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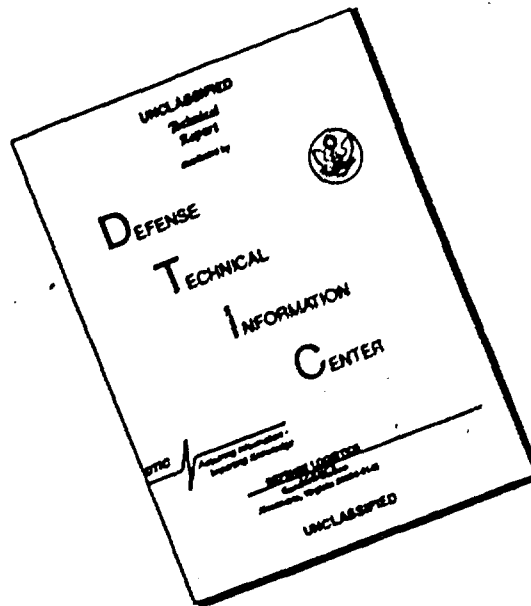
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The Aerospace Corporation Computer
Programs for the Solution
of Multielement Chemical Equilibria

Volume II. Chemical Program Description

17 JULY 1963

Prepared by H. J. VALE

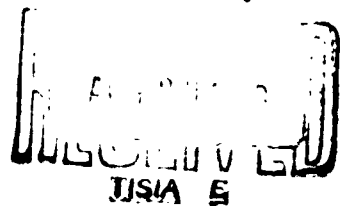
Computation and Data Processing Center

Prepared for COMMANDER BALLISTIC SYSTEMS DIVISION

AIR FORCE SYSTEMS COMMAND

UNITED STATES AIR FORCE

Norton Air Force Base, California



AEROSPACE CORPORATION
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THE AEROSPACE CORPORATION COMPUTER PROGRAMS FOR THE
SOLUTION OF MULTIELEMENT CHEMICAL EQUILIBRIA,

Volume II. Chemical Program Description.

Prepared by

H. J. Vale

Computation and Data Processing Center

AEROSPACE CORPORATION
El Segundo, California

Contract No. AF 04(695)-69
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17 Jul 1963,

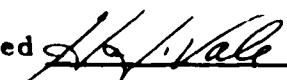
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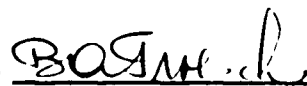
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FOREWORD

The first volume of The Aerospace Corporation Computer Programs for the Solution of Multi-element Chemical Equilibria was not designated Volume I. It was published on 28 June 1963, and the report number is identical to Volume II.

ABSTRACT

Work has been completed on a system of programs to compute complex chemical equilibria. These programs use a general numerical and analytical approach and accept a very flexible **problem** formulation. The computation capabilities of this **system** include rocket engine performance, flame composition **and** temperature determination, Mollier diagram production, **and** equilibria solution for any prescribed regime of pressure **and** temperature. Ionic species are considered where requested **and** when available.

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NOMENCLATURE

a	local velocity of sound, ft/sec
a_{ij}	number of atoms of i th element in j th chemical constituent
c_j	coefficient matrix of the j th product based on element columns (column matrix)
(C. M.)	coefficient matrix of major products based on element rows
$(C. M.)^{-1}$	(C. M.) inverted
C^*	velocity of rocket gas flow at the rocket throat, ft/sec
C_p	molar specific heat at constant pressure, cal/mole $^{\circ}K$
E_j	equilibrium coefficient (row) matrix of j th product
g	gravitational constant (32.174 ft/sec ²)
(H_m)	total relative molar enthalpy matrix of the major products (row matrix)
H_T^o	sum of sensible enthalpy and chemical energy, kcal/g
H_f	heat of formation of the data product kcal/mole
$(H_T^o)_j$	H_T^o for j th constituent, kcal/mole
IOPT	optimum (vacuum) impulse
M	molecular weight, g/mole
n	total number of moles
n_j	moles of j th constituent
P	pressure, lb/in ²
P_j	partial pressure of j th constituent, lb/in ²
$(\ln p_m)$	log partial pressure matrix of major products based on element rows (row matrix)
P_c	chamber pressure, lb/in ²

NOMENCLATURE (Continued)

p_e	exit pressure, lb/in ²
p_o	ambient pressure, lb/in ²
R	universal gas constant (consistent units)
s	gram entropy, cal/(g) °K
(S_m)	total molar entropy matrix of the major products (row matrix)
S_T^o	molar entropy at standard conditions, cal/mole °K
T	temperature, °K

I. INTRODUCTION

The computer programs described in this report form a logical system whose overall function is to compute chemical equilibria. The method used to solve the equation system is not unique in concept, but it is unique in both the manner of application and in the flexibility of approach.

Each program within the system produces a specific kind of solution. In this report, Rocket Performance, Mollier Diagram Producer, Flame Equilibrium Solver, and General Equilibrium Solver are discussed.

The system of programs is contained on a single library tape. All are written in the FORTRAN language, and all use the same data library tape.

II. OUTLINE OF PROGRAM SYSTEM

A. SYSTEM LOGICAL CONSTRUCTION

The program system consists of a series of FORTRAN main programs called chain links and a series of subroutines which may be associated with these main programs. Each link of the program chain communicates with its subroutine system and with other links through an area in the computer called COMMON. This region is used also for working storage whenever possible to minimize the memory storage not used for working instructions.

All input to the system is processed by the input link, which is always the first program written on the program library tape. This link reads and verifies the input data cards, searches the data library tape for the qualified system products, and produces the mass balance answer sheet. This link then calls the computation link requested by the user.

Individual links have been prepared such that the main program uses subroutines from a logical pool. A given subroutine is used in any of the links which require it. Improvement or alteration of any subroutine such that its capabilities are increased improves the capabilities of all the links which use it. The main program decides the type of matrix to be solved; and the subroutine system chooses the dependent variables, constructs the error matrix, solves it, and applies the proper corrections.

B. EQUATIONS USED

The basic system equations used are as follows. The derivations of the error equations are in Refs. 1, 4, and 5.

1. The Conservation of Atomic Types (Mass Balance)

$$\sigma_i = \sum_{j=1}^{\beta} a_{ij} n_j$$

where

$$\sigma_i = \sum_{j=1}^{\text{All products}} (\text{element } i\text{'s coefficient in the } j\text{th product}) * (\text{number of moles of the } j\text{th product})$$

2. Pressure Conservation

$$P = \sum_{j=1}^{\gamma} p_j$$

where γ stands for all gases. Condensed phases have zero partial pressure.

3. Conservation of (Static) Enthalpy

$$H = \sum_{j=1}^{\beta} (H_T^0)_j n_j$$

where $(H_T^0)_j$ equals total relative enthalpy per mole for j th product.

4. Conservation of Internal Energy

$$E = \sum_{j=1}^{\beta} (E_T^0)_j n_j$$

where $E_T^0 = H_T^0 - RT$.

5. Chemical Equilibrium

$$\ln K_j = \ln p_j - (C.M.)^{-1}(C_j)(\ln p_m)$$

or

$$\ln K_j = \frac{(S_T^0)_j - (C.M.)^{-1}(C_j)(S_m)}{R} - \frac{(H_T^0)_j - (C.M.)^{-1}(C_j)(H_m)}{RT}$$

6. Conservation of Entropy

$$S = \frac{1}{A} \sum_{j=1}^{\beta} \left[n_j (S_T^0)_j - R p_j \ln p_j \right]$$

where

$$(S_T^0)_j = \text{entropy per mole for } j\text{th product}$$

$$A = MP$$

$$= (\text{average gas mole weight}) * (\text{system pressure})$$

7. Acoustic Velocity

$$a^2 = \left(\frac{\delta P}{\delta \rho} \right)_s = \frac{RT \sum_{j=1}^{\beta} p_j \left[\frac{d(\ln p_j)}{d(\ln T)} \right]}{AM \left[\frac{d(\ln A)}{d(\ln T)} - 1 \right]_s}$$

8. Conservation of System Energy

$$H_s = \frac{\sum_{j=1}^{\beta} (H_T^o)_j n_j}{A} + \frac{M^2 R T \sum_{j=1}^{\beta} p_j \left[\frac{d(\ln p_j)}{d(\ln T)} \right]_s}{2 A^2 \left[\frac{d(\ln A)}{d(\ln T)} - 1 \right]_s}$$

C. SYSTEM DATA STRUCTURE

Thermodynamic data from 0° to 6000°K are used and maintained in table form throughout the system. Particular values of C_p , H , and S are interpolated using adjacent table entries. The two problems resulting from this method of data reference are, first, the thermodynamic values obtained in areas where the curve's slope is rapidly changing and, second, the value between a solid and liquid phase of the same molecule. The first difficulty is resolved by increasing the number of tabulated values in the areas of great curvature, such as below 300°K. The second is resolved by assuming that any species will crystallize in such a fashion that there will be super-cooled liquid droplets and super-heated crystals existing simultaneously.¹ Then, the numerical values of the thermodynamic variables may be obtained by linear interpolation across the crystallization discontinuity. This effectively averages the variables involved and allows all condensed species to be handled using a coherent, single, data list. There are no mathematical problems with multiple tables for the same species, but the programs updating the thermodynamic data tapes would be more complex, so this is not allowed.

The input chain produces a vector based on the elemental list of the particular problem. This vector is used to sort qualifying products from the data library. A qualifying product's data block is processed by updating the sensible enthalpies contained in the block to become relativised total

¹ The accompanying physical assumption is that physical contact between crystal and liquid does not exist.

enthalpies and by writing the updated data onto the data buffer tape. Further explanation of the enthalpy handling is perhaps required. The program must work with the total system energy as a positive number. In order to ensure this situation, all elements have an associated base enthalpy. These are algebraically added, depending on the elemental structure of the molecule, to form a base enthalpy for the molecule. (The list of element bases forms the first record on the data tape, see Table 1.) The heat of formation of the molecule, at 298.159°K, is added to this molecular base enthalpy to form the total enthalpy for the molecule at standard temperature. The sensible enthalpy (relative to 298.159°K) is stored on the data library tape in the individual data blocks as a function of temperature. Thus, at any temperature, an additional amount is added to form the total relative enthalpy.

The total relative enthalpy may be expressed algebraically as

$$H_j^T = \sum_{i=1}^n a_{ij} H_{\text{base}_i} + \Delta H_{f(\text{at } 298.159^\circ\text{K})j} + \Delta H_{(298.159^\circ\text{K})j}^T$$

Input data is treated in a similar manner with respect to the base enthalpies of the elemental components. The heat of formation from the ingredient formulation card is added to the molecular base enthalpy to form a total relative enthalpy per mole.

At present, the upper temperature in the tables is 6000°K. The program extrapolates linearly for values of C_p , H, and S for temperatures above this. There is no reason to limit temperature coverage to 6000°K, but all arrays must have identical temperature sequences since the temperature list is stored only once.

The data library and maintenance programs will be covered in detail in Volume III of this report.

Table 1

Elements Contained on the Data Tape and Their H_{base}

<u>Element</u>	<u>H_{base}</u>	<u>Element</u>	<u>H_{base}</u>
H	34.7204	S	108.3410
HE	0.0	CL	4.9985
LI	131.6341	AR	0.0
BE	131.2607	K	-20.0290
B	175.0770	CA	-44.5590
C	92.2136	TI	286.8570
N	1.8858	FE	98.1290
O	2.0554	NI	-99.9790
F	31.5318	BR	2.5000
NE	0.0	RB	-19.0290
NA	70.7260	ZR	389.6670
MG	253.5467	CD	23.7920
AL	233.6251	CS	-17.3490
SI	250.1876	PB	180.0310
P	5.5120	E	0.0

D. SYSTEM MAIN PROGRAM STRUCTURE

1. Input, Link 1

The input link (Fig. 1) has the dual function of reading the proper cards to initiate a problem and of altering the specification of the last computed problem so as to compute a new point. The input data cards are printed out before the data on them are used for computation or table searching. The library data blocks are buffered onto the secondary tape for faster data updating. Before selecting the requested computation chain link, the input chain searches a table for first guess values and makes them available for the computation link.

2. Rocket Performance, Link 2

The rocket performance link (Fig. 2) is separated into three logical divisions; the first two essentially prepare the foundation for the last. In the first part, the chamber temperature and composition are determined, the system is examined for the major products, and the entire system of the variables is

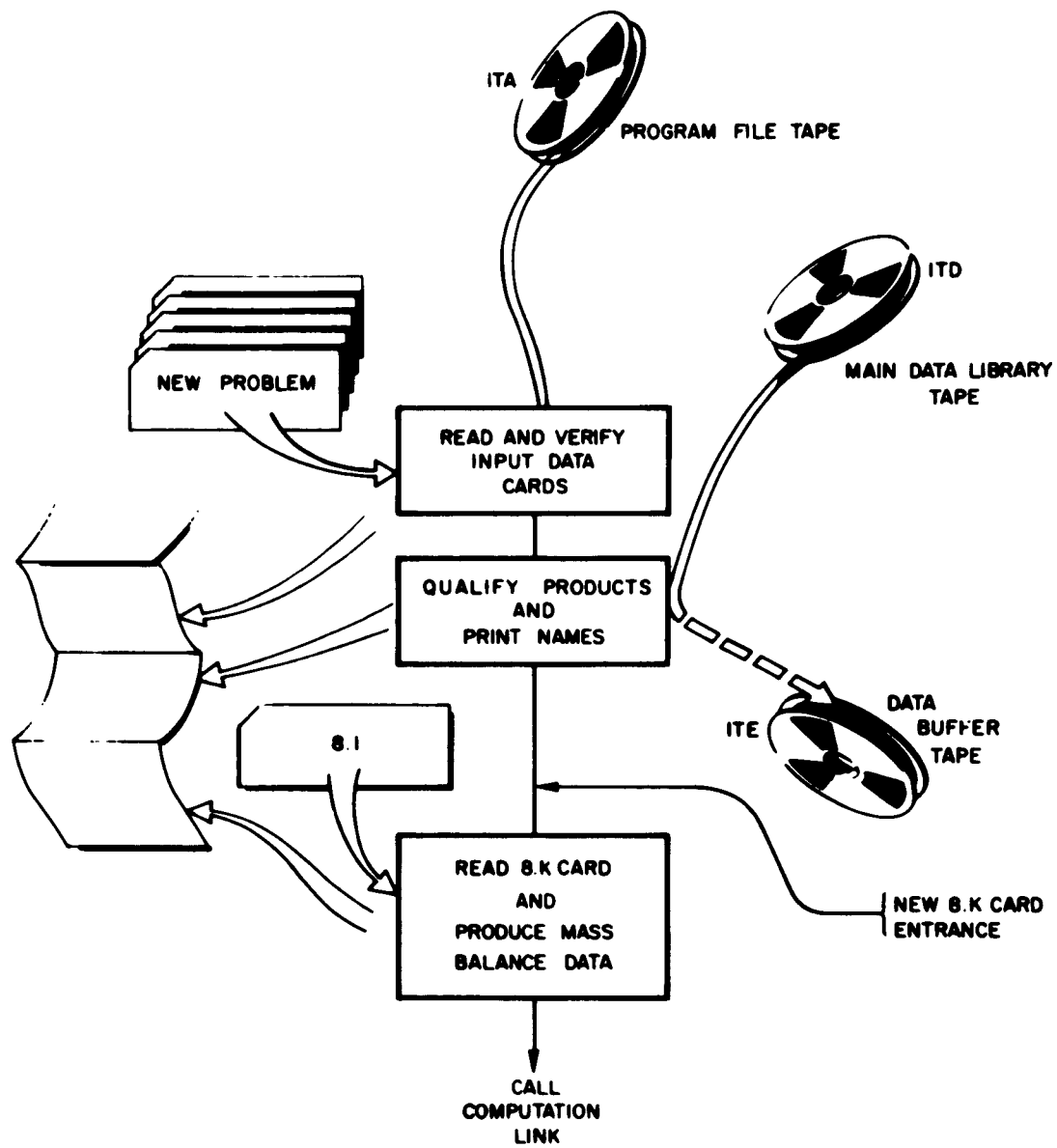


Fig. 1. Input Link

saved on the utility tape ITG. In the second phase, the matrix controls are altered to compute alternately acoustic velocity and isentropic expansion to Mach 1. These equations allow the program to determine the exact throat condition. When converged, the C^* and area per unit system mass flow are stored. At this point, the chamber conditions are restored from ITG, and the last part of the program is begun.

The final phase is accomplished by solving an isentropic expansion equation system to expand to a specified series of pressures. This is handled by maintaining a series of pressure ratios (the first of which is 1.0) and successively dividing the chamber pressure by each of these. At each convergence, a series of answers are written on the answer buffer tape ITB, forming one column of TABLE ONE² and one row of TABLE TWO. The table of pressure ratios is selected to result in 1 atm pressure for a variety of chamber pressures and to result in a relatively smooth coverage of EPSILON (Area of flow/Area of throat) versus I_g . The computation link selects the output link after the pressure ratio list is worked through.

For the second and succeeding cases of a given problem, the rocket computation chain anticipates a better (faster) chamber convergence when the previous chamber conditions are used instead of the first guesses. Sometimes this faith is misplaced, especially when the new case differs drastically. Experience to date has shown that the total computer time is less for a series of cases when adjacent mixtures are not radically different. A simple rule of thumb would be that mixture ratios should change no more than 10 per cent.

3. Rocket Output, Link 3

This program (Fig. 2) produces the output sheets normally associated with the propulsion program. Answers are arranged in what is hoped is a readable manner. The TABLE THREE listings are produced by parabolic interpolation

²Capitalized names refer to the answer sheet titles.

on the epsilon from TABLE TWO. The off-design variables A and B are defined below.

$$\begin{aligned} \text{IEPS} &= \text{IOPT} + \frac{P_e}{P_c} \frac{C^*}{g} \text{EPSILON} - \frac{P_o}{P_c} \frac{C^*}{g} \text{EPSILON} \\ &= \text{IOPT} + A + B P_o \end{aligned}$$

4. General Solver, Link 5

The general solver link (Fig. 3) is capable of solutions for three specific types of outputs: Mollier Diagram, Equilibrium Solution (at a series of temperatures for a given pressure), and Ambient Flame Solution. In the first two, the matrix is asked only to compute equilibrium at a specified pressure and temperature. The last type, Flame Solver, uses the specified pressure to find both the system composition and temperature using the available energy of the original ingredients. In all three cases, control is specified by an item on data card 5, and the program system relinquishes control to link 1 at the end.

5. Other Links

Other system programs now exist. Two of these are Shock Tube Performance and Detonation Velocity Solver. These will be reported on at a future time.

E. SYSTEM OPERATION

The programs contained in this system are coded in FORTRAN II and are designed to run in the CHAIN mode. Normal operation is separated into the maintenance of the program library tape and the use of the program library for production. The isolation of the production phase is efficient since the user is assured of access to the latest system, hopefully synonymous with the most powerful, and he does not have the responsibility of maintaining a usable, updated program deck.

The system is updated by putting the program library tape on the computer and loading it with the entire system of programs. At this time, test cases may be run to verify proper operation of the chain system.

Production usage involves only the selection of the input link from the previously prepared program tape. The program system takes over to read the data, to select the solution required, and to produce answers.

III. PROGRAM USAGE

A. DATA REQUIRED

Appendix A details the format of all data cards. These cards are read with standard FORTRAN input statements. It should be noted that each problem begins with complete specification of the execution tape configuration. Thus, sequentially executed problems may use different thermodynamic data libraries.

The basic data deck starts with the above mentioned computer specification and control card. Available on this card are program control variables which may be used to dump program iterations or increase iteration limits. These controls should be used carefully since execution time will be increased.

Cards 2 and 3 are used as titles for all answer sheets. These cards are printed as a single line, alongside or below the identification of the thermodynamic data tape used. The character of the data tape identification is discussed later, but all answer sheets have this code as part of the page title.

Card 4 specifies the macroscopic logic of the problem, number of system ingredients, what type of solution required, and number and kind of combination of these ingredients.

Card 5 is the only data card which must be considered in light of the computation type requested. Obviously, different input is required for Mollier Diagrams and for Rocket Performance. These data are given on this card. Basically, this card describes the system variable limits or particular specifications.

Card types 6, 6.I, 7, 7.J, and 8.K specify the exact ingredients to be used, their proportions to each other, and any limitations on products to be used in the solution system.

B. THERMODYNAMIC DATA LIBRARY

The program system uses a data library tape containing several hundred product data sets. These sets are sorted in the first phase of the program, and applicable sets are written on a buffer tape. The overall data block contains the following items:

- 1) State indicator (1 if gas, 2 if condensed)
- 2) Name of product
- 3) Elemental structure of product arranged as a vector, as long as the elements contained in the tape and with corresponding vector elements being the atoms of that element contained in the molecule
- 4) Heat of formation in Kcal/mole at 298.16°K
- 5) Upper, lower, and discontinuity (if any) temperatures
- 6) Data tables of T , C_p , $\Delta H/T$, and S for values of temperature from zero to 6000°K in increments of 100° . Additional points have been inserted at 50° , 150° , and 250°K to aid in low temperature interpolation.

A listing of the products contained on the tape and their heats of formation (at 298.16°) are given in Table 2. A subsequent report will give all programs necessary to put the JANAF (Ref. 2) data on this data library.

C. ANSWER DISCUSSION AND VERIFICATION

1. Rocket Performance

The test case chosen for rocket performance illustration is one of several standard systems which are run to verify a program change. The chamber

conditions match Ref. 3 relatively close considering that the most dominant products had heat of formation (at 298.159°K) differences of the following:

<u>Product</u>	<u>References H_f</u>	<u>H_f Used</u>
LiOH	-53.8	-57.7000
LiF	-77.6	-79.3000
Li ₂ O (cond)	-142.4	-143.0486
LiCl	-49.0	-46.7780

The general result of this energy difference was a slightly lower chamber temperature (53°K) and a 1 atm I_s increase of about 2 sec in the Aerospace answers.

The input data cards are printed as answers on the leading page. As products are qualified by the thermodynamic data tape search subroutine (SIFT), the product name and its heat of formation (at 298.159°K) are printed. The ingredient formulation card is read and printed out. Although weight per cent was specified, the moles and mole per cents of the ingredients were also computed and printed. All three are always printed when any one is specified. At this point, the system is broken down into the atoms of the elemental species per gram of entire system. The resulting numbers are the mass balance values used during the convergence of the problem. The mass balance may be verified by adding the atoms of the respective elements using TABLE ONE compositions.

As detailed elsewhere, the system energy (enthalpy) per system gram is altered depending upon the base values of the contained elements. The present list of base enthalpies are given in Table 2. The total propellant enthalpy is obtained by adding the heat of formation per mole of each constituent to that constituent's relative base enthalpy and then combining all constituent energies per mole according to the moles of each given in the mass balance printout. This value should check the chamber enthalpy given in the first column of TABLE ONE. The answers reported for enthalpy in

Table 2

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
H	52.102	AlCl ₂ F	-181.8
He	1.4812	AlF	-61.3
Li	38.41	Cl ₃ FSi	-201.
Be	77.922	SiF	10.9018
B	132.618	FPS	-41.
C	170.886	FP	-17.
N	112.965	PbFC1	-85.5613
O	59.5590	ClF	-13.501
F	18.86	FK	-76.
Ne	1.4812	FeF	-5.71
Na	25.7550	PbFBr	-76.4185
Mg	35.33	BrF	-19.3776
Al	78.00	PbF	-14.5068
Si	110.00	F ⁻	-63.0387
P	79.83	F ₂ Mg	-177.
S	66.44	AlClF ₂	-235.
Cl	28.922	AlF ₂	-157.
Ar	0.0	F ₂ Si	-118.
K	21.31	F ₂ P	-109.
Ca	46.0402	F ₂ K ₂	-203.56
Ti	112.49	F ₂ Ti	-132.
Fe	96.4473	FeF ₂	-108.8545
Ni	101.6102	F ₂ Zr	-146.7
Br	26.7096	PbF ₂	163.0852
Rb	20.5102	F ₂	0.
Zr	145.8	AlF ₃	-285.448
Cd	26.9698	ClF ₃ Si	-315.
Cs	18.8302	SiF ₃	-188.9357
Pb	46.3402	F ₃ P	-220.7
E	.0002	ClF ₃	-38.79
HLiO	-57.7	F ₃ Ti	-255.3
HLi	32.1	FeF ₃	-209.8056
BeHO	-41.0	F ₃ Zr	-271.1
BeH	77.37	F ₄ Si	-372.9
BHO	-47.127	F ₄ Ti	-369.6
BHO ₂	-135.32	F ₄ Zr	-391.
BH	114.761	PbF ₄	-183.1355
CHNO	-27.9	F ₆ S	-288.5
CHN	31.2	ClNa	-44.05
CHFO	-94.0	Na ⁺	144.2552
CHO	-2.9	ClMg	1.
CHCl ₂ F	-61.0	Cl ₂ Mg	-100.7
CHClF ₂	-112.0	MgBr	-12.9488

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
FeO ₂ H ₂	-44.8474	Li ₂	50.4
Fe ₂ O ₃ H ₂	-44.8221	F ₃ Li ₃	-357.6
F ₂ H ₂ Si	-194.	Cl ₃ Li ₃	-228.3
Cl ₂ H ₂ Si	-75.	BeC ₂	135.
SiH ₂ Br ₂	18.7389	BeO	30.44
H ₂ S	4.8150	BeClF	-124.
H ₂ P	76.3002	BeFBr	-126.3854
H ₂	0.	BeF	4.816
BH ₃ O ₃	-238.6	BeF ₂	-182.8
BH ₃	18.	BeClBr	-84.7217
B ₃ H ₃ O ₆	-541.69	BeCl	36.989
CH ₃ F	-59.	BeCl ₂	-80.38
CH ₃ Cl	-20.634	BeBr	-17.
CH ₃	32.	BeBr ₂	-58.886
H ₃ N	-11.040	Be ⁺	292.9235
H ₃ O ⁺	139.	Be ₂ O ₂	-102.4
FeO ₃ H ₃	-113.7178	Be ₂ Cl ₄	-185.
FH ₃ Si	-105.	Be ₃ O ₃	-259.8
ClH ₃ Si	-48.	Be ₄ O ₄	-377.2
SiH ₃ Br	29.8534	Be ₅ O ₅	-493.6
SiH ₃	23.7276	Be ₆ O ₆	-631.1
H ₃ P	6.43	BN	151.748
CH ₄	-17.9251	BFO	-142.923
C ₂ H ₄ O	-12.19	BClO	-84.811
C ₂ H ₄	12.496	BO ⁺	167.1494
H ₄ Si	7.8	BO	3.744
B ₂ H ₆	7.53	BClF	-77.8
B ₃ H ₆ N ₃	-124.2	BCl ₂ F	-153.97
CH ₆	-17.895	BFB ₂	-122.8872
B ₅ H ₉	15.02	BF	-45.469
B ₁₀ H ₁₄	2.8	BClF ₂	-211.65
FLiO	-10.	BF ₂ Br	-196.4394
ClLiO	-3.4	BF ₂	-133.843
LiN	39.0	BF ₃	-270.
LiO	14.0	BS	70.5
FLi	-79.3	BClBr ₂	-65.2485
ClLi	-43.8	BCl	43.2 ²
LiBr	-42.1411	BCl ₂ Br	-81.176
Li ⁺	161.6507	BCl ₂	-19.62
Li ₂ O	-34.1	BCl ₃	-97.1
ClFLi ₂	-180.2	BBr	59.498
F ₂ Li ₂	-213.5	BBr ₃	-60.4
Cl ₂ Li ₂	-140.8	B ⁺	326.5228

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
B ₂ O ₂	-111.6	C ₂ F ₄	-151.7
B ₂ O ₃	-210.1	Al ₂ C ₂	120.042
B ₂ Cl ₄	-118.5	SiC ₂	160.143
B ₂	199.3	Si ₂ C ₂	301.6619
B ₃ F ₃ O ₃	-567.	C ₂ ⁺	473.304
B ₃ Cl ₃ O ₃	-402.	C ₂	197.028
CFN	-12.8	C ₃ O ₂	-8.3
CClN	31.6	Si ₂ C ₃	165.0888
CN ⁻	21.0504	C ₃	189.67
CN	94.	C ₄ N ₂	127.5
CClFO	-106.5	C ₄	242.321
CF ₂ O	-150.2	C ₅	242.374
COS	-33.08	FNO	-15.65
CCl ₂ O	-52.4	ClNO	12.6
CO ⁺	305.6472	NO ⁺	234.8979
CO	-26.417	NO	21.6520
CO ₂ ⁺	223.7088	NO ₂	8.060
CO ₂	-94.054	FN	58.6
CCl ₃ F	-71.	F ₃ N	-29.7
CF ⁺	349.4422	AlN	104.5
CF	74.4	NSi	121.0
CF ₂ Cl ₂	-59.1725	NP	21.59
CF ₂ ⁺	225.4683	NS	-54.0
CF ₂	-46.	N ⁺	449.565
CClF ₃	-171.9	N ₂ O	19.5
CF ₃ ⁺	94.1467	N ₂ O ₃	20.185
CF ₃	-130.	N ₂ O ₄	10.5540
CF ₄ ⁺	192.8418	N ₂ O ₅	3.06
CF ₄	-218.	N ₂ ⁺	359.8
AlC	209.958	N ₂	-0.
SiC	192.1625	AlFO	-121.
Si ₂ C	127.0336	OSiF	82.424
Si ₃ C	-14.7543	FeFO	-87.2606
CP	93.	PbOF	-73.0613
CS	71.5	FO	32.4
CS ₂	27.55	F ₂ SiO	219.0843
CCl	132.	F ₂ OS	-113.
CCl ₄	-25.94	F ₂ O	7.6
C ⁻	143.5641	NaO	13.2
C ⁺	197.2641	MgO	4.1900
C ₂ N ₂	73.87	AlClO	-55.
C ₂ F ₂ ⁺	180.4322	AlO	17.387
C ₂ F ₂	-51.3	Al ₂ O ⁺	140.7249

Table 2 (Cont'd)

Products Contained in the Library and Their H_f

Product	H_f	Product	H_f
Al_2O	-39.4	CHF_3	-162.6
$OSiCl$	53.6395	$CHCl_3$	-25.0
Cl_2SiO	107.2549	CH	142.006
OSi	21.411	HNO	14.089
Cl_3OP	-134.6	HN	79.2
OP	-1.455	FHO	-26.1
OS	-.12	$HNaO$	-55.44
$FeClO$	-37.9748	$HMgO$	-12.2
$PbOCl$	-39.4235	$AlHO$	-3.447
ClO	24.192	$ClHO$	-21.4
Cl_2O	18.1	$FeOH$	-9.7882
OTi	15.1	OH^-	-31.7425
FeO	64.2042	HO	9.33
Fe_2O	80.6257	$AlHO_2$	-109.0
$PbOBr$	-30.2816	FeO_2H	-55.673
OZr	24.7	HF^+	299.5394
PbO	6.0573	FH	-64.5
O^-	25.0501	F_3HSi	-283.
O^+	373.1501	HNa	29.88
F_2O_2S	-150.	HMg	40.7
Al_2O_2	-105.28	AlH	61.7
O_2Si	-73.9	Cl_3HSi	-112.
O_2P	-73.0	$HSiBr_3$	79.0481
O_2S	-70.96	HSi	114.
ClO_2	25.	HP	54.9
O_2Ti	-79.8	HS	32.0
Fe_2O_2	13.3972	HCl^+	271.7486
O_2Zr	-71.5	ClH	-21.97
PbO_2	-26.6111	HBr	-12.277
O_2^-	-3.53	PbH	60.9805
O_2^+	371.3	$H_2Li_2O_2$	-169.4
O_2	0.	BeH_2O_2	-156.7
$ClFO_3$	-5.12	BeH_2	30.
O_3S	-94.45	BH_2O_2	-45.
Fe_2O_3	-53.5267	BH_2	66.
O_3	34.	CH_2O	-27.7
O_6P_4	-684.905	CH_2ClF	-58.
$O_{10}P_4$	-681.9	CH_2F_2	-105.5
FNa	-67.	CH_2Cl_2	-22.4
Na_2	32.87	CH_2	66.835
$ClFMg$	-136.9	C_2H_2	54.19
FMg	-21.	H_2N	40.3
$AlClF$	-123.	H_2O	-57.798

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

Product	H_f	Product	H_f
Mg ⁺	210.903	Cl ₃ Zr	-153.8
AlS	69.	Cl ₄ Ti	-182.4
AlCl	-11.3	Cl ₄ Zr	-208.8
AlCl ₂	-78.	PbCl ₄	-134.1344
AlCl ₃	-139.022	BrK	-42.58
AlBr	0.	K ⁺	121.5102
AlBr ₃	-101.197	K ₂	30.374
Al ⁺	216.5936	Br ₄ Ti	-131.329
Al ₂ Cl ₆	-312.11	PbBr	11.3366
Al ₂ Br ₆	-230.948	PbBr ₂	-33.8686
Al ₂	106.1479	Br ₂	7.387
SSi	16.926	PbBr ₄	-88.8482
ClSi	48.1	CS ⁺	108.5302
Cl ₂ Si	-37.66	Li liquid	0.
BrSiCl ₃	-83.1311	Be cond	0.
Cl ₄ Si	-145.7	B cond	0.
SiBr	32.8389	C solid	0.
SiBr ₂	-26.9442	Mg solid	0.
SiBr ₃	-87.1206	Al cond	0.
SiBr ₄	104.1263	Si cond	0.
Si ₂	137.	P cond	0.
Si ₃	145.9	Fe cond	0.
Cl ₃ PS	-91.	LiOH cond	-116.6699
PS	22.5	LiAlO ₂ cond	-284.3111
Cl ₃ P	-62.5	LiF cond	-146.1759
Cl ₅ P	-84.63	LiCl liquid	-94.4642
P ₂	42.83	Li ₂ O cond	-143.0486
P ₄	31.03	Li ₃ N cond	-51.5771
PbS	-286.1165	BeO cond	-143.0976
MgS	33.2	Be ₂ C cond	-22.2151
S ₂	30.84	Be ₃ N ₂ cond	-135.4728
S ₈	24.51	BN solid	-60.2938
ClK	-51.175	NaBO ₂ cond	-234.9039
ClTi	17.	B ₂ O ₃ cond	-305.3443
FeCl	43.4989	B ₄ C cond	-12.2046
PbCl	0.6055	Na ₂ B ₄ O ₇ cond	-795.4951
Cl ⁻	-57.0563	AlN solid	-74.9299
Cl ₂ K ₂	-147.85	Mg ₃ N ₂ solid	-113.3437
FeCl ₂	-41.6859	MgO solid	-144.1931
Cl ₂ Zr	-92.	FeO cond	-63.4894
PbCl ₂	-51.9985	NaAlO ₂ cond	-273.616
Cl ₂	0.	SiO ₂ cond	-207.4485
FeCl ₃	-62.0048	TiO ₂ liquid	-216.0349

Table 2 (Cont'd)

Products Contained in the Data Library and Their H_f

<u>Product</u>	<u>H_f</u>
ZrO ₂ liquid	-270.1879
Al ₂ O ₃ cond	-400.6065
Fe ₂ O ₃ cond	-200.0143
Fe ₃ O ₄ cond	-266.2888
Al ₂ SiO ₅ cond	-655.597
MgF ₂ liquid	-259.0197
FeF ₂ cond	-178.1306
AlF ₃ cond	-355.2036
FeF ₃ cond	-242.1555
MgCl ₂ cond	-153.7136
AlCl ₃ liquid	-162.3365
FeCl ₂ cond	-79.6529
FeCl ₃ cond	-96.0793
Br ₂ K ₂ crystal	-126.16

this table are to be thought of as static enthalpies and contain no kinetic energy terms. Thus, the difference between the chamber enthalpy and any subsequent expansion station enthalpy is proportional to the square of the vacuum specific impulse available in a rocket physically terminated at that station. The formula used in the program to obtain the values in the right column of TABLE TWO is the following:

$$I_s(\text{exit station}) = 294.98 \sqrt{\Delta H_{\text{chamber} - \text{exit station}}}$$

Each enthalpy may be verified by accumulating the products of the moles of each gas product times its total relative enthalpy for the gas temperature.

TABLE THREE is essentially an interpolation of data from TABLE TWO. Area ratios, or EPSILON values, from TABLE TWO are interpolated using a quadratic curve fit to obtain I_{opt} , C_F , and PC/PE for integer EPSILONs. The relationship between the other variables can now be found using the equations given under the discussion of the rocket performance output link.

TABLE TWO values of EPSILON become progressively farther apart as the expansion plane static pressure decreases. Thus, EPSILONs above about 50.0 are numerically illogical to use for interpolation purposes.

2. Flame Temperature Solution

The solution of the flame temperature given the rocket chamber pressure instead of 1 atm, results in verification of the chamber temperature and products. In this case, all products are listed in whatever amount they exist since trace compounds may be of interest. The enthalpy column gives the total relative enthalpy at the specified temperature.

3. Mollier Diagram Solution

The same case as above was run on the Mollier Diagram option. The diagram is plotted as Fig. 4. Note that the lower temperature conditions result in many more condensed species than would exist in the rocket system. The enthalpy printed is the system total relative enthalpy.

4. Equilibrium Solution

Capability to compute a charge balance is in all the program systems. However, it has been used most extensively in the equilibrium option. This case was chosen to illustrate the disappearance of a component (the charged species) entirely. The program considers the electron charge in the same manner as an elemental constituent. Thus, the unique requirement of zero mass balance may be used wherever appropriate. The output listings are quite self-explanatory in headings and units of the variables.

Basically, the Equilibrium Solver works down a specified adiabat of the Mollier Diagram, while the Flame Solver gives a single point at the intersection of the adiabat and the system enthalpy.

IV. ITERATION ERRORS

The overall iteration procedure followed in this system is to solve the error matrices for corrections to the independent variables, apply them, solve for dependent variables, and repeat. The matrix answers can be treated both as meaningful variable increments and as error indicators. Table 3 gives the sum of the absolute value of the errors of the sample case as a function of the problem iteration. The Newtonian iteration method converged rapidly in this case, since the initial temperature guess was a fortunate one. Normally, the initial estimate is much further from the convergence solution, and in these cases the matrix answers cannot be used in altering the variables. The program has a fixed limitation on the size of the increment permitted. These values can be changed, but they now stand as ± 5.0 for changes to major product partial pressure logarithms and 1.0 for changes to the average molecular weight logarithm. The system temperature is never allowed more than a 10 per cent change in either direction.

Table 3
Iteration Errors in the Sample Problem

<u>Iteration</u>	<u>Rank of Error Matrix</u>	<u>Tempera- ture ($^{\circ}$K)</u>	<u>$\sum \epsilon$</u>	<u>Comments</u>
1	6	3000.0	25.872	Initial Guesses
2	6	3000.0	21.963	
3	6	3000.0	9.6484	
4	6	3000.0	1.21141	
5	6	3000.0	0.12599	
6	6	3000.0	0.00114	
7	6	3000.0	$<10^{-6}$	
8	7	3000.0	10.34375	$\text{Li}_2\text{O}_{(c)}$ in
9	7	3000.0	5.0998	
10	7	3000.0	13.7603	
11	7	3000.0	1.2142	
12	7	3000.0	0.06053	
13	7	3000.0	0.000194	Temp released
14	8	3004.54	0.16606	
15	9	3004.54	$<10^{-3}$	Chamber done
16	10	3004.54	$<10^{-5}$	

As some indicator of the difficulty of convergence in the rocket link, three numbers are always printed just ahead of the main answers. These numbers give the number of chamber, throat, and expansion iterations.

V. PROGRAM SYSTEM ALTERATION

The logical design of this chemistry solving system is such that a great deal of flexibility is allowed. This occurs in two ways. If a new kind of solution is required which needs only the basic equilibrium, mass balance, and energy balance equations, a new main program link can be written incorporating whatever external restrictions are desired. An example of this is the detonation solver link which satisfies the Chapman-Jouget and Rankine-Hugoniot equations using only the basic solver package. If alterations to the basic equations are required, the specific subroutine may be modified, leaving all main program links able to incorporate the new capabilities. An example of this is alteration of the general gas law equation to some variation of Van der Waal's equation. The most common variation is Abel's equation $P(V - b) = RT$, where intermolecular forces are ignored, but the molecular volume is considered. The Virial equation has already been incorporated into the detonation link. Another example of program equation alteration might be the changing of the equilibrium subroutine to use rate coefficients in the Arrhenius equation to determine the relationship between the independent (major) species and the remainder.

VI. METHOD USED

It is assumed that the reader is familiar with both the matrix construction and the notation used in Refs. 1, 4, and 5; therefore, they will not be repeated. The matrix to be solved is basically the one described there, except that the matrix order is changed to solve for corrections to the current major products, and a charge balance equation is added to allow compilation with ionic species present. The only alterations required to the basic matrix scheme are the equilibrium equations and, of course, the placement of column variables.

Equilibrium definition in terms of any species may be reduced to the following procedure. First, the problem is defined in terms of the elemental species forming the original ingredients. The list of elements thus specified is used to select all possible or allowed species from the data library tape. The chosen species have their respective elemental subscripts placed in a vector array corresponding to the position of the subscripted element. Thus, any products chosen have coefficient vectors whose positions are related to the original element vector. By a program ground rule, as many products are picked as majors as there are elements in the problem. The product coefficient vectors thus form a square matrix based on the row element order. This is illustrated in Appendix B, Section I.

The coefficient matrix is examined by the program for two necessary conditions. Each element must be represented in some product, but may be in several products, and there can be no two products whose elemental subscripts are linearly dependent. For example, OH and H_2O_2 can never simultaneously exist as major products. If these conditions are satisfied, this matrix is inverted and used to define the equilibrium relationships between all other species and the major products forming this matrix. References 1 and 3 would have a unit matrix at this point. Equilibrium coefficients are automatically obtained in Appendix B, Section I.

The important characteristic of this matrix is the simplicity with which the major products can change. The change procedure is the comparison of molar quantities of the chosen majors with the other species available. When one of the nonmajor species exists in an amount significantly larger than a chosen major, the majors are repicked allowing the newly dominating species to become a major product. Thus, the major product species remain those in largest quantity, independent of temperature and pressure level.

The basic matrix formed from mass balance, pressure conservation, and energy conservation equations is constructed as illustrated in Appendix B; Section II. The upper left submatrix is still a unit matrix. The lower left matrix is built with column entries which are dependent on the species appearing and are in the same sequence as the rows in the upper right submatrix. In the method outlined here, all equilibrium equations are always satisfied, so the error entry in the upper right submatrix is always zero. The reduction of the three matrices is accomplished by normal matrix arithmetic and poses no problem.

Two basic types of trouble can occur in thermochemical programs. The first, iteration control, is solvable using experience with the general solution system and the type of problems computed in each computation chain. In general, each type of computation requires its own iteration control and dependent variable limitations. However, most of the iteration searching is eliminated if the iteration temperature is severely limited in its change. The programs described here incorporate a linearly varying temperature increment/decrement upper bound which changes from about 100°K at 3000°K to about 15°K at 300°K . The temperature increment obtained from the iteration variables is tested before being applied; and if it falls outside this boundary, the boundary limit change is used instead. In cases of crystallizing liquids, the discontinuity temperature is maintained constant until all system variables except energy have been satisfied.

First guess problems are approached as if the program were to use the atomic species as major products. Choices of the atomic partial pressures are made. The system temperature is fixed at a constant, high value, and the gas species equilibrium is computed. Any condensible products are allowed to appear. System major products are chosen, and the problem is released for general solution.

The first guesses for the atomic species are chosen using the following formula.

$$p_i = FG_i * M_i * P_c * 25$$

where

P_c = system pressure

M_i = moles per gram system weight of the atomic type

FG_i = the value found in a lookup of the elemental species

The FG table is given in Appendix C.

APPENDIX A

How to Write Data for the N Element Chemistry System

The cards in the order required, starting with the first card after the
* DATA control card are the following:

1. Computer specification and control card
2. Title card #1 (columns 1 through 72)
3. Title card #2 (columns 1 through 36)
4. Problem specification card
5. Special option card
6. System component title and specification card
- 6.1 Component element card
cards 6. and 6.1 repeat for as many components
as are specified on problem spec card (#4)
7. Control number for included/excluded products
- 7.1 Included/excluded product #1
.
.
.
7. J Included/excluded product #J
cards 7. J repeat for as many as are required
NOTE: cards 7 through 7. J are needed only
when control card #1 indicates it. Otherwise
they are omitted.
- 8.1 Component combination card #1
.
.
.
8. K Component combination card #K
cards 8 K repeat for as many combinations
as are requested in cards #4
Program chooses next problem starting at card #1,
after reading all 8. K cards.

INDIVIDUAL CARD BREAKDOWN

CARD NO. 1

<u>ITEM</u>	<u>COLUMNS</u>	<u>NORMALLY</u>	<u>DEFINITION</u>
ITA	1-3	16 in cols 2, 3	Program Chain Unit ^{*2}
ITB	4-6	4 in col 6	Answer Buffer Unit
ITC	7-9	9 in col 9	Program Loop Recover Unit
ITD	10-12	5 in col 12	Thermo Library Unit
ITE	13-15	10 in cols 14, 15	Thermo Data Buffer Unit
ITF	16-18	4 in col 18	Chamber Condition Buffer Unit
ITG	19-21	14 in cols 20, 21	Expansion System Recovery Unit
ITH	22-24	4	System Condition Buffer
ITI	25-27	2 in col 27	System Input Tape Unit
ITO	28-30	3 in col 30	System Output Tape Unit
IP	31-33	+ in col 32, 1 or 0* ¹ in col 33	Product inclusion/exclusion Control
IT ^{*3}	43-45	Normally ZERO or blank. For program iteration dump put 1 in col 45	
IU	46-48	Normally ZERO or blank. For program iteration dump, put 1 in col 48	

*¹ If IP is +1, the program is to allow all selected products except those specified.

If IP is 0 or blank, the program chooses all possible products.

If IP is -1, the program allows only the specified products to be considered in the solution.

*² IBM allows this number to be two (2) for B-2, three (3) for B-3, or A-4 for anything else, we have modified the chain selecting routine so that a "16" selects tape B-8.

The "16" is used for production runs, where the chain library has been previously created and is now mounted on unit B-8. When the chain program library is to be made, and a trial calculation completed, an 11 is required, since the program tape is written on tape B-3.

- *³ If IT is made to be -1 on the control card, the number of allowable iteration loops (before terminating problem) is doubled. This control should not normally be used except in cases of extremely large numbers of elements and condensibles appearing, and only then when it has been proven that the problem would have converged if allowed to iterate longer.

CARD NO. 2 and 3

Any alphabetically punched title, which will be printed at the top of all answer sheets.

CARD NO. 4

<u>ITEM</u>	<u>COL UMNS</u>	<u>DEFINITION</u>
IH	1-12*	Input style code 1 in col 12 if moles given in cards 8, J 2 in col 12 if mole percents 3 in col 12 if weight percents 4 in col 12 if mixture ratio 5 in col 12 if oxidizer ratio
IJ	13-24*	This is the computation control number
	<u>To compute</u>	<u>IJ is</u> <u>Program</u>
	Rocket Perf.	1 chain link 2
	Mollier Diag.	2
	Flame Solution	2 chain link 5
	Equil. Solution	2
	Shock Perf.	4 chain link 11

Chain link 5 computes any of the three available options depending on the value of the last item on card 5. See card 5 detail description.

IK	25-36*	The number of total propellant components This can be any number up to 15 for IH = 1, 2, or 3, but is always 2 (in col 36) for IH = 4 or 5
----	--------	---

<u>ITEM</u>	<u>COLUMNS</u>	<u>DEFINITION</u>
IL	37-48*	The number of combinations of these propellants

* All numbers are right oriented within the field given
(i. e. , an IH of 1 would be in col 12)

CARD NO. 5

The content of this card varies with the program chain used (the IJ in card 4). Each item has the card position as follows:

<u>ITEM</u>	<u>COLUMNS</u>	<u>DECIMAL PLACE IN COLUMN</u>
1	1 - 12	6
2	13 - 24	18
3	25 - 36	30
4	37 - 48	42
5	49 - 60	56
6	61 - 72	68

For IJ = 1 (Rocket Performance)

<u>ITEM</u>	<u>IS</u>
1	Chamber pressure in psia
2	Not used
3	Chamber Temperature guess if desired, otherwise may be left blank and program chooses 3000°K
4, 5, 6	Not used

For IJ = 2 (Mollier Diagram)

<u>ITEM</u>	<u>IS</u>
1	Upper pressure boundary (psia)
2	Lower pressure boundary (psia) - the program drops the pressure by a factor of 1/10 until the lower boundary is reached.
3	Upper temperature boundary (°K)
4	Lower temperature boundary (°K)
5	Temperature decrement - the program always computes the lower temperature point so the decrement does not have to exactly fit between the temperature boundaries
6	1. (specifies Mollier Diagram)

For IJ = 2 (Equilibrium Solution)

<u>ITEM</u>	<u>IS</u>
1	Pressure (psia)
2	Not used
3	Upper temperature ($^{\circ}$ K)
4	Lower temperature ($^{\circ}$ K)
5	Temperature decrement ($^{\circ}$ K)
6	2. (Specifies Equilibrium Solution)

For IJ = 2 (Flame Solution)

<u>ITEM</u>	<u>IS</u>
1	Pressure (psia)
2, 3, 4, 5	Not used
6	3. (specifies Flame Solution)

CARD NO. 6

<u>ITEM</u>	<u>COLUMNS</u>	<u>DEFINITION</u>
Name	1 - 24	Component alphabetical name. Any combination is allowable for IH = 1, 2, or 3. For style 4 and 5, one of the propellants must contain the letters FUEL in columns 19 through 22 with columns 23 and 24 blank
ΔH_f	25 - 36	Heat of formation of the molecule in KCAL/MOLE. Decimal place in column 31
	41, 42	The number of atomic species forming the molecule (right oriented)
	43 - 72	Any information desired. These columns are not read nor used. It is suggested that information be placed here as to the reference for the heat of formation

In order to allow computation using ionized molecules, the user must specifically select the electron gas as if it were a part of the composition. This may be done by using the name ION in columns 1-3 with zero heat of formation and one atomic species indicated in column 42. Card 6.1 would contain E in column one and 1.0 in columns 5, 6 and 7. See card 8 detailed write-up for quantity specification.

CARDS NO. 6.1

<u>ITEM</u>	<u>COLUMNS</u>	<u>DEFINITION</u>
Element Name	1 - 2	The standard chemical abbreviation* for one of the elements contained in the immediately preceding component card 6.
Coefficient	3 - 12	The numerical coefficient associated with the above element. Decimal point in col 6 or 7.
Element Name	13 - 14	The abbreviation for the next element*.
Coefficient	15 - 24	The coefficient for this element.
The groups of 2 cols for element name and 10 cols for its coefficient continue across the card.		

	#1	#2	#3	#4	#5	#6
Element	1-2	13-14	25-26	37-38	49-50	61-62
Coefficient	3-12	15-24	27-36	39-48	51-60	63-72
Decimal	6	18	30	42	56	68

A maximum of 15 elements are allowed for each component ingredient. A maximum of 15 component ingredients are allowed (IH = 1, 2 or 3) for each total system.

* Since there may be some question as to what is the standard chemical abbreviation, a list of the element names used in the program follows:

H	N	AL	K	RB
HE	O	SI	CA	ZR
LI	F	P	TI	CD
BE	NE	S	FE	CS
B	NA	CL	NI	PB
C	MG	AR	BR	E (electron gas)

CARD NO. 7 (OPTIONAL)

Col 1-12 (right orient on 12) contains the number of included/excluded products.

CARDS NO. 7. J (OPTIONAL)

Exact product name in cols 1-12 with its state indicator (1 if gas, 2 if condensed or solid) in cols 13, 14*

One product per card.

CARDS NO. 8. K

Combination specification of system components in the order of their data cards. All are in floating point notation in the following manner:

<u>NUMBER</u>	<u>FRACTION COLS</u>	<u>+</u>	<u>EXPONENT</u>
1	2-9	10	11, 12
2	14-21	22	23, 24
3	26-33	34	35, 36
4	38-45	46	47, 48
5	50-57	58	59, 60
6	62-69	70	71, 72

If more than 6 components form the system, the combination specs follow on the next card.

When systems are computed including ionic species, the number of moles (weight percent, mole percent) of the electron gas must be exactly zero.

* Complete sets of these cards will be furnished upon request.

APPENDIX B

Example of Matrix Construction

Section I

Sample system of elements

H
O
Al

Potential products

H	AlO
O	Al ₂ O
Al	O ₂
OH	Al ₂ O ₂
AlOH	O ₃
AlH	Al ₂ O ₃ (crystal)
H ₂	Al (crystal)
H ₂ O	H ₂ O (liquid)

As an example, it will be assumed that the following have been chosen by the computer routine as major products.

H₂
H₂O
Al

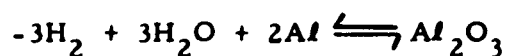
The coefficient matrix and its inverse are

$$\begin{array}{c} \text{C. M.} = \begin{array}{c} \text{H} \\ \text{O} \\ \text{Al} \end{array} \begin{array}{c} \text{H}_2 \\ \text{H}_2\text{O} \\ \text{Al} \end{array} \begin{pmatrix} 2 & 2 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \end{array} \quad \begin{array}{c} \text{C. M.}^{-1} = \begin{array}{c} \text{H} \\ \text{O} \\ \text{Al} \end{array} \begin{array}{c} \text{H}_2 \\ \text{H}_2\text{O} \\ \text{Al} \end{array} \begin{pmatrix} 1/2 & -1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \end{array}$$

Each equilibrium coefficient row E_j can be determined as for Al_2O_3

$$E_{\text{Al}_2\text{O}_3} = \begin{array}{c} \text{H} \\ \text{O} \\ \text{Al} \end{array} \begin{array}{c} \text{H}_2 \\ \text{H}_2\text{O} \\ \text{Al} \end{array} \begin{pmatrix} 1/2 & -1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{array}{c} \text{Al}_2\text{O}_3 \\ \\ \end{array} \begin{pmatrix} 0 \\ 3 \\ 2 \end{pmatrix} = (-3 \ 3 \ 2)$$

which would define equilibrium between Al_2O_3 and the majors as



resulting in

$$K_{\text{Al}_2\text{O}_3} = \frac{P_{\text{Al}_2\text{O}_3}}{P_{\text{H}_2}^{-3} P_{\text{H}_2\text{O}}^3 P_{\text{Al}}^2}$$

or

$$\ln K_{\text{Al}_2\text{O}_3} + 3 \ln P_{\text{H}_2} - 3 \ln P_{\text{H}_2\text{O}} - 2 \ln P_{\text{Al}} = \ln P_{\text{Al}_2\text{O}_3}$$

The generalized equation is

$$E_j = (\text{C. M.}^{-1})(c_j)$$

Section II

Following the matrix scheme outlined in Ref. 1, 4, and 5, the basic error matrix for the solution of an H, O, Al system which contains Al_2O_3 crystal, solving mass balance, equilibrium, pressure conservation, and energy conservation may be partitioned into

$$\left(\begin{array}{c|c} a_1 & a_2 \\ \hline a_3 & a_4 \end{array} \right)$$

where a_1 equals an identity matrix.

$$-a_2 = - \begin{array}{c} \begin{array}{ccccccc} \delta \ln p_{\text{H}_2} & \delta \ln p_{\text{H}_2\text{O}} & \delta \ln p_{\text{Al}} & \delta \ln n_{\text{Al}_2\text{O}_3(\text{c})} & \delta \ln A & \delta \ln T & e \\ \left(\begin{array}{ccccccc} E_{\text{H}} & & & 0 & 0 & q_{\text{H}} & 0 \\ E_{\text{O}} & & & 0 & 0 & q_{\text{O}} & 0 \\ E_{\text{OH}} & & & 0 & 0 & q_{\text{OH}} & 0 \\ E_{\text{AlOH}} & & & 0 & 0 & q_{\text{AlOH}} & 0 \\ E_{\text{AlH}} & & & 0 & 0 & q_{\text{AlH}} & 0 \\ E_{\text{AlO}} & & & 0 & 0 & q_{\text{AlO}} & 0 \\ E_{\text{Al}_2\text{O}} & & & 0 & 0 & q_{\text{Al}_2\text{O}} & 0 \\ E_{\text{O}_2} & & & 0 & 0 & q_{\text{O}_2} & 0 \\ E_{\text{Al}_2\text{O}_2} & & & 0 & 0 & q_{\text{Al}_2\text{O}_2} & 0 \\ E_{\text{O}_3} & & & 0 & 0 & q_{\text{O}_3} & 0 \end{array} \right) \end{array} \end{array}$$

	H	O	OH	AlOH	AlH	AlO	Al ₂ O	Al ₂ O ₂	O ₃
σ_H	PH	0	POH	PAIOH	PAIH	0	0	0	0
σ_O	0	PO	POH	PAIOH	0	PAIO	PAI ₂ O	2PAI ₂ O ₂	3PO ₃
σ_{Al}	0	0	0	0	PAIH	PAIO	2PAI ₂ O	2PAI ₂ O ₂	0
$\alpha_3 = Al_2O_3(c)$	0	0	0	0	0	0	0	0	0
Σp_i	PH	PO	POH	PAIOH	PAIH	PAIO	PAI ₂ O	PAI ₂ O ₂	PO ₃
Σh	h _H	h _O	h _{OH}	h _{AlOH}	h _{AlH}	h _{AlO}	h _{Al₂O}	h _{Al₂O₂}	h _{O₃}

	$\delta \ln p_{H_2}$	$\delta \ln p_{H_2O}$	$\delta \ln p_{Al}$	$\delta \ln A_m$	$Al_2O_3(c)$	$\delta \ln A$	$\delta \ln T$	ϵ
σ_H	2PH ₂	2PH ₂ O	0	0	-AaH	0	0	ϵ_H
σ_O	0	PO	0	3PAI ₂ O ₃ (c)	-AaO	0	0	ϵ_O
σ_{Al}	0	0	PAI	2PAI ₂ O ₃ (c)	-AaAl	0	0	ϵ_{Al}
$\alpha_4 = Al_2O_3(c)$	(	EAl ₂ O ₃ (c)	)	0	0	9Al ₂ O ₃ (c)	Al ₂ O ₃ (c)	
Σp_i	PH ₂	PH ₂ O	PAI	0	0	0	0	ϵ_p
Σh	h _{H₂}	h _{H₂O}	h _{Al}	h _{Al₂O₃(c)}	-Ah	TC'	ϵ_H	

APPENDIX C

Initial Guess Constants

Initial guess constants for elements now contained on the thermodynamic data tape are as follows.

<u>Element</u>	<u>FG</u>	<u>Element</u>	<u>FG</u>
H	2.8×10^{-3}	Ca	1.0×10^{-3}
He	1.0	Sc	1.0×10^{-3}
Li	4.5×10^{-4}	Ti	1.0×10^{-5}
Be	2.0×10^{-6}	Cr	1.0×10^{-3}
B	8.1×10^{-6}	Fe	1.0×10^{-3}
C	1.4×10^{-10}	Co	1.0×10^{-3}
N	3.0×10^{-6}	Ni	1.0×10^{-3}
O	1.1×10^{-5}	Ca	1.0×10^{-3}
F	2.0×10^{-2}	Fn	1.0×10^{-3}
Ne	1.0	Br	1.0×10^{-3}
Na	1.2×10^{-3}	Ag	1.0×10^{-3}
Mg	4.5×10^{-4}	Cd	1.0×10^{-3}
Al	1.5×10^{-7}	I	1.0×10^{-3}
Si	1.0×10^{-6}	Cs	1.0×10^{-3}
P	2.9×10^{-2}	Ba	1.0×10^{-3}
S	7.9×10^{-2}	Hg	1.0×10^{-3}
Cl	1.0×10^{-6}	Pb	1.0×10^{-1}
Ar	1.0×10^{-3}	Bi	1.0×10^{-3}
K	1.0×10^{-3}	U	1.0×10^{-3}
		e	1.0×10^{-10}

APPENDIX D
Rocket Performance Sample Output

TEST CASE	CLC3F+LI	REFERENCE DUMMINS P 673 BLANK
3	1	1
1000.		
CLC3F	-15.1	3
CL 1.	1.	2
LI 1.	-21.6	
LI 1.		

***** PRODUCTS CHOSEN ARE THE FOLLOWING

H	HEAT OF FORMATION	52.1020
LI	HEAT CF FORMATION	38.4100
J	HEAT OF FORMATION	59.5590
F	HEAT OF FORMATION	18.8600
CL	HEAT CF FORMATION	28.9220
MLIU	HEAT LF FORMATION	-57.7000
HLI	HEAT OF FORMATION	32.1000
FHO	HEAT OF FORMATION	-26.1000
CLHC	HEAT OF FORMATION	-21.4000
HO	HEAT CF FORMATION	9.3300
FH	HEAT OF FORMATION	-64.5000
CLH	HEAT OF FORMATION	-21.9700
M2L1202	HEAT CF FORMATION	-169.4000
H2U	HEAT CF FORMATION	-57.7980
H2	HEAT OF FORMATION	0.
FLIG	HEAT OF FORMATION	-10.0000
CLLIU	HEAT OF FORMATION	-3.4000
LIU	HEAT CF FORMATION	14.0000
HLI	HEAT OF FORMATION	-79.3000
LICL	HEAT OF FORMATION	-46.7780
LI2U	HEAT OF FORMATION	-34.1000
CLFL12	HEAT CF FORMATION	-180.2000
F2L12	HEAT OF FORMATION	-213.5000
CL2L12	HEAT CF FORMATION	-140.8000
LI12	HEAT OF FORMATION	50.4000
F3L13	HEAT CF FORMATION	-357.6000
CL3L13	HEAT OF FORMATION	-228.3000
FC	HEAT OF FORMATION	32.4000
F2U	HEAT OF FORMATION	7.6000
CLU	HEAT CF FORMATION	24.1920
CL2U	HEAT OF FORMATION	18.1000
CLU2	HEAT OF FORMATION	25.0000
U2	HEAT OF FORMATION	0.
CLFU3	HEAT CF FORMATION	-5.1200
J3	HEAT OF FORMATION	34.0000
CLF	HEAT CF FORMATION	-13.5010
F2	HEAT OF FORMATION	0.
CLF3	HEAT CF FORMATION	-38.7900
CL2	HEAT OF FORMATION	0.

(MAD)
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CM()
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AEROSPACE CORPORATION				
TEST CASE 2	CLU3F+LIH	REFERENCE DUBBINS P 673		
COMPONENT	WEIGHT PERCENT	MOLES	MULE PERCENT	MULE PERCENT
CLU3F	69.999997	1.000000		15.326426
LIH	29.999999	5.524678		84.673574
ELEMENTS		MASS BALANCE (MOLES/GM)		
H	0.8467			0.37745345E-01
LI	0.8467			0.37745345E-01
C	0.4598			0.20496403E-01
F	0.1533			0.68321345E-02
CL	0.1533			0.68321345E-02

THE ERIC CARL LIBRARY INC. 5/14/53

TEST CASE: 6034-114
REFERENCE DUBINS P 673
CHAMBER PRESSURE = 1000 PSIA

TABLE ONE
THERMO-ANALYTIC CHARACTERISTICS FOR EACH EXPANSION PLANE

PRESSURE (PSIA)	1 96.277	961.538	833.333	714.286	574.642	293.919	146.959	97.973
TEMPERATURE (DEG N)	3 104.565	2991.173	2 343.379	2833.356	2825.261	2631.960	2454.839	2360.369
S (CAL/CM)	5 (85.5)	5676.7	5641.6	5634.5	5553.5	5404.7	5263.6	5186.5
S (CAL/CM-DEG N)	2.817	2.819	2.819	2.819	2.819	2.819	2.819	2.819
CP (CAL/CM)	1.837	1.841	1.857	1.872	1.891	1.927	1.928	1.915
GAMMA	1.152	1.152	1.152	1.151	1.149	1.144	1.139	1.136
AVERAGE GAS FLOW MT	23.973	23.993	24.059	24.134	24.243	24.609	25.016	25.022
GAZ FLOW/100 CM	4.17195	4.16793	4.16640	4.16461	4.12487	4.06356	3.99745	3.95852
DETAILED FLOW/100 CM	1.42197	0.43026	0.43655	0.44378	0.45674	0.49273	0.53617	0.56279

COMPOSITIONNELLES DES JARDINS D'APPELLANT

M	0.3361	0.33586	0.33324	0.3062	0.27222	0.21877	0.21258	0.20987
L1	0.25515	0.25333	0.24673	0.23935	0.22852	0.19330	0.15616	0.13519
L2	0.25514	0.25512	0.25510	0.25008	0.25006	0.25001	0.25001	0.25000
L3	0.25514	0.25513	0.25512	0.25012	0.25008	0.25004	0.25002	0.25001
L4	1.24460	1.24463	1.24273	1.24033	1.23511	1.22936	1.17066	1.14312
L5	0.33703	0.33627	0.33366	0.33101	0.32751	0.31855	0.31187	0.30896
L6	0.33017	0.33049	0.33039	0.30382	0.30313	0.30170	0.30091	0.30063
L7	0.32432	0.32403	0.32302	0.32201	0.32369	0.31733	0.31475	0.31355
L8	0.32475	0.32465	0.32433	0.32431	0.32360	0.32262	0.32193	0.32163
L9	0.32556	0.32506	0.32506	0.32006	0.32006	0.32005	0.32005	0.32005
M2L12L2	0.3552	0.34932	0.34677	0.34427	0.34121	0.33561	0.33513	0.33793
M2	0.86776	0.86271	0.86965	0.87754	0.88737	0.91764	0.94574	0.96041
L10	0.62434	0.62422	0.62369	0.62318	0.60258	0.60132	0.60065	0.60042
L11	0.64781	0.64809	0.64907	0.65034	0.65128	0.65430	0.65633	0.65710
L12L	0.67152	0.67164	0.67225	0.67245	0.67296	0.67416	0.67494	0.67524
L12U	0.67103	0.671603	0.671506	0.671404	0.671267	0.670898	0.670632	0.670466
L2L12	0.63332	0.63332	0.63332	0.63332	0.63333	0.63340	0.63352	0.63362
L2L12	0.63384	0.63384	0.63385	0.63387	0.63390	0.63434	0.63424	0.63440

***** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE *****

THEME WITH LIBRARY TAPE 55 5/14/63

TEST CASE L CLOJF+LIH REFERENCE DUBRINS P 673
CHAMBER PRESSURE = 1000 PSIA

TABLE ONE
THERMODYNAMIC CONDITIONS FOR EACH EXPANSION PLANE

	73.483	58.784	48.987	29.392	24.493	20.994	18.370	14.696
PRESSURE (PSIA)	2296.899	2249.542	2212.000	2111.911	2077.898	2049.812	2025.959	1987.104
TEMPERATURE (DEG K)	5135.3	5094.4	5062.9	4978.0	4948.9	4924.7	4904.1	4870.4
M (CAL/CM)	2.819	2.819	2.819	2.819	2.819	2.819	2.819	2.819
S (CAL/CM-DEG K)	1.751	1.868	1.876	1.842	1.830	1.820	1.812	1.800
CP (CAL/CM)	1.134	1.132	1.131	1.128	1.127	1.126	1.125	1.123
GAMMA	25.435	25.577	25.690	26.007	26.120	26.215	26.298	26.436
AVERAGE GAS MOLE WT	3.93097	3.90977	3.89257	3.84516	3.82852	3.81458	3.80261	3.78278
GAS MOLES/100 GM	1.58257	0.59715	0.60957	0.64465	0.65724	0.66794	0.67722	0.69280
COND MOLES/100 GM								

COMPOSITION MOLES PER 100 GRAMS PROPELLANT

H	0.00824	0.00721	0.00643	0.00462	0.00409	0.00369	0.00337	0.00290
LI	0.12092	0.11031	0.10198	0.08047	0.07351	0.06791	0.06330	0.05609
HCLO	1.12151	1.10375	1.08466	1.04256	1.02507	1.00982	0.99628	0.97293
HCL	0.00724	0.00616	0.00535	0.00356	0.00305	0.00268	0.00239	0.00196
HC	0.0043	0.00342	0.00294	0.00201	0.0018	0.0015	0.0014	0.0011
FM	0.01283	0.01232	0.01175	0.01103	0.01076	0.01054	0.01037	0.01010
CLM	0.00145	0.00139	0.00124	0.00102	0.00096	0.00091	0.00087	0.00080
M2L12H2	0.00005	0.00004	0.00024	0.00004	0.00004	0.00004	0.00004	0.00004
H2O	0.34133	0.34475	0.34803	0.36206	0.36526	0.37006	0.37452	0.38254
H2	0.00774	0.00762	0.00726	0.00668	0.00691	0.00727	0.00662	0.00628
LIU	0.00031	0.00024	0.00019	0.00011	0.00009	0.00007	0.00006	0.00005
FLI	0.65746	0.65764	0.65773	0.65768	0.65753	0.65738	0.65722	0.65687
LICL	0.67534	0.67545	0.67551	0.67553	0.67551	0.67548	0.67544	0.67535
LICU	0.00045	0.00030	0.00020	0.00019	0.00017	0.00015	0.00013	0.00013
CLFL12	0.00370	0.00378	0.00385	0.00409	0.00418	0.00428	0.00436	0.00451
F2L12	0.00453	0.00464	0.00474	0.00504	0.00523	0.00546	0.00567	0.00568
CL2L12	0.00134	0.00132	0.00131	0.00128	0.00128	0.00128	0.00127	0.00127
LI12	0.00222	0.00017	0.00014	0.00007	0.00005	0.00004	0.00004	0.00003

F3L13	CCAC	0.00006	0.00006	0.00007	0.00009	0.00009	0.00010	0.00011	0.00012
L120		0.58257	0.59716	0.60957	0.64465	0.65724	0.66794	0.67722	0.69280

***** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE *****

THERMO DATA LIBRARY FILE 50 5/14/53

TEST CASE E CLOSFLH REFERENCE DUBBINS P 673
CHAMBER PRESSURE = 1000 PSIA

TABLE LNE
THERMODYNAMIC COEFFICIENTS FOR EACH EXPANSION PLANE

PRESSURE (PSIA)	4.797	7.343	5.878	2.500	1.250	1.000	0.667	0.500
TEMPERATURE (DEG R)	1019.350	1873.445	1839.055	1716.431	1646.775	1627.521	1593.465	1565.550
H (CAL/GR)	4811.7	4775.6	4745.1	4629.3	4551.9	4527.3	4481.9	4448.7
S (CAL/GR-DEG R)	2.713	2.713	2.819	2.819	2.819	2.819	2.819	2.819
CP (CAL/GR)	1.775	1.775	1.771	1.776	2.193	2.349	2.586	2.586
GAMMA	1.121	1.113	1.117	1.112	1.131	1.092	1.092	1.091
AVERAGE GAS MOLE WT	26.085	26.061	26.937	27.515	27.350	27.297	27.296	27.470
GAS MOLES/100 GR	3.74747	3.72288	4.70412	3.63443	3.65634	3.66344	3.66375	3.64027
CAL MOLES/100 GR	1.72111	0.74126	1.75687	1.81637	0.79472	0.78818	0.78829	0.80997

COMPOSITION-MOLES PER 100 GRAMS PROPELLANT

H	0.00214	0.00173	0.00151	0.00080	0.00058	0.00054	0.00046	0.00039
LI	0.04452	0.03744	0.03263	0.01861	0.01805	0.01808	0.01721	0.01455
MLD	0.92701	0.89583	0.86566	0.76525	0.80686	0.81918	0.81964	0.77898
MLI	0.00130	0.00104	0.00084	0.00036	0.00027	0.00024	0.00023	0.00015
HE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
FM	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
GLH	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
H2L1202	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
H2O	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
H2	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
FLI	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LIOL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LI2O	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
CLFL12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
F2L12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
CL2L12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LI12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

F3L13	CCU	C.00015	C.00018	C.00021	C.00037	C.00038	C.00037	C.00036	C.00039
L120		C.72113	C.74126	C.75687	C.81637	C.79472	C.78818	C.78829	C.80997

..... MISTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE

THEME DATA LIBRARY 1200 5/14/54

TEST CASE 1 CUBIC POLY REFERENCE DUMINS P 673
CHAMBER PRESSURE = 1000 PSIA

WC/PE	P PSIA	T JEG.-K	M CAL/GM	GAMMA	EPSILON	CF	IS LB-SEC/LB
1.0000	1000.000	3704.5	5686.52	1.1525	0.	0.	C.
1.0400	961.5335	2791.2	5676.74	1.1523	2.3292	0.1790	29.16
1.0800	933.3333	2793.4	5641.62	1.1515	1.2463	0.3636	62.50
1.0900	914.2457	2493.4	5604.55	1.1506	1.9545	0.5183	84.45
1.0950	874.6416	2825.2	5553.45	1.1492	1.9000	0.6604	107.60
1.0980	833.3113	2632.0	5404.69	1.1444	1.2329	0.9611	156.60
1.0990	746.2594	2454.8	5263.57	1.1392	1.8468	1.1773	191.84
1.0995	716.723	2365.3	5186.45	1.1361	2.4258	1.2802	208.59
1.0999	73.4332	2296.9	5133.94	1.1341	2.9733	1.3457	219.27
1.0999	58.7341	2249.5	5094.41	1.1325	3.4374	1.3930	226.98
1.0999	48.1357	2212.0	5062.88	1.1312	4.0335	1.4296	232.95
1.0999	24.3323	2111.9	4977.99	1.1278	5.9340	1.5238	248.30
1.0999	24.4333	2277.9	4948.85	1.1260	6.8021	1.5548	253.35
1.0999	24.3342	2049.8	4924.69	1.1256	7.6753	1.5801	257.47
1.0999	18.3723	2226.0	4904.10	1.1247	8.5280	1.6013	260.92
1.0999	14.6363	1987.1	4870.37	1.1233	10.1838	1.6355	266.49
1.0999	9.7373	1919.3	4811.17	1.1207	14.1141	1.6937	275.98
1.0999	7.3483	1873.4	4770.63	1.1189	17.8398	1.7325	282.30
1.0999	5.3784	1839.1	4740.06	1.1174	21.4255	1.7612	286.97
1.0999	2.5320	1716.4	4629.28	1.1120	43.6513	1.8614	303.30
1.0999	1.2500	1546.8	4551.90	1.1010	81.3403	1.9283	314.21
1.0999	1.0000	1527.5	4527.31	1.0974	99.6364	1.9491	317.59
1.0999	0.8067	1593.5	4481.92	1.0920	143.5124	1.9869	323.75
1.0999	0.5000	1565.5	4448.72	1.0900	184.2755	2.0141	328.18

2-1

6

***** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE *****

THEME DATA LIBRARY TAPE 55 5/14/63

TEST CASE 1 CLO3FALIM REFERENCE DOBBINS P 673
CHAMBER PRESSURE = 1000 PSIA

TABLE THREE

EPSILON	PC/PE	I UPI	A	E	I EPS	CF OPI	CF EPS
1.0000	1.7401	107.60	93.64	1.16	231.24	0.6603	1.2350
2.0000	7.6665	197.83	42.40	3.33	240.23	1.2141	1.4743
3.0000	13.7742	219.73	35.48	4.49	255.20	1.3485	1.5662
4.0000	20.3930	232.91	31.97	5.65	264.87	1.4294	1.6256
5.0000	27.4158	241.78	29.72	6.81	271.50	1.4838	1.6662
6.0000	34.7397	248.90	28.14	8.98	277.05	1.5275	1.7003
7.0000	42.3537	254.35	26.93	1.14	281.28	1.5610	1.7263
8.0000	50.2048	258.85	25.96	1.30	284.81	1.5886	1.7479
9.0000	58.2631	262.66	25.17	1.47	287.83	1.6120	1.7665
10.0000	66.5140	265.91	24.50	1.63	290.41	1.6319	1.7823
11.0000	74.9123	268.89	23.93	1.79	292.81	1.6502	1.7970
12.0000	83.4671	271.52	23.43	1.96	294.95	1.6664	1.8101
13.0000	92.2297	273.59	22.97	2.12	296.55	1.6790	1.8200
14.0000	101.0540	275.15	22.57	2.28	298.32	1.6923	1.8308
15.0000	110.0025	277.72	22.22	2.44	299.94	1.7044	1.8408
16.0000	119.1211	279.37	21.89	2.61	301.25	1.7145	1.8488
17.0000	128.3039	281.01	21.59	2.77	302.60	1.7246	1.8571
18.0000	137.5844	282.54	21.32	2.93	303.86	1.7340	1.8648
19.0000	146.9623	283.96	21.07	3.10	305.03	1.7427	1.8720
20.0000	156.4862	285.18	20.83	3.26	306.01	1.7502	1.8780
21.0000	166.0322	286.45	20.61	3.42	307.06	1.7580	1.8844
22.0000	175.6443	287.67	20.41	3.58	308.08	1.7655	1.8907
23.0000	185.3228	288.95	20.22	3.75	309.07	1.7727	1.8968
24.0000	195.0674	289.98	20.05	3.91	310.03	1.7796	1.9027
25.0000	204.8782	291.07	19.88	4.07	310.95	1.7863	1.9083

***** SHIFTING EQUILIBRIUM EXPANSION-ROCKET PERFORMANCE *****

THEME DATA LIBRARY TAPE 55 5/14/63

TEST CASE C CLUBFO-LIM REFERENCE DUMHINS P 673
CHAMBER PRESSURE = 1000 PSIA

TABLE THREE

EPSILON	PC/PE	I UPT	A	H	I EPS	CF OPT	CF EPS
26.0000	214.7553	292.11	19.73	4.24	311.84	1.7927	1.9138
27.0000	224.6446	293.11	19.58	4.40	312.69	1.7989	1.9190
28.0000	234.7132	294.07	19.44	4.56	313.51	1.8047	1.9240
29.0000	244.7639	294.98	19.30	4.73	314.29	1.8103	1.9288
30.0000	254.8259	295.85	19.18	4.89	315.03	1.8157	1.9333
31.0000	265.1341	296.68	19.05	5.05	315.73	1.8207	1.9376
32.0000	275.4085	297.46	18.93	5.21	316.39	1.8255	1.9417
33.0000	285.2759	298.35	18.59	5.38	314.98	1.8190	1.9331
34.0000	295.6277	297.11	18.49	5.54	315.60	1.8234	1.9369
35.0000	305.9886	297.82	18.40	5.70	316.22	1.8278	1.9407
36.0000	321.3585	298.51	18.31	5.87	316.82	1.8320	1.9444
37.0000	331.7374	299.19	18.23	6.03	317.42	1.8361	1.9480
38.0000	341.1254	299.85	18.15	6.19	318.00	1.8402	1.9516
39.0000	351.5222	300.49	18.08	6.35	318.57	1.8442	1.9551
40.0000	361.9281	301.13	18.01	6.52	319.13	1.8480	1.9586
41.0000	372.3431	301.74	17.94	6.68	319.68	1.8518	1.9619
42.0000	382.7671	302.34	17.88	6.84	320.22	1.8555	1.9652
43.0000	393.2000	302.93	17.82	7.01	320.75	1.8591	1.9685
44.0000	403.6420	303.50	17.76	7.17	321.26	1.8626	1.9716
45.0000	414.0930	304.06	17.71	7.33	321.77	1.8660	1.9747
46.0000	424.5530	304.60	17.65	7.50	322.25	1.8694	1.9777
47.0000	435.0220	305.13	17.60	7.66	322.73	1.8726	1.9806
48.0000	445.5000	305.64	17.56	7.82	323.20	1.8757	1.9835
49.0000	455.9871	306.14	17.51	7.98	323.65	1.8788	1.9863
50.0000	466.4832	306.62	17.47	8.15	324.08	1.8818	1.9889

1

APPENDIX E

Flame Composition Sample Output

2

3

TEST CASE 2		CLC3F+LIM		REFERENCE DUBBINS P 673		
				BLANK		
1000.	4	10001	2	100.	1	100.
CLC3F				3		3.
CL 1.	U	3.	F			
LIM	M	FUEL		2		
LI 1.		1.				

..... AND THE RESULTS ARE THE FOLLOWING:

CL	HEAT OF FORMATION	52.1020
CL	HEAT OF FORMATION	38.4100
CL	HEAT OF FORMATION	59.5590
CL	HEAT OF FORMATION	18.8600
CL	HEAT OF FORMATION	28.9220
CL	HEAT OF FORMATION	-57.7000
CL	HEAT OF FORMATION	32.1000
CL	HEAT OF FORMATION	-26.1000
CL	HEAT OF FORMATION	-21.4000
CL	HEAT OF FORMATION	9.3300
CL	HEAT OF FORMATION	-64.5000
CL	HEAT OF FORMATION	-21.9700
CL	HEAT OF FORMATION	-169.4000
CL	HEAT OF FORMATION	-57.7980
CL	HEAT OF FORMATION	0.
CL	HEAT OF FORMATION	-10.0000
CL	HEAT OF FORMATION	-3.4000
CL	HEAT OF FORMATION	14.0000
CL	HEAT OF FORMATION	-79.3000
CL	HEAT OF FORMATION	-46.7780
CL	HEAT OF FORMATION	-34.1000
CL	HEAT OF FORMATION	-180.2000
CL	HEAT OF FORMATION	-213.5000
CL	HEAT OF FORMATION	-145.8000
CL	HEAT OF FORMATION	50.4000
CL	HEAT OF FORMATION	-357.6000
CL	HEAT OF FORMATION	-228.3000
CL	HEAT OF FORMATION	32.4000
CL	HEAT OF FORMATION	7.6000
CL	HEAT OF FORMATION	24.1920
CL	HEAT OF FORMATION	18.1000
CL	HEAT OF FORMATION	25.0000
CL	HEAT OF FORMATION	0.
CL	HEAT OF FORMATION	-5.1200
CL	HEAT OF FORMATION	34.0000
CL	HEAT OF FORMATION	-13.5010
CL	HEAT OF FORMATION	0.
CL	HEAT OF FORMATION	-38.7900
CL	HEAT OF FORMATION	0.

LI	LIQUID	HEAT OF FORMATION	-0.0003
LIF	COND	HEAT OF FORMATION	-116.6699
LIF	COND	HEAT OF FORMATION	-146.1759
LICL	LIQUID	HEAT OF FORMATION	-94.4642
LICL	COND	HEAT OF FORMATION	-143.0486

23333333+C1

55 5/14/63
 TEST CASE C
 REFERENCE DUMINS P 673
 FUEL COMPONENT LIM
 OXIDIZER COMPONENT CLO3F
 MIXTURE RATIO
 2.33333
 OXIDIZER RATIO
 0.72402

SYSTEM ELEMENTS	FUEL FORMULA	OXIDIZER FORMULA	MASS BALANCE (MOLES/SYSTEM-GM)
H	1.00000	O.	0.37745346E-01
LI	1.00000	O.	0.37745346E-01
U	0.	0.00000	0.20496403E-01
F	0.	1.00000	0.68321343E-02
CL	0.	1.00000	0.68321343E-02

FLAME COMPOSITION, OPTICALLY SELECTED, UNHEATED SYSTEM ENTHALPY (KCAL/GM) = 5.68651

FU	0.211683E-12	0.463219E-11	8.90614	89.46574	70.20648	-121.47273
F2L	0.	0.	13.84418	108.94000	88.88195	-158.10975
CLU	0.23535E-12	0.711675E-11	9.24559	55.34491	74.10799	-167.31582
CL2L	0.257197E-13	0.554953E-15	13.85414	66.57530	93.73197	-215.04654
CLC2	0.667299E-15	0.145077E-13	14.34505	70.75253	91.15571	-203.12882
C2	0.21547E-06	0.464316E-05	9.55304	27.60031	67.98746	-176.67101
CLF03	0.	0.	25.59368	102.82192	118.75474	-253.98193
L3	0.376741E-14	0.14451E-13	13.80503	75.72202	85.81112	-182.10128
CLF	0.345350E-11	0.757427E-10	9.28609	47.19747	72.14205	-169.55652
F2	0.131430E-14	0.345753E-13	9.53505	87.53897	68.58443	-118.52598
CLF3	0.	0.	19.80918	113.10093	111.35698	-221.47604
CL2	0.343093E-13	0.747214E-10	9.37532	34.46850	73.77419	-187.18931
L1	0.	0.	6.65145	150.02692	24.34957	77.76894
L1CH	0.	0.	20.74000	110.47824	59.22739	-67.47307
L1F	0.	0.	15.31000	62.80357	45.65457	-74.36762
L1CL	0.	0.	14.40000	81.14543	49.36796	-67.18778
L12U	0.428072E-02	0.931972E-01	23.00000	193.04751	62.99744	3.76894

APPENDIX F
Mollier Diagram Sample Output

***** PRODUCTS CHOSEN ARE THE FOLLOWING

H	HEAT OF FORMATION	52.1020
LI	HEAT OF FORMATION	38.4100
U	HEAT OF FORMATION	59.5590
F	HEAT OF FORMATION	18.8600
CL	HEAT OF FORMATION	28.9220
HLIC	HEAT OF FORMATION	-57.7000
HLI	HEAT OF FORMATION	32.1000
FLU	HEAT OF FORMATION	-26.1000
CLHC	HEAT OF FORMATION	-21.4000
HC	HEAT OF FORMATION	9.3300
FL	HEAT OF FORMATION	-64.5000
CLW	HEAT OF FORMATION	-21.9700
H2L12U2	HEAT OF FORMATION	-169.4000
H2O	HEAT OF FORMATION	-57.7980
H2	HEAT OF FORMATION	0.
FLIC	HEAT OF FORMATION	-10.0000
CLLIU	HEAT OF FORMATION	-3.4000
LIU	HEAT OF FORMATION	14.0000
FLI	HEAT OF FORMATION	-79.3000
LICL	HEAT OF FORMATION	-46.7780
L12O	HEAT OF FORMATION	-34.1000
CLFLI2	HEAT OF FORMATION	-180.2000
F2LI2	HEAT OF FORMATION	-213.5000
LI12	HEAT OF FORMATION	-140.8000
F3LI3	HEAT OF FORMATION	50.4000
CL3LI3	HEAT OF FORMATION	-357.6000
FL	HEAT OF FORMATION	-228.3000
F2O	HEAT OF FORMATION	32.4000
CLO	HEAT OF FORMATION	7.6000
CL2U	HEAT OF FORMATION	24.1920
CLU2	HEAT OF FORMATION	18.1000
O2	HEAT OF FORMATION	25.0000
CLF03	HEAT OF FORMATION	0.
U3	HEAT OF FORMATION	-5.1200
CLF	HEAT OF FORMATION	34.0000
F2	HEAT OF FORMATION	-13.5010
CLF3	HEAT OF FORMATION	0.
CL2	HEAT OF FORMATION	-38.7900
		C.

-0.0000
 -116.6699
 -146.1759
 -94.4642
 -143.0486

HEAT OF FORMATION
 HEAT OF FORMATION
 HEAT OF FORMATION
 HEAT OF FORMATION
 HEAT OF FORMATION

LIQUID
 LIQUID
 LIQUID
 LIQUID
 LIQUID

2333333+01

55 5/14/63
 TEST CASE F CLC3F+LIP
 AEROSPACE CORPORATION
 REFERENCE DOHRNS P 673
 FUEL COMPONENT LIP
 OXIDIZER COMPONENT CLC3F
 MIXTURE RATIO 2.53333
 OXIDIZER RATIO 0.72402
 SYSTEM ELEMENTS FUEL FORMULA OXIDIZER FORMULA MASS BALANCE (MOLES/SYSTEM-GM)

H	1.00000	C.	0.37745346E-01
LI	1.00000	O.	0.37745346E-01
C	0.	3.00000	0.20496403E-01
F	0.	1.00000	0.68321343E-02
CL	0.	1.00000	0.68321343E-02

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LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1200.00 SICAL/GM-DEG)= 2.0253 H(KCAL/GM)= 3.7967 RHO(GM/CU-CM)=0.316314E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1500.00 SICAL/GM-DEG)= 1.9533 H(KCAL/GM)= 3.6755 RHO(GM/CU-CM)=0.374531E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1700.00 SICAL/GM-DEG)= 1.9033 H(KCAL/GM)= 3.5765 RHO(GM/CU-CM)=0.425513E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1900.00 SICAL/GM-DEG)= 1.8170 H(KCAL/GM)= 3.4333 RHO(GM/CU-CM)=0.475886E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1500.00 SICAL/GM-DEG)= 1.7668 H(KCAL/GM)= 3.3615 RHO(GM/CU-CM)=0.516456E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1400.00 SICAL/GM-DEG)= 1.7153 H(KCAL/GM)= 3.2869 RHO(GM/CU-CM)=0.559113E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1300.00 SICAL/GM-DEG)= 1.6612 H(KCAL/GM)= 3.2139 RHO(GM/CU-CM)=0.606030E-01
 LIQU COND PRESENT
 LIF COND PRESENT
 LIQU LIQUID PRESENT
 LIQU LIQUID PRESENT
 P(PSIA)= 0.10000E+04 T(DFR-K)=1200.00 SICAL/GM-DEG)= 1.6037 H(KCAL/GM)= 3.1420 RHO(GM/CU-CM)=0.659314E-01
 LIQU COND PRESENT
 LIF COND PRESENT

[illegible]

P(PSIA)=	0.10000E-04	COND	PRESENT	SICAL/CM-DEG)=	0.6092	MIKCAL/GM)=	2.4418	RHO(GM/CU-CM)=	0.265347E-00
L12U	COND	PRESENT							
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-04	COND	PRESENT	SICAL/CM-DEG)=	0.3559	MIKCAL/GM)=	2.4063	RHO(GM/CU-CM)=	0.398021E-00
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-04	COND	PRESENT	SICAL/CM-DEG)=	0.1972	MIKCAL/GM)=	2.3764	RHO(GM/CU-CM)=	0.796042E-00
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.9381	MIKCAL/GM)=	6.8383	RHO(GM/CU-CM)=	0.301780E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.8304	MIKCAL/GM)=	6.4128	RHO(GM/CU-CM)=	0.325293E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.7257	MIKCAL/GM)=	6.0095	RHO(GM/CU-CM)=	0.350697E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.6263	MIKCAL/GM)=	7.6371	RHO(GM/CU-CM)=	0.377468E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.5364	MIKCAL/GM)=	7.3088	RHO(GM/CU-CM)=	0.404936E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.4560	MIKCAL/GM)=	7.0231	RHO(GM/CU-CM)=	0.432580E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.3863	MIKCAL/GM)=	6.7827	RHO(GM/CU-CM)=	0.459623E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.3270	MIKCAL/GM)=	6.5839	RHO(GM/CU-CM)=	0.485856E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.2767	MIKCAL/GM)=	6.4202	RHO(GM/CU-CM)=	0.511331E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.2334	MIKCAL/GM)=	6.2838	RHO(GM/CU-CM)=	0.536385E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.1952	MIKCAL/GM)=	6.1672	RHO(GM/CU-CM)=	0.561503E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.1605	MIKCAL/GM)=	6.0649	RHO(GM/CU-CM)=	0.587138E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.1282	MIKCAL/GM)=	5.9728	RHO(GM/CU-CM)=	0.613671E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.0974	MIKCAL/GM)=	5.8581	RHO(GM/CU-CM)=	0.641469E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	3.0676	MIKCAL/GM)=	5.8092	RHO(GM/CU-CM)=	0.670856E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	2.9468	MIKCAL/GM)=	5.5065	RHO(GM/CU-CM)=	0.762122E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	2.8486	MIKCAL/GM)=	5.2606	RHO(GM/CU-CM)=	0.854460E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	2.7697	MIKCAL/GM)=	5.0751	RHO(GM/CU-CM)=	0.941282E-03
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	2.7024	MIKCAL/GM)=	4.9235	RHO(GM/CU-CM)=	0.102692E-02
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							
P(PSIA)=	0.10000E-03	COND	PRESENT	SICAL/CM-DEG)=	2.6395	MIKCAL/GM)=	4.7885	RHO(GM/CU-CM)=	0.111670E-02
L12H	COND	PRESENT							
L1F	COND	PRESENT							
L1CL	LIQUID	PRESENT							
L12U	COND	PRESENT							

P(PSIA)= 0.10000E 03 T(DIG-K)=2000.00 SICAL/GM-DEG)= 2.4912 H(KCAL/GM)= 4.4430 RHC(GM/CU-CM)=0.155055E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1700.00 SICAL/GM-DEG)= 2.3961 H(KCAL/GM)= 4.2975 RHO(GM/CU-CM)=0.153716E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1400.00 SICAL/GM-DEG)= 2.3206 H(KCAL/GM)= 4.1575 RHO(GM/CU-CM)=0.170879E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1700.00 SICAL/GM-DEG)= 2.2540 H(KCAL/GM)= 4.0410 RHO(GM/CU-CM)=0.187950E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1600.00 SICAL/GM-DEG)= 2.0455 H(KCAL/GM)= 3.7134 RHC(GM/CU-CM)=0.223876E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1500.00 SICAL/GM-DEG)= 1.8707 H(KCAL/GM)= 3.4370 RHO(GM/CU-CM)=0.308313E-02
 LI20 COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1400.00 SICAL/GM-DEG)= 1.7916 H(KCAL/GM)= 3.3221 RHO(GM/CU-CM)=0.473715E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1300.00 SICAL/GM-DEG)= 1.7249 H(KCAL/GM)= 3.2320 RHO(GM/CU-CM)=0.549237E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1200.00 SICAL/GM-DEG)= 1.6607 H(KCAL/GM)= 3.1516 RHO(GM/CU-CM)=0.622625E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E 03 T(DIG-K)=1100.00 SICAL/GM-DEG)= 1.5553 H(KCAL/GM)= 3.0318 RHO(GM/CU-CM)=0.699647E-02
 LIF COND PRESENT
 LI20 COND PRESENT

P(PSIA)= 0.10000E 03 T(DLG-K)=1000.00 S(CAL/°M-DEG)= 1.4858 H(KCAL/GM)= 2.9588 RHO(GM/CU-CM)=0.783653E-C2
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 900.00 S(CAL/°M-DEG)= 1.4095 H(KCAL/GM)= 2.8865 RHO(GM/CU-CM)=0.879289E-02
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 800.00 S(CAL/°M-DEG)= 1.3278 H(KCAL/GM)= 2.8171 RHO(GM/CU-CM)=0.993482E-02
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 700.00 S(CAL/°M-DEG)= 1.1274 H(KCAL/GM)= 2.6674 RHO(GM/CU-CM)=0.113701E-C1
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 600.00 S(CAL/°M-DEG)= 1.0338 H(KCAL/GM)= 2.6067 RHO(GM/CU-CM)=0.132673E-C1
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 500.00 S(CAL/°M-DEG)= 0.9277 H(KCAL/GM)= 2.5484 RHO(GM/CU-CM)=0.159208E-01
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 400.00 S(CAL/°M-DEG)= 0.8042 H(KCAL/GM)= 2.4931 RHO(GM/CU-CM)=0.199011E-01
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 300.00 S(CAL/°M-DEG)= 0.6569 H(KCAL/GM)= 2.4418 RHO(GM/CU-CM)=0.265348E-01
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT
 P(PSIA)= 0.10000E 03 T(DLG-K)= 200.00 S(CAL/°M-DEG)= 0.4035 H(KCAL/GM)= 2.4063 RHO(GM/CU-CM)=0.398021E-C1
 LIQ COND PRESENT
 LIF COND PRESENT
 LIQ LIQUID PRESENT
 LIQ LIQUID PRESENT

PIPSIA)=	0.10000E-03	COND	PRESENT	SICAL/GM-DEG)=	100.00	H(KCAL/GM)=	0.2449	RHO(GM/CU-CM)=	0.796042E-01
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.3325	H(KCAL/GM)=	4.3325	RHO(GM/CU-CM)=	0.226936E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.9327	H(KCAL/GM)=	4.9327	RHO(GM/CU-CM)=	0.240611E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.7169	H(KCAL/GM)=	4.7169	RHO(GM/CU-CM)=	0.257020E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.5843	H(KCAL/GM)=	4.5843	RHO(GM/CU-CM)=	0.276824E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.4362	H(KCAL/GM)=	4.4362	RHO(GM/CU-CM)=	0.300655E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.2772	H(KCAL/GM)=	4.2772	RHO(GM/CU-CM)=	0.328886E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	4.1146	H(KCAL/GM)=	4.1146	RHO(GM/CU-CM)=	0.361450E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.9574	H(KCAL/GM)=	3.9574	RHO(GM/CU-CM)=	0.397685E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.8125	H(KCAL/GM)=	3.8125	RHO(GM/CU-CM)=	0.436273E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.6868	H(KCAL/GM)=	3.6868	RHO(GM/CU-CM)=	0.475467E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.5931	H(KCAL/GM)=	3.5931	RHO(GM/CU-CM)=	0.513495E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.5013	H(KCAL/GM)=	3.5013	RHO(GM/CU-CM)=	0.549246E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.4374	H(KCAL/GM)=	3.4374	RHO(GM/CU-CM)=	0.582840E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.3857	H(KCAL/GM)=	3.3857	RHO(GM/CU-CM)=	0.615369E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.3413	H(KCAL/GM)=	3.3413	RHO(GM/CU-CM)=	0.648016E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.3014	H(KCAL/GM)=	3.3014	RHO(GM/CU-CM)=	0.681706E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.2641	H(KCAL/GM)=	3.2641	RHO(GM/CU-CM)=	0.717095E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.2284	H(KCAL/GM)=	3.2284	RHO(GM/CU-CM)=	0.754708E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.1936	H(KCAL/GM)=	3.1936	RHO(GM/CU-CM)=	0.795022E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	3.0328	H(KCAL/GM)=	3.0328	RHO(GM/CU-CM)=	0.922256E-04
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	2.8969	H(KCAL/GM)=	2.8969	RHO(GM/CU-CM)=	0.105574E-03
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	2.7985	H(KCAL/GM)=	2.7985	RHO(GM/CU-CM)=	0.117794E-03
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	2.7117	H(KCAL/GM)=	2.7117	RHO(GM/CU-CM)=	0.130440E-03
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	2.5184	H(KCAL/GM)=	2.5184	RHO(GM/CU-CM)=	0.161399E-03
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							
PIPSIA)=	0.10000E-02	COND	PRESENT	SICAL/GM-DEG)=	2.3064	H(KCAL/GM)=	2.3064	RHO(GM/CU-CM)=	0.187175E-03
LIF	COND	PRESENT							
LICL	LIQUID	PRESENT							
LIZU	COND	PRESENT							

LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=1500.00 SICAL/GM-DEG)= 2.2045 H(KCAL/GM)= 3.7813 RHO(GM/CU-CM)=0.211404E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=1400.00 SICAL/GM-DEG)= 2.1207 H(KCAL/GM)= 3.6603 RHO(GM/CU-CM)=0.235784E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=1300.00 SICAL/GM-DEG)= 1.9362 H(KCAL/GM)= 3.4108 RHO(GM/CU-CM)=0.307412E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=1200.00 SICAL/GM-DEG)= 1.8370 H(KCAL/GM)= 3.2864 RHO(GM/CU-CM)=0.357472E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=1100.00 SICAL/GM-DEG)= 1.7293 H(KCAL/GM)= 3.1635 RHO(GM/CU-CM)=0.397530E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=1000.00 SICAL/GM-DEG)= 1.5865 H(KCAL/GM)= 2.9688 RHO(GM/CU-CM)=0.672121E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=900.00 SICAL/GM-DEG)= 1.4702 H(KCAL/GM)= 2.8973 RHO(GM/CU-CM)=0.832465E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=800.00 SICAL/GM-DEG)= 1.3794 H(KCAL/GM)= 2.8200 RHO(GM/CU-CM)=0.979341E-03
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=700.00 SICAL/GM-DEG)= 1.1758 H(KCAL/GM)= 2.6679 RHO(GM/CU-CM)=0.113526E-02
 LIF COND PRESENT
 LI20 COND PRESENT
 P(PSIA)= 0.10000E+02 TIME(K)=600.00 SICAL/GM-DEG)= 1.0815 H(KCAL/GM)= 2.6068 RHO(GM/CU-CM)=0.132668E-02
 LIF COND PRESENT

LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	0.9753	M(KCAL/GM)=
					2.5444
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	0.9751	M(KCAL/GM)=
					2.4431
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	0.7046	M(KCAL/GM)=
					2.4420
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.40000	0.00	SICAL/WM-DEG)=	0.9444	M(KCAL/GM)=
					3.1523
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.00000	0.00	SICAL/WM-DEG)=	0.2920	M(KCAL/GM)=
					2.3799
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.7316	M(KCAL/GM)=
					12.7431
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.6719	M(KCAL/GM)=
					12.5064
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.6054	M(KCAL/GM)=
					12.2507
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.5302	M(KCAL/GM)=
					11.9686
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.4422	M(KCAL/GM)=
					11.6475
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.3363	M(KCAL/GM)=
					11.2707
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.2050	M(KCAL/GM)=
					10.8190
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	5.0433	M(KCAL/GM)=
					10.2775
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	4.8489	M(KCAL/GM)=
					9.6461
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	4.6285	M(KCAL/GM)=
					9.3515
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	4.4174	M(KCAL/GM)=
					9.2456
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	3.9782	M(KCAL/GM)=
					7.5831
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
LIF	0.00	PRESENT			
LICL	0.00	PRESENT			
P(PSIA)=	0.10000	0.00	SICAL/WM-DEG)=	3.8195	M(KCAL/GM)=
					6.5929

PIPSIA)=	0.10000E 01	TIDLG-K)=2600.00	SICAL/GM-DEG)=	3.7020	M(KCAL/GM)=	6.2512	RHO(GM/CU-CM)=	0.605508E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=2500.00	SICAL/GM-DEG)=	3.6184	M(KCAL/GM)=	6.0687	RHO(GM/CU-CM)=	0.648963E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=2400.00	SICAL/GM-DEG)=	3.5564	M(KCAL/GM)=	5.9158	RHO(GM/CU-CM)=	0.690033E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=2300.00	SICAL/GM-DEG)=	3.5047	M(KCAL/GM)=	5.7942	RHO(GM/CU-CM)=	0.731333E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=2200.00	SICAL/GM-DEG)=	3.4582	M(KCAL/GM)=	5.6896	RHO(GM/CU-CM)=	0.774480E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=2100.00	SICAL/GM-DEG)=	3.4146	M(KCAL/GM)=	5.5957	RHO(GM/CU-CM)=	0.820426E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=2000.00	SICAL/GM-DEG)=	3.3726	M(KCAL/GM)=	5.5076	RHO(GM/CU-CM)=	0.869860E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=1900.00	SICAL/GM-DEG)=	3.3318	M(KCAL/GM)=	5.4301	RHO(GM/CU-CM)=	0.923405E-05
P(PSIA)=	0.10000E 01	TIDLG-K)=1800.00	SICAL/GM-DEG)=	3.0967	M(KCAL/GM)=	4.9989	RHO(GM/CU-CM)=	0.111446E-04
	L120	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1700.00	SICAL/GM-DEG)=	2.9380	M(KCAL/GM)=	4.7172	RHO(GM/CU-CM)=	0.128708E-04
	L120	COND	PRESENT					
P(PSIA)=	0.10001E 01	TIDLG-K)=1600.00	SICAL/GM-DEG)=	2.7662	M(KCAL/GM)=	4.4441	RHO(GM/CU-CM)=	0.143711E-04
	L120	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1500.00	SICAL/GM-DEG)=	2.5121	M(KCAL/GM)=	4.0527	RHO(GM/CU-CM)=	0.180163E-04
	L1F	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1400.00	SICAL/GM-DEG)=	2.3184	M(KCAL/GM)=	3.7711	RHO(GM/CU-CM)=	0.218894E-04
	L120	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1300.00	SICAL/GM-DEG)=	2.2119	M(KCAL/GM)=	3.6265	RHO(GM/CU-CM)=	0.248344E-04
	L1F	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1200.00	SICAL/GM-DEG)=	2.1703	M(KCAL/GM)=	3.5120	RHO(GM/CU-CM)=	0.280217E-04
	L1F	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1100.00	SICAL/GM-DEG)=	1.8492	M(KCAL/GM)=	3.1986	RHO(GM/CU-CM)=	0.381126E-04
	L1F	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=1000.00	SICAL/GM-DEG)=	1.7592	M(KCAL/GM)=	3.1033	RHO(GM/CU-CM)=	0.436526E-04
	L1F	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=900.00	SICAL/GM-DEG)=	1.6914	M(KCAL/GM)=	3.0393	RHO(GM/CU-CM)=	0.487914E-04
	L1F	COND	PRESENT					
P(PSIA)=	0.10000E 01	TIDLG-K)=800.00	SICAL/GM-DEG)=	1.4736	M(KCAL/GM)=	2.8547	RHO(GM/CU-CM)=	0.837930E-04
	L1F	COND	PRESENT					

P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 6.1769 H(KCAL/GM)= 12.7006 RHO(GM/CU-CM)=0.219790E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 6.1765 H(KCAL/GM)= 12.4577 RHO(GM/CU-CM)=0.229194E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 6.0732 H(KCAL/GM)= 12.1943 RHO(GM/CU-CM)=0.239666E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 5.9655 H(KCAL/GM)= 11.9145 RHO(GM/CU-CM)=0.251549E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 5.8672 H(KCAL/GM)= 11.5455 RHO(GM/CU-CM)=0.265573E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 5.7792 H(KCAL/GM)= 11.1735 RHO(GM/CU-CM)=0.282964E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 5.674 H(KCAL/GM)= 10.6590 RHO(GM/CU-CM)=0.305630E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 5.5615 H(KCAL/GM)= 9.7732 RHO(GM/CU-CM)=0.336295E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 5.0577 H(KCAL/GM)= 9.1402 RHO(GM/CU-CM)=0.377930E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 4.7461 H(KCAL/GM)= 8.3273 RHO(GM/CU-CM)=0.431800E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 4.4411 H(KCAL/GM)= 7.5124 RHO(GM/CU-CM)=0.496046E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 4.1776 H(KCAL/GM)= 6.8521 RHO(GM/CU-CM)=0.565545E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.9515 H(KCAL/GM)= 6.3662 RHO(GM/CU-CM)=0.632885E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.4505 H(KCAL/GM)= 5.0577 RHO(GM/CU-CM)=0.691700E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.2455 H(KCAL/GM)= 5.5265 RHO(GM/CU-CM)=0.743476E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.7712 H(KCAL/GM)= 9.7281 RHO(GM/CU-CM)=0.794042E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.6449 H(KCAL/GM)= 5.6124 RHO(GM/CU-CM)=0.846929E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.5223 H(KCAL/GM)= 5.5100 RHO(GM/CU-CM)=0.903710E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.5420 H(KCAL/GM)= 5.4170 RHO(GM/CU-CM)=0.965277E-06
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.4934 H(KCAL/GM)= 5.3326 RHO(GM/CU-CM)=0.103237E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 3.2395 H(KCAL/GM)= 4.7174 RHO(GM/CU-CM)=0.122245E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1500.00 SICAL/GM-DEG)= 2.9657 H(KCAL/GM)= 4.4324 RHO(GM/CU-CM)=0.147509E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1400.00 SICAL/GM-DEG)= 2.7792 H(KCAL/GM)= 4.2201 RHO(GM/CU-CM)=0.171271E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1300.00 SICAL/GM-DEG)= 2.4469 H(KCAL/GM)= 3.7735 RHO(GM/CU-CM)=0.226444E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1200.00 SICAL/GM-DEG)= 2.2930 H(KCAL/GM)= 3.5601 RHO(GM/CU-CM)=0.266030E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1100.00 SICAL/GM-DEG)= 2.1543 H(KCAL/GM)= 3.4216 RHO(GM/CU-CM)=0.302239E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)=1000.00 SICAL/GM-DEG)= 1.8982 H(KCAL/GM)= 3.1541 RHO(GM/CU-CM)=0.411310E-05
 P(PSIA)= 0.10000E+00 I(0E0-K)= 900.00 SICAL/GM-DEG)= 1.7827 H(KCAL/GM)= 3.0435 RHO(GM/CU-CM)=0.485428E-05
 LIF COND PRESENT

P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	1.7093	M(KCAL/GM)=	2.9811	RHO(GM/CU-CM)=	0.549076E-05
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	1.3673	M(KCAL/GM)=	2.7327	RHO(GM/CU-CM)=	0.943152E-05
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	1.1796	M(KCAL/GM)=	2.6105	RHO(GM/CU-CM)=	0.132116E-04
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	1.0711	M(KCAL/GM)=	2.5502	RHO(GM/CU-CM)=	0.159160E-04
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	0.9472	M(KCAL/GM)=	2.4931	RHO(GM/CU-CM)=	0.199011E-04
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	0.8000	M(KCAL/GM)=	2.4420	RHO(GM/CU-CM)=	0.265269E-04
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	0.5465	M(KCAL/GM)=	2.4063	RHO(GM/CU-CM)=	0.398021E-04
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					
P(PSIA)=	0.10000E+00	S(CAL/IN-DEG)=	0.3679	M(KCAL/GM)=	2.3806	RHO(GM/CU-CM)=	0.795958E-04
LICL	LIQUID	PRESENT					
LI20	COND	PRESENT					
LIF	COND	PRESENT					

PIP(SIA)= 0.10000E-01 T(DEF-K)=4000.00 SICAL/GM-DEG)= 6.9223 H(KCAL/GM)= 13.5644 RHO(GM/CU-CM)=0.189309E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3000.00 SICAL/GM-DEG)= 6.9054 H(KCAL/GM)= 13.4954 RHO(GM/CU-CM)=0.194302E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3000.00 SICAL/GM-DEG)= 6.8959 H(KCAL/GM)= 13.4210 RHO(GM/CU-CM)=0.199647E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2700.00 SICAL/GM-DEG)= 6.8631 H(KCAL/GM)= 13.3354 RHO(GM/CU-CM)=0.205434E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3000.00 SICAL/GM-DEG)= 6.8342 H(KCAL/GM)= 13.2322 RHO(GM/CU-CM)=0.211790E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3500.00 SICAL/GM-DEG)= 6.7940 H(KCAL/GM)= 13.1016 RHO(GM/CU-CM)=0.218925E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=4000.00 SICAL/GM-DEG)= 6.7491 H(KCAL/GM)= 12.9329 RHO(GM/CU-CM)=0.227087E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3000.00 SICAL/GM-DEG)= 6.6550 H(KCAL/GM)= 12.7204 RHO(GM/CU-CM)=0.236439E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3200.00 SICAL/GM-DEG)= 6.6097 H(KCAL/GM)= 12.4717 RHO(GM/CU-CM)=0.247225E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3100.00 SICAL/GM-DEG)= 6.5244 H(KCAL/GM)= 12.2051 RHO(GM/CU-CM)=0.259184E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=3000.00 SICAL/GM-DEG)= 6.4323 H(KCAL/GM)= 11.9258 RHO(GM/CU-CM)=0.272527E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2000.00 SICAL/GM-DEG)= 6.3254 H(KCAL/GM)= 11.6031 RHO(GM/CU-CM)=0.288114E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2500.00 SICAL/GM-DEG)= 6.1832 H(KCAL/GM)= 11.2042 RHO(GM/CU-CM)=0.307749E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2700.00 SICAL/GM-DEG)= 5.9803 H(KCAL/GM)= 10.5471 RHO(GM/CU-CM)=0.334439E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2500.00 SICAL/GM-DEG)= 5.8064 H(KCAL/GM)= 9.8749 RHO(GM/CU-CM)=0.428964E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2600.00 SICAL/GM-DEG)= 4.8914 H(KCAL/GM)= 7.8837 RHO(GM/CU-CM)=0.502950E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2300.00 SICAL/GM-DEG)= 4.5209 H(KCAL/GM)= 7.0126 RHO(GM/CU-CM)=0.588652E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2200.00 SICAL/GM-DEG)= 4.2389 H(KCAL/GM)= 6.3771 RHO(GM/CU-CM)=0.675458E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2100.00 SICAL/GM-DEG)= 4.0609 H(KCAL/GM)= 5.9937 RHO(GM/CU-CM)=0.750743E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=2000.00 SICAL/GM-DEG)= 3.9565 H(KCAL/GM)= 5.7434 RHO(GM/CU-CM)=0.813771E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1900.00 SICAL/GM-DEG)= 3.8841 H(KCAL/GM)= 5.6382 RHO(GM/CU-CM)=0.875187E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1800.00 SICAL/GM-DEG)= 3.8181 H(KCAL/GM)= 5.5161 RHO(GM/CU-CM)=0.940567E-07
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1700.00 SICAL/GM-DEG)= 3.7553 H(KCAL/GM)= 5.4070 RHO(GM/CU-CM)=0.101178E-06
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1600.00 SICAL/GM-DEG)= 3.6967 H(KCAL/GM)= 5.3094 RHO(GM/CU-CM)=0.108969E-06
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1500.00 SICAL/GM-DEG)= 3.6411 H(KCAL/GM)= 5.2231 RHO(GM/CU-CM)=0.117504E-06
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1400.00 SICAL/GM-DEG)= 3.51574 H(KCAL/GM)= 4.5183 RHO(GM/CU-CM)=0.153796E-06
 L120 COND PRESENT
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1300.00 SICAL/GM-DEG)= 2.9121 H(KCAL/GM)= 4.1863 RHO(GM/CU-CM)=0.182775E-06
 L120 COND PRESENT
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1200.00 SICAL/GM-DEG)= 2.5829 H(KCAL/GM)= 3.7791 RHO(GM/CU-CM)=0.235570E-06
 L1F COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1100.00 SICAL/GM-DEG)= 2.3235 H(KCAL/GM)= 3.4794 RHO(GM/CU-CM)=0.289788E-06
 L1F COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.10000E-01 T(DEF-K)=1000.00 SICAL/GM-DEG)= 2.2148 H(KCAL/GM)= 3.3653 RHO(GM/CU-CM)=0.331762E-06
 L1F COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.10000E-01 T(DEF-K)= 900.00 SICAL/GM-DEG)= 1.9204 H(KCAL/GM)= 3.0881 RHO(GM/CU-CM)=0.460700E-06
 L1F COND PRESENT

L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 1.7141 H(KCAL/GM)= 2.9139 RHO(GM/CU-CM)=0.547741E-06
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 1.7141 H(KCAL/GM)= 2.9243 RHO(GM/CU-CM)=0.627651E-06
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 1.2440 H(KCAL/GM)= 2.6212 RHO(GM/CU-CM)=0.126977E-05
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 1.1140 H(KCAL/GM)= 2.5520 RHO(GM/CU-CM)=0.159172E-05
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 0.9950 H(KCAL/GM)= 2.4944 RHO(GM/CU-CM)=0.199003E-05
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 0.8477 H(KCAL/GM)= 2.4420 RHO(GM/CU-CM)=0.265269E-05
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 0.5942 H(KCAL/GM)= 2.4063 RHO(GM/CU-CM)=0.396021E-05
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 5010000-21 I(TEMP)= 0.4350 H(KCAL/GM)= 2.3794 RHO(GM/CU-CM)=0.796043E-05
 L1F LIQUID PRESENT
 L100 LIQUID PRESENT
 L120 LIQUID PRESENT
 P(PSIA)= 0.10000E+02 I(TEMP)= 7.4287 H(KCAL/GM)= 13.5822 RHO(GM/CU-CM)=0.189084E-09

PIPSIA)=	0.1C000E-02	T(DEG-K)=3900.00	SICAL/GM-DEG)=	7.4138	M(KCAL/GM)=	13.5232	RHO(GM/CU-CM)=0.193947E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3800.00	SICAL/GM-DEG)=	7.3983	M(KCAL/GM)=	13.4639	RHO(GM/CU-CM)=0.199075E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3700.00	SICAL/GM-DEG)=	7.3823	M(KCAL/GM)=	13.4035	RHO(GM/CU-CM)=0.204498E-08
PIPSIA)=	0.10500E-02	T(DEG-K)=3600.00	SICAL/GM-DEG)=	7.3652	M(KCAL/GM)=	13.3411	RHO(GM/CU-CM)=0.210255E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3500.00	SICAL/GM-DEG)=	7.3464	M(KCAL/GM)=	13.2746	RHO(GM/CU-CM)=0.216402E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3400.00	SICAL/GM-DEG)=	7.3249	M(KCAL/GM)=	13.2004	RHO(GM/CU-CM)=0.223030E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3300.00	SICAL/GM-DEG)=	7.2983	M(KCAL/GM)=	13.1114	RHO(GM/CU-CM)=0.230289E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3200.00	SICAL/GM-DEG)=	7.2625	M(KCAL/GM)=	12.9952	RHO(GM/CU-CM)=0.238439E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3100.00	SICAL/GM-DEG)=	7.2114	M(KCAL/GM)=	12.8343	RHO(GM/CU-CM)=0.247870E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=3000.00	SICAL/GM-DEG)=	7.1390	M(KCAL/GM)=	12.6137	RHO(GM/CU-CM)=0.259018E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2900.00	SICAL/GM-DEG)=	7.0470	M(KCAL/GM)=	12.3422	RHO(GM/CU-CM)=0.272003E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2800.00	SICAL/GM-DEG)=	6.9463	M(KCAL/GM)=	12.0553	RHO(GM/CU-CM)=0.286479E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2700.00	SICAL/GM-DEG)=	6.8412	M(KCAL/GM)=	11.7662	RHO(GM/CU-CM)=0.302522E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2600.00	SICAL/GM-DEG)=	6.7126	M(KCAL/GM)=	11.4258	RHO(GM/CU-CM)=0.321753E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2500.00	SICAL/GM-DEG)=	6.5228	M(KCAL/GM)=	10.9424	RHO(GM/CU-CM)=0.347647E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2400.00	SICAL/GM-DEG)=	6.2221	M(KCAL/GM)=	10.2070	RHO(GM/CU-CM)=0.386346E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2300.00	SICAL/GM-DEG)=	5.7712	M(KCAL/GM)=	9.1486	RHO(GM/CU-CM)=0.447558E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2200.00	SICAL/GM-DEG)=	5.2382	M(KCAL/GM)=	7.9496	RHO(GM/CU-CM)=0.535759E-08
PIPSIA)=	0.10000E-02	T(DEG-K)=2100.00	SICAL/GM-DEG)=	4.7671	M(KCAL/GM)=	6.9356	RHO(GM/CU-CM)=0.640638E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=2000.00	SICAL/GM-DEG)=	4.4268	M(KCAL/GM)=	6.2369	RHO(GM/CU-CM)=0.746177E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=1900.00	SICAL/GM-DEG)=	4.2336	M(KCAL/GM)=	5.8531	RHO(GM/CU-CM)=0.833698E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=1800.00	SICAL/GM-DEG)=	4.1297	M(KCAL/GM)=	5.6665	RHO(GM/CU-CM)=0.906823E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=1700.00	SICAL/GM-DEG)=	4.0478	M(KCAL/GM)=	5.5230	RHO(GM/CU-CM)=0.982052E-08
PIPSIA)=	0.1C000E-02	T(DEG-K)=1600.00	SICAL/GM-DEG)=	3.9714	M(KCAL/GM)=	5.3969	RHO(GM/CU-CM)=0.106454E-07
PIPSIA)=	0.1C000E-02	T(DEG-K)=1500.00	SICAL/GM-DEG)=	3.8987	M(KCAL/GM)=	5.2642	RHO(GM/CU-CM)=0.115554E-07
PIPSIA)=	0.1C000E-02	T(DEG-K)=1400.00	SICAL/GM-DEG)=	3.8316	M(KCAL/GM)=	5.1869	RHO(GM/CU-CM)=0.125554E-07
PIPSIA)=	0.10000E-02	T(DEG-K)=1300.00	SICAL/GM-DEG)=	3.3187	M(KCAL/GM)=	4.4971	RHO(GM/CU-CM)=0.163966E-07
L12U	CUND	PRESENT					
PIPSIA)=	0.1C000E-02	T(DEG-K)=1200.00	SICAL/GM-DEG)=	3.0148	M(KCAL/GM)=	4.1157	RHO(GM/CU-CM)=0.199132E-07
L12U	CUND	PRESENT					
PIPSIA)=	0.1C000E-02	T(DEG-K)=1100.00	SICAL/GM-DEG)=	2.6464	M(KCAL/GM)=	3.6981	RHO(GM/CU-CM)=0.256535E-07
L1F	CUND	PRESENT					
L12U	CUND	PRESENT					
PIPSIA)=	0.1C000E-02	T(DEG-K)=1000.00	SICAL/GM-DEG)=	2.3741	M(KCAL/GM)=	3.4081	RHO(GM/CU-CM)=0.321125E-07
L1F	CUND	PRESENT					
L12U	CUND	PRESENT					
PIPSIA)=	0.1C000E-02	T(DEG-K)= 900.00	SICAL/GM-DEG)=	2.2600	M(KCAL/GM)=	3.2999	RHO(GM/CU-CM)=0.371327E-07
L1F	CUND	PRESENT					
L12U	CUND	PRESENT					
PIPSIA)=	0.10000E-02	T(DEG-K)= 800.00	SICAL/GM-DEG)=	1.9106	M(KCAL/GM)=	3.0032	RHO(GM/CU-CM)=0.534877E-07
L1F	CUND	PRESENT					

C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 2.9247 RHO(GM/CM-CM) = 0.6273E-07
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 4.3466 RHO(GM/CM-CM) = 0.204899E-06
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 3.3722 RHO(GM/CM-CM) = 0.245879E-06
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 3.2413 RHO(GM/CM-CM) = 0.307349E-06
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 4.2213 RHO(GM/CM-CM) = 0.146946E-06
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 3.2073 RHO(GM/CM-CM) = 0.599162E-06
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 3.1207 RHO(GM/CM-CM) = 0.325738E-05
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.5441 RHO(GM/CM-CM) = 0.189062E-03
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.5264 RHO(GM/CM-CM) = 0.193909E-09
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.4684 RHO(GM/CM-CM) = 0.199016E-09
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.4113 RHO(GM/CM-CM) = 0.204395E-09
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.3533 RHO(GM/CM-CM) = 0.210085E-09
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.2956 RHO(GM/CM-CM) = 0.216101E-09
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.2373 RHO(GM/CM-CM) = 0.222485E-09
 C10L LI 10 10 0.000000
 C12L LI 12 12 0.000000
 P(PSIA) = 13.1775 RHO(GM/CM-CM) = 0.229282E-09

PIPSTA)= 0.10000E-03 TIDEG-K)=3200.00 SICAL/JM-DEG)= 7.7936 H(KCAL/GM)= 13.1142 RHO(GM/CU-CM)=0.236561E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=3100.00 SICAL/JM-DEG)= 7.7771 H(KCAL/GM)= 13.0435 RHO(GM/CU-CM)=0.244433E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=3000.00 SICAL/JM-DEG)= 7.7485 H(KCAL/GM)= 12.9563 RHO(GM/CU-CM)=0.253108E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2900.00 SICAL/JM-DEG)= 7.7073 H(KCAL/GM)= 12.8347 RHO(GM/CU-CM)=0.262988E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2800.00 SICAL/JM-DEG)= 7.6424 H(KCAL/GM)= 12.6500 RHO(GM/CU-CM)=0.274745E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2700.00 SICAL/JM-DEG)= 7.5454 H(KCAL/GM)= 12.3932 RHO(GM/CU-CM)=0.289044E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2600.00 SICAL/JM-DEG)= 7.4276 H(KCAL/GM)= 12.0712 RHO(GM/CU-CM)=0.305603E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2500.00 SICAL/JM-DEG)= 7.3110 H(KCAL/GM)= 11.7737 RHO(GM/CU-CM)=0.323591E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2400.00 SICAL/JM-DEG)= 7.1814 H(KCAL/GM)= 11.4564 RHO(GM/CU-CM)=0.344323E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2300.00 SICAL/JM-DEG)= 6.9827 H(KCAL/GM)= 10.9906 RHO(GM/CU-CM)=0.372458E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2200.00 SICAL/JM-DEG)= 6.6357 H(KCAL/GM)= 10.2113 RHO(GM/CU-CM)=0.416700E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2100.00 SICAL/JM-DEG)= 6.0661 H(KCAL/GM)= 8.9686 RHO(GM/CU-CM)=0.492670E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=2000.00 SICAL/JM-DEG)= 5.4603 H(KCAL/GM)= 7.6235 RHO(GM/CU-CM)=0.605550E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=1900.00 SICAL/JM-DEG)= 4.9700 H(KCAL/GM)= 6.5673 RHO(GM/CU-CM)=0.733643E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=1800.00 SICAL/JM-DEG)= 4.5350 H(KCAL/GM)= 5.9664 RHO(GM/CU-CM)=0.852708E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=1700.00 SICAL/JM-DEG)= 4.3777 H(KCAL/GM)= 5.6701 RHO(GM/CU-CM)=0.943982E-09
 PIPSTA)= 0.10000E-03 TIDEG-K)=1600.00 SICAL/JM-DEG)= 4.2778 H(KCAL/GM)= 5.5250 RHO(GM/CU-CM)=0.103042E-08
 PIPSTA)= 0.10000E-03 TIDEG-K)=1500.00 SICAL/JM-DEG)= 4.1854 H(KCAL/GM)= 5.3919 RHO(GM/CU-CM)=0.112606E-08
 PIPSTA)= 0.10000E-03 TIDEG-K)=1400.00 SICAL/JM-DEG)= 4.0973 H(KCAL/GM)= 5.2540 RHO(GM/CU-CM)=0.123280E-08
 PIPSTA)= 0.10000E-03 TIDEG-K)=1300.00 SICAL/JM-DEG)= 4.0164 H(KCAL/GM)= 5.1453 RHO(GM/CU-CM)=0.135065E-08
 PIPSTA)= 0.10000E-03 TIDEG-K)=1200.00 SICAL/JM-DEG)= 3.9402 H(KCAL/GM)= 4.9423 RHO(GM/CU-CM)=0.149184E-08
 L12U COND PRESENT
 PIPSTA)= 0.10000E-03 TIDEG-K)=1100.00 SICAL/JM-DEG)= 3.8624 H(KCAL/GM)= 4.80126 RHO(GM/CU-CM)=0.221208E-09
 L12U COND PRESENT
 PIPSTA)= 0.10000E-03 TIDEG-K)=1000.00 SICAL/JM-DEG)= 2.8667 H(KCAL/GM)= 3.5194 RHO(GM/CU-CM)=0.301035E-08
 L12U COND PRESENT
 PIPSTA)= 0.10000E-03 TIDEG-K)= 900.00 SICAL/JM-DEG)= 2.4190 H(KCAL/GM)= 3.3389 RHO(GM/CU-CM)=0.359581E-08
 L12U COND PRESENT
 PIPSTA)= 0.10000E-03 TIDEG-K)= 800.00 SICAL/JM-DEG)= 2.2764 H(KCAL/GM)= 3.2187 RHO(GM/CU-CM)=0.427486E-08
 L12U COND PRESENT
 PIPSTA)= 0.47946E-11 TIDEG-K)= 700.00 SICAL/JM-DEG)= 0.0512 H(KCAL/GM)= 0.0605 RHO(GM/CU-CM)=0.130814E-10
 L12U COND PRESENT
 PIPSTA)= 0. COND PRESENT
 TIDEG-K)= 600.00 SICAL/GM-DEG)= 0.9299 H(KCAL/GM)= 1.2097 RHO(GM/CU-CM)=0.414856E-10
 L12U COND PRESENT
 PIPSTA)= 0. COND PRESENT
 TIDEG-K)= 500.00 SICAL/JM-DEG)= 0.1697 H(KCAL/GM)= 0.6707 RHO(GM/CU-CM)=0.497925E-10
 L12U COND PRESENT

PIPSIA)=	0.10000E-04	TIDEG-K)=1700.00	SICAL/GM-DEG)=	4.8553	MIKCAL/GM)=	6.0279	RHO(GM/CU-CM)=0.874007E-10
PIPSIA)=	0.10000E-04	TIDEG-K)=1500.00	SICAL/GM-DEG)=	4.6246	MIKCAL/GM)=	5.7012	RHO(GM/CU-CM)=0.989145E-10
PIPSIA)=	0.10000E-04	TIDEG-K)=1500.00	SICAL/GM-DEG)=	4.5036	MIKCAL/GM)=	5.5166	RHO(GM/CU-CM)=0.108839E-09
PIPSIA)=	0.10000E-04	TIDEG-K)=1400.00	SICAL/GM-DEG)=	4.3933	MIKCAL/GM)=	5.3575	RHO(GM/CU-CM)=0.119954E-09
PIPSIA)=	0.10000E-04	TIDEG-K)=1300.00	SICAL/GM-DEG)=	4.2980	MIKCAL/GM)=	5.2145	RHO(GM/CU-CM)=0.132547E-09
PIPSIA)=	0.10000E-04	TIDEG-K)=1200.00	SICAL/GM-DEG)=	4.1937	MIKCAL/GM)=	5.0965	RHO(GM/CU-CM)=0.146480E-09
PIPSIA)=	0.10000E-04	TIDEG-K)=1100.00	SICAL/GM-DEG)=	3.4481	MIKCAL/GM)=	4.2371	RHO(GM/CU-CM)=0.204288E-09
	LIF COND	PRESENT					
PIPSIA)=	0.10000E-04	TIDEG-K)=1000.00	SICAL/GM-DEG)=	3.1266	MIKCAL/GM)=	3.8973	RHO(GM/CU-CM)=0.249063E-09
	LIF COND	PRESENT					
PIPSIA)=	0.10000E-04	TIDEG-K)= 900.00	SICAL/GM-DEG)=	2.5761	MIKCAL/GM)=	3.3739	RHO(GM/CU-CM)=0.351861E-09
	LIF COND	PRESENT					
P(PSIA)=	0.10000E-04	TIDEG-K)= 800.00	SICAL/GM-DEG)=	2.4561	MIKCAL/GM)=	3.2714	RHO(GM/CU-CM)=0.408566E-09
	LIF COND	PRESENT					
PIPSIA)=	0.10000E-04	TIDEG-K)= 700.00	SICAL/GM-DEG)=	2.0413	MIKCAL/GM)=	2.9667	RHO(GM/CU-CM)=0.597715E-09
	LIF COND	PRESENT					
	LIF LIQUID	PRESENT					
	LIF LIQUID	PRESENT					
P(PSIA)=	0.25447E-04	TIDEG-K)= 600.00	SICAL/GM-DEG)=	1.7086	MIKCAL/GM)=	3.3439	RHO(GM/CU-CM)=0.189555E-08
	LIF COND	PRESENT					
	LIF LIQUID	PRESENT					
	LIF LIQUID	PRESENT					
P(PSIA)=	0.25447E-04	TIDEG-K)= 500.00	SICAL/GM-DEG)=	2.6477	MIKCAL/GM)=	5.3061	RHO(GM/CU-CM)=0.227466E-08
	LIF COND	PRESENT					
	LIF LIQUID	PRESENT					
	LIF LIQUID	PRESENT					
P(PSIA)=	0.10000E-04	TIDEG-K)= 400.00	SICAL/GM-DEG)=	1.6474	MIKCAL/GM)=	4.2619	RHO(GM/CU-CM)=0.109845E-08
	LIF COND	PRESENT					
	LIF LIQUID	PRESENT					
	LIF LIQUID	PRESENT					
P(PSIA)=	0.11148E-04	TIDEG-K)= 300.00	SICAL/GM-DEG)=	1.4732	MIKCAL/GM)=	4.2219	RHO(GM/CU-CM)=0.163279E-08
	LIF LIQUID	PRESENT					
	LIF COND	PRESENT					
	LIF LIQUID	PRESENT					
	LIF LIQUID	PRESENT					
P(PSIA)=	0.30305E-04	TIDEG-K)= 200.00	SICAL/GM-DEG)=	1.1222	MIKCAL/GM)=	3.2093	RHO(GM/CU-CM)=0.665757E-08
	LIF COND	PRESENT					
	LIF LIQUID	PRESENT					
	LIF COND	PRESENT					

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PIP(SIA)= 0.10000E-05 T(DEL-K)= 800.00 SICAL/°M-DEG)= 2.5950 H(KCAL/GM)= 3.2888 RHO(GM/CU-CM)=0.402967E-10
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.10000E-05 T(DEL-K)= 700.00 SICAL/GM-DEG)= 2.4433 H(KCAL/GM)= 3.1770 RHO(GM/CU-CM)=0.483742E-10
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.1001E-05 T(DEL-K)= 600.00 SICAL/°M-DEG)= 1.9838 H(KCAL/GM)= 2.8711 RHO(GM/CU-CM)=0.730735E-10
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.27125E-05 T(DEL-K)= 500.00 SICAL/°M-DEG)= 1.6973 H(KCAL/GM)= 3.2853 RHO(GM/CU-CM)=0.238361E-09
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.27125E-05 T(DEL-K)= 400.00 SICAL/°M-DEG)= 2.4788 H(KCAL/GM)= 5.1957 RHO(GM/CU-CM)=0.297952E-09
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.27125E-05 T(DEL-K)= 300.00 SICAL/°M-DEG)= 8.1050 H(KCAL/GM)= 28.4562 RHO(GM/CU-CM)=0.397269E-09
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.10033E-05 T(DEL-K)= 200.00 SICAL/°M-DEG)= 1.2804 H(KCAL/GM)= 4.1753 RHO(GM/CU-CM)=0.220417E-09
 LIF COND PRESENT
 L120 COND PRESENT
 PIP(SIA)= 0.10033E-05 T(DEL-K)= 100.00 SICAL/GM-DEG)= 1.0907 H(KCAL/GM)= 3.1775 RHO(GM/CU-CM)=0.440834E-09
 LIF COND PRESENT
 L120 COND PRESENT

I

APPENDIX G

Equilibrium Composition Sample Output

8

D

	4N2 + O2 + CH2	FROM	4333 DEGREES TO 1000	DEGREES
S A GREENE	1	2	4	2
	14.696	6000.	1000.	500.
N2	2.	0.	1	2.
O2	2.	0.	1	
CH2	2.	68.0693	2	
C	1.			
ION		0.	1	
E	1.			

***** PRODUCTS CHOSEN ARE THE FOLLOWING

H	HEAT OF FORMATION	52.1020
C	HEAT OF FORMATION	170.8860
N	HEAT OF FORMATION	112.9650
O	HEAT OF FORMATION	59.5590
E	HEAT OF FORMATION	0.0002
CHNO	HEAT OF FORMATION	-27.9000
CHN	HEAT OF FORMATION	31.2000
CHO	HEAT OF FORMATION	-2.9000
CH	HEAT OF FORMATION	142.0060
HNO	HEAT OF FORMATION	14.0890
HN	HEAT OF FORMATION	79.2000
OH-	HEAT OF FORMATION	-31.7425
HO	HEAT OF FORMATION	9.3300
CH2O	HEAT OF FORMATION	-27.7000
CH2	HEAT OF FORMATION	66.8350
C2H2	HEAT OF FORMATION	54.1900
H2N	HEAT OF FORMATION	40.3000
H2O	HEAT OF FORMATION	-57.7980
H2	HEAT OF FORMATION	0.
CH3	HEAT OF FORMATION	32.0000
H3N	HEAT OF FORMATION	-11.0400
H3O+	HEAT OF FORMATION	139.0000
CH4	HEAT OF FORMATION	-17.9251
C2H4O	HEAT OF FORMATION	-12.1900
C2H4	HEAT OF FORMATION	12.4960
CH6	HEAT OF FORMATION	-17.8950
CN-	HEAT OF FORMATION	21.0504
CN	HEAT OF FORMATION	94.0000
CO+	HEAT OF FORMATION	305.6472
CO	HEAT OF FORMATION	-26.4170
CO2+	HEAT OF FORMATION	223.7088
CO2	HEAT OF FORMATION	-94.0540
C-	HEAT OF FORMATION	143.5641
C+	HEAT OF FORMATION	431.2600
C2H2	HEAT OF FORMATION	73.8700
C2+	HEAT OF FORMATION	473.3040
C2	HEAT OF FORMATION	197.0280
C3O2	HEAT OF FORMATION	-8.3000
C3	HEAT OF FORMATION	189.6700

C4N2	HEAT OF FORMATION	127.5000
C4	HEAT OF FORMATION	242.3210
C5	HEAT OF FORMATION	242.3740
N0+	HEAT OF FORMATION	234.8979
N0	HEAT OF FORMATION	21.6520
N02	HEAT OF FORMATION	8.0600
N+	HEAT OF FORMATION	449.5650
N20	HEAT OF FORMATION	19.5000
N203	HEAT OF FORMATION	20.1850
N204	HEAT OF FORMATION	10.5540
N205	HEAT OF FORMATION	3.0600
N2+	HEAT OF FORMATION	359.8000
N2	HEAT OF FORMATION	0.
U-	HEAT OF FORMATION	25.0501
O+	HEAT OF FORMATION	373.1501
O2-	HEAT OF FORMATION	-3.5300
O2+	HEAT OF FORMATION	371.3000
O2	HEAT OF FORMATION	0.
O3	HEAT OF FORMATION	34.0000
C	HEAT OF FORMATION	0.

SOL ID +01 0

+01 1

+01 1

4

SS 5/14/63
 4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES S A GREENE
 AEROSPACE CORPORATION

COMPONENT	WEIGHT PERCENT	MOLES	MOLE PERCENT
N2	70.885752	4.000000	66.666667
O2	20.241506	1.000000	16.666667
CH2	8.872737	1.000000	16.666667
ION	-0.	-0.	-0.

ELEMENTS	MOLES	MASS BALANCE (MOLES/GM)
H	0.3333	0.12650941E-01
C	0.1667	0.63254708E-02
N	1.3333	0.50603767E-01
O	0.3333	0.12650941E-01
E	-0.	-0.

EQUILIBRIUM GAS WITH SELECTED, UNPATED SYSTEM ENTHALPY (KCAL/GP) = 1.57454

TAPE 55 5/14/63
 4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES S A GREENE

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS	AVAILABLE NON-HEATED SYSTEM			
								PRESSURE (ATM) 0.100000E 01			
								TEMPERATURE (DEG K) 6000.00			
								SYSTEM ENTHALPY (KCAL/GM) 1.5745			
								SYSTEM ENTHALPY (KCAL/GM) 5.1985			
								SYSTEM ENTROPY (CAL/GM-DEG) 3.4199			
								SYSTEM GAS CP 0.39945			
H	0.229143E-00	0.12610488E-01	0.22914350E-00	4.9680	0.280334E 18	42.3065	-138.6888				
C	0.792088E-02	0.43591241E-03	0.79209066E-02	5.5410	0.969042E 16	53.0101	-25.2321				
N	0.146218E-00	0.80468547E-02	0.14621833E-00	6.1000	0.178883E 18	51.8221	-166.3323				
O	0.121870E-00	0.67068898E-02	0.12187000E-00	5.3230	0.149096E 18	53.6544	-231.3280				
E	0.319603E-03	0.17588834E-04	0.31960439E-03	4.9680	0.391003E 15	19.9016	-29.6015				
CHNO	0.554533E-09	0.3051775E-10	0.55453444E-09	19.6790	0.678416E 09	106.3947	-430.7553				
CHN	0.318105E-05	0.17506371E-06	0.31810595E-05	16.1260	0.389170E 13	86.6548	-277.4738				
CHO	0.102719E-05	0.56529631E-07	0.10271924E-05	13.7840	0.125667E 13	88.4396	-331.1331				
CH	0.347633E-05	0.19131396E-06	0.34763406E-05	9.6090	0.425295E 13	68.0724	-89.3051				
HNO	0.504486E-08	0.27763534E-09	0.50448749E-08	14.7582	0.617189E 10	84.0646	-374.1114				
HN	0.128052E-03	0.70471123E-05	0.12805214E-03	9.5490	0.156559E 15	67.3384	-238.6128				
OH-	0.958657E-09	0.52769075E-10	0.95865985E-09	9.3715	0.117307E 10	67.6558	-290.6537				
HO	0.201451E-03	0.11086509E-04	0.20145149E-03	9.3700	0.246455E 15	67.6613	-311.2130				
CH2O	0.119728E-10	0.65339807E-12	0.11872809E-10	19.6480	0.145252E 08	98.3342	-351.9027				
CH2	0.406577E-08	0.22375312E-09	0.40657882E-08	14.6800	0.497408E 10	78.2717	-165.0650				
C2H2	0.119190E-10	0.65044133E-12	0.11819083E-10	22.5210	0.144594E 08	100.0011	-178.3449				
H2N	0.123450E-07	0.67938606E-09	0.12345034E-07	13.6720	0.151029E 11	77.7977	-284.6139				
H2O	0.162752E-06	0.89568013E-08	0.16275284E-06	14.4220	0.199112E 12	78.0652	-382.5619				
H2	0.198771E-03	0.10939033E-04	0.19877173E-03	10.1000	0.243177E 15	55.0205	-210.8857				
CH3	0.384337E-12	0.21151339E-13	0.38433818E-12	19.5430	0.470199E 06	89.7524	-210.8317				
H3N	0.318422E-11	0.17523838E-12	0.31842334E-11	19.4610	0.389559E 07	89.1970	-342.3434				
H3O+	0.250490E-12	0.13785304E-13	0.25049093E-12	19.4606	0.306450E 06	89.2049	-253.6639				
CH4	0.	0.	0.	25.4085	0.	99.8967	-258.1132				
C2H4O	0.	0.	0.	37.2770	0.	142.6814	-351.1331				
C2H4	0.	0.	0.	31.3470	0.	123.1757	-242.8006				
CH6	0.	0.	0.	25.4090	0.	99.8649	-188.5714				
CN-	0.207915E-06	0.11442234E-07	0.20791531E-06	11.0297	0.254363E 12	74.4218	-214.2584				
CN	0.231464E-02	0.12738240E-03	0.23146487E-02	9.1390	0.283174E 16	72.9116	-199.7903				
CO+	0.547027E-06	0.30104732E-07	0.54702909E-06	9.1748	0.669234E 12	71.6341	-41.8555				

C0	0.10468E-00	0.57602105E-02	0.10466802E-00	9.1750	0.128051E 18	71.6331	-312.4347
C02+	0.167359E-09	0.92103358E-11	0.16735978E-09	15.5297	0.204748E 09	90.4923	-201.7948
C02	0.740276E-05	0.51746542E-06	0.94027955E-05	15.5250	0.115034E 14	90.3667	-457.7616
C-	0.120443E-07	0.66305628E-09	0.12048308E-07	5.5406	0.147399E 11	53.0096	8.9293
C+	0.107318E-04	0.59060833E-06	0.10731865E-04	4.9823	0.131293E 14	51.8771	179.0782
C2+2	0.149221E-08	0.82121190E-10	0.14922132E-08	20.7590	0.182557E 10	112.8529	-301.9747
C2+	0.167564E-08	0.92215879E-10	0.16756425E-08	9.2508	0.204998E 10	74.3292	200.6641
C2	0.351433E-05	0.19780815E-06	0.35943458E-05	9.8550	0.439732E 13	75.3156	-16.3671
C3+2	0.516395E-14	0.29418934E-15	0.51639667E-14	26.6920	0.631759E 04	131.1176	-369.3538
C3	0.469450E-09	0.26937724E-10	0.46948181E-09	14.8350	0.598831E 09	89.8193	6.8493
C4+2	0.	0.	0.	32.6240	0.	155.5473	-255.6465
C4	0.170123E-13	0.93624160E-15	0.17012321E-13	20.7700	0.208128E 05	112.9960	46.3489
C5	0.	0.	0.	26.7030	0.	130.0507	68.4995
N0+	0.305410E-03	0.16907712E-04	0.30541071E-03	9.3128	0.373639E 15	75.1873	-223.5777
N0	0.273403E-02	0.15046259E-03	0.27340358E-02	9.1940	0.334481E 16	75.1405	-375.2795
N02	0.617326E-08	0.33973507E-09	0.61732809E-08	13.8640	0.755238E 10	94.4630	-476.6860
N+	0.522118E-06	0.28733869E-07	0.52211932E-06	6.1000	0.638760E 12	51.8219	108.8177
N20	0.118737E-06	0.65344762E-08	0.11873709E-06	14.8360	0.145263E 12	91.8203	-444.7424
N203	0.	0.	0.	25.7490	0.	143.3287	-688.3897
N204	0.	0.	0.	31.6840	0.	156.6495	-744.0563
N205	0.	0.	0.	37.6250	0.	174.8453	-926.4538
N2+	0.194752E-06	0.10717826E-07	0.19475220E-06	9.1652	0.238259E 12	69.9966	-68.6508
N2	0.383904E-00	0.21127528E-01	0.38390551E-00	9.1650	0.469669E 18	70.0080	-367.0391
O-	0.338631E-06	0.18646999E-07	0.33883215E-06	5.3234	0.414527E 12	53.6547	-204.3581
O+	0.299808E-05	0.16499413E-06	0.29980864E-05	5.3234	0.366785E 13	53.6547	20.7799
O2-	0.803125E-11	0.44198658E-12	0.60312794E-11	10.2790	0.982545E 07	74.8898	-333.7984
O2+	0.755170E-11	0.41559540E-12	0.75517289E-11	10.2790	0.923877E 07	74.8898	-81.9304
O2	0.386848E-04	0.21289527E-05	0.36684917E-04	10.2760	0.473271E 14	74.8826	-391.7057
O3	0.361046E-11	0.19869570E-12	0.36104731E-11	13.8840	0.441705E 07	95.3925	-455.1232
C	0.	0.	0.	6.6060	0.	16.4818	26.6650

SCL10

S A GREENE

TAPE 55 5/14/63
4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES

PRESSURE (ATM) 0.10000000 C1
TEMPERATURE (DEG K) 5500.00
AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 4.3267
SYSTEM ENTROPY (KCAL/GM-DEG) 3.2689
SYSTEM GAS CP 0.38904

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.240680E-00	0.12565862E-01	0.24068087E-00	4.9680	0.321217E 18	41.8742	-117.6417
C	0.122559E-02	0.63987990E-04	0.12255972E-02	5.5090	0.163570E 16	52.5290	1.1555
N	0.644040E-01	0.33666998E-02	0.64404255E-01	5.8500	0.860517E 17	51.3019	-140.5171
O	0.118327E-00	0.61778493E-02	0.11832774E-00	5.2690	0.157922E 18	53.1936	-204.6149
E	0.150274E-03	0.78457807E-05	0.15027455E-03	4.9680	0.200559E 15	19.4693	-19.7572
CHNO	0.105382E-08	0.55541783E-10	0.10638223E-08	19.6440	0.141979E 10	124.6834	-377.9253
CHN	0.242047E-05	0.12639838E-06	0.24209778E-05	16.0010	0.323108E 13	85.2864	-234.4724
CHU	0.157979E-05	0.92480592E-07	0.15797962E-05	13.7600	0.210842E 13	87.2414	-287.2597
CH	0.111056E-05	0.57982398E-07	0.11105687E-05	9.5330	0.161588E 11	67.2398	-55.4753
H2O	0.121074E-07	0.63212556E-09	0.12107448E-07	14.7310	0.161588E 11	82.8016	-332.3853
HN	0.121587E-03	0.63480589E-05	0.12158787E-03	9.3900	0.162273E 15	66.6840	-205.1570
OH-	0.171656E-08	0.33758365E-10	0.17965717E-08	9.3002	0.239773E 10	66.8434	-257.0257
HO-	0.477715E-03	0.24941442E-04	0.47771717E-03	9.3060	0.637569E 15	66.8696	-277.5762
CH2O	0.344239E-10	0.17975798E-11	0.34430036E-10	19.6070	0.459539E 08	96.6267	-303.1537
CH2	0.365934E-08	0.19157598E-09	0.36693601E-08	14.6390	0.489719E 10	76.9965	-126.2460
C2H2	0.632855E-11	0.33041284E-12	0.63285789E-11	22.3090	0.844522E 07	98.0509	-128.8245
H2N	0.260064E-07	0.13577894E-08	0.26006488E-07	13.6280	0.347087E 11	76.6100	-246.0379
H2U	0.104469E-05	0.54543066E-07	0.10446933E-05	14.3030	0.139426E 13	76.8152	-343.8354
H2	0.511515E-03	0.26706138E-04	0.51151735E-03	9.9300	0.682679E 15	54.1489	-183.5898
CH3	0.734576E-12	0.38352105E-13	0.73457898E-12	19.4970	0.980381E 06	88.0526	-166.3736
H3N	0.156519E-10	0.81718557E-12	0.15652005E-10	19.3850	0.208894E 08	87.5165	-296.1663
H3U+	0.989613E-12	0.51667851E-13	0.98962280E-12	19.3852	0.132077E 07	87.5148	-209.4781
CH4	0.	0.	0.	25.3296	0.	97.6892	-208.7090
C2H4O	0.	0.	0.	37.1870	0.	139.4412	-280.5884
C2H4	0.	0.	0.	31.2640	0.	120.4525	-181.8884
CH6	0.	0.	0.	25.3300	0.	97.6776	-139.1748
CN-	0.625881E-07	0.32677164E-08	0.62588370E-07	11.0400	0.835315F 11	73.4616	-177.2844
CN	0.721182E-03	0.37652404E-04	0.72118488E-03	9.1120	0.962505F 15	72.1171	-163.5280
CN+	0.857043E-07	0.44746085E-08	0.85704637E-07	9.1379	0.114383F 12	70.8375	-6.2351

C0	0.113175E-00	0.11917563E-00	9.1300	0.159054E 18	70.8366	-276.8148
C02+	0.727160E-10	0.72716095E-10	15.4549	0.970491E 08	89.1397	-156.8815
C02	0.137087E-04	0.26708422E-04	15.4150	0.350460E 14	69.0206	-412.9097
C-	0.137646E-04	0.53279175E-10	5.5094	0.177046E 10	52.5280	35.3155
C+	0.392475E-06	0.20004336E-07	4.9748	0.531814E 12	51.4440	204.9100
C2+2	0.312663E-09	0.16326096E-10	25.7390	0.41727E 09	111.0475	-245.9928
C2+	0.271971E-10	0.14149581E-11	9.2162	0.362979E 08	73.5257	237.6306
C2	0.259737E-04	0.14041969E-07	1.8500	0.359357E 12	74.4578	21.0306
C302	0.241372E-14	0.12601995E-15	20.6660	0.322140E 04	128.7962	-304.3773
C3	0.225647E-10	0.11743610E-11	14.8220	0.301220E 08	88.5049	51.5737
C4	0.	0.	32.5920	0.	152.7100	-178.5720
C4N2	0.	0.	20.7520	0.	111.1597	102.4008
C5	0.	0.	26.6790	0.	127.7285	132.9520
N0+	0.149008E-03	0.79110275E-05	9.2646	0.199610E 15	74.3792	-186.1838
N0	0.393773E-02	0.20558445E-03	9.1640	0.525588E 16	74.3411	-337.9017
N02	0.156042E-07	0.40435756E-04	13.8500	0.205615E 11	93.2572	-429.7525
N+	0.306163E-07	0.15994749E-08	5.8497	0.408612E 11	51.3521	134.5997
N20	0.179891E-06	0.17989187E-06	14.8230	0.240087E 12	90.5300	-399.1506
N203	0.	0.	25.7330	0.	141.0691	-617.2782
N204	0.	0.	31.6630	0.	153.8939	-666.4132
N205	0.	0.	37.6000	0.	171.5729	-739.8492
N2+	0.254244E-07	0.13274036E-08	9.1100	0.339319E 11	69.2012	-33.8488
N2	0.449910E-00	0.23499763E-01	9.1160	0.600400E 18	69.2122	-332.2293
O-	0.247323E-06	0.12912699E-07	5.2691	0.330083E 12	53.1939	-177.6445
O+	0.461119E-06	0.24074980E-07	5.2691	0.615420E 12	53.1939	47.4935
O2-	0.115255E-10	0.60174357E-12	10.2280	0.153822E 08	73.9976	-296.5736
O2+	0.156252E-11	0.97241972E-13	10.2280	0.248576E 07	73.9976	-44.7056
O2	0.935030E-04	0.48918104E-05	10.2250	0.124792E 15	73.9905	-354.4830
O3	0.106943E-10	0.55834684E-12	13.8789	0.142729E 08	94.1646	-407.7245
C	0.	0.	6.4940	0.	15.9120	34.7651

SOLID

S A GREENE

TAPE 55 5/14/63 4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 ULGrees

PRESSURE (ATM) 0.100000E 01
 TEMPERATURE (DEG K) 5000.00
 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
 SYSTEM ENTHALPY (KCAL/GM) 3.8383
 SYSTEM ENTROPY (KCAL/GM-DEG) 3.1761
 SYSTEM GAS CP 0.38397

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.244270E-00	0.12429087E-01	0.24426995E-00	4.9680	0.358607E 18	41.4004	-96.8196
C	0.114639E-03	0.58334297E-05	0.11463936E-03	5.4680	0.168330E 15	52.0064	27.2881
N	0.228862E-01	0.11645637E-02	0.22886168E-01	5.6080	0.335987E 17	50.7568	-115.0049
O	0.116687E-00	0.59376292E-02	0.11668711E-00	5.2100	0.171306E 18	52.6941	-178.1458
E	0.415044E-04	0.31296520E-05	0.61504357E-04	4.9680	0.902932E 14	18.9958	-10.1391
CMNO	0.187408E-08	0.95362591E-10	0.18740789E-08	19.5970	0.275129E 10	102.8138	-326.0476
CMN	0.138651E-05	0.70552640E-07	0.13865103E-05	15.8620	0.203550E 13	83.7682	-192.2043
CMO	0.225124E-05	0.11455452E-06	0.22512414E-05	13.7290	0.330500E 13	85.9313	-243.9705
CM	0.236091E-06	0.12013520E-07	0.23609138E-06	9.4530	0.346601E 12	66.3348	-22.0776
MNO	0.318634E-07	0.16213704E-08	0.31863397E-07	14.6956	0.467779E 11	81.3993	-291.3297
MN	0.102720E-03	0.52269255E-05	0.10272026E-03	9.4070	0.150801E 15	65.6117	-172.1113
OM-	0.367676E-08	0.18709206E-09	0.36767592E-08	9.2256	0.539777E 10	65.9606	-223.8218
MO	0.131007E-02	0.66663156E-04	0.13100736E-02	9.2250	0.192329E 16	65.9862	-244.3575
CM2O	0.100912E-09	0.51349289E-11	0.10091233E-09	19.5520	0.148147E 09	94.7609	-255.3060
CM2	0.259656E-04	0.13212627E-09	0.25965639E-08	14.5850	0.381196E 10	75.6035	-88.0894
C2H2	0.212262E-11	0.10800968E-12	0.21226212E-11	22.0770	0.311617E 07	95.9356	-80.3204
M2N	0.545994E-07	0.27782928E-08	0.54599398E-07	13.5710	0.801562E 11	75.3130	-208.0191
M2O	0.906331E-05	0.46118696E-06	0.90633102E-05	14.1740	0.133056E 14	75.4581	-305.7631
M2	0.145660E-02	0.74119045E-04	0.14565977E-02	9.7480	0.213840E 16	53.2116	-156.7491
CM3	0.122410E-11	0.62288287E-13	0.12240981E-11	19.4200	0.179707E 07	86.1982	-122.8049
M3N	0.972703E-10	0.44407533E-11	0.87270302E-10	19.2870	0.128120E 09	85.6634	-254.8665
M3O+	0.463941E-11	0.23607654E-12	0.46394090E-11	19.2874	0.681101E 07	85.6717	-166.1746
CM4	0.775557E-15	0.39464236E-16	0.77555667E-15	25.2269	0.113858E 04	95.2798	-160.4576
C2H4O	0.	0.	0.	37.0710	0.	135.9027	-211.7413
C2H4	0.	0.	0.	31.1550	0.	117.4772	-122.3918
CM6	0.	0.	0.	25.2270	0.	95.2684	-90.9306
CN-	0.121715E-07	0.61934847E-09	0.12171522E-07	11.0163	0.178687E 11	72.4100	-140.8120
CN	0.146498E-03	0.74545588E-05	0.14649802E-03	9.0830	0.215070E 15	71.2504	-127.6848
CO+	0.833583E-08	0.42416894E-09	0.83358271E-08	9.0998	0.122376E 11	69.9684	28.9689

C0	0.123959E-00	0.63076369E-02	0.12395850E-00	9.1000	0.181981E 18	69.9678	-241.6122
C02+	0.247622E-10	0.12569714E-11	0.24702177E-10	15.3759	0.362647E 08	87.6660	-112.6744
C02	0.854262E-04	0.43468126E-05	0.85424166E-04	15.3060	0.125409E 15	87.5571	-368.7620
C-	0.816356E-10	0.41540331E-11	0.81635637E-10	5.4682	0.119847E 09	52.0056	61.4511
C+	0.677497E-08	0.34474465E-04	0.67749698E-08	4.9709	0.994618E 10	50.9700	230.5155
C2M2	0.328337E-10	0.16707467E-11	0.32833747E-10	20.7130	0.482025E 08	109.0724	-190.9572
C2+	0.143474E-12	0.76059718E-14	0.14947361E-12	9.1841	0.219439E 06	72.6487	274.1775
C2	0.224029E-04	0.47019253E-09	0.22402890E-08	9.8550	0.135655E 11	73.5191	58.0762
C302	0.682619E-15	0.34724919E-16	0.68241894E-15	26.6330	0.100184E 04	126.2560	-240.6023
C3	0.377220E-12	0.19134877E-13	0.37722039E-12	14.8040	0.553789E 06	87.0640	95.6238
C4M2	0.	0.	0.	32.5520	0.	149.6055	-102.9810
C4	0.	0.	0.	20.7280	0.	109.2137	157.5064
C5	0.	0.	0.	26.6480	0.	125.1873	196.1900
N0+	0.616212E-04	0.31357003E-05	0.61623219E-04	9.2139	0.904677E 14	73.4986	-149.2111
N0	0.535567E-02	0.29794609E-03	0.53556711E-02	4.1320	0.859658E 16	73.4694	-300.9470
N02	0.451121E-07	0.22955294E-08	0.45112064E-07	13.8440	0.662280E 11	91.9367	-383.4463
N+	0.974634E-03	0.49534311E-10	0.97463429E-09	5.6076	0.143084E 10	50.7565	160.1155
N20	0.268865E-06	0.13691201E-07	0.26886487E-06	14.8060	0.394715E 12	89.1181	-354.2329
N203	0.	0.	0.	25.7120	0.	138.6374	-547.3361
N204	0.	0.	0.	31.6360	0.	150.8771	-590.2066
N205	0.	0.	0.	37.5670	0.	167.9909	-654.9452
N2+	0.137454E-04	0.10072921E-04	0.13745445E-08	9.0744	0.290613E 10	68.3342	0.5388
N2	0.492709E-00	0.24562658E-01	0.49270879E-00	9.0740	0.708654E 18	68.3452	-297.8356
O-	0.171377E-06	0.87205449E-08	0.17137736E-06	5.2102	0.251595E 12	52.6445	-151.1706
O+	0.503629E-07	0.25627207E-08	0.50362944E-07	5.2102	0.739367E 11	52.6945	73.9674
O2-	0.183386E-10	0.93315917E-12	0.18338573E-10	10.1560	0.269225E 08	73.0260	-259.8138
O2+	0.365765E-12	0.18612117E-13	0.36576790E-12	10.1560	0.536976E 06	73.0260	-7.9458
O2	0.281133E-03	0.14305487E-04	0.28113343E-03	10.1560	0.412726E 15	73.0190	-317.7274
O3	0.416153E-10	0.21174983E-11	0.41615336E-10	13.8723	0.610946E 08	92.8621	-360.9576
C				6.3920	0.	15.2979	42.5701

SOLID

AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
SYSTEM ENTHALPY (KCAL/GM) 3.4978
SYSTEM ENTROPY (KCAL/GM-DEG) 3.1045
SYSTEM GAS CP 0.38C34
PRESSURE (ATM) 0.100000E 01
TEMPERATURE (DEG K) 4500.00

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.23866E-00	0.11945839E-01	0.2386679E-00	4.9680	0.389637E 18	40.8766	-76.2467
C	0.64561E-05	0.32037342E-06	0.64061005E-05	5.4140	0.104496E 14	51.4325	53.1530
N	0.43129E-02	0.31571678E-03	0.61279875E-02	5.3900	0.102977E 17	50.1777	-89.7688
O	0.11094E-00	0.5548814E-02	0.11095393E-00	5.1500	0.180368E 16	52.1486	-151.9288
E	0.20317E-04	0.10161071E-05	0.20317904E-04	4.9680	0.331424E 14	18.4724	-0.7597
CHNO	0.34120E-08	0.1703665E-09	0.34120043E-08	19.5360	0.556565E 10	100.7519	-275.1463
CHN	0.66959E-04	0.33356581E-07	0.66989419E-04	15.7080	0.103799E 13	82.1056	-150.7324
CH	0.37292E-05	0.18149651E-06	0.37292467E-05	13.5880	0.526754E 13	84.4675	-201.3630
CH	0.34194E-07	0.17200745E-08	0.34394145E-07	9.3680	0.561336E 11	65.3433	10.8459
HNO	0.93147E-07	0.46984947E-08	0.1549332E-07	14.0481	0.153251E 12	79.8533	-251.0100
MN	0.78158E-04	0.39087349E-05	0.78158007E-04	9.3000	0.127691E 15	64.6268	-139.5473
OH-	0.78027E-05	0.39021672E-06	0.78026681E-04	9.1430	0.127277E 11	64.9930	-191.0796
HO	0.415297E-02	0.20769274E-03	0.4152968E-02	9.1430	0.677431E 16	65.0183	-211.6009
CH2O	0.33701E-04	0.16854523E-10	0.33701850E-09	19.4790	0.549744E 09	92.7046	-208.4316
CH2	0.15815E-04	0.78032769E-10	0.15815181E-08	14.5140	0.257377E 10	74.0710	-50.6665
C2H2	0.53145E-12	0.26578394E-13	0.53145438E-12	21.6350	0.866927E 06	93.6231	-32.9261
M2N	0.120731E-04	0.60378589E-08	0.12073134E-06	13.4960	0.196937E 12	73.8871	-170.7136
H2O	0.112777E-03	0.5600347E-05	0.11277661E-03	14.0300	0.183961E 15	73.9729	-268.4035
M2	0.481305E-02	0.24100371E-03	0.48130451E-02	9.5550	0.785081E 16	52.1943	-130.3919
CH3	0.20375AE-11	0.10189951E-12	0.20375551E-11	19.3180	0.332365E 07	84.1578	-80.2100
M3N	0.613641E-04	0.30698613E-10	0.6136418E-04	19.1570	0.100130E 10	83.6382	-212.5336
M3O+	0.273006E-10	0.13653234E-11	0.27300639E-10	19.1576	0.445127E 08	83.6462	-123.8368
CH4	0.397746E-14	0.19891546E-15	0.39774598E-14	25.0897	0.648902E 04	92.6288	-113.4694
C2H4C	0.	0.	0.	36.9150	0.	132.0052	-144.7494
C2H4	0.	0.	0.	31.0100	0.	114.2025	-64.4602
CH6	0.	0.	0.	25.0900	0.	92.6175	-43.9473
CN-	0.15592E-08	0.78012868E-10	0.1559242E-08	10.9328	0.254654E 10	71.2532	-104.8915
CN	0.204576E-04	0.10231008E-05	0.20457648E-04	9.0500	0.333705E 14	70.2953	-92.2948
CO+	0.489578E-09	0.24484150E-10	0.48957846E-09	9.0593	0.798599E 09	69.0118	63.7176

C0	0.126114E-00	0.6307249E-02	0.12611794E-00	9.0590	0.205723E 16	69.0105	-206.8597
C02	0.671010E-11	0.3255745E-12	0.67101327E-11	15.2907	0.106193E 08	86.0458	-69.2390
C02	0.330676E-03	0.1664686E-04	0.3336660E-03	15.2160	0.544275E 15	85.9487	-325.3771
C-	0.261894E-11	0.1304763E-12	0.26189791E-11	5.4141	0.427207E 07	51.4323	87.3128
C+	0.491074E-10	0.24558930E-11	0.49107374E-10	4.7691	0.801039E 08	50.4464	255.8719
C2+2	0.203427E-11	0.10173519E-12	0.20342694E-11	20.6760	0.331430E 07	106.8916	-136.9560
C2+	0.	0.	0.	9.1479	0.	71.6630	310.2645
C2	0.152257E-00	0.7614494E-11	0.15225738E-00	7.8550	0.248352E 09	72.4605	94.5816
C302	0.	0.	0.	26.5880	0.	123.4524	-178.1638
C3	0.261142E-14	0.13059101E-15	0.26114226E-14	14.7810	0.425975E 04	85.4711	138.9276
C+2	0.	0.	0.	32.4970	0.	146.1792	-29.0221
C4	0.	0.	0.	20.6960	0.	107.0310	211.5781
C5	0.	0.	0.	26.6060	0.	122.3818	258.0950
N0+	0.204245E-04	0.10214409E-05	0.20424455E-04	9.1609	0.333153E 14	72.5306	-112.6995
N0	0.74153E-02	0.44604164E-03	0.74189282E-02	9.0970	0.145485E 17	72.5094	-264.4495
N02	0.151732E-06	0.75442164E-08	0.15173132E-06	13.8200	0.247505E 12	90.4787	-337.8359
N+	0.147647E-10	0.73743181E-12	0.14746687E-10	5.3902	0.240548E 08	50.1776	185.3506
N20	0.433536E-06	0.20131101E-07	0.43353584E-06	14.7830	0.658247E 12	87.5592	-310.0571
N203	0.134447E-14	0.67237836E-16	0.13444708E-14	25.6840	0.214313E 04	135.9291	-478.6800
N204	0.	0.	0.	31.5980	0.	147.5460	-515.5872
N205	0.	0.	0.	37.5230	0.	164.0351	-571.9214
N2+	0.64401E-10	0.43223263E-11	0.6440086E-10	9.0306	0.141001E 09	67.3604	34.4717
N2	0.494253E-00	0.24917982E-01	0.49825324E-00	9.0300	0.812749E 18	67.3918	-263.8991
O-	0.101343E-06	0.50682399E-08	0.10134315E-06	5.1496	0.165311E 12	52.1488	-124.9577
O+	0.339649E-08	0.16988089E-09	0.33968923E-08	5.1496	0.554100E 10	52.1488	100.1803
O2-	0.289273E-10	0.14466755E-11	0.28927334E-10	10.0600	0.471862E 08	71.9609	-223.5631
O2+	0.480052E-13	0.24407795E-14	0.48805168E-13	10.0600	0.796109E 05	71.9609	28.3049
O2	0.100819E-02	0.50420402E-04	0.10081927E-02	10.0620	0.164456E 16	71.9539	-281.4804
O3	0.146170E-09	0.98105890E-11	0.14616988E-09	13.8633	0.319992E 09	91.4010	-314.8855
C	0.	0.	0.	6.2990	0.	14.6294	50.0555

SUM

PRODUCT	MOLE FRACTION	POLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS	PRESSURE (ATM) 0.10000E 01 TEMPERATURE (DEG K) 4000.00 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745 SYSTEM ENTHALPY (KCAL/GM) 3.1082 SYSTEM ENTROPY (KCAL/GM-DEG) 3.0123 SYSTEM GAS CP 0.37781			
H	0.209161E-00	0.10112766E-01	0.20916134E-00	4.9680	0.383831E 18	40.2918	-55.9529				
C	0.199011E-06	0.96220277E-08	0.19901145E-06	5.3450	0.365205E 12	50.7991	78.7118				
N	0.124674E-02	0.61245720E-04	0.12667391E-02	5.2130	0.232459E 16	49.5536	-64.8318				
O	0.923056E-01	0.44628943E-02	0.92305601E-01	5.0910	0.169390E 18	51.5458	-126.0030				
E	0.485425E-05	0.23469879E-06	0.48542520E-05	4.9680	0.890802E 13	17.8872	8.3230				
CH4O	0.654117E-08	0.31625988E-09	0.65411719E-08	19.4510	0.120037E 11	98.4562	-225.3355				
CH4N	0.275713E-06	0.13330497E-07	0.27571335E-06	15.5330	0.505961E 12	80.2658	-110.1319				
CH4O	0.455808E-05	0.22037921E-06	0.45580813E-05	13.6310	0.836452E 13	82.8779	-159.5119				
CH	0.316171E-08	0.15286610E-09	0.31617144E-08	9.2730	0.580205E 10	64.2455	43.2482				
H2O	0.298903E-06	0.13968204E-07	0.28890298E-06	14.5826	0.530165E 12	78.1318	-211.5356				
HN	0.498301E-04	0.24092411E-05	0.49830094E-04	9.1990	0.914431E 14	63.5376	-107.5025				
OH-	0.145868E-07	0.70525979E-09	0.14586818E-07	9.0461	0.267682E 11	63.9218	-158.8462				
HO	0.139183E-01	0.67293926E-03	0.13918336E-01	9.0460	0.255415E 17	63.9467	-179.3546				
CH2O	0.123895E-08	0.59902074E-10	0.12389486E-08	19.3790	0.227359E 10	90.4153	-162.6378				
CH2	0.783053E-09	0.37859907E-10	0.78305271E-09	14.4160	0.143698E 10	72.3667	-14.0479				
C2H2	0.100239E-12	0.48464682E-14	0.10023902E-12	21.5570	0.183948E 06	91.0670	13.2516				
H2N	0.261480E-06	0.12642317E-07	0.26147978E-06	13.3930	0.479841E 12	72.3038	-134.1624				
H2	0.187664E-02	0.90733721E-04	0.18766365E-02	13.8500	0.344381E 16	72.3301	-231.8173				
H2	0.173849E-01	0.84054305E-03	0.17384868E-01	9.3420	0.319029E 17	51.0619	-104.5700				
CH3	0.318683E-11	0.15408056E-12	0.31868331E-11	19.1750	0.584815E 07	81.8901	-38.6856				
H3N+	0.510804E-08	0.24696915E-09	0.51080384E-08	18.9800	0.937375E 10	81.3920	-171.2671				
H3O+	0.174423E-09	0.84332102E-11	0.17442325E-09	18.9806	0.320084E 09	81.3999	-82.5651				
CH4	0.230015E-13	0.11121000E-14	0.23001453E-13	24.9011	0.422099E 05	89.6844	-67.8776				
C2H4O	0.	0.	0.	36.7010	0.	127.6685	-79.8074				
C2H4	0.	0.	0.	30.8110	0.	110.5533	-8.2533				
CH6	0.	0.	0.	24.9010	0.	89.6729	1.6394				
CN-	0.126538E-09	0.61180138E-11	0.12653827E-09	10.7584	0.232210E 09	69.9750	-69.5792				
C4	0.197802E-05	0.95635679E-07	0.19780232E-05	9.0120	0.362986E 13	69.2310	-57.4050				
CO+	0.153915E-10	0.74416482E-12	0.15391487E-10	9.0143	0.282449E 08	67.9473	97.9529				

C0	0.129183E-00	0.62459069E-02	0.12918347E-00	9.0140	0.237064E 18	67.9461	-172.6154
C02+	0.119386E-11	0.57722013E-13	0.11938586E-11	15.1959	0.219085E 07	84.2459	-26.6572
C02	0.163860E-02	0.79224793E-04	0.16385985E-02	15.1190	0.300699E 16	84.1625	-282.8417
C-	0.374380E-13	0.18130920E-14	0.37437952E-13	5.3450	0.687023E 05	50.7986	112.8733
C+	0.125417E-12	0.62088605E-14	0.12841724E-12	4.9686	0.235658E 06	49.8611	280.9518
C2N2	0.82227AE-13	0.39756425E-14	0.82227820E-13	20.6290	0.150896E 06	104.4591	-84.1374
C2+	0.	0.	0.	9.1084	0.	70.6079	345.8423
C2	0.115622E-11	0.56385717E-13	0.11662202E-11	9.8360	0.214013E 07	71.3209	130.5357
C3C2	0.	0.	0.	26.5260	0.	120.3244	-117.2050
C3	0.	0.	0.	14.7480	0.	83.6673	181.4161
C4N2	0.	0.	0.	32.4210	0.	142.3556	43.1308
C4	0.	0.	0.	20.6520	0.	104.5957	264.4972
C5	0.	0.	0.	26.5490	0.	119.2510	318.5192
N0+	0.491112E-05	0.23744851E-06	0.49111240E-05	9.1051	0.901239E 13	71.4549	-76.6979
N0	0.132868E-01	0.64240561E-03	0.13286811E-01	9.0580	0.243826E 17	71.4402	-228.4572
N02	0.537759E-06	0.26000193E-07	0.53775942E-06	13.8070	0.986841E 12	88.8515	-292.9968
N+	0.852635E-13	0.41224128E-14	0.85263456E-13	5.2126	0.156467E 06	49.5538	210.2857
N20	0.593688E-06	0.28704311E-07	0.59368842E-06	14.7520	0.108948E 13	85.8194	-266.7027
N203	0.698603E-14	0.33776857E-15	0.69860338E-14	25.6440	0.128201E 05	132.9261	-411.4556
N204	0.	0.	0.	31.5470	0.	143.8265	-442.7237
N205	0.	0.	0.	37.4610	0.	159.6192	-490.9867
N2+	0.186439E-11	0.90141594E-13	0.18643896E-11	8.9828	0.342134E 07	66.3197	67.9014
N2	0.516010E 00	0.24948627E-01	0.51600997E 00	8.9830	0.946928E 18	66.3313	-230.4648
D-	0.429022E-07	0.20742448E-08	0.42902226E-07	5.0915	0.787298E 11	51.5458	-99.0313
O+	0.112289E-09	0.54290738E-11	0.11228899E-09	5.0915	0.206061E 09	51.5458	126.1067
O2-	0.367252E-10	0.17452986E-11	0.36925154E-10	9.9320	0.677612E 08	70.7834	-187.8717
O2+	0.334749E-14	0.16187213E-15	0.33479853E-14	9.9320	0.614388E 04	70.7634	63.9963
O2	0.389433E-02	0.18852925E-03	0.38993319E-02	9.9320	0.715565E 16	70.7761	-245.7927
O3	0.937409E-09	0.45322910E-10	0.93740926E-09	13.8508	0.172024E 10	89.7688	-269.5851
C	0.	0.	0.	6.2130	0.	13.8931	57.1877

SOLID

TAPE 55 5/14/63
 4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES S A GREENE

PRESSURE (ATM) 0.100000E 01
 TEMPERATURE (DEG K) 3500.00
 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
 SYSTEM ENTHALPY (KCAL/GM) 2.4451
 SYSTEM ENTROPY (CAL/GM-DEG) 2.8343
 SYSTEM GAS CP 0.37283

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.123334E-00	0.54548026E-02	0.12333379E-00	4.9680	0.258562E 18	39.6280	-35.9688
C	0.355408E-08	0.15718960E-09	0.35540771E-08	5.2610	0.745380E 10	50.0902	103.9410
N	0.165466E-03	0.73182188E-05	0.16546587E-03	5.0860	0.347024E 15	48.8672	-40.2256
O	0.480226E-01	0.21239408E-02	0.48022576E-01	5.0410	0.100716E 18	50.8700	-100.3979
E	0.642517E-06	0.28417236E-07	0.64251737E-06	4.9680	0.134752E 13	17.2239	17.1045
CHNO	0.109951E-07	0.48629239E-09	0.10995133E-07	19.3310	0.230596E 11	95.8659	-176.7389
CHN	0.984791E-07	0.43732198E-08	0.98479065E-07	15.3260	0.207375E 12	78.2046	-70.5010
CHO	0.439933E-05	0.22111022E-06	0.43993304E-05	13.5500	0.104849E 14	81.0535	-118.5188
CH	0.157358E-09	0.69861825E-11	0.15735849E-09	9.1640	0.331279E 09	63.0143	75.0712
HNO	0.577574E-06	0.25544924E-07	0.57757402E-06	14.4891	0.121132E 13	76.1905	-172.9147
HN	0.193366E-04	0.88162354E-06	0.19336622E-04	9.0810	0.418059E 14	62.3168	-76.0310
OH-	0.114781E-07	0.52534556E-09	0.11478131E-07	8.9281	0.249115E 11	62.7215	-127.1792
HO	0.301041E-01	0.13314448E-02	0.30104139E-01	8.9290	0.631360E 17	62.7464	-147.6751
CH2O	0.327761E-08	0.14497069E-09	0.32778060E-08	14.2350	0.687439E 10	87.8370	-118.0621
CH2	0.734936E-09	0.10567660E-10	0.23893615E-09	14.2780	0.501110E 09	70.4504	21.6671
C2H2	0.134484E-13	0.61670978E-15	0.13448409E-13	21.2250	0.292534E 05	88.2102	58.0951
H2N	0.350097E-06	0.15484071E-07	0.35009684E-06	13.2490	0.734242E 12	70.5245	-98.4432
H2O	0.222618E-01	0.98459420E-03	0.22261801E-01	13.6170	0.466887E 17	70.4959	-196.1015
H2	0.440257E-01	0.19471691E-02	0.44025745E-01	9.1100	0.923332E 17	49.8494	-79.3294
CH3	0.294009E-11	0.13140352E-12	0.29800946E-11	18.9760	0.625002E 07	79.3423	1.6357
H3N+	0.271571E-07	0.12011053E-08	0.27157146E-07	18.7310	0.569554E 11	78.8731	-131.1867
H3O+	0.530690E-09	0.23471324E-10	0.53068967E-09	18.7314	0.111299E 10	78.8614	-42.4822
CH4	0.813688E-13	0.35987762E-14	0.81368793E-13	24.6325	0.170651E 06	86.3766	-23.8454
C2H4O	0.	0.	0.	36.3960	0.	122.7879	-17.1707
C2H4	0.	0.	0.	30.5280	0.	106.4649	46.0269
CH6	0.	0.	0.	24.6330	0.	86.3651	45.6652
CN-	0.638797E-11	0.28252669E-12	0.63879650E-11	10.4642	0.133972E 08	68.5569	-34.9397
CN	0.154577E-06	0.68366177E-08	0.15457680E-06	8.9660	0.324187E 12	68.0307	-23.0831
CO+	0.227335E-12	0.10079349E-13	0.22789538E-12	8.9615	0.477954E 06	66.7472	131.6425

C0	0.134515--00	0.59494754E-02	0.13450484E-00	8.9610	0.282091E 16	66.7466	-138.9385
C02+	0.115506E-12	0.50241313E-14	0.11359585E-12	15.0858	0.238239E 06	82.2197	14.9701
C02	0.115506E-12	0.37636369E-03	0.11359585E-12	15.0060	0.178488E 17	82.1516	-241.2538
C-	0.	0.	0.	5.2612	0.	50.0904	138.0990
C+	0.	0.	0.	4.9685	0.	49.1977	305.7199
C2N2	0.337335E-14	0.14319681E-15	0.33733591E-14	20.5590	0.707479E 04	101.7087	-32.5496
C2+	0.	0.	0.	9.0637	0.	69.3946	380.8494
C2	0.523426E-14	0.23437562E-15	0.52342629E-14	9.7820	0.111139E 05	70.0103	165.8775
C3	0.	0.	0.	26.4360	0.	116.7880	-57.9078
C4N2	0.	0.	0.	14.7000	0.	81.6649	222.9749
C3	0.	0.	0.	32.3120	0.	138.0333	113.2515
C4	0.	0.	0.	20.5880	0.	101.8426	316.1204
C5	0.	0.	0.	26.4650	0.	115.7119	377.2770
N0+	0.661351E-06	0.24250209E-07	0.66135099E-06	9.0458	0.138702E 13	70.2430	-41.2670
N0	0.148632E-01	0.65825292E-03	0.14893183E-01	9.0120	0.312138E 17	70.2341	-193.0344
N02	0.120545E-05	0.53314794E-07	0.12054543E-05	13.7750	0.252814E 13	87.0102	-249.0218
N+	0.	0.	0.	5.0855	0.	48.8670	234.8940
N20	0.675519E-06	0.29921042E-07	0.67651862E-06	14.7070	0.141383E 13	83.8521	-224.2734
N203	0.176218E-13	0.77937600E-15	0.17621805E-13	25.5870	0.369574E 05	129.4855	-345.8393
N204	0.	0.	0.	31.4720	0.	139.6190	-371.8399
N205	0.	0.	0.	37.3720	0.	154.6220	-412.3970
N2+	0.174252E-13	0.77952898E-15	0.17625250E-13	8.9268	0.369645E 05	65.1239	100.7687
N2	0.564542E 00	0.24968560E-01	0.56454237E 00	8.9270	0.118399E 19	65.1356	-197.5919
O-	0.746597E-08	0.33020468E-09	0.74659704E-08	5.0412	0.156580E 11	50.8695	-73.4240
O+	0.115787E-11	0.51210117E-13	0.11578673E-11	5.0412	0.242834E 07	50.8695	151.7140
O2-	0.174611E-10	0.77227069E-12	0.17461140E-10	9.7620	0.366204E 08	69.4583	-152.8024
O2+	0.	0.	0.	9.7620	0.	69.4683	99.0656
O2	0.961716E-02	0.42534762E-03	0.96171644E-02	9.7620	0.201696E 17	69.4614	-210.7278
O3	0.137843E-08	0.87501999E-10	0.19784314E-08	13.8326	0.414927E 10	87.9205	-225.1526
C	0.	0.	0.	6.1340	0.	13.0686	63.9332

SOLID

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS	PRESSURE (ATM) 0.100000E 01 TEMPERATURE (DEG K) 3000.00 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745 SYSTEM ENTHALPY (KCAL/GM) 1.7225 SYSTEM ENTROPY (KCAL/GM-DEG) 2.6125 SYSTEM GAS CP 0.36732			
H	0.349483E-01	0.13893359E-02	0.34948297E-01	4.9680	0.855114E 17	38.8620	-16.3406				
C	0.364495E-10	0.14490168E-11	0.36449566E-10	5.1680	0.891846E 08	49.2870	128.7886				
N	0.110149E-04	0.43788728E-06	0.11014913E-04	5.0110	0.269512E 14	48.0900	-15.9822				
O	0.847571E-02	0.33694386E-03	0.84757137E-02	5.0040	0.207383E 17	50.0960	-75.1515				
E	0.290217E-07	0.11537287E-08	0.29021673E-07	4.9680	0.710101E 11	16.4580	25.5299				
CHNO	0.115800E-07	0.46035036E-09	0.11579945E-07	19.1540	0.283338E 11	92.8990	-129.5287				
CHN	0.318765E-07	0.12672207E-08	0.31876527E-07	15.0710	0.779954E 11	75.8620	-31.9732				
CHO	0.293669E-05	0.11692482E-06	0.29386906E-05	13.4300	0.719038E 13	78.9630	-78.4925				
CH	0.361234E-11	0.14360503E-12	0.36123382E-11	9.0330	0.883866E 07	61.6120	106.2340				
HNC	0.350835E-06	0.13947093E-07	0.35083461E-06	14.3491	0.858421E 12	73.9673	-135.3619				
HN	0.334617E-05	0.13302385E-06	0.33461720E-05	8.9350	0.818760E 13	60.9290	-45.2148				
OH-	0.136002E-08	0.54066415E-10	0.13600232E-08	8.7772	0.332770E 10	61.3567	-96.1519				
HO	0.201031E-01	0.79917757E-03	0.20103053E-01	8.7780	0.491881E 17	61.3820	-116.6331				
CH2O	0.360437E-08	0.14328811E-09	0.36043662E-08	19.0190	0.881915E 10	84.8680	-74.8631				
CH2	0.349493E-10	0.13913644E-11	0.34999322E-10	14.0760	0.853362E 08	68.2640	56.3534				
C2H2	0.160673E-14	0.63874108E-16	0.16067325E-14	20.8200	0.393135E 04	84.9690	101.4980				
H2N	0.166910E-06	0.66353417E-08	0.16690987E-06	13.0370	0.408394E 12	68.4980	-63.6764				
H2O	0.821468E-01	0.32656658E-02	0.82146768E-01	13.3040	0.200986E 18	68.4210	-161.3637				
H2	0.494392E-01	0.19654065E-02	0.49439167E-01	8.8590	0.120988E 18	48.4650	-54.7442				
CH3	0.110998E-11	0.44125382E-13	0.11099597E-11	18.6780	0.271585E 07	76.4390	40.5978				
H3N	0.469476E-07	0.18663549E-08	0.46947557E-07	18.3670	0.114871E 12	76.0130	-92.4500				
H3O+	0.290280E-09	0.11539800E-10	0.29027986E-09	18.3671	0.710256E 09	76.0209	-3.7436				
CH4	0.103221E-12	0.41034359E-14	0.10322060E-12	24.2333	0.252560E 06	82.6088	18.4226				
C2H4C	0.	0.	0.	35.9410	0.	117.2110	42.8622				
C2H4	0.	0.	0.	30.1070	0.	101.7900	98.1178				
CH4	0.	0.	0.	24.2330	0.	82.5970	87.9290				
CN-	0.166026E-12	0.66002014E-14	0.16602593E-12	10.0402	0.406232E 06	66.9780	-1.0491				
CN	0.112089E-07	0.44560028E-09	0.11208930E-07	8.9060	0.274260E 11	66.6540	10.5934				
CO+	0.119736E-14	0.47599982E-16	0.11973622E-14	8.8953	0.292970E 04	65.3708	164.6804				

C0	0.129331E-00	0.51414324E-02	0.12933107E-00	6.8950	0.315447E 18	55.3700	-105.9009
C02+	0.304949E-14	0.12122956E-15	0.30494905E-14	14.9495	0.746148E 04	79.9014	55.5146
C02	0.297811E-01	0.11839198E-02	0.29781119E-01	14.8730	0.728663E 17	79.8480	-200.7385
C-	0.	0.	0.	5.1677	0.	49.2868	162.9479
C+	0.	0.	0.	4.9686	0.	48.4318	330.1323
C2N2	0.	0.	0.	20.4540	0.	98.5480	17.5318
C2+	0.	0.	0.	9.0102	0.	68.0015	415.2071
C2	0.	0.	0.	9.6760	0.	68.5100	200.5162
C302	0.	0.	0.	26.3000	0.	112.7230	-0.5053
C3	0.	0.	0.	14.6260	0.	79.3450	263.4338
C4N2	0.	0.	0.	32.1480	0.	133.0640	181.0580
C4	0.	0.	0.	20.4910	0.	98.6760	366.2704
C5	0.	0.	0.	26.3380	0.	111.6410	434.1420
ND+	0.302444E-07	0.12039655E-08	0.30285362E-07	8.9773	0.741021E 11	68.8539	-6.4844
ND	0.723827E-02	0.28775062E-03	0.72382739E-02	8.9550	0.177106E 17	68.8490	-158.2537
ND2	0.622042E-06	0.24730261E-07	0.62208171E-06	13.7280	0.152211E 13	84.8900	-206.0333
N+	0.	0.	0.	5.0105	0.	48.0697	259.1377
N20	0.340890E-06	0.13551770E-07	0.34089041E-06	14.6380	0.834089E 12	81.5900	-182.8979
N203	0.460563E-14	0.18309238E-15	0.46056296E-14	25.5000	0.112690E 05	125.5480	-282.0570
N204	0.	0.	0.	31.3570	0.	134.7760	-303.2106
N205	0.	0.	0.	37.2350	0.	148.8720	-336.4901
N2+	0.	0.	0.	8.8556	0.	63.7531	132.9965
N2	0.632833E 00	0.25157686E-01	0.63283345E 00	8.8550	0.154841E 19	63.7650	-165.3584
O-	0.193079E-09	0.76756671E-11	0.19307893E-09	5.0042	0.472425E 09	50.0955	-48.1780
O+	0.173846E-14	0.69110730E-16	0.17384581E-14	5.0042	0.425365E 04	50.0955	176.9500
O2-	0.719700E-12	0.28610970E-13	0.71969972E-12	9.5510	0.176096E 07	67.9797	-118.4322
O2+	0.	0.	0.	9.5510	0.	67.9797	133.4358
O2	0.568417E-02	0.22536805E-03	0.56841734E-02	9.5510	0.139080E 17	67.9730	-176.3621
O3	0.396251E-09	0.15752582E-10	0.39625111E-09	13.8047	0.969546E 09	85.7902	-181.7114
C	0.	0.	0.	6.0570	0.	12.1290	70.2386

SOL10

S A GREENE

TAPE 55 5/14/63
4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES

PRESSURE (ATM) 0.100000E C1
 TEMPERATURE (DEG K) 2500.00
 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
 SYSTEM ENTHALPY (KCAL/GM) 1.3368
 SYSTEM ENTROPY (KAL/GM-DEG) 2.4737
 SYSTEM GAS CP 0.36164

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.544222E-02	0.20756491E-03	0.54422185E-02	4.9640	0.159792E 17	37.9568	2.8692
C	0.212695E-12	0.81121214E-14	0.21269459E-12	5.0770	0.624504E 06	46.3539	153.2037
N	0.236729E-06	0.90287846E-08	0.23672891E-06	4.9780	0.695073E 12	47.1102	7.8421
O	0.208251E-03	0.79426256E-05	0.20825053E-03	4.9440	0.611456E 15	49.1854	-50.3238
E	0.229060E-09	0.86981390E-11	0.22805960E-09	4.9680	0.669618E 09	15.5523	33.5393
CHNO	0.105279E-07	0.40153257E-09	0.10527925E-07	18.8780	0.309115E 11	89.4311	-83.9235
CHN	0.201102E-07	0.76699986E-09	0.20110242E-07	14.7330	0.590468E 11	73.1437	5.2906
CHO	0.122301E-05	0.46645185E-07	0.12230067E-05	13.2400	0.359094E 13	76.5515	-33.5937
CH	0.577965E-13	0.22043446E-14	0.57796496E-13	4.8640	0.169700E 06	59.9800	130.5443
HNO	0.417703E-07	0.15931100E-08	0.41770320E-07	14.1275	0.122444E 12	71.3703	-93.0095
HN	0.234445E-06	0.89416592E-08	0.23444454E-06	8.7430	0.688366E 12	59.3170	-15.1422
OH-	0.897643E-11	0.34235902E-12	0.89764331E-11	6.5739	0.263562E 08	59.7745	-65.8587
HO	0.293666E-02	0.10818952E-03	0.28366596E-02	8.5730	0.832887E 16	59.7799	-80.3312
CH2O	0.330994E-08	0.12624036E-09	0.33099409E-08	18.4770	0.971950E 10	81.4495	-33.2539
CH2	0.687208E-11	0.26209934E-12	0.68720760E-11	13.7640	0.201775E 08	65.7252	89.6727
C2H2	0.422284E-15	0.31361724E-16	0.42228423E-15	20.2820	0.241435E 04	81.2213	142.9785
H2N	0.452263E-07	0.17249209E-08	0.45226314E-07	12.7130	0.132791E 12	66.1493	-23.9994
H2O	0.114454E-00	0.43652607E-02	0.11445432E-00	12.8650	0.336056E 18	66.0338	-127.7336
H2	0.472551E-01	0.18022983E-02	0.47255100E-01	8.5750	0.139748E 18	46.8756	-30.9012
CH3	0.727455E-12	0.27744967E-13	0.72745519E-12	18.2150	0.213592E 07	73.0740	77.9470
H3O+	0.706637E-07	0.26950977E-08	0.70663727E-07	17.8100	0.207480E 12	72.7713	-55.2459
CH4	0.461189E-10	0.17589652E-11	0.46118934E-10	17.8108	0.135412E 09	72.7206	33.4556
C2H4	0.345448E-12	0.13175305E-13	0.34544802E-12	23.6077	0.101429E 07	78.2448	58.6543
C2H6O	0.	0.	0.	35.2260	0.	110.7201	99.8891
C2H4	0.	0.	0.	29.4470	0.	96.3585	147.6395
CH6	0.	0.	0.	23.6080	0.	78.2333	124.1532
CN-	0.187229E-14	0.71408571E-16	0.18722867E-14	9.5192	0.549733E 04	65.1434	32.0029
CN	0.943634E-09	0.35989963E-10	0.94363364E-09	8.8230	0.277066E 10	65.0567	43.5298
CO+	0.	0.	0.	8.8040	0.	63.7569	196.9742

CO	0.11607E+00	0.45236275E-02	0.11860660E-00	8.8040	0.348247E 18	63.7559	-73.6065
CO2+	0.	0.	0.	14.7656	0.	77.1681	94.8062
CO2	0.47241E-01	0.18017958E-02	0.47241926E-01	14.6920	0.138710E 18	77.1529	-161.4706
C-	0.	0.	0.	5.0769	0.	48.3533	187.3643
C+	0.	0.	0.	4.9688	0.	47.5259	354.1285
C2N2	0.	0.	0.	20.2850	0.	94.8331	65.9052
C2+	0.	0.	0.	8.9406	0.	66.3650	448.8106
C2	0.	0.	0.	9.4970	0.	66.7617	234.3452
C302	0.	0.	0.	26.0820	0.	107.9465	54.6977
C3	0.	0.	0.	14.5060	0.	76.5625	302.7775
C4N2	0.	0.	0.	31.8840	0.	127.2261	246.1716
C4	0.	0.	0.	20.3360	0.	94.9533	414.7947
C5	0.	0.	0.	26.1360	0.	106.8568	488.8008
NO+	0.11607E-09	0.72443332E-11	0.19109697E-09	8.8909	0.561090E 09	67.2248	27.9472
NO	0.64926E-13	0.26248550E-04	0.68926886E-03	8.8770	0.202380E 16	67.2230	-124.2235
NO2	0.17615E-07	0.63123249E-09	0.17861477E-07	13.6500	0.524441E 11	82.3938	-164.1938
N+	0.	0.	0.	4.9777	0.	47.1797	282.9617
N2U	0.321221E-07	0.12556423E-08	0.32922132E-07	14.5280	0.966645E 11	78.9304	-142.7478
N2D3	0.	0.	0.	25.3590	0.	120.9104	-220.4371
N2O4	0.	0.	0.	31.1710	0.	129.0754	-237.2076
N2O5	0.	0.	0.	37.0120	0.	142.1017	-265.6951
N2+	0.	0.	0.	8.7561	0.	62.1473	164.4830
N2	0.443054E+00	0.25248726E-01	0.66305411E 00	8.7560	0.194683E 19	62.1589	-133.8654
O-	0.178100E-12	0.47926914E-14	0.17809999E-12	4.9836	0.522929E 06	49.1853	-23.3511
O+	0.	0.	0.	4.9836	0.	49.1853	201.7869
O2-	0.	0.	0.	9.3010	0.	66.2614	-84.8610
O2+	0.	0.	0.	9.3010	0.	66.2614	167.0370
O2	0.709235E-03	0.79954436E-05	0.20963538E-03	9.3010	0.615522E 15	66.2546	-142.7942
O3	0.846072E-12	0.33718287E-13	0.88407179E-12	13.7589	0.259577E 07	83.2773	-139.4258
C	0.	0.	0.	5.9740	0.	11.0325	76.0358

SOLID

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS	PRESSURE (ATM) 0.10000E 01			
								TEMPERATURE (DEG K) 2000.00			
								AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745			
								SYSTEM ENTHALPY (KCAL/GM) 1.1348			
								SYSTEM ENTROPY (CAL/GM-DEG) 2.3840			
								SYSTEM GAS CP 0.35322			
H	0.373350E-03	0.14172994E-04	0.37335005E-03	4.9680	0.137027E 16	36.8478	21.5816				
C	0.	0.	0.	5.0080	0.	47.2296	177.1097				
N	0.732937E-09	0.27823506E-10	0.73293671E-09	4.9690	0.269002E 10	46.0699	31.1659				
O	0.407441E-06	0.15467151E-07	0.40744118E-06	4.9780	0.149539E 13	48.0743	-25.9984				
E	0.596875E-12	0.22658380E-13	0.59687512E-12	4.9680	0.219085E 07	14.4437	41.0486				
CHNO	0.109222E-07	0.41462519E-09	0.10922204E-07	18.4240	0.400866E 11	85.2668	-40.2142				
CHN	0.242880E-07	0.32201252E-09	0.24287982E-07	14.2460	0.891416E 11	69.9095	41.0861				
CH	0.393244E-06	0.14928190E-07	0.39324372E-06	12.9210	0.144328E 13	73.6305	-2.0239				
CH	0.	0.	0.	8.6240	0.	58.0288	166.1608				
HNO	0.937228E-09	0.35578730E-10	0.93722757E-09	13.7508	0.343981E 10	68.2575	-64.0771				
HN	0.462815E-08	0.17569224E-09	0.46281474E-08	8.4720	0.169862E 11	57.3948	14.0524				
OH-	0.873411E-14	0.33156140E-15	0.87341084E-14	8.2852	0.320559E 05	57.8927	-36.4271				
HO	0.823279E-04	0.31253043E-05	0.82327878E-04	8.2850	0.302159E 15	57.9181	-56.8865				
CH2O	0.394629E-08	0.14980794E-09	0.39462941E-08	18.0950	0.144837E 11	77.3430	6.4763				
CH2	0.153704E-11	0.60626330E-13	0.15970404E-11	13.2600	0.586145E 07	62.7076	122.0033				
C2H2	0.184290E-14	0.69959549E-16	0.18428993E-14	19.5040	0.676380E 04	76.7602	182.5118				
H2N	0.739564E-08	0.28075092E-09	0.73956404E-08	12.1960	0.271434E 11	63.3680	2.4002				
H2O	0.113227E-00	0.42982838E-02	0.11322692E-00	12.2140	0.415565E 18	63.2342	-95.3971				
H2	0.531726E-01	0.20165200E-02	0.53172573E-01	8.1950	0.195154E 18	45.0041	-7.9163				
CH3	0.113572E-11	0.43113813E-13	0.11357193E-11	17.4380	0.416831E 07	69.0910	113.5690				
H3N	0.169395E-06	0.64305355E-08	0.16939545E-06	16.9200	0.621714E 12	68.8338	-19.8345				
H3O+	0.591563E-12	0.22456712E-13	0.59156270E-12	16.9206	0.217115E 07	68.8411	68.8838				
CH4	0.702840E-11	0.26680987E-12	0.70284004E-11	22.5626	0.257956E 08	73.0872	96.5355				
C2H4O	0.	0.	0.	34.0220	0.	102.9865	153.3767				
C2H4	0.	0.	0.	28.3440	0.	89.9040	194.3049				
CH6	0.	0.	0.	22.5620	0.	73.0759	166.0290				
CN-	0.	0.	0.	8.9884	0.	63.1315	64.0982				
CN	0.485670E-10	0.18436842E-11	0.48566984E-10	8.6930	0.178250E 09	63.0820	75.5760				
CO+	0.	0.	0.	8.6636	0.	61.8074	228.3819				

C0	0.113320E-00	0.43018091E-02	0.11331978E-00	8.6640	0.415906E 18	61.8064	-42.1993
C02+	0.	0.	0.	14.4874	0.	73.9206	132.6113
C02	0.533076E-01	0.20236457E-02	0.53307597E-01	14.4240	0.195649E 18	73.9230	-123.6787
C-	0.	0.	0.	5.0078	0.	47.2290	211.2697
C+	0.	0.	0.	4.9691	0.	46.4171	377.6247
C2N2	0.	0.	0.	19.9930	0.	90.3374	112.2362
C2+	0.	0.	0.	8.8390	0.	64.3808	481.5145
C2	0.	0.	0.	4.2320	0.	64.6710	267.2214
C302	0.	0.	0.	25.7020	0.	102.1665	107.2754
C3	0.	0.	0.	14.2920	0.	73.1825	340.6129
C4N2	0.	0.	0.	34.4260	0.	120.1596	308.0789
C4	0.	0.	0.	20.0640	0.	90.4441	461.0936
C5	0.	0.	0.	25.7810	0.	101.0617	540.8314
N0+	0.142455E-13	0.53322868E-15	0.14046494E-13	8.7666	0.515534E 05	65.2543	60.6839
N0	0.993591E-05	0.37338752E-06	0.98359068E-05	8.7590	0.360997E 14	65.2545	-91.0864
N02	0.213155E-10	0.80917311E-12	0.21315525E-10	13.5100	0.782321E 08	79.3619	-123.7272
N+	0.	0.	0.	4.9691	0.	46.0703	306.2844
N20	0.479753E-09	0.18212226E-10	0.47975294E-09	14.3350	0.176079E 10	75.7089	-104.0600
N203	0.	0.	0.	25.1080	0.	115.2780	-161.3109
N204	0.	0.	0.	30.8370	0.	122.1542	-174.3382
N205	0.	0.	0.	36.6130	0.	133.8840	-194.6257
N2+	0.	0.	0.	9.6009	0.	50.2101	193.0306
N2	0.666506E 00	0.25301694E-01	0.66650623E 00	8.6010	0.244621E 19	60.2221	-103.2546
O-	0.	0.	0.	4.9778	0.	48.0742	0.9741
O+	0.	0.	0.	4.9778	0.	48.0742	226.1121
O2-	0.	0.	0.	9.0290	0.	54.2172	-52.2248
O2+	0.	0.	0.	4.0290	0.	54.2172	193.6432
O2	0.376514E-06	0.14293084E-07	0.37651351E-06	9.0290	0.138188E 13	54.2107	-110.1514
O3	0.	0.	0.	13.6757	0.	80.2157	-98.5249
C	SOLID 0.	0.	0.	5.8650	0.	9.7111	81.2335

PRESSURE (ATM) 0.100000E 01
 TEMPERATURE (DEG K) 1500.00
 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
 SYSTEM ENTHALPY (KCAL/GM) 0.9575
 SYSTEM ENTROPY (CAL/GM-DEG) 2.2820
 SYSTEM GAS CP 0.33998

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.443321E-05	0.16825323E-06	0.44332130E-05	4.9680	0.216943E 14	35.4190	39.6649
C	0.	0.	0.	4.9750	0.	45.7940	200.3836
N	0.494529E-13	0.18768799E-14	0.4945291E-13	4.9680	0.242002E 06	44.6410	53.8603
O	0.121417E-10	0.46081387E-12	0.12141734E-10	4.9820	0.594167E 08	46.6420	-2.3025
E	0.	0.	0.	4.9680	0.	13.0145	47.9303
CHNO	0.119898E-07	0.45159724E-09	0.11898890E-07	17.6220	0.582283E 11	80.0760	1.1742
CHN	0.362044E-07	0.13740618E-08	0.36204409E-07	13.4790	0.177170E 12	65.9170	75.0823
CHO	0.580218E-07	0.22020964E-08	0.58021845E-07	12.3410	0.283935E 12	69.9920	33.9184
CH	0.	0.	0.	8.2520	0.	55.5990	194.5935
HNO	0.163743E-11	0.62145074E-13	0.16374268E-11	13.0515	0.801290E 07	64.3960	-30.8758
HN	0.663611E-11	0.25185936E-12	0.66361057E-11	8.0650	0.324744E 08	55.0150	42.1777
OH-	0.	0.	0.	7.8662	0.	55.5688	-8.0389
HO	0.211135E-06	0.80131781E-08	0.21113488E-06	7.8660	0.103321E 13	55.5940	-28.4851
CH2O	0.537819E-08	0.20411786E-09	0.53781907E-08	17.0130	0.263187E 11	72.2840	43.9298
CH2	0.147457E-12	0.55964274E-14	0.14745723E-12	12.4040	0.721596E 06	59.0110	152.4669
C2H2	0.830833E-14	0.31532493E-15	0.83083255E-14	18.2910	0.406576E 05	71.3380	219.5940
H2N	0.351317E-09	0.13333510E-10	0.35131741E-09	11.3400	0.171920E 10	59.9780	33.2676
H2O	0.102615E-00	0.38945524E-02	0.10261545E-00	11.2330	0.502158E 18	59.8590	-64.5952
H2	0.64C.75E-01	0.24307876E-02	0.64047504E-01	7.7200	0.313422E 18	42.7160	14.0348
CH3	0.250142E-11	0.94936103E-13	0.25014195E-11	16.0530	0.122409E 08	64.2630	146.9493
H3N	0.721080E-06	0.27367070E-07	0.72108006E-06	15.4420	0.352867E 13	64.1710	13.4545
H3O+	0.	0.	0.	15.4433	0.	64.1780	102.1768
CH4	0.115910E-08	0.43991239E-10	0.11591013E-08	20.6881	0.567217E 10	66.8514	131.5726
C2H4C	0.	0.	0.	31.8260	0.	93.4970	202.5837
C2H4	0.	0.	0.	26.3610	0.	82.0190	237.3573
CH6	0.	0.	0.	20.6880	0.	66.8400	201.0600
CN-	0.	0.	0.	8.5221	0.	60.6174	95.0599
CN	0.356262E-12	0.13521154E-13	0.35626156E-12	8.4630	0.174340E 07	60.6120	106.5274
CO+	0.	0.	0.	8.4175	0.	59.3485	258.6974

CO	0.102014E-00	0.38945550E-02	0.10201551E-00	0.4170	0.502159E 18	59.3480	-11.8849
CO2+	0.	0.	0.	14.0012	0.	69.8183	168.5895
CO2	0.640504E-01	0.24303123E-02	0.64050791E-01	13.9530	0.313438E 18	69.8170	-87.7050
C-	0.	0.	0.	4.9747	0.	45.7942	234.5423
C+	0.	0.	0.	4.9698	0.	44.9875	400.4929
C2N2	0.	0.	0.	19.4340	0.	84.6600	156.0478
C2+	0.	0.	0.	8.6634	0.	61.8618	513.1032
C2	0.	0.	0.	8.9070	0.	62.0630	298.9327
C3O2	0.	0.	0.	24.9600	0.	94.8710	156.6142
C3	0.	0.	0.	13.8620	0.	68.9180	376.5488
C4N2	0.	0.	0.	30.5420	0.	111.2370	366.0245
C4	0.	0.	0.	19.5300	0.	84.7430	504.9529
C5	0.	0.	0.	25.0830	0.	93.7390	589.6095
NO+	0.	0.	0.	8.5554	0.	62.7611	92.7150
NO	0.744575E-04	0.23739450E-04	0.78357547E-08	8.5520	0.383450E 11	62.7630	-59.0552
NO2	0.	0.	0.	13.2270	0.	75.5130	-84.9658
N+	0.	0.	0.	4.9681	0.	44.6410	328.9793
N2O	0.415920E-12	0.15745670E-13	0.41592807E-12	13.9580	0.203538E 07	71.6350	-67.1794
N2O3	0.	0.	0.	24.5990	0.	108.1230	-105.3815
N2O4	0.	0.	0.	30.1580	0.	113.3730	-115.3591
N2O5	0.	0.	0.	35.7960	0.	123.4590	-130.1756
N2+	0.	0.	0.	8.3296	0.	57.7726	224.6105
N2	0.666665E 00	0.25301871E-01	0.66666527E 00	8.3300	0.326239E 19	57.7840	-73.7254
O-	0.	0.	0.	4.9822	0.	46.6417	24.6702
O+	0.	0.	0.	4.9822	0.	46.6417	249.8082
O2-	0.	0.	0.	8.7380	0.	61.6628	-20.7277
O2+	0.	0.	0.	8.7380	0.	61.6628	231.1403
O2	0.407751E-11	0.34527659E-12	0.90975057E-11	8.7380	0.445195E 08	61.6560	-78.6671
O3	0.	0.	0.	13.5014	0.	76.3043	-59.3501
C	0.	0.	0.	5.6690	0.	8.0500	85.6906

SOL10

TAPE 55 5/14/63 4N2 + O2 + CH2 FROM 4333 DEGREES TO 1000 DEGREES S A GREENE

PRESSURE (ATM) 0.100000E C1
 TEMPERATURE (DEG K) 1000.00
 AVAILABLE NON-HEATED SYSTEM ENTHALPY (KCAL/GM) 1.5745
 SYSTEM ENTHALPY (KCAL/GM) 0.7844
 SYSTEM ENTROPY (CAL/GM-DEG) 2.1417
 SYSTEM GAS CP 0.31056

PRODUCT	MOLE FRACTION	MOLES	PARTIAL PRESSURE	CP	ATOMS/CC	ENTROPY	H-TS
H	0.680738E-09	0.25834088E-10	0.68073848E-09	4.9680	0.499689E 10	33.4044	56.9048
C	0.	0.	0.	4.9690	0.	43.7786	222.8110
N	0.	0.	0.	4.9680	0.	42.6264	75.7112
O	0.	0.	0.	4.9990	0.	44.6191	20.5476
E	0.	0.	0.	4.9680	0.	11.0001	53.9679
CHNO	0.138506E-07	0.52563166E-09	0.13850603E-07	16.1250	0.101669E 12	73.2220	39.5880
CHN	0.811000E-07	0.30777527E-08	0.81100009E-07	12.1820	0.595306E 12	60.7591	106.8044
CHO	0.112734E-08	0.42782554E-10	0.11273372E-08	11.2160	0.827509E 10	65.2064	67.7792
CH	0.	0.	0.	7.6540	0.	52.3737	221.6304
HNO	0.	0.	0.	11.6254	0.	59.3767	0.1275
HN	0.	0.	0.	7.4720	0.	51.8675	68.9425
OH-	0.	0.	0.	7.3299	0.	52.4944	19.0195
H2O	0.132118E-11	0.50138947E-13	0.13211811E-11	7.3290	0.969798E 07	52.5201	-1.4142
CH2O	0.939308E-08	0.35646835E-09	0.93930825E-08	14.8170	0.689489E 11	65.8059	78.5242
CH2	0.117266E-14	0.44502424E-16	0.11726565E-14	10.9680	0.860776E 04	54.2692	180.8426
C2H2	0.167165E-12	0.63439424E-14	0.16716540E-12	16.3180	0.122706E 07	64.3170	253.5919
H2N	0.737536E-12	0.27989551E-13	0.73753580E-12	9.9920	0.541380E 07	55.6550	62.2249
H2O	0.757217E-01	0.28736470E-02	0.75721738E-01	9.8510	0.555827E 18	55.5919	-35.6837
H2	0.908788E-01	0.34488604E-02	0.90878842E-01	7.2190	0.667086E 18	39.7029	34.6823
CH3	0.109405E-10	0.41519404E-12	0.10940527E-10	13.4860	0.803077E 08	58.2581	177.6354
H3N	0.121972E-04	0.46288654E-06	0.12197243E-04	13.0430	0.895325E 14	58.3935	44.1527
H3O+	0.	0.	0.	13.0456	0.	58.4003	132.8775
CH4	0.298729E-04	0.11336789E-05	0.29872889E-04	17.1600	0.219279E 15	59.1518	163.1426
C2H4O	0.	0.	0.	27.4770	0.	81.4283	246.4445
C2H4	0.737916E-11	0.28003978E-12	0.73791593E-11	22.5740	0.541659E 08	72.0561	275.9817
CH6	0.673076E-13	0.25573641E-14	0.67387559E-13	17.1600	0.494651E 06	59.1401	232.6247
CN-	0.	0.	0.	7.9962	0.	57.2681	124.5787
CN	0.	0.	0.	7.9950	0.	57.2708	136.0449
CO+	0.	0.	0.	7.9305	0.	56.0292	287.5895

C0	0.756618E-01	0.28713726E-02	0.75661808E-01	7.9310	0.555387E 18	56.0280	17.0069
C02+	0.	0.	0.	12.9991	0.	64.3322	202.2023
C02	0.909869E-01	0.34529609E-02	0.9098690E-01	12.9800	0.667879E 18	64.3431	-54.0882
C-	0.	0.	0.	4.9693	0.	43.7708	256.9694
C+	0.	0.	0.	4.9720	0.	42.9866	422.5103
C2N2	0.	0.	0.	18.2370	0.	77.0075	196.5731
C2+	0.	0.	0.	8.2878	0.	58.4194	543.2252
C2	0.	0.	0.	8.5820	0.	58.5235	329.1333
C302	0.	0.	0.	23.3060	0.	85.0607	201.7332
C3	0.	0.	0.	12.8620	0.	62.8393	410.3678
C4N2	0.	0.	0.	28.6170	0.	99.2154	418.8083
C4	0.	0.	0.	18.3260	0.	77.0497	545.5092
C5	0.	0.	0.	23.5110	0.	83.8616	634.1504
N0+	0.	0.	0.	8.1248	0.	59.3739	123.2987
N0	0.493715E-14	0.18736515E-15	0.49371462E-14	8.1230	0.362406E 05	59.3767	-23.4709
N02	0.	0.	0.	12.5270	0.	70.2775	-48.4418
N+	0.	0.	0.	4.9681	0.	42.6265	350.8301
N20	0.	0.	0.	13.1080	0.	66.1341	-32.6595
N203	0.	0.	0.	23.3690	0.	98.3740	-53.6141
N204	0.	0.	0.	28.4820	0.	101.4507	-61.4816
N205	0.	0.	0.	33.7540	0.	109.3157	-71.7771
N2+	0.	0.	0.	7.8143	0.	54.4958	252.7238
N2	0.666709E 00	0.25301631E-01	0.66670856E 00	7.8150	0.489390E 19	54.5078	-45.6209
O-	0.	0.	0.	4.9990	0.	44.6186	47.5197
O+	0.	0.	0.	4.9990	0.	44.6186	272.6577
O2-	0.	0.	0.	8.3360	0.	38.1988	9.2895
O2+	0.	0.	0.	8.3360	0.	38.1988	261.1575
O2	0.	0.	0.	8.3360	0.	58.1918	-48.6535
O3	0.	0.	0.	13.0408	0.	70.9123	-22.4629
C	SOLIO 0.	0.	0.	5.1490	0.	5.8441	89.1935
4	+01 1	+01 5	+01 0	+00			

APPENDIX H
Program Listing


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C      LOOKA READS N1 CARDS IN ALPHABETIC FORMAT AND IMMEDIATELY 01H0042
C      PRINTS THEM OUT IN THE SAME FORMAT. IF N2 IS ZERO, IT 01H0043
C      DOESNT START AT THE TOP OF THE NEXT PAGE 01H0044
C      READ INPUT TAPE IT1,8,ITITLE,LANK 01H0045
C      IG=0
C      FORMAT(12A6/7A6)
C      REMIND ITR
C      REMIND ITC
C      REMIND ITD
C      REMIND ITF
C      CALL SFTH(ITB)
C      CALL SFTH(ITC)
C      CALL SFTH(ITD)
C      CALL SFTH(ITE)
C      CALL LOOKA(2,0,IT1,ITO)
C      READ INPUT TAPE IT1,10,IM,IJ,IK,IL
C      IM CONTROLS THE TYPE OF INGREDIENT PROPORTION
C      IJ SPECIFIES THE SOLUTION TYPE
C      IK IS THE NUMBER OF INGREDIENTS
C      IL IS THE NUMBER OF COMBINATIONS REQUIRED
C      FORMAT(4I12)
C      IF(IM-6)12,46,46
C      READ INPUT TAPE IT1,14,PREF,(ABLOCK(1),1=2,6)
C      BOX-A-*****
C      FORMAT(6F12,8)
C      IF(INF-IL)18,2,2
C      NF=NO OF COMPLETED POINTS,IL=NO OF POINTS REQUIRED
C      IN THIS SET*****
C      GO TO(20,22,24,26,28),IH
C      CALL INPUT1(L)
C      GO TO(29,54),L
C      CALL INPUT1(L)
C      GO TO(29,54),L
C      CALL INPUT1(L)
C      GO TO(29,56),L
C      CALL INPUT2(L)
C      GO TO(29,58),L
C      CALL INPUT2(L)
C      GO TO(29,58),L
C      IF(IJ-7)30,48,48
C      GO TO(32,34,36,38,40,42,44),IJ

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32 CALL CHAIN(2,ITA)                                01M0082
C *****ROCKET PERFORMANCE*****                  01M0083
34 CALL CHAIN(5,ITA)                                01M0084
C *****MOLLIER DIAGRAM*****                      01M0085
36 CALL CHAIN(8,ITA)                                01M0086
C *****SIMPLE EQUILIBRIUM-SOLID OR GAS*****       01M0087
38 CALL CHAIN(11,ITA)                               01M0088
C *****SMOCK PERFORMANCE *****                 01M0089
40 CALL CHAIN(14,ITA)                               01M0090
C *****NOT SPECIFIED*****                        01M0091
42 CALL CHAIN(17,ITA)                               01M0092
C *****NOT SPECIFIED*****                        01M0093
44 CALL CHAIN(20,ITA)                               01M0094
C *****ERROR 1 IN OVER 5*****                    01M0095
46 N=1                                                01M0096
GO TO 60                                             01M0097
C48 IJ OVER 6*****                                01M0098
48 N=2                                                01M0099
GO TO 60                                             01M0100
C54 ERROR IN MOLES OR MOLE PERCENT*****            01M0101
54 N=3                                                01M0102
GO TO 60                                             01M0103
C56 ERROR IN WEIGHT PERCENT*****                  01M0104
56 N=4                                                01M0105
GO TO 60                                             01M0106
C58 ERROR IN M/R OR O/R*****                     01M0107
58 N=5                                                01M0108
60 WRITE OUTPUT TAPE ITO,62,N                      01M0109
62 FORMAT(27H ERROR IN CHAIN 1 OF TYPE 112/        01M0110
*20H PROBLEM DELETED)                             01M0111
GO TO 2                                             01M0112
END                                                 01M0113

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1EXPAN=0
REWIND ITB
MM=NA*10
MM=XMAXOF(50,MM)
IF(IT) 2,4,4
2MM=2*MM
IT=0
4MM=MM-10
REWIND ITG
IF(INF)12,12,10
10READ TAPE ITG,TEMP,PREF,NA,BIGA,((BIBL(I,J),I=1,NA),J=1,NA),NB,
*(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITATE(I),I=1,ND),*(PARRAY(I),
*(MAJOR(I),I=1,NA)
REWIND ITG
CALL LOGS
TT=TEMP
CALL INTERP(TT,NONE,DELTA)
IF(NONE) 11, 18, 11
11TEMP=ABLOCK(3)
CALL LOGS
GO TO 18
C12NEW PROBLEM-NO CHAMBER DATA ON ITC *****
12I2=4
IM=0
IN=0
NB=0
IF(ABLOCK(3))14,14,16
14ABLOCK(3)=3000.
16TEMP=ABLOCK(3)
ABLOCK(1)=PREF
PREF=PREF/14.696006
BIGA=20.*PREF
LE=0
18LOOP ONE COUNTER SET
CSETUP FOR CONSTANT TEMP COMBUSTION MATRIX *****
CNA=0
KB=1
KC=0
KT=1
100CALL GETMAJ(L)
CALL BUILD(L)

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CALL CROUT(A,ANS,NC,DETERM,NOERR)
CALL CHECKIL)
ICOMB=ICOMB+1
LE=LF+1
IF(LF-MN)102,104,104
IF(IU)108,108,104
102 CALL DUMP2(100.)
104 IF(LF-MN)108,108,106
106 CALL ESCORT(100.)
108 GO TO (100,110),L
110 CORRECT LOOP EXIT-CHAMBER DONE *****
112 WRITE TAPE ITG,TEMP,PREF,NA,BIGA,((BIBLE(I,J),I=1,NA),J=1,NA),NB,
*IPRESS(I),PLN(I),MASKPR(I),ITATE(I),I=1,ND),IPARRAY(I),
*IMAJOR(I),I=1,NA)
112 REWIND ITG
KA=1
CALL BUILDIL)
N=NC-1
SC=A/(NC,N)/BIGA
C VELOCITY OF SOUND MATRIX *****
LF=0
200 KA=1
KB=0
KC=0
KT=-1
CALL GETMAJIL)
CALL BUILDIL)
CALL CROUT(A,ANS,NC,DETERM,NOERR)
IF(IU) 201, 203, 201
201 CALL DUMP2(199.)
203 CALL GETDJS(DJ,DAM1)
C MACH ONE MATRIX *****
KC=1
205 CALL BUILDIL)
CALL CROUT(A,ANS,NC,DETERM,NOERR)
CALL CHECKIL)
ITHROT=ITHROT+1
LF=LF+1
IF(LF-MN)204,206,206
204 IF(IU)209,209,206
206 CALL DUMP2(200.)

```

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01M0215
01M0216
01M0217
01M0218
01M0219
01M0220
01M0221
01M0222
01M0223
01M0224
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01M0226
01M0227
01M0228
01M0229
01M0230
01M0231
01M0232
01M0233
01M0234
01M0235
01M0236
01M0237
01M0238
01M0239
01M0240
01M0241
01M0242
01M0243
01M0244
01M0245
01M0246
01M0247
01M0248
01M0249
01M0250
01M0251
01M0252
01M0253
01M0254
01M0255

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208	IF(LF-MM)209,209,208	01M0256
209	CALL ESCORT(200,)	01M0257
210	IF(KT) 210, 210, 205	01M0258
211	GO TO(200,212),L	01M0259
212	THROAT COMPLETED *****	01M0260
213	PTHR=0.	01M0261
214	GAMTH=0.	01M0262
215	DO 214 I=1,NG	01M0263
216	GAMTH=GAMTH+PRESS(I)*DJ(I)	01M0264
217	PTHR=PTHR+PRESS(I)	01M0265
218	GAMTH=GAMTH/(DAM1*PTHR)	01M0266
219	EMTH=BIGA/PTHR	01M0267
220	ATOWD=189.27599*TEMP/(PTHR*EMTH*299.15427*SORTF(	01M0268
221	*GAMTH*TEMP/EMTH))	01M0269
222	CSTAR=472.829104*PREF*ATOWD	01M0270
223	ABLOCK(5)=CSTAR	01M0271
224	ABLOCK(7)=PTHR	01M0272
225	CALL PTABL(0,PTHR,PREF)	01M0273
226	OBTAINS REFERENCE EXPANSION PRESSURE RATIO TO PTHROAT	01M0274
227	PC=ABLOCK(1)/14.696006	01M0275
228	START OUTPUT EXPANSION LOOP SET *****	01M0276
229	PC=PREF	01M0277
230	READ TAPE ITG,TEMP,PREF,NA,BIGA,((BIBLE(I,J),I=1,NA),J=1,NA),NB,	01M0278
231	*IPRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITATE(I),I=1,ND),PARRAY(I),	01M0279
232	*IMAJOR(I),I=1,NA)	01M0280
233	REWIND ITG	01M0281
234	CALL LOGS	01M0282
235	REWIND ITB	01M0283
236	NONE=0	01M0284
237	NSUB=0	01M0285
238	IF(IIS) 218, 218, 216	01M0286
239	IF(IIS-24) 217,218,218	01M0287
240	MEND=24-IIS	01M0288
241	GO TO 220	01M0289
242	MEND=24	01M0290
243	DO 340 NDO=1,MEND	01M0291
244	LG=0	01M0292
245	CALL PTABL(NDO,P1,PC)	01M0293
246	PREF=PC/P1	01M0294
247	KA=1	01M0295
248	KB=1	01M0296

```

300 KC=0
    KT=0
    CALL GETMAJ(L)
    CALL BUILD(L)
    N=NC-1
    SI=-A(NC,N)/BIGA
    CALL CROUT(A,ANS,NC,DETERM,NOERR)
    CALL CHECK(L)
    IEXPAN=IEXPAN+1
    LG=LG+1
    IF(LG-MN)302,302,304
    IF(LV)307,307,304
302 CALL DUMP2(300,1)
304 IF(LG-MN)307,307,306
306 CALL ESCORT(300,1)
    NSUB=NSUB+1
    GO TO 340
307 GO TO(300,308),L
308 EXPANSION AT CONSTANT ENTROPY COMPLETED *****01M0315
C ACUSTIC VELOCITY MATRIX *****01M0316
    KA=1
    KB=0
    KC=0
    KT=-1
    CALL BUILD(L)
    CALL CROUT(A,ANS,NC,DETERM,NOERR)
    CALL GETDJS(DJ,DAM1)
    COEFFICIENT OF HEAT EXPANSION AT CONST PRESS *****01M0323
    KA=-1
    CALL BUILD(L)
    CALL CROUT(A,ANS,NC,DETERM,NOERR)
    CALL GETYJS
    GAMEXP=0.
    CEXP=0.
    DO 326 I=1,ND
    IF(MASKPR(I))326,320,326
320 IF(PRESS(I)-1.E-10)326,322,322
322 CEXP=CEXP+1000./TEMP*(PRESS(I)*CPHSDK(2,1)*YJ(I)-CPHSDK(2,1)*
    *YJA*PRESS(I)+TEMP/1000.*PRESS(I)*CPHSDK(1,1))
    IF(I-NG)324,324,326
324 GAMEXP=GAMEXP+PRESS(I)*DJ(I)

```

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01M0297
01M0298
01M0299
01M0300
01M0301
01M0302
01M0303
01M0304
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01M0306
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01M0308
01M0309
01M0310
01M0311
01M0312
01M0313
01M0314
01M0315
01M0316
01M0317
01M0318
01M0319
01M0320
01M0321
01M0322
01M0323
01M0324
01M0325
01M0326
01M0327
01M0328
01M0329
01M0330
01M0331
01M0332
01M0333
01M0334
01M0335
01M0336
01M0337

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```

326 CONTINUE
   GAMEXP=GAMEXP/(DAM1*PREF)
   CPEXP=CPEXP/BIGA
   XGAS=0.
   DO 328 I=1,ND
328   XIP(I)=100.*PRESS(I)/PREF
   DO 330 I=1,NG
330   XGAS=XGAS+XIP(I)
   CMEXP=PREF*XGAS/BIGA
   P=14.696006*PREF
   COMPUTE OUTPUT PARAMETERS *****
   HE=0.
   SE=0.
   ZERO=0.
   CMEXT=BIGA/PREF
   DO 334 I=1,ND
334   IF(MASKPRI(I))334,332,334
332   HE=HE+PRESS(I)*CPHSDK(2,I)
   SE=SE+PRESS(I)*CPHSDK(3,I)
   IF(ITATE(I)-1)334,333,334
333   SE=SE-1.98725*PRESS(I)*PLN(I)
334   CONTINUE
   HE=HE/BIGA
   SE=SE/BIGA
   MD=HE*1000.
   DO 337 I=1,ND
337   XIP(I)=PRESS(I)/BIGA*100.
   WRITE TAPE ITB,P,TEMP,MD,S1,CPEXP,GAMEXP,CMEXT,ZERO,ZERO,
+ (XIP(I),I=1,ND)
   IF(INDO-1)336,336,338
336   WRITE TAPE ITB,P1,P,TEMP,MD,GAMEXP,ZERO,ZERO,ZERO
   GO TO 340
338   EI=294.98*SORTF(MC-HE)
   AEOWD=5.882893*TEMP/(PREF*CMEXT*EI)
   EPSIL=AEOWD/ATOWD
   CF=32.174*EI/CSTAR
   WRITE TAPE ITB,P1,P,TEMP,MD,GAMEXP,EPSIL,CF,EI
   NN=NDONE+1
340   NDONE=NDONE+1
   NN=NDONE-NSUB
400   REWIND ITB

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01M0336
01M0339
01M0340
01M0341
01M0342
01M0343
01M0344
01M0345
01M0346
01M0347
01M0348
01M0349
01M0350
01M0351
01M0352
01M0353
01M0354
01M0355
01M0356
01M0357
01M0358
01M0359
01M0360
01M0361
01M0362
01M0363
01M0364
01M0365
01M0366
01M0367
01M0368
01M0369
01M0370
01M0371
01M0372
01M0373
01M0374
01M0375
01M0376
01M0377
01M0378

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406 WRITE OUTPUT TAPE ITO,406, ICOMB,ITHROT,LEXPAN
    FORMAT('06X,14,13,15)
    IF(15) 402, 404, 402
    CALL CHAIN(4,ITA)
402 CALL CHAIN(3,ITA)
404 CALL CHAIN(3,ITA)
    END

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01H0379
01H0380
01H0381
01H0382
01H0383

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C          CHAIN(3, )      ROCKET PERFORMANCE OUTPUT
C          ***** UPDATED 2/14/63
C          SUBROUTINES REQUIRED IN CHAIN(3, )
C          PARB
C          CHANGE
C          DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
C          * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), MEL(50), ITATE(
C          * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
C          * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(150),
C          * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
C          * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
C          DIMENSION DJ(150), YJ(150)
C          1/19/62
C          COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU
C          * FG, MCMOLE, MC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
C          * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
C          * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
C          * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
C          * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
C          * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
C          * TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
C          * GAMTH, PTHR, DAM, DJ, YJ, YJA
C          DIMENSION TABL1(24,159), TABL2(24,8), PCPE(50), EPS(50),
C          * PULSE(50), EPS1(50), CFO(50), FORT(50), AB(2,50), FEP(50),
C          * CFE(50), PCPI(50)
C          CALL CHANGE(10ME,6HONE )
C          CALL CHANGE(1TWO,6HTWO )
C          CALL CHANGE(1THREE,6MTHREE )
C          REWIND ITA
C          IPSAVE=IP
C          ILSAVE=IL
C          NTBL=ND+9
C          II=1
C          CSTAR=ABLOCK(5)
C          ICSTAR=CSTAR
C          I2=1
C          I3=8
C          IF(MH-8)2,2,1
C          II=2
C          GO TO 4

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```

1      NEXITP=XMINOF(NH,24)
4      DO 3 I=1,NEXITP
      READ TAPE ITB,(TABL1(I,J),J=1,NTBL)
3      READ TAPE ITB,(TABL2(I,J),J=1,8)
      DO 108 I=1,NEXITP
      SUMGAS=0.
      SUMSOL=0.
      DO 106 J=1,ND
      IF(MASKPR(J)) 106,100, 106
100    IF(ITATE(J)-1) 106, 103,104
103    SUMGAS=SUMGAS+TABL1(I,J+9)
      GO TO 106
104    SUMSOL=SUMSOL+TABL1(I,J+9)
106    CONTINUE
108    TABL1(I,8)=SUMGAS
      TABL1(I,9)=SUMSOL
      IPC=ABLOCK(1)
      IF(I1-2)20,6,20
6      WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I)
      *,I=1,18),IPC,IONE
      WRITE OUTPUT TAPE ITO,509,(TABL1(I,1),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,510,(TABL1(I,2),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,511,(TABL1(I,3),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,512,(TABL1(I,4),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,513,(TABL1(I,5),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,514,(TABL1(I,6),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,515,(TABL1(I,7),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,516,(TABL1(I,8),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,517,(TABL1(I,9),I=1,NEXITP)
      WRITE OUTPUT TAPE ITO,518
      IJUMP=0
      DO 16 J=1,ND
      J2=J+9
      IP=0
      DO 10 I=1,NEXITP
      IF(TABL1(I)-1.E-5)8,10,10
8      IP=IP+1
10     CONTINUE
12     IF(MASKPR(J))16,12,16
14     IF(IP-NEXITP) 14,16,16
      WRITE OUTPUT TAPE ITO,519,(NAME(K,J),K=1,2),(TABL1(I,J2),

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01H0426
01H0427
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01H0435
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01H0437
01H0438
01H0439
01H0440
01H0441
01H0442
01H0443
01H0444
01H0445
01H0446
01H0447
01H0448
01H0449
01H0450
01H0451
01H0452
01H0453
01H0454
01H0455
01H0456
01H0457
01H0458
01H0459
01H0460
01H0461
01H0462
01H0463
01H0464
01H0465
01H0466

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16      *I=1,NEXITP)
      CONTINUE
      WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),
      *I=1,18),IPC,ITWO
      WRITE OUTPUT TAPE ITO,520,ICSTAR,((TABL2(I,J),J=1,8),I
      *I=1,NEXITP)
      GO TO 58
18      K=-7
20      M=XMINOF(13,NEXITP)
22      K=K+8
      WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),
      *I=1,18),IPC,IONE
      WRITE OUTPUT TAPE ITO,509,(TABL1(I,1),I=K,M)
      WRITE OUTPUT TAPE ITO,510,(TABL1(I,2),I=K,M)
      WRITE OUTPUT TAPE ITO,511,(TABL1(I,3),I=K,M)
      WRITE OUTPUT TAPE ITO,512,(TABL1(I,4),I=K,M)
      WRITE OUTPUT TAPE ITO,513,(TABL1(I,5),I=K,M)
      WRITE OUTPUT TAPE ITO,514,(TABL1(I,6),I=K,M)
      WRITE OUTPUT TAPE ITO,515,(TABL1(I,7),I=K,M)
      WRITE OUTPUT TAPE ITO,516,(TABL1(I,8),I=K,M)
      WRITE OUTPUT TAPE ITO,517,(TABL1(I,9),I=K,M)
      DO 30 J=1,ND
      IP=0
      J3=J+9
      DO 26 I=K,M
      IF(TABL1(I,J3)-1.E-5)24,26,26
24      IP=IP+1
26      CONTINUE
      MX=M-K+1
      IF(IP-MX)28,30,30
28      WRITE OUTPUT TAPE ITO,519,(NAME(I,J),I=1,2),(TABL1(I,
      *J3),I=K,M)
30      CONTINUE
      IF(NEXITP-13)36,36,32
32      IF(M-13)36,34,36
34      I3=I3+8
      GO TO 22
36      WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),I
      *I=1,18),IPC,ITWO
      WRITE OUTPUT TAPE ITO,520,ICSTAR,((TABL2(I,J),J=1,8),I=

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01H0467
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01H0495
01H0496
01H0497
01H0498
01H0499
01H0500
01H0501
01H0502
01H0503
01H0504
01H0505
01H0506
01H0507

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*1,NEX(ITP)
NQ=NEX(ITP-4)
DO 38 I=1,NQ
  KK=I+4
  PCPE(I)=TABL2(KK,1)
  EPS(I)=TABL2(KK,6)
  PULSE(I)=TABL2(KK,8)
  ARG=C.
  IF(EPS(NQ)-3.) 58,58,40
  M=MINIF(EPS(NJ),50.)
  DO 42 I=1,M
    ARG-ARG+1.
    PCP(I)=PARB(EPS,PCPE,ARG,NQ)
    FOPT(I)=PARB(EPS,PULSE,ARG,NQ)
    TTT=CSTAR*ARG/32.174
    AB(1,I)=TTT/PCP(I)
    AB(2,I)=TTT/TABL2(1,2)
    FEP(I)=FOPT(I)+AB(1,I)
    CFE(I)=32.174*FEP(I)/CSTAR
    CFJ(I)=FOPT(I)*32.174/CSTAR
    EPS1(I)=ARG
  MN=C
  KK=1
  MM=MM+25
  MM=XMINGF(MM,M)
  48  WRITE OUTPUT TAPE ITO,500,TAPID(1),TAPID(2),(TITLE(I),I
    *1,18),IPC,I THREE
  54  WRITE OUTPUT TAPE ITO,522,(EPS1(I),PCP(I),FOPT(I),AB(1,
    *1),AB(2,I),FEP(I),CFJ(I),I=KK,MM)
    KK=MM+1
  IF(MM-M) 44, 58, 58
  REWIND ITO
  NF=NF+1
  IP=IPSAVE
  IL=ILSAVE
  59  CALL CHAIN(1,ITA)
  500  FORMAT(1H1,2X,26(1H*),51H SHIFTING EQUILIBRIUM EXPANSION-ROCKET PEO1M0544
    *RFORMANCE ,26(1H*)//1X,25HTHERMO DATA LIBRARY TAPE ,2A6//2X,18A6//01M0545
    *37X,18HCHAMBER PRESSURE =,110,5H PSIA//48X,6HTABLE ,1A6)
  510  FORMAT(6X,19HTEMPERATURE (DEG K),8F10.3)
  511  FORMAT(6X,11HH (CAL/GM),8X,8F10.1)

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01M0508
01M0509
01M0510
01M0511
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01M0543
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01M0546
01M0547
01M0548

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512 FORMAT(6X,17HS (CAL/GM-DEG K),2X,8F10.3) 01M0549
513 FORMAT(6X,11HCP (CAL/GM),8X,8F10.3) 01M0550
514 FORMAT(6X, 5HGAMMA,14X,8F10.3) 01M0551
515 FORMAT(6X,19HAVERAGE GAS MOLE WT,8F10.3) 01M0552
516 FORMAT(6X,17HGAS MOLES/100 GM ,F12.5,7F10.5) 01M0553
517 FORMAT(6X,18HCOND MOLES/100 GM ,F11.5,7F10.5//) 01M0554
518 FORMAT(1X,42HCOMPOSITION-MOLES PER 100 GRAMS PROPELLANT//) 01M0555
519 FORMAT(6X,2A6,7X,8F10.5) 01M0556
509 FORMAT(2X,49HTHERMODYNAMIC CONDITIONS FOR EACH EXPANSION PLANE//6X,01M0557
*15HPRESSURE (PSIA),4X,8F10.3) 01M0558
520 FORMAT(44X,6HC* =16,7H FT/SEC//10X,5HPC/PE,8X,1HP,13X,1MT,13X,1M01M0559
*H,8X,5HGAMMA,6X,7HEPSILON,8X,2HCF,9X,2HIS/22X,4HPSIA,9X,6HDEG,-K,801M0560
*X,6HCAL/GM,39X,9HLB-SEC/LB//18(F15.4,F13.4,F13.1,F15.2,F11.4,F12.4,01M0561
*,F11.4,F12.2//)) 01M0562
522 FORMAT(8X,7HEPSILON,8X,5HPC/PE,9X,5HI OPT,10X,1MA,12X,1MB,10X,5HI01M0563
* EPS,5X,6HCF OPT,5X,6HCF EPS//15(F15.4,F14.4,F13.2,F14.2,F13.2, 01M0564
*,F12.2,2F11.4//)) 01M0565
END 01M0566

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C      GENERAL PURPOSE SOLVER                                06M0001
      DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA( 06M0002
      * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE( 06M0003
      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150), 06M0004
      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(06M0005
      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20), 06M0006
      * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10) 06M0007
      DIMENSION DJ(150), YJ(150) 06M0008
      1/19/62 06M0009
      DIMENSION F(150), XIP(150) 06M0010
      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU(06M0011
      * FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 06M0012
      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, IIA, IIB, 06M0013
      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR, 06M0014
      * KA, KB, KC, KD, KE, KF, KG, KI, LA, LB, LC, LD, LE, LF, LG, LH, 06M0015
      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 06M0016
      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY(06M0017
      * , TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY 06M0018
      * GAMTH, PTHR, DAM1, DJ, YJ, YJA 06M0019
      DATA CARD 5 SPECIAL STRUCTURE 06M0020
      CARD FORMAT -6F12.8 06M0021
      LAST NUMBER ON CARD (60-72) 06M0022
      IF =1 MOLLIER SOLUTION 06M0023
      IF =2 EQUILIBRIUM OVER A FIXED PRESSURE-VARIABLE TEMP 06M0024
      IF =3 POINT SOLUTION REQUIRED AT GIVEN TEMP AND PRESS 06M0025
      ***** CONTROL OF 1 06M0026
      * ABLOCK(1)=UPPER PRESSURE 06M0027
      * ABLOCK(2)=LOWER PRESSURE 06M0028
      * ABLOCK(3)=UPPER TEMPERATURE 06M0029
      * ABLOCK(4)=LOWER TEMPERATURE 06M0030
      * ABLOCK(5)=TEMPERATURE INCREMENT (DECREMENT) 06M0031
      ***** CONTROL OF 2 06M0032
      * ABLOCK(1)=PRESSURE 06M0033
      * ABLOCK(2)=NOT USED 06M0034
      * ABLOCK(3)=UPPER TEMPERATURE 06M0035
      * ABLOCK(4)=LOWER TEMPERATURE 06M0036
      * ABLOCK(5)=TEMPERATURE INCREMENT (DECREMENT) 06M0037
      ***** CONTROL OF 3 06M0038
      * ABLOCK(1)=PRESSURE 06M0039
      * ABLOCK(2)=NOT USED 06M0040
      * ABLOCK(3)=NOT USED 06M0041

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C		* ABLOCK(4)=NOT USED	06H0042
C		* ABLOCK(5)=NOT USED	06H0043
C		* ABLOCK(6)=CONTROL INDICATOR AS STATED ABOVE	06H0044
C		*****	06H0045
		REWIND ITA	06H0046
		I2=4	06H0047
		NB=0	06H0048
		IE=1	06H0049
		IM=0	06H0050
		ITA=ITA	06H0051
		ITC=ITC	06H0052
		ITD=ITD	06H0053
		INT=0	06H0054
		MM=50	06H0055
		IF(NF) 4, 4, 6	06H0056
4		ABLOCK(1)=PREF/14.696	06H0061
		IF(IT) 3, 6, 6	06H0062
3		MM=100	06H0063
		IT=0	06H0064
6		PREF=ABLOCK(1)	06H0065
		IF(ABLOCK(6)-2.) 2, 24, 42	06H0066
2		ILOOP=1	06H0067
		IF(ABLOCK(2)) 8, 8, 10	06H0068
8		ABLOCK(2)=1.E-03	06H0069
10		PFINAL=ABLOCK(2)/14.696006	06H0070
		IF(ABLOCK(3)) 12, 12, 14	06H0071
12		ABLOCK(3)=6000.	06H0072
14		TEMP=ABLOCK(3)	06H0073
		IF(ABLOCK(4)) 16, 16, 18	06H0074
16		ABLOCK(4)=298.158	06H0075
18		TFINAL=ABLOCK(4)	06H0076
		IF(ABLOCK(5)) 20, 20, 22	06H0077
20		ABLOCK(5)=100.	06H0078
22		TDECR=ABLOCK(5)	06H0079
		GO TO 52	06H0080
24		ILOOP=2	06H0081
		PFINAL=PREF	06H0082
30		IF(ABLOCK(3)) 30, 30, 32	06H0083
32		ABLOCK(3)=6000.	06H0084
		TEMP=ABLOCK(3)	06H0085
		IF(ABLOCK(4)) 34, 34, 36	06H0086

34	ABLOCK(4)=298.158	06M0087
36	TFINAL=ABLOCK(4)	06M0088
	IF(ABLOCK(5)) 38,38,40	06M0089
38	ABLOCK(5)=100.	06M0090
40	TDECR=ABLOCK(5)	06M0091
	GO TO 52	06M0092
42	ILOOP=3	06M0093
	TDECR=100.	06M0094
	IF(ABLOCK(3)) 48,48,50	06M0095
48	ABLOCK(3)=6000.	06M0096
50	TEMP=ABLOCK(3)	06M0097
52	START SYSTEM COMPUTATION.	06M0098
	GO TO(54,58,62),ILOOP	06M0099
54	WRITE OUTPUT TAPE ITO,56,HC	06M0100
56	FORMAT(70H MOLLIER DIAGRAM OPTION SELECTED,UNHEATED SYSTEM ENT	06M0101
	*LPY (KCAL/GM)= F11.5)	06M0102
	IY=1	06M0103
	GO TO 66	06M0104
58	WRITE OUTPUT TAPE ITO,60,HC	06M0105
60	FORMAT(70H EQUILIBRIUM GAS OPTION SELECTED,UNHEATED SYSTEM ENT	06M0106
	*LPY (KCAL/GM)= F11.5)	06M0107
	IY=1	06M0108
	GO TO 66	06M0109
62	WRITE OUTPUT TAPE ITO,64,HC	06M0110
64	FORMAT(72H FLAME COMPOSITION OPTION SELECTED,UNHEATED SYSTEM ENT	06M0111
	*HALPY (KCAL/GM)= F11.5)	06M0112
	IY=0	06M0113
66	KA=0	06M0114
	KB=1	06M0115
	KC=0	06M0116
	KT=1	06M0117
	IM=0	06M01172
	NB=0	06M01174
	IPREF=0	06M0118
	ITEMP=0	06M0119
	BIGA=25.*PREF	06M0120
	IONG=0	06M0121
	IRETRY=0	06M0122
	TRESET=TEMP	06M0123
	IDONE=0	06M0124
68	LE=0	06M0125

```

POLD=PREF
CALL LOGS
CALL GENPIS
70 CALL GETMAJ(L)
CALL BUILD(L)
CALL CROUT(A,ANS,NC,DETERM,NOERR)
CALL CHECK(L)
LE=LE+1
IF(1) 700,702,700
700 CALL DUMP2(1.)
702 IF(KE-1) 73, 73, 72
72 PREF=0.
DO 2224 I=1,NG
2224 PREF=PREF+PRESS(I)
BIGA=8IGA+PREF/POLD
GO TO 2442
73 IF(LE-MM) 74, 200, 200
74 GO TO (70, 1200),L
200 IF(1ONG)212, 212,202
C PROBLEM HAS TROUBLE IN CONVERGING AT THIS TEMPERATURE
C THE SYSTEM WILL BE RESET TO THE LAST COMPLETED POINT AND
C THE TEMPERATURE RESET TO A SMALLER DECREMENT
202 IF(1TEMP)206, 204,206
204 ITEMP=1
TRESET=TEMP
TAGAIN=TEMP+TDECR
206 TDECR=TDECR/2.
TEMP=TAGAIN-TDECR
BACKSPACE ITG
C RESET SYSTEM TO LAST CONDITIONS WHICH CONVERGED
207 READ TAPE ITG,BIGA,NA,NB,(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITAO6H0156
*TE(I),I=1,ND),((BIBLE(I,J),I=1,NA),J=1,NA),PARRAY(I),I=06H0157
*1,NA)
IRETRY=IRETRY+1
IF(IRETRY-4) 68, 68, 208
208 WRITE OUTPUT TAPE ITO,210
210 FORMAT(69H THE SYSTEM HAS BEEN RETRIED 4 TIMES W9THOUT SUCCESS,J06H0162
*08 TERMINATED)
GO TO 2216
216 NF=NF+1
REWIND ITG

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06H0126
06H0127
06H0128
06H0129
06H0130
06H0131
06H0132
06H0133
06H0134
06H0135
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06H0137
06H0138
06H0139
06H0140
06H0141
06H0142
06H0143
06H0144
06H0145
06H0146
06H0147
06H0148
06H0149
06H0150
06H0151
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06H0153
06H0154
06H0155
06H0156
06H0157
06H0158
06H0159
06H0160
06H0161
06H0162
06H0163
06H0165
06H0166
06H0167

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CALL CHAIN(1,ITA)
212 WRITE OUTPUT TAPE ITO,214
214 FORMAT(56H THE JOB CANNOT CONVERGE AT INITIAL POINT, JOB TERMINATED)
*)
GO TO 216
1200 IF(1-LOOP-2) 1202, 1202, 2200
1202 IF(1-RESET-TEMP) 1210, 1212, 1210
1210 TEMP=TEMP-TDECR
GO TO 68
1212 WRITE TAPE ITG,BIGA,NA,NB,(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITAO,6H0177
*TE(I),I=1,ND),((BIBLE(I,J),I=1,NA),J=1,NA),(IMAJOR(I),PARRAY(I),I=
*1,NA)
ITEMP=C
PREF=0.
DO 1214 I=1,NG
1214 PREF=PREF+PRESS(I)
DO 1216 I=1,ND
1216 YJ(I)=PRESS(I)/BIGA
IRETRY=0
IDONE=IDONE+1
IONG=IONG+1
2200 SIGH=0.
SIGS=0.
DO 2206 I=1,ND
DJ(I)=(PRESS(I)/TEMP)*7.340389E+21
IF(MASKPR(I)) 2206, 2202, 2206
2202 SIGS=SIGS+CPMSDK(3,I)*PRESS(I)
SIGH=SIGH+CPMSDK(2,I)*PRESS(I)
IF(1-ITATE(I)-1) 2206, 2204, 2206
2204 SIGS=SIGS-1.98725*PRESS(I)*PLN(I)
2206 CONTINUE
SIGH=SIGH/BIGA
SIGS=SIGS/BIGA
POUT=PREF*14.696006
RHO=BIGA/(82.0597*TEMP)
2424 SUM=0.
DO 2426 I=1,ND
2426 SUM=SUM+PRESS(I)
DO 2428 I=1,ND
XIP(I)=PRESS(I)/SUM
2428 F(I)=CPMSDK(2,I)-1.E-3*TEMP*CPMSDK(3,I)

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06H0168
06H0169
06H0170
06H0171
06H0172
06H0173
06H0174
06H0175
06H0176
06H0177
06H0178
06H0179
06H0180
06H0181
06H0182
06H0183
06H0184
06H0185
06H0186
06H0187
06H0188
06H0189
06H0190
06H0191
06H0192
06H0193
06H0194
06H0195
06H0196
06H0197
06H0198
06H0199
06H0200
06H0201
06H0202
06H0203
06H0204
06H0205
06H0206
06H0207

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CPBAR=0.
DO 2430 I=1,NG
2430 CPBAR=CPBAR+CPHSDK(1,I)*PRESS(I)
CPBAR=CPBAR/BIGA
AVMOL=BIGA/PREF
IFIKE-1) 2446, 2446, 2442
2442 WRITE OUTPUT TAPE ITO, 2444, PREF, POLD
2444 FORMAT( 84H) THE SYSTEM HAS LOST A DEGREE OF FREEDOM, RESULTING IN 06H0215
* SINGULAR CORRECTION MATRICES, / 86 H THE SYSTEM PRESSURE IS DEPEND 06H0216
* SENT ON CONDENSIBLE SPECIES AND THEIR PARTIAL PRESSURES, / 72H THERO 06H0217
* BEFORE THE SYSTEM PRESSURE BECOMES A VARIABLE. THE NEW PRESSURE IS 06H0218
* E16.8/ 37H THE OLD OR LAST SYSTEM PRESSURE WAS E16.8)
GO TO 2213
2446 IF( ILOOP-2) 2207, 2300, 2400
2207 WRITE OUTPUT TAPE ITO, 2208, POUT, TEMP, SIGS, SIGM, RHO
C MOLLIER DIAGRAM OUTPUT *****06H0222
2208 FORMAT( 9H PIP(SIA)=E13.5, 10H T(DEG-K)= F7.2, 15H S(CAL/GM-DEG)=F7.4, 06H0224
* 12H H(KCAL/GM)= F8.4, 15H RHO(GM/CU-CM)=E12.6)
DO 2214 I=NG,ND
IF(I IATE(I)-1) 2214, 2214, 2210
2210 WRITE OUTPUT TAPE ITO, 2212, INAME(I,1), J=1, 2)
2212 FORMAT(10X, 2A6, 9H PRESENT)
2214 CONTINUE
2213 TDECR=ABSF(ABLOCK(5))
IRETRY=0
PREF=POLD
IF(TEMP-TFINAL) 2216, 2216, 2215
2215 TEMP=TEMP-TDECR
TRESET=TEMP
IF(TEMP-TFINAL) 2218, 68, 68
2216 IF(PREF-PFINAL) 216, 216, 2222
2218 TEMP=TFINAL
TRESET=TEMP
GO TO 68
2222 REWIND ITG
PREF=PREF/10.
IRETRY=-1
IONG=0
TEMP=ABLOCK(3)
TRESET = TEMP
IM=0
06H0208
06H0209
06H0210
06H0211
06H0212
06H0213
06H0214
06H0215
06H0216
06H0217
06H0218
06H0219
06H0220
06H0221
06H0222
06H0223
06H0224
06H0225
06H0226
06H0227
06H0228
06H0229
06H0230
06H0231
06H0232
06H0233
06H0234
06H0235
06H0236
06H0237
06H0238
06H0239
06H0240
06H0241
06H0242
06H0243
06H0244
06H0245
06H0246
06H0247
06H02472

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GO TO 66
2300 CONTINUE
C START EQUILIBRIUM GAS OPTION
WRITE OUTPUT TAPE ITO,406,TAPID(1),TAPID(2),IE,TITLE,PREF,TEMP,HC,06H0251
*SIGHSIGS,CPBAR,
* ((NAME(I,J),I=1,2),XIP(J),YJ(J),PRESS(J),CPHSDK(I),J,06H0253
* ),DJ(J) ,CPHSDK(3,J),F(J),J=1,ND) 06H0254
406 FORMAT(1H1,5X,5HTAPE ,2A6,60X,5HPAGE 12/1X,18A6//40X,14HPRESSURE 06H0255
*(ATM),E15,6/41X,19HTEMPERATURE (DEG K),F8,2/27X,46HAVAILABLE NON-H06H0256
*EATED SYSTEM ENTHALPY (KCAL/GM),F8,4/ 38X,25HSYSTEM ENTHALPY06H0257
* (KCAL/GM),F8,4/37X,27HSYSTEM ENTROPY (CAL/GM-DEG),F8,4/44X,13HSYS06H0258
*TEM GAS CP,F8,5//4X,7HPRODUCT,4X,13HMOLE FRACTION,8X,5HMOLES,6X, 06H0259
*16HPARTIAL PRESSURE,5X,2HCP,6X,8HATOMS/CC,5X,7HENTROPY,6X,4HMM-TS//06H0260
*(2X,2A6,E14,6, E16,8, E17,8,F11,4,E14,6,2F11,4) 06H0261
IE=IE+1 06H0262
GO TO 2213 06H0263
2400 WRITE TAPE ITG,BIGA,NA,NB,(PRESS(I),PLN(I),MASKOR(I),MASKPR(I),ITA06H0264
*TE(I),I=1,ND),I(181B(I,J),I=1,NA),J=1,NA),(IMAJOR(I),PARRAY(I),I=06H0265
*1,NA) 06H0266
REWIND ITG 06H0267
C START FLAME BURNING OPTION 06H0268
DO 2432 I=1,ND 06H0269
2432 DJ(I)=PRESS(I)/BIGA 06H0270
WRITE OUTPUT TAPE ITO,2434,(TAPID(I),I=1,2),TITLE,POUT,TEMP,SIGHS,06H0271
*IGS,CPBAR,AVMOL,(NAME(I,J),I=1,2),DJ(J),XIP(J),CPHSDK(I),J),CPHSDK06H0272
*(2,J),CPHSDK(3,J),F(J),J=1,ND) 06H0273
2434 FORMAT(1H1,43X,21HAEROSPACE CORPORATION/41X,26HFLAME TEMPERATURE 06H0274
*SOLUTION/ 7H TAPE ,2A6/2X,18A6//40X,15HPRESSURE(Psia) ,F12,6/39X06H0275
*19HTEMPERATURE(DEG-K) ,F11,6/39X,18HENTHALPY(KCAL/GM) ,F12,6/38X 06H0276
*21HENTROPY(CAL/GM-DEG K) ,F11,6/41X,14HAVERAGE GAS CP ,F12,6/37X,06H0277
*23HAVERAGE GAS MOLE WEIGHT ,F11,6//2X, 7HPRODUCT,11X,5HMOLES,6X,1306H0278
*HMOLE FRACTION,11X,2HCP,14X,1HM,14X,1HS,14X,4HMM-TS//12X,2A6,2E15,606H0279
*4F16,5)) 06H0280
GO TO 216 06H0281
END 06H0282

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SUBROUTINE AEROSP (ITO)
WRITE OUTPUT TAPE ITO,2
2  FORMAT(1H1,//// 52X,5(1HA)/48X,4(1HA),5X,4(1HA)/45X,3HAAA,13X,3HAO1H0116
   AA/ 44X,1HA,14X,2HAA,3X1HA/ 43X, 1HA,13X,4HAAAA,4X,1HA/43X,1HA,11X,01H0117
   ,6MAA AA,4X,1HA/ 42X,1HA,10X,2HAA,4X,2HAA,5X,1HA/42X,1HA,8X,10(1H01H0118
   ,A),5X,1HA/42X,1HA,6X,12(1HA),5X,1HA/43X,1HA,3X,2HAA,10X,2HAA,4X,1H01H0119
   ,A/43X,4HA AA12X,2HAA,4X,1HA/44X,1HA,19X,1HA/46X,3HAAA,13X,3HAAA/4801H0120
   ,X,4HAAA,5X4HAAA/52X,5(1HA)////)
   WRITE OUTPUT TAPE ITO,4
4  FORMAT(29X,2HNN,5X4HNN 5(1HE),21X,6(1HS),4X,8(1HT)/29X,4HNNNN,3X,01H0123
   ,4HNN 5(1HE),20X,3HSS5,2X,3HSS5,3X,8(1HT)/29X,5(1HN),2X,4HNN , 01H0124
   ,2HEE,23X,2HSS,4X,2HSS,6X,2HTT/29X, 6HNN NNN,5H NN ,2HEE,23X,3HSS01H0125
   ,11X,2HTT/29X,2HNN,2X,5(1HN),2X,4HEEEE,1X,18HLEMENT CHEMISTRY,3X,01H0126
   ,6(1HS),4H YS,3X,2HTT,3X,2HEM/29X,2HNN,3X,4HNNNN,2X,4HEEEE,23X,6(01H0127
   ,1HS),6X,2HTT/29X,2HNN,4X,3HNN,2X,2HEE,29X,2HSS,6X,2HTT/29X,2HNN,501H0128
   ,X,2HNN,2X,2HEE,22X,3HSS5,3X,3HSS5,6X,2HTT/29X,2HNN,5X,4HNN ,6(1HE)01H0129
   ,),19X,7(1HS),7X,2HTT/29X,2HNN,3X,4HNN ,6(1HE),20X,5(1HS),8X,2HTT,01H0130
   RETURN
   END
01H0131
01H0132

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C
SUBROUTINE SELECT
SUBROUTINE SELECT
DIMENSION A(40,41), ANS(40), BIBLF(15,15), COEFS(15,151), DATA(
* 3,20,151), CPHSDK(15,151), DATBU(4,65), FG(15), HEL(50), ITATE(
* 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
* MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(1044
* (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20), 01M1045
* WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
* 11 / 157 61
C
COMMON A, ABLOCK, ANS, BM, BIBLF, BIGA, COEFS, CPHSDK, DATA, DATBU, 01M1046
* FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01M1047
* IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB, 01M1048
* ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITJ, ITK, ITL, ITM, ITN, ITO, ITATE, IBREAK, IMAJOR, 01M1049
* KA, KB, KC, KD, KE, KF, KG, KH, KI, KJ, KK, KL, KM, KN, KO, KP, 01M1050
* LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01M1051
* NH, NI, NJ, NK, NL, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY, 01M1052
* TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
* 01M1053
DIMENSION NM(2), CM(50)
DO 5 I=1,150
5 MASKPR(I)=0
IF(I) 6,42,6
IP=1 CHOOSE ALL BUT FFG
C
IP=0 CHOOSE ALL
C
IP=-1 CHOOSE ONLY FFG
6 READ INPUT TAPE ITI,8,N
8 FORMAT(112)
DO 36 I=1,N
36 READ INPUT TAPE ITI,2,NM,KK
FORMAT(2A6,12)
DO 34 J=1,ND
34 IF(NM(1)-NAME(1,J)) 34, 10, 34
10 IF(NM(2)-NAME(2,J)) 34, 12, 34
12 IF(ABS(F(KK) -ABS(F( ITATE(J)))) 34, 29, 34
29 IF(IP) 32, 32, 30
30 MASKPR(J)=1
GO TO 34
32 MASKPR(J)=-1
34 CONTINUE
36 CONTINUE
IF(IP) 38, 42, 42
38 DO 40 J=1,ND

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40 MASKPR(J)=MASKPR(J)+1
42 IF(IQ)44,46,44
44 RETURN
46 WRITE OUTPUT TAPE ITO,48
48 FORMAT(1H1,10(1H*,)36H PRODUCTS CHOSEN ARE THE FOLLOWING//)
DO54 I=1,ND
IF(MASKPR(I))54,50,54
50 WRITE OUTPUT TAPE ITO,52,NAME(1,1),NAME(2,1),WORK(1)
52 FORMAT(25X,246,10X,17HHEAT OF FORMATION,F16,4)
54 CONTINUE
GO TO 44
END
01M1080
01M1081
01M1082
01M1083
01M1084
01M1085
01M1086
01M1087
01M1088
01M1089
01M1090
01M1091

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C SUBROUTINE INPUT1
C ***** UPDATED 2/14/63
C SUBROUTINE INPUT1(L)
C THIS SUBROUTINE COMBINES THE INGREDIENTS IN WEIGHT PERCENT
C MOLES OR MOLE PERCENT
C *****
C DIMENSION A(40,41), ANS(40), BIBL(15,15), COEFS(15,151), DATA(
* 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), MEL(50), ITATE(
* 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
* MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(10,576
* (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20), 01M0577
* WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
C 11 / 15/ 61
C COMMON A, ABLOCK, ANS, BM, BIBL, BIGA, COEFS, CPHSDK, DATA, DATBU, 01M0579
* FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01M0581
* IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB, 01M0582
* ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR, 01M0583
* KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH, 01M0584
* LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01M0585
* NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY, 01M0586
* TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
* DIMENSION HEACH(15), NOEL(15), NAMELS(15,15), Q(50),
* CL(15,15), WEIGHT(50), T(15,4)
C IF(NF) 1,28
C N IS THE COUNTER FOR COMPLETED ANS SETS ***** 01M0591
DO 2 I=1,IK
CALL LOOKA(1,0,ITI,ITO)
READ INPUT TAPE ITI,4,(T(I,J),J=1,4),HEACH(I),
*NOEL(I)
N=NOEL(I)
CALL LOOKA(1,0,ITI,ITO)
READ INPUT TAPE ITI,6,(NAMELS(I,J),CL(I,J),J=1,N)
FORMAT(4A6,F12,5,I6)
FORMAT(6I2,F10,5)
READ TAPE ITD,TAPID(1),TAPID(2),IN,IO,(NEL(I),HEL(I),
* I=1,IN)
IG=0
IG SET FOR NEW PROBLEM ***** 01M0605
DO 8 I=1,100
MASKEL(I)=0
01M0606
01M0607

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```

      WORK(I)=0.
      CONTINUE
      DO 16 I=1,IK
      WEIGHT(I)=0.
      N=NOEL(I)
      DO 16 J=1,N
      CALL SHIFT(1,NAMELS(I,J),M)
      CALL PERIOD(NAMELS(I,J),W,X1,X2,ERROR)
      IF(ERROR)GO,10,100
      WEIGHT(I)=WEIGHT(I)+W*CL(I,J)
      WEIGHT IN GRAMS/MOLE
      EACH FUEL WEIGHT IS COMPUTED *****
      DO 14 K=1,IN
      IF(NAMELS(I,J)-NEL(K)) 14, 12, 14
      MASKEL(K)=1
      HEACH(I)=HEACH(I)+HEL(K)*CL(I,J)
      C CORRECT THE INPUT HEAT OF FORMATION FOR THE TAPE BASES
      GO TO 16
      CONTINUE
      GO TO 102
      CONTINUE
      NA=0
      DO 20 I=1,IN
      IF(MASKEL(I))10,20,10
      NA=NA+1
      CONTINUE
      DO 22 I=1,IK
      N=NOEL(I)
      WRITE TAPE ITC,(I(I,J),J=1,4),HEACH(I),
      *NOEL(I)
      WRITE TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)
      WRITE TAPE ITC,(WEIGHT(I),I=1,IK)
      C THERE ARE IK+1 RECORDS ON ITC NOW, NEXT PROB.
      C THEY ARE READ FROM HERE RATHER THAN REDONE *****
      CALL SIFT(1)
      IF(IL)104,26,104
      REWIND ITC
      CALL SELECT
      GO TO 32
      C28 BOX(A) *****

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01M0608
01M0609
01M0610
01M0611
01M0612
01M0613
01M0614
01M0615
01M0616
01M0617
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01M0619
01M0620
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01M0632
01M0633
01M0634
01M0635
01M0636
01M0637
01M0638
01M0639
01M0640
01M0641
01M0642
01M0643
01M0644
01M0645
01M0646
01M0647
01M0648

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```

28      REWIND ITC
      DO 30 I=1,IK
      READ TAPE ITC,(T(I,J),J=1,4),HEACH(I),NOEL(I)
      N=NOEL(I)
30      READ TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)
      READ TAPE ITC,(WEIGHT(I),I=1,IK)
32      REWIND ITC
      READ FUEL SPECIFICATION CARDS *****
      CALL LOOKAT(0,IT1,ITO)
34      READ INPUT TAPE IT1,34,(Q(I),I=1,IK)
      FORMAT(6E12,8)
      DO 36 I=1,IK
      DO 36 J=1,IK
36      A(I,J)=0.
      A(I,I)=WEIGHT(I)
38      A(IK+1,I)=1.
      SL=0.
      IKP1=IK+1
      GO TO (40,40,46),IM
      MOLES OR MOLE PERCENT *****
40      DO 42 I=1,IK
      SL=SL+Q(I)*WEIGHT(I)
42      DO 44 I=1,IK
      WORK(I)=Q(I)*WEIGHT(I)/SL
44      A(I,IKP1)=-WORK(I)
      GO TO 52
46      WEIGHT PERCENT *****
48      DO 48 I=1,IK
      SL=SL+Q(I)
      DO 50 I=1,IK
      WORK(I)=Q(I)/SL*100.
50      A(I,IKP1)=-WORK(I)/100.
52      A(IKP1,IKP1)=0.
      CALL INVRSA(IKP1,TEST,DETER)
      WORK(IKP1)=A(IKP1,IKP1)*100.
      G=100.
      SUM=0.
      DO 51 I=1,IK
      IF(A(I,IKP1)) 512, 512, 510
510      G=MIN1F(G,A(I,IKP1))
512      WORK(I)=100.*A(I,IKP1)*WEIGHT(I)/A(IKP1,IKP1)

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01M0649
01M0650
01M0651
01M0652
01M0653
01M0654
01M0655
01M0656
01M0657
01M0658
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01M0660
01M0661
01M0662
01M0663
01M0664
01M0665
01M0666
01M0667
01M0668
01M0669
01M0670
01M0671
01M0672
01M0673
01M0674
01M0675
01M0676
01M0677
01M0678
01M0679
01M0680
01M0681
01M0682
01M0683
01M0684
01M0685
01M0686
01M0687
01M0688
01M0689

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51      WORK(I+32)=A(I,IKP1)*100.
      DO 49 I=1,IK
49      WORK(I+16)=A(I,IKP1)/G
      HC=0.
      C      WORK(I-15)=WEIGHT PERCENTS
      C      WORK(I+31)=NORMALIZED MOLES
      C      WORK(I+45)=MOLE PERCENTS*****
      AA=0.
      SL=0.
      DO 54 I=1,IK
      HC=HC+WEACH(I)*A(I,IKP1)
      ANS(I)=WEIGHT(I)*A(I,IKP1)
      SL=SL+ANS(I)
54      C      HC=SUMMATION(ENTHALPY OF EACH*WEIGHT FRACTION)
      C      ANS=WEIGHT(GRAMS) OF EACH FUEL USED
      C      SL=TOTAL SYSTEM REACTANTS WEIGHT *****
      C      HCMOLE=HC
      C      HC=HC/SL
      C      HC IS NOW IN KCAL/MOLE REACTANTS *****
      N=1
      DO 58 I=1,IN
      IF(MASKEL(I))56,58,56
56      CALL PERIOD(MEL(I),M,X1,X2,ERROR)
      FG(N)=X1
      N=N+1
58      CONTINUE
      L=1
      DO 57 I=1,NA
57      WORK(I+50)=0.
      DO 60 I=1,NA
      BM(I)=0.
      DO 60 J=1,IK
      N=NOEL(J)
      DO 60 JJ=1,M
      IF(NAME(I,I)-NAMELS(J,JJ)) 60,59,60
59      BM(I)=BM(I)+ANS(J)*CL(J,JJ)/(WEIGHT(J)*SL)
      C      WORK(I+50)=WORK(I+50)+CL(J,JJ)*A(J,IKP1)
      C      CONTINUE
      C      WORK(50-75)-CONTAINS ATOMS PER ELEMENT I
      C      WRITE OUTPUT TAPE ITO,62,(TAPID(I),I=1,2),TITLE,((T(I,J),J=1,4),
      C      *WORK(I),WORK(I+16),WORK(I+32),I=1,IK)

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01M0690
01M0691
01M0692
01M0693
01M0694
01M0695
01M0696
01M0697
01M0698
01M0699
01M0700
01M0701
01M0702
01M0703
01M0704
01M0705
01M0706
01M0707
01M0708
01M0709
01M0710
01M0711
01M0712
01M0713
01M0714
01M0715
01M0716
01M0717
01M0718
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01M0723
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01M0728
01M0729
01M0730

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62  FORMAT(1H1,4X,21HAEROSPACE CORPORATION/1X, 2A6/1X,18A6//12X, 01H0731
    *9HCOMPONENT,12X,14HWEIGHT PERCENT,15X,5HMOLES,16X,12HMOLE PERCENT 01H0732
    *//18X,4A6,F12.6,4X,F21.6,F24.6)) 01H0733
    WRITE OUTPUT TAPE ITO,64,(NAME (1,1),WORK(1,50)) 01H0734
    *3M(1),1=1,NA) 01H0735
64  FORMAT(1X//20X,8HELEMENTS,18X,5HMOLES,17X,23HMASS BALANCE (MOLES/G01H0736
    *M)//21X,A6,F24.4,18X,E16.8)) 01H0737
68  FORMAT( 8X,9HCOMPONENT,5X,4A6,19H NUMBER OF ELEMENTS,13, 01H0738
    *31H HEAT OF FORMATION (KCAL/MOLE)=F8.3) 01H0739
69  FORMAT(8X,10(A2,F6.4,2X)) 01H0740
701 WRITE OUTPUT TAPE ITO,701 01H0741
    FORMAT(1M)) 01H0742
    L=1 01H0743
    RETURN 01H0744
C  RESET ELEMENT MASK FOR NEW PROBLEM *****01H0745
100 WRITE OUTPUT TAPE ITO,101 01H0746
C  ERROR IN FINDING INPUT ELEMENT NAME *****01H0747
101 FORMAT(40H ERROR IN INPUT DATA -ELEMENT NOT LISTED//) 01H0748
    GO TO 106 01H0749
102 WRITE OUTPUT TAPE ITO,103 01H0750
103 FORMAT(47H ERROR IN INPUT DATA -INPUT ELEMENT NOT ON TAPE) 01H0751
    GO TO 106 01H0752
104 WRITE OUTPUT TAPE ITO,105 01H0753
105 FORMAT(41H ERROR IN INITIAL TAPE SORT PROB. BAD TAPE//) 01H0754
106 L=2 01H0755
    CALL DUMP2(12.) 01H0756
    RETURN 01H0757
    END 01H0758

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C      SUBROUTINE INPUT2
C      ***** UPDATED 2/14/63
C      SUBROUTINE INPUT2(I)
C      THIS SUBROUTINE COMBINES INGREDIENTS SPECIFIED IN MIXTURE
C      RATIO AND OXIDIZER RATIO
C      *****
C      DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,15), DATA(
C      * 3,20,151), CPHSK(15,151), DATBU(4,65), FG(15), MEL(50), ITATE(
C      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
C      * MASKS(150), NTAPE(4), NEL(50), NAME1(2,151), TBREAK(3,151), IBREAK(150),
C      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(10), TARRAY(20),
C      * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
C      11 / 15/ 61
C      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSK, DATA, DATBU,
C      * FG, HCMOLE, HC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
C      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
C      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
C      * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
C      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
C      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE,
C      * TARRAY,
C      * TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
C      DIMENSION HEACH(15), NOEL(15), NAME1(15,15), Q(150), CL(15,15), WEIGHT(
C      * 50), T(15,4)
C      IF(NF) 1,1,34
C      NF IS THE COUNTER FOR COMPLETED ANSWER SETS *****
C      DO 2 I=1,IK
C      CALL LOOKA(1,0,ITI,ITO)
C      READ INPUT TAPE ITI,4,(T(I,J),J=1,4),HEACH(I),NOEL(I)
C      N=NOEL(I)
C      CALL LOOKA(1,0,ITI,ITO)
C      READ INPUT TAPE ITI,6,(NAME1(I,J),CL(I,J),J=1,N)
C      FORMAT(A6,F12,5,16)
C      FORMAT(I6,I2,F10,5)
C      READ TAPE ITD,(TAPID(I),I=1,2),IN,IO,(NEL(I),MEL(I),I=1,N)
C      IG=0
C      IG SET FOR NEW PROBLEM
C      DO 8 I=1,100
C      MASKEL(I)=0
C      WORK(I)=0
C      DO604 I=1,IK
C      N=NOEL(I)

```

DO604	J=1,N	01H0816
DO602	K=1,IN	01H0817
CALL	SHIFT(1,NAMELS(I,J),W)	01H0818
IF	(NAMELS(I,J)-NEL(K)) 602,600,602	01H0819
600	MASKEL(K)=1	01H0820
HEACH(I)	=HEACH(I)+HEL(K)*CL(I,J)	01H0821
GO	TO 604	01H0822
602	CONTINUE	01H0823
604	CONTINUE	01H0824
NA=0		01H0825
DO 608	I=1,IN	01H0826
IF	(MASKEL(I)) 606,608,606	01H0827
606	NA=NA+1	01H0828
608	CONTINUE	01H0829
W=0.		01H0830
X=0.		01H0831
Y=0.		01H0832
Z=0.		01H0833
WO=0.		01H0834
WF=0.		01H0835
OW=0.		01H0836
FN=0.		01H0837
CALL	CHANGE(A1,6HFUEL)	01H0838
CALL	SHIFT(1,T(1,4),T(1,4))	01H0839
IF	(A1-T(1,4)) 12, 10, 12	01H0840
10	IFUEL=1	01H0841
	IOX=2	01H0842
GO	TO 14	01H0843
12	IFUEL=2	01H0844
	IOX=1	01H0845
14	N=NOEL (IFUEL)	01H0846
DO 22	J=1,N	01H0847
CALL	SHIFT(1,NAMELS(IFUEL,J),W1)	01H0848
CALL	PERIOD(NAMELS(IFUEL,J),WT,X1,VAL,ERWD)	01H0849
IF	(ERWD) 500,16,500	01H0850
16	IF(VAL) 18,20,20	01H0851
18	W=W-VAL*CL(IFUEL,J)	01H0852
	GO TO 22	01H0853
20	Y=Y+VAL*CL(IFUEL,J)	01H0854
22	WF=WF+CL(IFUEL,J)*WT	01H0855
	N=NOEL (IOX)	01H0856

```

DO 30 J=1,N
CALL SHIFT(I,NAMELS(IOX,J),W1)
CALL PERIOD(NAMELS(IOX,J),WT,X1, VAL,ERWD)
IF(ERWD) 510,24,510
IF(VAL) 26,28,28
24 X=X-VAL*CL(IOX,J)
26 GO TO 30
28 Z=Z+VAL*CL(IOX,J)
30 WO=WO+CL(IOX,J)*WT
C
C
IF IM=4 -INPUT IS MIXTURE RATIO *****
IF IM=5 -INPUT IS OXIDIZER RATIO *****
DO 32 I=1,IK
N=NOEL(I)
WRITE TAPE ITC,(I,I,J),J=1,4),MEACH(I),NOEL(I)
32 WRITE TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)
WRITE TAPE ITC,WFO,WOW,X,Y,Z ,IFUEL,IOX
CALL SIFT(I,I)
REWIND ITC
CALL SELECT
GO TO 38
34 REWIND ITC
DO 36 I=1,IK
READ TAPE ITC,(I,I,J),J=1,4),MEACH(I),NOEL(I)
N=NOEL(I)
36 READ TAPE ITC,(NAMELS(I,J),CL(I,J),J=1,N)
READ TAPE ITC,WFO,WOW,X,Y,Z,IFUEL,IOX
38 REWIND ITC
CALL LOOK(I,0,ITI,ITO)
READ INPUT TAPE ITI,40,RATIO
IF(IM=4)42,42,44
42 RM=RATIO
OR=0.
GO TO 46
44 RM=0.
OR=RATIO
46 ALPHA=(X-Z*OR)/((Y-Z)*OR+X-W)
BETA=1.-ALPHA
IF(RM)990,48,50
48 RM=(BETA/ALPHA)*(WO/WF)
GO TO 52
50 OR= (X*RM*WF/WO+W)/(Z*RM*WF/WO+Y)

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52  FN=(1.-RM/(RM+1.))/WF
    ON=(RM/(RM+1.))/WO
    MC=MEACH(IFUEL)*FN+MEACH(1OX)*ON
    N=1
    DO 72 I=1,NA
      WORK(I)=0.
      *ORR(I+15)=0.
      *W(I)=0.
      N1=NOEL(IFUEL)
      DO 58 K=1,N1
        IF(NAME(1,I)-NAMELS(IFUEL,K)) 58, 56, 58
      *W(I)=RM(I)*FN*CL(IFUEL,K)
      *ORR(I)=WORK(I)+CL(IFUEL,K)
      GO TO 6C
    CONTINUE
54  N2=NOEL(1OX)
    DO 64 K=1,N2
      IF(NAME(1,I)-NAMELS(1OX,K)) 64, 62, 64
      *W(I)=RM(I)*ON*CL(1OX,K)
      *ORR(I+15)=WORK(I+15)+CL(1OX,K)
      GO TO 72
    CONTINUE
56  CONTINUE
72  CONTINUE
    *RITE OUTPUT TAPE ITO,514,(TAPID(J),J=1,2),TITLE
    *FORMAT(1H1,44X,21HAEROSPACE CORPORATION/1X,2A6/1X,18A6//)
514  *RITE OUTPUT TAPE ITO,516,(T(IFUEL,J),J=1,4),(T(1OX,J),J=1,4),RM,01H0923
    *R
    DO 90 I=1,NA
      *I+15
90  *WRITE OUTPUT TAPE ITO,518,NAME(1,I),WORK(I),WORK(M),BM(I)
    L=1
994  *WRITE OUTPUT TAPE ITO,994
    *FORMAT(1H1)
    RETURN
516  *FORMAT(35X,14HFUEL COMPONENT,2X,4A6/33X,18HOXIDIZER COMPONENT,2X,401H0932
    *A6//39X,19HMIXTURE RATIO,5X,14HOXIDIZER RATIO/43X,F8.5,11X,F8.5//01H0933
    *11X,19MSYSTEM ELEMENTS,6X,12HFUEL FORMULA,5X,16HOXIDIZER FORMULA,501H0934
    *X,30HMASS BALANCE (MOLES/SYSTEM-GM)//)
    *FORMAT(E12.8)
40  *FORMAT(12X,A6,15X,F10.5,9X,F10.5,13X,E16.8)
518  *FORMAT(12X,A6,15X,F10.5,9X,F10.5,13X,E16.8)
500  *WRITE OUTPUT TAPE ITO,502

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01H0898
01H0899
01H0900
01H0901
01H0902
01H0903
01H0904
01H0905
01H0906
01H0907
01H0908
01H0909
01H0910
01H0911
01H0912
01H0913
01H0914
01H0915
01H0916
01H0917
01H0918
01H0919
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01H0921
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01H0926
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01H0928
01H0929
01H0930
01H0931
01H0932
01H0933
01H0934
01H0935
01H0936
01H0937
01H0938

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502 FORMAT( 56H1 A FUEL ELEMENT IS NOT IN SUBROUTINE PERIOD,JOB DELETED)H0939
   *D)
504 L=2
      RETURN
510 WRITE OUTPUT TAPE ITO,512
512 FORMAT( 61H1 AN OXIDIZER ELEMENT IS NOT IN SUBROUTINE PERIOD,JOB
   *ELETED)
      GO TO 504
990 WRITE OUTPUT TAPE ITO,992
992 FORMAT( 55H1 ERROR IN COMPUTING MIXTURE RATIO FROM OXIDIZER RATIO)H0948
   */58H      PROBLEM IS DELETED . CHECK INPUT DATA AND RESUBMIT ./1H101H0949
   *)
      L=2
      RETURN
      END
01H0940
01H0941
01H0942
01H0943
01H0944
01H0945
01H0946
01H0947
01H0948
01H0949
01H0950
01H0951
01H0952
01H0953

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BCI	1.0AL	01M0995
BCI	1.0SI	01M0996
BCI	1.0P	01M0997
BCI	1.0S	01M0998
BCI	1.0CL	01M0999
BCI	1.0AR	01M1000
BCI	1.0K	01M1001
BCI	1.0CA	01M1002
BCI	1.0SC	01M1003
BCI	1.0TI	01M1004
BCI	1.0CR	01M1005
BCI	1.0FE	01M1006
BCI	1.0CO	01M1007
BCI	1.0NI	01M1008
BCI	1.0CU	01M1009
BCI	1.0ZN	01M1010
BCI	1.0BR	01M1011
BCI	1.0AG	01M1012
BCI	1.0CD	01M1013
BCI	1.0I	01M1014
BCI	1.0CS	01M1015
BCI	1.0BA	01M1016
BCI	1.0HG	01M1017
BCI	1.0PB	01M1018
BCI	1.0BI	01M1019
BCI	1.0U	01M1020
BCI	1.0E	01M1021
BCI	1.0END	01M1022
DEC	1.008.4.003.6.940.9.013.10.82.12.011.14.008	01M1023
DEC	16.19.20.183.22.991.24.32.26.98.28.09	01M1024
DEC	30.975.32.066.35.457.39.944.39.100.40.08	01M1025
DEC	44.96.47.90.52.01.55.85.58.94.58.69.63.54	01M1026
DEC	65.38.79.916.107.88.112.41.126.91.132.91	01M1027
DEC	137.36.200.61.207.21.209.238.07.00054847	01M1028
DEC	.0028.1.4.5E-4.2.E-5.8.1E-6.1.4E-10	01M1029
DEC	3.E-6.1.1E-5.02.1.1.2E-3.4.5E-4	01M1030
DEC	1.5E-7.1.E-6.029.079.1.E-6.001.001	01M1031
DEC	.001.001.1.E-5.001.001.001.001	01M1032
DEC	.001.001.001.001.001.001.001	01M1033
DEC	.001.001.1.001.001.001.001	01M1034
DEC	1.0.0.1.2.3.4.0.0.2.1.0.1.2.3.	01M1035

6-9

9-9

01M1036
01M1037
01M1038

4.00-6.00-1.00.1.2.3.4.6.3.3.2.2.
2.00-1.00.1.2.00-1.00.1.2.2.2.3.6.00-1.

DEC
DEC
END

* * FAP	CALL SEQ (1 OR 2, NAME1, NAME2)	01M1092
SHIFT	ENTRY SHIFT	01M1093
	SXA EXIT-1,1	01M1094
	SXA EXIT-2,2	01M1095
	LDO* 1,4	01M1096
	MPY *06	01M1097
	PDX *1	01M1098
	PDX *2	01M1099
	LDO* 2,4	01M1100
	LGL 6	01M1101
	STO A	01M1102
	LGR 6	01M1103
	CLA A	01M1104
	SUB *060	01M1105
	TNZ EXIT-2	01M1106
	CAL OCT	01M1107
	ROL 6	01M1108
	STO* 2,4	01M1109
	TXI *-1,1,-1	01M1110
	TXL C,2,7	01M1111
	LDO* 2,4	01M1112
	LGR 6	01M1113
	CAL* 3,4	01M1114
	ROL 6	01M1115
	STO* 2,4	01M1116
	LDO* 3,4	01M1117
	CAL OCT	01M1118
	ROL 6	01M1119
	STO* 3,4	01M1120
	TXM B,1	01M1121
	AXT *2	01M1122
	AXT *1	01M1123
	TRA 4,4	01M1124
	OCT 6000000000000	01M1125
	PZE A	01M1126
	END	01M1127
		01M1128

6) OR 12) DEC IN IR 1
6) OR 12) DEC IN IR 2

```

C
C
C      SUBROUTINE CHECK
C      ***** UPDATED 2/14/63
C      SUBROUTINE CHECK(I)
C      DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,15), DATA(
C      * 3,20,151), CPMSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
C      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
C      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TEREAK(3,151), IBREAK(
C      * 13,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
C      * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
C      DIMENSION DJ(150), YJ(150)
C      1/19/62
C      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPMSDK, DATA, DATBU,
C      * FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
C      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
C      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
C      * KA, KB, KC, KD, KE, KF, KG, KI, LA, LB, LC, LD, LE, LF, LG, LH,
C      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
C      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE,
C      * TARRAY, TEREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
C      * GAMTH, PTHR, DAM1, DJ, YJ, YJA
C      REWRITTEN FOR MODE CONTROL
C      MODE1 REGULAR
C      MODE2 CONST TEMP
C      MODE3 DISCONTINUITY
C      MODE=MODE
C      IF(MODE-2) 2, 20, 22
C      MODE1 CONTROL
C      MODE=1
C      IF(KT-1) 6, 4, 6
C      KT=0
C      ASSIGN 1 TO IGO
C      GO TO 1000
C      CONTINUE
C      MODE 1 ASSIGNMENTS *****
C      ASSIGN 8 TO IOUT1
C      ASSIGN 1000 TO IOUT2
C      ASSIGN 16 TO IGO
C      ASSIGN 1010 TO IALTER
C      GO TO 1004
C      MODE=3
C      ENTER MODE 3 CONTROL-DECISIONS TO THIS POINT ARE- (ONLY ENTRANCE)
C      12
C

```

```

C          IN DISCONTINUITY
C          MUST LOOP ONCE MORE-AT LEAST
C          FIRST-RESET TO CONSTANT TEMP AND REDO PROBLEM
C          ASSIGN 16 TO IGO
C          GO TO 1000
C          L=2
C          TSTORE(1)=0.
C          TSTORE(2)=0.
C          TSTORE(5)=0.
C          GO TO 17
C          L=1
C          IF(IIM=1) 17. 18. 17
C          CALL LOGS
C          CALL GEMPIS
C          ONLY RETURN STATEMENT *****
C          RETURN
C          IM=1
C          GO TO 17
C          CONTINUE
C          MODE 2 ASSIGNMENTS *****
C          ASSIGN 1002 TO IOUT1
C          ASSIGN 16 TO IOUT2
C          IGO NOT ASSIGNED
C          ASSIGN 16 TO IALTER
C          IF (XABSF(KA)+XABSF(KB-1)+XABSF(KC)+XABSF(KT-1)) 2170. 200. 2170
C          IF(14) 202. 1004. 202
C          ASSIGN 8 TO IOUT1
C          GO TO 1004
C          CONTINUE
C          MODE 3 ASSIGNMENTS *****
C          ASSIGN 1016 TO IOUT1
C          ASSIGN 1000 TO IOUT2
C          ASSIGN 16 TO IGO
C          ASSIGN 1010 TO IALTER
C          GO TO 1004
C          ENTER CONSTANT TEMPERATURE MODE *****
C          1000 KASAV=KA
C          KBSAV=KB
C          KCSAV=KC
C          KTSAV=KT
C          KA=0

```

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01M1720
01M1721
01M1722
01M1723
01M1724
01M1725
01M1726
01M1727
01M1728
01M1729
01M1730
01M1731
01M1732
01M1733
01M1734
01M1735
01M1736
01M1737
01M1738
01M1739
01M1740
01M1741
01M1742
01M1743
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01M1746
01M1747
01M1748
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01M1750
01M1751
01M1752
01M1753
01M1754
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01M1756
01M1757
01M1758
01M1759
01M1760

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KB=1
KC=0
K*=1
IMODSV=MODE
MODE=2
TSTOP=TEMP
GO TO IGO *( 1, 16 )
LEAVE CONSTANT TEMPERATURE MODE *****
C 1002 KA=KASAV
KB=KBSAV
KC=KCSAV
KT=KTSV
MODE=IMODSV
GO TO 16
C TEST FOR LIMITS *****
1004 ER2=FLOATF(NA+NB+3)/20000.
ER1=0.
N=NA+NB+2
IF(KT-1) 2002, 2000, 2002
N=N-1
2002 DO 2004 I=1,N
2004 ER1=ER1+ ABSF( ANS(I))
IF(ER1-ER2) 2006,1006,1006
2006 CALL SOLIDS(L2)
IF(L2-1) 2008,2008,2010
2008 GO TO IOUT1*( 8, 1002, 1016)
2010 GO TO IOUT2 *( 16, 1000)
C IOUT1 -NO SOLIDS ENTERED
C IOUT2 -NEW SOLIDS
C OTHERWISE GO TO CHANGE VARIABLE VALUES *****
1006 N=NA+NB+2
C COMPUTATION BLOCK-VARIABLE TEMPERATURE CONTROLS *****
TTEST=EXP( LOGF(TEMP)+ANS(N))
PHONE=ABSF( TTEST-TEMP)/(TTEST-TEMP)
C IF PHONE IS POSITIVE-SYSTEM TEMPERATURE IS ASCENDING
C ... NEGATIVE ... DECENDING
XA=LOGF(1.+ .1*PHONE)
XA2=LOGF(1.+ .005 *PHONE)
C ALTER VARIABLES-EXCEPT FOR TEMPERATURE *****
DO 2110 J=1,NA
11=IMAJOR(J)

```

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01M1761
01M1762
01M1763
01M1764
01M1765
01M1766
01M1767
01M1768
01M1769
01M1770
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01M1772
01M1773
01M1774
01M1775
01M1776
01M1777
01M1778
01M1779
01M1780
01M1781
01M1782
01M1783
01M1784
01M1785
01M1786
01M1787
01M1788
01M1789
01M1790
01M1791
01M1792
01M1793
01M1794
01M1795
01M1796
01M1797
01M1798
01M1799
01M1800
01M1801

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```

2100 IF(ABS(ANS(J))-ABS(PLN(I))) 2104, 2104, 2100
2102 ANS(J)=5.*ANS(J)/ABS(ANS(J))
2104 PLN(I)=PLN(I)+ANS(J)
2106 IF(PLN(I)+40.) 2106, 2106, 2108
2108 PRESS(I)=0.
2110 GO TO 2110
2112 PRESS(I)=EXP(PLN(I))
2114 CONTINUE
C ELEMENTS AND PRODUCT GASSES TAKEN CARE OF, NOW FOR SOLIDS *****
2112 NSOL=NG
DO 2130 I=1,NB
2114 NSOL=NSOL+1
IF(ITATE(NSOL)) 2114, 2114, 2116
2116 INDEX=NA+I
B=ANS(INDEX)/PRESS(NSOL)
IF( B- 2. ) 2118, 2124, 2122
2118 IF( B+ 5. ) 2120, 2120, 2124
2120 B=-5.
2122 GO TO 2124
2122 B=2.
2124 PLN(NSOL)=PLN(NSOL)+B
IF(PLN(NSOL)+ 35. ) 2126, 2126, 2128
2126 PRESS(NSOL)=0.
PLN(NSOL)=0.
NB=NB-1
ITATE(NSOL)=-1+ABS(ITATE(NSOL))
GO TO 2130
2128 PRESS(NSOL)=EXP(PLN(NSOL))
2130 CONTINUE
2131 J=NA+NB+1
IF(ABS(ANS(J))-1. ) 2134, 2134, 2132
2132 ANS(J)=ANS(J)/ABS(ANS(J))
2134 BIGA=EXP(LOG(BIGA)+ANS(J))
GO TO ALTER(16, 1010)
C TEMPERATURE CORRECTION *****
DIMENSION YSTORE(10)
1010 N=NA+NB+2
IF(MODE-1) 2140, 2140, 2150
2140 IF(ABS(ITEST-TEMP)- 2. ) 2148, 2148, 2142

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01M1802
01M1803
01M1804
01M1805
01M1806
01M1807
01M1808
01M1809
01M1810
01M1811
01M1812
01M1813
01M1814
01M1815
01M1816
01M1817
01M1818
01M1819
01M1820
01M1821
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01M1829
01M1830
01M1831
01M1832
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01M1834
01M1835
01M1836
01M1837
01M1838
01M1839
01M1840
01M1841
01M1842

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2142 IF(ABS(XA)-ABS(ANS(N))) 2144,2148, 2148 01H1843
2144 ANS(N)=XA 01H1847
2148 TEMP=EXP(LOGF(TEMP)+ANS(N)) 01H1848
TTEST=TEMP 01H1849
C 01H1850
CALL INTERP(TTEST,NONE,D) 01H1851
TEST HERE FOR MODE 1 ENTRANCE INTO MODE 3 ***** 01H1852
IF (NONE) 12, 2149, 12 01H1853
2149 IF(ABS(TEMP-TSTOP)-.1*STOP) 16, 16, 1000 01H1854
C MODE 3 NEVER USES THE EXACT ANS(N) THE VALUE IS LIMITED BY XA2 AND 01H1855
C ALWAYS LINEARLY INTERPOLATED ***** 01H1856
2150 IF(TSTORE(2)) 2151, 2174, 2151 01H1857
2151 IF(ABS(TEMP-TTEST)-.1) 2176, 2176, 2152 01H1858
C TEST-BRACKETING OF ANSWER *****
2152 IF(ANS(N)) 2154, 2158, 2156
2154 IF(TSTORE(2)) 2174, 2158, 2158
2156 IF(TSTORE(2)) 2158, 2158, 2174
C ANSWER BRACKETED-INTERPOLATE LINEARLY ON LAST TWO ANSWERS *****01H1862
2158 GNU=ANS(N)/TSTORE(2)
TEMP=(GNU*TSTORE(1)-TEMP)/(GNU-1.)
C SET TO CONSTANT TEMPERATURE AGAIN . IGO HAS BEEN SET TO 16 01H1868
GO TO 1000 01H1869
C ANSWER NOT BRACKETED-CONTINUE USING XA2 *****01H1870
2174 TSTORE(2)=ANS(N)
TSTORE(1)=TEMP
C TEMP=EXP( LOGF(TEMP)+XA2) 01H1874
C MODE 3 RELEASES IF AWAY FROM DISCONTINUITY 01H1876
T=TEMP+10. 01H1877
TT=TEMP-10. 01H1878
CALL INTERP(T,NONE,D) 01H1879
CALL INTERP(TT,NTWO,D) 01H1880
IF (NONE) 1000, 2175, 1000 01H1881
2175 IF (NTWO) 1000, 2170, 1000 01H1882
1016 T=TEMP+10. 01H1883
TT=TEMP-10. 01H1884
CALL INTERP(T,NONE,D) 01H1885
CALL INTERP(TT,NTWO,D) 01H1886
IF (NONE) 8, 2168, 8 01H1887
2168 IF (NTWO) 8, 2170, 8 01H1888
2170 MODE=1 01H1889
C RELEASE FROM MODE 3 -THE ONLY PLACE IT CAN BE DONE *****01H1890
GO TO 16 01H1891

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2176 TEMP=(TEMP+TTEST)/2.
GO TO 16
END

01H1896
01H1897

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C      SUBROUTINE INTERP(TTEST,NONE,DELTA)
C      SUBROUTINE INTERP(TTEST,NONE,DELTA)
C      ***** UPDATED 2/14/63
C      DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
* 3,20,151), CPHSDK(5,151), CATBU(4,65), FG(15), MEL(50), ITATE(
* 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
* MASKS(150), NTAPE(4), MEL(50), NAME(2,151), TBREAK(3,151), IBREAK(
* 3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
* WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
C      DIMENSION DJ(150), YJ(150)
C      1/19/62
C      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU
* FG, HCMOLE, MC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
* IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
* ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
* KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
* LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
* NH, NI, NJ, NK, NTAPE, NAME, MEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
* , TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
* GAMTH, PTHR, DAM1, DJ, YJ, YJA
C      NB=NB
C      KB=KB
C      NONE=NONE
C      DELTA=DELTA
C      TTEST=TTEST
C      IF(NB)2,2,0
C      2      DELTA=1.
C      4      NONE=0
C      6      RETURN
C      8      NGP1=NG+1
C      DO 34 I=NGP1,ND
C      IF(MASKPR(I)) 34,10,34
C      IF(ITATE(I)) 34,34,12
C      DO 30 J=1,19
C      10      B=DATA(2,J+1,1)-DATA(2,J,1)-DATA(1,J,1)*(TARRAY(J+1)
C      *-TARRAY(J))/1000.
C      12      IF(ABS(B)-1.5)130,30,14
C      NO DISC,DISC OK,BIG DISCONT
C      14      IF(TEMP-TARRAY(J+1)) 15,22,26
C      15      IF(TEMP-TARRAY(J)) 27,27,16
C      16      IF(TTEST-TARRAY(J+1)) 28,28,17
C      16      IF(TTEST-TARRAY(J)) 27,27,16

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C16	SYSTEM TEMP IS WITHIN DISCONTINUITY *****	01M1368
17	TTEST=TARRAY(J+1)	01M1369
C	SET TTEST TO UPPER BOUNDARY	01M1370
18	NONE=-1	01M1371
19	DELTA=.0025	01M1372
20	RETURN	01M1373
22	IF(TTEST-TARRAY(J+1)) 23,30,30	01M1374
23	NONE=1	01M1375
	IF(KB) 19,25,24	01M1376
24	LE=LE-5	01M1377
	GO TO 19	01M1378
25	LF=LF-5	01M1379
	GO TO 19	01M1380
26	IF(TTEST-TARRAY(J+1)) 17,30,30	01M1381
27	IF(TTEST-TARRAY(J)) 30,30,29	01M1382
28	IF(TTEST-TARRAY(J)) 23,30,23	01M1383
29	TTEST=TARRAY(J) +1.E-06	01M1384
	NONE=-1	01M1385
	GO TO 19	01M1386
30	CONTINUE	01M1387
34	CONTINUE	01M1388
	NONE=0	01M1389
	DELTA=.0025	01M1390
	RETURN	01M1391
	END	01M1392

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C SUBROUTINE BUILD(L) ROCKET PERFORMANCE VERSION 01M1898
SUBROUTINE BUILD(L) 01M1899
DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,15), DATA(
* 3*20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE( 01M1900
* 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150), 01M1901
* MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(150) 01M1902
* (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20), 01M1903
* WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10) 01M1904
DIMENSION DJ(150), YJ(150) 01M1905
1/19/62 01M1906
COMMON A, ABLOCK, ANS, BM, BIBLE, 'GA, COEFS, CPHSDK, DATA, DATBU 01M1907
*FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01M1908
*IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB, 01M1909
*ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR, 01M1911
*KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH, 01M1912
*LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01M1913
*NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY 01M1914
*, TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY 01M1915
*, GAMTH, PTHR, DAMI, DJ, YJ, YJA 01M1916
MATRIX CONTROLS 01M1917
C TYPE KA KB KC KT COMMENTS P H S HDP XA XT DELTA 01M1918
C 1 0 1 0 1 CONST TEMP COMBUSTION X X ERRORS 01M1919
C 2 0 1 0 0 VARIABLE TEMP COMB. X X X ERRORS 01M1920
C 3 1 1 0 0 ASSIGNED PRESS(15ENTHOP) X X X ERRORS 01M1921
C 4 1 0 1 0 MACH ONE EXPANSION X X X ERRORS 01M1922
C 5 1 0 0 -1 ACOUSTIC VELOCITY X X X ERRORS 01M1923
C 6 -1 0 0 -1 SPECIFIC HEAT (CP) X X -XT 01M1924
C 7 0 -1 0 0 CONST DENSITY RHO EROM X -XT 01M1925
C 8 1 0 -1 0 DETONATION X X SPECIA 01M1926
C IPROW=0 01M1927
C ITHROW=0 01M1928
C IMP=0 01M1929
C ISROW=0 01M1930
C IACOL=0 01M1931
C ITCOL=0 01M1932
C ICON=0 01M1933
DIMENSION MPI(150), HDP(150), SPI(150) 01M1934
JFKC)16,16,2 01M1935
C2 COMPUTE HPRIMES***** 01M1936
01M1937
01M1938

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2      DO 4 I=1,ND                                01M1939
4      HP(I)=CPHSDK(2,I)*PRESS(I)                01M1940
      DO 14 I=1,ND                                01M1941
      IF(MASKPR(I))14,6,14                        01M1942
6      IF(ITATE(I)-1)10,8,12                      01M1943
8      HDP(I)=HP(I)+1.98725*TEMP*PRESS(I)*DJ(I)/(2000.*DAM1) 01M1944
      GO TO 14                                    01M1945
10     HDP(I)=0.                                  01M1946
      GO TO 14                                    01M1947
12     HDP(I)=HP(I)                              01M1948
14     CONTINUE                                  01M1949
16     IF(KA)32,32,18                            01M1950
18     COMPUTE SPRINES*****01M1951
20     IF(MASKPR(I)) 28,20,28                    01M1952
22     IF(ITATE(I)-1)28,22,24                    01M1953
      B=PRESS(I)*1.98725*(PLN(I)+1.)            01M1954
      GO TO 26                                    01M1955
24     B=0.                                       01M1956
26     SP(I)=PRESS(I)*CPHSDK(3,I)-B              01M1957
      GO TO 30                                    01M1958
28     SP(I)=0.                                  01M1959
30     CONTINUE                                  01M1960
32     NC=NA+NB+1                                01M1961
C32    BEGIN TO SET ROW AND COLUMN CONTROLS *****01M1962
      IF(KB)36,36,34                             01M1963
C34    MATRIX HAS P ROW AND XA COL              01M1964
34     IPROW=NC                                  01M1965
      IACOL=IPROW                                 01M1966
36     IF(KA)54,48,38                            01M1967
C38    MATRIX HAS S ROW AND XA COLUMN*****01M1968
38     IF(IPROW)42,42,40                         01M1969
C      IF PROW HAS BEEN SET, WE NEED XT COL*****01M1970
40     ISROW=IPROW+1                             01M1971
      ITCOL=ISROW                                01M1972
C      AND ERROR COLUMN*****01M1973
      ICON=ITCOL+1                              01M1974
      NC=ITCOL                                  01M1975
      GO TO 56                                  01M1976
C      PROW NOT SET                             01M1977
42     ISROW=NC                                  01M1978

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C      IACOL=ISROW
      IF(KC)46,46,44
      IF KC=0, ACOUSTIC VELOCITY MATRIX *****
      IHP=ISROW+1
      ITCOL=IHP
      ICON=IHP+1
      NC=IHP
      MACH ONE MATRIX DONE*****
      GO TO 56
      ITCOL=IACOL+1
      NC=IACOL
      ACOUSTIC VELOCITY MATRIX DONE*****
      GO TO 56
C48    GOT HERE FROM EFN 38 *****
      IF(KT)50,50,52
      IHROW=IHROW+1
      ITCOL=IHROW
      NC=IHROW
      ICON=NC+1
      COMBUSTION MATRIX DONE *****
      GO TO 56
      NC=IHROW
      ICON=IHROW+1
      COMBUSTION CONST TEMP MTX DONE *****
      GO TO 56
C54    SPECIFIC HEAT MATRIX- FROM EFN 36 *****
      IPROW=NC
      IACOL=IPROW
      ITCOL=IACOL+1
      CP MATRIX DONE *****
      NCPI=NC+1
      NAP1=NAP+1
      NGP1=NG+1
      NAP=NAP+NB
      DO 58 I=1,NC
      DO 58 J=1,NCPI
      A(I,J)=0.
      BEGIN ROW ENTRIES (J) FOR THE NA COL (I) *****
      DO 110 I=1,NA
      DO 64 J=1,ND
      WORK(J)=0.

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01H2021
01H2022
01H2023
01H2024
01H2025
01H2026
01H2027
01H2028
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01H2039
01H2040
01H2041
01H2042
01H2043
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01H2053
01H2054
01H2055
01H2056
01H2057
01H2058
01H2059
01H2060
01H2061

IF(MASKPR(J)) 64,60,64
DO 62 K=1,NA
WORK(J)=WORK(J)+BIBLE(I,K)*COEFS(K,J)
CONTINUE
I2=IMAJOR(I)
MASS BALANCE ENTRIES*****
DO 70 J=1,NA
DO 68 K=1,NG
IF(MASKOR(K))68,66,68
A(J,I)=A(J,I)+COEFS(J,K)*WORK(K)*PRESS(K)
CONTINUE
A(J,I)=A(J,I)+COEFS(J,I2)*PRESS(I2)
IF(NB)78,78,72
N=NA+1
DO 76 J=NGP1,ND
IF(IITATE(J))76,76,74
A(N,I)=WORK(J)
A(I,N)=COEFS(I,J)
N=N+1
CONTINUE
C78 START OPTION TESTING*****
78 IF(IIPROW)86,86,80
80 DO 84 J=1,NG
IF(MASKPR(J)) 84,81, 84
IF(MASKOR(J))84,82,84
81 A(I,ROW,I)=A(I,ROW,I)+PRESS(J)*WORK(J)
82 CONTINUE
84 A(I,ROW,I)=A(I,ROW,I)+PRESS(I2)
IF(IHROW)94,94,88
86 DO 92 J=1,NG
IF(MASKPR(J)) 92, 90, 92
IF(IHROW,I)=A(IHROW,I)+PRESS(J)*CPHSDK(2,J)*WORK(J)
90 CONTINUE
92 IF(IISROW)102,102,96
94 DO 100 J=1,NG
IF(MASKPR(J)) 100, 98,100
96 A(IISROW,I)=A(IISROW,I)+SP(J)*WORK(J)
98 CONTINUE
100 IF(IIMP)110,110,104
102 DO 108 J=1,NG
104 IF(MASKPR(J)) 108,106,108

```

```

106 A(IIMP,1)=A(IIMP,1)+HDP(J)*WORK(J)
108 CONTINUE
C110 END OF FIRST NA COL
110 CONTINUE
122 IF(NB) 500,500,122
124 IF(IHROW)132,132,124
C SOLID ENTRY FOR STATIC ENTHALPY COLUMN*****
124 NAP1=NA+1
N=NG+1
126 IF(IITATE(N))128,128,130
128 N=N+1
GO TO 126
130 A(IHROW,NAP1)=CPHSDK(2,N)
N=N+1
NAP1=NAP1+1
IF(NAP1-NAP)126,126,132
132 IF(IISROW)142,142,134
C SOLID ENTRY FOR ENTROPY COLUMN*****
134 NAP1=NA+1
N=NG+1
136 IF(IITATE(N))138,138,140
138 N=N+1
GO TO 136
140 A(IISROW,NAP1)=CPHSDK(3,N)
N=N+1
NAP1=NAP1+1
IF(NAP1-NAP)136,136,142
142 IF(IIMP) 500,500,144
C SOLID ENTRY FOR TOTAL ENTHALPY COLUMN*****
144 NAP1=NA+1
N=NG+1
146 IF(IITATE(N))148,148,150
148 N=N+1
GO TO 146
150 A(IIMP,NAP1)=CPHSDK(2,N)
NAP1=NAP1+1
N=N+1
IF(NAP1-NAP)146,146,500
C START XA COLUMN-ALWAYS DONE*****
500 DO 504 J=1,NA
DO 504 K=1,ND

```

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01M2062
01M2063
01M2064
01M2065
01M2066
01M2067
01M2068
01M2069
01M2070
01M2071
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01M2073
01M2074
01M2075
01M2076
01M2077
01M2078
01M2079
01M2080
01M2081
01M2082
01M2083
01M2084
01M2085
01M2086
01M2087
01M2088
01M2089
01M2090
01M2091
01M2092
01M2093
01M2094
01M2095
01M2096
01M2097
01M2098
01M2099
01M2100
01M2101
01M2102

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```

502 IF(MASKPR(K)) 504,502, 504
504 A(I,J,IACOL)=A(J,IACOL)-COEFS(I,J,K)*PRESS(K)
504 CONTINUE
152 IF(IHROW)160,160,154
154 DO 158 I=1,ND
158 IF(MASKPR(I))158,156,158
156 A(IHROW,IACOL)=A(IHROW,IACOL)-PRESS(I)*CPHSDK(2,I)
158 CONTINUE
160 IF(IISROW)172,172,162
162 DO 170 I=1,ND
170 IF(MASKPR(I)) 170, 164,170
164 IF(ITATE(I)-1)170,166,168
166 A(IISROW,IACOL)=A(IISROW,IACOL)-SP(I)-1.98725*PRESS(I)
GO TO 170
168 A(IISROW,IACOL)=A(IISROW,IACOL)-SP(I)
170 CONTINUE
172 IF(IHP)180,180,174
174 DO 178 I=1,ND
178 IF(MASKPR(I))178,176,178
176 A(IHP,IACOL)=A(IHP,IACOL)-HDP(I)
178 CONTINUE
180 IF(KT)182,182, 236
182 DO 186 I=1,NA
186 DO 186 J=1,NG
186 IF(MASKPR(J))186,184,186
184 A(I,IITCOL)=COEFS(I,J)*PRESS(J)*CPHSDK(4,J)+A(I,IITCOL)
186 CONTINUE
188 IF(NB)196,196,188
188 NAP1=NAP+1
188 NAP=NAP+NB
188 N=NG+1
190 IF(ITATE(N))192,192,194
192 N=N+1
194 GO TO 190
194 A(NAP1,IITCOL)=CPHSDK(4,N)
194 NAP1=NAP1+1
194 N=N+1
196 IF(NAP1-NAP)190,190,196
196 IF(IIPROW)204,204,198
198 DO 202 I=1,NG
198 IF(MASKPR(I))202,200,202

```

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01M2103
01M2104
01M2105
01M2106
01M2107
01M2108
01M2109
01M2110
01M2111
01M2112
01M2113
01M2114
01M2115
01M2116
01M2117
01M2118
01M2119
01M2120
01M2121
01M2122
01M2123
01M2124
01M2125
01M2126
01M2127
01M2128
01M2129
01M2130
01M2131
01M2132
01M2133
01M2134
01M2135
01M2136
01M2137
01M2138
01M2139
01M2140
01M2141
01M2142
01M2143

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```

200 A(I,IPROW,ITCOL)=A(I,IPROW,ITCOL)+PRESS(I)*CPHSDK(4,I)
202 CONTINUE
204 IF(I,IPROW)216,216,206
206 S1=0.
S2=0.
DO 214 I=1,ND
IF(MASKPR(I))214,208,214
208 IF(I,ITATE(I)-1)214,210,212
210 S1=S1+PRESS(I)*CPHSDK(4,I)*CPHSDK(2,I)
212 S2=S2+PRESS(I)*CPHSDK(1,I)
214 CONTINUE
216 A(I,ISROW,ITCOL)=S1+TEMP/1000.*S2
218 IF(I,ISROW)226,226,218
S1=0.
S2=0.
DO 225 I=1,ND
IF(MASKPR(I)) 225, 220, 225
220 IF(I,ITATE(I)-1) 225, 222, 224
222 S1=S1+CPHSDK(4,I)*SP(I)
224 S2=S2+PRESS(I)*CPHSDK(1,I)
225 CONTINUE
226 A(I,ISROW,ITCOL)=S1+S2
228 IF(I,IMP)236,236,228
S1=0.
S2=0.
DO 234 I=1,ND
IF(MASKPR(I)) 234, 230, 234
230 IF(I,ITATE(I)-1)234,232,233
232 S1=S1+MDP(I)*CPHSDK(4,I)
233 S2=S2+PRESS(I)*CPHSDK(1,I) +MDP(I)-HP(I)
234 CONTINUE
236 A(IMP,ITCOL)=S1+TEMP/1000.*S2
238 IF(I,ICON)238,238,242
238 DO 240 I=1,NC
240 A(I,ITCOL)=-A(I,ITCOL)
GO TO 276
242 DO I=1,NA
IF( BM(I) ) 243, 243, 2441
243 A(I,ICON)=A(I,IACOL)
A(I,IACOL)=0.
C*****
01M2144
01M2145
01M2146
01M2147
01M2148
01M2149
01M2150
01M2151
01M2152
01M2153
01M2154
01M2155
01M2156
01M2157
01M2158
01M2159
01M2160
01M2161
01M2162
01M2163
01M2164
01M2165
01M2166
01M2167
01M2168
01M2169
01M2170
01M2171
01M2172
01M2173
01M2174
01M2175
01M2176
01M2177
01M2178
01M2179
01M2180
01M2181
01M2182
01M2183
01M2184

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```

2441 GO TO 1245
2442 ABC=(BIGA*BM(I))/(-A(I,IACOL))
2443 A(I,ICON)=-A(I,IACOL)*LOGF(ABC)
1245 CONTINUE
2444 IF(NB1256*256*245
245 NAPI=NA+1
246 N=NG+1
247 IF(ITERATE(N))248,248,250
248 N=N+1
250 DO 254 J=1,NA
251 S1=0.
252 DO 252 K=1,NA
253 S1=S1+81BLE(J,K)*COEFS(K,N)
254 I1=IMAJOR(J)
255 A(NAPI,ICON)=A(NAPI,ICON)+S1*PLN(I1)
256 A(NAPI,ICON)=-((CPHSDK(5,N)+A(NAPI,ICON))
257 NAPI=NAPI+1
258 IF(NAPI-NAPI248,248,256
259 IF(IIPROW)264,264,258
260 DO 262 I=1,NG
261 IF(MASKPR(I))262,262,262
262 A(IIPROW,ICON)=A(IIPROW,ICON)+PRESS(I)
263 CONTINUE
264 A(IIPROW,ICON)=A(IIPROW,ICON)*LOGF(PREF/A(IIPROW,ICON))
265 IF(IIMROW)268,268,266
266 A(IIMROW,ICON)=-A(IIMROW,IACOL)*LOGF(BIGA*HC/(-A(IIMROW,IACOL)))
267 IF(IIMP)272,272,270
270 A(IIMP,ICON)=-A(IIMP,IACOL)*LOGF(BIGA*HC/(-A(IIMP,IACOL)))
271 IF(IISROW)276,276,274
274 A(IISROW,ICON)=-A(IISROW,IACOL)*LOGF(BIGA*SC/(-A(IISROW,IACOL)))
275 IF(IIU)277,277,277
277 IF(IIMP)280,280,278
278 WRITE OUTPUT TAPE 1'0,282,((NAME(I,J),I=1,2),MPI(J),HDP(J),SP(J),
279 *DJ(J),J=1,ND)
280 RETURN
281 FORMAT( 1M1,10X, 7HF:DDUCT,10X, 2MHP,16X,3MMHP,15X,2HSP,16X,2HDIJ/01M2227
282 */15X,2A6,4E16.8))
END
01M2185
01M2186
01M2190
01M2191
01M2192
01M2193
01M2194
01M2195
01M2196
01M2197
01M2198
01M2199
01M2200
01M2201
01M2202
01M2203
01M2204
01M2205
01M2206
01M2207
01M2208
01M2209
01M2210
01M2211
01M2212
01M2213
01M2214
01M2215
01M2216
01M2217
01M2218
01M2219
01M2220
01M2221
01M2222
01M2223
01M2227
01M2228
01M2229

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```

      8      PLN(I)=LOG(PRESS(I))
      CONTINUE
      IM=-1
      DO 12 I=1,NA
      DO 10 J=1,NA
      10      BIBLE(I,J)=0.
      12      BIBLE(I,I)=1.
      CALL LOGS
      CALL GENPIS
      14      RETURN
      15      IF(IX) 16, 16, 307
      16      IF(TEMP-1000.)14,14,17
      17      DO 28 I=1,NA
      17      STARTS CHECKING FOR REAL MAJOR PRODUCTS ** BOX-A-*****
      C17      A1=ABSF(PARRAY(I))
      M1=IMAJOR(I)
      DO 26 J=1,NG
      IF(MASKPR(J))26,18,26
      18      IF(MOUT(J))26,20,26
      20      IF(COEF5(I,J))22,26,22
      22      IF(A1-ABSF(PRESS(J))/PREF*COEF5(I,J)*BM(I)) 24, 24, 26
      24      S=0.
      DO 124 K=1,NA
      IF(COEF5(K,J)) 123, 124, 123
      123      S=S+1.
      124      CONTINUE
      IF(S-2.) 126, 126, 26
      126      A1=ABSF(PRESS(J))
      M1=J
      26      CONTINUE
      28      MOUT(M1)=I
      C      THE PRODUCTS WILL NOW BE MAGNITUDE ORDRD IN REVERSE
      DO 280 I=1,NA
      I2=NA+I-1
      A2=ABSF(PARRAY(I2))
      M1=IMAJOR(I2)
      DO 260 J=1,NG
      IF(MASKPR(J)) 260, 180, 260
      180      IF(MASKS(J)) 260,200, 260
      200      IF(COEF5(I2,J)) 220, 260, 220
      220      IF(A2-ABSF(PRESS(J))/PREF*COEF5(I2,J)*BM(I2)) 240, 240, 260

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01M1517
01M1518
01M1519
01M1520
01M1521
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01M1524
01M1525
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01M1533
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01M1552
01M1553
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01M1555
01M1556
01M1557

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240 S=0
DO 1244 K=1,NA
  IF(COEF(K,J)) 1243, 1244, 1243
1243 S=S+1.
1244 CONTINUE
  IF(S=7) 1260, 1260, 260
1260 A2=ABS(PRESS(J))
  M1=J
260 CONTINUE
280 MASKS(M1)=12
  A1=0
  A2=0
DO 330 I=1,NG
  IF(MOUT(I)) 300, 310, 300
  A1=A1+PRESS(I)
300 IF(MASKS(I)) 320, 330, 320
310 A2=A2+PRESS(I)
320 CONTINUE
  C THE GREATER SUM WILL BECOME THE MOUT(I) ARRAY
  IF( A1-A2 ) 335, 350, 350
335 DO 340 I=1,NG
  MOUT(I)=MASKS(I)
340 MASKS(I)=0
350 REPL=0
  C CHECK FOR DIFFERENCES BETWEEN MOUT ( ) AND MASKOR
DO 36 I=1,NG
  IF(MASKPR(I))36,29,36
29 IF(MOUT(I))32,30,32
30 IF(MASKOR(I))34,36,34
32 IF(MASKOR(I))36,34,36
34 REPL=REPL+1.
36 CONTINUE
  C REPL=REPL/2.
  C TEST REPL FOR CHANGES TO THE PRODUCT ARRAY*****
  IF(REPL)38,38,40
38 L=0
307 CALL JUGGLE(I)
  C BOX-B-----
  C MOUT IS SET FOR A NON-ZERO ENTRY AT THE MAJORS
  C POSITION, IN ORDER TO REPLACE A REDUNDANT COEF SET

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01M1558
01M1559
01M1560
01M1561
01M1562
01M1563
01M1564
01M1565
01M1566
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01M1569
01M1570
01M1571
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01M1573
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01M1580
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01M1582
01M1583
01M1584
01M1585
01M1586
01M1587
01M1588
01M1589
01M1590
01M1591
01M1592
01M1593
01M1594
01M1595
01M1596
01M1597
01M1598

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```

C 40 THE POSITIONS ARE NOT ORDERED NUMERICALLY *****01M1599
    I=1
    DO 50 J=1,NG
    IF(MASKPR(J))50,42,50
    IF(MOUT(J))46,50,46
    DO 48 K=1,NA
    A(I,K)=COEFS(K,J)
    I=I+1
    50 CONTINUE
    IF(I-1-NA)52,54,52
    C THE COEFFICIENT MATRIX AND MASK MOUT ARE SET *****01M1608
    L=6
    52 RETURN
    CALL LINC(L)
    L1 WILL BE ZERO IF NO REDUNDANCY
    IF(L1)84,84,62
    LC=LC+1
    62 START TO REPLACE REDUNDANT COEF SET
    C IF(LC-50)66,64,64
    L=5
    64 RETURN
    I=0
    66 I=I+1
    68 IF(MASKS(I))68,68,70
    J=0
    70 THE I-TH ROW IS REDUNDANT
    C DO 74 K=1,I
    J=J+1
    72 IF(MOUT(J))74,72,74
    74 CONTINUE
    C THE JT-H PRODUCT IS THE REDUNDANT COEF SET *****01M1628
    JJ=MOUT(J)
    C THE JJ-TH ELEMENT MAJOR MUST BE RECHOSEN *****01M1630
    A1=0
    DO 82 K=1,NG
    IF(MASKPR(K))82,76,82
    IF(MOUT(K))82,78,82
    76 IF(COEF(JJ,K))79,82,79
    78 IF(A1-ABSF(PRESS(K)))80,82,82
    79 M1=K
    80 A1= ABSF(PRESS(K))
    *****01M1631
    *****01M1632
    *****01M1633
    *****01M1634
    *****01M1635
    *****01M1636
    *****01M1637
    *****01M1638
    *****01M1639

```

```

82 CONTINUE
MOUT(MI)=JJ
MOUT(J)=0
GO TO 54
C84 NO REDUNDANCY IN THE MAJORS COEFFICIENTS *****
C AT THIS POINT , IT IS HOPE THAT MOUT()CONTAINS NON-ZERO ELEMENTS
C IN THE MAJOR PRODUCT POSITIONS,AND PARRAY() HAS MAJOR PRESSURES
C MOUT AND PARRAY ARE ORDERED BY ELEMENTS AND NOT SEQUENCE
84 CALL INVR(A,NA,TEST,DETER)
IF( TEST=1.) 83, 97, 83
83 DO 85 I=1,NG
85 MASKOR(I)=0
850 DO 92 I=1,NA
DO 88 J=1,NG
IF(MOUT(J)-I) 88, 86, 88
86 IMAJOR(I)=J
PARRAY(I)=PRESS(J)
MASKOR(J)=I
GO TO 90
88 CONTINUE
90 DO 92 K=1,NA
92 A(I,K)=COEFS(K,J)
DO 93 I=1,ND
93 MOUT(I)=0
94 CALL INVR (A,NA,TEST,DETER)
DO 96 I=1,NA
DO 96 J=1,NA
96 BIBLE(I,J)=A(J,I)
97 CALL LOGS
CALL GEMPIS
CALL JUGGLE(LI)
C WHEN LI IS 1 ALL IS WELL *****
98 IF(LI=1) 100, 99 , 100
99 L=2
RETURN
100 CONTINUE
102 L=4
RETURN
END

```

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01M1640
01M1641
01M1642
01M1643
01M1644
01M1645
01M1646
01M1647
01M1648
01M1649
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01M1651
01M1652
01M1653
01M1654
01M1655
01M1656
01M1657
01M1658
01M1659
01M1660
01M1661
01M1662
01M1663
01M1664
01M1665
01M1666
01M1667
01M1668
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01M1670
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01M1673
01M1674
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01M1676
01M1677
01M1678

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C      SUBROUTINE LINCCH
      DIMENSION A(40,41), ANS(40), BIBL(15,15), COEFS(15,15), DATA(
* 3,20,15), CPHSDK(15,15), DATBU(4,65), FG(15), MEL(50), ITATE(
* 15), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
* MASKS(150), NTAPE(4), NEL(50), NAME(2,15), TBREAK(3,15), IBREAK(15,20),
* (3,15), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
* WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
      11 / 15/ 61
C      COMMON A, ABLOCK, ANS, BM, BIBL, BIGA, COEFS, CPHSDK, DATA, DATBU
*FG, HCMOLE, HC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
* IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
* ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
* KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
* LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
* NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
* , TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
      L=0
C      LINEAR DEPENDENCY CHECK
      DO 2 I=1,ND
      MASKS(I)=0
      DO 24 I=1,NA
      MASKS(I)=1
      IPI=I+1
      LSAV=L
      DO 20 J=IPI,NA
      ACOMP=0.
      DO 18 K=I,NA
      CHECK COLUMNS
      IF(A(I,K))8,6,8
      6 IF(A(J,K))20,18,20
      8 IF(A(J,K)) 10, 20, 10
      10 IF(ACOMP)14,12,14
      12 ACOMP=A(I,K)/A(J,K)
      GO TO 18
      14 A1=A(I,K)/A(J,K)
      IF( ABSF(A1-ACOMP)-1.E-10) 18 , 18 , 20
      18 CONTINUE
      L=L+1
      20 CONTINUE
      IF ( LSAV-L) 24 , 22 , 22

```

01H2438
01H2439
01H2440
01H2441

22 MASK(1)=0
24 CONTINUE
RETURN
END

```

C
SUBROUTINE JUGGLE
SUBROUTINE JUGGLE(L)
DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
* 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), MEL(50), ITATE(
* 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
* MASKS(150), NTAPE(4), MEL(50), NAME(2,151), TBREAK(3,151), IBREAK(150),
* (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
* WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
11 / 15/ 61
COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU
*FG, MCMOLE, MC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
* IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
* ITC, ITD, ITE, ITF, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
* KA, KB, KC, KD, KE, KF, KG, KI, LA, LB, LC, LD, LE, LF, LG, LH,
* LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
* NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
* , TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
LB=0
ELAST=C.
IF(NB)2,3,2
L=1
RETURN
E=0.
DO 6 I=1,30
WORK(I)=0.
DO 14 I=1,NA
DO 12 J=1,ND
IF(MASKPR(J))12,10,12
10 WORK(I)=WORK(I)+PRESS(J)*COEFS(I,J)
12 CONTINUE
WORK(I)=LOGF(BM(I)*BIGA/WORK(I))
E=E+ABSF(WORK(I))
IF(E-ELAST) 8,15,15
15 IF(E-FLOATF(NA)*.7)2,2,16
16 LB=LB+1
IF(LB-50)20,18,18
18 L=2
GO TO 8
DO 26 I=1,NA
J=IMAJOR(I)
G=0

```

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01M2345
01M2346
01M2347
01M2348
01M2349
01M2350
01M2351
01M2352
01M2353
01M2354
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01M2356
01M2357
01M2358
01M2359
01M2360
01M2361
01M2362
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01M2368
01M2369
01M2370
01M2371
01M2372
01M2373
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01M2375
01M2376
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01M2378
01M2379
01M2380
01M2381
01M2382
01M2383

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```

21 DO 21 K=1,NA
22 G=G+WORK(K)*BIBLE(I,K)
23 PLN(J)=PLN(J)+G /10.
24 IF( PLN(J)+45.) 24, 24, 25
25 PRESS(J)=0.
26 PARRAY(I)=0.
27 GO TO 26
28 PRESS(J)=EXP(PLN(J))
29 PARRAY(I)=PRESS(J)
30 CONTINUE
31 CALL GENPIS
32 ELAST=E
33 GO TO 3
34 END

```

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01H2384
01H2385

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01H2388
01H2389
01H2390
01H2391
01H2392
01H2393
01H2394

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01H2395
01H2396

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C          SUBROUTINE INVR5
C          SUBROUTINE INVR5(A,N,TEST,DETER)
C          INVERTS THE COEFFICIENT AND PRODUCT MATRICES
C          DIMENSION A(40,41),L(40),M(40)
C          N=N
C          TEST=0.
C          DETER=1.
C          DO 100 K=1,N
C            BIGA=A(K,K)
C            DO 120 I=K,N
C              DO 120 J=K,N
C                IF(ABS(BIGA)-ABS(A(I,J)))110,110,120
C            BIGA=A(I,J)
C            L(K)=I
C            M(K)=J
C          CONTINUE
C          JROW=L(K)
C          IF(L(K)-K)135,135,125
C          DO 130 I=1,N
C            HOLD=-A(K,I)
C            A(K,I)=A(JROW,I)
C            A(JROW,I)=HOLD
C          ICOL=M(K)
C          IF(M(K)-K)145,145,137
C          DO 140 J=1,N
C            HOLD=-A(J,K)
C            A(J,K)=A(J,ICOL)
C            A(J,ICOL)=HOLD
C          IF(A(K,K))147,143,147
C          TEST=1.
C          GO TO 235
C          DO 155 IC=1,N
C            IF(IC-K)150,155,150
C            A(IC,K)=A(IC,K)/(-A(K,K))
C          CONTINUE
C          DO 165 I=1,N
C            DO 165 J=1,N
C              IF(I-K)157,165,157
C              IF(J-K)160,165,160
C              A(I,J)=A(I,K)*A(K,J)+A(I,J)
C          CONTINUE

```

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01M2442
01M2443
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01M2481
01M2482

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168 DO 175 JR=1,N
170 IF(JR-K)170,175,170
175 A(K,JR)=A(K,JR)/A(K,K)
175 CONTINUE
175 DETER=DETER+A(K,K)
180 A(K,K)=1.0/A(K,K)
180 CONTINUE
180 K=N
200 K=K-1
200 IF(K)235,235,203
203 I=L(K)
203 IF(I-K)220,220,205
205 DO 210 J=1,N
205 HOLD=A(J,K)
210 A(J,K)=-A(J,I)
210 A(J,I)=HOLD
220 J=M(K)
220 IF(J-K)200,200,225
225 DO 230 I=1,N
225 HOLD=A(K,I)
230 A(K,I)=-A(J,I)
230 A(J,I)=HOLD
235 GO TO 200
235 RETURN
235 END

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01M2483
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01M2494
01M2495
01M2496
01M2497
01M2498
01M2499
01M2500
01M2501
01M2502
01M2503
01M2504
01M2505
01M2506
01M2507

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SUBROUTINE GEMP1S
  DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
    3*20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
    151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
    MASKS(150), NTAPE(4), NEL(50), NAME(12,151), TBREAK(3,151), IBREAK(152512
    13,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20), 01H2508
    WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10) 01H2509
    11 / 15/ 61 01H2510
    01H2511
    01H2512
    01H2513
    01H2514
    01H2515
    COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU 01H2516
    ,FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL, 01H2517
    ,IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB, 01H2518
    ,ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR, 01H2519
    ,KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH, 01H2520
    ,LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG, 01H2521
    ,NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY 01H2522
    ,TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY 01H2523
    ,BIBLE CONTAINS THE PROPER ARRAY, THIS ROUTINE ONLY GETS 01H2524
    PARTIAL PRESSURES 01H2525
    DO 3 I=1,NG 01H2526
    PRESS(I)=0. 01H2527
    IF(MASKOR(I)) 3,2,3 01H2528
    PLN(I)=0. 01H2529
    CONTINUE 01H2530
    DO 12 I=1,NG 01H2531
    IF(MASKPR(I)) 12, 4, 12 01H2532
    IF(MASKOR(I)) 12, 5, 9 01H2533
    MASKOR(I) CONTAINS THE MAJOR PRODUCT CODES ONLY 01H2534
    DO 8 J=1,NA 01H2535
    I2=IMAJOR(J) 01H2536
    SUM=0. 01H2537
    DO 6 K=1,NA 01H2538
    SUM=SUM+COEFS(K,I)*BIBLE(J,K) 01H2539
    PLN(I)=PLN(I)+SUM*(PLN(I2)) 01H2540
    PLN(I)=CPHSDK(5,I)+PLN(I) 01H2541
    IF(PLN(I)+35) 12,10,10 01H2542
    PRESS(I)=EXP(PLN(I)) 01H2543
    CONTINUE 01H2544
    DO 14 I=1,NA 01H2545
    I1=IMAJOR(I) 01H2546
    PARRAY(I)=PRESS(I1) 01H2547
    DO 16 I=NG,ND 01H2548

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01H2549
01H2550
01H2551
01H2552
01H2553
01H2554

IF(IITATE(I)) 15,15,16
PRESS(I)=0.
PLN(I)=0.
16 CONTINUE
RETURN
END

15
16

```

SUBROUTINE ESCORT (E)
  DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
    * 3,20,151), CPHSDK(15,151), DATBU(4,65), FG(15), MEL(50), ITATE(
    * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
    * MASKS(150), NTAPE(4), MEL(50), NAME(2,151), TBREAK(3,151), IBREAK(15,151),
    * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
    * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
    11 / 157 61
  COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU(15,151),
    * FG, HCMOLE, MC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
    * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
    * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
    * KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
    * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
    * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY(15,151),
    * TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
    15 100, 10, 2, 10
  2  WRITE OUTPUT TAPE ITO,4
  4  FORMAT( 67H1 ESCORT ENCOUNTERED IN CHAMBER,NO RESCUE POSSIBLE. PROO1M2573
    *BLEM BUMPED.)
  6  CALL DUMP2(E)
  8  CALL CHAIN(1,ITA)
  10 IF(E-200.) 16,12,16
  12 WRITE OUTPUT TAPE ITO,14
  14 FORMAT( 66H1 ESCORT ENCOUNTERED IN THROAT,NO RESCUE POSSIBLE. PROBO1M2579
    *LEM BUMPED.)
    GO TO 8
  16 IF(NH) 22, 22,18
  18 WRITE OUTPUT TAPE ITO,20,NH
  20 FORMAT( 67H1 ESCORT ENCOUNTERED IN EXPANSION ITERATION AT THE EXPA01M2584
    *NSION NUMBER 14, 32M.THIS PRESSURE WILL BE SKIPPED /29H AND TO1M2585
    *HE PROBLEM CONTINUED.)
    TEMP=TEMP-100.
    RETURN
  22 WRITE OUTPUT TAPE ITO,24
  24 FORMAT( 61H1 ESCORT ENCOUNTERED REASON UNKNOWN. PROBLEM SYSTEM STO1M2590
    *OPPED.)
    GO TO 8
  END

```

```

C
SUBROUTINE LOGS
  DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
    * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
    * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
    * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(
    * 3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
    * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
    11 / 15/ 61
  COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU
  *FG, HCMOLE, MC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
  *IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
  *ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
  *KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
  *LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
  *NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
  * , TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
  DIMENSION H(15), S(15)
  R=1.98725
  IF(TEMP-TARRAY(20))4,4,2
  L=0
  LG=1
  CALL SIFTIT(L)

  GO TO 6
  IF(TEMP-TARRAY(1))2,6,6
  DO 10 I=2,20
  IF(TEMP-TARRAY(1))8,8,10
  IM1=I-1
  GO TO 12
  CONTINUE
  IM1=19
  I=20
  I=IM1+1
  DO 20 J=1,ND
  CPHSDK(1,J)=DATA(1,IM1,J)+(TEMP-TARRAY(IM1))/
  *(TARRAY(1)-TARRAY(IM1))*(DATA(1,I,J)-DATA(1,IM1,J))
  IF( ITATE(J)-1) 14,18,14
  14 IF(DATA(2,I,J)-DATA(2,IM1,J)-(TARRAY(1)-TARRAY(IM1))*
  *DATA(1,IM1,J)/1000.-1.5) 18,18,16
  16 CPHSDK(2,J)=(DATA(2,I,J)-DATA(2,IM1,J))/(TARRAY(1)

```

```

18      *-TARRAY(IM1))*(TEMP-TARRAY(IM1))+DATA(2,IM1,J)
      CPHSDK(3,J)=(DATA(3,I,J)-DATA(3,IM1,J))/(TARRAY(I)-
      *TARRAY(IM1))*(TEMP-TARRAY(IM1))+DATA(3,IM1,J)
      GO TO 20
20      CPHSDK(2,J)=DATA(2,IM1,J)+(DATA(1,IM1,J)+CPHSDK(1,J))
      *2.*(TEMP-TARRAY(IM1))/1000.
      CPHSDK(3,J)=DATA(3,IM1,J)+(DATA(1,IM1,J)+CPHSDK(1,J) )
      *2.*(LOGF(TEMP)-LOGF(TARRAY(IM1)))
      CONTINUE

22      DO 28 I=1,NA
      J=IMAJOR(I)
26      H(1)=CPHSDK(2,J)
28      S(1)=CPHSDK(3,J)
      DO 38 I=1,ND
      SUMH=0.
      SUMS=0.
      CPHSDK(4,I)=0.
      CPHSDK(5,I)=0.
      IF(MASKOR(I)) 38 , 30 , 38
30      DO 36 J=1,NA
      SIG=0.
      DO 34 K=1,NA
      IF(COEF(K,I)) 32,34,32
32      SIG=SIG+COEF(K,I)*BIBL(J,K)
34      CONTINUE
      SUMH=SUMH+SIG*H(J)
      SUMS=SUMS+SIG*S(J)
36      CPHSDK(4,I)=1000.*(CPHSDK(2,I)-SUMH)/(R*TEMP)
      SIGS=CPHSDK(3,I)-SUMS
      IF(ABSF(SIGS)-1.E-3) 35,35,37
35      CPHSDK(5,I)=-1.E6
      GO TO 38
37      CPHSDK(5,I)=SIGS/R-CPHSDK(4,I)
38      CONTINUE
      RETURN
      END

```

```

C
SUBROUTINE SOLIDS(L)
SUBROUTINE SOLIDS(L)
  DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,15), DATA(
    * 3,20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
    * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
    * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IEREA(150),
    * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
    * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KLOCK(10)
    11 / 15/ 61
  COMMON A, ABLOCK, ANS, BM, BIBLE, EIGA, COEFS, CPHSDK, DATA, DATBU
  * FG, MCNOL, MC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
  * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITS,
  * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITJ, ITK, ITL, ITM, ITN, ITO,
  * KA, KB, KC, KD, KE, KF, KG, KH, KI, KJ, KK, KL, KM, KN, KO, KP,
  * LI, LJ, MASKEL, MASKOR, MCUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
  * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE,
  * TARRAY, TBLOCK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
  IJ=NG+1
  ITES1=0
  ITES2=0
  SUM=0.
  DO 14 I=1,NC
    IF(ITATE(I)) 2,14,14
    Y=CPHSDK(5,I)-.2
    DO 6 J=1,NA
      IMAJ=IMAJOR(J)
      B=0.
      DO 4 K=1,NA
        B=B+BIBLE(J,K)*COEFS(K,I)
      Y=Y+B*PLN(IMAJ)
      IF(Y)14,14,8
      IF(SUM)10,10,12
      SUM=Y
      III=1
      ITES1=I
      GO TO 14
    IF(SUM-Y)10,14,14
  14 CONTINUE
  IF(ITES1)24,24,16
  DO 20 I=1,NA
    IF(COEFS(1,III))18,20,18

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18	PRESS(III)=.01*BIGA*BM(I)/COEFS(I,III)	01M2714
	PLN(III)=LOGF(PRESS(III))	01M2715
	ITATE(III)=XBSF(ITATE(III))	01M2716
	NB=NB+1	01M2717
	GO TO 22	01M2718
20	CONTINUE	01M2719
22	L=2	01M2720
	RETURN	01M2721
24	L=1	01M2722
	RETURN	01M2723
C	IF L=1-NO NEW SOLIDS*L=2-NEW SOLID	01M2724
	END	01M2725

```

SUBROUTINE GETDJS(DJ,DAM1)
DIMENSION A(40,41),ANS(40),BIBLE(15,15),COEFS(15,151),DATA(
* 3,20,151),CPHSDK(15,151),DABUI(4,65),FG(15),HEL(50),ITATE(
* 151),MASKEL(150),BM(15),MASKPR(150),MASKOR(150),MOUT(150),
* MASKS(150),NTAPE(4),NEL(50),NAME(2,151),TBREAK(3,151),IBREAK(
* (3,151),PARRAY(15),PRESS(150),PLN(150),TAPID(18),TARRAY(20),
* WORK(150),TITLE(18),IMAJOR(15),ABLOCK(10),KBLOCK(10)
DIMENSION DJ(150),YJ(150)
1/19/62
COMMON A,ABLOCK,ANS,BV,BIBLE,BIGA,COEFS,CPHSDK,DATA,DABUI
*FG,HCMOLE,HC,HEL,IA,IB,IC,ID,IE,IF,IG,IH,IJ,IK,IL,
* IM,IN,IO,IP,IQ,IR,IS,IT,IV,IW,IX,IY,IZ,ITA,ITB,
* ITC,ITD,ITE,ITF,ITG,ITH,ITI,ITQ,ITATE,IBREAK,IMAJOR,
* KA,KB,KC,KD,KE,KF,KG,KT,LA,LB,LC,LD,LE,LF,LG,LH,
* LI,LJ,MASKEL,MASKOR,MCUT,MASKS,NA,NB,NC,ND,NE,NF,
* NH,NI,NJ,NK,NTAPE,NAME,NEL,PRESS,PREF,PLN,SC,TITLE,
* TARRAY
*GAMTH,PTHR,DAM1,DJ,YJ,YJA
DO 2 I=1,ND
DJ(I)=0.
DO 4 J=1,NA
IJ=IMAJOR(I)
DJ(IJ)=ANS(IJ)
DO 14 I=1,NG
IF(MASKPR(I)) 14,6,14
IF(MASKOR(I)) 14,8,14
DO 12 J=1,NA
SUM=0.
IJ=IMAJOR(J)
DO 10 K=1,NA
SUM=SUM+COEFS(K,IJ)*BIBLE(J,K)
DJ(IJ)=DJ(IJ)+DJ(IJ)*SUM
DJ(IJ)=DJ(IJ)+CPHSDK(4,IJ)
CONTINUE
IF(NB) 22,22,16
NJ=NA+1
NAB=NA+NB
NAP=NG
NAP=NAP+1
IF(11TATE(NAP)) 18,18,20
DJ(NAP)=ANS(N1)/PRESS(NAP)

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22  N1=N1+1
    IF(N1-NAB) 10,10,22
    N=NA+NB+1
    DAM1=ANS(N)-1.
    RETURN
    END

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SUBROUTINE GETYJS
  DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,15), DATA(
    3,20,151), CPMSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
    151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
    MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), TBREAKO(150),
    (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
    WORK(150), TITLE(18), IMAJOR(15), AELOCK(10), KLOCK(10)
  DIMENSION DJ(150), YJ(150)
  1/19/62
  COMMON A, ABLOCK, ANS, EM, BIBLE, FIGA, COEFS, CPMSDK, DATA, DATBUO
  *FG, HCMOLE, MC, MEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
  *IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
  *ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, TBREAK, IMAJOR,
  *KA, KB, KC, KD, KE, KF, KG, KT, LA, LB, LC, LD, LE, LF, LG, LH,
  *LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
  *NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLR, SC, TITLE, TARRAYC
  * , TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
  *GAMTH, PTHR, DAMI, DJ, YJ, YJA
  CALL GETDJS(YJ, YJA)
  YJA=YJA+1.
  RETURN
END

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C

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FUNCTION PARB(EPS,QRZ,ARG,NN)
DIMENSION EPS(600),QRZ(600)
IF(ARG-EPS(NN))206,230,222
206 IF(ARG-EPS(NN-1))209,230,230
209 IF(ARG-EPS(3))211,211,217
211 T1=EPS(1)
    T2=EPS(2)
    T3=EPS(3)
    FT1=QRZ(1)
    FT2=QRZ(2)
    FT3=QRZ(3)
    GO TO 600
217 DO 222 I=4,NN
    IF(ARG-EPS(I))227,225,222
222 CONTINUE
227 EPT=(EPS(I-1)+EPS(I))/2.
219 T1=EPS(I-2)
    T2=EPS(I-1)
    T3=EPS(I)
    FT1=QRZ(I-2)
    FT2=QRZ(I-1)
    FT3=QRZ(I)
    GO TO 600
225 T1=EPS(I-1)
    T2=EPS(I)
    T3=EPS(I+1)
    FT1=QRZ(I-1)
    FT2=QRZ(I)
    FT3=QRZ(I+1)
600 AY=(FT2-FT1)/(T2-T1)
    BY=(FT3-FT2)/(T3-T2)
    C=T3-T1
    D=(BY-AY)/C
    E=ARG-T2
    G=(D+E)*AY
    PARB=(ARG-T1)*G+FT1
    GO TO 2223
230 T1=EPS(NN-2)
    T2=EPS(NN-1)
    T3=EPS(NN)

```

```

01M2795
01M2796
01M2797
01M2798
01M2799
01M2800
01M2801
01M2802
01M2803
01M2804
01M2805
01M2806
01M2807
01M2808
01M2809
01M2810
01M2811
01M2812
01M2813
01M2814
01M2815
01M2816
01M2817
01M2818
01M2819
01M2820
01M2821
01M2822
01M2823
01M2824
01M2825
01M2826
01M2827
01M2828
01M2829
01M2830
01M2831
01M2832
01M2833
01M2834
01M2835

```

FT1=QRZ(NN-2)
FT2=QRZ(NN-1)
FT3=QRZ(NN)
GO TO 600
2222 PARB=0.
2223 RETURN
END

01H2836
01H2837
01H2838
01H2839
01H2840
01H2841
01H2842

01M1198
01M1199
01M1200
01M1201

SUBROUTINE CHANGE(N1,N2)
N1=N2
RETURN
END

SUBROUTINE CHANGE(M1,M2)
M1=M2
RETURN
END

01H1198
01H1199
01H1200
01H1201

```

C
C
C      SUBROUTINE SIFTIT
C      ***** UPDATED 2/14/63
C      SUBROUTINE SIFTIT(L)
C      DIMENSION A(40,41), ANS(40), DIBLE(15,15), COEFS(15,151), DATA(
C      * 3,20,151), CPMSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
C      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MGUT(150),
C      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(150),
C      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
C      * WORK(150), TITLE(18), IMAJOR(15), ABLCK(10), KLUCK(10)
C      11 / 15/ 61
C      COMMON A, ABLOCK, AAS, BM, DIBLE, BIGA, COEFS, CPMSDK, DATA, DATBUC
C      * FG, HCMOLE, MC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
C      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
C      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
C      * KA, KB, KC, KD, KE, KF, KG, KH, KI, LA, LB, LC, LD, LE, LF, LG, LH,
C      * LI, LJ, MASKEL, MASKOR, MGUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
C      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
C      * TEMP, TBREAK, TAPID, WORK, MASKPR, KBLCK, PARRAY
C      8/28/61 H J VALE THIS SUBROUTINE SEARCHES THE
C      DATA TAPE AND QUALIFIES PRODUCTS
C      DIMENSION COBU (50)
C      NTAPE=IN
C      IF(IG)2,2,32
C      IF(NA-15)4,4,28
C      NEW PROBLEM*****
C      NEL( ) IS LOADED,NA IS NO OF ELEMENTS ,AND
C      MASKEL IS SET TO MASK COEFFICIENTS INTO COEFS
C      REWIND ITE
C      REWIND ITF
C      IG=1
C      TEMP=3000.
C      ND=1
C      ILO= 18
C      READ TAPE ITD,ITATE(ND)
C      IF(ITATE(ND)-99)8,20,20
C      IF(ITATE(ND)-1) 9,9,7
C      ITATE(ND)=-ITATE(ND)
C      READ TAPE ITD,(NAME(I,ND),I=1,2),(COBU (I),I=1,
C      * NTAPE),(TBREAK(I,ND),I=1,3),(IBREAK(I,ND),I=1,3), M298,(
C      * DATBU (I,J),I=1,4),J=1,65)
C      DO 12 I=1,NTAPE
01H1202
01H1203
01H1204
01H1205
01H1206
01H1207
01H1208
01H1209
01H1210
01H1211
01H1212
01H1213
01H1214
01H1215
01H1216
01H1217
01H1218
01H1219
01H1220
01H1221
01H1222
01H1223
01H1224
01H1225
01H1226
01H1227
01H1228
01H1229
01H1230
01H1231
01H1232
01H1233
01H1234
01H1235
01H1236
01H1237
01H1238
01H1239
01H1240
01H1241
01H1242

```

```

10 IF(COBU(1))10,12,10 01M1243
11 IF(MASKEL(1))12,6,12 01M1244
12 CONTINUE 01M1245
C PRODUCT WAS QUALIFIED-GO TO PUT IN DATA BLOCK. UPDATE ENTHALPIES FIRST 01M1246
HBASE=0. 01M1247
DO 13 I=1,IN 01M1248
13 HBASE=HBASE+COBU(I)*HEL(I) 01M1249
DO 15 I=1,65 01M1250
15 DATBU(I)=DATBU(I)+HBASE+H298 01M1251
C ENTHALPIES UPDATED TO MATCH THE TAPE BASE ARRAY ***** 01M1252
K=1 01M1253
DO 16 I=1,N1TAPE 01M1254
16 IF(MASKEL(I))14,16,14 01M1255
14 COEFS(K,ND)=COBU(I) 01M1256
K=K+1 01M1257
16 CONTINUE 01M1258
C TRANSFER THE DATA BLOCK 01M1259
DO 18 I=1,20 01M1260
DO 18 J=1,3 01M1261
K=ILO+I 01M1262
18 DATA(J,I,ND)=DATBU(J+1,K) 01M1263
WRITE TAPE ITR,((DATBU(J,I),J=1,4),I=1,65) 01M1264
WRITE TAPE ITR, NAME(1,ND),NAME(2,ND),(COBU(I),I=1,N1TAPE),H298 01M1265
WORK(ND)=H298 01M1266
ND=ND+1 01M1267
IF(ND-150)6,6,24 01M1268
20 WRITE TAPE ITR,ITATE(ND) 01M1269
END FILE ITR 01M1270
END FILE ITR 01M1271
REWIND ITR 01M1272
ND=ND-1 01M1273
21 REWIND ITR 01M1274
REWIND ITR 01M1275
DO 22 I=1,20 01M1276
JJ=I+ILO 01M1277
22 TARRAY(I)=DATBU(I,JJ) 01M1278
NE=0 01M1279
DO 23 I=1,ND 01M1280
IF(ITATE(I)-1) 25, 23, 25 01M1281
25 NE=NE+1 01M1282
23 CONTINUE 01M1283

```

```

NG=ND-NE
L=0
RETURN
24 REWIND ITE
   REWIND ITD
26 WRITE OUTPUT TAPE 6*26
   FORMAT(40H1 DATA STORAGE EXCEEDED PROBLEM DELETED)
   CALL EXIT
28 WRITE OUTPUT TAPE 6*30
   FORMAT(40H1 ELEMENT STORAGE GREATER THAN PROVIDED)
   CALL EXIT
32 IF(TEMP-TARRAY(20))34*54*54
34 IF(TEMP-TARRAY(1))36*36*56
36 IF(TARRAY(1))38*38*40
38 L=1
   RETURN
40 ILO=-10
   REWIND ITE
   READ TAPE ITE,((DATBU(I,J),I=1,4),J=1,65)
   REWIND ITE
   DO 42 I=1,65
   IF(TEMP-DATBU(I,1)) 43, 43, 42
42 ILO=ILO+1
43 K=1
   IF(ILO)44*44*46
44 ILO=0
   GO TO 50
46 IF(ILO-46) 50, 48, 48
48 ILO=45
50 READ TAPE ITE,((DATBU(I,J),I=1,4),J=1,65)
   DO 52 I=1,20
   DO 52 J=1,3
   JJ=I+ILO
52 DATA(J,I,K)=DATBU(I+1,JJ)
   K=K+1
   IF(K-ND)50*50*21
54 IF(TARRAY(20)-6000.)40*38*38
56 L=2
   IF L=0 SUCCESSFUL RETURN, ALL O K
   IF L=1 TEMP ARRAY UNCHANGABLE
   IF L=2 INCORRECT TEMP SELECTION, ERROR RETURN
C
C
C

```

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01M1284
01M1285
01M1286
01M1287
01M1288
01M1289
01M1290
01M1291
01M1292
01M1293
01M1294
01M1295
01M1296
01M1297
01M1298
01M1299
01M1300
01M1301
01M1302
01M1303
01M1304
01M1305
01M1306
01M1307
01M1308
01M1309
01M1310
01M1311
01M1312
01M1313
01M1314
01M1315
01M1316
01M1317
01M1318
01M1319
01M1320
01M1321
01M1322
01M1323
01M1324

```

RETURN
END

01H1325
01H1326

```

C      SUBROUTINE DUMP2(ENTRY)
C      SUBROUTINE DUMP2(ENTRY)
C      ***** UPDATED 2/14/63
C      DIMENSION A(40,41), ANS(40), BIBLE(15,15), COEFS(15,151), DATA(
C      * 3*20,151), CPHSDK(5,151), DATBU(4,65), FG(15), HEL(50), ITATE(
C      * 151), MASKEL(150), BM(15), MASKPR(150), MASKOR(150), MOUT(150),
C      * MASKS(150), NTAPE(4), NEL(50), NAME(2,151), TBREAK(3,151), IBREAK(151),
C      * (3,151), PARRAY(15), PRESS(150), PLN(150), TAPID(18), TARRAY(20),
C      * WORK(150), TITLE(18), IMAJOR(15), ABLOCK(10), KBLOCK(10)
C      11 / 15/ 61
C      COMMON A, ABLOCK, ANS, BM, BIBLE, BIGA, COEFS, CPHSDK, DATA, DATBU
C      * FG, HCMOLE, HC, HEL, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK, IL,
C      * IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, ITA, ITB,
C      * ITC, ITD, ITE, ITF, ITG, ITH, ITI, ITO, ITATE, IBREAK, IMAJOR,
C      * KA, KB, KC, KD, KE, KF, KG, KH, KI, LA, LB, LC, LD, LE, LF, LG, LH,
C      * LI, LJ, MASKEL, MASKOR, MOUT, MASKS, NA, NB, NC, ND, NE, NF, NG,
C      * NH, NI, NJ, NK, NTAPE, NAME, NEL, PRESS, PREF, PLN, SC, TITLE, TARRAY
C      * TEMP, TBREAK, TAPID, WORK, MASKPR, KBLOCK, PARRAY
C      ENTRY IS PRINTED OUT TO TELL POSITION OF PROGRAM AT TIME OF DUMP
C      IZ (IN COMMON) IS THE DUMP CONTROL VARIABLE
C      IZ=1 MATRIX, IZ=2 BIBLE, IZ=3 NEITHER, IZ=4
C      BOTH
C      C.J.LEINTZ      10/18/61
C      THE FOLLOWING IS ALWAYS PRINTED OUT
C      ENTRY=ENTRY
C      WRITE OUTPUT TAPE TO 100, ENTRY, IA, IB, IC, ID, IE, IF, IG, IH, IJ, IK,
C      1 IL, IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, NA, NB, NC, ND, NE, NF,
C      2 NG, NH, NI, NJ, NK, LA, LB, LC, LD, LE, LF, LG, LH, LI, LJ, KA, KB, KC, KD, KE, KF
C      100 FORMAT(1M1,7H ENTRY= F6,1,///5H IA=13,5H IB=13,5H IC=13,
C      15H ID=13,5H IE=13,5H IF=13,5H IG=13,5H IH=13,5H IJ=13,
C      25H IK=13,5H IL=13,5H IM=13,5H IN=13,5H IO=13,5H IP=13,
C      35H IQ=13,5H IR=13,5H IS=13,5H IT=13,5H IU=13,5H IV=13,
C      45H IW=13,5H IX=13,5H IY=13,5H IZ=13,5H NA=13,5H NB=13,
C      55H NC=13,5H ND=13,5H NE=13,5H NF=13,5H NG=13,5H NH=13,
C      65H NI=13,5H NJ=13,5H NK=13,5H LA=13,5H LB=13,5H LC=13,5H
C      75H LD=13,5H LE=13,5H LF=13,5H LG=13,5H LH=13,5H LI=13,
C      85H LJ=13,5H KA=13,5H KB=13,5H KC=13,5H KD=13,5H KE=13,
C      95H KF=13,5H)

```

```

WRITE OUTPUTTAPEITO,101,KG,KT,ITA,ITB,ITC,ITD,ITE,ITF,ITG,
1 ITH,ITI,ITO
101 FORMAT(5H KG=13.5H KT=13.6H ITA=13.5H ITB=13.
15H ITC=13.5H ITD=13.5H ITE=13.5H ITF=13.5H ITG=13.
25H ITH=13.5H ITI=13.5H ITO=13.5H)
WRITE OUTPUTTAPEITO,102,PREF,BIGA,TEMP,MC,SC
102 FORMAT(7H PREF=F9.4,5XSHBIGA=F11.5,5XSHTEMP=F11.5,
15X3HMC=F11.5,5X3HSC=F11.5/)
WRITE OUTPUTTAPEITO,103,NA,(IMAJOR(I),I=1,NA)
103 FORMAT(9H IMAJOR(13,1H),/(15I7))
WRITE OUTPUTTAPEITO,104,NA,(PARRAY(I),I=1,NA)
104 FORMAT(9H PARRAY(13,1H),/(15F7.3))
WRITE OUTPUTTAPEITO,106
106 FORMAT(1H,44X6HMASKPR,6H MOUT/16X5HITATE,20X6HMASKOR,
112H 1 1 MASKS/16X1H1,29X9H1 1 1 1/7X4HNAME,5X1HV,
26X5HPRESS,9X3HPLN,6X1HV,2X1HV,2X1HV,2H V,3X2HCP,
37X1HH,8X1HS,8X1HD,11X1HK)
DO 1 I=1,ND
1 WRITE OUTPUTTAPEITO,107,NAME(1,1),NAME(2,1),ITATE(1),PRESS(1),
1PLN(1),MASKOR(1),MASKPR(1),MOUT(1),MASKS(1),CPHSDK(1,1),
2CPHSDK(2,1),CPHSDK(3,1),CPHSDK(4,1),CPHSDK(5,1)
107 FORMAT(13X2A6,12,2PE14,6,0PE14,6,2I3,2I2,F7.3,F10.4,F8.3,F10.4,E14,
16)
GO TO (20,30,40,20),I2
C
C I2=1 OR 4, PRINTING OF MATRIX A(NC,NC+1) AND ANS(NC)
C
20 NC1=NC+1
WRITE OUTPUTTAPEITO,200,NC,NC1
200 FORMAT(1H1,2X9HMATRIX A(13,1H,13,1H)/)
DO 21 I=1,NC
21 WRITE OUTPUTTAPEITO,201,I,(A(I,J),J=1,NC1)
201 FORMAT(5H ROW13/(6E17.8))
WRITE OUTPUTTAPEITO,202,NC,(ANS(I),I=1,NC)
202 FORMAT(17X4HANS(13,1H),/(6E17.8))
GO TO (40,30,40,30),I2
C
C I2=2 OR 4, PRINTING OF BIBLE(NA,NA)
C
30 WRITE OUTPUTTAPEITO,300,NA,NA
300 FORMAT(1H1,2X13HMATRIX BIBLE(13,1H,13,1H)/)

```

01H1434
01H1435
01H1436
01H1437
01H1438
01H1439
01H1440
01H1441
01H1442
01H1443
01H1444
01H1445
01H1446
01H1447
01H1448
01H1449
01H1450
01H1451
01H1452
01H1453
01H1454
01H1455
01H1456
01H1457
01H1458
01H1459
01H1460
01H1461
01H1462
01H1463
01H1464
01H1465
01H1466
01H1467
01H1468
01H1469
01H1470
01H1471
01H1472
01H1473
01H1474

```

31 DO 31 I=1,NA
   WRITE OUTPUTTAPE(10,301,1,(B18LE(I,J),J=1,NA)
301 FORMAT(5H ROW13/(6E17.8))
40 RETURN
   END

```

```

01M1475
01M1476
01M1477
01M1478
01M1479

```

```

C          SUBROUTINE CROUT
C          SUBROUTINE CROUT ( A, ANS, NC, DETERM, NOERR)
C          SINGLE PRECISION MATRIX INVERSION AND
C          BACK SUBSTITUTION
C          8/28/61 H J VALE
C          DIMENSION A(40,41),M1(40),ANS(40),X(40)
C          NOERR=0
C          NOROW=NC
C          NOCOL=NOROW+1
C          DO 2 I=1,NOROW
C            M1(I)=1
C          2  TEST FOR ROW AND COLUMN REARRANGEMENT
C          DO 18 I=1,NOROW
C            A1=ABSF(A(I,1))
C            I1=I
C            I2=I
C            I3=I
C            DO 6 J=1,NOROW
C              DO 6 K=1,NOROW
C                IF(ABSF(A(I,J,K))-A1)6,6,4
C              4  I2=J
C              13=K
C              A1=ABSF(A(I,J,K))
C              6  CONTINUE
C              IF(I1-I2)8,12,12
C              DO 10 J1=1,NOCOL
C                Y=A(I1,J1)
C                A(I1,J1)=A(I2,J1)
C                A(I2,J1)=Y
C              10  IF(I1-I3)14,18,18
C              DO 16 J1=1,NOROW
C                Y=A(J1,I1)
C                A(J1,I1)=A(J1,I3)
C                A(J1,I3)=Y
C              16  M=M1(I1)
C                M1(I1)=M1(I3)
C                M1(I3)=M
C              18  CONTINUE
C              IF(A(I1,I2)20,20,22
C              20  NOERR=1
C              DETERM=0.

```

```

01H2230
01H2231
01H2232
01H2233
01H2234
01H2235
01H2236
01H2237
01H2238
01H2239
01H2240
01H2241
01H2242
01H2243
01H2244
01H2245
01H2246
01H2247
01H2248
01H2249
01H2250
01H2251
01H2252
01H2253
01H2254
01H2255
01H2256
01H2257
01H2258
01H2259
01H2260
01H2261
01H2262
01H2263
01H2264
01H2265
01H2266
01H2267
01H2268
01H2269
01H2270

```

```

22      RETURN
24      DO 24 I=2,NOCOL
      A(I,1)=A(I,1)/A(1,1)
      DO 30 I=2,NOROW
      DO 30 J=2,NOCOL
      KK=XMINOF(I,J)
      KO=KK-1
      SUM=0.
      DO 26 K=1,KO
      SUM=-A(I,K)*A(K,J)+SUM
      IF(ABSF(SUM+A(I,J))-1.E-7*ABSF(SUM)) 260,260,262
260      A(I,J)=0.
      GO TO 27
262      A(I,J)=SUM+A(I,J)
27      D=1.
      IF(J-1)30,30,28
28      D=A(K,K)
30      A(I,J)=A(I,J)/D
      X(NOROW)=A(NOROW,NOCOL)
      DO 320 I=2,NOROW
      M=NOROW-I+1
      X(M)=A(M,NOCOL)*1.E+07
      MP1=M+1
      DO 32 J=MP1,NOROW
      X(M)=X(M)-X(J)*A(M,J)*1.E+07
320      X(M)=X(M)/1.E+07
      N=1
      C      BACK SUBSTITUTE ANSWERS
34      IF(N-NOCOL)36,42,42
36      J=0
38      J=J+1
      IF(N-M1(J))38,40,38
40      ANS(N)=X(J)
      N=N+1
      GO TO 34
      42      DETERM=A(1,1)
      C      OBTAIN AND TEST DETERMINATE
      DO 44 I=1,NOROW
44      DETERM=DETERM+A(I,1)
      IF(ABSF(DETERM)-1.E-10)46,46,48
46      NOERR=2

```

```

01H2271
01H2272
01H2273
01H2274
01H2275
01H2276
01H2277
01H2278
01H2279
01H2280
01H2281
01H2282
01H2283
01H2284
01H2285
01H2286
01H2287
01H2288
01H2289
01H2290
01H2291
01H2292
01H2293
01H2294
01H2295
01H2296
01H2297
01H2298
01H2299
01H2300
01H2301
01H2302
01H2303
01H2304
01H2305
01H2306
01H2307
01H2308
01H2309
01H2310
01H2311

```

48 RETURN
END

01M2312
01M2313

```

SUBROUTINE PTABL(N,P1,PREF)
DIMENSION P(50)
IF(N)4,2,4
P(1)=1.
P(2)=1.04
P(3)=1.2
P(4)=1.4
P(5)=PREF/P1
P(6)=3.4023
P(7)=6.8046
P(8)=10.2069
P(9)=13.6091
P(10)=17.0114
P(11)=20.4137
P(12)=24.0229
P(13)=40.8275
P(14)=47.6323
P(15)=54.4366
P(16)=68.0457
P(17)=102.069
P(18)=136.091
P(19)=170.114
P(20)=400.0
P(21)=800.
P(22)=1000.
P(23)=1500.
P(24)=2000.
RETURN
P1=P(N)
RETURN
END

```

```

01M2314
01M2315
01M2316
01M2317
01M2318
01M2319
01M2320
01M2321
01M2322
01M2323
01M2324
01M2325
01M2326
01M2327
01M2328
01M2329
01M2330
01M2331
01M2332
01M2333
01M2334
01M2335
01M2336
01M2337
01M2338
01M2339
01M2340
01M2341
01M2342
01M2343
01M2344

```

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