                  1863
  151 DO 90 ID = 1,IUSE                                                 1864
      DO 90 JD = 1, IUSE1                                               1865
   90      G(ID,JD) = DRUM(ID,JD)                                       1866
C                                                                       1867
C      CALCULATE RESIDUALS (DELTA RIGHT HAND SIDE)                      1868
C                                                                       1869
   52 DSUM = 0.                                                         1870
      DO 62 I = 1, IUSE                                                 1871
           SUM = 0.                                                     1872
           DO 56 J = 1, IUSE                                            1873
   56           SUM = SUM + G(I,J)*X(J)                                 1874
           DELTA(I) = G(I,IUSE1) - SUM                                  1875
           IF(ABSF(G(I,IUSE1)) - 1.0) 62, 62, 60                        1876
   60      DELTA(I) = DELTA(I) / G(I,IUSE1)                             1877
   62      DSUM = ABSF(DELTA(I)) + DSUM                                 1878
      GO TO(66,80), KAPUT                                               1879
   66 IF(DSUM - DSUM1) 74,80,68                                         1880
   68 KAPUT = 2                                                         1881
      DO 72 K = 1,IUSE                                                  1882
   72      X(K) = X(K) - DX(K)                                          1883
      GO TO 52                                                          1884
   74 DSUM1 = DSUM                                                      1885
      ITERA = ITERA + 1                                                 1886
      IF(ITERA -  4) 92,80,92                                           1887
   92 DO 78 I = 1,IUSE                                                  1888
           IF(ABSF(G(I,IUSE1)) - 1.0) 75,75,76                          1889
   75      G(I,IUSE1) = DELTA(I)                                        1890
           GO TO 78                                                     1891
   76      G(I,IUSE1) = DELTA(I) * G(I,IUSE1)                           1892
   78      CONTINUE                                                     1893
      GO TO 6                                                           1894
   80 RETURN                                                            1895
```

```
      SUBROUTINE MATRIX                                                 1896
C                                                                       1897
C                                                                       1898
      COMMON C                                                          1899
      EQUIVALENCE   (G(1),      C(1)),     (G(420),     C(420))        1900
      EQUIVALENCE   (ANS(1),  C(421)),   (ANS(454),    C(874))        1901
      EQUIVALENCE   (HSUM,      C(424)),   (SSUM,       C(425))        1902
      EQUIVALENCE   (WTMOL,     C(426)),   (CP,         C(427))        1903
      EQUIVALENCE   (DLMPT,     C(428)),   (DLMTP,      C(429))        1904
      EQUIVALENCE   (GAMMA,     C(430)),   (ARATIO,     C(431))        1905
      EQUIVALENCE   (VMACH,     C(432)),   (SP IMP,     C(433))        1906
      EQUIVALENCE   (VACI,      C(434)),   (CF,         C(436))        1907
      EQUIVALENCE   (RHOI,      C(437)),   (RHOVAC,     C(438))        1908
      EQUIVALENCE   (RHO,       C(439))                                 1909
      EQUIVALENCE   (T PI,      C(440)),   (PI I,       C(441))        1910
      EQUIVALENCE   (EP PI,     C(442)),   (AW PI,      C(443))        1911
      EQUIVALENCE   (T ETA,     C(445))                                 1912
      EQUIVALENCE   (ETA I,     C(446)),   (EP ETA,     C(447))        1913
      EQUIVALENCE   (AW ETA,    C(448)),   (T SIG,      C(450))        1914
      EQUIVALENCE   (SIG I,     C(451)),   (EP SIG,     C(452))        1915
      EQUIVALENCE   (AW SIG,    C(453))                                 1916
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))       1917
      EQUIVALENCE   (FORM(1),   C(1329)), (FORM(15),  C(1343))        1918
      EQUIVALENCE   (ELMT(1),   C(1344)),  (ELMT(15), C(1358))        1919
      EQUIVALENCE   (LLMT(1),   C(1344)),  (LLMT(15), C(1358))        1920
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))        1921
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))       1922
      EQUIVALENCE   (EN(1),   C(1382)),  (EN(90),    C(1471))         1923
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))      1924
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))       1925
      EQUIVALENCE   (AMX,       C(1476)),    (AMF,       C(1477))     1926
      EQUIVALENCE   (RHOX,      C(1478)),    (RHOF,     C(1479))      1927
      EQUIVALENCE   (COEFX(1),    C(1480)),  (COEFX(20),  C(1499))     1928
      EQUIVALENCE   (DX(1),    C(1500)),   (DX(20),    C(1519))       1929
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))    1930
      EQUIVALENCE   (MMLA(1),   C(1520)),  (MMLA(18), C(1537))        1931
      EQUIVALENCE   (PROD(1),  C(1538)),   (PROD(3),   C(1540))       1932
      EQUIVALENCE   (SYSTM(1),  C(1541)),   (SYSTM(15),   C(1555))   1933
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))        1934
      EQUIVALENCE   (OF,     C(1556)),     (FPCT,   C(1557))          1935
      EQUIVALENCE   (EQRAT,     C(1558))                              1936
      EQUIVALENCE (KODE,    C(1559)),    (KASE,       C(1560))      1937
      EQUIVALENCE   (KONT,   C(1561)),    (NF,         C(1562))      1938
      EQUIVALENCE   (NO,        C(1563)), (NE,         C(1564))      1939
      EQUIVALENCE   (NOEQ, C(1565))                                   1940
      EQUIVALENCE   (BOX(1),    C(1771)), (BOX(15),    C(1785))      1941
      EQUIVALENCE   (BOF(1),    C(1786)), (BOF(15),    C(1800))      1942
      EQUIVALENCE   (HX,        C(1801)), (HF,         C(1802))      1943
      EQUIVALENCE   (VXPLS,     C(1803)), (VXMIN,      C(1804))      1944
      EQUIVALENCE   (VFPLS,     C(1805)), (VFMIN,      C(1806))      1945
      EQUIVALENCE   (EN LN(1),  C(1861)), (EN LN(90), C(1950))        1946
      EQUIVALENCE   (DEL N(1),  C(1951)), (DEL N(90), C(2040))        1947
      EQUIVALENCE   (HO(1),     C(2041)), (HO(90),     C(2130))       1948
      EQUIVALENCE   (S(1),      C(2131)), (S(90),      C(2220))       1949
      EQUIVALENCE   (X(1),      C(2221)), (X(20),      C(2240))       1950
      EQUIVALENCE   (DELTA(1),  C(2241)), (DELTA(20), C(2260))        1951
      EQUIVALENCE   (BO(1),     C(2261)), (BO(15),     C(2275))       1952
      EQUIVALENCE   (PO,        C(2276)), (HSUBO,      C(2277))       1953
      EQUIVALENCE   (SO,        C(2278)), (T LN,       C(2279))       1954
      EQUIVALENCE   (T,         C(2280)), (AAY LN,     C(2281))       1955
      EQUIVALENCE   (AAY,       C(2282)), (CPSUM,      C(2283))       1956
      EQUIVALENCE   (HC,        C(2284)), (TC LN,      C(2285))       1957
      EQUIVALENCE   (PCP(1),    C(2286)), (PCP(25),    C(2310))       1958
      EQUIVALENCE   (DATUM(1),  C(2311)), (DATUM(3),   C(2313))       1959
      EQUIVALENCE   (PC,        C(2314)), (TC,         C(2315))       1960
      EQUIVALENCE   (IPROB,     C(2316)), (IFIXT,      C(2317))       1961
      EQUIVALENCE   (IHS,       C(2318)), (ICOND,      C(2319))       1962
      EQUIVALENCE   (ISYM,      C(2320)), (IPROD,      C(2321))       1963
      EQUIVALENCE   (IDID,      C(2322)), (LDRUM,      C(2323))       1964
      EQUIVALENCE   (IDRM,      C(2323)), (KDRUM,      C(2324))       1965
      EQUIVALENCE   (L,         C(2325)), (L1,         C(2326))       1966
      EQUIVALENCE   (M,         C(2327)), (M1,         C(2328))       1967
      EQUIVALENCE   (N,         C(2329)), (IQ,         C(2330))       1968
      EQUIVALENCE   (IQ1,       C(2331)), (IQ2,        C(2332))       1969
      EQUIVALENCE   (IQ3,       C(2333)), (KMAT,       C(2334))       1970
      EQUIVALENCE   (IMAT,      C(2335)), (IUSE,       C(2335))       1971
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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),    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     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)= C.C
  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
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   12 DO 20  I=1, L                                                        2048
      IF (A(I,J)) 13,20,13                                                 2049
   13 TERM= A(I,J)*EN(J)                                                   2050
      DO 15  K=I, L                                                        2051
      G(I,K)= G(I,K) + A(K,J)*TERM                                         2052
   15 CONTINUE                                                             2053
C                                                                          2054
C     COMPLETE COLUMN  A FOR THE GAS MOLECULE                              2055
C                                                                          2056
      G(I,IQ1)=G(I,IQ1)+TERM                                               2057
   20 CONTINUE                                                             2058
      G(IQ1,IQ1)= G(IQ1,IQ1)+EN(J)                                         2059
C                                                                          2060
C     STATEMENT 24 IS FOR FIXED T, 30 IS FOR VARIABLE  T AND CONVERGED     2061
C     FIXED T                                                              2062
C                                                                          2063
   21 IF (IFIXT-2) 24,30,30                                                2064
C                                                                          2065
C     FOR ASSIGNED T BYPASS ENERGY ROW AND T COLUMN WHILE ITERATING        2066
C                                                                          2067
   24 TERM= (HC(J)-S(J))*EN(J)                                             2068
      DO 25  I=1, L                                                        2069
      G(I,IQ2)=G(I,IQ2)+A(I,J)*TERM                                        2070
   25 CONTINUE                                                             2071
      G(IQ1,IQ2)=G(IQ1,IQ2)+TERM                                           2072
      GO TO 65                                                             2073
C                                                                          2074
C     FILL IN TEMPERATURE COLUMN AND RIGHT HAND SIDE                       2075
C                                                                          2076
   30 TERM=HO(J)*EN(J)                                                     2077
      DO 35 I=1,L                                                          2078
      G(I,IQ2)= G(I,IQ2)+A(I,J)*TERM                                       2079
   35 CONTINUE                                                             2080
      G(IQ1,IQ2)= G(IQ1,IQ2)+TERM                                          2081
      TERM1=(HO(J)-S(J))*EN(J)                                             2082
      DO 40 I=1,L                                                          2083
      G(I,IQ3)= G(I,IQ3)+A(I,J)*TERM1                                      2084
   40 CONTINUE                                                             2085
      G(IQ1,IQ3)=G(IQ1,IQ3)+TERM1                                          2086
C                                                                          2087
C     STATEMENT 50 IS FOR ENTHALPY , 55 IS FOR ENTROPY EQUATION            2088
C                                                                          2089
   45 IF (IHS-2) 50,55,55                                                  2090
   50 G(IQ2,IQ2)=G(IQ2,IQ2)+HO(J)*TERM                                     2091
      G(IQ2,IQ3)=G(IQ2,IQ3)+HO(J)*TERM1                                    2092
      GO TO 65                                                             2093
C                                                                          2094
C     DURING EXPANSION THE ENTROPY ROW IS FILLED IN                        2095
C                                                                          2096
   55 TERM=S(J)*EN(J)                                                      2097
      DO 60  K=1,L                                                         2098
   60 G(IQ2,K)= G(IQ2,K)+A(K,J)*TERM                                       2099
      CONTINUE                                                             2100
      G(IQ2,IQ1)=G(IQ2,IQ1)+TERM                                           2101
      G(IQ2,IQ2)=G(IQ2,IQ2)+HO(J)*TERM                                     2102
      G(IQ2,IQ3)=G(IQ2,IQ3)+(HO(J)-S(J))*TERM                              2103
   65 CONTINUE                                                             2104
C                                                                          2105
C     AT THIS POINT PROCESSING OF GASEOUS PRODUCTS HAS BEEN COMPLETED      2106
C     AND CONDENSED PHASE PROCESSING IS BEGUN                              2107
C                                                                          2108
C     STATEMENT 70 IS FOR CONDENSED PRODUCTS, 101 IS FOR NO CONDENSED      2109
C                                                                          2110
   66 IF (ICOND-2) 70,101,101                                              2111
   70 K=L1                                                                 2112
      DO 100 J= M1,N                                                       2113
      CALL BYPASS (J,1)                                                    2114
      IF (IPROD-2) 100,74,100                                              2115
   74 DO 75  I=1,L                                                         2116
      G(I,K)=A(I,J)                                                        2117
   75 CONTINUE                                                             2118
C                                                                          2119
C     STATEMENT 80 IS FOR FIXED T, 85 IS FOR VARIABLE T AND CONVERGED      2120
C     FIXED T                                                              2121
C                                                                          2122
      IF (IFIXT-2) 80,85,85                                                2123
   80 G(K,IQ2)= HO(J)-S(J)                                                 2124
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      GO TO 95                                                          2125
   85 G(K,IQ2)= HO(J)                                                   2126
      G(K,IQ3)= HO(J)-S(J)                                              2127
C                                                                       2128
C     STATEMENT 95 IS FOR ENTHALPY, STATEMENT 90 IS FOR ENTROPY EQUATION 2129
C                                                                       2130
      IF (IHS-2) 95,90,90                                               2131
   90 G(IQ2,K)=S(J)                                                     2132
   95 K= K+1                                                            2133
  100 CONTINUE                                                          2134
C                                                                       2135
C     REFLECT SYMMETRIC PORTIONS OF THE MATRIX BEFORE COMPLETING THE    2136
C     CONDENSED PHASE CONTRIBUTIONS TO THE MATRIX                       2137
C                                                                       2138
  101 DO 104 I=1,ISYM                                                   2139
      DO 102 J=I,ISYM                                                   2140
      G(J,I)=G(I,J)                                                     2141
  102 CONTINUE                                                          2142
  104 CONTINUE                                                          2143
C                                                                       2144
C     THE ADDRESS OF THE NEXT INSTRUCTION IF SET DURING INITIALIZATION  2145
C     STATEMENT 105 IS FOR CONDENSED,130  IS FOR NO CONDENSED           2146
C                                                                       2147
      IF (ICOND-2) 105,130,130                                          2148
C                                                                       2149
C     COMPLETE COLUMN A OF MATRIX                                       2150
C                                                                       2151
  105 DO 125 J=M1,N                                                     2152
      CALL BYPASS (J,1)                                                 2153
      IF (IPROD-2) 125,106,125                                          2154
  106 DO 107 I=1,L                                                      2155
      G(I,IQ1)=G(I,IQ1)+A(I,J)*EN(J)                                    2156
  107 CONTINUE                                                          2157
      IF (IFIXT-2) 125,109,109                                          2158
  109 IF (IHS-2) 110,115,115                                            2159
  110 G(IQ2,IQ1)= G(IQ2,IQ1)+HO(J)*EN(J)                                2160
      GO TO 125                                                         2161
  115 G(IQ2,IQ1)= G(IQ2,IQ1)+S(J)*EN(J)                                 2162
  125 CONTINUE                                                          2163
  130 GO TO (131,133),IFIXT                                             2164
  131 KMAT=IQ2                                                          2165
      GO TO 136                                                         2166
  133 KMAT=IQ3                                                          2167
  136 IMAT=KMAT-1                                                       2168
C                                                                       2169
C     COMPLETE THE RIGHT HAND SIDE                                      2170
C                                                                       2171
      DO 145 I=1,IMAT                                                   2172
      G(I,KMAT)=G(I,KMAT)-G(I,IQ1)                                      2173
  145 CONTINUE                                                          2174
      DO 150 I=1,L                                                      2175
      G(I,KMAT)= G(I,KMAT)+ AAY*BO(I)                                   2176
  150 CONTINUE                                                          2177
      P= G(IQ1,IQ1)                                                     2178
  160 G(IQ1,KMAT) = G(IQ1,KMAT)+ PO                                     2179
      G(IQ1,IQ1)=0.0                                                    2180
C                                                                       2181
C     COMPLETE ENERGY ROW AND TEMPERATURE COLUMN                        2182
C                                                                       2183
      IF (KMAT-IQ2) 165,185,165                                         2184
  165 IF (IHS-2) 166,168,168                                            2185
  166 ENERGY=AAY*(HSUBO/T)                                              2186
      GO TO 169                                                         2187
  168 ENERGY= AAY*SO+PC-P                                               2188
  169 G(IQ2,IQ3)=G(IQ2,IQ3)+ ENERGY                                     2189
      G(IQ2,IQ2)= G(IQ2,IQ2)+CPSUM                                      2190
  185 RETURN                                                            2191
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      SUBROUTINE  CORE3                                                      2192
C                                                                            2193
C     FROZEN COMPOSITION EXPANSION                                           2194
C                                                                            2195
C                                                                            2196
      COMMON C                                                               2197
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))            2198
      EQUIVALENCE   (ANS(1),  C(421)),   (ANS(454),     C(874))            2199
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))            2200
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))            2201
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))            2202
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIO,     C(431))            2203
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))            2204
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))            2205
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))            2206
      EQUIVALENCE   (RHO,        C(439))                                     2207
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))            2208
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))            2209
      EQUIVALENCE   (T ETA,      C(445))                                     2210
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))            2211
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))            2212
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))            2213
      EQUIVALENCE   (AW SIG,     C(453))                                     2214
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))            2215
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))            2216
      EQUIVALENCE   (ELMT(1),    C(1344)),  (ELMT(15), C(1358))            2217
      EQUIVALENCE   (LLMT(1),    C(1344)),  (LLMT(15), C(1358))            2218
      EQUIVALENCE   (DATA(1),  C(1359)),  (DATA(23),  C(1381))            2219
      EQUIVALENCE   (MDATA(1),  C(1359)),  (MDATA(23), C(1381))           2220
      EQUIVALENCE   (EN(1),    C(1382)),  (EN(90),    C(1471))            2221
      EQUIVALENCE   (ISYS,      C(1472)),   (JEAN,      C(1473))           2222
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))            2223
      EQUIVALENCE   (AMX,        C(1476)),    (AMF,       C(1477))        2224
      EQUIVALENCE   (RHOX,       C(1478)),    (RHOF,      C(1479))        2225
      EQUIVALENCE   (COEFX(1),     C(1480)),  (COEFX(20),  C(1499))        2226
      EQUIVALENCE   (DX(1),     C(1500)),   (DX(20),    C(1519))          2227
      EQUIVALENCE   (FORMLA(1),  C(1520)),  (FORMLA(18),  C(1537))        2228
      EQUIVALENCE   (MMLA(1),    C(1520)),   (MMLA(18), C(1537))          2229
      EQUIVALENCE   (PROD(1),  C(1538)),   (PROD(3),    C(1540))         2230
      EQUIVALENCE   (SYSTM(1),  C(1541)),   (SYSTM(15),    C(1555))      2231
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))            2232
      EQUIVALENCE   (OF,      C(1556)),     (FPCT,    C(1557))            2233
      EQUIVALENCE   (EQRAT,      C(1558))                                  2234
      EQUIVALENCE (KODE,     C(1559)),    (KASE,       C(1560))          2235
      EQUIVALENCE   (KONT,    C(1561)),    (NF,          C(1562))         2236
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))         2237
      EQUIVALENCE   (NOEQ, C(1565))                                       2238
      EQUIVALENCE  (NOFROZ,  C(1566))                                     2239
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),    C(1785))          2240
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),    C(1800))          2241
      EQUIVALENCE   (HX,         C(1801)), (HF,          C(1802))         2242
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))          2243
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))          2244
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))           2245
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))           2246
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))          2247
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))          2248
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))          2249
      EQUIVALENCE   (DELTA(1),   C(2241)), (DELTA(20), C(2260))           2250
      EQUIVALENCE   (BO(1),      C(2261)), (BO(15),     C(2275))          2251
      EQUIVALENCE   (PO,         C(2276)), (HSUBO,      C(2277))          2252
      EQUIVALENCE   (SO,         C(2278)), (T LN,       C(2279))          2253
      EQUIVALENCE   (T,          C(2280)), (AAY LN,     C(2281))          2254
      EQUIVALENCE   (AAY,        C(2282)), (CPSUM,      C(2283))          2255
      EQUIVALENCE   (HC,         C(2284)), (TC LN,      C(2285))          2256
      EQUIVALENCE   (PCP(1),     C(2286)), (PCP(25),    C(2310))          2257
      EQUIVALENCE   (DATUM(1),   C(2311)), (DATUM(3),   C(2313))          2258
      EQUIVALENCE   (PC,         C(2314)), (TC,          C(2315))         2259
      EQUIVALENCE   (IPROB,      C(2316)), (IFIXT,      C(2317))          2260
      EQUIVALENCE   (IHS,        C(2318)), (ICOND,      C(2319))          2261
      EQUIVALENCE   (ISYM,       C(2320)), (IPROD,      C(2321))          2262
      EQUIVALENCE   (IDID,       C(2322)), (LDRUM,      C(2323))          2263
      EQUIVALENCE   (IDRM,       C(2323)), (KDRUM,      C(2324))          2264
      EQUIVALENCE   (L,          C(2325)), (L1,          C(2326))         2265
      EQUIVALENCE   (M,          C(2327)), (M1,          C(2328))         2266
      EQUIVALENCE   (N,          C(2329)), (IQ,          C(2330))         2267
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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
      S0= (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                                                    2343
    37 IF (SENSE LIGHT 4) 38,41                                                2344
    38 SENSE LIGHT 4                                                           2345
       DO 40 J=1,N                                                             2346
       IF (COEFT(8,J)) 40,39,40                                                2347
    39 IF (EN(J)) 40,40,309                                                    2348
    40 CONTINUE                                                                2349
       GO TO 49                                                                2350
    41 DO 44 J=1,N                                                             2351
       IF (EN(J)) 44,44,42                                                     2352
    42 IF (COEFT(5,J)+20.0-T) 285,43,43                                        2353
    43 IF (T-COEFT(4,J)+20.0) 295,44,44                                        2354
   285 IF (5000.0-COEFT(5,J)) 44,44,311                                        2355
   295 IF (COEFT(4,J)-300.0) 44,44,311                                         2356
    44 CONTINUE                                                                2357
C                                                                              2358
C      BEGIN ITERATION                                                         2359
C                                                                              2360
    49 PCP LN=LOGF(PCP(IADD))                                                  2361
    51 CPSUM=0.0                                                               2362
       T=EXPF(T LN)                                                            2363
       DO 60 J=1,N                                                             2364
       IF (EN(J)) 60,60,57                                                     2365
    57 CPSUM=CPSUM+((((COEFT(12,J)*T+COEFT(11,J))*T+COEFT(10,J))*T+COEFT(      2366
      19,J))*T+COEFT(8,J))*EN(J)                                               2367
    58 HO(J)=((((COEFT(12,J)/5.0)*T+COEFT(11,J)/4.0)*T+COEFT(10,J)/3.0)*T      2368
      1+COEFT(9,J)/2.0)*T +COEFT(13,J)/T+COEFT(8,J)                            2369
    59 S(J)=((((COEFT(12,J)/4.0 )*T+COEFT(11,J)/3.0)*T+COEFT(10,J)/2.0)*T      2370
      1 +COEFT(9,J))*T+COEFT(8,J)*T LN+COEFT(14,J)-EN LN(J)                     2371
    60 CONTINUE                                                                2372
       SUM H=0.0                                                               2373
       SUM S=0.0                                                               2374
       DO 63 J=1,N                                                             2375
       SUM H=SUM H+HO(J)*EN(J)                                                 2376
    63 SUM S=SUM S+S(J)*EN(J)                                                  2377
       IF (IADD-2) 81,65,65                                                    2378
    65 IF (SENSE LIGHT 4) 66,81                                                2379
    66 SENSE LIGHT 4                                                           2380
    67 D LN T=(SUM S+(ALPHA*PCP LN)-SO)/CPSUM                                  2381
C                                                                              2382
C      CHECK CONVERGENCE OF THE ITERATION                                      2383
C                                                                              2384
       T LN=T LN-D LN T                                                        2385
       IF (ABSF(D LN T)-0.5E-4) 73,73,51                                       2386
    73 IF (SENSE LIGHT 4) 17,17                                                2387
    81 DO 1181 J = 1,454                                                       2388
  1181 ANS(J) = ANSLAB(J)                                                      2389
       SUM H=T*SUM H/WTMOLF                                                    2390
       CPR=CPSUM/WTMOLF                                                        2391
       GAMMA=CPR/(CPR-(1.0/WTMOL))                                             2392
       IF (IADD-2) 209,191,197                                                 2393
C                                                                              2394
C      CHECK FOR CONVERGENCE AT THROAT                                         2395
C                                                                              2396
   191 DHSTAR=HC-SUM H - (GAMMA*T/(2.0*WTMOL))                                 2397
       IF (ABSF(DHSTAR/(HC-SUM H))-0.4E-4) 197,197,192                         2398
   192 IF (ITROT) 193,197,193                                                  2399
   193 PCP(2)=PCP(2)/(1.0+2.0*DHSTAR*WTMOL/(T*(GAMMA+1.0)))                    2400
       SENSE LIGHT 4                                                           2401
       ITROT=ITROT-1                                                           2402
       GO TO 49                                                                2403
C                                                                              2404
C      CALCULATE PERFORMANCE PARAMETERS                                        2405
C                                                                              2406
   197 SP IMP=294.98*SQRTF((HC-SUM H)*1.98726E-3)                              2407
       P=PC/PCP(IADD)                                                          2408
       AW=(86.4579*T)/(P*WTMOL*14.696006*SP IMP)                               2409
       IF (IADD-2) 203,201,203                                                 2410
   201 AWT=AW                                                                  2411
       CSTAR=32.174*PC*14.696006*AWT                                           2412
   203 CF=32.174*SP IMP/CSTAR                                                  2413
       ARATIO=AW/AWT                                                           2414
       VACI=SP IMP+P*14.696006*AW                                              2415
       VMACH=SP IMP/SQRTF(86.4579*GAMMA*T/WTMOL)                               2416
   207 ANS(2)=P                                                                2417
       ANS(3)=T                                                                2418
```

```
  209 HSUM=SUM H*1.98726                                                    2419
      CP=CPR*1.98726                                                        2420
      ANS(1)=PCP(IADD)                                                      2421
      ANS(15)=CSTAR                                                         2422
      WRITE TAPE 3,(ANS(I),I=1,454)                                         2423
      NO FROZ=NO FROZ+1                                                     2424
      IF (MISSED) 451,223,451                                               2425
  223 IADD=IADD+1                                                           2426
      IF (IADD-2) 1225,224,1225                                             2427
  224 PCP(2)=((GAMMA+1.0)/2.0)**(GAMMA/(GAMMA-1.0))                         2428
      T LN=T LN+LOGF(2.0/(GAMMA+1.0))                                       2429
 1225 IF (IADD-25) 225,225,451                                              2430
  225 IF (PCP(IADD)) 451,451,227                                            2431
  227 SENSE LIGHT 4                                                         2432
      GO TO 49                                                              2433
C                                                                           2434
C     ERROR PRINT OUT                                                       2435
C                                                                           2436
  305 WRITE OUTPUT TAPE 6,306,T,IADD                                        2437
  306 FORMAT (17HLTHE TEMPERATURE=E12.4,26H K, IS OUT OF RANGE,POINT I5)    2438
      IF (6000.0-T) 449,307,307                                             2439
  307 IF (T-200.0) 449,308,308                                              2440
  308 GO TO 41                                                              2441
  449 MISSED=1                                                              2442
      ITROT=0                                                               2443
      IF (SENSE LIGHT 4) 51,51                                              2444
  451 WRITE TAPE 3, (G(I), I=1,8044)                                        2445
      CALL CORE5                                                            2446
      RETURN                                                                2447
  309 WRITE OUTPUT TAPE 6,310,(COEFT(I,J),I=1,3),COEFT(6,J),COEFT(7,J)      2448
  310 FORMAT (13H6THE SPECIES 3A6,29H HAS NO DATA IN THE INTERVAL 2F9.1)    2449
      DO 1311 K = 1,15                                                      2450
      DO 1311 J = 1,90                                                      2451
 1311 COEFT(K,J) = COEFT1(K,J)                                              2452
      GO TO 449                                                             2453
  311 WRITE OUTPUT TAPE 6,312, (COEFT(I,J),I=1,3),T                         2454
  312 FORMAT (13H6THE SPECIES 3A6,19H HAS NO DATA AT T= F9.1)               2455
      GO TO 449                                                             2456
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      SUBROUTINE  CORE4                                                      2457
C                                                                            2458
C     CHAPMAN-JOUGUET DETONATIONS                                            2459
C                                                                            2460
C                                                                            2461
      COMMON C                                                               2462
      EQUIVALENCE   (G(1),       C(1)),     (G(420),     C(420))            2463
      EQUIVALENCE   (ANS(1),  C(421)),   (ANS(454),     C(874))            2464
      EQUIVALENCE   (HSUM,       C(424)),   (SSUM,       C(425))            2465
      EQUIVALENCE   (WTMOL,      C(426)),   (CP,         C(427))            2466
      EQUIVALENCE   (DLMPT,      C(428)),   (DLMTP,      C(429))            2467
      EQUIVALENCE   (GAMMA,      C(430)),   (ARATIC,     C(431))            2468
      EQUIVALENCE   (VMACH,      C(432)),   (SP IMP,     C(433))            2469
      EQUIVALENCE   (VACI,       C(434)),   (CF,         C(436))            2470
      EQUIVALENCE   (RHOI,       C(437)),   (RHOVAC,     C(438))            2471
      EQUIVALENCE   (RHO,        C(439))                                     2472
      EQUIVALENCE   (T PI,       C(440)),   (PI I,       C(441))            2473
      EQUIVALENCE   (EP PI,      C(442)),   (AW PI,      C(443))            2474
      EQUIVALENCE   (T ETA,      C(445))                                     2475
      EQUIVALENCE   (ETA I,      C(446)),   (EP ETA,     C(447))            2476
      EQUIVALENCE   (AW ETA,     C(448)),   (T SIG,      C(450))            2477
      EQUIVALENCE   (SIG I,      C(451)),   (EP SIG,     C(452))            2478
      EQUIVALENCE   (AW SIG,     C(453))                                     2479
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))              2480
      EQUIVALENCE   (FORM(1),    C(1329)), (FORM(15),  C(1343))              2481
      EQUIVALENCE   (DATA(1),  C(1359)), (DATA(23),  C(1381))              2482
      EQUIVALENCE   (MDATA(1),  C(1359)), (MDATA(23), C(1381))             2483
      EQUIVALENCE   (EN(1),   C(1382)), (EN(90),   C(1471))                2484
      EQUIVALENCE   (ISYS,     C(1472))                                    2485
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,      C(1475))            2486
      EQUIVALENCE   (AMX,        C(1476)),   (AMF,       C(1477))          2487
      EQUIVALENCE   (RHOX,       C(1478)),   (RHOF,      C(1479))          2488
      EQUIVALENCE   (COEFX(1),    C(1480)), (COEFX(20), C(1499))           2489
      EQUIVALENCE   (DX(1),     C(1500)), (DX(20),    C(1519))             2490
      EQUIVALENCE   (FORMLA(1),  C(1520)), (FORMLA(18),  C(1537))          2491
      EQUIVALENCE   (MMLA(1),   C(1520)), (MMLA(18), C(1537))              2492
      EQUIVALENCE   (PROD(1),  C(1538)), (PROD(3),   C(1540))              2493
      EQUIVALENCE   (SYSTM(1),  C(1541)), (SYSTM(15),   C(1555))           2494
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))             2495
      EQUIVALENCE   (OF,      C(1556)),     (FPCT,   C(1557))              2496
      EQUIVALENCE   (OOF,      C(1556))                                    2497
      EQUIVALENCE   (PERCF,     C(1557)),     (EQUIV,     C(1558))         2498
      EQUIVALENCE   (EQRAT,      C(1558))                                  2499
      EQUIVALENCE                          (KASE,       C(1560))         2500
      EQUIVALENCE   (KONT,   C(1561)),    (NF,          C(1562))          2501
      EQUIVALENCE   (NO,         C(1563)), (NE,          C(1564))          2502
      EQUIVALENCE   (NOEQ, C(1565))                                        2503
      EQUIVALENCE   (NOFROZ,     C(1566))                                  2504
      EQUIVALENCE   (P1,         C(1567)),   (T1,        C(1568))          2505
      EQUIVALENCE   (AM1,          C(1569)), (H1,        C(1570))          2506
      EQUIVALENCE   (CON,        C(1571)), (ITR,         C(1572))          2507
      EQUIVALENCE   (R,          C(1573)), (KODE,        C(1574))          2508
      EQUIVALENCE   (JEAN,       C(1575)), (GAMF,      C(1585))            2509
      EQUIVALENCE   (A1,     C(1576)), (A2,    C(1577)),   (A3,    C(1578)) 2510
      EQUIVALENCE   (A4,    C(1579)),    (A5,    C(1580)),    (A6,  C(1581)) 2511
      EQUIVALENCE   (A7,  C(1582)),   (A8,  C(1583)),    (A9,    C(1584))  2512
      EQUIVALENCE   (UUS,          C(1586)),     (US,  C(1587))            2513
      EQUIVALENCE   (PPP,      C(1588)),       (TTT,      C(1589))         2514
      EQUIVALENCE   (TE,      C(1590)),       (TEM,      C(1591))          2515
      EQUIVALENCE   (AMD,      C(1592)),       (UD,     C(1593))           2516
      EQUIVALENCE   (AMOL(1),    C(1594)),    (AMOL(105),    C(1698))      2517
      EQUIVALENCE (KD, C(1763)), (II, C(1764))                             2518
      EQUIVALENCE (MM, C(1765)), (IN, C(8046))                             2519
      EQUIVALENCE (ME, C(1769)), (KORE, C(8047))                           2520
      EQUIVALENCE   (BOX(1),     C(1771)), (BOX(15),    C(1785))           2521
      EQUIVALENCE   (BOF(1),     C(1786)), (BOF(15),    C(1800))           2522
      EQUIVALENCE   (HX,         C(1801)), (HF,         C(1802))           2523
      EQUIVALENCE   (VXPLS,      C(1803)), (VXMIN,      C(1804))           2524
      EQUIVALENCE   (VFPLS,      C(1805)), (VFMIN,      C(1806))           2525
      EQUIVALENCE (ELMT(1), C(1807)), (ELMT(15), C(1821))                  2526
      EQUIVALENCE (LLMT(1), C(1807)), (LLMT(15), C(1821))                  2527
      EQUIVALENCE   (EN LN(1),   C(1861)), (EN LN(90), C(1950))            2528
      EQUIVALENCE   (DEL N(1),   C(1951)), (DEL N(90), C(2040))            2529
      EQUIVALENCE   (HO(1),      C(2041)), (HO(90),     C(2130))           2530
      EQUIVALENCE   (S(1),       C(2131)), (S(90),      C(2220))           2531
      EQUIVALENCE   (X(1),       C(2221)), (X(20),      C(2240))           2532
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      EQUIVALENCE   (DELTA(1),  C(2241)), (DELTA(20), C(2260))                2533
      EQUIVALENCE   (BO(1),     C(2261)), (BO(15),    C(2275))                2534
      EQUIVALENCE   (PO,        C(2276)), (HSUBO,     C(2277))                2535
      EQUIVALENCE   (SO,        C(2278)), (T LN,      C(2279))                2536
      EQUIVALENCE   (T,         C(2280)), (AAY LN,    C(2281))                2537
      EQUIVALENCE   (AAY,       C(2282)), (CPSUM,     C(2283))                2538
      EQUIVALENCE   (HC,        C(2284)), (TC LN,     C(2285))                2539
      EQUIVALENCE   (PCP(1),    C(2286)), (PCP(25),   C(2310))                2540
      EQUIVALENCE   (DATUM(1),  C(2311)), (DATUM(3),  C(2313))                2541
      EQUIVALENCE   (PC,        C(2314)), (TC,        C(2315))                2542
      EQUIVALENCE   (IPROB,     C(2316)), (IFIXT,     C(2317))                2543
      EQUIVALENCE   (IHS,       C(2318)), (ICOND,     C(2319))                2544
      EQUIVALENCE   (ISYM,      C(2320)), (IPROD,     C(2321))                2545
      EQUIVALENCE   (IDID,      C(2322)), (LDRUM,     C(2323))                2546
      EQUIVALENCE   (IDRM,      C(2323)), (KDRUM,     C(2324))                2547
      EQUIVALENCE   (L,         C(2325)), (L1,        C(2326))                2548
      EQUIVALENCE   (M,         C(2327)), (M1,        C(2328))                2549
      EQUIVALENCE   (N,         C(2329)), (IQ,        C(2330))                2550
      EQUIVALENCE   (IQ1,       C(2331)), (IQ2,       C(2332))                2551
      EQUIVALENCE   (IQ3,       C(2333)), (KMAT,      C(2334))                2552
      EQUIVALENCE   (IMAT,      C(2335)), (IUSE,      C(2335))                2553
      EQUIVALENCE   (IADD,      C(2336)), (ITNUMB,    C(2337))                2554
      EQUIVALENCE   (ITAPE,     C(2338)), (P,         C(2339))                2555
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,     C(2341))                2556
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))            2557
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))             2558
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))             2559
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))                 2560
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))              2561
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))             2562
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))                          2563
C                                                                             2564
      DIMENSION   G(20,21),   A(15,90),   EN(90),      EN LN(90)              2565
      DIMENSION   DEL N(90),  HO(90),     S(90),       X(20)                  2566
      DIMENSION   DELTA(20),  BO(15),     PCP(25),     PROD(3)                2567
      DIMENSION   COEFX(20),  DX(20),     FORM(15)                            2568
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                                 2569
      DIMENSION   ELMT(15),   DATA(23),   DATUM(3),    FORMLA(18)             2570
      DIMENSION   BOX(15),    BOF(15),    ANS(454),    SYSTM(15)              2571
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                                  2572
      DIMENSION   ANSLAB(454),   COEFT(15,90)                                 2573
      DIMENSION   MATOM(101,3),     ATOM(101,3)                               2574
C                                                                             2575
C                                                                             2576
C   CORE LOAD 4   DETONATION VELOCITIES                                       2577
      IF(JEAN-101)100,101,100                                                 2578
  100 WRITE OUTPUT TAPE 6,2                                                   2579
    2 FORMAT (38H1   DETONATION VELOCITY   CALCULATIONS)                      2580
      PPP=15.0                                                                2581
      CON=(ACF+CCF*ACX)/(1.0+CCF)                                             2582
      AM1=AMX*AMF*(1.0+CCF)/(AMX+CCF*AMF)                                     2583
      WRITE OUTPUT TAPE 6,102,KODE                                            2584
  102 FORMAT (4X,5HKODE=I1)                                                   2585
      PCP(1)=1.0/PPP                                                          2586
      PCP(2)=0.0                                                              2587
      R=1.98726                                                               2588
      TTT=0.0                                                                 2589
      H1=HSUBO*R                                                              2590
      P1=PC                                                                   2591
      T1=TC                                                                   2592
      TC=0.0                                                                     Correction
      PC=PC*14.696006                                                         2593
      ITR=0                                                                   2594
      IUSE=0                                                                     Correction
      JEAN=101                                                                2595
   20 HSUBO=H1/R+.75*T1/AM1*PPP                                               2596
   21 KCRE  =0                                                                2597
      RETURN                                                                  2598
  101 DO 1101 J= 1,454                                                        2599
 1101 ANS(J) = ANSLAB(J)                                                      2600
      GAM=GAMMA                                                               2601
      IF(KODE)91,92,91                                                        2602
   91 GAMMA=GAMMA*(1.0+DLMPT)                                                 2603
```

```
 92 PPP=ANS(2)/P1                                                        2604
    TTT=ANS(3)/T1                                                        2605
    E=PPP                                                                2606
    EE=TTT                                                               2607
    IF(ITR)201,200,201                                                   2608
200 TEMM=WTMOL/AM1                                                       2609
    II=0                                                                 2610
    WRITE OUTPUT TAPE 6,203,II,PPP,TTT                                   2611
    DO 202 II=1,7                                                        2612
    TEM=TEMM/TTT*GAMMA                                                   2613
    PPPP=(1.0+GAMMA)/(2.0*TEM)*                                          2614
   2(1.0+SQRTF(1.0-4.0*TEM/(1.0+GAMMA)**2))                              2615
    TE=TEM/GAMMA*PPPP                                                    2616
    TTTT=EE-.75*R/(AM1*CP)*E+GAMMA*R/(2.*AM1*CP)*((TE**2-1.0)/TE)*PPPP   2617
    WRITE OUTPUT TAPE 6,203,II,PPPP,TTTT                                 2618
203 FORMAT(I5,2E20.8)                                                    2619
    IF(ABSF(PPPP-PPP)-.1)205,205,206                                     2620
206 PPP=PPPP                                                             2621
    TTT=TTTT                                                             2622
202 CONTINUE                                                             2623
205 PCP(1)=T1*TTTT                                                       2624
    PC=P1*PPPP                                                           2625
    TC=0.0                                                               2626
    IPROB=3                                                              2627
    ITR=1                                                                2628
    GAMMA=GAM                                                            2629
    GO TO 21                                                             2630
201 TEMM=PPP/TTT*WTMOL/AM1                                               2631
    TEM=(1.0-GAMMA*(TEMM-1.0))                                           2632
    A11=1.0/PPP-GAMMA*TEMM*(1.0+DLMPT)                                   2633
    A12=GAMMA*TEMM*(1.0-DLMTP)                                           2634
    A21=GAMMA/2.0*(DLMPT+TEMM**2*(2.0+DLMPT))-DLMTP                      2635
    HAL=GAMMA/2.0*(TEMM**2+1.0)                                          2636
    A22=HAL*(DLMTP-1.0)-WTMOL*CP/R                                       2637
    B1=1.0/PPP-TEM                                                       2638
    B2=WTMOL/(R*ANS(3))*(HSUM-H1)-GAMMA/2.0*(TEMM**2-1.0)                2639
    ASSIGN 51 TO JJ                                                      2640
 50 EEM=A11*A22-A21*A12                                                  2641
    X1=(B1*A22-B2*A12)/EEM                                               2642
    X2=(A11*B2-A21*B1)/EEM                                               2643
    GO TO JJ,(51,52,53,       59)                                        2644
 51 TE=ABSF(X1)                                                          2645
    TEM=ABSF(X2)                                                         2646
    IF(TE-.4)94,94,95                                                    2647
 94 IF(TEM-.4)96,96,95                                                   2648
 96 ALAM=1.0                                                             2649
    GO TO 97                                                             2650
 95 IF(TE-TEM)93,93,98                                                   2651
 93 HAL=TEM                                                              2652
    GO TO 99                                                             2653
 98 HAL=TE                                                               2654
 99 ALAM=.4/HAL                                                          2655
 97 PPPP=PPP*EXPF(X1*ALAM)                                               2656
    TTTT=TTT*EXPF(X2*ALAM)                                               2657
301 US=91.18496 *SQRTF(GAMMA*ANS(3)/WTMOL)                               2658
    UD=TEMM*US                                                           2659
    PCP(1)=T1*TTTT                                                       2660
    PC=P1*PPPP                                                           2661
    TC=0.0                                                               2662
    IPROB=3                                                              2663
    TE=WTMOL/AM1                                                         2664
    TEM=PPPP/TTTT*TE                                                     2665
    E=X1**2+X2**2                                                        2666
    EE=SQRTF(E)                                                          2667
    WRITE OUTPUT TAPE 6,10,ITR                                           2668
 10 FORMAT (21H0    ITERATION NUMBER=I2,10X,3HOLD,17X,3HNEW//)           2669
    WRITE OUTPUT TAPE 6,30,PPP,PPPP,TTT,TTTT,TEMM,TEM,X1,X2,US,UD,E      2670
   2,EE                                                                  2671
 30 FORMAT(6X,4HP/P1,10X,1H=2E20.8/6X,4HT/T1,10X,1H=2E20.8/6X,8HRHO/RH   2672
   101,6X,1H=2E20.8/6X,11HDEL LN P/P1,3X,1H=E20.8/6X,11HDEL LN T/T1,3X   2673
   2,1H=E20.8/6X,2HUS,12X,1H=E20.8/6X,2HUD,12X,1H=E20.8/6X,1HE,13X,1H=   2674
   3E20.8/6X,13HSQR ROOT OF E,1X,1H=E20.8)                               2675
    PPP=PPPP                                                             2676
    TTT=TTTT                                                             2677
    IF(ABSF(X1)-.5E-05)11,11,12                                          2678
 11 IF(ABSF(X2)-.5E-05)13,13,12                                          2679
```

```
   12 IF(ITR-10)14,13,13                                                  2680
   14 ITR=ITR+1                                                           2681
      GAMMA=GAM                                                           2682
      GO TO 21                                                            2683
   13 JEAN=1C                                                             2684
      P=PPP*P1                                                            2685
      T=TTT*T1                                                            2686
      US=91.18496 *SQRTF(GAMMA*T/WTMOL)                                   2687
      UD=TEM*US                                                           2688
      WRITE OUTPUT TAPE 6,31                                              2689
   31 FORMAT (17H1   FINAL ANSWERS//)                                     2690
      WRITE OUTPUT TAPE 6,32,PPP,TTT,TE,TEM,P,T,WTMOL,P1,T1,AM1,US,UD     2691
     2,CON                                                                2692
   32 FORMAT (6X,4HP/P1,10X,1H=E20.8/6X,4HT/T1,10X,1H=E20.8/6X,4HM/M1,10  2693
     2X,1H=E20.8/6X,8HRHO/RHO1,6X,1H=E20.8/6X,1HP,13X,1H=E20.8/6X,1HT,13  2694
     3X,1H=E20.8/6X,1HM,13X,1H=E20.8/6X,2HP1,12X,1H=E20.8/6X,2HT1,12X,1H  2695
     4=E20.8/6X,2HM1,12X,1H=E20.8/6X,2HUS,12X,1H=E20.8/6X,2HUD,12X,1H=E2  2696
     5C.8/6X,2HCP,12X,1H=E20.8)                                           2697
      IF(CON)41,40,41                                                     2698
   41 GAMF=CON/(CON-R/AM1)                                                2699
      AMD=UD/(91.18496*SQRTF(GAMF*T1/AM1))                                2700
      WRITE OUTPUT TAPE 6,42,GAMF,AMD                                     2701
   42 FORMAT (6X,7HGAMMA F,7X,1H=E20.8/6X,2HMD,12X,1H=E20.8)              2702
      GO TO 15C                                                           2703
   4C GAMF=0.0                                                            2704
      AMD=0.0                                                             2705
  15C FEM=.5*(2.C+DLMPT)                                                  2706
      TEMM=.5*(DLMTP-1.0)                                                 2707
      WRITE OUTPUT TAPE 6,55                                              2708
   55 FORMAT (17HC   DERIVATIVE OF,12X,4HLN P,13X,4HLN T,13X,5HLN UD/4X,  2709
     22HBY)                                                               2710
      B1=1.0/PPP-GAMMA*TEM                                                2711
      B2=GAMMA*  TEM**2                                                   2712
      ASSIGN 53 TO JJ                                                     2713
      GO TO 50                                                            2714
   53 CASE1=(FEM*X1+TEMM*X2-1.0)*UD                                       2715
      X1=X1-1.0                                                           2716
      WRITE OUTPUT TAPE 6,81,X1,X2,CASE1                                  2717
   81 FORMAT (6X,12HLNP1 AT T1,G,7X,1H=3E17.8)                            2718
      A1=X1                                                               2719
      A2=X2                                                               2720
      A3=CASE1                                                            2721
      B1=GAMMA*TEM                                                        2722
      B2=-B1*TEM-WTMOL*CON/R/TTT                                          2723
      ASSIGN 59 TO JJ                                                     2724
      GO TO 50                                                            2725
   59 CASE4=(FEM*X1+TEMM*X2+1.0)*UD                                       2726
      X2=X2-1.0                                                           2727
      WRITE OUTPUT TAPE 6,84,X1,X2,CASE4                                  2728
   84 FORMAT(6X,16HLNT1 AT P1,H1,M1,3X,1H=3E17.8)                         2729
      A4=X1                                                               2730
      A5=X2                                                               2731
      A6=CASE4                                                            2732
      B1=0.0                                                              2733
      B2=-WTMOL/(R*T)                                                     2734
      ASSIGN 52 TO JJ                                                     2735
      GO TO 50                                                            2736
   52 X1=X1*1000.0                                                        2737
      X2=X2*1000.0                                                        2738
      CASE5=(FEM*X1+TEMM*X2)*UD                                           2739
      WRITE OUTPUT TAPE 6,85,X1,X2,CASE5                                  2740
   85 FORMAT (6X,20HH1    AT T1,P1,M1    =3E17.8)                         2741
      A7=X1                                                               2742
      A8=X2                                                               2743
      A9=CASE5                                                            2744
      GAMMA=GAM                                                           2745
      IPROB=1                                                             2746
      UUS=91.18496*SQRTF(GAMF*T1/AM1)                                     2747
      WRITE TAPE 3,(G(I),I=1,8044)                                        2748
      CALL OUT                                                            2749
      KORE=1                                                              2750
      RETURN                                                              2751
```

```
      SUBROUTINE CUT                                                    2752
C                                                                       2753
      COMMON C                                                          2754
      EQUIVALENCE   (G(1),      C(1)),    (G(420),    C(420))         2755
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),    C(874))         2756
      EQUIVALENCE   (HSUM,      C(424)),  (SSUM,      C(425))         2757
      EQUIVALENCE   (WTMCL,     C(426)),  (CP,        C(427))         2758
      EQUIVALENCE   (DLMPT,     C(428)),  (DLMTP,     C(429))         2759
      EQUIVALENCE   (GAMMA,     C(430)),  (ARATIC,    C(431))         2760
      EQUIVALENCE   (VMACH,     C(432)),  (SP IMP,    C(433))         2761
      EQUIVALENCE   (VACI,      C(434)),  (CF,        C(436))         2762
      EQUIVALENCE   (RHOI,      C(437)),  (RHOVAC,    C(438))         2763
      EQUIVALENCE   (RHO,       C(439))                               2764
      EQUIVALENCE   (T PI,      C(440)),  (PI I,      C(441))         2765
      EQUIVALENCE   (EP PI,     C(442)),  (AW PI,     C(443))         2766
      EQUIVALENCE   (T ETA,     C(445))                               2767
      EQUIVALENCE   (ETA I,     C(446)),  (EP ETA,    C(447))         2768
      EQUIVALENCE   (AW ETA,    C(448)),  (T SIG,     C(450))         2769
      EQUIVALENCE   (SIG I,     C(451)),  (EP SIG,    C(452))         2770
      EQUIVALENCE   (AW SIG,    C(453))                               2771
      EQUIVALENCE   (ANSLAB(1), C(875)), (ANSLAB(454), C(1328))       2772
      EQUIVALENCE   (FORM(1),   C(1329)), (FORM(15),  C(1343))        2773
      EQUIVALENCE   (DATA(1),   C(1359)), (DATA(23),  C(1381))        2774
      EQUIVALENCE   (MDATA(1),  C(1359)), (MDATA(23), C(1381))        2775
      EQUIVALENCE   (EN(1),   C(1382)), (EN(90),    C(1471))        2776
      EQUIVALENCE   (ISYS,      C(1472))                              2777
      EQUIVALENCE   (ACX,       C(1474)),   (ACF,     C(1475))        2778
      EQUIVALENCE   (AMX,       C(1476)),   (AMF,     C(1477))        2779
      EQUIVALENCE   (RHOX,      C(1478)),   (RHOF,    C(1479))        2780
      EQUIVALENCE   (COEFX(1),    C(1480)), (COEFX(20), C(1499))        2781
      EQUIVALENCE   (DX(1),     C(1500)),   (DX(20),    C(1519))      2782
      EQUIVALENCE   (FORMLA(1), C(1520)), (FORMLA(18), C(1537))       2783
      EQUIVALENCE   (MMLA(1),   C(1520)), (MMLA(18), C(1537))         2784
      EQUIVALENCE   (PROD(1),   C(1538)), (PROD(3),   C(1540))        2785
      EQUIVALENCE   (SYSTM(1),  C(1541)), (SYSTM(15),   C(1555))      2786
      EQUIVALENCE   (MTSYS(1), C(1541)), (MTSYS(15),  C(1555))        2787
      EQUIVALENCE   (OCF,     C(1556))                                2788
      EQUIVALENCE   (OF,      C(1556)),     (FPCT,    C(1557))        2789
      EQUIVALENCE   (PERCF,     C(1557)),     (EQUIV,     C(1558))    2790
      EQUIVALENCE   (EQRAT,     C(1558))                              2791
      EQUIVALENCE                         (KASE,      C(1560))      2792
      EQUIVALENCE   (KONT,    C(1561)),   (NF,          C(1562))      2793
      EQUIVALENCE   (NC,        C(1563)), (NE,          C(1564))      2794
      EQUIVALENCE   (NCEC, C(1565))                                   2795
      EQUIVALENCE   (NCFRCZ,    C(1566))                              2796
      EQUIVALENCE   (P1,        C(1567)),   (T1,        C(1568))      2797
      EQUIVALENCE   (AM1,         C(1569)), (H1,        C(1570))      2798
      EQUIVALENCE   (CON,       C(1571)),   (ITR,       C(1572))      2799
      EQUIVALENCE   (R,         C(1573)),   (KCDE,      C(1574))      2800
      EQUIVALENCE   (JEAN,      C(1575)),   (GAMF,      C(1585))      2801
      EQUIVALENCE   (A1,    C(1576)), (A2,    C(1577)),   (A3,    C(1578))  2802
      EQUIVALENCE   (A4,    C(1579)),   (A5,    C(1580)),   (A6,  C(1581))  2803
      EQUIVALENCE   (A7,  C(1582)),   (A8,  C(1583)),   (A9,    C(1584))  2804
      EQUIVALENCE   (UUS,         C(1586)),     (US,  C(1587))        2805
      EQUIVALENCE   (PPP,       C(1588)),     (TTT,     C(1589))      2806
      EQUIVALENCE   (TE,      C(1590)),     (TEM,     C(1591))        2807
      EQUIVALENCE   (AMD,       C(1592)),     (UD,    C(1593))        2808
      EQUIVALENCE (KD, C(1763)), (II, C(1764))                        2809
      EQUIVALENCE (MM, C(1765)), (IN, C(8046))                        2810
      EQUIVALENCE (NF, C(1769))                                       2811
      EQUIVALENCE   (BCX(1),    C(1771)), (BCX(15),   C(1785))        2812
      EQUIVALENCE   (BCF(1),    C(1786)), (BCF(15),   C(1800))        2813
      EQUIVALENCE   (HX,        C(1801)), (HF,        C(1802))        2814
      EQUIVALENCE   (VXPLS,     C(1803)), (VXMIN,     C(1804))        2815
      EQUIVALENCE   (VFPLS,     C(1805)), (VFMIN,     C(1806))        2816
      EQUIVALENCE   (EN LN(1),  C(1861)), (EN LN(90), C(1950))        2817
      EQUIVALENCE   (DEL N(1),  C(1951)), (DEL N(90), C(2040))        2818
      EQUIVALENCE   (HC(1),     C(2041)), (HC(90),    C(2130))        2819
      EQUIVALENCE   (S(1),      C(2131)), (S(90),     C(2220))        2820
      EQUIVALENCE   (X(1),      C(2221)), (X(20),     C(2240))        2821
      EQUIVALENCE   (DELTA(1),  C(2241)), (DELTA(20), C(2260))        2822
      EQUIVALENCE   (BC(1),     C(2261)), (BC(15),    C(2275))        2823
      EQUIVALENCE   (PC,        C(2276)), (HSUBO,     C(2277))        2824
      EQUIVALENCE   (SC,        C(2278)), (T LN,      C(2279))        2825
      EQUIVALENCE   (T,         C(2280)), (AAY LN,    C(2281))        2826
      EQUIVALENCE   (AAY,       C(2282)), (CPSUM,     C(2283))        2827
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      EQUIVALENCE   (HC,        C(2284)), (TC LN,     C(2285))              2828
      EQUIVALENCE   (PCP(1),    C(2286)), (PCP(25),   C(2310))              2829
      EQUIVALENCE   (DATUM(1),  C(2311)), (DATUM(3),  C(2313))              2830
      EQUIVALENCE   (PC,        C(2314)), (TC,        C(2315))              2831
      EQUIVALENCE   (IPROB,     C(2316)), (IFIXT,     C(2317))              2832
      EQUIVALENCE   (IHS,       C(2318)), (ICOND,     C(2319))              2833
      EQUIVALENCE   (ISYM,      C(2320)), (IPROD,     C(2321))              2834
      EQUIVALENCE   (IDID,      C(2322)), (LDRUM,     C(2323))              2835
      EQUIVALENCE   (IDRM,      C(2323)), (KDRUM,     C(2324))              2836
      EQUIVALENCE   (L,         C(2325)), (L1,        C(2326))              2837
      EQUIVALENCE   (M,         C(2327)), (M1,        C(2328))              2838
      EQUIVALENCE   (IQ1,       C(2331)), (IQ2,       C(2332))              2839
      EQUIVALENCE   (N,         C(2329)), (IQ,        C(2330))              2840
      EQUIVALENCE   (IQ3,       C(2333)), (KMAT,      C(2334))              2841
      EQUIVALENCE   (IMAT,      C(2335)), (IUSE,      C(2335))              2842
      EQUIVALENCE   (IADD,      C(2336)), (ITNUMB,    C(2337))              2843
      EQUIVALENCE   (ITAPE,     C(2338)), (P,         C(2339))              2844
      EQUIVALENCE   (IDEBUG,    C(2340)), (IFROZ,     C(2341))              2845
      EQUIVALENCE   (COEFT1(1),  C(3692)), (COEFT1(1350), C(5041))          2846
      EQUIVALENCE   (COEFT2(1), C(5042)), (COEFT2(1350), C(6391))           2847
      EQUIVALENCE   (COEFT(1),  C(6392)),  (COEFT(1350), C(7741))           2848
      EQUIVALENCE   (ATOM(1),  C(7742)), (ATOM(303), C(8044))               2849
      EQUIVALENCE   (MATOM(1),  C(7742)), (MATOM(303),  C(8044))            2850
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))           2851
      EQUIVALENCE (ELMT(1), C(1807)), (ELMT(15), C(1821))                   2852
      EQUIVALENCE (LLMT(1), C(1807)), (LLMT(15), C(1821))                   2853
      EQUIVALENCE (AMOL(1), C(9268)), (AMOL(1170),  C(10437))               2854
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))                        2855
      EQUIVALENCE (KSAN,C(10623))                                                Moles
C                                                                           2856
      DIMENSION   G(20,21),                EN(90),     EN LN(90)            2857
      DIMENSION   DEL N(90),  HO(90),      S(90),      X(20)                2858
      DIMENSION   DELTA(20),  BO(15),      PCP(25),    PROD(3)              2859
      DIMENSION   COEFX(20),  DX(20),      FORM(15)                         2860
      DIMENSION COEFT1(15,90) , COEFT2(15,90)                               2861
      DIMENSION   ELMT(15),   DATA(23),    DATUM(3),   FORMLA(18)           2862
      DIMENSION   BOX(15),    BOF(15),     ANS(454),   SYSTM(15)            2863
      DIMENSION LLMT(15),MTSYS(15),MDATA(23)                                2864
      DIMENSION   ANSLAB(454),   COEFT(15,90)                               2865
      DIMENSION   MATOM(101,3),     ATOM(101,3)                             2866
      DIMENSION TITLE(3,105),            A(15,46)                           2867
      DIMENSION AMOL(13,90)                                                 2868
C                                                                           2869
C                                                                           2870
    2 FORMAT (9HCCASE NO.I5,F8.2,F8.2)                                      2871
    3 FORMAT (1HC,64X,52HWT FRACTION  ENTHALPY   STATE  TEMP    HEAT CAP    2872
     2ACITY/25X,16HCHEMICAL FORMULA,24X,10H(SEE NOTE),4X,7HCAL/MOL,9X,      2873
     35HDEG K,4X,13HCAL/MOL-DEG K)                                          2874
    4 FORMAT (1HC,84X,46HWT FRACTION  ENTHALPY   STATE  TEMP       CP  /    2875
     2        25X,16HCHEMICAL FORMULA,44X,10H(SEE NOTE),4X,7HCAL/MOL,       2876
     3        10X,5HDEG K)                                                  2877
    5 FORMAT(1H+,63X,F9.5,F12.3,4X,A1,F10.2,F11.4)                          2878
    6 FORMAT(1H+,83X,F9.5,F12.3,4X,A1,F10.2,F11.4)                          2879
    7 FORMAT (1HC,30X,4HO/F=F9.6,15H, PERCENT FUEL=F8.4,20H, EQUIVALENCE    2880
     1 RATIO=F7.4)                                                          2881
   20 FORMAT      (43X,46HDETONATION PROPERTIES OF AN IDEAL REACTING GAS)   2882
   21 FORMAT (43X,45HCALCULATED USING SPECIFIC HEAT RATIO AS GAMMA)         2883
   22 FORMAT (1HC,24HTHERMODYNAMIC PROPERITES/27X,12HUNBURNED GAS, 5X,10    2884
     2HBURNED GAS)                                                          2885
   23 FORMAT (1X,6HP, ATM,20X,F12.5,3X,F12.5)                               2886
   24 FORMAT (1X,8HT, DEG K,18X,F12.2,3X,F12.1)                             2887
   25 FORMAT (1X,9HH, CAL/G ,17X,F12.1,3X,F12.1)                            2888
   26 FORMAT (1X,15HS, CAL/G-DEG K ,26X,F12.4)                              2889
   27 FORMAT (1X,11HM, MOL. WT.15X,F12.3,3X,F12.3)                          2890
   28 FORMAT (1X,16HCP, CAL/G-DEG K ,10X,F12.4,3X,F12.4)                    2891
   29 FORMAT (1X,12H(DLNM/DLNP)T,14X,F12.5,3X,F12.5)                        2892
   30 FORMAT (1X,12H(DLNM/DLNT)P,14X,F12.4,3X,F12.4)                        2893
   31 FORMAT (1X,5HGAMMA,21X,F12.4,3X,F12.4)                                2894
   32 FORMAT (1X,9HUS, M/SEC,17X,F12.1,3X,F12.1)                            2895
   33 FORMAT(1HC/1X,40HBURNED GAS COMPOSITION IN MOLE FRACTIONS//)          2896
   34 FORMAT (1HC/1X,21HDETONATION PARAMETERS,                              2897
     22X,27H(UD IN M/SEC, H1 IN KCAL/G))                                    2898
   35 FORMAT (1HC,4HP/P1,4X,1H=F7.3,5X,21H(DL(P/P1)/DLP1)T1,H1=F8.5,5X,1    2899
     28H(DL(P/P1)/DLT1)P1=F8.5,5X,20H(DL(P/P1)/DH1)P1,T1=F8.5)              2900
   36 FORMAT ( 1X,4HT/T1,4X,1H=F7.3,5X,21H(DL(T/T1)/DLP1)T1,H1=F8.5,5X,1    2901
     18H(DL(T/T1)/DLT1)P1=F8.5,5X,20H(DL(T/T1)/DH1)P1,T1=F8.5)              2902
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```
   37 FORMAT (1X,4HM/M1,4X,1H=F7.4)                                          2903
   38 FORMAT (1X,9HRHO/RHO1=F7.4)                                            2904
   39 FORMAT (1X,9HMACH NO.=F7.4)                                            2905
   40 FORMAT (1X,9HUD      =F7.1,5X,16H(D UD/DLP1)T1,H1,4X,1H=F8.2,5X,13     2906
     1H(D UD/DLT1)P14X,1H=F8.2,5X,15H(D UD/DH1)P1,T1,4X,1H=F8.2)             2907
 1000 WRITE OUTPUT TAPE 6,18                                                 2908
   18 FORMAT (1H1)                                                           2909
  552 REWIND 3                                                               2910
  300 READ TAPE 3,(ANS(I),I=1,454)                                           2911
      HAL=P1*14.696006                                                       2912
      I=1                                                                    2913
      J=38                                                                   2914
      DO 350 JJ=1,N                                                          2915
      AMOL(1,I)=ANS(J)                                                       2916
      J=J+4                                                                  2917
  350 I=I+1                                                                  2918
      WRITE OUTPUT TAPE 6,20                                                 2919
      IF(KODE)351,352,351                                                    2920
  351 WRITE OUTPUT TAPE 6,21                                                 2921
  352 CONTINUE                                                               2922
B     ZERO=0.0000000000                                                      2923
  106 J=34                                                                   2924
      DO 104 I=1,N                                                           2925
      DO 105 II=1,3                                                          2926
      KK=J+II                                                                2927
  105 TITLE(II,I)=ANS(KK)                                                    2928
  104 J=J+4                                                                  2929
      ASSIGN 90 TO JEAN                                                      2930
   92 WRITE OUTPUT TAPE 6,2,KASE,HAL,T1                                      2931
      GO TO JEAN,(90,91)                                                     2932
   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 (1HC,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                                                               } Moles
  710 IF (KSAN) 712,711,712                                                  }
  711 WRITE OUTPUT TAPE 6,4                                                  }
      GO TO 97                                                               }
  712 WRITE OUTPUT TAPE 6,744                                                }
  744 FORMAT (1HC,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                                                      2937
  451 DO 100 I=1,NF                                                          2938
      II=I                                                                   2939
      MM=15                                                                  2940
      CALL SPEC                                                              2941
      IF(KD)401,400,401                                                      2942
  400 WRITE OUTPUT TAPE 6,5,A(I,34),A(I,32),A(I,42),A(I,44),A(I,36)          2943
      GO TO 100                                                              2944
  401 WRITE OUTPUT TAPE 6,6,A(I,34),A(I,32),A(I,42),A(I,44),A(I,36)          2945
  100 CONTINUE                                                               2946
  450 IF(NO)453,452,453                                                      2947
  453 DO 101 I=1,NO                                                          2948
      II=I                                                                   2949
      MM=0                                                                   2950
      CALL SPEC                                                              2951
      IF(KD)411,410,411                                                      2952
  410 WRITE OUTPUT TAPE 6,5,A(I,33),A(I,31),A(I,41),A(I,43),A(I,35)          2953
      GO TO 101                                                              2954
  411 WRITE OUTPUT TAPE 6,6,A(I,33),A(I,31),A(I,41),A(I,43),A(I,35)          2955
  101 CONTINUE                                                               2956
  452 CONTINUE                                                               2957
      WRITE OUTPUT TAPE 6,7,COF,PERCF,EQUIV                                  2958
      WRITE OUTPUT TAPE 6,22                                                 2959
      WRITE OUTPUT TAPE 6,23,P1,P                                            2960
      WRITE OUTPUT TAPE 6,24,T1,T                                            2961
      WRITE OUTPUT TAPE 6,25,H1,ANS(4)                                       2962
      WRITE OUTPUT TAPE 6,26,ANS(5)                                          2963
      WRITE OUTPUT TAPE 6,27,AM1,ANS(6)                                      2964
      WRITE OUTPUT TAPE 6,28,CON,ANS(7)                                      2965
      WRITE OUTPUT TAPE 6,29,ZERO,ANS(8)                                     2966
```

```
      WRITE OUTPUT TAPE 6,30,ZERO,ANS(9)                                  2967
      WRITE OUTPUT TAPE 6,31,GAMF,ANS(10)                                 2968
      WRITE OUTPUT TAPE6,32,UUS,US                                        2969
      WRITE OUTPUT TAPE 6,33                                              2970
      IN=1                                                                2971
      NE=2                                                                2972
      CALL COMP                                                           2973
      WRITE OUTPUT TAPE 6,34                                              2974
      WRITE OUTPUT TAPE 6,35,PPP,A1,A4,A7                                 2975
      WRITE OUTPUT TAPE 6,36,TTT,A2,A5,A8                                 2976
      WRITE OUTPUT TAPE 6,40,UD,A3,A6,A9                                  2977
      WRITE OUTPUT TAPE 6,37,TE                                           2978
      WRITE OUTPUT TAPE 6,38,TEM                                          2979
      WRITE OUTPUT TAPE 6,39,AMD                                          2980
  207 WRITE OUTPUT TAPE 6,16                                              2981
   16 FORMAT (1HO,30X,16HINPUT, G-ATOMS/G//)                              2982
      IF(NE-8)80,80,81                                                    2983
   80 KK=1                                                                2984
      KKK=NE                                                              2985
      LOOP=1                                                              2986
      GO TO 82                                                            2987
   81 KK=1                                                                2988
      KKK=8                                                               2989
      LOOP=2                                                              2990
   82 DO 85 J=1,LOOP                                                      2991
      WRITE OUTPUT TAPE 6,11,(ELMT(I),I=KK,KKK)                           2992
   11 FORMAT (11X,8(6X,A2,7X))                                            2993
      WRITE OUTPUT TAPE 6,12,(BOF (I),I=KK,KKK)                           2994
   12 FORMAT (5H FUEL,6X,8E15.7)                                          2995
      WRITE OUTPUT TAPE 6,13,(BOX (I),I=KK,KKK)                           2996
   13 FORMAT (8H OXIDANT,3X,8E15.7)                                       2997
      WRITE OUTPUT TAPE 6,14,(BO  (I),I=KK,KKK)                           2998
   14 FORMAT (11H PROPELLANT,8E15.7)                                      2999
      IF (LOOP-1) 86,85,86                                                3000
   86 KK=9                                                                3001
      KKK=NE                                                              3002
      WRITE OUTPUT TAPE 6,15                                              3003
   15 FORMAT(1HO)                                                         3004
   85 CONTINUE                                                            3005
      ASSIGN 91 TO JEAN                                                   3006
      GO TO 92                                                            3007
   91 IF (KSAN) 751,750,751                                                   Moles
  750 WRITE OUTPUT TAPE 6,119                                                 Moles
  119 FORMAT (6HONOTE.,2X,71HWEIGHT FRACTION OF FUEL IN TOTAL FUELS AND   3009
     1OF OXIDANT IN TOTAL OXIDANTS)                                       3010
  751 CONTINUE                                                                Moles
      RETURN                                                              3011
```

```
      SUBROUTINE ONCE (N,M)                                               3012
C                                                                         3013
C     OUTPUTS ODD PRODUCTS                                                3014
C                                                                         3015
C                                                                         3016
      COMMON C                                                            3017
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))         3018
      DIMENSION M(105),TITLE(3,105) ,TEM(10),FMT(3)                       3019
      WRITE OUTPUT TAPE 6,1                                               3020
B     FMT(1)=740130207360                                                 3021
B     FMT(3)=210634606060                                                 3022
B     TEM(1)=606001677302                                                 3023
B     TEM(2)=600104677302                                                 3024
B     TEM(3)=600207677302                                                 3025
B     TEM(4)=600400677302                                                 3026
B     TEM(5)=600503677302                                                 3027
B     TEM(6)=600606677302                                                 3028
B     TEM(7)=600711677302                                                 3029
B     TEM(8)=601102677302                                                 3030
B     TEM(9)=010005677302                                                 3031
B     TEM(10)=010110677302                                                3032
      K=0                                                                 3033
      KK=10                                                               3034
      DO 10 I=1,N                                                         3035
      J=M(I)                                                              3036
```

```
      IF(I-KK) 20,20,21                                                 3037
   20 K=K+1                                                             3038
      GO TO 5                                                           3039
   21 K=1                                                               3040
      KK=KK+10                                                          3041
      WRITE OUTPUT TAPE 6,1                                             3042
    1 FORMAT (1H )                                                      3043
    5 FMT(2)=TEM(K)                                                     3044
      WRITE OUTPUT TAPE 6,FMT,TITLE(2,J),TITLE(3,J)                     3045
   10 CONTINUE                                                          3046
      RETURN                                                            3047


      SUBROUTINE SPEC                                                   3048
C                                                                       3049
C     OUTPUTS FUEL AND OXIDANT FROM SUBROUTINE INPUT                    3050
C                                                                       3051
C                                                                       3052
      COMMON C                                                          3053
      EQUIVALENCE (KONT, C(1763))                                       3054
      EQUIVALENCE (I, C(1764)), (M,C(1765))                             3055
      EQUIVALENCE (A(1),  C(8578)),  (A(690),  C(9267))                 3056
      EQUIVALENCE (ELMT(1),  C(1807)), (ELMT(15),  C(1821))             3057
      DIMENSION A(15,46),TEM(5),ANAME(5),ELMT(15)                       3058
      DIMENSION II(5)                                                   3059
   55 FORMAT (10X,4HFUEL)                                               3060
   66 FORMAT (10X,7HOXIDANT)                                            3061
      IF (M ) 2,1,2                                                     3062
    1 WRITE OUTPUT TAPE 6,66                                            3063
      GO TO 3                                                           3064
    2 WRITE OUTPUT TAPE 6,55                                            3065
    3 K=0                                                               3066
      DO 11 J=1,15                                                      3067
      KK=I+M                                                            3068
      IF(A(J,KK))12,11,12                                               3069
   12 K=K+1                                                             3070
      TEM(K)=A(J,KK)                                                    3071
      ANAME(K)=ELMT(J)                                                  3072
      II(K)=TEM(K)                                                      3073
   11 CONTINUE                                                          3074
      IF(KONT)21,20,21                                                  3075
   20 WRITE OUTPUT TAPE 6,4,(ANAME(I),II(I),I=1,K)                      3076
    4 FORMAT(1H+,18X,5(A2,I2,5X))                                       3077
      GO TO 13                                                          3078
   21 WRITE OUTPUT TAPE 6,5,(ANAME(I),TEM(I),I=1,K)                     3079
    5 FORMAT (1H+,18X,5(A2,F8.5,3X))                                    3080
   13 RETURN                                                            3081
```

```
      SUBROUTINE COMP                                                   3082
C                                                                       3083
C     OUTPUTS COMPOSITION                                               3084
C                                                                       3085
C                                                                       3086
      COMMON C                                                          3087
      EQUIVALENCE (AMOL(1), C(9268)), (AMOL(1170), C(10437))            3088
      EQUIVALENCE (NANA, C(1768)), (IN, C(8046))                        3089
      EQUIVALENCE (ME, C(1769)), (N, C(2329))                           3090
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))       3091
      EQUIVALENCE   (MTITLE(1), C(8055)), (MTITLE(315),   C(8369))      3092
      EQUIVALENCE (OMIT,MOMIT)                                          3093
      DIMENSION              TITLE(3,105),IOMIT(105),ILESS(105)         3094
      DIMENSION AMOL(13,90)                                             3095
      DIMENSION FMT(4),TEM(4)                                           3096
      DIMENSION MTITLE (3,105)                                          3097
    1 FORMAT (1X,2A6,2X,13F9.5)                                         3098
    3 FORMAT (1HC,   118HADDITIONAL PRODUCTS WHICH WERE CONSIDERED BUT W 3099
     1HOSE MOLE FRACTIONS WERE LESS THAN 0.0C0005 FOR ALL ASSIGNED CONDI 3100
     2TIONS//)                                                          3101
    4 FORMAT (1HC,    59HPRODUCTS WHICH WERE INTENTIONALLY OMITTED FROM 3102
     1CALCULATIONS//)                                                   3103
B     OMIT=464431636060                                                 3104
B     TEM(1)=6C6C07677302                                               3105
B     TEM(2)=6C0306677302                                               3106
B     TEM(3)=6C0604677302                                               3107
B     TEM(4)=6C1102677302                                               3108
B     FMT(1)=74C130207360                                               3109
B     FMT(3)=21C673261033                                               3110
B     FMT(4)=053460606060                                               3111
      K=0                                                               3112
      KK=4                                                              3113
      ICM=0                                                             3114
      ILE=0                                                             3115
      IF(ME-1)61,60,61                                                  3116
   61 WRITE OUTPUT TAPE 6,44                                            3117
   60 II=0                                                              3118
      DO 9 I=1,N                                                        3119
      IF (MTITLE(1,I)-MOMIT) 10,100,10                                  3120
  100 ICM=ICM+1                                                         3121
      IOMIT(ICM)=I                                                      3122
      GO TO 9                                                           3123
   10 DO 11 J=1,IN                                                      3124
      IF(AMOL(J,I)-.5E-05)11,12,12                                      3125
   11 CONTINUE                                                          3126
      ILE=ILE+1                                                         3127
      ILESS(ILE)=I                                                      3128
      GO TO 9                                                           3129
   12 IF(ME-1)51,50,51                                                  3130
   50 WRITE OUTPUT TAPE 6,1 ,TITLE(2,I),TITLE(3,I),(AMOL(JJ,I),JJ=1,IN) 3131
      GO TO 9                                                           3132
   51 II=II+1                                                           3133
      IF(II-KK)200,200,201                                              3134
  200 K=K+1                                                             3135
      GO TO 5                                                           3136
  201 K=1                                                               3137
      KK=KK+4                                                           3138
      WRITE OUTPUT TAPE 6,44                                            3139
   44 FORMAT (1H )                                                      3140
    5 FMT(2)=TEM(K)                                                     3141
      WRITE OUTPUT TAPE 6,FMT,TITLE(2,I),TITLE(3,I),AMOL(1,I)           3142
    9 CONTINUE                                                          3143
      IF(ILE) 21,20,21                                                  3144
   21 WRITE OUTPUT TAPE 6,44                                            3145
      WRITE OUTPUT TAPE 6,3                                             3146
      CALL ONCE (ILE,ILESS)                                             3147
   20 IF(IOM) 31,30,31                                                  3148
   31 WRITE OUTPUT TAPE 6,44                                            3149
      WRITE OUTPUT TAPE 6,4                                             3150
      CALL ONCE (IOM,IOMIT)                                             3151
   30 RETURN                                                            3152
```

```
      SUBROUTINE  CORE5                                                    3153
C                                                                          3154
C     OUTPUT ROUTINE                                                       3155
C                                                                          3156
C                                                                          3157
      COMMON C                                                             3158
      EQUIVALENCE   (ANS(1),  C(421)),  (ANS(454),    C(874))            3159
      EQUIVALENCE   (PERCF,    C(1557)),    (EQUIV,    C(1558))           3160
      EQUIVALENCE   (IOF,     C(1556))                                     3161
      EQUIVALENCE (KODE,    C(1559)),   (KASE,      C(1560))             3162
      EQUIVALENCE   (KONT,   C(1561)),   (NF,         C(1562))           3163
      EQUIVALENCE   (NO,        C(1563)), (NE,        C(1564))           3164
      EQUIVALENCE   (NOEQ, C(1565))                                      3165
      EQUIVALENCE   (NOFROZ,    C(1566))                                 3166
      EQUIVALENCE (KO, C(1763)), (II, C(1764))                           3167
      EQUIVALENCE (MM, C(1765))                                          3168
      EQUIVALENCE (LEN, C(1766)), (MAY, C(1767))                         3169
      EQUIVALENCE (NANA, C(1768)), (ME, C(1769))                         3170
      EQUIVALENCE (LOOP, C(1770)), (KTAPE, C(8045))                      3171
      EQUIVALENCE   (BOX(1),    C(1771)), (BOX(15),   C(1785))           3172
      EQUIVALENCE   (BOF(1),    C(1786)), (BOF(15),   C(1800))           3173
      EQUIVALENCE   (BO(1),     C(2261)), (BO(15),    C(2275))           3174
      EQUIVALENCE   (IPROB,     C(2316)), (IFIXT,     C(2317))           3175
      EQUIVALENCE   (N,         C(2329)), (IO,        C(2330))           3176
      EQUIVALENCE (IN, C(8046))                                          3177
      EQUIVALENCE (KK, C(8048)), (KKK, C(8049))                          3178
      EQUIVALENCE   (TITLE(1),    C(8055)), (TITLE(315), C(8369))        3179
      EQUIVALENCE (ELMT(1), C(1807)), (ELMT(15), C(1821))                3180
      EQUIVALENCE (PAR(1),  C(8370)), (PAR(208),  C(8577))               3181
      EQUIVALENCE(A(1), C(8578)),  (A(690), C(9267))                     3182
      EQUIVALENCE (AMOL(1),  C(9268)),  (AMOL(1170),  C(10437))          3183
      EQUIVALENCE (DER(1), C(10438)),  (DER(169), C(10606))              3184
      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 (KSAN,C(10623))                                            Moles
      DIMENSION SAREA(13)                                                    Area ratio
      DIMENSION        TITLE(3,105),PAR(13,16),DER(13,13),               3185
     2           A(15,46),ELMT(15)                                       3186
     3,ANS(454)                                                         3187
      DIMENSION BOX(15),BOF(15),BO(15)                                   3188
      DIMENSION AMOL(13,90)                                              3189
      DIMENSION         ASOL(13)                                         3190
B     EXIT=256731636060                                                  3191
    2 FORMAT (9HCCASE NO.I5,F8.1,F7.3)                                   3192
    3 FORMAT (1HC,64X,46HWT FRACTION  ENTHALPY   STATE  TEMP    DENSITY/  3193
     225X,16HCHEMICAL FORMULA,24X,10H(SEE NOTE),4X,7HCAL/MOL,10X,        3194
     35HDEG K,4X,4HG/CC)                                                 3195
    4 FORMAT (1HC,84X,46HWT FRACTION  ENTHALPY   STATE  TEMP    DENSITY/  3196
     2        25X,16HCHEMICAL FORMULA,44X,10H(SEE NOTE),4X,7HCAL/MOL,     3197
     3        8X,5HDEG K,4X,4HG/CC)                                       3198
    5 FORMAT(1H+,63X,F9.5,F12.3,4X,A1,F10.2,F11.6)                       3199
    6 FORMAT(1H+,83X,F9.5,F12.3,4X,A1,F10.2,F11.6)                       3200
    7 FORMAT (1HC,30X,4HO/F=F9.6,15H, PERCENT FUEL=F8.4,20H, EQUIVALENCE 3201
     1 RATIO=F7.4,10H, DENSITY=F7.4)                                     3202
      DO 60 I=1,13                                                       3203
   60 ASOL(I)=EXIT                                                       3204
      IF(IPROB-2)550,550,551                                             3205
  550 NANA=2                                                             3206
      GO TO 552                                                          3207
  551 NANA=1                                                             3208
  552 REWIND 3                                                           3209
      KANE = NANA                                                        3210
      DO 200 ME=1,KANE                                                   3211
      KTAPE=0                                                            3212
  300 READ TAPE 3, (ANS(I),I=1,454)                                      3213
      KTAPE=KTAPE+1                                                      3214
      HAL=ANS(2)*14.696006                                               3215
      HALL=ANS(19)                                                       3216
      IF(ME-1)202,201,202                                                3217
  201 LEN=NOEQ                                                           3218
      GO TO 203                                                          3219
  202 LEN=NOFROZ                                                         3220
  203 IF(LEN-13)102,102,103                                              3221
  102 KODE=0                                                             3222
      GO TO 106                                                          3223
```

```
  103 KONT=0                                                                    3224
      KODE=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 (KD) 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 (1HC,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 (1HC,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(KD)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(KD)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(KODE)51,50,51                                                          Area ratio
   50 IN=LEN                                                                    3266
      GO TO 56                                                                  3267
   51 IF(KONT) 53,52,53                                                         3268
   52 IN=KODE                                                                   3269
      KONT=1                                                                    3270
      GO TO 56                                                                  3271
   53 IN=LEN -13                                                                3272
      KODE=0                                                                    3273
   56 CALL READ                                                                 3274
      IF(IPRCR-2)600,600,601                                                    3275
  601 WRITE OUTPUT TAPE 6,602                                                   3276
  602 FORMAT (37HOEQUILIBRIUM 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,(ASCL(I),I=1, KK)                                  3284
```

```
 61 FORMAT (1HC,16X,7HCHAMBER,4X,7HTHROAT ,10(3X,A6),3X,A4)                    3285
    GO TO 65                                                                  3286
 64 WRITE OUTPUT TAPE 6,66,(ASOL(I),I=1,IN)                                   3287
 66 FORMAT (1HC,15X,13(3X,A6))                                                3288
 65 CONTINUE                                                                  3289
    CALL PERPAR                                                               3290
    IF(NE-1)206,205,206                                                       3291
205 WRITE OUTPUT TAPE 6,99                                                    3292
 99 FORMAT(1H )                                                               3293
    WRITE OUTPUT TAPE 6,9                                                     3294
  9 FORMAT (12HODERIVATIVES)                                                  3295
    IF(MAY-1) 503,502,503                                                     3296
503 CALL PERDER                                                               3297
    GO TO 504                                                                 3298
502 CALL PERDEY                                                               3299
504 CONTINUE                                                                  3300
206 WRITE OUTPUT TAPE 6,99                                                    3301
    WRITE OUTPUT TAPE 6,10                                                    3302
 10 FORMAT (15HOMOLE FRACTIONS//)                                             3303
    CALL COMP                                                                 3304
    ASSIGN 3000 TO LENNN                                                          Area ratio
207 WRITE OUTPUT TAPE 6,16                                                    3305
 16 FORMAT (1HC,30X,16HINPUT, G-ATOMS/G//)                                    3306
    IF(NE-8)80,80,81                                                          3307
 80 KK=1                                                                      3308
    KKK=NE                                                                    3309
    LOOP=1                                                                    3310
    GO TO 82                                                                  3311
 81 KK=1                                                                      3312
    KKK=8                                                                     3313
    LOOP=2                                                                    3314
 82 DO 85 J=1,LOOP                                                            3315
    WRITE OUTPUT TAPE 6,11,(ELMT(I),I=KK,KKK)                                 3316
 11 FORMAT (11X,8(6X,A2,7X))                                                  3317
    WRITE OUTPUT TAPE 6,12,(BOF (I),I=KK,KKK)                                 3318
 12 FORMAT (5H FUEL,6X,8E15.7)                                                3319
    WRITE OUTPUT TAPE 6,13,(BOX (I),I=KK,KKK)                                 3320
 13 FORMAT (8H OXIDANT,3X,8E15.7)                                             3321
    WRITE OUTPUT TAPE 6,14,(BO  (I),I=KK,KKK)                                 3322
 14 FORMAT (11H PROPELLANT,8E15.7)                                            3323
    IF (LOOP-1) 86,85,86                                                      3324
 86 KK=9                                                                      3325
    KKK=NE                                                                    3326
    WRITE OUTPUT TAPE 6,15                                                    3327
 15 FORMAT(1HO)                                                               3328
 85 CONTINUE                                                                  3329
    ASSIGN 91 TO JEAN                                                         3330
    GO TO 92                                                                  3331
 91 IF (KSAN) 751,750,751                                                         Moles
750 WRITE OUTPUT TAPE 6,119                                                       Moles
119 FORMAT (6HONOTE.,2X,71HWEIGHT FRACTION OF FUEL IN TOTAL FUELS AND        3333
   1OF OXIDANT IN TOTAL OXIDANTS)                                             3334
751 CONTINUE                                                                      Area ratio
    GO TO LENNN,(3000,3001)                                                       Area ratio
3000 IF(KODE)96,95,96                                                             Area ratio
 96 MAY=MAY+1                                                                 3336
    GO TO 1000                                                                3337
 95 IF(IPROB-2)700,700,701
700 IF(NAREA)702,701,702
702 IF(LEN-4)701,703,703
703 CALL SANFO
    IF(IPROB-2)7000,7001,7001
7001 IF(ME-1)7003,7002,7003
7002 WRITE OUTPUT  TAPE 6,7005
7005 FORMAT (    25X,8OHTHEORETICAL ROCKET PERFORMANCE ASSUMING EQUILIB
    2RIUM COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERAT
    3URE/                                                                         Area ratio
    445X,24HFOR ASSIGNED AREA RATIOS)
    GO TO 5050
7003 WRITE OUTPUT TAPE 6,7006
7006 FORMAT (    25X,75HTHEORETICAL 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
```

```
 4000 FORMAT(1H1, 25X,75HTHECRETICAL ROCKET PERFORMANCE ASSUMING FROZEN
     2COMPOSITION DURING EXPANSION/
     345X,24HFOR ASSIGNED AREA RATIOS)
      GO TO 505C
   71 WRITE OUTPUT TAPE 6,5000
 5000 FORMAT (1H1,25X,80HTHECRETICAL ROCKET PERFORMANCE ASSUMING EQUILIB
     2RIUM COMPOSITION DURING EXPANSION/
     345X,24HFOR ASSIGNED AREA RATIOS)
 505C CONTINUE
      ASSIGN 2001 TO LENN                                              } Area ratio
      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                                                                    3339
      RETURN                                                                      3340
C                                                                                 3341
C                                                                                 3342
C                                                                                 3343
                                                                                  3344


      SUBROUTINE HEAD                                                             3345
C                                                                                 3346
C     OUTPUTS PROPER HEADING ACCORDING TO PROBLEM NUMBER                          3347
C                                                                                 3348
C                                                                                 3349
      COMMON C                                                                    3350
      EQUIVALENCE (IPROB, C(2316)), (ME, C(1769))                                 3351
  100 FORMAT (    25X,80HTHECRETICAL ROCKET PERFORMANCE ASSUMING EQUILIB         3352
     2RIUM COMPOSITION DURING EXPANSION)                                          3353
  200 FORMAT (    25X,75HTHECRETICAL ROCKET PERFORMANCE ASSUMING FROZEN          3354
     2COMPOSITION DURING EXPANSION)                                               3355
  300 FORMAT (    25X,80HTHECRETICAL ROCKET PERFORMANCE ASSUMING EQUILIB         3356
     2RIUM COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERAT          3357
     3URE)                                                                        3358
  400 FORMAT (    25X,75HTHECRETICAL ROCKET PERFORMANCE ASSUMING FROZEN          3359
     2COMPOSITION DURING EXPANSION/44X,28HFROM AN ASSIGNED TEMPERATURE)           3360
  500 FORMAT (    25X,74HTHECRETICAL THERMODYNAMIC PROPERTIES AT ASSIGNE         3361
     2D PRESSURE AND TEMPERATURES)                                                3362
  600 FORMAT (    25X,74HTHECRETICAL THERMODYNAMIC PROPERTIES AT ASSIGNE         3363
     2D TEMPERATURE AND PRESSURES)                                                3364
      IF(IPROB-2)1,2,10                                                           3365
   10 IF (IPROB-4) 3,4,5                                                          } H,P
    5 WRITE OUTPUT TAPE 6,9000                                                    }
 9000 FORMAT(25X, 47HTHEORETICAL THERMODYNAMIC COMBUSTION PROPERTIES)             }
      RETURN
    1 IF(ME-1)12,11,12                                                            3367
   11 WRITE OUTPUT TAPE 6,100                                                     3368
      RETURN                                                                      3369
   12 WRITE OUTPUT TAPE 6,200                                                     3370
      RETURN                                                                      3371
    2 IF(ME-1)14,13,14                                                            3372
   13 WRITE OUTPUT TAPE 6,300                                                     3373
      RETURN                                                                      3374
   14 WRITE OUTPUT TAPE 6,400                                                     3375
      RETURN                                                                      3376
    3 WRITE OUTPUT TAPE 6,500                                                     3377
      RETURN                                                                      3378
    4 WRITE OUTPUT TAPE 6,600                                                     3379
      RETURN                                                                      3380
C                                                                                 3381
C                                                                                 3382
C                                                                                 3383
```

```
      SUBROUTINE PERDER                                                 3384
C                                                                       3385
C     OUTPUTS PERFORMANCE DERIVATIVES                                   3386
C                                                                       3387
C                                                                       3388
      COMMON C                                                          3389
      EQUIVALENCE (IN, C(8046))                                         3390
      EQUIVALENCE (PER(1), C(10438)),  (PER(169), C(10606))             3391
      DIMENSION PER(13,13)                                              3392
    1 FORMAT (15H0(DLI/DLPC)PC/P13F9.5)                                 3393
    2 FORMAT (15H (DLT/DLPC)PC/P13F9.5)                                 3394
    3 FORMAT (16H (DLAR/DLPC)PC/PF8.5,12F9.5)                           3395
    4 FORMAT (16H (DLCS/DLPC)PC/PF8.5,12F9.5)                           3396
    5 FORMAT (15H0(DLI/DHC)PC/P*13F9.5)                                 3397
    6 FORMAT (15H (DLT/DHC)PC/P*13F9.5)                                 3398
    7 FORMAT (16H (DLAR/DHC)PC/P*F8.5,12F9.5)                           3399
    8 FORMAT (16H (DLCS/DHC)PC/P*F8.5,12F9.5)                           3400
    9 FORMAT (16H *(HC IN KCAL/G))                                      3401
   10 FORMAT (13H0(DLI/DLPCP)S,2X,13F9.5)                               3402
   11 FORMAT (13H (DLT/DLPCP)S,2X,13F9.5)                               3403
   12 FORMAT (15H (DLAR/DLPCP)S 13F9.5)                                 3404
      WRITE OUTPUT TAPE 6,1,(PER(I,2),I=1,IN)                           3405
      WRITE OUTPUT TAPE 6,2,(PER(I,1),I=1,IN)                           3406
      WRITE OUTPUT TAPE 6,3,(PER(I,3),I=1,IN)                           3407
      WRITE OUTPUT TAPE 6,4,(PER(I,5),I=1,IN)                           3408
      WRITE OUTPUT TAPE 6,5,(PER(I,7),I=1,IN)                           3409
      WRITE OUTPUT TAPE 6,6,(PER(I,6),I=1,IN)                           3410
      WRITE OUTPUT TAPE 6,7,(PER(I,8),I=1,IN)                           3411
      WRITE OUTPUT TAPE 6,8,(PER(I,10),I=1,IN)                          3412
      WRITE OUTPUT TAPE 6,9                                             3413
      WRITE OUTPUT TAPE 6,10,(PER(I,12),I=1,IN)                         3414
      WRITE OUTPUT TAPE 6,11,(PER(I,11),I=1,IN)                         3415
      WRITE OUTPUT TAPE 6,12,(PER(I,13),I=1,IN)                         3416
      RETURN                                                            3417
C                                                                       3418
C                                                                       3419
C                                                                       3420


      SUBROUTINE PERDEY                                                 3421
C                                                                       3422
C     OUTPUTS PERFORMANCE DERIVATIVES                                   3423
C                                                                       3424
C                                                                       3425
      COMMON C                                                          3426
      EQUIVALENCE (IN, C(8046))                                         3427
      EQUIVALENCE (PER(1), C(10438)),  (PER(169), C(10606))             3428
      DIMENSION PER(13,13)                                              3429
    1 FORMAT (15H0(DLI/DLPC)PC/P,9X,12F9.5)                             3430
    2 FORMAT (15H (DLT/DLPC)PC/P13F9.5)                                 3431
    3 FORMAT (16H (DLAR/DLPC)PC/P,8X,12F9.5)                            3432
    4 FORMAT (16H (DLCS/DLPC)PC/P,8X,12F9.5)                            3433
    5 FORMAT (15H0(DLI/DHC)PC/P*,9X,12F9.5)                             3434
    6 FORMAT (15H (DLT/DHC)PC/P*13F9.5)                                 3435
    7 FORMAT (16H (DLAR/DHC)PC/P*,8X,12F9.5)                            3436
    8 FORMAT (16H (DLCS/DHC)PC/P*,8X,12F9.5)                            3437
    9 FORMAT (16H *(HC IN KCAL/G))                                      3438
   10 FORMAT (13H0(DLI/DLPCP)S,11X,12F9.5)                              3439
   11 FORMAT (13H (DLT/DLPCP)S,2X,13F9.5)                               3440
   12 FORMAT (15H (DLAR/DLPCP)S,9X,12F9.5)                              3441
      WRITE OUTPUT TAPE 6,1,(PER(I,2),I=2,IN)                           3442
      WRITE OUTPUT TAPE 6,2,(PER(I,1),I=1,IN)                           3443
      WRITE OUTPUT TAPE 6,3,(PER(I,3),I=2,IN)                           3444
      WRITE OUTPUT TAPE 6,4,(PER(I,5),I=2,IN)                           3445
      WRITE OUTPUT TAPE 6,5,(PER(I,7),I=2,IN)                           3446
      WRITE OUTPUT TAPE 6,6,(PER(I,6),I=1,IN)                           3447
      WRITE OUTPUT TAPE 6,7,(PER(I,8),I=2,IN)                           3448
      WRITE OUTPUT TAPE 6,8,(PER(I,10),I=2,IN)                          3449
      WRITE OUTPUT TAPE 6,9                                             3450
      WRITE OUTPUT TAPE 6,10,(PER(I,12),I=2,IN)                         3451
      WRITE OUTPUT TAPE 6,11,(PER(I,11),I=1,IN)                         3452
      WRITE OUTPUT TAPE 6,12,(PER(I,13),I=2,IN)                         3453
      RETURN                                                            3454
C                                                                       3455
C                                                                       3456
C                                                                       3457
```

```
      SUBROUTINE READ                                                    3458
C                                                                        3459
C     SORTS WHAT IS ON TAPE 3                                            3460
C                                                                        3461
C                                                                        3462
      COMMON C                                                           3463
      EQUIVALENCE   (ANS(1), C(421)), (ANS(454),    C(874))              3464
      EQUIVALENCE (LEN, C(1766)), (MAY, C(1767))                         3465
      EQUIVALENCE (LOOP, C(1770)), (KTAPE, C(8045))                      3466
      EQUIVALENCE (IN, C(8046))                                          3467
      EQUIVALENCE  (NN,   C(2329))                                       3468
      EQUIVALENCE (PAR(1), C(8370)), (PAR(208), C(8577))                 3469
      EQUIVALENCE (AMOL(1),  C(9268)), (AMCL(1170), C(10437))            3470
      EQUIVALENCE (DER(1), C(10438)),  (DER(169), C(10606))              3471
      DIMENSION PAR(13,16),DER(13,13),              ANS(454)             3472
      DIMENSION AMCL(13,90)                                              3473
      DO 1 I=1,IN                                                        3474
      DO 2 J=1,16                                                        3475
    2 PAR(I,J)=ANS(J)                                                    3476
      N=1                                                                3477
      DO 3 J=20,32                                                       3478
      DER(I,N)=ANS(J)                                                    3479
    3 N=N+1                                                              3480
      N=1                                                                3481
      J=38                                                               3482
      DO 4 JJ=1,NN                                                       3483
      AMCL(I,N)=ANS(J)                                                   3484
      J=J+4                                                              3485
    4 N=N+1                                                              3486
      IF(KTAPE-LEN)100,1,100                                             3487
  100 READ TAPE 3,(ANS(K),K=1,454)                                       3488
      KTAPE=KTAPE+1                                                      3489
    1 CONTINUE                                                           3490
      RETURN                                                             3491
C                                                                        3492
C                                                                        3493
C                                                                        3494


      SUBROUTINE PERPAR                                                  3495
C                                                                        3496
C     OUTPUTS PERFORMANCE PARAMETERS                                     3497
C                                                                        3498
C                                                                        3499
      COMMON C                                                           3500
      EQUIVALENCE (KODE, C(1768))                                        3501
      EQUIVALENCE (IN, C(8046)),  (MAY, C(1767))                         3502
      EQUIVALENCE (PAR(1), C(8370)), (PAR(208), C(8577))                 3503
      DIMENSION PAR(13,16),NN(13)                                        3504
   10 FORMAT (5H PC/P,10X)                                               3505
   11 FORMAT (8H P, ATM ,7X)                                             3506
   12 FORMAT (9H T, DEG K,6X,13I9)                                       3507
   13 FORMAT (9H H, CAL/G,6X,13F9.1)                                     3508
   14 FORMAT (15H S, CAL/(G)(K) 13F9.4)                                  3509
   15 FORMAT (10HOM, MCL WT,5X,13F9.3)                                   3510
   16 FORMAT (11H (DLM/DLP)T,4X,13F9.5)                                  3511
   17 FORMAT (11H (DLM/DLT)P,4X,13F9.4)                                  3512
   18 FORMAT (15H CP, CAL/(G)(K)13F9.4)                                  3513
   19 FORMAT (6H GAMMA,9X,13F9.4)                                        3514
   20 FORMAT (12H MACH NUMBER,3X,13F9.3)                                 3515
   21 FORMAT (15HCCSTAR, FT/SEC 13I9)                                    3516
   22 FORMAT (3H CF,12X,13F9.3)                                          3517
   23 FORMAT (6H AE/AT,9X,13F9.3)                                        3518
   24 FORMAT (15H IVAC,LB-SEC/LB13F9.1)                                  3519
   25 FORMAT (15H I, LB-SEC/LB  13F9.1)                                  3520
      IF(KODE-1)2,1,2                                                    3521
    1 WRITE OUTPUT TAPE 6,111                                            3522
  111 FORMAT (8HCP, ATM ,7X)                                             3523
      GO TO 3                                                            3524
    2 WRITE OUTPUT TAPE 6,10                                             3525
      CALL VAR(1,2)                                                      3526 Area ratio
      WRITE OUTPUT TAPE 6,11                                             3527
```

```
      3 CALL VAR(2,2)                                                    3528 Area ratio
        DO 6C I=1,IN                                                     3529
     6C NN(I)=PAR(I,3)+.5                                                3530
        WRITE CUTPUT TAPE 6,12,(NN(I),I=1,IN)                            3531
        WRITE CUTPUT TAPE 6,13,(PAR(I,4),I=1,IN)                         3532
        WRITE CUTPUT TAPE 6,14,(PAR(I,5),I=1,IN)                         3533
        WRITE CUTPUT TAPE 6,15,(PAR(I,6),I=1,IN)                         3534
        IF(KODE)6,5,6                                                    3535
      6 WRITE CUTPUT TAPE 6,16,(PAR(I,8),I=1,IN)                         3536
        WRITE CUTPUT TAPE 6,17,(PAR(I,9),I=1,IN)                         3537
      5 WRITE CUTPUT TAPE 6,18,(PAR(I,7),I=1,IN)                         3538
        WRITE CUTPUT TAPE 6,19,(PAR(I,10),I=1,IN)                        3539
        IF(KODE-1)41,4C,41                                               3540
     4C RETURN                                                           3541
     41 WRITE CUTPUT TAPE 6,2C,(PAR(I,12),I=1,IN)                        3542
        DO 61 I=1,IN                                                     3543
     61 NN(I)=PAR(I,15)+.5                                               3544
        IF (MAY-1) 51,5C,51                                              3545
     5C WRITE CUTPUT TAPE 6,31,(NN(I),I=2,IN)                            3546
        WRITE CUTPUT TAPE 6,32,(PAR(I,16),I=2,IN)                        3547
        WRITE CUTPUT TAPE 6,33                                           3548
        CALL VAR(11,2)                                                   3549 Area ratio
        WRITE CUTPUT TAPE 6,34,(PAR(I,14),I=2,IN)                        3550
        WRITE CUTPUT TAPE 6,35,(PAR(I,13),I=2,IN)                        3551
     31 FORMAT (15HOCSTAR, 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 CUTPUT TAPE 6,21,(NN(I),I=1,IN)                            3558
        WRITE CUTPUT TAPE 6,22,(PAR(I,16),I=1,IN)                        3559
        WRITE CUTPUT TAPE 6,23                                           3560
        CALL VAR(11,2)                                                   3561 Area ratio
        WRITE CUTPUT TAPE 6,24,(PAR(I,14),I=1,IN)                        3562
        WRITE CUTPUT 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 PC/P,P, AND AE/AT                             3570
C                                                                        3571
C                                                                        3572
        COMMON C                                                         3573
        EQUIVALENCE (IN, C(8C46)), (MAY, C(1767))                        3574
        EQUIVALENCE (PAR(1), C(837C)), (PAR(20E), 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)=60C104677326                                             3582
B       TEMM(2)=60C203677326                                             3583
B       TEMM(3)=60C302677326                                             3584
B       TEMM(4)=60C401677326                                             3585
B       TEMM(5)=60C500677326                                             3586
B       TEMM(6)=60C511677326                                             3587
B       TEMM(7)=60C610677326                                             3588
B       TEMM(8)=60C707677326                                             3589
B       TEMM(9)=601006677326                                             3590
B       TEMM(1C)=6C1105677326                                            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                                                          3600
      AM(2)=TWO                                                          3601
      AM(3)=ONE                                                          3602
      AM(4)=ZERO                                                         3603
      GO TO 4                                                            3604
    2 TEM(1)=1.0                                                         3605
      TEM(2)=10.0                                                        3606
      TEM(3)=100.0                                                       3607
      AM(1)=FR                                                           3608
      AM(2)=THR                                                          3609
      AM(3)=TWO                                                          3610
      AM(4)=ONE                                                          3611
      GO TO 4                                                            3612
    3 TEM(1)=10.0                                                        3613
      TEM(2)=100.0                                                       3614
      TEM(3)=1000.0                                                      3615
      AM(1)=THR                                                          3616
      AM(2)=TWO                                                          3617
      AM(3)=ONE                                                          3618
      AM(4)=ZERO                                                         3619
    4 DO 5 I=1,IN                                                        3620
      IF (I-1) 53,50,53                                                  3621
   50 IF (MAY-1) 53,52,53                                                3622
   52 IF(INDEX-11) 53,5,53                                               3623
   53 CONTINUE                                                           3624
      FMT(2)=TEMM(I)                                                     3625
      DO 6 J=1,3                                                         3626
      IF(PAR(I,INDEX)-TEM(J))10,6,6                                      3627
   10 FMT(3)=AM(J)                                                       3628
   11 WRITE OUTPUT TAPE 6,FMT,PAR(I,INDEX)                               3629
      GO TO 5                                                            3630
    6 CONTINUE                                                           3631
      FMT(3)=AM(4)                                                       3632
      WRITE OUTPUT TAPE 6,FMT,PAR(I,INDEX)                               3633
    5 CONTINUE                                                           3634
      RETURN                                                             3635
```

```
      SUBROUTINE SANFO                                                      5000
C                                                                           5001
C     (USED FOR AREA RATIO INTERPOLATION ONLY)                              5002
C                                                                           5003
C                                                                           5004
      COMMON C                                                              5005
      EQUIVALENCE(SAREA(1),C(10608)),(SAREA(13),C(10620))                   5006
      EQUIVALENCE(NAREA,C(10607))                                           5007
      EQUIVALENCE (PER(1), C(10438)),  (PER(169), C(10606))                 5008
      EQUIVALENCE (PAR(1),  C(8370)), (PAR(208),  C(8577))                  5009
      EQUIVALENCE (PC,C(2314)),  (HC,C(2284))                               5010
      EQUIVALENCE   (NCEQ, C(1565))                                         5011
      EQUIVALENCE (LEN,C(1766)), (ME,C(1769))                               5012
      EQUIVALENCE  (IN,C(8046))                                             5013
      EQUIVALENCE  (IUNDER,C(10621))                                        5014
      EQUIVALENCE  (IOVER,C(10622))                                         5015
      EQUIVALENCE(PCP(1),C(2286)),  (PCP(25),C(2310))                       5016
      DIMENSION PCP(25)                                                     5017
      DIMENSION PAR(13,16),PER(13,13),SAREA(13),TEM(13,10),SPEC(2)          5018
      DIMENSION A(6,7)                                                      5019
      DIMENSION ANS(6)                                                      5020
      DIMENSION TEMM(13)                                                    5021
      LEN=LEN                                                               5022
      NUNN=0                                                                5023
   80 NUN=0                                                                 5024
      DO 82  I=3,LEN                                                        5025
      IF (PCP(I)-PCP(2)) 83, 83, 89                                         5026
   89 NUNN=NUNN+1                                                           5027
      GO TO 82                                                              5028
   83 NUN=NUN+1                                                             5029
   82 CONTINUE                                                              5030
   81 IF (NUN) 85,84,85                                                     5031
   84 KCK=4                                                                 5032
      GO TO 86                                                              5033
   85 KCK=4+NUN                                                             5034
      KCKK=KCK-2                                                            5035
   86 CONTINUE                                                              5036
   97 L=1                                                                   5037
      DO 1 I=1,NAREA                                                        5038
      IF (I-IUNDER) 100,100,101                                             5039
  100 IF(NUN-1)201,201,200                                                  5040
  201 L=L-1                                                                 5041
      GO TO 1                                                               5042
  200 DO 22  J=4,KOKK                                                       5043
      IF (SAREA(I)-PAR(J,11)) 22,44,44                                      5044
   44 IND=J-1                                                               5045
      GO TO 6                                                               5046
   22 CONTINUE                                                              5047
      IND=KOKK-1                                                            5048
      GO TO 6                                                               5049
  101 IF(NUNN-1)201,201,202                                                 5050
  202 DO 2  J=KCK,LEN                                                       5051
      IF(SAREA(I)-PAR(J,11)) 4,4,2                                          5052
    4 IND=J-1                                                               5053
      GO TO 6                                                               5054
    2 CONTINUE                                                              5055
      IF(SAREA(I)-PAR(LEN,11)*3.0)91,90,90                                  5056
   91 IND=LEN-1                                                             5057
    6 IF(ME-1)60,66,60                                                      5058
   60 K=IND                                                                 5059
      DO 64 J=1,2                                                           5060
      PER(K,12)=1.98726*PAR(K,3)/(2.0*PAR(K,6)*(HC*1.98726-PAR(K,4)))       5061
      PER(K,11)=-1.98726/(PAR(K,7)*PAR(K,6))                                5062
      PER(K,13)=1.0/PAR(K,10)-PER(K,12)                                     5063
   64 K=K+1                                                                 5064
      TEM(L,10)=PAR(1,6)                                                    5065
   66 SPEC(1)=1.0/PER(IND,13)                                               5066
      SPEC(2)=1.0/PER(IND+1,13)                                             5067
      CALL SET(PAR(IND,1),SPEC,PAR(IND,11),SAREA(I),TEM(L,5))               5068
      CALL SET(PAR(IND,3),PER(IND,11),PAR(IND,1),TEM(L,5),TEM(L,7))         5069
      IF(ME-1)70,71,70                                                      5070
   71 SPEC(1)=-PAR(IND,8)+PAR(IND,9)*PER(IND,11)                            5071
      SPEC(2)=-PAR(IND+1,8)+PAR(IND+1,9)*PER(IND+1,11)                      5072
      CALL SET(PAR(IND,6),SPEC,PAR(IND,1),TEM(L,5),TEM(L,10))               5073
   70 K=IND                                                                 5074
      DO 20 J=1,2                                                           5075
```

```
      A(J,7)=PAR(K,13)**2                                                    5076
      A(J+2,7)=2.0*A(J,7)*PER(K,12)                                          5077
      A(J+4,7)=(1.0-PAR(K,10))/PAR(K,10)*A(J+2,7)                            5078
      A(J,1)=1.0                                                             5079
      A(J+2)=0.0                                                             5080
      A(J+4)=0.0                                                             5081
      A(J,2)=LOGF(PAR(K,1))                                                  5082
      A(J+2,2)=1.0                                                           5083
      A(J+4,2)=0.0                                                           5084
      DO 50 M=3,6                                                            5085
      A(J,M)=A(J,2)**(M-1)                                                   5086
      A(J+2,M)=A(J,2)**(M-2)*FLOATF(M-1)                                     5087
   50 A(J+4,M)=A(J+2,M)/A(J,2)*FLOATF(M-2)                                   5088
   20 K=K+1                                                                  5089
      CALL MGAUS(A,6,ANS)                                                    5090
      TEM(L,2)=ANS(1)                                                        5091
      SPEC=LOGF(TEM(L,5))                                                    5092
      DO 21 J=2,6                                                            5093
   21 TEM(L,2)=TEM(L,2)+ANS(J)*SPEC**(J-1)                                   5094
      TEM(L,6)=1.98726*HC-1000.0*TEM(L,2)/294.98**2                          5095
      IF(TEM(L,2))90,90,23                                                   5096
   23 TEM(L,2)=SQRTF(TEM(L,2))                                               5097
      IF(L-2)25,24,24                                                        5098
   24 IF(TEM(L,2)-TEM(L-1,2))90,25,25                                        5099
   25 TEM(L,1)=TEM(L,2)+PAR(2,15)*SAREA(I)/(32.174*TEM(L,5))                 5100
      TEM(L,3)=PAR(2,15)                                                     5101
      TEM(L,4)=TEM(L,2)*32.174/TEM(L,3)                                      5102
      TEM(L,8)=PC/TEM(L,5)                                                   5103
      TEM(L,9)=PAR(2,5)                                                      5104
      TEMM(L)=SAREA(I)                                                       5105
    1 L=L+1                                                                  5106
   90 L=L-1                                                                  5107
      IN=L                                                                   5108
      DO 30 I=1,IN                                                           5109
      PAR(I,1)=TEMM(I)                                                       5110
      DO 30 J=2,11                                                           5111
   30 PAR(I,J)=TEM(I,J-1)                                                    5112
      RETURN                                                                 5113
C                                                                            5114
C                                                                            5115
C                                                                            5116


      SUBROUTINE SET(ONE,TWO,THREE,ARG,HAL)                                  5117
C                                                                            5118
C     (USED FOR AREA RATIO INTERPOLATION ONLY)                               5119
C     SETS UP ALL 4 BY 5 MATRICES                                            5120
C                                                                            5121
C                                                                            5122
      DIMENSION A(6,7),ANS(6),ONE(2),TWO(2),THREE(2)                         5123
      DO 8 J=1,2                                                             5124
      A(J,5)=LOGF(ONE(J))                                                    5125
      A(J+2,5)=TWO(J)                                                        5126
    8 A(J,2)=LOGF(THREE(J))                                                  5127
      DO 1 I=1,2                                                             5128
      A(I,1)=1.0                                                             5129
      A(I+2,1)=0.0                                                           5130
      A(I+2,2)=1.0                                                           5131
      DO 1 J=2,3                                                             5132
      A(I,J+1)=A(I,2)**J                                                     5133
      A(I+2,J+1)=A(I,2)**(J-1)*FLOATF(J)                                     5134
    1 CONTINUE                                                               5135
      CALL MGAUS(A,4,ANS)                                                    5136
      HAL=ANS(1)                                                             5137
      SUM=LOGF(ARG)                                                          5138
      DO 10 J=1,3                                                            5139
   10 HAL=HAL+SUM**J*(ANS(J+1))                                              5140
      HAL=EXPF(HAL)                                                          5141
      RETURN                                                                 5142
C                                                                            5143
C                                                                            5144
C                                                                            5145
```

```
      SUBROUTINE MGAUS(A,N,ANS)                                          5146
C                                                                        5147
C     (USED FOR AREA RATIO INTERPOLATION ONLY)                           5148
C     SOLVES FOR INTERPOLATION COEFFICIENTS                              5149
C                                                                        5150
C                                                                        5151
      DIMENSION A(6,7),ANS(6)                                            5152
      DO 1 I=1,N                                                         5153
    1 ANS(I)=0.0                                                         5154
      DO 10 I=1,N                                                        5155
      DO 9 J=I,N                                                         5156
      A(I,J+1)=A(I,J+1)/A(I,I)                                           5157
      IF(I-N) 9,20,9                                                     5158
    9 CONTINUE                                                           5159
      K=I+1                                                              5160
      DO 8 II=K,N                                                        5161
      DO 8 JJ=I,N                                                        5162
    8 A(II,JJ+1)=-A(II,I)*A(I,JJ+1)+A(II,JJ+1)                           5163
   10 CONTINUE                                                           5164
   20 ANS(N)=A(I,J+1)                                                    5165
      IF(N-1)31,30,31                                                    5166
   30 RETURN                                                             5167
   31 J=N-1                                                              5168
      II=J                                                               5169
      DO 11 I=1,II                                                       5170
      K=J+1                                                              5171
      DO 12 M=1,I                                                        5172
      ANS(J)=ANS(K)*A(J,K)+ANS(J)                                        5173
   12 K=K+1                                                              5174
      ANS(J)=A(J,K)-ANS(J)                                               5175
   11 J=J-1                                                              5176
      RETURN                                                             5177
C                                                                        5178
C                                                                        5179
C                                                                        5180


      SUBROUTINE EXITT                                                   5181
C                                                                        5182
C     (USED FOR AREA RATIO INTERPOLATION ONLY)                           5183
C     OUTPUTS DATA FOR ASSIGNED AREA RATIOS                              5184
C                                                                        5185
C                                                                        5186
      COMMON C                                                           5187
      EQUIVALENCE (IN, C(8046)),  (MAY, C(1767))                         5188
      EQUIVALENCE (PAR(1), C(8370)), (PAR(208), C(8577))                 5189
      EQUIVALENCE (LEN,C(1766)), (ME,C(1769))                            5190
      DIMENSION PAR(13,16),NN(13)                                        5191
C     MAY MUST EQUAL 2                                                   5192
C     IN MUST EQUAL NAREA                                                5193
   80 WRITE OUTPUT TAPE 6,23                                             5194
   23 FORMAT (6HCAE/AT,9X,13F9.3)                                        5195
      CALL VAR(1,6)                                                      5196
      WRITE OUTPUT TAPE 6,24,(PAR(I,2),I=1,IN)                           5197
   24 FORMAT (15H IVAC,LB-SEC/LB13F9.1)                                  5198
      WRITE OUTPUT TAPE 6,25,(PAR(I,3),I=1,IN)                           5199
   25 FORMAT (15H I, LB-SEC/LB  13F9.1)                                  5200
      DO 61 I=1,IN                                                       5201
   61 NN(I)=PAR(I,4)+.5                                                  5202
   51 WRITE OUTPUT TAPE 6,21,(NN(I),I=1,IN)                              5203
   21 FORMAT (15H CSTAR, FT/SEC 13I9)                                    5204
      WRITE OUTPUT TAPE 6,22,(PAR(I,5),I=1,IN)                           5205
   22 FORMAT (3H CF,12X,13F9.3)                                          5206
    2 WRITE OUTPUT TAPE 6,10                                             5207
   10 FORMAT (5HCPC/P,10X)                                               5208
      CALL VAR(6,6)                                                      5209
      WRITE OUTPUT TAPE 6,11                                             5210
   11 FORMAT (8H P, ATM ,7X)                                             5211
      CALL VAR(7,6)                                                      5212
      DO 60 I=1,IN                                                       5213
   60 NN(I)=PAR(I,8)+.5                                                  5214
      WRITE OUTPUT TAPE 6,12,(NN(I),I=1,IN)                              5215
   12 FORMAT (9H T, DEG K,6X,13I9)                                       5216
      WRITE OUTPUT TAPE 6,13,(PAR(I,9),I=1,IN)                           5217
   13 FORMAT (9H H, CAL/G,6X,13F9.1)                                     5218
      WRITE OUTPUT TAPE 6,14,(PAR(I,10),I=1,IN)                          5219
   14 FORMAT (15H S, CAL/(G)(K) 13F9.4)                                  5220
      WRITE OUTPUT TAPE 6,15,(PAR(I,11),I=1,IN)                          5221
   15 FORMAT (10H M, MOL WT,5X,13F9.3)                                   5222
      RETURN                                                             5223
C                                                                        5224
C                                                                        5225
C                                                                        5226
```

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          SUB     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     83,2
    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          TCOA    *
    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 = 0 F*VXMIN + VFMIN
        IF(EQRAT) 9050,745,9050
9050    EQRAT = ABSF((0 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	1.003600
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
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	20.794	21.067	21.672	22.150	22.483	22.681	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)	1.3049	1.2047	2.2510	1.5840	1.0264	0.5416	0.5272	0.3927	0.3657	0.3477	0.3359
GAMMA	1.1654	1.1639	1.1122	1.1220	1.1444	1.2176	1.2277	1.2880	1.3130	1.3347	1.3505
MACH NUMBER	0.	1.000	1.460	2.164	2.696	3.216	3.817	4.460	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	427.9	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	0.04007	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*		0.13504	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	0.00048	0.00006	0.	0.	0.	0.	0.	0.
C3(G)	0.00340	0.00491	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)	0.00030	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)	0.03864	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	0.11080	0.11380	0.12411	0.13254	0.13829	0.14030	0.14108	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.	0.00274	0.05345	0.08104	0.09445	0.09468	0.09426	0.09429	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 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 COMPOSITION 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	1.1639	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	0.00309	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.
H1C1N1(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)	0.10830	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	12650.000	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	18.940	18.788
(DLM/DLP)T	0.03280	0.03415	0.03739	0.04210	0.04722	0.05161	0.05601	0.05966	0.06327	0.06625
(DLM/DLT)P	-0.5060	-0.5392	-0.6172	-0.7330	-0.8683	-0.9960	-1.1383	-1.2692	-1.4131	-1.5444
CP, CAL/(G)(K)	1.2340	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	0.00093	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	0.64289	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

C1H4(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	0.1289599E-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 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.	C	2.					0.5		12050.	L	298.15	F	1.0036
N	2.	H	8.							.5		12734.8	L	298.15	F	0.7861
F	2.									1.		-3030.892	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.