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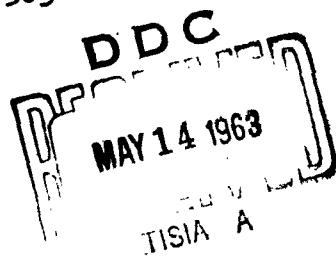
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FLAME SPEED DATA REDUCTION
AND CORRELATION USING A DIGITAL COMPUTER

TECHNICAL DOCUMENTARY REPORT ASD-TDR-63-182
February 1963

Flight Accessories Laboratory
Aeronautical Systems Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

Project No. 6075 Task No. 607505



(Prepared under Contract No. AF 33(657)-7617
by Monsanto Research Corporation, Dayton,
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FOREWORD

This report describes work performed under Contracts AF 33(616)-7757 and AF 33(657)-7617, "A Research Program for Understanding the Mechanisms of Flame Inhibition," and AF 33(616)-7458, "Fire-Resistant High Temperature Hydraulic Fluids." The former contract was initiated under Project No. 6075, "Flight Vehicle Hazard Protection," Task No. 607505, "A Research Program for Understanding the Mechanisms of Flame Inhibition." The latter was initiated under Project No. 7340, "Non-Metallic and Composite Materials," Task No. 734008, "Power Transmission, Heat Transfer Fluids, and Other Forms of Energy Transfer Fluids."

The contracts were performed at the Dayton Laboratory of Monsanto Research Corporation. The first two contracts were sponsored by the Flight Accessories Laboratory, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio with Mr. Benito P. Botteri serving as project engineer. The third contract was sponsored by the Directorate of Materials Processes, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio with Mr. Harold Adams as project engineer.

For Monsanto, the computer program was written by Dr. G. H. Ringrose of Monsanto Research Corporation and Dr. D. R. Miller and Dr. A. C. Pauls of Monsanto Chemical Company. Dr. G. B. Skinner served as project leader.

The authors are indebted to Dr. W. C. Hammann of Monsanto Chemical Company for the hand calculations that led to the adoption of the general mathematical approach. This contribution and the many helpful suggestions made by numerous people are acknowledged with gratitude. Particular assistance was given by Mr. D. J. Kaufman, also of Monsanto Chemical Company, who was instrumental in trouble shooting and expediting the machine solutions.

The routines were originally programmed and run on the IBM 704 computer in the Research and Engineering Division of Monsanto Chemical Company, St. Louis. Later the programs were adapted for solution by an IBM 7090, at the Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

ABSTRACT

Two digital computer routines were developed to process flame speed data resulting from the burning of compounds in air and oxygen, and to correlate particular structural configuration with flame speed.

In both routines a high degree of flexibility has been incorporated to assure efficient utilization under several foreseeable circumstances.

The first routine, FSC, processes the raw experimental data to obtain flame speeds, equivalence ratios, and the equivalence ratio at the maximum flame speed. This information is stored on a master magnetic tape for subsequent calculations.

The second routine, FSR, permits selection of specific data groups from the master tape for analysis. A linear model was chosen for the correlation.

This technical documentary report has been reviewed and is approved.


WILLIAM C. SAVAGE
Chief, Environmental Branch
Flight Accessories Laboratory

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FLAME SPEED DATA REDUCTION AND CORRELATION USING A DIGITAL COMPUTER

I. INTRODUCTION

Two Air Force-supported programs at this laboratory concern the relative rates of combustion of a number of chemical compounds. One program /AF 33(616)-74587 deals with the synthesis of potential high temperature hydraulic fluids and the other /AF 33(616)-76177 with increasing our understanding of the mechanisms of flame inhibition, the ultimate objective being the development of agents for extinguishing propellant fires.

Searches for effective fire-resistant fluids or propellant fire extinguishants would be systematized and expedited if a general method for characterizing, measuring, and predicting combustibility were at hand. Unfortunately, most flammability tests and specifications in use are so application-oriented or otherwise restricted as to be of only limited value for general use. A measure of the intrinsic ability of a material to support or inhibit combustion, as free as possible from influences peculiar to the testing procedure, is the first requisite. Given such a measure, there is then the possibility of relating combustibility to the molecular structures of materials tested and of predicting therefrom the combustibility of untested candidates.

This report describes computation routines designed to support the above approach. Flame speed - a state property of a combustible gas mixture - is the intrinsic measure of combustibility selected for use in characterization, correlation, and prediction. Earlier work, although limited to pure hydrocarbons burned in air, tends to confirm the approach adopted here.

The routines are programmed in the FORTRAN II language for IBM 7090 solution.

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II. THEORETICAL ASPECTS

Theoretical flame speed is commonly defined as the subsonic rate of perpendicular propagation of an infinite plane flame front through the quiescent combustible gas. External forces (for example, gravitational or magnetic fields) are presumed absent or insignificant, and the flame-induced flow is assumed to be laminar and one-dimensional.

When defined in this idealized manner, flame speed is a function only of the initial temperature, pressure, and composition of the combustible gas. It is thus an intensive state property of the gas, just as are density, enthalpy, viscosity, refractive index, and the like. Moreover, flame speed is a transport property dependent upon the rates of energy, momentum, mass, and chemical exchange accompanying combustion.

Prediction of flame speed from gas temperature, pressure, and composition is a long-standing goal of combustion research. A reasonably general and accurate method would be extremely useful in solving a range of practical and theoretical problems. Combustor and propulsion system design may be cited, in addition to the materials search problems underwriting the work of this report.

In principle, flame speeds can be predicted theoretically. Simultaneous solution of the differential equations of change is possible when all important physical-chemical properties (e.g., heats of reaction, reaction rate constants, density, diffusivities, emissivity, etc.) are known. Unfortunately, many of these properties are not yet known. Combustion reaction mechanisms are normally quite complex and are consequently poorly understood. Much remains to be done, even in the identification of intermediate chemical species.

While theory is of little practical utility, empirical correlations offer considerable promise. Hibbard and Pinkel (Ref. 1) achieved a good correlation of maximum flame speed of 37 hydrocarbons (mixed with air) versus the concentrations of the various C-H bond types present. The relation used was of the form

$$u_{\max} = \sum_j b_j (c_j)_{\max} \quad (1)$$

The concentration $(c_j)_{\max}$ of the j type bond is determined at the fuel-to-oxidizer ratio which yields the maximum flame velocity $u_{\max}$ and the corresponding influence coefficient for this bond is designated b_j . The average per cent deviation

between the measured and predicted maximum flame speeds was about 2% for the 37 hydrocarbons correlated.

The approach of Hibbard and Pinkel was extended by Hammann and Blake (Ref. 2) in calculation of flame speed coefficients of the various bond types in fuels containing oxygen, nitrogen, sulphur, boron, and silicon in addition to carbon and hydrogen. Their correlations were based upon data obtained experimentally by burning 142 model compounds and upon data reported by Gibbs and Calcote (Ref. 3). Several modifications of the correlation model, Equation 1, were tested and Equation 1A was found to provide the most acceptable correlation.

$$\frac{u_{\max}}{(c_f)_{\max}} = \sum_j b_j n_j \quad (1A)$$

The number of j-type contributors occurring in each molecule of fuel is designated n_j .

While the agreement between the predicted and measured flame speeds was not as good as for hydrocarbons alone, the results convincingly supported the general utility of the linear correlation technique. The computer routines described in this report were used by Hammann and Blake.

DEFINITIONS

The following terms are used frequently throughout the report:

Contributor A countable structural feature of a fuel molecule (e.g., each hydrogen bonded to a primary carbon in ethane, $\begin{array}{c} \text{H} \text{ H} \\ | \quad | \\ \text{HC}-\text{CH} \\ | \quad | \\ \text{H} \text{ H} \end{array}$, could be classed as a contributor).

Contributor number j An identifying code number which is assigned to each defined contributor (e.g., the primary-H contributor was assigned the code number 37).

Contributor count n_j (or n_{ij}) The number of j-type contributors contained in a molecule of fuel (or in a molecule of the i th fuel) (e.g., the contributor count of the contributor primary-H in the fuel ethane would be 6).

Fuel A material that forms a combustible mixture when mixed with an oxidant. Included are impurities, additives, and all compounds not included in the gaseous oxidant. For totalling the contributor count for mixed or composite fuels,

it is assumed that the over-all fuel has additive properties of the compounds present. For example, if z_1 is the mole fraction of compound 1 in the fuel, and n_{1j} is the count for contributor j, then

$$n_j = z_1 n_{1j} + z_2 n_{2j} + \dots$$

Oxidant The portion of the combustible mixture which includes the oxygen and inert gases but excludes the fuel.

Equivalence Ratio The actual fuel-to-oxygen ratio divided by the fuel-to-oxygen ratio stoichiometrically required for complete combustion of the fuel oxidizer. This is a measure of the richness or leanness of the flame.

Standard Error "standard deviation." Synonymous with the statistical quantity

Data Group A unit of data pertaining to a single fuel-oxidant combination burned at various equivalence ratios but otherwise under identical conditions. The components of a data group in the order in which they are stored by the computer on master tape 6 are:

(a) Serial Number Assigned sequentially by the computer in order of tape location.

(b) Fuel Name Alphabetic and/or numeric representation of the fuel, e.g., (n-Pentene-2). A maximum of 12 characters (including blanks) is permitted.

(c) Fuel Numbers Code numbers which are used to classify the types of fuel.

(1) Fuel Class Number General fuel type (e.g., 01-organic aliphatic; 02-organic aromatic, 00-inorganic).

(2) Fuel Group Number Denotes subclassification of fuel type (e.g., 06-saturated cyclic compound).

(3) Fuel Member Number An arbitrary code number, used to indicate sequence of experimental analysis of a particular group.

Thus for the fuel cyclopropane the fuel number is 010601.

(d) Data Source Number Designates the source of the data (e.g., 01-literature-, 02-experimental).

- (e) Experimental Conditions Number A code to distinguish data taken under different experimental conditions, such as temperature, pressure, per cent oxygen in oxidant, etc.
- (f) Flame speed at unity equivalence ratio, u_{stoc} (cm/sec).
- (g) Maximum flame speed, u_{max} (cm/sec).
- (h) Fuel concentration at unity equivalence ratio, $(c_f)_{stoc}$ (molecules/cc).
- (i) Fuel concentration at the conditions of maximum flame speed $(c_f)_{max}$ (molecules/cc).
- (j) Equivalence ratio at the maximum flame speed, ϕ_{max}
- (k) Number of different defined (i.e., coded) contributors in the fuel molecule.
- (l) List of the contributor code numbers with their respective counts for the fuel considered.

III. DESCRIPTIVE OUTLINE OF THE CALCULATIONS

An analysis of the computations required to reduce the experimental data and perform the regression analyses led to the separation of the problem into two sections. The first section processes the raw experimental data and calculates the flame speeds, concentrations, and equivalence ratios. These quantities are then stored on a master reel of magnetic tape. The second section, namely, the flame speed regression section, uses this reel of magnetic tape as its input data. From these data, the regression coefficients of the flame speeds and other dependent variables are determined.

Corresponding to each of these sections is a Fortran routine that is described in detail in a later section. A general discussion of these routines follows.

DATA REDUCTION (Routine FSC)

The data reduction routine calculates the flame speed and related quantities from the raw data, tests these quantities for inconsistencies, and prepares or corrects the master reel of magnetic tape with acceptable data.

Flame Speed The calculations are based upon the conical (Bunsen) burner method for flame speed determination. Measured flows of the several components of the mixture are passed in laminar flow through a burner tube at a controlled temperature and pressure. A roughly conical flame front is stabilized at the mouth of the tube.

The large density gradient in the gas stream at the flame front permits the use of schlieren photographic techniques to record the flame profile. It is assumed that the flame is symmetrical about its vertical axis. Figure 1 is schlieren photograph of a typical flame cone.

The flame speed is determined by dividing the total volumetric gas flow rate by the area of the flame front. Since the flame cone photographed is seldom a "right circular cone," its surface area must be determined from measurements at several intermediate points. To do so, the diameter is measured at several heights of the cone as illustrated in Figure 2. The surface area between any two of these diameter measurements is assumed to be that of a frustrum of a right circular cone. The sum of the surface areas of these frustra gives a fairly accurate value of the true flame front area. Actually, the local flame speed is slightly above the average at the cone tip



Fig. 1 Schlieren Photograph of a Flame Cone

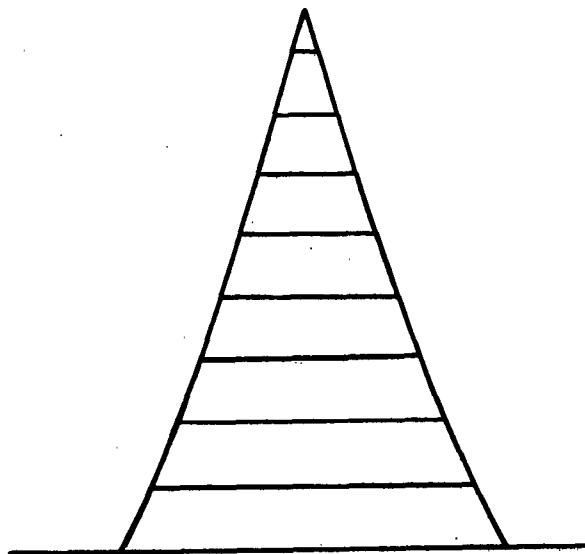


Fig. 2 Diagram of Flame Cone Profile

and slightly below the average at the base. Therefore, the calculated flame speed must be considered an average value only. Evidence has shown that there is a slight dependence of flame speed on the total volumetric flow rate of the gases, the burner part geometry, and the burner part temperature. Slight influences are also made by the method used to define the cone area (i.e., schlieren shadow, or radiant photography). However, by standardizing on one of the techniques, this variable can be eliminated.

Valid Data Tests Once a series of flame speeds has been obtained, it is necessary to determine the conditions for maximum flame speed (since the correlations proposed are based on conditions at the maximum flame speed). This is accomplished by fitting an empirical curve of flame speed vs. equivalence ratio (u vs. ϕ) to the data and solving the equation for the maximum. The flame speed at stoichiometric conditions ($\phi = 1$) is also determined.

If a maximum flame speed lies within the data range the data are acceptable for further tests. If no maximum or a minimum is found within the data range, the data are not acceptable.

Storage on Magnetic Tape Data groups termed acceptable are stored on a master reel of magnetic tape for use by the regression routine.

Options The computational routine contains several options depending upon the form of the input data. These options permit sections of the computational procedure to be omitted. For example, a set of flame speed vs. equivalence ratio data available from previous calculations could be entered directly into the sequence, and the original raw data calculations would be by-passed. These options are detailed in Section VI.

FLAME SPEED REGRESSION (Routine FSC)

A multiple linear regression model similar to that used by Hibbard and Pinkel (Ref. 1) (but including a constant term) was selected:

$$y = b_0 + \sum_j b_j n_j \quad (2)$$

Independent Variables In equation (2) the independent variables were chosen to be the contributor counts rather than the contributor concentration. This simplifies the prediction and data handling, and adds flexibility by making the "independent" variables more independent. This is true because the

contributor concentrations depend upon the mixture temperature, pressure, equivalence ratio, and oxidant composition, as well as upon fuel composition. A simple relation exists between the contributor counts and concentration, as shown in Equation 3:

$$c_j = n_j c_f \quad \text{molecules/cc} \quad (3)$$

where c_f is the concentration of fuel in the combustible mixture. Multiplying Equation 2 by c_f gives the equivalent of the Hibbard-Pinkel model ($b_0 = 0$).

Dependent Variables For the reasons mentioned above, the dependent variable y would be set equal to $u_{\max}/(c_f)_{\max}$ when the coefficients comparable to those published by Hibbard and Pinkel are wanted. However, this is not the only dependent variable of possible interest. In predictions of maximum flame speed, for example, it is necessary to predict fuel concentration (or fuel-oxidant ratio, or equivalence ratio) at maximum flame speed. This is most readily done by correlating fuel concentration (etc.) at maximum flame speed against contributor counts. Correlations at stoichiometric fuel-oxidant ratio may be equally interesting. To emphasize that such other dependent variables can be handled with equal facility, the indefinite dependent variable y is used.

Coefficients With the emphasis so far given to fuel composition, it is appropriate to recall that calculated b_j 's are not constants. Values will depend on several or all of the following (depending on the definition of y):

1. initial mixture temperature
2. initial mixture pressure
3. some specification of fuel-oxidant ratio
4. oxidant composition
5. contributor definitions
6. dependent variable definition

The above list includes the primary state properties. Since experimental flame speeds (distinguished from theoretical flame speeds) are always obtained under conditions differing from the ideal, values of b_j will be related to:

7. experimental conditions (oxidant composition, temperature, pressure, etc.
8. source of data (laboratory, technique, journal reference, etc.

All listed factors should be considered when sets of coefficients are compared.

Block Regressions Obtaining a full set of coefficients is basically a stepwise trial-and-error process. The trial-and-error enters in the definition of contributors (i.e., independent variables). Since it is not known at the outset which structural features will give the best correlations, it is necessary to accommodate definition of new contributors as the analysis progresses. In addition, it is desirable and most efficient to calculate certain coefficients using only a particular class of fuels. C-H bond coefficients, for example, are most readily and accurately determined from flame speed data on hydrocarbons. If accurately determined, a coefficient should be applicable unchanged in later regressions.

The above considerations indicated that a "block regression" procedure (certain coefficients held constant) would be most advantageous. This procedure may be expressed mathematically by Equation 4:

$$y - \sum_s b_s n_s = b_o + \sum_u b_u n_u \quad (4)$$

The b_s coefficients represent those whose values are known, and are termed the "prespecified coefficients." The b_o and b_u coefficients are those to be determined by the regression analysis. The constant term b_o may be either calculated or prespecified as zero.

Block Selection Criteria All of the data groups that are acceptable for regression analysis are stored on a single master reel of magnetic tape. Seven different accept-reject tests are available for selection of these data. The selecting criteria comprise (1) data group serial number, (2) fuel class number, (3) fuel class-group number, (4) fuel member number, (5) data source number, (6) experimental conditions number, and (7) fuel contributor content.

For flexibility, these tests may be ignored, or applied singly or in any combination. The tests are described in detail in the following section.

IV. MATHEMATICAL OUTLINE OF THE CALCULATIONS

FLAME SPEED DATA REDUCTION CALCULATIONS (Routine FSC)

Functions Performed The functions performed by Routine FSC may be classed in five groupings. The portions of the computer program used in each function are enclosed in parentheses.

Function 1 (Subroutines EXPD 1 or EXPD 3)

Given: (a) Combustion mixture, temperature and pressure
(b) Fuel stoichiometric oxygen demand
(c) Mole fraction of O₂ in oxidant
(d) Molar volume of fuel
(e) Volumetric flow rate of oxidant
(f) Flame envelope dimensions

Calculate: (a) Volumetric flow rate of mixture
(b) Area of flame envelope
(c) Flame speed
(d) Equivalence ratio

(a) Volumetric flow rate of the mixture, q_m

$$w_x = q_x^*/22,414 \quad \text{g-moles/sec} \quad (5)$$

$$w_f = q_f/v_f \quad \text{g-moles/sec} \quad (6)$$

w_f and w_x are the molar flow rates of the fuel and oxidizer and q_f and q_x^{*} are the volumetric flow rates in cc/sec (the latter at S.T.P.). v_f is the molar volume of the fuel and must be based on the same fuel density as q_f.

$$v_m = 62,366(t_m + 273.15)/P_m \quad \text{cc/g-mole} \quad (7)$$

where v_m is the molar volume of the mixture and t_m (°C) and P_{mv} (atm.) are the temperature and pressure of the mixture.

$$\text{Therefore: } q_m = (w_x + w_f)v_m \quad \text{cc/sec} \quad (8)$$

(b) Area of flame envelope, A

The increment of surface area ΔA_1 between any two heights h_1 and h_{1-1} is given by

$$\Delta A_1 = \pi \left(\frac{D_{1-1} + D_1}{2} \right) \sqrt{(h_1 - h_{1-1})^2 + \left(\frac{D_{1-1} - D_1}{2} \right)^2} \text{ cm}^2 \quad (9)$$

where D_1 is the measured diameter at the upper height and D_{1-1} is that at the lower height. The total surface area of the flame is calculated by summing these increments over the whole height

$$A = \sum_{i=1}^n \Delta A_i \quad \text{cm}^2 \quad (10)$$

(c) Flame speed, u

Once the total flame area has been determined, flame speed can be easily calculated:

$$u = q_m / A \quad (11)$$

(d) Equivalence ratio, ϕ

From its definition as the actual fuel-to-oxygen ratio divided by the stoichiometric fuel-to-oxygen ratio, the equivalence ratio is calculated:

$$\phi = (w_f / w_o) / (w_f / w_{ost}) \quad (12)$$

where w_o is the molar flow rate of oxygen used in the experiment and w_{ost} is that rate required for complete reaction.

$$\text{But } w_o = w_x z_{ox} \quad \text{g-moles/sec} \quad (13)$$

$$\text{and } w_{ost} = w_f r_{st} / 2 \quad \text{g-moles/sec} \quad (14)$$

where z_{ox} is the mole fraction of oxygen in the oxidant and where r_{st} is the number of atoms of oxygen required to completely oxidize one molecule of fuel.

$$\text{Therefore } \phi = w_f r_{st} / 2 w_x z_{ox} \quad (15)$$

Function 2 (Subroutine MAXM)

Given: A series of experimental values of flame speed vs. equivalence ratio. (The flow rates are the only controllable variables.)

Calculate: (a) Maximum flame speed
(b) Flame speed at stoichiometric conditions
(c) Equivalence ratio at maximum flame speed

(a) Maximum flame speed, $u_{\max}$

Past work has shown that curves of u vs. ϕ generally are concave from below with a maximum in the vicinity of $\phi=1$. Figure 3 is an example of such a curve.

Many of the curves are fairly symmetrical in the vicinity of the peak and are nearly parabolic in shape. Others are fairly asymmetrical and are better approximated by a higher order power series. To find the peak of a given series of measured values of u vs. ϕ , the data are fitted with an equation of the form

$$u = \sum_{r=1}^R a_r \phi^{r-1} \quad \text{cm/sec} \quad (16)$$

The method of calculating the "a" coefficients depends upon the number of points available, N . If $N = 4$, a perfect cubic fit ($R = 4$) is obtained by solution of the simultaneous equations

$$u_n = \sum_{r=1}^R a_r \phi_n^{r-1} \quad n = 1, \dots, R \quad (17)$$

If $N > 4$, a least square cubic fit ($R = 4$) is obtained by the solution of the "normal regression equations."

$$\sum_{n=1}^N u_n \phi_n^{r-1} = \sum_{q=1}^R (a_q \sum_{n=1}^N \phi_n^{r+q-2}) \quad r = 1 \dots R \quad (18)$$

The normal regression equations are the result of a mathematical treatment on the original polynomial, Equation 17. An explanation of the analysis may be found in statistics texts such as Hoel (Ref. 6).

Solution of these equations gives the set of "a" coefficients which minimize the residual sum of the squares:

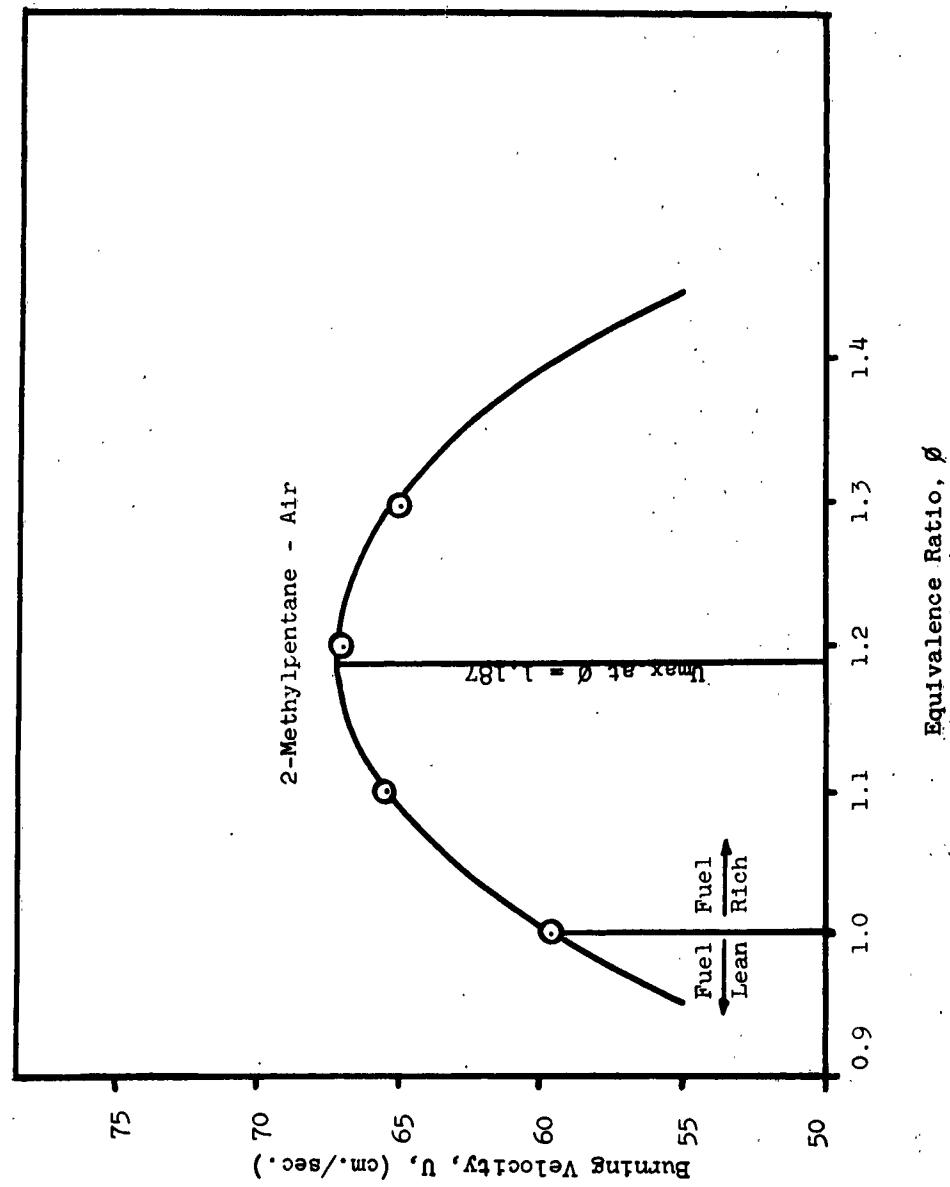


Fig. 3 Typical Curve Showing Burning Velocity, U , vs. Equivalence Ratio, ϕ

$$Q = \sum_{n=1}^N (u_n - \hat{u}_n)^2 \quad (19)$$

where $\hat{u}_n$ represents a predicted value.

The standard deviation of u about $\hat{u}$ is

$$S = \sqrt{Q/(N-R)} \quad \text{cm/sec} \quad (20)$$

If the calculated standard deviation is greater than the one specified, the cubic fit is declared unsatisfactory and a parabolic fit using Equation 18 with $r=3$ is tried. If the standard deviation is still too high, the data set is ignored.

If only three points are available, a perfect parabolic fit, $r=3$, is obtained in the manner of Equation 17. Less than three points are not considered since they cannot define a curve with a maximum.

(b) Equivalence ratios

(1) Cubic maximum Once the cubic fitting procedure has been satisfactorily completed, it is necessary to determine the maximum point ($u_{\max}, \phi_{\max}$) of the curve. Two additional factors must be considered. The maximum velocity must occur within the data range considered, and a minimum velocity must not occur within the data range. If either of these conditions is violated, a parabolic fit is attempted.

Double differentiation of Equation 17 with $r=4$ gives

$$\dot{\hat{u}} = a_2 + 2a_3\phi + 3a_4\phi^2 \quad (21)$$

$$\text{and } \ddot{\hat{u}} = 2a_3 + 6a_4\phi \quad (22)$$

At the maximum

$$\dot{\hat{u}}_{\max} = 0 \quad (23)$$

$$\text{and } \ddot{\hat{u}}_{\max} < 0 \quad (24)$$

Solving Equations 21 - 24 yields

$$\phi_{\max} = (a_3/3a_4)(1 \pm \sqrt{1 - 3a_2a_4/a_3^2}) \quad (25)$$

$$\text{and } 0 > \ddot{\hat{u}}_{\max} = 2a_3 + 6a_4\phi_{\max} \quad (26)$$

The inequality shows that the upper sign is to be used in Equation 26 when a_3 is positive, and vice versa.

For a real maximum to exist, three conditions must be fulfilled:

$$a_4 \neq 0 \quad (27)$$

$$a_3 \neq 0 \quad (28)$$

$$1 - 3a_2a_4/a_3^2 > 0 \quad (\text{real roots}) \quad (29)$$

(ii) Cubic minimum The equivalence ratio at the minimum point ($u_{\min}, \phi_{\min}$) of the cubic equation must also be determined:

$$\phi_{\min} = -(a_3/3a_4)(1 \mp \sqrt{1 - 3a_2a_4/a_3^2}) \quad (30)$$

The upper sign is understood to hold when a_3 is positive, and vice versa. This equivalence ratio must not lie within the data range.

(iii) Parabolic maximum When a satisfactory parabolic fit is obtained, $\phi_{\max}$ is given by

$$\phi_{\max} = -a_2/2a_3 \quad (31)$$

in which a_3 must be negative.

Function 3 (Executive routine)

- Given: (a) Combustion mixture temperature and pressure
 (b) Fuel stoichiometric oxygen demand
 (c) Mole fraction of O_2 in oxidant
 (d) Equivalence ratio at maximum flame speed

- Calculate: (a) Fuel concentration at maximum flame speed
 (b) Fuel concentration at stoichiometric conditions

(a) Fuel concentration at $u_{\max}, (c_f)_{\max}$ For any value of the equivalence ratio ϕ , the fuel concentration is given by

$$c_f = \frac{(6.0238 \times 10^{23})_{\text{pm}}}{62,366(t_m + 273.15)(1 + r_{st}/2\phi z_{ox})} \quad (32)$$

molecules cc

Therefore $(c_f)_{\max} = c_f$ evaluated at $\phi = \phi_{\max}$ (33)

Similarly, (b) Fuel concentration at $\phi = 1$, $(c_f)_{\text{stoc}}$

$(c_f)_{\text{stoc}} = c_f$ evaluated at $\phi = 1$ (34)

Function 4 (Executive Routine)

Given: (a) Results listed above
(b) Composition, source, conditions and related input information

Action: Stores in memory only acceptable data groups

Function 5 (Subroutine Tape)

Given: (a) Acceptable groups stored in memory and on master tape 6
(b) Changes to be made in the data already on the master tape

Action: (a) Edit the existing master tape data
(b) Add new data groups to the master tape

In all cases, the input data, intermediate values, and output values are printed out at each step.

Function Options Four options are provided to permit portions of the program to be by-passed. The options would be exercised if portions of the experimental data had been processed previously or if outside data were to be used.

1. Complete calculation (Functions 1 through 4)
2. Partial calculation (Functions 2 through 4)
3. No calculation (Function 4)
4. Tape writing (Function 5 - follows successful execution of the other options)

FLAME SPEED REGRESSION CALCULATIONS (Routine FSR)

Functions Performed Routine FSR prepares the input data tape for the Esso Regression Analysis subroutine. Its operation may be considered in three stages:

Function 1

- Given: (a) All data groups currently stored on master tape 6.
(b) A list of data group accept/reject tests

Action: Selects and stores up to 300 data groups passing the accept/reject tests

Seven different tests are available for accepting or rejecting data groups now recorded on the master tape for the regression analysis. These tests may be employed in any combination desired, including omission of any or all. A limit of 300 acceptable data groups has been imposed for each regression run. If more than 300 could pass the tests, only the first 300 doing so are accepted for regression.

(a) Data group serial number test Those data groups whose serial numbers (machine assigned in order of tape position) are given in an input specification list are unacceptable.

(b) Fuel class test Only those data groups whose fuel class numbers are specified in an input list are acceptable.

(c) Fuel group test Only those data groups whose fuel class-group numbers are specified in an input list are acceptable.

(d) Fuel member test Only those data groups whose fuel class-group-member numbers are not specified in an input list are acceptable.

(e) Data source test Only those data groups whose source number corresponds to an input source number are acceptable.

(f) Experimental conditions test Only those data groups whose experimental conditions number corresponds to an input conditions number are acceptable.

(g) Contributor count tests Data groups may be acceptable or unacceptable depending on the presence or absence of given contributors in the fuel molecule. In addition, the counts of any specified contributors may be assumed zero whether they are zero or not on the master tape.

Function 2

- Given:
- (a) All data groups selected as above
 - (b) Dependent variable numerator and denominator code numbers
 - (c) A list of prespecified coefficients with their corresponding contributor numbers

Calculate: Adjusted and scaled dependent variables for regression

(a) Dependent variable calculation The basic regression problem is to determine the b_u and b_o coefficients in the equation

$$y = b_o + \sum_u b_u n_u \quad (35)$$

such that the sum of the squares of the difference between the actual and predicted values is minimized. Routine FSR provides the option to define the dependent variable y provided the independent variables are still contributor counts. Thus, if regression of the maximum flame speed on contributor concentrations at maximum flame speed is desired, y would be defined

$$y = u_{\max} / (c_f)_{\max} \quad (36)$$

The dependent variable y may be any quantity expressible as a simple ratio of any two of the following quantities:

<u>Quantity</u>	<u>Identification Number</u>
1.0	1
u_{stoc}	2
u_{max}	3
$(c_f)_{\text{stoc}}$	4
$(c_f)_{\text{max}}$	5
ϕ_{max}	6

(b) Dependent variable adjustment If it is desired to prespecify (and therefore not calculate) some of the b coefficients in a given problem, it is necessary to adjust

the dependent variable by subtracting the contributions associated with the prespecified coefficients. Equation 37 indicates the procedure

$$y'_1 = y_1 - \sum_s b_s n_{1s} \quad (37)$$

(c) Dependent variable scaling To avoid exceeding the numerical limit of the computer (10^38) during the regression calculations, all of the final dependent variables are scaled (i.e., multiplied by a constant factor)

$$Y_1 = y'_1 \cdot 10^E \quad (38)$$

so that the largest Y_1 in a given problem does not exceed 1000.

Function 3

Given: (a) All data obtained above
(b) Input lists of overriding regression control data (optional)

Action: For each valid regression problem store on tape 7:

- (a) Output page heading
- (b) Regression control data
- (c) Independent variable values (contributor counts)
- (d) Adjusted and scaled dependent variable values

The regression analysis routine, a modification of SHARE E-R-MPR2, requires input data for the control of calculation and printing. One of the functions of routine FSR is to supply the needed data in the proper form. Although this is done automatically using internally stored values, input control data may be given if it is desired to override any of these values.

In all cases the important input data and intermediate and output values are printed for each function listed above.

V. THE COMPUTER PROGRAM

FLAME SPEED DATA REDUCTION (Routine FSC)

Routine FSC consists of an executive, or master control program and the eight subroutines listed below.

1. EXPD1
2. EXPD3
3. MAXM
4. TAPE
5. CROUT
6. INPUT
7. VDECOM
8. DECDCP

Section IV contained a brief outline of the functions of the executive routine and the first four subroutines listed above. Here, these shall be discussed in more detail.

Executive Routine The executive routine controls the selection of five of the eight subroutines. The first data card in each group contains information regarding the option to be performed, the use of EXPD1 or EXPD3 and the use of MAXM. The executive routine reads this card and sequences the operations accordingly. Diagnostic code numbers are present in each of the subroutines and if any of these are exercised the executive routine will cause the printout of a diagnostic. If subroutine MAXM indicates that the data processed were satisfactory, the executive routine will store the pertinent values in memory prior to their addition to the master tape. Two small calculations, $(cf)_{st}$ and $(cf)_{max}$ are also made. It has been attempted to indicate each step in the actual program with "comment cards", and for convenience a nomenclature list precedes each routine. These can be found in Appendix A.

Subroutines EXPD1 and EXPD3 Both subroutines perform the same basic calculation of total cone area, flame speed, and equivalence ratio. However, the respective data outputs differ slightly. It was considered less confusing if each alternative had its own subroutine. Which subroutine to use is determined mainly by the intended use of the data after processing.

If the data to be processed are to be considered for addition to the master tape, subroutine EXPD1 should be used. In this subroutine, one experimental run number pertains to the entire data group and the input and output are set up accordingly.

If a set of control data are run sequentially, subroutine EXPD3 should be used. Each calculation is listed sequentially in the output to avoid confusion of the output with that from EXPD1. Sample printouts from both subroutines may be found in Appendix A.

Subroutines MAXM and CROUT Subroutine MAXM analyzes the data to see if either a valid cubic maximum or a parabolic maximum occurs within the data range. Subroutine CROUT solves the equations generated for the regression coefficients. As the logic used in subroutine MAXM is more involved than in the others, a brief stepwise description is presented.

1. If the number of experiments (or points) per data group is 1 or 2, signal that the data are "bad" and return to the executive routine. If there are 3 points, go to step 6; otherwise go to step 2.
2. Calculate the cubic coefficients either from the cubic polynomial (4 points) or from the "normal regression equations" (more than 4 points), as indicated in Section IV. If the calculation is successful, go to step 3; if not, to step 6.
3. Check cubic maxima criteria (coefficients zero or imaginary square root). If all are satisfied go to step 4; if not, to step 6.
4. Calculate $\phi_{\max}$ and $\phi_{\min}$. Check for $\phi_{\max}$ inside data range and $\phi_{\min}$ outside data range of ϕ . If so, go to step 5; if not, to step 6.
5. Calculate u_{stoc} , $u_{\max}$, $\hat{u}_n$, absolute and per cent differences between u_n and $\hat{u}_n$, and standard deviation S . If S is less than or equal to a specified value, signal the data "good" and return to the executive routine; if greater, signal the data "bad" and return to the executive routine.
6. Calculate the parabolic coefficients from the quadratic polynomial (3 point) or from the "normal regression equations" (more than 3 points). If the calculation succeeds, go to step 7; if not, to step 9.
7. Check for negative coefficient a_3 (curve concave downwards). If so, calculate $\phi_{\max}$ and go to step 8; if not, to step 9.

8. Check for $\phi_{\max}$ inside ϕ data range. If so, go to step 5; if not, to step 9.

9. Signal the data "bad" and return to the executive routine.

Subroutine TAPE This subroutine controls all operations that change the contents of the master tape. The first portion of the routine scans the tape and makes the alterations to the data groups that were specified on an input data card. The second section permits the alteration or addition of contributor code numbers and names. The third section adds to the master tape the new data groups that were either approved by MAXM or entered via option 3. The final section is used only for the initial makeup of the master tape. Once the tape contains some data the other portions of the program may be used without a sequencing diagnostic.

Subroutines INPUT, VDECOM, and DECDCP These subroutines facilitate preparation of the input data cards by permitting a variable width format. The complete card format is described in Section VI.

FLAME SPEED REGRESSION (Routine FSR)

Routine FSR prepares the input data for the E-R-MPR2 Esso Multiple Regression subroutine. It does not alter the input data (with the exception of scaling the dependent variable), but serves only for selecting the appropriate data for the regression analysis. In addition, control data are supplied for the Esso program.

Accept/Reject Tests Seven tests are provided for accepting or rejecting data groups. The first six tests are simple yes/no choices and were explained in Section IV. These tests are listed below.

1. Data group serial number test
2. Fuel class test
3. Fuel group test
4. Fuel member test
5. Data source test
6. Experimental conditions test

Test 7, the contributor count test, is more complicated and will be explained here in detail.

Data groups will be found acceptable or unacceptable depending upon the presence or absence of particular contributors in the fuel molecule. In addition, the counts of any contributor may be set equal to zero. The code numbers and test operation are listed below.

- zero test - The count of the specified contributor(s) is set to zero
- one test - The count of this contributor may be either zero or positive.
- two test - The count of this contributor must be zero or the group will be rejected.
- three test- The count of this contributor must be positive or the group will be rejected.
- four to nine tests - Six tests are available to select data groups on the basis of a particular contributor content. The acceptance of a data group may be conditional upon it containing (+) and/or excluding (-) a certain number of a list of contributors. An example should clarify this.

Example

The data card types are given an alphabetic identification. The contributor count tests are specified on a "P" type card and the conditional tests on a "Q" type card.

(a) Sample P-type Card 1, 0, 15, 1,
16, 0, 27, 4, 29, 5, 32, 3, 33, 5, 34,
4, 37, 2, 40, 6, 61, 0.

Interpretation

Apply zero test (0) to contributors
number 1-14, 16-26, 61 and up
Apply one test (1) to contributor
number 15
Apply two test (2) to contributors
number 37-39
Apply three test (3) to contributor
number 32

The above tests are specific; the following are conditional:

Apply four test (4) to contributors
number 27, 28, 34-36
Apply five test (5) to contributors
number 29-31, 33
Apply six test (6) to contributors
number 40, 41

(b) Corresponding Q-type Card

+3, -2, +1

Interpretation

Four test; the data group must contain (+) at least 3 contributors from the list 27, 28, 34-36.

Five test; the data group must not contain (-) at least 2 contributors from the list 29-31, 33.

Six test; the data group must contain either contributor 40 or 41.

NOTE: Conditional tests 7 to 9 were not used in the example.

Dependent Variable Limitations Up to 10 different dependent variables may be regressed in a single computer run (problem numbers 1 to 10). All problems in the same run share a common list of regression control data and operate on the same set of selected data groups.

Regression Control Data The regression analysis subroutine, a modification of SHARE E-R-MPR2, requires several pieces of information for the control of calculation and printing. One function of routine FSR is to supply the needed data in the proper form. This is done automatically using internally stored values. Only when it is desired to override one or more of the internal values is it necessary to supply input control data. Internally stored values are given in the following list.

<u>Item</u>	<u>Description</u>	<u>Built-in Value</u>
Dec. 1	Tolerance	0.001*
2	F value for entering variable	0.00002*
3	F value for removing variable	0.00001*
Int. 1	Problem number	calculated
2	Number of variables	calculated
3	Number of points (data groups)	calculated
4	Weighting factors given	1 (no)
5	Intermediate steps printed	0 (yes)*
6	Raw sums of squares and cross products printed	1 (no)*
7	Averages to be printed	1 (no)*
8	Residual sums of products to be printed	1 (no)*
9	Partial correlation coefficients to be printed	1 (no)*
10	Predicted values (Y_i 's) to be printed	0 (yes)*
11	Constant term (b_0) to be assumed non-zero	1 (no)*

Values marked with an asterisk may be overridden by input values.

VI. USE OF THE COMPUTER PROGRAMS

Both routines have been written in the standard FORTRAN II language compatible with most large-scale computing equipment. A maximum of four magnetic tape units are required in addition to any tape units used for input-output operations. The routines, as presented in Appendices A and B, are programmed to be compatible with the IBM 7090 Monitor system, with Tape 2 designated as the input and Tape 3 as the output.

Two additional routines have been included to avoid the storage of the master data tape over a period of time. Routine FSRDM will prepare a master data deck, or modify an existing data deck from information contained on the master data tape. Routine FSRTL will prepare a tape from the master data deck. These routines are presented in Appendix C.

INPUT DATA DECK PREPARATION

The programs accept the standard IBM type, 80-column punched cards. However, only columns 1 to 72 may contain information to be processed by the computer. It is recommended that columns 73-80 be used for some type of identification both for the users standpoint as well as for the computing center.

All decimal input data and most integer input data are processed via subroutines VDECOM and DECDCP before being used in the computation portion of the main routine. The use of these subroutines simplifies data card preparation to the extent that field widths may be neglected. It is only necessary to provide a blank space or a comma between entries on the data cards. One restriction is imposed though. No entry may end in column 72 on the data card.

FLAME SPEED DATA REDUCTION

The input data deck may consist of several sets of cards depending on the nature of the data and the option applicable. If only the calculated flame speed is of interest, an unlimited number of data sets may be entered. If, however, options 1, 2, or 3 are used for the purpose of adding data groups to the master tape, an option 4 must follow every 20 sets or less. This limitation is imposed because of the internal storage requirements of the program. Options 1, 2, or 3 may be run in any order.

To simplify the makeup of the data decks, each card fulfilling a specific purpose has been assigned an alphabetic code letter. Below are listed the data deck requirements for each of the options available. The actual makeup of the cards follows.

Option 1 Calculation of Flame Speeds from Raw Data

The first four card types set up the calculation sequence and define certain general conditions. The remaining cards contain the experimental measurements for each flame photograph. Thus, for a total of N_2 photographs, the card order would be:

<u>Card Order</u>	<u>Card Type</u>
1	A
2	X
3	B
4	C
5 to $N_2 + 4$	D

Certain entries on the A card determine whether or not a full calculation or just the flame speeds are required. If the latter is the case, any number of these sets may be submitted, otherwise the maximum number before a tape writing sequence is 20. N_2 is limited to 10.

Option 2 Calculations for Given Equivalence Ratios and Flame Speeds

The first four card types are similar to those mentioned above. The last card contains the predetermined flame speeds and equivalence ratios.

<u>Card Order</u>	<u>Card Type</u>
1	A
2	X
3	B
4	C
5	E

Option 3 All Final Values Given

Only the information on the first three card types is required.

<u>Card Order</u>	<u>Card Type</u>
1	A
2	X
3	B

Option 4 Tape Writing and Editing

The first card type remains the same. The second card type contains information about the remaining two card types.

<u>Card Order</u>	<u>Card Type</u>
1	A
2	F
3	G
4	H

Card Content by Card Type All numerical input data for routine FSC are processed by subroutines VDECOM and DECDCP. In the listings below, all integer quantities are designated Int. and all floating point quantities (e.g. .002 or 2.E-3 or 2.-3) are designated Dec. The only restrictions on preparation of these cards are that column 72 must be blank and each entry must be separated by at least one blank or comma. Readin of alphanumeric input is accomplished with an "A" format and the card column designations below must be maintained.

A Card

Entry 1	Int.	1000, card identification
2	Int.	Run number (1 to 9999)
3	Int.	4, number of integer entries following
4	Int.	Option number (1 to 4)
5	Int.	EXPD, subroutine number (1 or 3)
6	Int.	N ₀ , number of inhibitors present
7	Int.	MAXM, subroutine switch (0-use, 1-bypass)
8	Int.	1, number of decimal entries following
9	Dec.	0., dummy entry

X Card

Entry	Columns	
1		Int. 0000, card identification
2		Int. 0, dummy entry
3		Int. 0, dummy entry
4	13-24	Alphabetic, fuel name
5	25-36	Alphabetic, date
6	37-48	Alphabetic, inhibitor name
7	49-60	Alphabetic, inhibitor name

A maximum of ten inhibitor names may be entered. These names must follow sequentially on the data cards and must occupy twelve columns per name. Columns 1 to 12 on each card, however, must contain the three integer entries listed above. Thus, if N_0 were 4, the fuel name, data and three inhibitor names would go on the first X card while the fourth name would appear in Columns 13 to 25 of the second X card.

B Card

Entry 1	Int.	2000, card identification
2	Int.	Run number
3	Int.	7, number of integer entries following
4	Int.	Option number (1 to 3)
5	Int.	Fuel class number (0 to 99)
6	Int.	Fuel group number (0 to 99)
7	Int.	Fuel member number (0 to 99)
8	Int.	Data source number (1 to 9999)
9	Int.	Experimental condition number (1 to 9999)
10	Int.	N_1 , number of contributors listed on following B cards (1 to 100)
11	Int.	5, number of decimal entries following
12	Dec.	Flame speed at stoichiometric conditions (cm/sec)*
13	Dec.	Maximum flame speed (cm/sec)*
14	Dec.	Fuel concentration at stoichiometric conditions (molecules/cc)*
15	Dec.	Fuel concentration at maximum flame speed (molecules/cc)*
16	Dec.	Equivalence ratio at maximum flame speed*

*Enter 0.0 when these values are not known (i.e., for options 1 and 2)

B Card Continuation

Entry 1	Int.	2001, card identification
2	Int.	Run number
3	Int.	N_2 , number of integer entries following ($N_2 \leq 10$)
4 to N_2+3	Int.	Contributor code numbers
N_2+4	Int.	N_2 , number of decimal entries following
N_2+5 to $2N_2+5$	Dec.	Contributor count

If more than ten contributors are present, additional continuation cards may be used. For each subsequent continuation card increase the card identification number by one (1).

C Card

Entry	1	Int.	3000, card identification
	2	Int.	Run number
	3	Int.	2, number of integer entries following
	4	Int.	Option number (1 or 2)
	5	Int.	N ₃ , number of experiments in data group (EXPDI) or number of experimental runs (EXPDI) (i.e., number of D cards)
	6	Int.	7, number of decimal entries following
	7	Dec.	Mixture temperature (°C)
	8	Dec.	Mixture absolute pressure (mm Hg)
	9	Dec.	Stoichiometric oxygen ratio (atoms oxygen/molecule fuel)
	10	Dec.	Mole fraction O ₂ in oxidant
	11	Dec.	Volume per mole of fuel at given fuel flow rates (cc/gram-mole)
	12	Dec.	Maximum allowable standard deviation in u vs. ϕ curve for addition to tape (assumed 1.0 cm/sec if 0.0 entered)
	13	Dec.	Actual distance between teeth tips seen on schlieren photograph (cm) (assumed to be 0.2 cm if 0.0 entered)

D Card

Entry	1	Int.	4000, card identification
	2	Int.	Run number
	3	Int.	2, number of integer entries following
	4	Int.	1, option number
	5	Int.	N ₄ , number of diameter measurements listed on continuation card (1 to 100)
	6	Int.	6, number of decimal entries following
	7	Dec.	Fuel flow at mole volume of entry 11 on C card
	8	Dec.	Oxidant flow at STP (cc/sec)
	9	Dec.	Mole fraction of inhibitor in final mixture
	10	Dec.	Measured peak height (arbitrary units)
	11	Dec.	Reference length (cm)
	12	Dec.	Reference length (arbitrary units)

D Card Continuation

Entry	1	Int.	4001, card identification
	2	Int.*	Run number
	3	Int.	N_5 , number of integer entries following
	4 to $N_5 + 3$	Int.**	Station height of diameter measurement (1 = cone base)
	$N_5 + 5$ to $2N_5 + 5$		Cone diameter (arbitrary units)

*For data processing by subroutine EXPD1, the run number on each D card must be the same as that on the A, B and C cards. For processing by routine EXPD3, the run number is to be incremented by one for each subsequent D card.

**The station heights correspond to the "teeth locations referred to in the C card description. The distance between twenty reference teeth was accurately known. As all flame speed measurements were made on a microfilm reader, it was found to be more accurate and more convenient to measure the flame diameters and teeth spacing in any suitable units (say mm) and have the computer rescale the measurements to the desired units.

E Card

Entry	1	Int.	5000, card identification
	2	Int.	Run number
	3	Int.	1, number of integer entries following
	4	Int.	2, option number
	5	Int.	N_3 , number of flame speed - equivalence ratio entries (1 - 10)

E Card Continuation

Entry	1	Int.	5001, card identification
	2	Int.	Run number
	3	Int.	1, number of integer entries following
	4	Int.	0, dummy entry
	5	Int.*	N_3 , number of flame speed equivalence ratio entries
	6 to $6 + N_3$	Dec.	

* N_3 is entry 5 on the C card and must not have a value exceeding 10.

F Card

Entry	1	Int.	6000, card identification
	2	Int.	Run number
	3	Int.	5, number of integer entries following
	4	Int.	4, option number
	5	Int.	N_6 , number of G-card groupings to follow (0 to 20)(contributor count changes)
	6	Int.	N_7 , number of entry pairs on H-card (0 to 50)(contributor name changes)
	7	Int.	7, for initial tape makeup, otherwise zero
	8	Int.	0, for other than last data card set; 1, for last set
	9	Int.	1, number of decimal entries to follow
	10	Dec.	0., dummy entry

G Card

Entry	1	Int.	7000, card identification
	2	Int.	Run number
	3	Int.	2, number of integer entries following
	4	Int.	Data group serial number
	5	Int.	N_8 , number of entry pairs in contributor count change list (0 to 90)
	6	Int.	1, number of decimal entries following
	7	Dec.	0., dummy entry

G Card Continuation

Entry	1	Int.	7001, card identification
	2	Int.	Run number
	3	Int.*	N_9 , number of integer entries following (0 to 10)
	4 to N_9+3	Int.	Contributor number
	N_9+4	Int.	N_9 , number of decimal entries following
N_9+5 to $4+2N_9$		Dec.	Contributor count

*If $N_8 > 10$ additional continuation cards will be required. The card identification number must be incremented by one on each continuation card.

H Card

Columns 1 to 4	0000
6	0
8	0
13 - 16	contributor number
25 - 28	contributor number
...	
61 - 64	contributor number
* 19 - 24	alphabetic contributor name
31 - 36	alphabetic contributor name
...	
67 - 72	alphabetic contributor name

*There are to be five entry pairs per H card. If N_7 from the F card is greater than 5, continue the listing on additional cards at five pairs per card.

Fortran Routine The Fortran II program is listed in Appendix A with sample printouts. Duplicate decks of this program are available.

FLAME SPEED REGRESSION

The number and type of cards comprising the data deck will depend upon the number of tests and changes wanted. To facilitate the deck makeup, each specific data card has been given an alphabetic code letter from I through U. Card types I, J, K, and T in the deck are mandatory with the K-type card containing control integers governing the number and type of all but one of the remaining cards.

<u>Card Order</u>	<u>Card Type</u>
1	I
2	J
3	K
Next, unless $N_2 = 0$	L
Next, unless $N_3 = 0$	M
Next, unless $N_4 = 0$	N
Next, unless $N_5 = 0$	O
Next, unless $N_6 = 0$	P

<u>Card Order</u>	<u>Card Type</u>
Next, unless $N_7 = 0$	Q
Next, unless $N_8 = 0$	R
Next, unless $N_9 = 0$	S
Next	T } *
Next, unless $N_{10} = 0$	U }

* N_1 pairs of these cards may be used ($N_1 \leq 10$). The T card contains N_{10} and hence governs the use of the U type card.

Card Content by Card Type With exception of the I, J, R and U type cards, all input data to routine FSR are integers. A fixed format is used to accomplish this with four spaces allotted to each entry (18I4). The type U cards are decomposed in sub-routines VDECOM and DECDCP with the same limitations as described for routine FSC. When card column designations are given, they must be adhered to.

I Card - Subtitle Information for Routine FSR Printout

Column	1	Alpha	Blank
	2-72	Alpha	Subtitle

J Card - Title for Regression Program Printout

Column	1	Alpha	One (1)
Column	2-72	Alpha	Title

K Card - Routine FSR Control Card

Entry	1	Int.	Regression run number (1 to 9999)
	2	Int.	N_1 , number of dependent variable choices in this run
	3	Int.	N_2 , number of entries in input list (L card) of unacceptable data group serial numbers (0 to 300)
	4	Int.	N_3 , number of entries in input list (M card) of acceptable fuel class numbers () to 13)
	5	Int.	N_4 , number of entries in input list (N card) of acceptable fuel class group numbers (0 to 40)
	6	Int.	N_5 , number of entries in input list (O card) of unacceptable fuel class-group-member numbers (0 to 80)
	7	Int.	Acceptable data source number (0 to 999, 0 means all sources acceptable).

Entry	8	Int.	Acceptable experimental conditions number (0 to 999, 0 means all conditions acceptable)
	9	Int.	N_6 , number of entry pairs in input list (P card) of contributor count tests (0 to 200)
	10	Int.	N_7 , number of entries in input list (Q card) of conditional count test criteria (0 to 6)
	11	Int.	N_8 , one if overriding decimal regression control data (R card) to be read; otherwise zero
	12	Int.	N_9 , number of entry pairs in input list (S card) of overriding integer regression control data (0 to 7)
	13	Int.	Highest contributor number in use (1 to 200, higher ones ignored)
	14	Int.	1, for the last run, otherwise zero

L Card

Entry 1 to N_2	Int.	Unacceptable data group serial numbers ($N_2 \leq 300$)
------------------	------	---

M Card

Entry 1 to N_3	Int.	Acceptable fuel class numbers ($N_3 \leq 20$)
------------------	------	---

N Card

Entry 1 to $2N_4$	Int.	Acceptable fuel class-group numbers ($N_4 \leq 40$) paired.
-------------------	------	---

O Card

Entry 1 to $3N_5$	Int.	Unacceptable fuel class-group-members ($N_5 \leq 80$) in trios.
-------------------	------	---

P Card (see "Contributor Count Tests")

Entry 1,3 $2N_6-1$	Int.	Contributor number N_6 pairs
2,4 $2N_6$	Int.	Contributor count test ($N_6 \leq 200$)

Q Card

Entry 1 to N_7	Int.	Conditional count test criteria. First entry goes with test 4, second with 5, etc. ($N_7 \leq 6$)
------------------	------	---

R Card (see "Regression Control Data")

Columns 1 to 10 Dec.	Tolerance
11 to 20 Dec.	F value for entering variable
21 to 30 Dec.	F value for removing variable

S Card (see "Regression Control Data")

Entry 1,3 $2N_9-1$ Int.	Integer regression control item number	
2,4 $2N_9$ Int.	Overriding integer regression control data	$N_9 \leq 7$

T Card

Entry 1	Int.	Dependent variable numerator identification number (1 to 6)
2	Int.	Dependent variable denominator identification number (1 to 6)
3	Int.	N_{10} , number of entry pairs in input list (U card) of prespecified regression coefficients for this problem (0 to 50)

U Card

Entry 1	Int.	1, card number
2	Int.	Run number
3	Int.*	N_{11} , number of integer and decimal pairs to follow
4 to $3+N_{11}$	Int.	Contributor number
$N_{11}+4$	Int.	N_{11}
$N_{11}+5$ to $4+2N_{11}$	Dec.	Prespecified coefficient

*If $N_{10} > 10$ additional U type cards will be required until all of the contributor numbers and coefficients are entered. The card number must be incremented by one for each additional card.

Fortran Routine The Fortran II program for routine FSR is listed in Appendix B. Duplicate decks of this program are available.

MASTER DATA DECK LOADING AND MODIFICATION

Routine FSRTL The only data cards required by the routine are those of the master data deck itself. The card image of this deck will be read onto logical tape 6 which will then be given an end of file and rewound.

Routine FSRDM If it is desired to update the master data deck, routine FSRDM will cause any or all of the data groups on the master tape to be punched. The master tape must be logical tape 6. All control data for the routine are integers and a fixed format is used which provides a six-column field width (12I6).

First control card for Routine FSRDM

Entry	1	Int.	Number of data groups in the master data card deck
	2	Int.	N_1 , number of data groups which have been altered since last deck makeup
	3	Int.	Punch contributor name list? (1=yes, 2=no)
	4	Int.	Punch dependent variable name list? (1=yes, 2=no)

If none of the data groups have been modified, $N_1 = 0$ and the routine will punch only those data groups added since the last makeup. If $N_1 \neq 0$ an additional control card is required.

Second control card for Routine FSRDM

Entry 1 to N_1	Int.	Serial number of data groups that have been modified since last deck makeup.
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The Fortran II programs for routines FSRTL and FSRDM are listed in Appendix C. Duplicate decks of these programs are available.

VII. NOMENCLATURE

a	Power series fitted coefficient
A	Area of flame schlieren cone, cm ²
b	Regression coefficient
c	Number concentration, cm ⁻³
D	Diameter of flame schlieren cone, cm
E	Dependent variable scaling exponent
h	Height above burner port, cm
n	Contributor count, no./molecule
N	A number
p	Absolute pressure, mm Hg
q	Volumetric flow rate, cm ³ /sec.
Q	Residual sum of squared differences
r	Atoms of oxygen per molecule of fuel
R	Maximum value of r subscript
S	Standard deviation
t	Temperature, °C
u	Flame speed, cm/sec.
v	Molar volume, cm ³ /g-mole
w	Molar flow rate, g-moles/sec.
x	Independent variable
y	Dependent variable
Y	Adjusted and scaled dependent variable
z	Mole fraction
Δ	Increment prefix
π	3.14159 ...
ϕ	Equivalence ratio

Subscripts

f	Of fuel
i	Data group index, block regression
j	Contributor index (or number)
m	Of combustible mixture
min	At minimum of cubic fitting equation
max	At maximum flame speed
n	Height index
o	Of oxygen, or zero index
p	At peak of flame cone
q	Dummy r index
r	Term index, u- ϕ curve
s	Specified (or prespecified)
stoc	Stoichiometric
u	Unspecified (to be calculated by regression)
x	In oxidant

Superscripts

$\wedge$	Calculated from a fitted equation
*	At STP (0°C, 760 mm Hg abs.)
'	Adjusted
.	First derivative
..	Second derivative

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APPENDIX A

Fortran Program and Sample Printouts
for Routine FSC

ROUTINE FSCX

FLAME SPEED CALCULATION EXECUTIVE PROGRAM

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C FSCX 2018 FEB 20, 1962 FLAME SPEED CALCULATIONS MOD 2 FSCX 1
C EXECUTIVE ROUTINE FOR FLAME SPEED CALCULATIONS MRC - DAYTON FSCX 2
C NOMENCLATURE FSCX 3
C A1(1) AND A2(1) - FUEL NAME FSCX 4
C AL(K,L) - NUMBER OF STRUCTURAL CONTRIBUTORS PER MOLECULE FSCX 5
C CNK - FUEL CONCENTRATION AT MAXIMUM FLAME VELOCITY FSCX 6
C (MOLECULES / CC) FSCX 7
C CSTOC - FUEL CONCENTRATION AT STOICHIOMETRIC FSCX 8
C CONDITIONS (MOLECULES / CC) FSCX 9
C DU AND TE - FIRST AND SECOND HALVES OF DATE FSCX 10
C I, K, AND M - COUNTING INTEGERS FSCX 11
C I1A(1) - FUEL CLASS NUMBER FSCX 12
C I1B(1) - FUEL GROUP NUMBER FSCX 13
C I1C(1) - FUEL MEMBER NUMBER FSCX 14
C I2(1) - DATA SOURCE NUMBER FSCX 15
C I3(1) - EXPERIMENTAL CONDITIONS NUMBER FSCX 16
C I4(1) - NUMBER OF STRUCTURAL CONTRIBUTORS CONSIDERED FSCX 17
C IADD - NUMBER OF DATA GROUPS ACCEPTABLE FOR WRITING FSCX 18
C ICANT - OPTION CONTROL INTEGER CHECK FSCX 19
C ICTL - OPTION CONTROL INTEGER FSCX 20
C IEXPD - EXPD. SUBROUTINE SELECTION INTEGER FSCX 21
C INHIB1(J,I) AND FSCX 22
C INHIB2(J,I) - INHIBITOR NAMES FSCX 23
C IPN - NUMBER OF EXPERIMENTS FSCX 24
C J1(K,L) - SPECIES CONTRIBUTOR CODE NUMBER FSCX 25
C KODE - SIGNAL INTEGER FOR ACCEPTABLE DATA FSCX 26
C NKUN - RUN NUMBER OF DATA GROUP FSCX 27
C NRUNT - RUN NUMBER CHECK FSCX 28
C O(N) - EQUIVALENCE RATIOS FSCX 29
C NUMINH - NUMBER OF INHIBITORS USED FSCX 30
C OISK - ATOMS OF OXYGEN TO COMPLETELY OXIDIZE ONE FSCX 31
C MOLECULE OF FUEL FSCX 32
C OMX - EQUIVALENCE RATIO AT MAXIMUM FLAME VELOCITY FSCX 33
C PM - ABSOLUTE PRESSURE OF GAS MIXTURE (MM. MERCURY) FSCX 34
C STDS - MAXIMUM ALLOWABLE STANDARD DEVIATION OF U VS. FSCX 35
C D CURVE FOR ADDITION TO TAPE FSCX 36
C D AND DINI - EQUIVALENCE RATIO FSCX 37
C U AND UIN - FLAME SPEED (CM./SEC) FSCX 38
C TEETH - ACTUAL DISTANCE BETWEEN TEETH TIPS SEEN ON FSCX 39
C SCHLIEREN PHOTOGRAPH (CM.) FSCX 40
C TM - MIXTURE TEMPERATURE (DEG. C) FSCX 41
C UNX - MAXIMUM FLAME SPEED (CM./SEC) FSCX 42
C USTOC - FLAME SPEED AT STOICHIOMETRIC CONDITIONS FSCX 43
C (CM./SEC) FSCX 44
C VBFO - VOLUME PER MOLE OF FUEL (CC./GRAM-MOLE) FSCX 45
C VBM - VOLUME PER MOLE OF MIXTURE (CC./GRAM-MOLE) FSCX 46
C YOX - MOLE FRACTION OXYGEN IN OXIDANT FSCX 47
C COMMON INT, DEC, IC, J11, J2, J3, NIN, NEX FSCX 48
C DIMENSION INT(10), DEC(10) FSCX 49
C DIMENSION A1(20), A2(20), B1(100,20), DA(6,20), I1A(20), I1B(20), FSCX 50
C I1C(20), I2(20), I3(20), I4(20), J1(100,20), O(10), U(10) FSCX 51
C , INHIB1(10,20), INHIB2(10,20) FSCX 52
C NIN = 1 FSCX 53
C 20 IADD = 0 FSCX 54
C 30 CALL INPUT FSCX 55
C NEX = NEX FSCX 56
C GO TO (31, 321, 701, 300, 901, 300, 300, 300), NEX FSCX 57
C A CARD ASSIGNMENTS FSCX 58
C 31 NRUN = J11 FSCX 59
C ICTL = INT(1) FSCX 60
C IEXPD = INT(2) FSCX 61
C NUMINH = INT(3) FSCX 62
C MAXON = INT(4) FSCX 63
C IF (NRUN) 32, 210, 32 FSCX 64
C 32 IF (NUMINH) 320, 320, 33 FSCX 65
C 320 NUMINH = 1 FSCX 66
C OPTION SELECTION FSCX 67
C 33 IF (ICTL = 4) 40, 150, 30 FSCX 68
C 40 IF (ICTL = 1, 30, 50) FSCX 69
C 50 I = IADD + 1 FSCX 70
C X CARD READING FSCX 71
C 52 READ INPUT TAPE 2, 1002 FSCX 72
C , A1(1), A2(1), DU, TE, (INHIB1(J,I), INHIB2(J,I), J=1, FSCX 73
C NUMINH) FSCX 74
C GO TO 30 FSCX 75
C B CARD ASSIGNMENTS FSCX 76
C 521 NUMCON = IC - 2000 FSCX 77
C IF (NUMCON) 523, 522, 523 FSCX 78
C 522 NRUNT = J11 FSCX 79
C ICANT = INT(1) FSCX 80
C I1A(1) = INT(2) FSCX 81
C I1B(1) = INT(3) FSCX 82
C I1C(1) = INT(4) FSCX 83
C I2(1) = INT(5) FSCX 84
C I3(1) = INT(6) FSCX 85
C K1 = INT(7) FSCX 86
C DO 5220 K = 2, 6 FSCX 87
C 5220 DA(K,I) = DEC(K-1) FSCX 88
C GO TO 30 FSCX 89
C 523 IF (NRUNT = J11) 300, 5230, 300 FSCX 90
C 5230 LIMIT = 10 * NUMCON FSCX 91
C IGO = LIMIT - 9 FSCX 92
C IF (LIMIT = K1) 525, 525, 524 FSCX 93

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FLAME SPEED CALCULATION EXECUTIVE PROGRAM

```

524 LIMIT = K1                                FSCX 107
525 M = 0                                      FSCX 108
DO 526 K = 1GO, LIMIT                          FSCX 109
M = M + 1                                      FSCX 110
J1(K,1) = INT(M)                              FSCX 111
526 B1(K,1) = DEC(M)                          FSCX 112
IF (LIMIT - K1) 30, 53, 30                    FSCX 113
53 14(1) = K1                                  FSCX 114
C                                              FSCX 115
C PRINTOUT OF INPUT DATA                      FSCX 116
C WRITE OUTPUT TAPE 3, 1010                     FSCX 117
V, NRUN, DU, TE                               FSCX 118
WRITE OUTPUT TAPE 3, 1011                     FSCX 119
WRITE OUTPUT TAPE 3, 1012                     FSCX 120
9 A1(1), A2(1), (INM1B1(J,1), INM1B2(J,1), J=1, NUMINM) FSCX 121
WRITE OUTPUT TAPE 3, 1013                     FSCX 122
9 11A(1), 11B(1), 11C(1), 12(1), 13(1)       FSCX 123
WRITE OUTPUT TAPE 3, 1014                     FSCX 124
9 (DAIK,1), K=2,6)                            FSCX 125
WRITE OUTPUT TAPE 3, 1015                     FSCX 126
9 (J1(K,1), B1(K,1), K=1, K1)                FSCX 127
C                                              FSCX 128
C RUN NUMBER CONSISTENCY CHECK                 FSCX 129
IF (NRUN - NRUNT) 200, 55, 200                FSCX 130
C                                              FSCX 131
C CONTROL INTEGER CHECK                       FSCX 132
C 55 IF (1CTL - 1CANT) 200, 60, 200           FSCX 133
C                                              FSCX 134
C OPTION SELECTION                            FSCX 135
60 IF (1CTL - 2) 70, 70, 120                  FSCX 136
70 GO TO 30                                    FSCX 137
C                                              FSCX 138
C C CARD ASSIGNMENTS                          FSCX 139
701 NRUNT = J11                                FSCX 140
1CANT = INT(1)                                FSCX 141
IPN = INT(2)                                  FSCX 142
TM = DEC(3)                                   FSCX 143
PM = DEC(2)                                   FSCX 144
OFSR = DEC(3)                                 FSCX 145
VOX = DEC(4)                                  FSCX 146
VHFO = DEC(5)                                 FSCX 147
STDS = DEC(6)                                 FSCX 148
TEETH = DEC(7)                                FSCX 149
74 WRITE OUTPUT TAPE 3, 1017                   FSCX 150
WRITE OUTPUT TAPE 3, 1019                     FSCX 151
9 TM, PM, OFSR, VOX, VHFO                     FSCX 152
C                                              FSCX 153
C RUN NUMBER CONSISTENCY CHECK                 FSCX 154
IF (NRUN - NRUNT) 200, 71, 200                FSCX 155
C                                              FSCX 156
C CONTROL INTEGER CHECK                       FSCX 157
71 IF (1CTL - 1CANT) 200, 75, 200             FSCX 158
75 VBM = 62366.0 * (TM + 275.15) / PM         FSCX 159
CSTOC = 6.0238E23 / (VBM * 11.0 + OFSR / (2.0 * VOX)) FSCX 160
C                                              FSCX 161
C EXPERIMENTAL DATA PROCESSING               FSCX 162
C GO TC (80, 90), 1CTL                        FSCX 163
80 GO TO (82, 83, 83), IEXPD                  FSCX 164
82 CALL EXPD1(NRUN, 1CTL, OFSR, VOX, VBFO, VBM, IPN, O, U, KODE, TEETH, FSCX 165
1 NRUNT)                                       FSCX 166
GO TO 84                                       FSCX 167
83 CALL EXPD3(NRUN, 1CTL, OFSR, VOX, VBFO, VBM, IPN, O, U, KODE, TEETH, FSCX 168
1 NRUNT)                                       FSCX 169
84 IF (KODE - 3) 81, 100, 81                  FSCX 170
90 GO TO 30                                    FSCX 171
C                                              FSCX 172
C E CARD ASSIGNMENTS                          FSCX 173
901 NUMCON = 1C - 5000                        FSCX 174
IF (NUMCON) 904, 902, 904                    FSCX 175
902 NRUNT = J11                                FSCX 176
1CANT = INT(1)                                FSCX 177
DO 903 N = 1, IPN                            FSCX 178
903 O(N) = DEC(N)                             FSCX 179
GO TO 30                                       FSCX 180
904 DO 905 N = 1, IPN                         FSCX 181
905 U(N) = DEC(N)                             FSCX 182
C                                              FSCX 183
C RUN NUMBER CONSISTENCY CHECK                 FSCX 184
IF (NRUN - NRUNT) 200, 91, 200                FSCX 185
C                                              FSCX 186
C CONTROL INTEGER CHECK                       FSCX 187
91 IF (1CTL - 1CANT) 200, 100, 200            FSCX 188
C                                              FSCX 189
C DETERMINATION OF MAXIMUM FLAME SPEED         FSCX 190
100 CALL MAXM (IPN, O, U, OMX, UM, USTOC, KODE, STOS, IEXPD, MAXON, FSCX 191
1 NRUNT)                                       FSCX 192
C                                              FSCX 193
C TEST FOR SUCCESSFUL DETERMINATION OF MAXIMUM FLAME SPEED FSCX 194
IF (KODE - 3) 30, 110, 30                     FSCX 195
C                                              FSCX 196
C TEST FOR REASON FOR UNSUCCESSFUL DETERMINATION OF MAX SPEED FSCX 197
81 IF (KODE - 1) 30, 200, 30                  FSCX 198
110 CMX = 6.0238E23 / (VBM * 11.0 + OFSR / (OMX * VOX * 2.0)) FSCX 199

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(CONTINUED)

FSCX	213
FSCX	214
FSCX	215
FSCX	216
FSCX	217
FSCX	218
FSCX	219
FSCX	220
FSCX	221
FSCX	222
FSCX	223
FSCX	224
FSCX	225
FSCX	226
FSCX	227
FSCX	228
FSCX	229
FSCX	230
FSCX	231
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FSCX	300
FSCX	301
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FSCX	303
FSCX	304
FSCX	305
FSCX	306
FSCX	307
FSCX	308
FSCX	309

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SUBROUTINE EXPD1

EXPERIMENTAL FLAME SPEED DATA REDUCTION

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EXPDI EXPDI SUBROUTINE MOD 0 MARCH 1, 1962 MRC-DAYTON EXPDI 1
C EXPDI 2
C Nomenclature EXPDI 3
C AN - CUMULATIVE CONE AREA = 2/P1 EXPDI 4
C A(N) - TOTAL CONE AREA (SQUARE CM.) EXPDI 5
C D(K) - CONE DIAMETER AT ABOVE ELEVATION (CM.) EXPDI 6
C DA(K) - MEASURED DIAMETER AT ABOVE ELEVATION EXPDI 7
C DELS - INCREMENT SLANT HEIGHT (CM.) EXPDI 8
C ELA - REFERENCE LENGTH MEASURED IN UNITS OF DA(K) EXPDI 9
C ELCM - REFERENCE LENGTH MEASURED IN CM. EXPDI 10
C FMI(N) - MOLE FRACTION OF INHIBITOR IN MIXTURE EXPDI 11
C H(K) - ELEVATION ABOVE BURNER TOP (CM.) EXPDI 12
C HPKA - MEASURED PEAK HEIGHT EXPDI 13
C ICANT - OPTION CONTROL INTEGER CHECK EXPDI 14
C IH(K) - MEASURED ELEVATION ABOVE BURNER TOP EXPDI 15
C IPK - TOTAL NUMBER OF CONE MEASUREMENTS EXPDI 16
C IPN - NUMBER OF EXPERIMENTS EXPDI 17
C IRK - NUMBER OF DIAMETER MEASUREMENTS PER RUN EXPDI 18
C KODE - SIGNAL INTEGER FOR ACCEPTABLE DATA EXPDI 19
C NRUN - RUN NUMBER OF DATA GROUP EXPDI 20
C NRUNT - RUN NUMBER CHECK EXPDI 21
C O AND OIN - EQUIVALENCE RATIO EXPDI 22
C OFSR - ATOMS OF OXYGEN TO COMPLETELY OXIDIZE ONE EXPDI 23
C MOLECULE OF FUEL EXPDI 24
C OFOIN - FUEL FLOW (CC./SEC. AT VBFD MOLAL VOLUME) EXPDI 25
C UMIN - VOLUME FLOW OF MIXTURE (CC./SEC. AT ACTUAL EXPDI 26
C TEMPERATURE AND PRESSURE) EXPDI 27
C OXOIN - OXIDANT FLOW (CC./SEC. AT 0 DEG. C, 760 MM. HG) EXPDI 28
C SF - SCALE FACTOR (CM./UNITS OF DA(K)) EXPDI 29
C TEETH - ACTUAL DISTANCE BETWEEN TEETH TIPS SEEN ON EXPDI 30
C SCHLIEREN PHOTOGRAPH (CM.) EXPDI 31
C U AND UIN - FLAME SPEED (CM./SEC) EXPDI 32
C VBFD - VOLUME PER MOLE OF FUEL (CC./GRAM-MOLE) EXPDI 33
C VBM - VOLUME PER MOLE OF MIXTURE (CC./GRAM-MOLE) EXPDI 34
C WF - FUEL FLOW (GRAM-MOLES/SEC.) EXPDI 35
C WK - OXIDANT FLOW (GRAM-MOLES/SEC.) EXPDI 36
C YOX - MOLE FRACTION OXYGEN IN OXIDANT EXPDI 37
C SUBROUTINE EXPDI(NRUN,IC1,OFSR,YOX,VBFD,VBM,IPN,O,U,KODE,TEETH, EXPDI 38
C NRUNT) EXPDI 39
C COMMON INT, DEC, IC, J11, J2, J3, NIN, NEX EXPDI 40
C DIMENSION INT(10), DEC(10) EXPDI 41
C DIMENSION A(100), O(100), DA(100), H(100), IH(100), FMI(15) EXPDI 42
C O(15), OFO(15), OMI(15), OXO(15), U(15) EXPDI 43
C WRITE OUTPUT TAPE 3, 1010 EXPDI 44
C L = 0 EXPDI 45
C KODE = 3 EXPDI 46
C DO 100 N=1,IPN EXPDI 47
C 10 CALL INPUT EXPDI 48
C NEX = NEX EXPDI 49
C IF(NEX - 4) 200, 11, 200 EXPDI 50
C 11 NUMCON = IC - 4000 EXPDI 51
C IF(NUMCON) 13, 12, 13 EXPDI 52
C D CARD ASSIGNMENTS EXPDI 53
C 12 NRUNT = J11 EXPDI 54
C ICANT = INT(1) EXPDI 55
C IRK = INT(2) EXPDI 56
C OFOIN = DEC(1) EXPDI 57
C OXOIN = DEC(2) EXPDI 58
C FMI(N) = DEC(3) EXPDI 59
C HPKA = DEC(4) EXPDI 60
C ELCM = DEC(5) EXPDI 61
C ELA = DEC(6) EXPDI 62
C GO TO 10 EXPDI 63
C 13 IF(NRUN) = J11) 200, 141, 200 EXPDI 64
C 141 LIMIT = 10* NUMCON EXPDI 65
C IGO = LJMLT - 9 EXPDI 66
C IF(LIMIT - IRK) 142, 142, 140 EXPDI 67
C 140 LIMIT = IRK EXPDI 68
C 142 M = 0 EXPDI 69
C DO 143 K = IGO, LIMIT EXPDI 70
C M = M + 1 EXPDI 71
C IH(K) = INT(M) EXPDI 72
C 143 DA(K) = DEC(M) EXPDI 73
C IF(LIMIT - IRK) 10, 144, 10 EXPDI 74
C 144 IF(TEETH) 14, 15, 14 EXPDI 75
C 15 TEETH = 0.2 EXPDI 76
C 14 SF = ELCM / ELA EXPDI 77
C IPK = IRK + 1 EXPDI 78
C TEST FOR MORE THAN ONE HUNDRED MEASUREMENTS EXPDI 79
C IF(IPK-100) 19, 30 EXPDI 80
C 19 DO 20 K = 1, IRK EXPDI 81
C H(K) = TEETH * FLOATE(IH(K)-1) EXPDI 82
C 20 D(K) = DA(K) * SF EXPDI 83
C CALCULATION OF PEAK HEIGHT IN CM. EXPDI 84
C H(IPK) = HPKA * SF EXPDI 85
C D(IPK) = 0.0 EXPDI 86
C JPK1 = 1 EXPDI 87
C PRINTOUT OF FLAME FRONT DIMENSIONS EXPDI 88
C TEST FOR MORE THAN TEN MEASUREMENTS EXPDI 89
C IF(IPK-10) 24, 24, 21 EXPDI 90
C 21 DO 23 JPK=1, IPK, 10 EXPDI 91
C IF(L-48) 230, 230, 231 EXPDI 92
C 231 WRITE OUTPUT TAPE 3, 1020 EXPDI 93
C L=0 EXPDI 94
C EXPDI 95
C EXPDI 96
C EXPDI 97
C EXPDI 98
C EXPDI 99
C EXPDI 100
C EXPDI 101
C EXPDI 102
C EXPDI 103
C EXPDI 104
C EXPDI 105
C EXPDI 106

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EXPERIMENTAL FLAME SPEED DATA REDUCTION

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C PRINTOUT FOR GROUPS OF TEN MEASUREMENTS EXPD1 107
C EXPD1 108
230 WRITE OUTPUT TAPE 3, 10121, EXPD1 109
9 N = 1 (H(K),K= JPK1, JPK ) EXPD1 110
WRITE OUTPUT TAPE 3, 1013, EXPD1 111
9 (DA(K),K= JPK1, JPK ) EXPD1 112
WRITE OUTPUT TAPE 3, 1014, EXPD1 113
9 (H(K),K= JPK1, JPK ) EXPD1 114
WRITE OUTPUT TAPE 3, 1015, EXPD1 115
9 (D(K),K= JPK1, JPK ) EXPD1 116
JPK1 = JPK + 1 EXPD1 117
23 L = L + 8 EXPD1 118
24 JPK = JPK + 1 EXPD1 119
IF (L-48) 25,25,241 EXPD1 120
241 WRITE OUTPUT TAPE 3, 1020 EXPD1 121
L = 0 EXPD1 122
C EXPD1 123
C PRINTOUT FOR LESS THAN TEN MEASUREMENTS EXPD1 124
C EXPD1 125
25 WRITE OUTPUT TAPE 3, 10121, EXPD1 126
9 N = 1 (H(K),K= JPK1, JPK ) EXPD1 127
WRITE OUTPUT TAPE 3, 1013, EXPD1 128
9 (DA(K),K= JPK1, JPK ) EXPD1 129
WRITE OUTPUT TAPE 3, 1014, EXPD1 130
9 (H(K),K= JPK1, JPK ) EXPD1 131
WRITE OUTPUT TAPE 3, 1015, EXPD1 132
9 (D(K),K= JPK1, JPK ) EXPD1 133
WRITE OUTPUT TAPE 3, 10151, EXPD1 134
9 SF EXPD1 135
L = L + 8 EXPD1 136
C EXPD1 137
C RUN NUMBER CONSISTENCY CHECK EXPD1 138
C EXPD1 139
IF (NRUN - NRUNT) 30,31,30 EXPD1 140
30. KODE = 1 EXPD1 141
NRUNT = NRUN EXPD1 142
GO TO 100 EXPD1 143
C EXPD1 144
C CONTROL INTEGER CHECK EXPD1 145
C EXPD1 146
31 IF (ICTL - ICANT) 30,35,30 EXPD1 147
C EXPD1 148
C CALCULATION OF OXIDANT AND FUEL FLOW EXPD1 149
C EXPD1 150
35 WX = QX(IN)/22414.0 EXPD1 151
WF = QF(IN)/VDFD EXPD1 152
QM(IN) = (WF + WX) * VM / (1.0 - EM(IN)) EXPD1 153
C EXPD1 154
C CALCULATION OF EQUIVALENCE RATIO EXPD1 155
C EXPD1 156
Q(IN) = WF * OF54 / (2.0 * WX * YOX) EXPD1 157
IRK = JPK - 1 EXPD1 158
C EXPD1 159
C CALCULATION OF CONE AREA EXPD1 160
C EXPD1 161
AR = 0.0 EXPD1 162
DO 40 K=1, IRK EXPD1 163
DELS = SQRT((H(K+1) - H(K))**2 + ((D(K) - D(K+1))/2.0)**2) EXPD1 164
40 AR = AR + (D(K) + D(K+1)) * DELS EXPD1 165
AINI = 1.570796 * AR EXPD1 166
C EXPD1 167
C CALCULATION OF FLAME SPEED EXPD1 168
C EXPD1 169
U(IN) = QM(IN)/AINI EXPD1 170
100 CONTINUE EXPD1 171
IF (L+100-561) 101,101,102 EXPD1 172
102 WRITE OUTPUT TAPE 3, 1018 EXPD1 173
L = 0 EXPD1 174
C EXPD1 175
C PRINTOUT OF FLAME SPEED EXPD1 176
C EXPD1 177
101 WRITE OUTPUT TAPE 3, 1016 EXPD1 178
DO 110 N=1,100 EXPD1 179
110 WRITE OUTPUT TAPE 3, 1017 EXPD1 180
9 N, QF(IN), QX(IN), FRI(IN), QM(IN), AINI, U(IN), D(IN) EXPD1 181
NRUNT = NRUN EXPD1 182
120 RETURN EXPD1 183
C EXPD1 184
C DIAGNOSTIC - UNACCEPTABLE CARD ORDER EXPD1 185
C EXPD1 186
200 NEX = 2 EXPD1 187
WRITE OUTPUT TAPE 3, 3000, IC, J11 EXPD1 188
KODE = 1 EXPD1 189
GO TO 120 EXPD1 190
C EXPD1 191
C FORMAT STATEMENTS EXPD1 192
C EXPD1 193
1010 FORMAT EXPD1 194
9 (1H0, 10X, 22HFLAME FRONT DIMENSIONS / 1H0, 4H SET. ) EXPD1 195
10121 FORMAT EXPD1 196
9 (1H0, 14, 2X, 19HSTATION (MEASURED), 4X, 1019 ) EXPD1 197
1013 FORMAT EXPD1 198
9 (1H, 6X, 19HDIA METER (MEASURED), 4X, 10F 9.3 ) EXPD1 199
1014 FORMAT EXPD1 200
9 (1H, 6X, 14HHEIGHT (CM.), 9X, 10F 9.5 ) EXPD1 201
1015 FORMAT EXPD1 202
9 (1H, 6X, 14HDIA METER (CM.), 9X, 10F 9.5 ) EXPD1 203
10151 FORMAT EXPD1 204
9 (1H, 6X, 12HSCALE FACTOR 3X, F 10.5 ) EXPD1 205
1016 FORMAT EXPD1 206
9 (1H0, 4H SET, 7X, 9HFUEL FLOW, 4X, 12HOXIDANT FLOW, 3X, EXPD1 207
1 13HMOLE FRACTION, 5X, 11HVOLUME FLOW, 7X, 9HCONE AREA, EXPD1 208
2 5X, 11HFLAME SPEED, 5X, 11HEQUIVALENCE, EXPD1 209
3 1H, 11X, 9HICG/SEC, 4X, 9HICG/SEC, 4X, 9HININIBITOR, EXPD1 210
4 8X, 9HICG/SEC, 8X, 9HISO. CM, 6X, 9HICG/SEC, EXPD1 211
5 9X, 9HSHRATIO, 1. EXPD1 212

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SUBROUTINE EXPD1

(CONTINUED)

EXPERIMENTAL FLAME SPEED DATA REDUCTION

1017 FORMAT	EXPD1 213
9 (1H, 14, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5,	EXPD1 214
1, 6X, F10.5)	EXPD1 215
1018 FORMAT	EXPD1 216
9 (1H1)	EXPD1 217
1020 FORMAT	EXPD1 218
9 (1H1, 10X, 22HFLAME FRONT DIMENSIONS /1MO, 4M RUN)	EXPD1 219
3000 FORMAT(1H0, 25X, 41HDATA CARD ORDER INCORRECT - CARD NUMBER	EXPD1 220
1, 4X, 2X, 12HRUN NUMBER 15)	EXPD1 221
END	EXPD1 222

SUBROUTINE EXPD3

EXPERIMENTAL FLAME SPEED DATA REDUCTION

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CEXPD3  EXPD3 SUBROUTINE MOD1 SEPT 8, 1962  NRC DAYTON  EXPD3  1
C  EXPD3  2
C  NOMENCLATURE  EXPD3  3
C  EXPD3  4
C  AN  - CUMULATIVE CONE AREA *2/PI  EXPD3  5
C  AIN  - TOTAL CONE AREA (SQ. CM.)  EXPD3  6
C  DIA(K)  - CONE DIAMETER AT ABOVE ELEVATION (CM.)  EXPD3  7
C  DA(K)  - MEASURED DIAMETER AT ABOVE ELEVATION  EXPD3  8
C  DELS  - INCREMENT SLANT HEIGHT (CM.)  EXPD3  9
C  ELA  - REFERENCE LENGTH MEASURED IN UNITS OF DIA(K)  EXPD3  10
C  ELCM  - REFERENCE LENGTH MEASURED IN CM.  EXPD3  11
C  FMI(N)  - MOLE FRACTION OF INHIBITOR IN MIXTURE  EXPD3  12
C  H(K)  - ELEVATION ABOVE BURNER TOP (CM.)  EXPD3  13
C  HPKA  - MEASURED PEAK HEIGHT  EXPD3  14
C  ICANT  - OPTION CONTROL INTEGER CHECK  EXPD3  15
C  IM(K)  - MEASURED ELEVATION ABOVE BURNER TOP  EXPD3  16
C  IPK  - TOTAL NUMBER OF CONE MEASUREMENTS  EXPD3  17
C  IRK  - NUMBER OF EXPERIMENTS  EXPD3  18
C  IRK  - NUMBER OF DIAMETER MEASUREMENTS PER RUN  EXPD3  19
C  JPK, JPK1, N, K,  - COUNTING INTEGERS  EXPD3  20
C  KODE  - SIGNAL INTEGER FOR ACCEPTABLE DATA  EXPD3  21
C  NRUN  - RUN NUMBER OF DATA GROUP  EXPD3  22
C  NRUNT  - RUN NUMBER CHECK  EXPD3  23
C  O AND OIN  - EQUIVALENCE RATIO  EXPD3  24
C  OFSR  - ATOMS OF OXYGEN TO COMPLETELY OXIDIZE ONE  EXPD3  25
C  MOLECULE OF FUEL  EXPD3  26
C  OFOIN  - FUEL FLOW (CC./SEC. AT VBFO MOLAL VOLUME)  EXPD3  27
C  VHM  - VOLUME FLOW OF MIXTURE (CC./SEC. AT ACTUAL  EXPD3  28
C  TEMPERATURE AND PRESSURE)  EXPD3  29
C  OXOIN  - OXIDANT FLOW (CC./SEC. AT 0 DEG. C, 760 MM. HG)  EXPD3  30
C  SF  - SCALE FACTOR (CM./UNITS OF DIA(K))  EXPD3  31
C  TEETH  - ACTUAL DISTANCE BETWEEN TEETH TIPS SEEN ON  EXPD3  32
C  SCHLIEREN PHOTOGRAPH (CM.)  EXPD3  33
C  U AND UIN  - FLAME SPEED (CM./SEC.)  EXPD3  34
C  VBFO  - VOLUME PER MOLE OF FUEL (CC./GRAM-MOLE)  EXPD3  35
C  VHM  - VOLUME PER MOLE OF MIXTURE (CC./GRAM-MOLE)  EXPD3  36
C  WF  - FUEL FLOW (GRAM-MOLES/SEC.)  EXPD3  37
C  WX  - OXIDANT FLOW (GRAM-MOLES/SEC.)  EXPD3  38
C  YOX  - MOLE FRACTION OXYGEN IN OXIDANT  EXPD3  39
C  EXPD3  40
SUBROUTINE EXPD3(NRUN,ICL,OFSR,YOX,VBFO,VBM,IPN,O,U,KODE,TEETH,
1  NRUNT )  EXPD3  41
COMMON INT, DEC, IC, J11, J2, J3, NIN, NEX  EXPD3  42
DIMENSION INI(10), DEC(10)  EXPD3  43
DIMENSION A(100), DI(100), DA(100), H(100), IM(100), FMI(15)  EXPD3  44
1  DA(15), OFOIN(15), OFOIN(15), OXOIN(15), U(15)  EXPD3  45
WRITE OUTPUT TAPE 3, 1010  EXPD3  46
L=0  EXPD3  47
KODE = 3  EXPD3  48
DO 100 N=1,IPN  EXPD3  49
10 CALL INPUT  EXPD3  50
NEX = NEX  EXPD3  51
IF( NEX - 4) 200, 11, 200  EXPD3  52
11 NUMCON = IC * 4000  EXPD3  53
IF( NUMCON ) 13, 12, 13  EXPD3  54
C  EXPD3  55
C  O CARD ASSIGNMENTS  EXPD3  56
C  EXPD3  57
C  EXPD3  58
12 NRUNT = J11  EXPD3  59
ICANT = INT(1)  EXPD3  60
IRK = INT(2)  EXPD3  61
OFOIN = DEC(1)  EXPD3  62
OXOIN = DEC(2)  EXPD3  63
FMI(N) = DEC(3)  EXPD3  64
HPKA = DEC(4)  EXPD3  65
ELCM = DEC(5)  EXPD3  66
ELA = DEC(6)  EXPD3  67
GO TO 10  EXPD3  68
13 IF( NRUNT - J11) 200, 141, 200  EXPD3  69
141 LIMIT = JOE NUMCON  EXPD3  70
IGO = LIMIT - 9  EXPD3  71
IF( LIMIT - IRK ) 142, 142, 140  EXPD3  72
140 LIMIT = IRK  EXPD3  73
142 M = 0  EXPD3  74
DO 143 K = IGO, LIMIT  EXPD3  75
M = M + 1  EXPD3  76
IH(K) = INT(N)  EXPD3  77
143 DA(K) = DEC(N)  EXPD3  78
IF( LIMIT - IRK ) 10, 144, 10  EXPD3  79
144 INUN = NRUN + N - 1  EXPD3  80
IF(TEETH)14,15,14  EXPD3  81
15 TEETH = 0.2  EXPD3  82
14 SF = ELCM / ELA  EXPD3  83
IPK = IRK + 1  EXPD3  84
C  EXPD3  85
C  TEST FOR MORE THAN ONE HUNDRED MEASUREMENTS  EXPD3  86
C  EXPD3  87
IF(IPK-100)19,19,30  EXPD3  88
19 DO 20 K = 1, IRK  EXPD3  89
H(K) = TEETH * FLOATE(IH(K)-1)  EXPD3  90
20 DIA(K) = DA(K) * SF  EXPD3  91
C  EXPD3  92
C  CALCULATION OF PEAK HEIGHT IN CM.  EXPD3  93
C  EXPD3  94
H(IPK) = HPKA * SF  EXPD3  95
O(IPK) = 0.0  EXPD3  96
JPK1 = 1  EXPD3  97
C  EXPD3  98
C  PRINTOUT OF FLAME FRONT DIMENSIONS  EXPD3  99
C  EXPD3  100
C  TEST FOR MORE THAN TEN MEASUREMENTS  EXPD3  101
C  EXPD3  102
IF(IPK-10) 24,24,21  EXPD3  103
21 DO 23 JPK=10,IPK,10  EXPD3  104
IF(L-40)230,230,231  EXPD3  105
231 WRITE OUTPUT TAPE 3, 1020  EXPD3  106

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EXPERIMENTAL FLAME SPEED DATA REDUCTION

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      L=0
      EXPD3 107
      C
      C PRINTOUT FOR GROUPS OF TEN MEASUREMENTS
      EXPD3 108
      C
      C 230 WRITE OUTPUT TAPE 3, 10121,
      EXPD3 109
      C      IRUN, (IH(K), K= JPK1, JPK )
      EXPD3 110
      C      WRITE OUTPUT TAPE 3, 1013,
      EXPD3 111
      C      (DA(K), K= JPK1, JPK )
      EXPD3 112
      C      WRITE OUTPUT TAPE 3, 1014,
      EXPD3 113
      C      (HI(K), K= JPK1, JPK )
      EXPD3 114
      C      WRITE OUTPUT TAPE 3, 1015,
      EXPD3 115
      C      (DI(K), K= JPK1, JPK )
      EXPD3 116
      C      JPK1 = JPK + 1
      EXPD3 117
      C 231 L = L + 8
      EXPD3 118
      C 241 IF (L=8) 25, 25, 241
      EXPD3 119
      C 241 WRITE OUTPUT TAPE 3, 1020
      EXPD3 120
      C      L=0
      EXPD3 121
      C
      C PRINTOUT FOR LESS THAN TEN MEASUREMENTS
      EXPD3 122
      C
      C 25 WRITE OUTPUT TAPE 3, 1012,
      EXPD3 123
      C      IRUN, HPKA, (IH(K), K= JPK1, IRK )
      EXPD3 124
      C      WRITE OUTPUT TAPE 3, 1013,
      EXPD3 125
      C      (DA(K), K= JPK1, IRK )
      EXPD3 126
      C      WRITE OUTPUT TAPE 3, 1014,
      EXPD3 127
      C      (HI(K), K= JPK1, IPK )
      EXPD3 128
      C      WRITE OUTPUT TAPE 3, 1015,
      EXPD3 129
      C      (DI(K), K= JPK1, IPK )
      EXPD3 130
      C      WRITE OUTPUT TAPE 3, 10151,
      EXPD3 131
      C      ELCM, ELA
      EXPD3 132
      C      L= L+10
      EXPD3 133
      C
      C RUN NUMBER CONSISTENCY CHECK
      EXPD3 134
      C
      C IF (IRUN - NRUNT) 30, 31, 30
      EXPD3 135
      C 30 KODE = 1
      EXPD3 136
      C      IRUNT = NRUNT
      EXPD3 137
      C      GO TO 100
      EXPD3 138
      C
      C CONTROL INTEGER CHECK
      EXPD3 139
      C
      C 31 IF (ICTL - ICANT) 30, 35, 30
      EXPD3 140
      C
      C CALCULATION OF OXIDANT AND FUEL FLOW
      EXPD3 141
      C
      C 35 WX = QXOIN/22414.0
      EXPD3 142
      C      WF = QFOIN/VBFO
      EXPD3 143
      C      QM(N) = (WF + WX) * VBM / (1.0 - FMI(N))
      EXPD3 144
      C
      C CALCULATION OF EQUIVALENCE RATIO
      EXPD3 145
      C
      C D(N) = WF*OFSR/(2.0*WX*VOX)
      EXPD3 146
      C
      C CALCULATION OF CONE AREA
      EXPD3 147
      C
      C AR = 0.0
      EXPD3 148
      C DO 40 K = 1, IRK
      EXPD3 149
      C      DELS = SQRT((H(K+1) - H(K))**2 + ((D(K) - D(K+1))/2.0)**2)
      EXPD3 150
      C 40 AR = AR + (D(K) + D(K+1))*DELS
      EXPD3 151
      C      A(N) = 1.570796*AR
      EXPD3 152
      C
      C CALCULATION OF FLAME SPEED
      EXPD3 153
      C
      C U(N) = QM(N)/A(N)
      EXPD3 154
      C 100 CONTINUE
      EXPD3 155
      C      IF (L+10N - 56) 101, 101, 102
      EXPD3 156
      C 102 WRITE OUTPUT TAPE 3, 1018
      EXPD3 157
      C      L=0
      EXPD3 158
      C
      C PRINTOUT OF FLAME SPEED
      EXPD3 159
      C
      C 101 WRITE OUTPUT TAPE 3, 1016
      EXPD3 160
      C      DO 110 N=1, 10N
      EXPD3 161
      C      IRUN = NRUN - 1 + N
      EXPD3 162
      C 110 WRITE OUTPUT TAPE 3, 1017,
      EXPD3 163
      C      IRUN, QFO(N), QXO(N), FMI(N), QM(N), A(N), U(N), D(N)
      EXPD3 164
      C      NRUNT = IRUNT
      EXPD3 165
      C 120 RETURN
      EXPD3 166
      C
      C DIAGNOSTIC - UNACCEPTABLE CARD ORDER
      EXPD3 167
      C
      C 200 NEX = 2
      EXPD3 168
      C      WRITE OUTPUT TAPE 3, 3000, IC, J11
      EXPD3 169
      C      KODE = 1
      EXPD3 170
      C      GO TO 120
      EXPD3 171
      C
      C FORMAT STATEMENTS
      EXPD3 172
      C
      C 1010 FORMAT
      EXPD3 173
      C      9 (1H, 10X, 22HFLAME FRONT DIMENSIONS /1H0, 4H RUN )
      EXPD3 174
      C 1012 FORMAT
      EXPD3 175
      C      9 (1H, 14, 2X, 20HPEAK HEIGHT (MEASURED UNITS) P8.2 /
      EXPD3 176
      C      1H, 6X, 19HSTATION (MEASURED), 4X, 1019)
      EXPD3 177
      C 10121 FORMAT
      EXPD3 178
      C      9 (1H, 14, 2X, 19HSTATION (MEASURED), 4X, 1019)
      EXPD3 179
      C 1013 FORMAT
      EXPD3 180
      C      9 (1H, 6X, 19HDIAMETER (MEASURED), 4X, 10F 9.3 )
      EXPD3 181
      C 1014 FORMAT
      EXPD3 182
      C      9 (1H, 6X, 14HHEIGHT (CM.), 9X, 10F 9.5 )
      EXPD3 183
      C 1015 FORMAT
      EXPD3 184
      C      9 (1H, 6X, 14HDIAMETER (CM.), 4X, 10F 9.5 )
      EXPD3 185
      C 10151 FORMAT
      EXPD3 186
      C      9 (1H, 6X, 26HACTUAL LENGTH OF REFERENCE 3X.F10.5.3H, 5HCH.
      EXPD3 187
      C      7A, 20HMEASURED LENGTH OF REFERENCE 3X.F10.5.3H UNITS )
      EXPD3 188
      C 1016 FORMAT
      EXPD3 189
      C      9 (1H, 4H RUN, 7X, 5HFUEL FLOW, 4X, 12HOXIDANT FLOW, 1 2X,
      EXPD3 190
      C

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SUBROUTINE EXPD3

(CONTINUED)

EXPERIMENTAL FLAME SPEED DATA REDUCTION

1 13MHOLE FRACTION , 5X, 11HVOLUME FLOW , 7X, 9MCONE AREA , 1	EXPD3	213
2 5X, 11MFLAME SPEED , 5X, 11MEQUIVALENCE /	EXPD3	214
3 1M , 11X, 9M(C.C./SEC), 6X, 9M(C.C./SEC) , 6X, 9MINHIBITOR ,	EXPD3	215
4 8X , 9M(C.C./SEC), 8X, 9M(SQ. CM.), 6X, 9M(CN./SEC) ,	EXPD3	216
5 9X , 9M(RATIO) ,	EXPD3	217
1017 FORMAT	EXPD3	218
9 (1M , 14, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5, 6X, F10.5,	EXPD3	219
1 6X, F10.5)	EXPD3	220
1018 FORMAT	EXPD3	221
9 (1M)	EXPD3	222
1020 FORMAT	EXPD3	223
9 (1M, 10X, 22MFLAME FRONT DIMENSIONS /1M0 , 4M RUN)	EXPD3	224
3000 FORMAT(1M0, 25X, 41M DATA CARD ORDER INCORRECT - CARD NUMBER	EXPD3	225
1 14, 5X, 12M RUN NUMBER 15)	EXPD3	226
END	EXPD3	227

SUBROUTINE MAXM

MAXIMUM FLAME SPEED DETERMINATION

```

C MAXM SUBROUTINE MAXM FOR ROUTINE 2018 FEB 28 1962 MRC - DAYTON MAXM 1
C NONENCLATURE MAXM 2
C MAXM 3
C MAXM 4
C MAXM 5
C MAXM 6
C MAXM 7
C MAXM 8
C MAXM 9
C MAXM 10
C MAXM 11
C MAXM 12
C MAXM 13
C MAXM 14
C MAXM 15
C MAXM 16
C MAXM 17
C MAXM 18
C MAXM 19
C MAXM 20
C MAXM 21
C MAXM 22
C MAXM 23
C MAXM 24
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C MAXM 97
C MAXM 98
C MAXM 99
C MAXM 100
C MAXM 101
C MAXM 102
C MAXM 103
C MAXM 104
C MAXM 105
C MAXM 106

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C MAXM SUBROUTINE MAXM FOR ROUTINE 2018 FEB 28 1962 MRC - DAYTON
 C NONENCLATURE
 C A(K) - COEFFICIENTS OF FITTED EQUATION
 C ARG - ARGUMENT OF QUADRATIC SQUARE ROOT
 C G(J,K) - SUM OF SQUARES AND CROSS PRODUCTS OF THE
 C X(N,K) MATRIX
 C IPN - NUMBER OF DATA POINTS
 C J, K, L, M - INDICES
 C KV - SIGNAL FLAG FOR SEQUENCE OF CALCULATIONS
 C KODE - SIGNAL INTEGER FOR ACCEPTABLE DATA
 C MAXON - SWITCH TO BYPASS MAXM SUBROUTINE
 C (ANY NON-ZERO VALUE BYPASSES SUBROUTINE)
 C NCF - NUMBER OF COEFFICIENTS
 C O(N) - EQUIVALENCE RATIO
 C OH - LARGEST EQUIVALENCE RATIO IN SET
 C OINF - EQUIVALENCE RATIO AT INFLECTION POINT OF CUBIC
 C CURVE
 C OL - SMALLEST EQUIVALENCE RATIO IN SET
 C OMX - EQUIVALENCE RATIO AT MAXIMUM FLAME VELOCITY
 C STDS - MAXIMUM ALLOWABLE STANDARD DEVIATION OF U VS
 C U - CURVE FOR ADDITION TO TAPE
 C SUM - SUM OF THE SQUARES OF THE DEVIATIONS
 C UIN - FLAME SPEED (CM./SEC)
 C UOIN - DEVIATION BETWEEN MEASURED AND PREDICTED
 C FLAME SPEED (CM./SEC)
 C UOPIN - PERCENT DEVIATION BETWEEN MEASURED AND
 C PREDICTED FLAME SPEED
 C UMX - MAXIMUM FLAME SPEED (CM./SEC)
 C UOPIN - PREDICTED FLAME SPEED (CM./SEC)
 C USTD - STANDARD DEVIATION OF FLAME SPEED (CM./SEC)
 C USTOC - FLAME SPEED AT STOICHIOMETRIC CONDITIONS
 C (CM./SEC)
 C X(N,K) - INDEPENDENT VARIABLES
 C SURROUTINE MAXM, IPN, O, U, OMX, UMX, USTOC, KODE, STDS,
 C IEXP, MAXON, NRUN
 C COMMON INT, DEC, J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J21, J22, J23, J24, J25, J26, J27, J28, J29, J30, J31, J32, J33, J34, J35, J36, J37, J38, J39, J40, J41, J42, J43, J44, J45, J46, J47, J48, J49, J50, J51, J52, J53, J54, J55, J56, J57, J58, J59, J60, J61, J62, J63, J64, J65, J66, J67, J68, J69, J70, J71, J72, J73, J74, J75, J76, J77, J78, J79, J80, J81, J82, J83, J84, J85, J86, J87, J88, J89, J90, J91, J92, J93, J94, J95, J96, J97, J98, J99, J100, J101, J102, J103, J104, J105, J106, J107, J108, J109, J110, J111, J112, J113, J114, J115, J116, J117, J118, J119, J120, J121, J122, J123, J124, J125, J126, J127, J128, J129, J130, J131, J132, J133, J134, J135, J136, J137, J138, J139, J140, J141, J142, J143, J144, J145, J146, J147, J148, J149, J150, J151, J152, J153, J154, J155, J156, J157, J158, J159, J160, J161, J162, J163, J164, J165, J166, J167, J168, J169, J170, J171, J172, J173, J174, J175, J176, J177, J178, J179, J180, J181, 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MAXIMUM FLAME SPEED DETERMINATION	
70 NCF = 4	MAXM 107
K9 = 1	MAXM 108
IF DIVIDE CHECK 71, 71	MAXM 109
71 OMK = 0.0	MAXM 110
OMK = 0.0	MAXM 111
OINF = -A(3)/(3.0*A(4))	MAXM 112
IF DIVIDE CHECK 310, 75	MAXM 113
75 KV = 2	MAXM 114
ARG = 1.0 - 3.0*A(2)*A(4)/A(3)**2	MAXM 115
IF DIVIDE CHECK 310, 80	MAXM 116
C	MAXM 117
TEST FOR SQUARE ROOT OF NEGATIVE NUMBER	MAXM 118
C	MAXM 119
80 IF (ARG) 310, 310, 85	MAXM 120
85 KV = 3	MAXM 121
C	MAXM 122
DETERMINATION OF EQUIVALENCE RATIO AT MAXIMUM FLAME SPEED	MAXM 123
C	MAXM 124
OMK = OINF*(1.0 + SIGN(SQRT(ARG), A(3)))	MAXM 125
C	MAXM 126
TEST TO SEE IF EQUIVALENCE RATIO AT MAXIMUM FLAME SPEED IS WITHIN	MAXM 127
C	MAXM 128
DATA RANGE	MAXM 129
C	MAXM 130
IF (OMK - OM) 90, 90, 300	MAXM 131
90 IF (OL - OMK) 95, 95, 300	MAXM 132
95 KV = 4	MAXM 133
OMIN = OINF*(1.0 - SIGN(SQRT(ARG), A(3)))	MAXM 134
C	MAXM 135
TEST FOR MINIMUM POINT IN DATA RANGE	MAXM 136
C	MAXM 137
IF (OMIN - OM) 100, 110, 110	MAXM 138
100 IF (OL - OMIN) 300, 110, 110	MAXM 139
110 KV = 7	MAXM 140
GO TO 300	MAXM 141
C	MAXM 142
END OF OPERATION ON CUBIC FIT	MAXM 143
C	MAXM 144
ATTEMPT TO FIT THREE DATA POINTS TO A THREE CONSTANT EQUATION	MAXM 145
150 DO 160 N=1, IPN	MAXM 146
160 X(N,4) = U(N)	MAXM 147
CALL CROUT (3, X, A)	MAXM 148
IF (SENSE LIGHT 3) 161, 230	MAXM 149
C	MAXM 150
PRINTOUT OF UNSUCCESSFUL FIT	MAXM 151
C	MAXM 152
161 WRITE OUTPUT TAPE 3, 1012	MAXM 153
WRITE OUTPUT TAPE 3, 1013,	MAXM 154
9 ((X(K,1), L=1,4), K=1,3)	MAXM 155
GO TO 500	MAXM 156
C	MAXM 157
ATTEMPT TO FIT FOUR OR MORE DATA POINTS TO A THREE CONSTANT	MAXM 158
C	MAXM 159
EQUATION	MAXM 160
C	MAXM 161
200 DO 210 N=1, IPN	MAXM 162
210 X(N,4) = U(N)	MAXM 163
DO 220 J=1,3	MAXM 164
DU 220 K=1,4	MAXM 165
G(J,K) = 0.0	MAXM 166
DO 220 N=1, IPN	MAXM 167
C	MAXM 168
GENERATION OF THREE REGRESSION EQUATIONS	MAXM 169
C	MAXM 170
220 G(J,K) = G(J,K) + X(N,J)*X(N,K)	MAXM 171
C	MAXM 172
SOLUTION OF THREE EQUATIONS IN THREE UNKNOWN	MAXM 173
C	MAXM 174
CALL CROUT (3, G, A)	MAXM 175
C	MAXM 176
TEST FOR UNSUCCESSFUL SOLUTION	MAXM 177
C	MAXM 178
IF (SENSE LIGHT 3) 221, 230	MAXM 179
C	MAXM 180
PRINTOUT OF UNSUCCESSFUL FIT	MAXM 181
C	MAXM 182
221 WRITE OUTPUT TAPE 3, 1012	MAXM 183
WRITE OUTPUT TAPE 3, 1013,	MAXM 184
9 ((G(K,1), L=1,4), K=1,3)	MAXM 185
GO TO 500	MAXM 186
C	MAXM 187
OPERATIONS ON THREE OR MORE DATA POINTS	MAXM 188
C	MAXM 189
230 NCF = 3	MAXM 190
K9 = 5	MAXM 191
A(4) = 0.0	MAXM 192
OMK = 0.0	MAXM 193
OMK = 0.0	MAXM 194
IF (A(3)) 240, 310, 310	MAXM 195
240 KV = 6	MAXM 196
C	MAXM 197
DETERMINATION OF EQUIVALENCE RATIO AT MAXIMUM FLAME SPEED	MAXM 198
C	MAXM 199
OMK = -A(2)/(2.0*A(3))	MAXM 200
C	MAXM 201
TEST TO SEE IF EQUIVALENCE RATIO AT MAXIMUM FLAME SPEED IS WITHIN	MAXM 202
C	MAXM 203
DATA RANGE	MAXM 204
C	MAXM 205
IF (OMK - OM) 250, 250, 300	MAXM 206
250 IF (OL - OMK) 260, 260, 300	MAXM 207
C	MAXM 208
END OF OPERATION ON PARABOLIC FIT	MAXM 209
C	MAXM 210
OPERATION ON DATA AFTER SUCCESSFUL FIT	MAXM 211
C	MAXM 212
260 KV = 7	MAXM 212

MAXIMUM FLAME SPEED DETERMINATION

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C      CALCULATION OF MAXIMUM FLAME SPEED
C      MAXM 213
C      300 UMX = A(1) + OMX*(A(2) + OMX*(A(3) + OMX*(A(4))))
C      MAXM 214
C      MAXM 215
C      CALCULATION OF FLAME SPEED AT AN EQUIVALENCE RATIO OF ONE
C      MAXM 216
C      MAXM 217
C      310 USTOC = A(1) + A(2) + A(3) + A(4)
C      MAXM 218
C      SUM = 0.0
C      MAXM 219
C      DO 320 N=1,IPN
C      MAXM 220
C      UP(N) = A(1) + O(N)*(A(2) + O(N)*(A(3) + O(N)*A(4)))
C      MAXM 221
C      MAXM 222
C      COMPARISON OF PREDICTED VS. MEASURED EQUIVALENCE RATIOS
C      MAXM 223
C      MAXM 224
C      UD(N) = U(N) - UP(N)
C      MAXM 225
C      MAXM 226
C      CALCULATION OF THE PERCENT ERROR OF THE DEVIATION
C      MAXM 227
C      MAXM 228
C      UDP(N) = 100.0*UD(N)/UP(N)
C      MAXM 229
C      MAXM 230
C      SUMMATION OF THE SQUARE OF THE DEVIATIONS
C      MAXM 231
C      MAXM 232
C      320 SUM = SUM + UD(N)**2
C      MAXM 233
C      IF (IPN - NCF) 330,330,340
C      MAXM 234
C      330 USTD = 0.0
C      MAXM 235
C      GO TO 350
C      MAXM 236
C      MAXM 237
C      CALCULATION OF STANDARD DEVIATION OF FLAME SPEED
C      MAXM 238
C      MAXM 239
C      340 USTD = SQRT(SUM/ELDATE(IPN-NCF))
C      MAXM 240
C      350 WRITE OUTPUT TAPE 3, 1014
C      MAXM 241
C      WRITE OUTPUT TAPE 3, 1015
C      MAXM 242
C      WRITE OUTPUT TAPE 3, 1016
C      MAXM 243
C      9 (A(K),K=1,4),USTD,OMX,UMX
C      MAXM 244
C      IF (IEXPO - 1) 351,352,351
C      MAXM 245
C      351 WRITE OUTPUT TAPE 3, 1017
C      MAXM 246
C      DO 354 N=1, IPN
C      MAXM 247
C      INUN = NRUN + N - 1
C      MAXM 248
C      354 WRITE OUTPUT TAPE 3, 1018
C      MAXM 249
C      9 INUN, DINI, UINI, UP(N), UD(N), UDP(N)
C      MAXM 250
C      GO TO 353
C      MAXM 251
C      352 WRITE OUTPUT TAPE 3, 1017
C      MAXM 252
C      DO 3521 N = 1, IPN
C      MAXM 253
C      3521 WRITE OUTPUT TAPE 3, 1018
C      MAXM 254
C      9 N, DINI, UINI, UP(N), UD(N), UDP(N)
C      MAXM 255
C      353 IF (K9-4) 360,360,370
C      MAXM 256
C      MAXM 257
C      ERROR PRINT - CUBIC FIT OF CURVE UNSATISFACTORY
C      MAXM 258
C      MAXM 259
C      360 WRITE OUTPUT TAPE 3, 1019
C      MAXM 260
C      GO TO (361,362,363,364), K9
C      MAXM 261
C      MAXM 262
C      DIAGNOSTIC - PARABOLIC FIT INDICATED, A3 SMALL OR ZERO
C      MAXM 263
C      MAXM 264
C      361 WRITE OUTPUT TAPE 3, 1020
C      MAXM 265
C      GO TO 200
C      MAXM 266
C      MAXM 267
C      ERROR PRINT - NO MAXIMUM
C      MAXM 268
C      MAXM 269
C      362 WRITE OUTPUT TAPE 3, 1021
C      MAXM 270
C      GO TO 200
C      MAXM 271
C      MAXM 272
C      ERROR PRINT - MAXIMUM OUTSIDE DATA RANGE
C      MAXM 273
C      MAXM 274
C      363 WRITE OUTPUT TAPE 3, 1022
C      MAXM 275
C      GO TO 200
C      MAXM 276
C      MAXM 277
C      ERROR PRINT - MINIMUM POINT IN DATA RANGE
C      MAXM 278
C      MAXM 279
C      364 WRITE OUTPUT TAPE 3, 1023
C      MAXM 280
C      GO TO 200
C      MAXM 281
C      370 IF (K9 - 7) 371,380,500
C      MAXM 282
C      MAXM 283
C      ERROR PRINT - PARABOLIC FIT OF CURVE UNSATISFACTORY
C      MAXM 284
C      MAXM 285
C      MAXM 286
C      371 WRITE OUTPUT TAPE 3, 1024
C      MAXM 287
C      IF (K9 - 6) 372,373,500
C      MAXM 288
C      372 WRITE OUTPUT TAPE 3, 1021
C      MAXM 289
C      GO TO 500
C      MAXM 290
C      373 WRITE OUTPUT TAPE 3, 1022
C      MAXM 291
C      GO TO 500
C      MAXM 292
C      380 IF (STDS) 381,381,382
C      MAXM 293
C      381 STDS = 1.0
C      MAXM 294
C      MAXM 295
C      TEST TO SEE IF STANDARD DEVIATION WITHIN SPECIFIED RANGE
C      MAXM 296
C      MAXM 297
C      382 IF (USTD - STDS) 400,400,383
C      MAXM 298
C      MAXM 299
C      ERROR PRINT - STANDARD DEVIATION TOO HIGH
C      MAXM 300
C      MAXM 301
C      383 WRITE OUTPUT TAPE 3, 1025
C      MAXM 302
C      9 STDS
C      MAXM 303
C      GO TO 500
C      MAXM 304
C      400 KODE = 3
C      MAXM 305
C      500 RETURN
C      MAXM 306
C      MAXM 307
C      FORMAT STATEMENTS
C      MAXM 308
C      MAXM 309
C      1001 FORMAT
C      MAXM 310
C      9 (1H)
C      MAXM 311
C      1011 FORMAT
C      MAXM 312
C      9 (1H, 10X, E12.5, 10X, E12.5, 10X, E12.5, 10X, E12.5, 10X, E12.5)
C      MAXM 313
C      1012 FORMAT
C      MAXM 314
C      9 (1H, 10X, 73MPARABOLIC FIT OF FLAME SPEED CURVE FAILED - MATRIX
C      MAXM 315
C      1 OF THE COEFFICIENTS IS /
C      MAXM 316
C      2 1H, 10X, 12HEQUIV. RATIO, 8X, 16HEQUIV. RATIO **2, 9X,
C      MAXM 317
C      3 11HFLAME SPEED //)
C      MAXM 318

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MAXIMUM FLAME SPEED DETERMINATION

1013 FORMAT		MAXM	319
9 (1H, 10X, E12.5, 10X, E12.5, 10X, E12.5, 10X, E12.5)		MAXM	320
1014 FORMAT		MAXM	321
9 (1H, 10X, 22HFLAME SPEED CURVE DATA)		MAXM	322
1014 FORMAT		MAXM	323
9 (1H, 6X, 4(4X, 1PE12.4), 5X, 'OPF0.4', 8X, F9.5, 9X, F9.4)		MAXM	324
1017 FORMAT		MAXM	325
9 (1H, 10X, 8HDATA SET, 10X, 11HEQUIVALENCE, 10X, 8HMEASURED		MAXM	326
1 11X, 9HPREDICTED 10X, 9HDEVIATION 11X, 7HPERCENT /		MAXM	327
2 1H 31X, 5HRATIO 12X, 11HFLAME SPEED 8X, 11HFLAME SPEED		MAXM	328
3 28X, 9HDEVIATION /)		MAXM	329
10171 FORMAT		MAXM	330
9 (1H, 10X, 8H RUN, 10X, 11HEQUIVALENCE, 10X, 8HMEASURED		MAXM	331
1 11X, 9HPREDICTED 10X, 9HDEVIATION 11X, 7HPERCENT /		MAXM	332
2 1H 31X, 5HRATIO 12X, 11HFLAME SPEED 8X, 11HFLAME SPEED		MAXM	333
3 28X, 9HDEVIATION /)		MAXM	334
1018 FORMAT		MAXM	335
9 (1H, 10X, 18, 10X, F11.4, 10X, F9.4, 10X, F9.4, 10X, F9.4, 10X, F9.4)		MAXM	336
1019 FORMAT		MAXM	337
9 (1H, 10X, 35HCUBIC FIT OF CURVE UNSATISFACTORY -)		MAXM	338
1020 FORMAT		MAXM	339
9 (1H, 47X, 23HPARABOLIC FIT INDICATED)		MAXM	340
1021 FORMAT		MAXM	341
9 (1H, 47X, 16HNO MAXIMUM FOUND)		MAXM	342
1022 FORMAT		MAXM	343
9 (1H, 47X, 26HMAXIMUM OUTSIDE DATA RANGE)		MAXM	344
1023 FORMAT		MAXM	345
9 (1H, 47X, 27HMINIMUM POINT IN DATA RANGE)		MAXM	346
1024 FORMAT		MAXM	347
9 (1H, 6X, 39HPARABOLIC FIT OF CURVE UNSATISFACTORY -)		MAXM	348
1025 FORMAT		MAXM	349
9 (1H, 10X, 31HSTANDARD DEVIATION GREATER THAN F6.3)		MAXM	350
1010 FORMAT		MAXM	351
9 (1H, 10X, 69HCUBIC FIT OF FLAME SPEED CURVE FAILED - MATRIX OF		MAXM	352
1 THE COEFFICIENTS IS /		MAXM	353
2 1H, 10X, 12HEQUIV. RATIO, 8X, 16HEQUIV. RATIO **2, 6X,		MAXM	354
3 16HEQUIV. RATIO **3, 4X, 11HFLAME SPEED /)		MAXM	355
1015 FORMAT		MAXM	356
9 (1H, 34X, 12HCOEFFICIENTS, 30X, 8HSTANDARD, 4X,		MAXM	357
1 17HEQUIVALENCE RATIO, 6X, 7HMAXIMUM /		MAXM	358
2 1H, 15X, 2HA1, 15X, 2HA2, 14X, 2HA3, 14X, 2HA4, 10X,		MAXM	359
3 9HDEVIATION, 3X, 18HAT MAX FLAME SPEED, 3X,		MAXM	360
4 11HFLAME SPEED /)		MAXM	361
END		MAXM	362

SUBROUTINE TAPE

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CTAPE	SUBROUTINE TAPE FOR ROUTINE 2018 MARCH 5, 1962 MAC - DAYTON	TAPE 1
C		TAPE 2
C	NOMENCLATURE	TAPE 3
C		TAPE 4
C	A1(I) AND A2(I) - FUEL NAME	TAPE 5
C	ACCL(I,K) - NUMBER OF STRUCTURAL CONTRIBUTORS PER MOLECULE	TAPE 6
C	IN REVISED LIST	TAPE 7
C	AGNL(K) - CONTRIBUTOR NAMES (FROM CARDS)	TAPE 8
C	D(I,K,I) - NUMBER OF STRUCTURAL CONTRIBUTORS PER MOLECULE	TAPE 9
C	BLK - BLANK (USED IN CONTRIBUTOR NAME LIST)	TAPE 10
C	D(I,K) - DECIMAL DATA STORAGE	TAPE 11
C	DNM(K) - DEPENDENT VARIABLE NAME LIST	TAPE 12
C	DU AND TE - FIRST AND SECOND HALVES OF DATE	TAPE 13
C	FGCJL(J) - NUMBER OF STRUCTURAL CONTRIBUTORS PER MOLECULE	TAPE 14
C	FOR CONTRIBUTOR NUMBER LFGCCN(K)	TAPE 15
C	FGCL(K) - NUMBER OF STRUCTURAL CONTRIBUTORS PER MOLECULE	TAPE 16
C	FOR CONTRIBUTOR NUMBER LFGCCN(K)	TAPE 17
C	FN1 AND FN2 - FIRST AND SECOND HALVES OF FUEL NAME	TAPE 18
C	GNL(J) - CONTRIBUTOR NAME (FROM TAPE)	TAPE 19
C	I, J, K, L - INDICES	TAPE 20
C	IIA(I) - FUEL CLASS NUMBER	TAPE 21
C	IIG(I) - FUEL GROUP NUMBER	TAPE 22
C	IIC(I) - FUEL MEMBER NUMBER	TAPE 23
C	IID(I) - DATA SOURCE NUMBER	TAPE 24
C	IIE(I) - EXPERIMENTAL CONDITIONS NUMBER	TAPE 25
C	IIF(I) - NUMBER OF STRUCTURAL CONTRIBUTORS CONSIDERED	TAPE 26
C	IIO - NUMBER OF DATA GROUPS ACCEPTABLE FOR WRITING	TAPE 27
C	ICANT - OPTION CONTROL INTEGER CHECK	TAPE 28
C	ICTL - OPTION CONTROL INTEGER	TAPE 29
C	IFNC - FUEL CLASS NUMBER	TAPE 30
C	IFNG - FUEL GROUP NUMBER	TAPE 31
C	IFNM - FUEL MEMBER NUMBER	TAPE 32
C	INDS - DATA SOURCE CODE FOR GROUP SERIAL NUMBER ISFN	TAPE 33
C	INEC - DATA EXPERIMENTAL CONDITIONS CODE FOR GROUP	TAPE 34
C	SERIAL NUMBER ISFN	TAPE 35
C	IPACC - NUMBER OF CONTRIBUTOR COUNT CHANGES FOLLOWING	TAPE 36
C	(REMAINDER OF -G- CARD)	TAPE 37
C	IPCN - NUMBER OF CONTRIBUTOR NAME CHANGES FOLLOWING	TAPE 38
C	(SIX PER -H- CARD)	TAPE 39
C	IPEGC - NUMBER OF PAIRS IN CONTRIBUTOR COUNT LIST	TAPE 40
C	FOLLOWING ON TAPE	TAPE 41
C	IPFM - NUMBER OF CARDS FOLLOWING WITH CONTRIBUTOR	TAPE 42
C	COUNT CHANGES (I-G CARDS)	TAPE 43
C	IPJ - NUMBER OF GROUPS ON TAPE 2 BEFORE ADDITIONS	TAPE 44
C	IPIN - NUMBER OF GROUPS ON TAPE 2 AFTER ADDITIONS	TAPE 45
C	ISEN - DATA GROUP SERIAL NUMBER (FROM TAPE 2)	TAPE 46
C	ITP - CODE INTEGER FOR INITIAL TAPE PREPARATION	TAPE 47
C	J(I,K,I) - SPECIES CONTRIBUTOR CODE NUMBER	TAPE 48
C	JGNL(K) - CONTRIBUTOR CODE NUMBER	TAPE 49
C	KI - NUMBER OF STRUCTURAL CONTRIBUTORS CONSIDERED	TAPE 50
C	LACNL(K) - CONTRIBUTOR CODE NUMBER (FROM CARDS)	TAPE 51
C	LFGCCN(K) - CONTRIBUTOR CODE NUMBER (FROM TAPE)	TAPE 52
C	LFMNL - DATA GROUP SERIAL NUMBER (FROM CARDS)	TAPE 53
C	LIPACC(L) - NUMBER OF CONTRIBUTOR COUNT CHANGES FOR DATA	TAPE 54
C	GROUP SERIAL NUMBER LFMNL	TAPE 55
C	M - COUNTING INTEGER FOR LINES PRINTED PER PAGE	TAPE 56
C	NRUN - RUN NUMBER OF DATA GROUP	TAPE 57
C	NRUNT - RUN NUMBER CHECK	TAPE 58
C	SUBROUTINE TAPE INRUN, ICTL, A1, A2, IIA, IIB, IIC, IID, IIE, IIF, IIO, IIP, IIS, IIT, IJ, IJ1, IJ2, IJ3, IJ4, IJ5, IJ6, IJ7, IJ8, IJ9, IJ10, IJ11, IJ12, IJ13, IJ14, IJ15, IJ16, IJ17, IJ18, IJ19, IJ20, IJ21, IJ22, IJ23, IJ24, IJ25, IJ26, IJ27, IJ28, IJ29, IJ30, IJ31, IJ32, IJ33, IJ34, IJ35, IJ36, IJ37, IJ38, IJ39, IJ40, IJ41, IJ42, IJ43, IJ44, IJ45, IJ46, IJ47, IJ48, IJ49, IJ50, IJ51, IJ52, IJ53, IJ54, IJ55, IJ56, IJ57, IJ58, IJ59, IJ60, IJ61, IJ62, IJ63, IJ64, IJ65, IJ66, IJ67, IJ68, IJ69, IJ70, IJ71, IJ72, IJ73, IJ74, IJ75, IJ76, IJ77, IJ78, IJ79, IJ80, IJ81, IJ82, IJ83, IJ84, IJ85, IJ86, IJ87, IJ88, IJ89, IJ90, IJ91, IJ92, IJ93, IJ94, IJ95, IJ96, IJ97, IJ98, IJ99, IJ100, IJ101, IJ102, IJ103, IJ104, IJ105, IJ106	TAPE 59
1	COMMON INT, DEC, IC, J11, J2, J3, NIN, NEX	TAPE 60
1	DIMENSION INT(10), DEC(10)	TAPE 61
1	DIMENSION A1(20), A2(20), B1(100,20), DA(6,20), II(20), I2(20), I3(20)	TAPE 62
1	, I4(20), J1(100,20), ACCL(20,90), AGNL(50), D(6), DNM(6), FGCJL(90),	TAPE 63
1	FGCJL(200), GNL(200), JGNL(50), LACNL(20,90), LFMNL(20), LFGCCN(90),	TAPE 64
3	LIPACC(20), IIA(20), IIB(20), IIC(20)	TAPE 65
M = 4		TAPE 66
9	WRITE OUTPUT TAPE 3, 3000,	TAPE 67
9	DU, TE	TAPE 68
9	WRITE OUTPUT TAPE 3, 3001,	TAPE 69
9	NRUN	TAPE 70
10	REWIND 6	TAPE 71
10	CALL INPUT	TAPE 72
NEX = NEX		TAPE 73
IF (NEX - 6) 600, 11, 33		TAPE 74
C		TAPE 75
C	F CARD ASSIGNMENTS	TAPE 76
C		TAPE 77
11	NRUNT = J11	TAPE 78
ICANT = INT(1)		TAPE 79
IPFM = INT(2)		TAPE 80
IPCN = INT(3)		TAPE 81
ITP = INT(4)		TAPE 82
LAST = INT(5)		TAPE 83
C		TAPE 84
C	RUN NUMBER CONSISTENCY CHECK	TAPE 85
C		TAPE 86
IF (NRUN - NRUNT) 29,21,29		TAPE 87
C		TAPE 88
C	OPTION CONTROL INTEGER CHECK	TAPE 89
C		TAPE 90
21	IF (ICTL - ICANT) 29,22,29	TAPE 91
C		TAPE 92
C	TESTS FOR EXECUTABLE CONDITIONS	TAPE 93
C		TAPE 94
22	IF (ITP + 7) 25, 28,25	TAPE 95
25	IF (IPFM) 26,26,32	TAPE 96
C		TAPE 97
C	TEST FOR GROUPS READY TO BE ADDED	TAPE 98
C		TAPE 99
26	IF (IPCN) 27,27,40	TAPE 100
27	IF (IADD) 30,30,40	TAPE 101
C		TAPE 102
C	DIAGNOSTIC - INITIAL TAPE PREPARATION	TAPE 103
C		TAPE 104
28	WRITE OUTPUT TAPE 3, 3002	TAPE 105
C		TAPE 106

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GO TO 195	TAPE 107
C ERROR PRINT - DATA OUT OF ORDER	TAPE 108
C	TAPE 109
29 WRITE OUTPUT TAPE 3, 3003;	TAPE 110
9 NRUN, NRUNT, ICTL, ICANT	TAPE 111
GO TO 600	TAPE 112
C	TAPE 113
C DIAGNOSTIC - NO ACTION CALLED FOR	TAPE 114
C	TAPE 115
30 WRITE OUTPUT TAPE 3, 3005	TAPE 116
GO TO 495	TAPE 117
32 L = 0	TAPE 118
321 L = L + 1	TAPE 119
GO TO 10	TAPE 120
C	TAPE 121
C G-CARD ASSIGNMENTS	TAPE 122
C	TAPE 123
33 IF (NEX - 7) 600, 330, 600	TAPE 124
330 NUMCON = IC - 7000	TAPE 125
IF (NUMCON) 332, 331, 332	TAPE 126
331 LFMN(L) = INT(1)	TAPE 127
IPACC = INT(2)	TAPE 128
GO TO 10	TAPE 129
332 IF (NRUNT - J11) 600, 333, 600	TAPE 130
333 LIMIT = 10 * NUMCON	TAPE 131
IGO = LIMIT - 9	TAPE 132
IF (LIMIT - IPACC) 335, 335, 334	TAPE 133
334 LIMIT = IPACC	TAPE 134
335 M2 = 0	TAPE 135
DO 336 K = IGO, LIMIT	TAPE 136
M2 = M2 + 1	TAPE 137
LACH(L, K) = INT(M2)	TAPE 138
336 ACCL(L, K) = UEC(M2)	TAPE 139
IF (LIMIT - IPACC) 10, 35, 10	TAPE 140
35 IPACC(L) = IPACC	TAPE 141
IF (L - IPFM) 321, 40, 40	TAPE 142
C	TAPE 143
C READING OF MASTER TAPE 6	TAPE 144
C	TAPE 145
40 READ INPUT TAPE 6, 2000	TAPE 146
READ INPUT TAPE 6, 2001, IPI	TAPE 147
C	TAPE 148
C READY SCRATCH TAPE 8	TAPE 149
C	TAPE 150
REWIND 8	TAPE 151
C	TAPE 152
C COMPUTATIONS FOR ALTERATIONS AND ADDITIONS TO DATA GROUPS ON TAPE	TAPE 153
C	TAPE 154
DO 90 I=1, IPI	TAPE 155
C	TAPE 156
C READ EACH GROUP STORED ON TAPE 6	TAPE 157
C	TAPE 158
READ INPUT TAPE 6, 2002;	TAPE 159
9 ISFN, FN1, FN2, IFNC, IFNG, IFNM, INDS, INEC, (O(K), K=2,6),	TAPE 160
1 IPFGC, (LPFGC(K), FGCL(K), K=1, IPFGC)	TAPE 161
C	TAPE 162
C TEST FOR PROPER DATA GROUP SERIAL NUMBER SEQUENCE ON TAPE	TAPE 163
C	TAPE 164
IF (1 - ISFN) 41, 45, 41	TAPE 165
41 REWIND 6	TAPE 166
REWIND 8	TAPE 167
C	TAPE 168
C TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT	TAPE 169
C	TAPE 170
IF (M - 52) 42, 43, 43	TAPE 171
43 WRITE OUTPUT TAPE 3, 3020	TAPE 172
C	TAPE 173
C ERROR PRINT - DATA GROUP SERIAL NUMBER INCONSISTENCY	TAPE 174
C	TAPE 175
42 WRITE OUTPUT TAPE 3, 3005;	TAPE 176
9 ISFN, 1	TAPE 177
GO TO 500	TAPE 178
C	TAPE 179
C BYPASS OF TESTS IF NO CARDS TO BE READ	TAPE 180
C	TAPE 181
45 IF (IPFM) 80, 80, 46	TAPE 182
C	TAPE 183
C COMPUTATIONS FOR ADDITION OF INFORMATION TO TAPE 6	TAPE 184
C	TAPE 185
46 DO 47 L=1, IPFM	TAPE 186
C	TAPE 187
C TEST FOR ALTERATIONS TO GROUP ISFN ON TAPE BY DATA FROM -G- CARD	TAPE 188
C	TAPE 189
IF (1 - LFMN(L)) 47, 50, 47	TAPE 190
47 CONTINUE	TAPE 191
GO TO 80	TAPE 192
50 DO 51 J=1, 200	TAPE 193
C	TAPE 194
C ZERO COUNT LIST STORAGE	TAPE 195
C	TAPE 196
51 FGCL(J) = 0.0	TAPE 197
DO 52 K=1, IPFGC	TAPE 198
C	TAPE 199
C STORE TAPE VALUES OF THE NUMBER OF STRUCTURAL CONTRIBUTORS PER	TAPE 200
C MOLECULE FOR EACH CONTRIBUTOR WITHIN THE SPECIFIED GROUP	TAPE 201
C	TAPE 202
J = LPFGC(K)	TAPE 203
52 FGCL(J) = FGCL(K)	TAPE 204
C	TAPE 205
C ADDITION OF NEW VALUES OF THE NUMBER OF STRUCTURAL CONTRIBUTORS	TAPE 206
C PER MOLECULE FOR THOSE CONTRIBUTORS LISTED ON THE -G- CARD	TAPE 207
C	TAPE 208
IPACC = L(IPACC)	TAPE 209
DO 53 K=1, IPACC	TAPE 210
J = LACH(L, K)	TAPE 211
C	TAPE 212

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53	FGCJL(J) = ACCL(L,K)	TAPE 213
	K = 0	TAPE 214
C		TAPE 215
C	LIST CONTRIBUTOR CODE NUMBERS AND NUMBER OF CONTRIBUTORS PER	TAPE 216
C	MOLECULE TO BE WRITTEN ON TAPE 3	TAPE 217
C		TAPE 218
	DO 55 J=1,200	TAPE 219
	IF (FGCJL(J)) 54,55,54	TAPE 220
54	K = K + 1	TAPE 221
	LFGCCN(K) = J	TAPE 222
	FGCL(K) = FGCJL(J)	TAPE 223
55	CONTINUE	TAPE 224
	IPFGC = K	TAPE 225
C		TAPE 226
C	TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT	TAPE 227
C		TAPE 228
	IF (M + IPFGC/6 - 52) 56,57,57	TAPE 229
57	WRITE OUTPUT TAPE 3, 3020	TAPE 230
	M=0	TAPE 231
56	M = M + IPFGC/6 + 6	TAPE 232
C		TAPE 233
C	PRINTOUT OF ALTERED LISTS	TAPE 234
C		TAPE 235
	WRITE OUTPUT TAPE 3, 3006	TAPE 236
	WRITE OUTPUT TAPE 3, 3007	TAPE 237
9	ISFN, (LFGCCN(K),FGCL(K),K=1,IPFGC)	TAPE 238
C		TAPE 239
C	INTERIM STORAGE ON TAPE 8	TAPE 240
C		TAPE 241
80	WRITE OUTPUT TAPE 8, 2002	TAPE 242
9	ISFN,FN1,FN2,IFNC,IFNG,IFNM,INDS,INEC,(DI(K),K=2,6),	TAPE 243
1	IPFGC,(LFGCCN(K),FGCL(K),K=1,IPFGC)	TAPE 244
90	CONTINUE	TAPE 245
C		TAPE 246
C	END OF ALTERATIONS AND ADDITIONS TO DATA GROUPS ON TAPE	TAPE 247
C		TAPE 248
C	ALTERATIONS OR ADDITIONS TO CONTRIBUTOR NAME LIST	TAPE 249
C		TAPE 250
C		TAPE 251
C	READ CONTRIBUTOR NAMES AND DEPENDENT VARIABLE NAME LIST FROM TAPE	TAPE 252
	READ INPUT TAPE 6, 2003	TAPE 253
9	(GNL(I),J=1,200)	TAPE 254
	READ INPUT TAPE 6, 2003	TAPE 255
9	(DNM(K),K=1,6)	TAPE 256
	REWIND 6	TAPE 257
	REWIND 8	TAPE 258
		TAPE 259
	TEST FOR ALTERATION OR ADDITION	TAPE 260
		TAPE 261
	IF (IPCN) 100,100,95	TAPE 262
		TAPE 263
	H CARD READING	TAPE 264
		TAPE 265
95	READ INPUT TAPE 2, 1001	TAPE 266
9	(JGNL(K),AGNL(K),K=1,IPCN)	TAPE 267
C		TAPE 268
C	TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT	TAPE 269
C		TAPE 270
	IF (M + IPCN/7 - 52) 97,98,98	TAPE 271
98	WRITE OUTPUT TAPE 3, 3020	TAPE 272
	M=0	TAPE 273
97	M=M + IPCN/7 + 6	TAPE 274
C		TAPE 275
C	PRINTOUT OF ALTERATIONS OR ADDITIONS TO CONTRIBUTOR NAME LIST	TAPE 276
C		TAPE 277
	WRITE OUTPUT TAPE 3, 3008	TAPE 278
	WRITE OUTPUT TAPE 3, 3009	TAPE 279
9	(JGNL(K),AGNL(K),K=1,IPCN)	TAPE 280
	DO 96 K=1,IPCN	TAPE 281
	J = JGNL(K)	TAPE 282
C		TAPE 283
C	ADD ALTERED OR NEW NAMES TO LIST	TAPE 284
C		TAPE 285
96	GNL(J) = AGNL(K)	TAPE 286
C		TAPE 287
C	REVISE GROUP COUNT	TAPE 288
C		TAPE 289
	100 IPIN = IP1 + IADD	TAPE 290
C		TAPE 291
C	PREPARE CORRECTED TAPE 6	TAPE 292
C		TAPE 293
	WRITE OUTPUT TAPE 6, 2000	TAPE 294
	WRITE OUTPUT TAPE 6, 2001	TAPE 295
9	IPIN	TAPE 296
C	(A) - CORRECTED GROUPS PREVIOUSLY ON TAPE	TAPE 297
C		TAPE 298
	DO 110 I = 1,IP1	TAPE 299
	READ INPUT TAPE 8, 2002	TAPE 300
9	ISFN,FN1,FN2,IFNC,IFNG,IFNM,INDS,INEC,(DI(K),K=2,6),	TAPE 301
1	IPFGC,(LFGCCN(K),FGCL(K),K=1,IPFGC)	TAPE 302
110	WRITE OUTPUT TAPE 8, 2002	TAPE 303
9	ISFN,FN1,FN2,IFNC,IFNG,IFNM,INDS,INEC,(DI(K),K=2,6),	TAPE 304
1	IPFGC,(LFGCCN(K),FGCL(K),K=1,IPFGC)	TAPE 305
	IF (IADD) 115,115,117	TAPE 306
C		TAPE 307
C	TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT	TAPE 308
C		TAPE 309
115	IF (M - 56) 113,116,114	TAPE 310
114	WRITE OUTPUT TAPE 3, 3020	TAPE 311
	M=0	TAPE 312
113	M=M+2	TAPE 313
C		TAPE 314
C	DIAGNOSTIC - NO NEW DATA GROUPS ADDED TO TAPE	TAPE 315
C		TAPE 316
	WRITE OUTPUT TAPE 3, 3011	TAPE 317
	GO TO 140	TAPE 318

(CONTINUED)

C	(B)	- ADDITION OF NEW GROUPS TO TAPE	TAPE 320
C			TAPE 321
C	TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT		TAPE 322
C			TAPE 323
C	117 IF(M - 5) 118,116,116		TAPE 324
C	116 WRITE OUTPUT TAPE 3, 3020		TAPE 325
C	M=0		TAPE 326
C	118 M=M+5		TAPE 327
C			TAPE 328
C	PRINTOUT OF NEW GROUPS ADDED TO TAPE		TAPE 329
C			TAPE 330
C	WRITE OUTPUT TAPE 3, 3012		TAPE 331
C	120 DO 130 I=1,IADD		TAPE 332
C	ISFN = IP + 1		TAPE 333
C	K1 = I4(I)		TAPE 334
C	IF(M - 5) 129,128,128		TAPE 335
C	128 WRITE OUTPUT TAPE 3, 3020		TAPE 336
C	WRITE OUTPUT TAPE 3, 3012		TAPE 337
C	M=0		TAPE 338
C	129 M=M+1		TAPE 339
C	WRITE OUTPUT TAPE 3, 3013,		TAPE 340
C	A(1),A2(1), ISFN ,I1A(1),I1B(1),I1C(1),I2(1),I3(1),		TAPE 341
C	DAI2(1), DAI3(1), DA(3,1), DA(5,1), DA(6,1)		TAPE 342
C	130 WRITE OUTPUT TAPE 6, 2002,		TAPE 343
C	ISFWA(1),A2(1),I1A(1),I1B(1),I1C(1),I2(1),I3(1),		TAPE 344
C	(DA(K,1),K=2,6),K1,(J1(K,1),B1(K,1),K=1,K1)		TAPE 345
C			TAPE 346
C	TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT		TAPE 347
C			TAPE 348
C	IF(M+I4(1)/6 - 5) 131,132,132		TAPE 349
C	132 WRITE OUTPUT TAPE 3, 3020		TAPE 350
C	M=0		TAPE 351
C	131 M=M+6		TAPE 352
C	WRITE OUTPUT TAPE 3, 3014		TAPE 353
C	DO 135 I=1,IADD		TAPE 354
C	ISFN = IP + 1		TAPE 355
C	K1 = I4(I)		TAPE 356
C			TAPE 357
C	TEST TO LIMIT THE NUMBER OF LINES PRINTED PER PAGE OF OUTPUT		TAPE 358
C			TAPE 359
C	IF(M+I4(1)/6 - 5) 133,134,134		TAPE 360
C	134 WRITE OUTPUT TAPE 3, 3020		TAPE 361
C	WRITE OUTPUT TAPE 3, 3014		TAPE 362
C	M=0		TAPE 363
C	133 M=M+I4(1)/6 + 2		TAPE 364
C	135 WRITE OUTPUT TAPE 3, 3007,		TAPE 365
C	ISFN, (J1(K,1),B1(K,1),K=1,K1)		TAPE 366
C			TAPE 367
C	(C) - ADDITION OF CONTRIBUTOR NAME LIST TO TAPE		TAPE 368
C			TAPE 369
C	140 WRITE OUTPUT TAPE 6, 2003,		TAPE 370
C	(GNL(J),J=1,200)		TAPE 371
C	WRITE OUTPUT TAPE 6, 2003,		TAPE 372
C	(DNN(K),K=1,6)		TAPE 373
C	END FILE 6		TAPE 374
C	REWIND 6		TAPE 375
C	REWIND 8		TAPE 376
C	GO TO 500		TAPE 377
C			TAPE 378
C	END OF OPERATIONS ON ALTERATIONS AND ADDITIONS TO TAPE 2		TAPE 379
C			TAPE 380
C	OPERATIONS FOR INITIAL MAKEUP OF TAPE 2		TAPE 381
C			TAPE 382
C	195 IF (IPCN) 490,490,210		TAPE 383
C	TITLE CARD READING		TAPE 384
C			TAPE 385
C	210 READ INPUT TAPE 2, 2000		TAPE 386
C			TAPE 387
C	M CARD READING		TAPE 388
C			TAPE 389
C	READ INPUT TAPE 2, 1001,		TAPE 390
C	(JGNL(K),AGNL(K),K=1,IPCN)		TAPE 391
C			TAPE 392
C	DEPENDENT VARIABLE NAME LIST CARD READING		TAPE 393
C			TAPE 394
C	READ INPUT TAPE 2, 1002,		TAPE 395
C	(DNN(K),K=1,6),BLK		TAPE 396
C	DO 215 J=1,200		TAPE 397
C			TAPE 398
C	BLANK OUT ENTIRE CONTRIBUTOR NAME FIELD		TAPE 399
C			TAPE 400
C	215 GNL(J) = BLK		TAPE 401
C	DO 220 K=1,IPCN		TAPE 402
C	J = JGNL(K)		TAPE 403
C			TAPE 404
C	STORE GROUPS FROM -M- CARD IN CONTRIBUTOR NAME FIELD		TAPE 405
C			TAPE 406
C	220 GNL(J) = AGNL(K)		TAPE 407
C	IF (IADD) 490,490,230		TAPE 408
C			TAPE 409
C	PRINTOUT OF INITIAL DATA FOR TAPE		TAPE 410
C			TAPE 411
C	230 WRITE OUTPUT TAPE 3, 2000		TAPE 412
C	WRITE OUTPUT TAPE 3, 3010		TAPE 413
C	WRITE OUTPUT TAPE 3, 3009,		TAPE 414
C	(JGNL(K),AGNL(K),K=1,IPCN)		TAPE 415
C	WRITE OUTPUT TAPE 3, 3015,		TAPE 416
C	(DNN(K),K=1,6),BLK		TAPE 417
C			TAPE 418
C	PREPARE TAPE 6		TAPE 419
C			TAPE 420
C	WRITE OUTPUT TAPE 6, 2000		TAPE 421
C	WRITE OUTPUT TAPE 6, 2001,		TAPE 422
C			TAPE 423
C			TAPE 424

(CONTINUED)

MASTER LIBRARY TAPE MODIFICATION

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DO 240 I=1,IADD
K1 = J+I(1)
240 WRITE OUTPUT TAPE 6, 2002,
      1 ,A(I(1),A2(I),I1A(I),I1B(I),I1C(I),I2(I),I3(I),
      (DA(K,I),K=2,6),K1,IJ1(K,I),8(I,K,I),K1,K1)
WRITE OUTPUT TAPE 6, 2003,
      (GNL(J),J=1,200)
WRITE OUTPUT TAPE 6, 2003,
      (DNN(I),I=1,6)
END FILE 6
WRITE OUTPUT TAPE 3, 3016
REWIND 6
C END OF INITIAL PREPARATION OF TAPE 6
C GO TO 500
C ERROR PRINT - NO DATA FOR INITIAL TAPE PREPARATION
C
490 WRITE OUTPUT TAPE 3, 3017,
      9 IPCN,IADD
495 REWIND 6
500 RETURN
500 NEX = 2
WRITE OUTPUT TAPE 3, 4000, IC, J11
GO TO 500
C FORMAT STATEMENTS
C
1001 FORMAT
      9 (12X , ,14,2X,A6,14,2X,A6,14,2X,A6,14,2X,A6)
1002 FORMAT (12X, 7A6 )
2000 FORMAT(1H1,11X6OH
      1 )
2001 FORMAT
      9 (1HO,6{6})
2002 FORMAT
      9 (1HO,16,2A6,5{6},IPSE12,4,16/(1H,16,E12,4,16,E12,4,16,E12,4,16,
      E12,4,16,E12,4,16,E12,4))
2003 FORMAT
      9 (1HO,6{6X,A6}/(1H,6X,A6,6X,A6,6X,A6,6X,A6,6X,A6,6X,A6,6X,A6,6X,
      1A6,6X,A6))
3000 FORMAT
      9 (1H1, 3X, 10ZHHMONSANTO RESEARCH CORPORATION FLAME SPEED CALCULATI
      ROUTINE 2018 MODIFICATION 1 DATE 2A6 )
3001 FORMAT
      9 (1HO,10X, 30HTAPE 2 WRITING INFORMATION - RUN 14 )
3002 FORMAT
      9 (1HO,15X, 28H INITIAL TAPE PREPARATION )
3003 FORMAT
      9 (1HO, 16X,30HDATA OUT OF ORDER - RUN NUMBER 14,
      1 14X, 20HMISPLACED RUN NUMBER, 1X,
      2 /1HO 16X,22HOPTION CONTROL INTEGER 14,
      3 22X,21HCONTROL INTEGER CHECK 14)
3004 FORMAT
      9 (1HO,10X, 20HNO ACTION CALLED FOR )
3005 FORMAT
      9 (1HO,10X, 57HGROUP SERIAL NUMBER INCONSISTENCY - SERIAL NUMB
      1ER = 14 , 5X, 11HLOCATION = 14 )
3006 FORMAT
      9 (1HO,10X, 34HALTERATIONS TO DATA GROUPS ON TAPE /
      1 1H 114M DATA GROUP ,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11H
      2CONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR
      3/ 1H ,117H SERIAL CODE COUNT / CODE COUNT / CODE
      4 COUNT / CODE COUNT / CODE COUNT / CODE COUNT / CODE
      5/ 1H ,116H NUMBER NUMBER MOLECULE NUMBER MOLECULE NUMBE
      6R MOLECULE NUMBER MOLECULE NUMBER MOLECULE NUMBER MOLECULE /)
3007 FORMAT
      9 (1HO, 11O,7X, 6(16,2X,F7.3,2X) /(1H, 17X,16,2X,F7.3,2X,16,2X,F7.3
      1,2X,16,2X,F7.3,2X,16,2X,F7.3,2X,16,2X,F7.3,2X,16,2X,F7.3 ))
3008 FORMAT
      9 (1HO,10X, 32HCHANGES IN CONTRIBUTOR NAME LIST )
3009 FORMAT
      9 (1HO,14H CONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11H
      1CONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR
      2/ 1H , 5H CODE 13X,4HCODE 13X,4HCODE 13X,4HCODE 13X,4HCODE 13X,
      3 4HCODE 13X,4HCODE /
      4 1H ,117HNUMBER NAME NUMBER NAME NUMBER NAME NUMBER
      5R NAME NUMBER NAME NUMBER NAME NUMBER NAME /
      6/11H 16,2X,A6,3X,16,2X,A6,3X,16,2X,A6,3X,16,2X,A6,3X,16,2X,A6,3X
      7;16,2X,A6,3X,16,2X,A6, )
3010 FORMAT
      9 (1HO,10X, 29HINITIAL CONTRIBUTOR NAME LIST )
3011 FORMAT
      9 (1HO,10X, 32HNO NEW DATA GROUPS ADDED TO TAPE )
3012 FORMAT
      9 (1HO,10X, 25HDATA GROUPS ADDED TO TAPE /
      1 1H ,10H FUEL NAME 19X,12HCODE NUMBERS 22X,14HSTOICHIOMETRIC 11X
      2,13HMAXIMUM SPEED, 6X,11HEQUIVALENCE /1H ,13X,10HSERIAL CLASS G
      3ROUP MEMBER DATA EXPERIMENT FLAME FUEL FLAME
      4 FUEL RATIO AT /
      5 1H ,39X,77HSOURCE CONDITIONS SPEED CONCENTRATION SPEED
      6 CONCENTRATION MAXIMUM /1H ,57X,61H(C/M,SEC) (MOLECULES/CCL,C/M,
      7/SEC) (MOLECULES/CCL) FLAME SPEED /)
3013 FORMAT
      9 (1H , 2A6, 17,216, 317, 4X, F9.4, 2X,1PE12,4,2X, OPFY,4,2X,1PE12,
      24,3X, OPFR,4 )
3014 FORMAT
      9 (1HO,10X, 32HADDITIONS TO DATA GROUPS ON TAPE /
      1 1H ,14H DATA GROUP ,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11H
      2CONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR,6X,11HCONTRIBUTOR
      3/ 1H ,117H SERIAL CODE COUNT / CODE COUNT / CODE COUNT / CODE
      4 COUNT / CODE COUNT / CODE COUNT / CODE COUNT / CODE
      5/ 1H ,116H NUMBER NUMBER MOLECULE NUMBER MOLECULE NUMBE
      6R MOLECULE NUMBER MOLECULE NUMBER MOLECULE NUMBER MOLECULE /)

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SUBROUTINE CROUT		
MATRIX INVERSION FOR SUBROUTINE MAXM		
CCRT	CROUT SUBROUTINE MOD 100 PROBLEM 2018 MARCH 1, 1962 HRC DAYTON	CROUT 1
C		CROUT 2
C	NOMENCLATURE	CROUT 3
C		CROUT 4
C	DIVISA - NON-ZERO DIAGONAL ELEMENT DIVISOR	CROUT 5
C	ID, JN, K, I, JA	CROUT 6
C	J1	CROUT 7
C	ITCTR - ITERATION COUNTER	CROUT 8
C	NVAR - NUMBER OF INDEPENDENT VARIABLES IN EQUATIONS	CROUT 9
C	W, W(I), Y(I) - COEFFICIENTS (OUTPUT)	CROUT 10
C	Z, Z(I,J), X(I,J) - MATRIX OF INDEPENDENT VARIABLES (INPUT)	CROUT 11
C		CROUT 12
C	SUBROUTINE CROUTINVAR,Z,W	CROUT 13
C	DIMENSION X(10,11),Y(10),Z(10,11),W(10)	CROUT 14
C	JN=NVAR+1	CROUT 15
C	DO 2 I=1,NVAR	CROUT 16
C	DO 2 J=1,JN	CROUT 17
C	2 X(I,J)=Z(I,J)	CROUT 18
C	ITCTR=0	CROUT 19
C	3 ID=1	CROUT 20
C		CROUT 21
C	TEST FOR TWO OR MORE VARIABLES	CROUT 22
C		CROUT 23
C	IF(NVAR-1)100,100,8	CROUT 24
C		CROUT 25
C	TEST OF ZERO DIAGONAL ELEMENT	CROUT 26
C		CROUT 27
C	8 IF(X(ID,ID)) 9,11,9	CROUT 28
C	9 DIVSR= X(ID,ID)	CROUT 29
C	DO 10 J=ID,JN	CROUT 30
C	10 X(ID,J)= X(ID,J)/DIVSR	CROUT 31
C	11 ID=1	CROUT 32
C		CROUT 33
C	INVERSION OF MATRIX	CROUT 34
C		CROUT 35
C	DO 20 I=1,NVAR	CROUT 36
C	DO 20 J=1,JN	CROUT 37
C	20 X(I,J)= X(I,J) - ((X(ID,J))* (X(I,ID)))	CROUT 38
C	IF (ID-JN+2)121,22,23	CROUT 39
C		CROUT 40
C	SIGNAL FLAG TO INDICATE SOLUTION NOT POSSIBLE	CROUT 41
C		CROUT 42
C	23 SLNSE LIGHT 4	CROUT 43
C	GO TO 50	CROUT 44
C	21 ID=ID+1	CROUT 45
C	GO TO 8	CROUT 46
C	22 ID= ID +1	CROUT 47
C		CROUT 48
C	TEST FOR ZERO DIAGONAL ELEMENT	CROUT 49
C		CROUT 50
C	IF(X(ID,ID)) 24,11,24	CROUT 51
C		CROUT 52
C	SIGNAL FLAG TO INDICATE SOLUTION NOT POSSIBLE	CROUT 53
C		CROUT 54
C	11 SENSE LIGHT 3	CROUT 55
C	GO TO 50	CROUT 56
C	24 DIVSR = X(ID,ID)	CROUT 57
C		CROUT 58
C	INVERSION OF MATRIX	CROUT 59
C		CROUT 60
C	DO 25 J= ID,JN	CROUT 61
C	25 X(ID,J)= X(ID,J)/DIVSR	CROUT 62
C	K=NVAR	CROUT 63
C	Y(K)= X(NVAR,JN)	CROUT 64
C	126 IF(K-1)150,150,26	CROUT 65
C	26 K=K-1	CROUT 66
C	Y(K)= X(K,JN)	CROUT 67
C	J1= K+1	CROUT 68
C	DO 30 J=J1,NVAR	CROUT 69
C	30 Y(K)= Y(K)- (X(K,J))*Y(J1)	CROUT 70
C	GO TO 126	CROUT 71
C	50 RETURN	CROUT 72
C	100 W(1)= X(1,2)/X(1,1)	CROUT 73
C	IF DIVIDE CHECK 11, 50	CROUT 74
C	150 IF (ITCTR) 151,151,200	CROUT 75
C		CROUT 76
C	COEFFICIENT STORAGE IN OUTPUT VECTOR	CROUT 77
C		CROUT 78
C	151 DO 152 I =1,NVAR	CROUT 79
C	152 W (I) = Y(I)	CROUT 80
C	GO TO 251	CROUT 81
C	200 DO 201 I =1,NVAR	CROUT 82
C	201 W(I)= W(I) - Y(I)	CROUT 83
C		CROUT 84
C	TEST FOR SATISFACTORY COMPLETION OF SOLUTION	CROUT 85
C		CROUT 86
C	IF(ITCTR-3)251,50,50	CROUT 87
C	251 ITCTR = ITCTR +1	CROUT 88
C	DO 152 I = 1,NVAR	CROUT 89
C	DO 152 J = 1,NVAR	CROUT 90
C	152 X(I,J)= Z(I,J)	CROUT 91
C	DO 153 I =1,NVAR	CROUT 92
C	X (I,JN) = -1.0 * Z (I,JN)	CROUT 93
C	DO 153 J = 1,NVAR	CROUT 94
C	153 X(I,JN) = X(I,JN)+ (X(I,J))* (W(J))	CROUT 95
C	GO TO 3	CROUT 96
C	END	CROUT 97

SUBROUTINE FSCI	
DATA CARD INPUT	
CFSCI DATA CARD INPUT SUBROUTINE FOR FLAME SPEED CALCULATIONS	FSCI 1
SUBROUTINE INPUT	FSCI 2
COMMON INT, DEC, IC, J11, J2, J3, NIN, NEX	FSCI 3
DIMENSION INT(10), DEC(10), KARRAY(10), PARRAY(10)	FSCI 4
NIN = NIN	FSCI 5
4 NUMDCP = 3	FSCI 6
KPASS = 0	FSCI 7
401 KPASS = KPASS + 1	FSCI 8
CALL VDECON(NUMDCP, KARRAY, PARRAY, KPASS)	FSCI 9
GO TO(402, 403, 410), KPASS	FSCI 10
402 I = KARRAY(1)	FSCI 11
IC = I	FSCI 12
L = I/1000	FSCI 13
IF(IC) 4020, 4, 4020	FSCI 14
4020 J11 = KARRAY(2)	FSCI 15
J2 = KARRAY(3)	FSCI 16
NUMDCP = J2 + 1	FSCI 17
GO TO 401	FSCI 18
405 DO 406 J=1, J2	FSCI 19
406 INT(J) = KARRAY(J)	FSCI 20
J3 = KARRAY(J2+1)	FSCI 21
NUMDCP = J3	FSCI 22
GO TO 401	FSCI 23
410 DO 412 J=1, J3	FSCI 24
412 DEC(J) = PARRAY(J)	FSCI 25
NEX = 1	FSCI 26
GO TO (50, 60), NIN	FSCI 27
49 NIN = 1	FSCI 28
50 RETURN	FSCI 29
60 IF(IC = 1000) 4, 49, 4	FSCI 30
END	FSCI 31

SUBROUTINE VDECON

INTEGER INPUT DATA DECOMPOSITION

SUBROUTINE VDECON (KARRAY, P, KPASS)	VDECON	1
DIMENSION P(10)	VDECON	2
DIMENSION IDUMMY(30), DUMMY(30)	VDECON	3
DIMENSION KINPUT(72), KARRAY(10), PARRAY(10), AINPUT(72)	VDECON	4
1 KOUTPT(72), AOUTPT(72)	VDECON	5
COMMON IDUMMY, IPLUS, IMINUS, IDECPT, ICONMA, IE, ISLANK,	VDECON	6
1 KINPUT, NUMDCP, PARRAY, I, L, NEX, N1	VDECON	7
EQUIVALENCE (DUMMY, IDUMMY)	VDECON	8
9 (IPLUS, IPLUS), (IMINUS, IMINUS), (IDECPT, IDECPT),	VDECON	9
1 (ICONMA, ICONMA), IE, IE, I, ISLANK, ISLANK,	VDECON	10
2 (AINPUT, KINPUT), (AOUTPT, KOUTPT)	VDECON	11
REWIND 5	VDECON	12
NUMDCP = N	VDECON	13
NEX = 1	VDECON	14
N1 = 1	VDECON	15
L = 1	VDECON	16
GO TO 1, 10, 50, KPASS	VDECON	17
1 CONTINUE	VDECON	18
C SET UP CHARACTERS FOR LATER TEST	VDECON	19
8 PLUS = 206060606060	VDECON	20
8 AMINUS = 406060606060	VDECON	21
8 DECP = 336060606060	VDECON	22
8 CONMA = 736060606060	VDECON	23
8 E = 256060606060	VDECON	24
8 BLANK = 606060606060	VDECON	25
C READ ALPHANUMERIC CHARACTERS	VDECON	26
5 READ INPUT TAPE 5, 1000, (AINPUT(J), J=1, 72)	VDECON	27
10	VDECON	28
GO TO 10, 10, 50, KPASS	VDECON	29
C DECOMPOSITION OF INTEGERS	VDECON	30
10 DO 21 N = N1, NUMDCP	VDECON	31
N1 = N	VDECON	32
C SEARCH FOR START OF NUMBER	VDECON	33
101 IF (KINPUT(1) - ISLANK) 102, 11, 102	VDECON	34
102 IF (KINPUT(1) - ICONMA) 12, 11, 12	VDECON	35
11 I = 1	VDECON	36
IF (I - 72) 101, 101, 5	VDECON	37
C SELECT INTEGERS	VDECON	38
12 L1 = L	VDECON	39
M = 0	VDECON	40
DO 20 J=1, 6	VDECON	41
KOUTPT(L) = KINPUT(I)	VDECON	42
IF (KINPUT(I) - IMINUS) 122, 120, 122	VDECON	43
122 IF (KINPUT(I) - IPLUS) 123, 120, 123	VDECON	44
120 M = 1	VDECON	45
123 L = L + 1	VDECON	46
I = I + 1	VDECON	47
IF (KINPUT(I) - ISLANK) 121, 13, 121	VDECON	48
121 IF (KINPUT(I) - ICONMA) 20, 13, 20	VDECON	49
C RIGHT ADJUST IN FIELD	VDECON	50
13 IF (J-6) 14, 21, 14	VDECON	51
14 KDO = J - M	VDECON	52
DO 15 K = 1, KDO	VDECON	53
L2 = L1 + 6 - K	VDECON	54
L3 = L1 + 1 - K	VDECON	55
15 KOUTPT(L2) = KOUTPT(L3)	VDECON	56
L = L1 + 6	VDECON	57
KDO = 6 - J + M	VDECON	58
KGO = 1 + K	VDECON	59
DO 16 K = KGO, KDO	VDECON	60
L4 = L1 + K	VDECON	61
16 KOUTPT(L4) = 0	VDECON	62
GO TO 21	VDECON	63
20 CONTINUE	VDECON	64
21 CONTINUE	VDECON	65
IEND = 6 + NUMDCP	VDECON	66
C WRITE ALPHANUMERIC CHARACTERS	VDECON	67
WRITE OUTPUT TAPE 5, 1000, (AOUTPT(J), J=1, IEND)	VDECON	68
REWIND 5	VDECON	69
C READ INTEGER LIST	VDECON	70
READ INPUT TAPE 5, 1001, (KARRAY(I), I=1, NUMDCP)	VDECON	71
REWIND 5	VDECON	72
60 RETURN	VDECON	73
50 CALL DECDP	VDECON	74
NEX = NEX	VDECON	75
GO TO (30, 5), NEX	VDECON	76
30 DO 31 J = 1, NUMDCP	VDECON	77
31 P(J) = PARRAY(J)	VDECON	78
GO TO 60	VDECON	79
1000 FORMAT(72A1)	VDECON	80
1001 FORMAT(11I6)	VDECON	81
END	VDECON	82

SUBROUTINE DECDP

FLOATING POINT INPUT DATA DECOMPOSITION

SUBROUTINE DECDP	DECDP	1
COMMON IDUMNY, IPLUS, IMINUS, IDECPT, ICOMMA, IE, IBLANK,	DECDP	2
1 KINPUT, NUMDCP, PARRAY, I, L, NEX, NI	DECDP	3
EQUIVALENCE (IDUMNY, IDUMNY)	DECDP	4
EQUIVALENCE (ADUPT, KOUTPT)	DECDP	5
DIMENSION ADUPT(72), KOUTPT(72), PARRAY(10), KINPUT(72)	DECDP	6
DIMENSION IDUMNY(30), IDUMNY(30)	DECDP	7
NEX = NEX	DECDP	8
M = L	DECDP	9
GO TO 150, 511, NEX	DECDP	10
C DECOMPOSITION OF DECIMAL AND EXPONENTIAL NUMBERS	DECDP	11
C LIMIT DECOMPOSITION TO 6 NUMBERS	DECDP	12
50 IF (NUMDCP - 6) 503, 503, 502	DECDP	13
502 IDEC = 6	DECDP	14
END = 12 * IDEC	DECDP	15
GO TO 504	DECDP	16
503 IDEC = NUMDCP	DECDP	17
END = 12 * NUMDCP	DECDP	18
504 IF (I - 72) 51, 51, 505	DECDP	19
505 NEX = 2	DECDP	20
GO TO 300	DECDP	21
51 NEX = 1	DECDP	22
DO 100 N = NI, IDEC	DECDP	23
NI = N	DECDP	24
C SEARCH FOR START OF NUMBER	DECDP	25
510 IF (KINPUT(I) - IBLANK) 52, 53, 52	DECDP	26
52 IF (KINPUT(I) - ICOMMA) 54, 53, 54	DECDP	27
53 I = I + 1	DECDP	28
IF (I - 72) 510, 510, 505	DECDP	29
54 NI = N	DECDP	30
C STORE NUMBERS UP TO DECIMAL POINT	DECDP	31
541 IF (KINPUT(I) - IDECPT) 55, 65, 55	DECDP	32
55 KOUTPT(N) = KINPUT(I)	DECDP	33
I = I + 1	DECDP	34
N = N + 1	DECDP	35
GO TO 541	DECDP	36
C TEST FOR END OF NUMBER OR EXPONENTIAL	DECDP	37
60 IF (KINPUT(I) - IE) 61, 70, 61	DECDP	38
61 IF (KINPUT(I) - IPLUS) 62, 70, 62	DECDP	39
62 IF (KINPUT(I) - IMINUS) 63, 70, 63	DECDP	40
63 IF (KINPUT(I) - ICOMMA) 64, 80, 64	DECDP	41
64 IF (KINPUT(I) - IBLANK) 65, 80, 65	DECDP	42
C STORE DECIMAL POINT AND NUMBERS	DECDP	43
65 KOUTPT(N) = KINPUT(I)	DECDP	44
I = I + 1	DECDP	45
N = N + 1	DECDP	46
GO TO 60	DECDP	47
C COMPLETE EXPONENTIAL FIELD THROUGH 8 LOCATIONS	DECDP	48
70 LDO = NI + 7	DECDP	49
DO 71 JI = M, LDO	DECDP	50
71 KOUTPT(JI) = 0	DECDP	51
M = NI + 8	DECDP	52
C STORE E IN LOCATION 9	DECDP	53
KOUTPT(9) = IE	DECDP	54
IF (KINPUT(I) - IE) 73, 72, 73	DECDP	55
72 I = I + 1	DECDP	56
C TEST FOR SIGN OF EXPONENT	DECDP	57
73 IF (KINPUT(I) - IMINUS) 74, 76, 74	DECDP	58
74 IF (KINPUT(I) - IPLUS) 75, 76, 75	DECDP	59
75 KOUTPT(M+1) = IPLUS	DECDP	60
GO TO 77	DECDP	61
C STORE SIGN	DECDP	62
76 KOUTPT(M+1) = KINPUT(I)	DECDP	63
I = I + 1	DECDP	64
C TEST FOR END OF EXPONENT	DECDP	65
77 IF (KINPUT(I+1) - IBLANK) 78, 79, 78	DECDP	66
78 IF (KINPUT(I+1) - ICOMMA) 79, 79, 79	DECDP	67
79 KOUTPT(M+2) = 0	DECDP	68
KOUTPT(M+3) = KINPUT(I)	DECDP	69
GO TO 792	DECDP	70
791 KOUTPT(M+2) = KINPUT(I)	DECDP	71
KOUTPT(M+3) = KINPUT(I+1)	DECDP	72
792 I = I + 2	DECDP	73
M = NI + 12	DECDP	74
GO TO 100	DECDP	75
C COMPLETE DECIMAL FIELD	DECDP	76
80 LDO = NI + 11	DECDP	77
DO 81 JI = M, LDO	DECDP	78
81 KOUTPT(JI) = 0	DECDP	79
M = NI + 12	DECDP	80
100 CONTINUE	DECDP	81
C WRITE ALPHANUMERIC CHARACTERS	DECDP	82
WRITE OUTPUT TAPE 5, 1010, (KOUTPT(J), J=1, IEND)	DECDP	83
IF (NUMDCP - IDEC) 201, 201, 200	DECDP	84
200 M = 1	DECDP	85
NI = NI + 1	DECDP	86
IEND = 12 * (NUMDCP - 6)	DECDP	87
IDEC = NUMDCP	DECDP	88
GO TO 504	DECDP	89
201 REWIND 5	DECDP	90
C READ DECIMAL AND EXPONENTIAL LIST	DECDP	91
READ INPUT TAPE 5, 1010, (PARRAY(J), J=1, NUMDCP)	DECDP	92
REWIND 5	DECDP	93
300 L = M	DECDP	94
RETURN	DECDP	95
1000 FORMAT (72A1)	DECDP	96
1010 FORMAT (6F12.5)	DECDP	97
END	DECDP	98

IMPLY DATA

FUEL NAME		INITIATORS USED	
HYDROGEN			
FUEL CLASS NUMBER	0	FUEL GROUP NUMBER	0
FUEL MEMBER NUMBER	0		
DATA SOURCE NUMBER	1	EXPERIMENTAL CONDITIONS NUMBER	1
FLAME VELOCITY AT STOICHIOMETRIC CONCENTRATION RATIO	0.	CM./SEC.	
MAXIMUM FLAME VELOCITY	0.	CM./SEC.	
FUEL CONCENTRATION AT STOICHIOMETRIC CONDITIONS	0.	MOLECULES/CC.	
FUEL CONCENTRATION AT CONDITIONS OF MAXIMUM VELOCITY	0.	MOLECULES/CC.	
EQUIVALENCE RATIO AT MAXIMUM FLAME SPEED	0.		
SPECIES CONTRIBUTOR CODE NUMBER	NUMBER OF CONTRIBUTORS PER MOLECULE OF FUEL		
1	2.000		
2	2.000		
3	3.000		
4	2.000		
5	4.000		
6	5.000		
7	7.000		

EXPERIMENTAL DATA

MIXTURE TEMPERATURE 25.0 DEG. C.

MIXTURE PRESSURE 760.0 MM. MERCURY

ATOMS OF OXYGEN TO COMPLETELY OXIDIZE ONE MOLECULE OF FUEL 1.00

MOLE FRACTION OXYGEN IN OXIDANT 0.2100

VOLUME PER MOLE OF FUEL 2.2414E 04 CC. PER GRAM-MOLE

FLAME FRONT DIMENSIONS

RUN

735 PEAK HEIGHT (MEASURED UNITS) 63.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

41.000

0.

0.61538

4.00000

30.000

0.20000

0.45028

CM.

21.000

0.40000

0.31520

CM.

14.000

0.60000

0.21013

CM.

6.500

0.80000

0.09756

0.

0.99255

0.

0.

0.

MEASURED LENGTH OF REFERENCE 266.50000 UNITS

736 PEAK HEIGHT (MEASURED UNITS) 62.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

40.500

0.

0.60788

4.00000

30.000

0.20000

0.45028

CM.

21.000

0.60000

0.31520

CM.

13.500

0.60000

0.20263

CM.

6.500

0.80000

0.09756

0.

0.93058

0.

0.

0.

MEASURED LENGTH OF REFERENCE 266.50000 UNITS

737 PEAK HEIGHT (MEASURED UNITS) 65.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

42.000

0.

0.63516

4.00000

31.000

0.20000

0.45028

CM.

22.000

0.60000

0.33270

CM.

15.000

0.60000

0.22684

CM.

8.000

0.80000

0.12098

0.

0.98299

0.

0.

0.

MEASURED LENGTH OF REFERENCE 266.50000 UNITS

738 PEAK HEIGHT (MEASURED UNITS) 73.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

42.000

0.

0.63277

4.00000

32.500

0.20000

0.45028

CM.

29.000

0.60000

0.36158

CM.

18.000

0.60000

0.27115

CM.

11.500

0.80000

0.17326

0.

5.500

1.00000

0.08286

0.

MEASURED LENGTH OF REFERENCE 265.50000 UNITS

739 PEAK HEIGHT (MEASURED UNITS) 73.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

41.500

0.

0.62524

4.00000

32.500

0.20000

0.45028

CM.

25.000

0.60000

0.37665

CM.

18.500

0.60000

0.27872

CM.

11.500

0.80000

0.17326

0.

5.500

1.00000

0.08286

0.

MEASURED LENGTH OF REFERENCE 265.50000 UNITS

740 PEAK HEIGHT (MEASURED UNITS) 75.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

42.500

0.

0.63315

4.00000

34.000

0.20000

0.45028

CM.

26.000

0.60000

0.38734

CM.

19.000

0.60000

0.28305

CM.

12.500

0.80000

0.18622

0.

7.000

1.00000

0.10428

0.

MEASURED LENGTH OF REFERENCE 268.50000 UNITS

741 PEAK HEIGHT (MEASURED UNITS) 77.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

43.000

0.

0.64259

4.00000

36.000

0.20000

0.45028

CM.

27.000

0.60000

0.40374

CM.

21.000

0.60000

0.31402

CM.

15.000

0.80000

0.22430

0.

8.500

1.00000

0.12710

0.

MEASURED LENGTH OF REFERENCE 267.50000 UNITS

742 PEAK HEIGHT (MEASURED UNITS) 88.00

STATION (MEASURED)

DIAMETER (MEASURED)

HEIGHT (CM.)

DIAMETER (CM.)

ACTUAL LENGTH OF REFERENCE

44.000

0.

0.65549

4.00000

37.000

0.20000

0.45028

CM.

30.500

0.60000

0.45438

CM.

24.000

0.60000

0.35754

CM.

17.500

0.80000

0.26071

0.

13.000

1.00000

0.19367

0.

MEASURED LENGTH OF REFERENCE 268.50000 UNITS

RUN	FUEL FLOW (CC./SEC)	OXIDANT FLOW (CC./SEC)	MOLE FRACTION INHIBITOR	VOLUME FLOW (CC./SEC)	CCNE AREA (SQ. CM.)	FLAME SPEED (CM./SEC)	EQUIVALENCE RATIO
735	75.20000	137.30000	0.	231.95763	0.91660	255.73156	1.30508
736	91.40000	137.30000	0.	249.64099	0.89899	277.68917	1.58499
737	107.60000	137.30000	0.	267.32434	0.97310	276.71471	1.86392
738	124.00000	137.30000	0.	285.22602	1.09941	259.43550	2.15031
739	124.00000	126.80000	0.	273.74558	1.10860	247.07953	2.32838
740	124.00000	116.50000	0.	262.92146	1.15208	227.86642	2.93423
741	124.00000	106.20000	0.	251.27836	1.24668	201.95869	2.78002
742	124.00000	86.00000	0.	229.22872	1.43982	159.20607	3.43300

FLAME SPEED CURVE DATA

COEFFICIENTS				STANDARD DEVIATION	EQUIVALECE RATIO AT MAX FLAME SPEED	MAXIMUM FLAME SPEED
A1	A2	A3	A4			
-3.8707E C2	7.9649E C2	-3.2718E C2	4.1696E C1	1.9729	1.72288	278.0486
RUN	EQUIVALECE RATIO	MEASURED FLAME SPEED	PREDICTED FLAME SPEED	DEVIATION	PERCENT DEVIATION	
735	1.3041	254.7315	255.3638	-0.6324	-0.2476	
736	1.3838	277.4892	275.8121	1.6771	0.6008	
737	1.8639	274.7147	275.8816	-1.1669	-0.4230	
738	2.1853	288.6355	280.8619	7.7736	2.6928	
739	2.3284	247.0795	246.2792	0.8003	0.3230	
740	2.3182	227.8666	226.6501	1.2165	0.5344	
741	2.7800	201.9987	202.2344	-0.2357	-0.1168	
742	3.6330	193.2061	199.1999	-5.9938	-3.0992	

DATA ACCEPTABLE

FUEL NAME

INITIATORS USED

HYDROGEN

FUEL CLASS NUMBER	C	FUEL GROUP NUMBER	D	FUEL READER NUMBER	0
DATA SOURCE NUMBER	1	EXPERIMENTAL CONDITIONS NUMBER	1		
FLAME VELOCITY AT STOICHIOMETRIC CONCENTRATION RATIO	203.8567			CM./SEC	
MAXIMUM FLAME VELOCITY	278.0488			CM./SEC	
FUEL CONCENTRATION AT STOICHIOMETRIC CONDITIONS	0.726220E 19			MOLECULES/CC.	
FUEL CONCENTRATION AT CONDITIONS OF MAXIMUM VELOCITY	0.103363E 20			MOLECULES/CC.	
EQUIVALENCE RATIO AT MAXIMUM FLAME SPEED	1.72288				

APPENDIX B

Fortran program and Sample Printouts
for Routine FSR

ROUTINE FSR

FLAME SPEED REGRESSION CALCULATIONS

*62-215	10000	7	O.S. MRC7617 RINGROSE	FSR	1
LIST				FSR	2
SYMBOL TABLE				FSR	3
FSR	FLAME SPEED REGRESSION ROUTINE 1922A MRC - DAYTON MARCH 12, 1962			FSR	4
C				FSR	5
C	NOMENCLATURE			FSR	6
C	CGC(K,KUV)	- INPUT LIST OF PRESPECIFIED CONTRIBUTOR		FSR	7
C		COEFFICIENTS		FSR	8
C	CGC(J,I)	- LIST OF PRESPECIFIED COEFFICIENTS		FSR	10
C	DIRT	- FLAME SPEED DATA		FSR	11
C	DNM(K)	- NAME LIST OF DEPENDENT VARIABLE COMPONENTS		FSR	12
C	PGC(J,I)	- INTERNAL FULL LIST OF CONTRIBUTOR COUNTS		FSR	13
C	PGCL(K)	- INPUT TAPE LIST OF CONTRIBUTOR COUNTS		FSR	14
C	FN1 AND FN2	- FIRST AND SECOND HALVES OF FUEL NAME (ON TAPE)		FSR	15
C	FN1(L) AND			FSR	16
C	FN2(L) AND	- FIRST AND SECOND HALVES OF ACCEPTED FUEL		FSR	17
C		NAMES LIST		FSR	18
C	GNL(J)	- INPUT TAPE LIST OF CONTRIBUTOR NAMES		FSR	19
C	I	- DATA SERIAL NUMBER INDEX		FSR	20
C	ICFN	- FUEL CLASS NUMBER (ON TAPE)		FSR	21
C	IGFN	- FUEL GROUP NUMBER (ON TAPE)		FSR	22
C	IMFN	- FUEL MEMBER NUMBER (ON TAPE)		FSR	23
C	INDS	- DATA SOURCE NUMBER (ON TAPE)		FSR	24
C	INRC	- EXPERIMENTAL CONDITIONS NUMBER (ON TAPE)		FSR	25
C	IPCEN	- NUMBER OF ENTRIES IN INPUT LIST OF ACCEPTABLE		FSR	26
C		FUEL CLASS NUMBERS		FSR	27
C	IPCTG	- NUMBER OF ENTRIES IN INPUT LIST OF CONDITIONAL		FSR	28
C		TEST CRITERIA		FSR	29
C	IPCTG3	- NUMBER OF CONDITIONAL TESTS + 3		FSR	30
C	IPDV	- NUMBER OF DEPENDENT VARIABLES TO BE REGRESSED		FSR	31
C	IPCGG	- NUMBER OF ENTRIES IN (KDV)TH LIST OF		FSR	32
C		PRESPECIFIED COEFFICIENTS		FSR	33
C	IPGFN	- NUMBER OF ENTRIES IN INPUT LIST OF ACCEPTABLE		FSR	34
C		FUEL CLASS-GROUP NUMBERS		FSR	35
C	IP1	- NUMBER OF DATA GROUPS ON TAPE 2		FSR	36
C	IP1GTM	- NUMBER OF DUAL ENTRIES IN INPUT LIST OF		FSR	37
C		CONTRIBUTOR TESTS		FSR	38
C	IPJ	- HIGHEST VALUE OF CONTRIBUTOR NUMBER INDEX		FSR	39
C	IPJRC	- NUMBER OF DUAL ENTRIES IN INPUT LIST OF		FSR	40
C		INTEGERS TO OVERRIDE REGRESSION CONTROL		FSR	41
C		DATA		FSR	42
C	IPM	- NUMBER OF INDEPENDENT VARIABLES FOR REGRESSION		FSR	43
C	IPMC	- NUMBER OF PRESPECIFIED COEFFICIENTS IN		FSR	44
C		REGRESSION DATA		FSR	45
C	IPMFN	- NUMBER OF ENTRIES IN INPUT LIST OF		FSR	46
C		UNACCEPTABLE FUEL MEMBER NUMBERS		FSR	47
C	IPN	- NUMBER OF ACCEPTED DATA GROUPS FOR REGRESSION		FSR	48
C	IPRCL	- NUMBER OF ENTRIES IN INPUT LIST OF DECIMAL		FSR	49
C		DATA TO OVERRIDE REGRESSION CONTROL DATA		FSR	50
C	IPSPN	- NUMBER OF ENTRIES IN INPUT LIST OF ACCEPTABLE		FSR	51
C		DATA SERIAL NUMBERS		FSR	52
C	ISFN	- DATA GROUP SERIAL NUMBER (ON TAPE)		FSR	53
C	J	- CONTRIBUTOR NUMBER INDEX		FSR	54
C	J1, J2, K, L			FSR	55
C	ML AND N2	- INDICES		FSR	56
C	JGTM	- CONTRIBUTOR COUNT TEST NUMBER		FSR	57
C	JIN(J)	- CONTRIBUTOR STATUS		FSR	58
C		(-1 - POSSIBLE, 0 - OMIT, 1 - INCLUDE,		FSR	59
C		2 - INCLUDE (COEFFICIENT PRESPECIFIED)		FSR	60
C	KDV	- DEPENDENT VARIABLE INDEX (PROBLEM NUMBER)		FSR	61
C	KDVO	- DEPENDENT VARIABLE DENOMINATOR IDENTIFICATION		FSR	62
C		NUMBER		FSR	63
C	KOVN	- DEPENDENT VARIABLE NUMERATOR IDENTIFICATION		FSR	64
C		NUMBER		FSR	65
C	KSFE	- DEPENDENT VARIABLE SCALE FACTOR EXPONENT		FSR	66
C	LCGCN(MC)	- LIST OF ACCEPTED CONTRIBUTOR NUMBERS HAVING		FSR	67
C		PRESPECIFIED COEFFICIENTS		FSR	68
C	LCFN(K)	- INPUT LIST OF ACCEPTABLE FUEL CLASS NUMBERS		FSR	69
C	LCGCN(K,KDV)	- INPUT LIST OF CONTRIBUTOR CODE NUMBERS HAVING		FSR	70
C		PRESPECIFIED COEFFICIENTS		FSR	71
C	LCFCN(K)	- INPUT LIST OF CONDITIONAL TEST CRITERIA		FSR	72
C	LDVD(KDV)	- INPUT LIST OF DEPENDENT VARIABLE DENOMINATOR		FSR	73
C		NUMBERS		FSR	74
C	LDVN(KDV)	- INPUT LIST OF DEPENDENT VARIABLE NUMERATOR		FSR	75
C		NUMBERS		FSR	76
C	LFGCN(K)	- INPUT TAPE LIST OF CONTRIBUTOR CODE NUMBERS		FSR	77
C		HAVING POSITIVE COUNTS		FSR	78
C	LGFN(I,K)	- INPUT LIST OF ACCEPTABLE FUEL CLASS-GROUP		FSR	79
C		NUMBERS		FSR	80
C	LGTM(J)	- FULL LIST OF CONTRIBUTOR COUNT TEST NUMBERS		FSR	81
C		1 - OMIT, 1 - ACCEPT, 2 - REJECT GROUP IF		FSR	82
C		COUNT NOT ZERO, 3 - REJECT GROUP IF COUNT		FSR	83
C		ZERO, 4 TO 9 - CONDITIONAL TESTS 1		FSR	84
C	LIGCN(K)	- INPUT LIST OF CONTRIBUTOR NUMBERS HAVING COUNT		FSR	85
C		TEST ENTRIES		FSR	86
C	LIGTM(K)	- INPUT LIST OF CONTRIBUTOR COUNT TEST NUMBERS		FSR	87
C	LIPCGG(KDV)	- INPUT LIST OF NUMBER OF ENTRY PAIRS OF		FSR	88
C		PRESPECIFIED REGRESSION COEFFICIENTS		FSR	89
C	LIVCN(M)	- LIST OF ACCEPTED INDEPENDENT CONTRIBUTOR		FSR	90
C		NUMBERS		FSR	91
C	LNFM(I,K)	- INPUT LIST OF UNACCEPTABLE FUEL CLASS-GROUP-		FSR	92
C		MEMBER NUMBERS		FSR	93
C	LOKSPN(I)	- LIST OF ACCEPTED DATA SERIAL NUMBERS		FSR	94
C	LRC(K)	- INPUT LIST OF OVERRIDING INTEGER REGRESSION		FSR	95
C		CONTROL DATA		FSR	96
C	LRCC(K)	- LIST OF INTEGER REGRESSION CONTROL DATA		FSR	97
C	LSFN(K)	- INPUT LIST OF ACCEPTABLE DATA NUMBERS		FSR	98
C	N	- INDEX OF ACCEPTED CONTRIBUTORS WITHOUT		FSR	99
C		PRESPECIFIED COEFFICIENTS		FSR	100
C	MC	- INDEX OF ACCEPTED CONTRIBUTORS WITH		FSR	101
C		PRESPECIFIED COEFFICIENTS		FSR	102
C	N	- INDEX OF ACCEPTED DATA GROUPS		FSR	103
C	NDS	- ACCEPTABLE DATA SOURCE NUMBER		FSR	104

ROUTINE FSR		(CONTINUED)
FLAME SPEED REGRESSION CALCULATIONS		
C	10 - ALL SOURCES ACCEPTABLE	FSR 105
C	1,2,ETC - ONLY SOURCES ACCEPTABLE	FSR 106
C	NEG - ACCEPTABLE EXPERIMENTAL CONDITIONS NUMBER	FSR 107
C	10 - ALL SOURCES ACCEPTABLE	FSR 108
C	1,2,ETC - ONLY SOURCES ACCEPTABLE	FSR 109
C	NOL(K) - COLUMN HEADINGS FOR INDEPENDENT CONTRIBUTORS	FSR 110
C	TABLE	FSR 111
C	NRCI(K) - INPUT LIST OF OVERRIDING INTEGER REGRESSION	FSR 112
C	DATA INDICIES	FSR 113
C	NSER - RUN NUMBER	FSR 114
C	NMZ(K) - CUMULATIVE SUM OF NON-ZERO VALUES OF	FSR 115
C	CONTRIBUTOR COUNT INDEX (K)	FSR 116
C	NZ(K) - CUMULATIVE SUM OF ZERO VALUES OF CONTRIBUTOR	FSR 117
C	COUNT INDEX (K)	FSR 118
C	OCGNL(M) - ACCEPTABLE INDEPENDENT CONTRIBUTOR NAMES	FSR 119
C	OGNL(N) - NAMES OF ACCEPTED CONTRIBUTORS WITH	FSR 120
C	PRESPECIFIED COEFFICIENTS	FSR 121
C	OPL(M) - LIST OF INDEPENDENT CONTRIBUTOR COUNTS	FSR 122
C	PFAIL - REGRESSION VALIDITY INDICATOR	FSR 123
C	1.0 - ACCEPTABLE, 1.0 - UNACCEPTABLE	FSR 124
C	RCGL(K) - LIST OF DECIMAL REGRESSION CONTROL DATA	FSR 125
C	V - DEPENDENT VARIABLE (BEFORE OR AFTER	FSR 126
C	COEFFICIENT ADJUSTMENT)	FSR 127
C	YMX(K) - MAXIMUM ABSOLUTE VALUE OF Y ENCOUNTERED	FSR 128
C		FSR 129
C	COMMON INT, DEC, IC, J11, J2, J3, N1N, NEX	FSR 130
C	DIMENSION INT(10), DEC(10)	FSR 131
C	DIMENSION CGC(50,10), CGCJ(200), D161, DNM(61), FGCJ(200),	FSR 132
C	1 FGCJ(40), FNIL(300), FNIL(300), GNL(200), OCGNL(50),	FSR 133
C	2 UGNL(100), OPL(57), RCGL(31), YMX(101),	FSR 134
C	3 JIN(200), LCCCN(50), LCFN(201), LCCCN(50,10), LTC(9),	FSR 135
C	4 LVD(101), LDVN(101), LFGCCN(40), LCFN(2,401), LGTN(200),	FSR 136
C	5 LGTCN(50), LGTCN(50), LIPCCG(10), L1VCM(100), LMFN(3,80),	FSR 137
C	6 LOKSPN(300), LRC(111), LACC(111), LSPN(300), NMZ(9), NOL(10),	FSR 138
C	7 NRCI(111), NZ(9), COEN(100)	FSR 139
C		FSR 140
C	SETUP OF COLUMN HEADINGS FOR INDEPENDENT CONTRIBUTORS TABLE	FSR 141
C		FSR 142
C	DU 14 K=1,10	FSR 143
C	19 NOL(K) = K-1	FSR 144
C	PFAIL = 0.0	FSR 145
C	REWIND 7	FSR 146
C	REWIND 8	FSR 147
C	REWIND 6	FSR 148
C		FSR 149
C	SETUP FOR SCALE FACTOR CALCULATIONS	FSR 150
C		FSR 151
C	20 DO 21 K=1,10	FSR 152
C	21 YMX(K) = 0.0	FSR 153
C		FSR 154
C	SETUP OF CONTRIBUTOR STATUS LIST 10 -POSSIBLE- CONDITION	FSR 155
C	-1 POSSIBLE, 0 OMIT, 1 INCLUDE,	FSR 156
C	2 INCLUDE (COEFFICIENT PRESPECIFIED)	FSR 157
C		FSR 158
C	DO 23 J=1,200	FSR 159
C	23 JIN(J) = -1	FSR 160
C		FSR 161
C	READ AND PRINT INPUT DATA	FSR 162
C	GENERAL	FSR 163
C		FSR 164
C	I CARD READING	FSR 165
C		FSR 166
C	READ INPUT TAPE 2, 1001	FSR 167
C		FSR 168
C	J CARD READING	FSR 169
C		FSR 170
C	READ INPUT TAPE 2, 1006	FSR 171
C		FSR 172
C	K CARD READING	FSR 173
C		FSR 174
C	READ INPUT TAPE 2, 1000	FSR 175
C	9 NSER, IPDV, IPSFN, IPCFN, IPCFN, IPNPN, NOS, NEG, IP1GYN,	FSR 176
C	1 IPCYC, IPNCL, IPLHC, IPJ, LAST	FSR 177
C	WRITE OUTPUT TAPE 3, 1010,	FSR 178
C	9 NSER	FSR 179
C	WRITE OUTPUT TAPE 3, 1001	FSR 180
C	WRITE OUTPUT TAPE 3, 1011,	FSR 181
C	9 NSER, IPDV, IPJ, NOS, NEG, IPSFN, IPCFN	FSR 182
C	WRITE OUTPUT TAPE 3, 1012,	FSR 183
C	9 IPCFN, IPNPN, IP1GYN, IPCYC, IPNCL, IPLHC	FSR 184
C		FSR 185
C	TEST FOR NO ENTRIES IN DATA SERIAL NUMBER INPUT LIST	FSR 186
C		FSR 187
C	IF (IPSFN) 24,30,25	FSR 188
C	PAUSE REMOVED	FSR 189
C	24 CONTINUE	FSR 190
C		FSR 191
C	L CARD READING	FSR 192
C		FSR 193
C	25 READ INPUT TAPE 2, 1000,	FSR 194
C	9 (LSPN(K),K=1,IPSFN)	FSR 195
C	WRITE OUTPUT TAPE 3, 1013	FSR 196
C	WRITE OUTPUT TAPE 3, 1030,	FSR 197
C	9 (LSPN(K),K=1,IPSFN)	FSR 198
C		FSR 199
C	TEST FOR NO ENTRIES IN FUEL CLASS NUMBER INPUT LIST	FSR 200
C		FSR 201
C	30 IF (IPCFN) 24,32,31	FSR 202
C		FSR 203
C	M CARD READING	FSR 204
C		FSR 205
C	31 READ INPUT TAPE 2, 1000,	FSR 206
C	9 (LCPN(K),K=1,IPCFN)	FSR 207
C	WRITE OUTPUT TAPE 3, 1014	FSR 208

ROUTINE FSR		(CONTINUED)
PLANE SPEED REGRESSION CALCULATIONS		
WRITE OUTPUT TAPE 3, 1030, 9 (LCFNI(K),K=1,IPCFNI)	FSR 209 FSR 210	
C TEST FOR NO ENTRIES IN FUEL CLASS-GROUP NUMBER INPUT LIST	FSR 211	
C 32 IF (IPCFNI) 24,34,33	FSR 212 FSR 213	
C N CARD READING	FSR 214 FSR 215	
C 33 READ INPUT TAPE 2, 1000, 9 (LGFNI(1,K),LGFNI(2,K),K=1,IPGFNI)	FSR 216 FSR 217	
WRITE OUTPUT TAPE 3, 1015	FSR 218	
WRITE OUTPUT TAPE 3, 1050, 9 (LGFNI(1,K),LGFNI(2,K),K=1,IPGFNI)	FSR 219 FSR 220	
C TEST FOR NO ENTRIES IN FUEL CLASS-GROUP-MEMBER NUMBER INPUT LIST	FSR 221 FSR 222	
C 34 IF (IPMFNI) 24,40,35	FSR 223 FSR 224	
C O CARD READING	FSR 225 FSR 226	
C 35 READ INPUT TAPE 2, 1000, 9 (LMFNI(1,K),LMFNI(2,K),LMFNI(3,K),K=1,IPMFNI)	FSR 227 FSR 228	
WRITE OUTPUT TAPE 3, 1016	FSR 229	
WRITE OUTPUT TAPE 3, 1039, 9 (LMFNI(1,K),LMFNI(2,K),LMFNI(3,K),K=1,IPMFNI)	FSR 230 FSR 231	
C TEST FOR NO ENTRIES IN CONTRIBUTOR TEST INPUT LIST	FSR 232 FSR 233	
C 40 IF (IPIGTNI) 24,55,41	FSR 234 FSR 235	
C P CARD READING	FSR 236 FSR 237	
C 41 READ INPUT TAPE 2, 1000, 9 (LIGTCNI(K),LIGTCNI(K),K=1,IPIGTNI)	FSR 238 FSR 239	
WRITE OUTPUT TAPE 3, 1017	FSR 240	
WRITE OUTPUT TAPE 3, 1031, 9 (LIGTCNI(K),LIGTCNI(K),K=1,IPIGTNI)	FSR 241 FSR 242	
C SET UP COMPLETE LIST OF CONTRIBUTOR COUNT TEST NUMBERS	FSR 243	
C - 0 - OMIT	FSR 244	
C - 1 - ACCEPT	FSR 245	
C - 2 - REJECT GROUP IF COUNT NOT ZERO	FSR 246	
C - 3 - REJECT GROUP IF COUNT ZERO	FSR 247	
C - 4 TO 9 - CONDITIONAL TESTS	FSR 248	
DO 48 K=1,IPIGTNI	FSR 249	
J1 = LIGTCNI(K)	FSR 250	
IF (K - IPIGTNI) 44,43,42	FSR 251	
C PAUSE REMOVED	FSR 252	
42 CONTINUE	FSR 253	
C SET CONTRIBUTOR CODE NUMBER LIMIT	FSR 254	
C 43 J2 = IPJ	FSR 255	
GO TO 45	FSR 256	
C REAJUST UPPER LIMIT TO NOT OVERLAP NEXT FIELD	FSR 257	
C 44 J2 = LIGTCNI(K+1) - 1	FSR 258	
C STORE CONTRIBUTOR COUNT TEST NUMBERS IN SEQUENCE	FSR 259	
C 45 DO 48 J= J1,J2	FSR 260	
LGTNI(J) = LGTCNI(K)	FSR 261	
IF (LGTNI(J)) 46,47,48	FSR 262	
C PAUSE REMOVED	FSR 263	
46 CONTINUE	FSR 264	
47 JINI(J) = 0	FSR 265	
48 CONTINUE	FSR 266	
C TEST FOR NO ENTRIES IN CONDITIONAL TEST CRITERIA LIST	FSR 267 FSR 268	
C 50 IF (IIPCTC) 24,55,51	FSR 269	
51 IPCTC3 = IPCTC + 3	FSR 270	
C Q CARD READING	FSR 271 FSR 272	
C READ INPUT TAPE 2, 1000, 9 (LCCTC(K),K=4,IPCTC3)	FSR 273 FSR 274	
WRITE OUTPUT TAPE 3, 1018	FSR 275	
WRITE OUTPUT TAPE 3, 1030, 9 (LCCTC(K),K=4,IPCTC3)	FSR 276 FSR 277	
C SET UP ESSO REGRESSION CONTROL DATA	FSR 278	
C INITIALIZE WITH STANDARD VALUES OF DECIMAL QUANTITIES	FSR 279	
55 RCCL(1) = 0.001	FSR 280	
RCCL(2) = 0.00002	FSR 281	
RCCL(3) = 0.00001	FSR 282	
C INITIALIZE WITH STANDARD VALUES OF INTEGER QUANTITIES	FSR 283	
DO 56 K=4,11	FSR 284	
56 LRCC(K) = 1	FSR 285	
LRCC(5) = 0	FSR 286	
LRCC(10) = 0	FSR 287	
C TEST FOR NO ENTRIES IN DECIMAL OVERRIDE LIST	FSR 288	
C IF (IPRCL) 24,56,57	FSR 289	
C R CARD READING	FSR 290	
C SUBSTITUTE OVERRIDING DECIMAL VALUES	FSR 291 FSR 292	

ROUTINE FSR		(CONTINUED)
FLAME SPEED REGRESSION CALCULATIONS		
C	57 READ INPUT TAPE 2, 2001, 9 (RCCL(K),K=1,3)	FSR 313 FSR 314 FSR 315
C	TEST FOR NO ENTRIES IN INTEGER OVERRIDE LIST	FSR 316
C	58 IF (IPLRC) 24,61,59	FSR 317 FSR 318 FSR 319
C	S CARD READING	FSR 320 FSR 321 FSR 322
C	59 READ INPUT TAPE 2, 1000, 9 (NRCL(K),LRC(K),K=1,IPLRC)	FSR 323 FSR 324 FSR 325
C	SUBSTITUTE OVERRIDING INTEGER VALUES	FSR 326 FSR 327
C	DO 60 K=1,IPLRC L = NRCL(K)	FSR 328 FSR 329 FSR 330
C	60 LRCC(L) = LRC(K)	FSR 331
C	PRINTOUT OF ESSO REGRESSION CONTROL NUMBER LIST	FSR 332 FSR 333
C	61 WRITE OUTPUT TAPE 3, 1019 WRITE OUTPUT TAPE 3, 1032, 9 (RCCL(K),K=1,3),(LRCC(K),K=4,11)	FSR 334 FSR 335 FSR 336
C	SET UP LIST OF DEPENDENT VARIABLE CODE NUMBERS AND NUMBER OF CORRESPONDING PRESPECIFIED REGRESSION COEFFICIENTS	FSR 337 FSR 338 FSR 339 FSR 340
C	65 DO 67 KDV = 1,IPDV	FSR 341 FSR 342
C	T CARD READING	FSR 343 FSR 344 FSR 345
C	HEAD INPUT TAPE 2, 1000, 9 LDVND(KDV),LDVD(KDV),LIPGCG(KDV)	FSR 346 FSR 347 FSR 348
C	TEST FOR NO PRESPECIFIED REGRESSION COEFFICIENTS	FSR 349 FSR 350 FSR 351
C	IF (LIPGCG(KDV)) 24,67,66	FSR 352
C	66 IPGCG = LIPGCG(KDV)	FSR 353 FSR 354 FSR 355
C	U CARD ASSIGNMENTS	FSR 356 FSR 357 FSR 358
C	660 CALL INPUT M = 0 LIMIT = 10*IC LQO = LIMIT - 9 IF (LIMIT - IPGCG) 662, 662, 661	FSR 359 FSR 360 FSR 361 FSR 362 FSR 363
C	661 LIMIT = IPGCG	FSR 364
C	662 DO 663 K = LQO, LIMIT K = M + 1 (CGCCN(K,KDV)) = INT(M)	FSR 365 FSR 366 FSR 367 FSR 368
C	663 CGC(K, KDV) = DEC(M) IF (LIMIT - IPGCG) 660, 67, 67	FSR 369 FSR 370 FSR 371
C	67 CONTINUE	FSR 372
C	START OF FIRST TAPE 6 PASS	FSR 373 FSR 374 FSR 375
C	HEADING READING	FSR 376 FSR 377 FSR 378
C	100 READ INPUT TAPE 6, 1002	FSR 379 FSR 380 FSR 381
C	INDIVIDUAL DATA GROUP READING	FSR 382 FSR 383 FSR 384
C	READ INPUT TAPE 6, 1003, IPI D11 = 1.0 N = 0 DO 190 I=1,IPI	FSR 385 FSR 386 FSR 387 FSR 388 FSR 389 FSR 390 FSR 391
C	READ INPUT TAPE 6, 1004, 9 (ISFN,FN1,FN2,ICFN,IGFN,IMFN,INDS,INEC,(D(K),K=2,6) I,IPFGC,(LFGCCN(K),FGCL(K),K=1,IPFGC)	FSR 392 FSR 393 FSR 394 FSR 395 FSR 396 FSR 397 FSR 398 FSR 399
C	TEST FOR DATA GROUP SERIAL NUMBER SEQUENCE	FSR 400 FSR 401 FSR 402
C	IF (I - ISFN) 104,106,104	FSR 403 FSR 404 FSR 405
C	PAUSE REMOVED	FSR 406 FSR 407 FSR 408
C	104 CONTINUE	FSR 409 FSR 410 FSR 411
C	TEST FOR LIMIT OF 300 ACCEPTABLE DATA GROUPS	FSR 412 FSR 413 FSR 414
C	106 IF (N-300) 110,107,105	FSR 415 FSR 416 FSR 417
C	PAUSE REMOVED	FSR 418 FSR 419 FSR 420
C	108 CONTINUE	FSR 421 FSR 422 FSR 423
C	107 PFAIL = 3.0 GO TO 190	FSR 424 FSR 425 FSR 426
C	START TESTING SEQUENCE FOR ACCEPTABLE REGRESSION DATA	FSR 427 FSR 428 FSR 429
C	110 IF (IPSPN) 111,120,112	FSR 430 FSR 431 FSR 432
C	PAUSE REMOVED	FSR 433 FSR 434 FSR 435
C	111 CONTINUE	FSR 436 FSR 437 FSR 438
C	TEST FOR UNACCEPTABLE DATA GROUP SERIAL NUMBERS	FSR 439 FSR 440 FSR 441
C	112 DO 113 K = 1,IPSPN IF (I - LSPN(K)) 113,190,113	FSR 442 FSR 443 FSR 444 FSR 445
C	113 CONTINUE	FSR 446 FSR 447 FSR 448
C	120 IF (LSPN) 111,123,121	FSR 449 FSR 450 FSR 451
C	TEST FOR ACCEPTABLE FUEL CLASS NUMBER	FSR 452 FSR 453 FSR 454
C	121 DO 122 K=1,IPCFN IF (ICFN - LCFN(K)) 122,129,122	FSR 455 FSR 456 FSR 457 FSR 458
C	122 CONTINUE GO TO 190	FSR 459 FSR 460

ROUTINE FSR		(CONTINUED)
PLANE SPEED REGRESSION CALCULATIONS		
123 IF (IPGFN) 111,126,124	FSR	417
C	FSR	418
TEST FOR ACCEPTABLE FUEL CLASS-GROUP NUMBERS	FSR	419
C	FSR	420
124 DO 125 K=1,IPGFN	FSR	421
IF (ICFN-LGFN(1,K)) 125,124,125	FSR	422
1241 IF (ICFN-LGFN(2,K)) 125,126,125	FSR	423
125 CONTINUE	FSR	424
GO TO 190	FSR	425
126 IF (IPMFN) 111,130,127	FSR	426
C	FSR	427
TEST FOR ACCEPTABLE FUEL CLASS-GROUP-MEMBER NUMBERS	FSR	428
C	FSR	429
127 DO 128 K=1,IPMFN	FSR	430
IF (ICFN-LMFN(1,K)) 128,127,128	FSR	431
1271 IF (ICFN-LMFN(2,K)) 128,1272,128	FSR	432
1272 IF (IMFN-LMFN(3,K)) 128,190,128	FSR	433
128 CONTINUE	FSR	434
130 IF (INDS) 111,135,131	FSR	435
C	FSR	436
TEST FOR ACCEPTABLE DATA SOURCE NUMBER	FSR	437
C	FSR	438
131 IF (INUS - NDS) 190,135,190	FSR	439
135 IF (NEC) 111,140,136	FSR	440
C	FSR	441
TEST FOR ACCEPTABLE EXPERIMENTAL CONDITIONS NUMBER	FSR	442
C	FSR	443
136 IF (INEC - NEC) 190,140,190	FSR	444
C	FSR	445
TEST FOR AN UNDEFINED DEPENDENT VARIABLE	FSR	446
(UNACCEPTABLE IF EITHER NUMERATOR OR DENOMINATOR ZERO)	FSR	447
C	FSR	448
140 DO 142 KDV=1,IPDV	FSR	449
K = LDV(KDV)	FSR	450
IF (D(K)) 141,190,141	FSR	451
141 K = LDV(KDV)	FSR	452
IF (D(K)) 142,190,142	FSR	453
142 CONTINUE	FSR	454
150 IF (IPIGIN) 111,180,151	FSR	455
C	FSR	456
TEST FOR CONTRIBUTOR COUNT TESTS	FSR	457
C	FSR	458
151 DO 152 J=1,IPJ	FSR	459
152 FCCJ(J) = 0.0	FSR	460
DO 153 K=1,IPFCC	FSR	461
J = LFCCCN(K)	FSR	462
C	FSR	463
STORE CONTRIBUTOR NUMBERS FROM GROUP BEING TESTED	FSR	464
C	FSR	465
153 FCCJ(J) = FCCJ(K)	FSR	466
DO 154 K=5,9	FSR	467
NZ(K) = 0	FSR	468
154 NNZ(K) = 0	FSR	469
C	FSR	470
OPERATIONS ON CONTRIBUTOR COUNT TEST NUMBERS	FSR	471
C	FSR	472
DO 165 J = 1,IPJ	FSR	473
JGYN = LGYN(J)	FSR	474
C	FSR	475
CONTRIBUTOR COUNT TEST 2 - ONLY ZERO COUNTS ACCEPTED	FSR	476
C	FSR	477
IF (JGYN - 2) 165,156,157	FSR	478
156 IF (FCCJ(J)) 190,165,190	FSR	479
C	FSR	480
CONTRIBUTOR COUNT TEST 3 - ONLY NON-ZERO COUNTS ACCEPTED	FSR	481
C	FSR	482
CONTRIBUTOR COUNT TESTS 4 TO 9	FSR	483
C	FSR	484
157 IF (JGYN - 3) 158,159,160	FSR	485
PAUSE REMOVED	FSR	486
C	FSR	487
158 CONTINUE	FSR	488
159 IF (FCCJ(J)) 165,190,165	FSR	489
160 IF (FCCJ(J)) 161,162,161	FSR	490
C	FSR	491
SUM OF NON-ZERO VALUES OF INDEX (JGYN)	FSR	492
C	FSR	493
161 NNZ(JGYN) = NNZ(JGYN) + 1	FSR	494
GO TO 165	FSR	495
C	FSR	496
SUM OF ZERO VALUES OF INDEX (JGYN)	FSR	497
C	FSR	498
162 NZ(JGYN) = NZ(JGYN) + 1	FSR	499
165 CONTINUE	FSR	500
IF (IPCTC) 111,180,171	FSR	501
C	FSR	502
TEST FOR CONDITIONAL CONTRIBUTOR COUNT TESTS	FSR	503
C	FSR	504
171 DO 175 K=4,IPCTC3	FSR	505
IF (LCTC(K)) 172,175,175	FSR	506
172 IF (NNZ(K) + LCTC(K)) 190,175,175	FSR	507
173 IF (NNZ(K) - LCTC(K)) 190,175,175	FSR	508
175 CONTINUE	FSR	509
C	FSR	510
CALCULATIONS ON ACCEPTABLE DATA GROUPS	FSR	511
C	FSR	512
180 DO 182 K=1,IPFCC	FSR	513
J = LFCCCN(K)	FSR	514
C	FSR	515
JINI(J) EITHER -1 OR 0	FSR	516
C	FSR	517
IF (JINI(J) + 1) 182,181,182	FSR	518
181 JINI(J) = 1	FSR	519
182 CONTINUE	FSR	520
N = N + 1	FSR	521
LURSP(N) = 1	FSR	522

FLAME SPEED REGRESSION CALCULATIONS

C		FSR	521
C	SETUP OF DESIRED DEPENDENT VARIABLE	FSR	522
C		FSR	523
	DO 189 KDV = 1,IPDV	FSR	524
	KDVN = LDVN(KDV)	FSR	525
	KDVD = LDVD(KDV)	FSR	526
	Y = O(KDVN)/U(KDVD)	FSR	527
	IPCGC = LIPCGC(KDV)	FSR	528
C		FSR	529
C	TEST FOR NO PRESPECIFIED COEFFICIENTS	FSR	530
C		FSR	531
	IF (IPCGC) 111,189,184	FSR	532
184	DO 186 L = 1,IPCGC	FSR	533
	J = LFGCCN(L)	FSR	534
C		FSR	535
C	TEST ONLY THOSE CONTRIBUTORS WHICH ARE NOT TO BE OMITTED	FSR	536
C		FSR	537
	IF (JINI(J) - 1) 188,185,188	FSR	538
185	DO 186 L = 1,IPCGC	FSR	539
C		FSR	540
C	TEST EACH CONTRIBUTOR IN GROUP	FSR	541
C		FSR	542
	IF (J - LFGCCN(L,KDV)) 186,187,186	FSR	543
186	CONTINUE	FSR	544
	GO TO 188	FSR	545
C		FSR	546
C	ADJUST VALUE OF DEPENDENT VARIABLE	FSR	547
C		FSR	548
	187 Y = Y - CGC(L,KDV)*FGCL(K)	FSR	549
188	CONTINUE	FSR	550
C		FSR	551
C	DETERMINE MAXIMUM VALUE OF Y FOR SCALING TO FIT ESSO OUTPUT	FSR	552
C		FSR	553
	189 VMX(KDV) = MAXI(VMX(KDV),ABS(Y))	FSR	554
	FN1(LIN) = FN1	FSR	555
	FN2(LIN) = FN2	FSR	556
190	CONTINUE	FSR	557
	IPN = N	FSR	558
	READ INPUT TAPE 6, 1005, (GNL(I),I=1,200)	FSR	559
	READ INPUT TAPE 6, 1005, (DNM(I),I=1,6)	FSR	560
	REWRITE 6	FSR	561
C		FSR	562
C	END OF FIRST TAPE 6 PASS	FSR	563
C		FSR	564
C	TEST FOR NO ACCEPTABLE DATA	FSR	565
C		FSR	566
	IF (IPN) 191,191,192	FSR	567
C		FSR	568
C	DIAGNOSTIC - NO DATA ACCEPTABLE - PROCESS NEXT RUN	FSR	569
C		FSR	570
	191 WRITE OUTPUT TAPE 3, 1025	FSR	571
	GO TO 302	FSR	572
C		FSR	573
C	PRINT LIST OF ACCEPTABLE DATA SERIAL NUMBER AND FUEL NAMES	FSR	574
C		FSR	575
	192 LRCC(3) = IPN	FSR	576
	WRITE OUTPUT TAPE 3, 1022	FSR	577
193	WRITE OUTPUT TAPE 3, 1034,	FSR	578
	9 (LOKSFN(I), FN1(LIN), FN2(LIN), N=1, IPN)	FSR	579
C		FSR	580
C	TEST FOR DIAGNOSTIC PRINTOUT - FIRST 300 DATA GROUPS USED	FSR	581
C		FSR	582
	IF (PFAIL - 3.0) 200,194,200	FSR	583
194	WRITE OUTPUT TAPE 3, 1027	FSR	584
	PFAIL = 0.0	FSR	585
C		FSR	586
C	GENERATION OF ESSO REGRESSION INPUT DATA	FSR	587
C		FSR	588
C	SET UP DEPENDENT VARIABLE	FSR	589
C		FSR	590
	200 DU 300 KDV=1,IPDV	FSR	591
	KDVN = LDVN(KDV)	FSR	592
	KDVD = LDVD(KDV)	FSR	593
	IPCGC = LIPCGC(KDV)	FSR	594
	IF (IPCGC) 24,210,206	FSR	595
206	DO 207 J=1,IPJ	FSR	596
207	CGCJ(J) = 0.0	FSR	597
C		FSR	598
C	SET UP LIST OF PRESPECIFIED COEFFICIENTS	FSR	599
C		FSR	600
	DD 204 K = 1,IPCGC	FSR	601
	J = LFGCCN(K,KDV)	FSR	602
	CGCJ(J) = CGC(K,KDV)	FSR	603
	IF (JINI(J) - 1) 209,208,209	FSR	604
C		FSR	605
C	SET JINI(J) = 2 FOR CONTRIBUTORS WITH SPECIFIED COEFFICIENTS ONLY	FSR	606
C		FSR	607
	208 JINI(J) = 2	FSR	608
209	CONTINUE	FSR	609
C		FSR	610
C	DETERMINE NUMBER OF INDEPENDENT VARIABLES FOR REGRESSION	FSR	611
C		FSR	612
	210 M = 0	FSR	613
	MC = 0	FSR	614
	DU 213 J=1,IPJ	FSR	615
C		FSR	616
C	TEST FOR STATUS OF CONTRIBUTOR	FSR	617
C		FSR	618
	IF (JINI(J) - 1) 213,211,212	FSR	619
C		FSR	620
C	INCREMENT NUMBER OF DEPENDENT VARIABLES INDEX	FSR	621
C		FSR	622
	211 M = M + 1	FSR	623
	LIVCNTH = J	FSR	624

FLAME SPEED REGRESSION CALCULATIONS

OGNL(M) = GNL(J)	FSR 625
GO TO 213	FSR 626
C	FSR 627
INCREMENT NUMBER OF PRESPECIFIED COEFFICIENTS INDEX	FSR 628
C	FSR 629
212 MC = MC + 1	FSR 630
OGNL(MC) = GNL(J)	FSR 631
LCCCN(MC) = J	FSR 632
213 CONTINUE	FSR 633
IPN = M	FSR 634
IPMC = MC	FSR 635
C	FSR 636
TEST FOR EXCEEDING LIMIT OF DEPENDENT VARIABLES COUNT OF ESSO	FSR 637
REGRESSION PROGRAM	FSR 638
C	FSR 639
IF (IPN-57) 220,220,216	FSR 640
216 PFAIL = 1.0	FSR 641
GO TO 260	FSR 642
C	FSR 643
FINAL MAKEUP OF ESSO REGRESSION CONTROL DATA	FSR 644
C	FSR 645
220 LRCC(1) = KDV	FSR 646
LRCC(2) = IPN + 1	FSR 647
LRCC(3) = IPN	FSR 648
C	FSR 649
WRITE TITLE AND CONTROL DATA FOR REGRESSION ANALYSIS	FSR 650
C	FSR 651
WRITE OUTPUT TAPE 7, 1006	FSR 652
WRITE OUTPUT TAPE 7, 1007, (RCCL(K),K=1,3), (LRCC(K),K=1,3)	FSR 653
C	FSR 654
START OF SECOND TAPE 6 PASS	FSR 655
C	FSR 656
READ INPUT TAPE 6, 1002	FSR 657
READ INPUT TAPE 6, 1003, 1P1	FSR 658
C	FSR 659
CALCULATION OF DEPENDENT VARIABLE SCALE FACTOR	FSR 660
C	FSR 661
KSFE = 0	FSR 662
C	FSR 663
REDUCE POWER OF 10 UNTIL YMX LESS THAN 1000.	FSR 664
C	FSR 665
221 IF (YMX(KDV) - 1000.) 223,222,222	FSR 666
222 YMX(KDV) = YMX(KDV)/10.0	FSR 667
KSFE = KSFE + 1	FSR 668
GO TO 221	FSR 669
C	FSR 670
INCREASE POWER OF 10 UNTIL YMX GREATER THAN 100.	FSR 671
C	FSR 672
223 IF (YMX(KDV) - 100.0) 224,230,230	FSR 673
224 KSFE = KSFE - 1	FSR 674
YMX(KDV) = 10.0*YMX(KDV)	FSR 675
GO TO 223	FSR 676
C	FSR 677
CHOOSE ACCEPTABLE DATA GROUPS FROM TAPE	FSR 678
C	FSR 679
230 DO 235 M = 1,IPN	FSR 680
231 READ INPUT TAPE 6, 1004,	FSR 681
1, 1PFGC, (LFCCCN(K),FCCL(K),K=1,1PFGC)	FSR 682
C	FSR 683
TEST FOR ACCEPTABLE SERIAL NUMBERS	FSR 684
C	FSR 685
IF (1SPN - LKSPNIN) 231,235,232	FSR 686
C	FSR 687
PAUSE REMOVED	FSR 688
232 CONTINUE	FSR 689
233 DO 236 J = 1,1PJ	FSR 690
236 FGC(J) = 0.0	FSR 691
DO 237 K = 1,1PFGC	FSR 692
J = LFCCCN(K)	FSR 693
237 FGC(J) = FCCL(K)	FSR 694
C	FSR 695
PREPARE LIST OF INDEPENDENT CONTRIBUTOR COUNTS	FSR 696
C	FSR 697
DO 238 M = 1,IPN	FSR 698
J = LIVCN(M)	FSR 699
238 OPLTH = FGC(J)	FSR 700
C	FSR 701
CALCULATION OF DEPENDENT VARIABLE	FSR 702
C	FSR 703
240 V = O(KDV)/O(KDVO)	FSR 704
C	FSR 705
TEST FOR NO PRESPECIFIED COEFFICIENTS	FSR 706
C	FSR 707
IF (IPMC) 241,250,242	FSR 708
PAUSE REMOVED	FSR 709
241 CONTINUE	FSR 710
DO 243 MC = 1,IPMC	FSR 711
242 J = LCCCN(MC)	FSR 712
C	FSR 713
DEPENDENT VARIABLE ADJUSTMENT FROM PRESPECIFIED COEFFICIENTS	FSR 714
C	FSR 715
243 V = V - CGC(J)*FGC(J)	FSR 716
C	FSR 717
DEPENDENT VARIABLE SCALING	FSR 718
C	FSR 719
250 V = V*10.0**(-KSFE)	FSR 720
C	FSR 721
WRITE DATA FOR REGRESSION ANALYSIS	FSR 722
C	FSR 723
WRITE OUTPUT TAPE 7, 1006, 1SPN, (OPLTH,M=1,IPN),V	FSR 724
255 CONTINUE	FSR 725
REWIND 6	FSR 726
C	FSR 727
END OF SECOND TAPE 6 PASS	FSR 728

ROUTINE FSR		(CONTINUED)
FLAME SPEED REGRESSION CALCULATIONS		
C	PRINTOUT OF SUCCESSFUL DATA PREPARATION INFORMATION	FSR 729
C	260 WRITE OUTPUT TAPE 3, 1010,	FSR 730
	NSER	FSR 731
	WRITE OUTPUT TAPE 3, 10101,	FSR 732
	KDV	FSR 733
	WRITE OUTPUT TAPE 3, 1020,	FSR 734
	KSEF,DNM(KDV),DNM(KDVS)	FSR 735
	IF (IPGCG) 24,262,261	FSR 736
	261 WRITE OUTPUT TAPE 3, 1021,	FSR 737
	IPMC	FSR 738
	WRITE OUTPUT TAPE 3, 1033,	FSR 739
	(LCGCGN(K,KDV),CGC(K,KDV),K=1,IPGCG)	FSR 740
C	TEST FOR NO INDEPENDENT VARIABLES	FSR 741
C	262 IF (IPM) 270,270,263	FSR 742
C	PRINTOUT OF INDEPENDENT CONTRIBUTORS WITH THEIR REGRESSION	FSR 743
C	INDICES	FSR 744
C	263 WRITE OUTPUT TAPE 3, 1023	FSR 745
	WRITE OUTPUT TAPE 3, 1035,	FSR 746
	(INDL(K),K=1,10)	FSR 747
C	PRINT OUT FIRST 9	FSR 748
C	M2 = XMINOF(Y,IPM)	FSR 749
	WRITE OUTPUT TAPE 3, 1036,	FSR 750
	(LIVCN(M),OGNL(M), M=1,M2)	FSR 751
	IF (IPM - 9) 270,270,265	FSR 752
	265 LNX = IPM/10	FSR 753
C	PRINT OUT IN SEQUENCES OF 10	FSR 754
C	DO 266 LN = 1,LNX	FSR 755
	M1 = 10*LN	FSR 756
	M2 = XMINOF (M1+9,IPM)	FSR 757
	266 WRITE OUTPUT TAPE 3, 1037,	FSR 758
	M1,LIVCN(M),OGNL(M), M=M1,M2)	FSR 759
	270 IF (IPMC) 280,280,271	FSR 760
C	PRINTOUT OF NAMES OF CONTRIBUTORS WHICH HAVE PRESPECIFIED	FSR 761
C	COEFFICIENTS	FSR 762
C	271 WRITE OUTPUT TAPE 3, 1024	FSR 763
	LNX = 1 + (IPMC - 1)/10	FSR 764
	DO 272 LN=1,LNX	FSR 765
	MC1 = 10*LN - 9	FSR 766
	MC2 = XMINOF (MC1+9,IPMC)	FSR 767
	272 WRITE OUTPUT TAPE 3, 1038,	FSR 768
	(LCGCGN(MC1),OGCNL(MC2), MC=MC1,MC2)	FSR 769
	280 IF (PFAIL - 1.0) 290,281,290	FSR 770
C	DIAGNOSTIC - CAPACITY OF REGRESSION ROUTINE EXCEEDED	FSR 771
C	281 WRITE OUTPUT TAPE 3, 1026	FSR 772
	PFAIL = 0.0	FSR 773
	GO TO 2901	FSR 774
	290 PFAIL = 0.0	FSR 775
	REWIND 7	FSR 776
C	INTAPE = 7	FSR 777
C	CALL ESSD REGRESSION PROGRAM	FSR 778
C	CALL ESSD4 (INTAPE)	FSR 779
	2901 DO 300 J= 1, IPJ	FSR 780
	IF (JIMEJ) - 2) 300,292,291	FSR 781
C	PAUSE REMOVED	FSR 782
	291 CONTINUE	FSR 783
	292 JINTJ) = 1	FSR 784
	300 CONTINUE	FSR 785
C	TEST FOR END OF CALCULATIONS	FSR 786
C	302 IF(LAST)301,20,301	FSR 787
	301 REWIND 7	FSR 788
	REWIND 6	FSR 789
	WRITE OUTPUT TAPE 3, 2000	FSR 790
	GO TO 20	FSR 791
C	FORMAT STATEMENTS	FSR 792
C	1000 FORMAT (1814)	FSR 793
	1001 FORMAT (72H	FSR 794
	1	FSR 795
	1002 FORMAT (72H	FSR 796
	1	FSR 797
	1003 FORMAT (1H0 616)	FSR 798
	1004 FORMAT	FSR 799
	9 (1H0 16,2A6,516,1P5E12.4,16/(1H 16,E12.4,16,E12.4,16,	FSR 800
	1E12.4,16,E12.4,16,E12.4))	FSR 801
	1005 FORMAT	FSR 802
	4 (1H0 916X,A6)/(1H 6X,A6,6X,A6,6X,A6,6X,A6,6X,A6,6X,A6,6X,	FSR 803
	1A6,6X,A6))	FSR 804
	1006 FORMAT (72H	FSR 805
	1	FSR 806
	1007 FORMAT (3F10.5,315,12,712)	FSR 807
	1008 FORMAT (17,5X,1P5E12.4 / (6E12.4))	FSR 808
	1010 FORMAT	FSR 809
	9 (1H1 5X, 48HMONSANTO RESEARCH CORPORATION FLAME SPEED REGRESSIO	FSR 810
	IN - ROUTINE 1422 - MODIFICATION 1 - RUN 14)	FSR 811
	10101 FORMAT	FSR 812

FLAME SPEED REGRESSION CALCULATIONS

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9 (1H, 10X, 4H PROBLEM 14 ) PSR 833
1011 FORMAT(1H, 3H RUN 14, 17X, 32H NUMBER OF PROBLEMS IN THIS RUN 14, PSR 834
7X, 40H HIGHEST CONTRIBUTOR CODE NUMBER IN USE 17 / PSR 835
2 (1H, 20X, 31H ACCEPTABLE DATA SOURCE NUMBER 19, PSR 836
3 7X, 42H ACCEPTABLE EXPERIMENTAL CONDITIONS NUMBER 14 / PSR 837
4 (1H, 37X, 44H ENTRIES TO BE READ FROM THE INPUT DATA CARDS / PSR 838
5 (1H, 3X, 9H CARD TYPE 5X, 17H NUMBER OF ENTRIES PSR 839
6 20X, 17H LIST SIGNIFICANCE / PSR 840
7 (1H, 6X, 3H-L- 14X, 14, 8X, 40H- UNACCEPTABLE DATA GROUP SERIAL PSR 841
#L NUMBERS / PSR 842
9 (1H, 6X, 3H-M- 14X, 14, 8X, 31H- ACCEPTABLE FUEL CLASS NUMBERS / PSR 843
1012 FORMAT PSR 844
9 (1H, 6X, 3H-N- 14X, 14, 8X, 37H- ACCEPTABLE FUEL CLASS-GROUP NU PSR 845
MBERS / 1H, 6X, 3H-O- 14X, 14, 8X, 46H- UNACCEPTABLE FUEL-CLASS-GROUP- PSR 846
MEMBER NUMBERS / PSR 847
3 (1H, 6X, 3H-P- 14X, 14, 8X, 32H- CONTRIBUTOR COUNT TEST NUMBERS PSR 848
4 / 1H, 6X, 3H-U- 14X, 14, 8X, 33H- CONDITIONAL COUNT TEST CRITERI PSR 849
5A / 1H, 6X, 3H-N- 14X, 14, 8X, 44H- OVERRIDING DECIMAL REGRESSION PSR 850
6 CONTROL DATA / PSR 851
7 (1H, 6X, 3H-S- 14X, 14, 8X, 44H- OVERRIDING INTEGER REGRESSION PSR 852
8 CONTROL DATA / PSR 853
1013 FORMAT PSR 854
9 (1H, 10X, 46H LIST OF UNACCEPTABLE DATA GROUP SERIAL NUMBERS / ) PSR 855
1014 FORMAT PSR 856
9 (1H, 10X, 37H LIST OF ACCEPTABLE FUEL CLASS NUMBERS / ) PSR 857
1015 FORMAT PSR 858
9 (1H, 10X, 43H LIST OF ACCEPTABLE FUEL CLASS-GROUP NUMBERS / ) PSR 859
1016 FORMAT PSR 860
9 (1H, 10X, 52H LIST OF UNACCEPTABLE FUEL CLASS-GROUP-MEMBER NUMBER PSR 861
15 / ) PSR 862
1017 FORMAT PSR 863
9 (1H, 10X, 31H LIST OF CONTRIBUTOR COUNT TESTS / ) PSR 864
1018 FORMAT PSR 865
9 (1H, 10X, 27H LIST OF COUNT TEST CRITERIA / ) PSR 866
1019 FORMAT PSR 867
9 (1H, 10X, 28H ESSO REGRESSION CONTROL LIST / ) PSR 868
1020 FORMAT PSR 869
9 (1H, 48X, 13 / PSR 870
1 (1H, 10X, 21H INDEPENDENT VARIABLE = A6, 1H/ A6, 4H X10 ) PSR 871
1021 FORMAT PSR 872
9 (1H, 10X, 46H MINUS 14, 32H CONTRIBUTIONS OF THE FOLLOWING / PSR 873
1 (1H, 10X, 49H LIST OF CONTRIBUTOR CODE NUMBERS WITH THEIR PRESPECI PSR 874
FIED COEFFICIENTS / ) PSR 875
1022 FORMAT PSR 876
9 (1H, 10X, 31H LIST OF ACCEPTED DATA SERIAL NUMBERS AND FUEL NAMES PSR 877
1 / ) PSR 878
1023 FORMAT PSR 879
9 (1H, 10X, 77H LIST OF INDEPENDENT CONTRIBUTORS WITH THEIR CORRESP PSR 880
ONDING REGRESSION INDICES / ) PSR 881
1024 FORMAT PSR 882
9 (1H, 10X, 53H LIST OF CONTRIBUTORS HAVING PRESPECIFIED COEFFICIEN PSR 883
15 / ) PSR 884
1025 FORMAT PSR 885
9 (1H, 10X, 18H NO ACCEPTABLE DATA ) PSR 886
1026 FORMAT PSR 887
9 (1H, 10X, 39H CAPACITY OF REGRESSION ROUTINE EXCEEDED ) PSR 888
1027 FORMAT PSR 889
9 (1H, 10X, 46H ONLY THE FIRST 300 ACCEPTABLE DATA GROUPS USED ) PSR 890
1030 FORMAT PSR 891
9 (1H, 10X, 1816 ) PSR 892
1031 FORMAT PSR 893
9 (1H, 10X, 16, 13, 16, 13, 16, 13, 16, 13, 16, 13, 16, 13, 16, 13, 16, 13, PSR 894
116, 13, 16, 13, 16, 13 ) PSR 895
1032 FORMAT PSR 896
9 (1H, 10X, 3(F10.5, 3X), 10X, 14, 7(13 ) PSR 897
1033 FORMAT PSR 898
9 (1H, 11X, 16, 16E12.4, 16, E12.4, 16, E12.4, 16, E12.4, 16, E12.4, PSR 899
16, E12.4 ) PSR 900
1034 FORMAT PSR 901
9 (1H, 11X, 15, 1X, 2A6, 15, 1X, 2A6, 15, 1X, 2A6, 15, 1X, 2A6, PSR 902
15, 1X, 2A6, 15, 1X, 2A6 ) PSR 903
1035 FORMAT PSR 904
9 (1H, 5X, 19, 9(11) PSR 905
1036 FORMAT PSR 906
9 (1H, 20X, 4(14, 1X, A6)) PSR 907
1037 FORMAT PSR 908
9 (1H, 12, 7X, 10(14, 1X, A6)) PSR 909
1038 FORMAT PSR 910
9 (1H, 9X, 10(14, 1X, A6)) PSR 911
1039 FORMAT PSR 912
9 (1H, 10X, 14, 3H / 12, 3H / 12, 18, 3H / 12, 3H / 12, PSR 913
18, 3H / 12, 3H / 12, 18, 3H / 12, 3H / 12, PSR 914
2 18, 3H / 12, 3H / 12, 18, 3H / 12, 3H / 12 ) PSR 915
1040 FORMAT PSR 916
9 (1H, 10X, 14, 3H / 12, 18, 3H / 12, 18, 3H / 12, 18, 3H / 12, PSR 917
18, 3H / 12, 18, 3H / 12, 18, 3H / 12, 18, 3H / 12 ) PSR 918
2000 FORMAT(1H, 25X, 20H EXECUTION COMPLETED ) PSR 919
2001 FORMAT(1H, 310.5 ) PSR 920
END PSR 921

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SUBROUTINE ESS04		
MULTIPLE LINEAR REGRESSION CALCULATIONS		
• LISTB	ESS04	1
• SYMBOL TABLE	ESS04	2
CESS02 ESS04 REGRESSION SUBROUTINE MOD 4	ESS04	3
C PNESS04 INPUT FORMAT 9F12.3	ESS04	4
C VARIABLE INPUT TAPE SPECIFICATIONS	ESS04	5
C SUBROUTINE ESS04 (INTAPE)	ESS04	6
C DIMENSION DATA(60), VECTOR(60,60), AVE(60), SIGMA(60), COEN(60), SIGMCO	ESS04	7
C (60), INDEX(60)	ESS04	8
C DIMENSION RATIO(60), DEC(101), FMT(120), HEAD(12)	ESS04	9
C REWINU INTAPE	ESS04	10
C READ INPUT TAPE INTAPE, 4000, (HEAD(I), I=1,12)	ESS04	11
C HEAD INPUT TAPE INTAPE, 5,	ESS04	12
C 5, TOL, EFIN, EFOUT, NOPROB, INVAR, NODATA, IFMT, IFSTEP	ESS04	13
C 1, IFRAV, IFAVE, IFRESO, IFCOEN, IFPRD, IFCNST	ESS04	14
C INDATA = 1	ESS04	15
C NRUNSE = 1	ESS04	16
C IDEPSE = INVAR + 1	ESS04	17
C INEIGT = INVAR + 2	ESS04	18
C GO TO (101, 102), INDATA	ESS04	19
C 101 WRITE OUTPUT TAPE 3, 5003, (HEAD(I), I=1, 12)	ESS04	20
C WRITE OUTPUT TAPE 3,	ESS04	21
C 5, TOL, EFIN, EFOUT, NOPROB, INVAR, NODATA, IFMT, IFSTEP	ESS04	22
C 1, IFRAV, IFAVE, IFRESO, IFCOEN, IFPRD, IFCNST	ESS04	23
C 102 DO 4020 I=1, INVAR	ESS04	24
C 4020 COEN(I)=0.0	ESS04	25
C IFMT = 1, THEN ALL WHTS = 1.0	ESS04	26
C IFSTEP = 1, DO NOT PRINT EACH STEP	ESS04	27
C IFRAV = 1, DO NOT PRINT RAW SUMS AND SQUARES	ESS04	28
C IFAVE = 1, DO NOT PRINT AVERAGES	ESS04	29
C IFRESO = 1, DO NOT PRINT RESIDUAL SUMS SQUARES	ESS04	30
C IFCOEN = 1, DO NOT PRINT PARTIAL COEFFICIENTS	ESS04	31
C IFPRD = 1, DO NOT CALC PREDICTED VALUES	ESS04	32
C IFCNST = 1, DO NOT HAVE CONST TERM IN EQUATION	ESS04	33
C INDATA = 1, LIST INPUT DATA ON TAPE 3	ESS04	34
C NOIN = 0	ESS04	35
C VAR = 0	ESS04	36
C K = 0	ESS04	37
C FLEVEL = 0	ESS04	38
C NUENT = 0	ESS04	39
C NOMIN = 0	ESS04	40
C NUMAX = 0	ESS04	41
C NOVAV = INVAR	ESS04	42
C NVPI = NOVAV + 1	ESS04	43
110 DO 120 I = 1, NVPI	ESS04	44
120 DO 120 J = 1, NVPI	ESS04	45
120 VECTOK(I,J) = 0.0	ESS04	46
121 REWINU 8	ESS04	47
140 IF (FMT) 900, 500, 150	ESS04	48
900 WRITE OUTPUT TAPE 3, 905	ESS04	49
GO TO 910	ESS04	50
150 INPUT = NOVAV + 1	ESS04	51
DO 170 N = 1, NODATA	ESS04	52
160 READ INPUT TAPE INTAPE, 5000, (DEC(I), I=1, INPUT)	ESS04	53
J1 = 1	ESS04	54
RUN = DEC(NRUNSE)	ESS04	55
DATA(NOVAV) = DEC(IDEPSE)	ESS04	56
DO 1613 J = 1, INPUT	ESS04	57
IF J - NRUNSE(1611, 1613, 1611	ESS04	58
1611 IF J - IDEPSE(1612, 1613, 1612	ESS04	59
1612 DATA(J1) = DEC(J)	ESS04	60
J1 = J1 + 1	ESS04	61
1613 CONTINUE	ESS04	62
161 WRITE TAPE 8, (DATA(I), I = 1, NOVAV), RUN	ESS04	63
GO TO (162, 180), INDATA	ESS04	64
162 WRITE OUTPUT TAPE 3,	ESS04	65
5, 11, RUN, (DATA(I), I = 1, NOVAV)	ESS04	66
180 DO 190 I = 1, NOVAV	ESS04	67
200 VECTOR(I, NOVAV + 1) = VECTOR(I, NOVAV + 1) + DATA(I)	ESS04	68
210 DO 220 J = 1, NOVAV	ESS04	69
220 VECTOR(I, J) = VECTOR(I, J) + DATA(I) * DATA(J)	ESS04	70
190 CONTINUE	ESS04	71
170 VECTOR(NVPI, NVPI) = VECTOR(NVPI, NVPI) + 1.0	ESS04	72
230 DO 562	ESS04	73
C CALCULATION SUMS WHEN VARIABLE WEIGHTS	ESS04	74
500 INPUT = NOVAV + 2	ESS04	75
DO 510 N = 1, NODATA	ESS04	76
520 READ INPUT TAPE INTAPE, 5000, (DEC(I), I=1, INPUT)	ESS04	77
J1 = 1	ESS04	78
RUN = DEC(NRUNSE)	ESS04	79
DATA(NOVAV) = DEC(IDEPSE)	ESS04	80
WHT = DEC(INEIGT)	ESS04	81
DO 5204 J = 1, INPUT	ESS04	82
IF J - NRUNSE(5201, 5204, 5201	ESS04	83
5201 IF J - IDEPSE(5202, 5204, 5202	ESS04	84
5202 IF J - INEIGT(5203, 5204, 5203	ESS04	85
5203 DATA(J1) = DEC(J)	ESS04	86
J1 = J1 + 1	ESS04	87
5204 CONTINUE	ESS04	88
521 WRITE TAPE 8, (DATA(I), I = 1, NOVAV), RUN	ESS04	89
GO TO (522, 530), INDATA	ESS04	90
522 WRITE OUTPUT TAPE 3,	ESS04	91
5, 11, RUN, (DATA(I), I = 1, NOVAV)	ESS04	92
530 DO 540 I = 1, NOVAV	ESS04	93
550 VECTOR(I, NOVAV + 1) = VECTOR(I, NOVAV + 1) + DATA(I) * WHT	ESS04	94
560 DO 560 J = 1, NOVAV	ESS04	95
570 VECTOR(I, J) = VECTOR(I, J) + DATA(I) * DATA(J) * WHT	ESS04	96
580 VECTOR(NVPI, NVPI) = VECTOR(NVPI, NVPI) + WHT	ESS04	97
C COMPLETED SUMS OF SQUARES AND CROSS PRODUCTS. THESE ARE IN	ESS04	98
C 1STORAGE IN LOCATION, VECTOR(I, J). THESE WILL BE PRINTED OUT ON	ESS04	99
C 2TAPE 3 UNDER CONTROL OF STATEMENT 100	ESS04	100
565 NOVAV = NOVAV - 1	ESS04	101
566 NVPI = NOVAV + 1	ESS04	102
REWINU INTAPE	ESS04	103
WRITE OUTPUT TAPE 3, 5003, (HEAD(I), I = 1, 12)	ESS04	104

MULTIPLE LINEAR REGRESSION CALCULATIONS

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567 WRITE OUTPUT TAPE 3, 90, NOPROB, NODATA, NOVAR, VECTOR(NOVPL,
      INOVPL), EFIM, EFOUT
      ESSD4 105
570 GO TO 4003
      ESSD4 106
4003 IF (IPRAW) 900, 580, 650
      ESSD4 107
580 WRITE OUTPUT TAPE 3, 15
      ESSD4 108
590 WRITE OUTPUT TAPE 3, 20, 11, VECTOR(1, NOVPL), I = 1, NOVMI
      ESSD4 109
600 WRITE OUTPUT TAPE 3, 25, VECTOR(NOVAR, NOVPL)
      ESSD4 110
610 WRITE OUTPUT TAPE 3, 30
      ESSD4 111
620 WRITE OUTPUT TAPE 3, 35, ((1, J, VECTOR(1, J), J = 1, NOVMI), I = 1, NOVMI)
      ESSD4 112
630 WRITE OUTPUT TAPE 3, 40, 11, VECTOR(1, NOVAR), I = 1, NOVMI
      ESSD4 113
640 WRITE OUTPUT TAPE 3, 45, VECTOR(MUVAR, NOVAR)
      ESSD4 114
      GO TO 650
      ESSD4 115
C. CALCULATION OF RESIDUAL SUMS OF SQUARES AND CROSS PRODUCTS
      ESSD4 116
650 IF (IFCNST) 900, 651, 735
      ESSD4 117
651 IF (VECTOR(NOVPL, NOVPL)) 652, 652, 655
      ESSD4 118
652 WRITE OUTPUT TAPE 3, 654
      ESSD4 119
      GO TO 910
      ESSD4 120
655 DO 660 I = 1, NOVAR
      ESSD4 121
660 DO 660 J = 1, NOVAR
      ESSD4 122
      VECTOR(1, J) = VECTOR(1, J) - (VECTOR(1, NOVPL) * VECTOR(J, NOVPL)
      - / VECTOR(NOVPL, NOVPL))
      ESSD4 123
680 DO 690 I = 1, NOVAR
      ESSD4 124
690 AVE(I) = VECTOR(1, NOVPL) / VECTOR(NOVPL, NOVPL)
      ESSD4 125
700 IF (IFAVE) 900, 710, 735
      ESSD4 126
710 WRITE OUTPUT TAPE 3, 50
      ESSD4 127
720 WRITE OUTPUT TAPE 3, 20, 11, AVE(I), I = 1, NOVMI
      ESSD4 128
730 WRITE OUTPUT TAPE 3, 25, AVE(NOVAR)
      ESSD4 129
735 IF (IFRESO) 900, 740, 760
      ESSD4 130
740 WRITE OUTPUT TAPE 3, 55
      ESSD4 131
750 WRITE OUTPUT TAPE 3, 35, ((1, J, VECTOR(1, J), J = 1, NOVMI), I = 1, NOVMI)
      ESSD4 132
760 WRITE OUTPUT TAPE 3, 40, 11, VECTOR(1, NOVAR), I = 1, NOVMI
      ESSD4 133
770 WRITE OUTPUT TAPE 3, 45, VECTOR(NOVAR, NOVAR)
      ESSD4 134
780 NOSTEP = -1
      ESSD4 135
781 ASSIGN 1320 TO NUMBER
      ESSD4 136
782 DEFR = VECTOR(NOVPL, NOVPL) - 1.0
      ESSD4 137
790 DO 800 I = 1, NOVAR
      ESSD4 138
791 IF (VECTOR(1, I)) 792, 794, 810
      ESSD4 139
792 WRITE OUTPUT TAPE 3, 793,
      ESSD4 140
      9
      ESSD4 141
      GO TO 910
      ESSD4 142
793 FORMAT (31H ERROR RESIDUAL SQUARE VARIABLE 14, 31H IS NEGATIVE, PROB
      ILEN TERMINATED)
      ESSD4 143
794 WRITE OUTPUT TAPE 3, 795, 1
      ESSD4 144
796 SIGMA(I) = 1.0
      ESSD4 145
797 GO TO 800
      ESSD4 146
798 FORMAT (10H1H VARIABLE 15, 12H IS CONSTANT)
      ESSD4 147
810 SIGMA(I) = SQRT(VECTOR(1, I))
      ESSD4 148
800 VECTOR(1, I) = 1.0
      ESSD4 149
820 DO 830 I = 1, NOVMI
      ESSD4 150
840 IPI = 1 + I
      ESSD4 151
841 DO 850 J = IPI, NOVAR
      ESSD4 152
850 VECTOR(1, J) = VECTOR(1, J) / (SIGMA(I) * SIGMA(J))
      ESSD4 153
830 VECTOR(1, I) = VECTOR(1, I)
      ESSD4 154
860 IF (IFCDEN) 900, 870, 1000
      ESSD4 155
870 WRITE OUTPUT TAPE 3, 60
      ESSD4 156
874 NOVMI2 = NOVMI - 1
      ESSD4 157
875 DO 885 I = 1, NOVMI2
      ESSD4 158
880 IPI = 1 + I
      ESSD4 159
885 WRITE OUTPUT TAPE 3, 35, ((1, J, VECTOR(1, J), J = IPI, NOVMI)
      ESSD4 160
890 WRITE OUTPUT TAPE 3, 40, 11, VECTOR(1, NOVAR), I = 1, NOVMI
      ESSD4 161
1000 NOSTEP = NOSTEP + 1
      ESSD4 162
1001 IF (VECTOR(NOVAR, NOVAR)) 1002, 1002, 1010
      ESSD4 163
1002 NSTPMI = NOSTEP - 1
      ESSD4 164
      WRITE OUTPUT TAPE 3, 1004, NSTPMI
      ESSD4 165
      GO TO 1381
      ESSD4 166
1010 SIGV = SIGMA(NOVAR) * SQRT(VECTOR(NOVAR, NOVAR) / DEFR)
      ESSD4 167
1015 DEFR = DEFR - 1.0
      ESSD4 168
1016 IF (DEFR) 1017, 1017, 1020
      ESSD4 169
1017 WRITE OUTPUT TAPE 3, 1019, NOSTEP
      ESSD4 170
      GO TO 1381
      ESSD4 171
1020 VMIN = 0.0
      ESSD4 172
1030 VMAX = 0.0
      ESSD4 173
1035 NOIN = 0
      ESSD4 174
1040 DO 1050 I = 1, NOVMI
      ESSD4 175
1041 IF (VECTOR(1, I)) 1042, 1050, 1060
      ESSD4 176
1042 WRITE OUTPUT TAPE 3, 1044, I, NOSTEP
      ESSD4 177
1045 GO TO 910
      ESSD4 178
1060 IF (VECTOR(1, I) - TOL) 1050, 1080, 1080
      ESSD4 179
1080 VAR = VECTOR(1, NOVAR) * VECTOR(NOVAR, I) / VECTOR(1, I)
      ESSD4 180
1090 IF (VAR) 1100, 1050, 1110
      ESSD4 181
1100 NOIN = NOIN + 1
      ESSD4 182
1120 INDEX(NOIN) = I
      ESSD4 183
1130 CUEN(NOIN) = VECTOR(1, NOVAR) * SIGMA(NOVAR) / SIGMA(I)
      ESSD4 184
1140 SIGMO(NOIN) = (SIGV / SIGMA(I)) * SQRT(VECTOR(1, I))
      ESSD4 185
      KATIO(NOIN) = CUEN(NOIN) / SIGMO(NOIN)
      ESSD4 186
1150 IF (VMIN) 1160, 1170, 904
      ESSD4 187
904 WRITE OUTPUT TAPE 3, 906
      ESSD4 188
      GO TO 910
      ESSD4 189
1170 VMIN = VAR
      ESSD4 190
1180 NOIN = 1
      ESSD4 191
1190 GO TO 1050
      ESSD4 192
1160 IF (VAR - VMIN) 1050, 1050, 1170
      ESSD4 193
1110 IF (VAR - VMAX) 1050, 1050, 1210
      ESSD4 194
1210 VMAX = VAR
      ESSD4 195
1220 NMAX = 1
      ESSD4 196
1050 CONTINUE
      ESSD4 197
1230 IF (NOIN) 903, 1240, 1245
      ESSD4 198
903 WRITE OUTPUT TAPE 3, 907
      ESSD4 199
      GO TO 910
      ESSD4 200
1240 WRITE OUTPUT TAPE 3, 65, SIGV
      ESSD4 201
1260 GO TO 1350
      ESSD4 202
1245 IF (IFCNST) 900, 1250, 1244
      ESSD4 203
1246 CNST = 0.0
      ESSD4 204
1247 GO TO 1300
      ESSD4 205

```

MULTIPLE LINEAR REGRESSION CALCULATIONS

```

1250 CNST = AVE(MOVAR)
1270 DO 1280 I = 1, NOIN
1290 J = INDEX(I)
1280 CNST = CNST - (COEN(I) * AVE(J))
1300 IF (IFSTEP) 900, 1310, 1320
1310 IF (NOENT) 1311, 1311, 1313
1311 WRITE OUTPUT TAPE 3, 91, NOSTEP, K
1312 GO TO 1314
1313 WRITE OUTPUT TAPE 3, 92, NOSTEP, K
1314 WRITE OUTPUT TAPE 3, 70, FLEVEL, SIGV, CNST,
1 (INDEX(J), COEN(J), SIGMC(J), RATIO(J), J-1, NOIN 1
1315 GO TO NUMBER, (1320, 1380)
1320 FLEVEL = VMIN * DEFR / VECTOR (MOVAR, MOVAR)
1330 IF (FOUT) = FLEVEL 1350, 1350, 1340
1340 K = NOIN
1345 NOENT = 0
GO TO 1391
1350 FLEVEL = VMAX * DEFR / (VECTOR(MOVAR, MOVAR) - VMAX)
1360 IF (EFIN - FLEVEL) 1370, 1361, 1380
1361 IF (EFIN) 1380, 1380, 1370
1370 K = NOMAX
1380 NOENT = K
1391 IF (K) 1392, 1392, 1400
1392 WRITE OUTPUT TAPE 3, 1395, NOSTEP
1394 GO TO 910
1400 DO 1410 I = 1, NOVAR
1420 IF (I-K) 1430, 1410, 1430
1430 DO 1440 J = 1, NOVAR
1450 IF (J-K) 1460, 1440, 1460
1460 VECTOR(I, J) = VECTOR(I, J) - (VECTOR(I, K) * VECTOR(K, J) / VECTOR
- (K, K))
1440 CONTINUE
1410 CONTINUE
1470 DO 1480 I = 1, NOVAR
1490 IF (I-K) 1500, 1480, 1500
1500 VECTOR(I, K) = - VECTOR(I, K) / VECTOR(K, K)
1480 CONTINUE
1510 DO 1520 J = 1, NOVAR
1530 IF (J-K) 1540, 1520, 1540
1540 VECTOR(K, J) = VECTOR(K, J) / VECTOR(K, K)
1520 CONTINUE
1550 VECTOR(K, K) = 1.0 / VECTOR(K, K)
1560 GO TO 1000
1560 WRITE OUTPUT TAPE 3, 75,
9 NOSTEP
1581 IF (IFSTEP) 900, 1581, 1570
1570 ASSIGN 1580 TO NUMBER
1571 GO TO 1310
1580 GO TO 1581
1581 IF (FPRED) 900, 1582, 910
1582 NEWNO = 0
1583 WRITE OUTPUT TAPE 3, 85
CUMSUM = 0.
1590 DO 1600 N = 1, NODATA
1600 READ TAPE 8, (DATA(I), I = 1, NOVAR), RUN
1610 YPRED = CNST
1620 DO 1630 I = 1, NOIN
1640 K = INDEX(I)
1650 YPRED = YPRED + COEN(I) * DATA(K)
1650 DEV = DATA(MOVAR) - YPRED
CUMSUM = CUMSUM + DEV
1660 WRITE OUTPUT TAPE 3, 80, RUN, DATA(MOVAR), YPRED, DEV, CUMSUM
910 IF ACCUMULATOR OVERFLOW 6000, 6001
6001 IF QUOTIENT OVERFLOW 6000, 6002
6002 IF DIVIDE CHECK 6000, 100
6000 WRITE OUTPUT TAPE 3, 6004
100 CONTINUE
RETURN
6004 FORMAT(70HVIEW RESULTS WITH SKEPTICISM. OVERFLOW, UNDERFLOW OR DIV
TIDE CHECK HAS OCCURRED.)
END...
C
5 FORMAT (3F10.5, 3I5, 1H 1012)
6 FORMAT
9 ( 1H , 3F10.5 , 3I5 , 1H , 1012 )
10 FORMAT (6(F12.5))
11 FORMAT ( 1H , 1PE12.5 , 8E12.5 )
15 FORMAT (1H 4NH
20 FORMAT (1H 11H SUM X( 12,3H) = E12.4, 8H SUM X( 12,3H) =E12.4,
10H SUM X( 12,3H) =E12.4, 8H SUM X(12,3H) =E12.4 )
25 FORMAT (17H SUM Y =E12.4)
30 FORMAT(10H 70H RAW SUM OF SQUARES A
1ND CROSS PRODUCTS// )
35 FORMAT (1H 7H X(12,7H) VS X(12,3H) = E15.6,
1 6H X(12,7H) VS X(12,3H) = E15.6,
2 6H X(12,7H) VS X(12,3H) = E15.6 )
40 FORMAT (1H 7H X(12,12H) VS Y =E15.6,
1 6H X(12,12H) VS Y =E15.6,
2 6H X(12,12H) VS Y =E15.6 )
45 FORMAT (1H 21H Y VS Y =E15.6)
50 FORMAT (1H 063H AVERAGE VALUE OF
- VARIABLES// )
55 FORMAT(1H 077H RESIDUAL SUMS OF SQUA
-RES AND CROSS PRODUCTS//)
60 FORMAT(1H 069H PARTIAL CORRELATI
-ON COEFFICIENTS//)
65 FORMAT (25H0 STANDARD ERROR OF Y = F12.6 )
70 FORMAT (11H F LEVEL F12.4/25H STANDARD ERROR OF Y & F12.4/12H
1 CONSTANT E15.5/50H VARIABLE COEFFICIENT STD ERR
2OR OF COEF 17H COEF/STD ERROR // (16H -K- 13)
33(18.5))
75 FORMAT (10H COMPLETED 15,20H STEPS OF REGRESSION)
90 FORMAT(12HSTEPWISE REGRESSION //12H PROBLEM NO 110 //13H NO OF
1DATA = 12 //10H NO OF VARIABLES = 110 //10H WEIGHTED DEGREES OF FR
2LETON = F12.2 //23H F LEVEL TO ENTER VARIABLE = F10.5 //23H F LEVE

```

(CONTINUED)

3) TO REMOVE VARIABLE = F10.5 ///							
91	FORMAT(4#DSTEP NO.15 /7SH	VARIABLE REMOVED 16)				ESS04	313
92	FORMAT(4#DSTEP NO.15 /2DH	VARIABLE ENTERING 18)				ESS04	314
93	FORMAT(1\$H RUM F4.0,3\$H	F10.5,3\$H F10.5,3\$H F10.5,3\$H F10.5,				ESS04	316
134	F10.5/(14\$H	F10.5,3\$H F10.5,3\$H F10.5,3\$H F10.5,3\$H F10.				ESS04	317
25,3\$H	F10.5))					ESS04	318
634	FORMAT(1\$H	ZERO NUMBER OF DATA. SO LONG.)				ESS04	319
905	FORMAT(42\$H ERROR IN CONTROL CARD; PROBLEM TERMINATED)					ESS04	320
906	FORMAT(25\$H ERROR, VMIN PLUS, SOLONG)					ESS04	321
907	FORMAT(26\$H ERROR,NMIN MINUS, SOLONG)					ESS04	322
1004	FORMAT(14#D3TH SQUARE NON-POSITIVE,TERMINATE STEP 1 5)					ESS04	323
1019	FORMAT(14#D24H NO MORE DEGREES FREEDOM STEP 1 5)					ESS04	324
1044	FORMAT(14#DU1M SQUARE X=15,17M NEGATIVE, SOLONG 15,6M STEPS)					ESS04	325
1395	FORMAT(12\$H K=0, STEP 16, 7H SOLONG)					ESS04	326
6112	FORMAT(3#HDTOTAL CORRELATION COEFFICIENT SQUARED F10.5)					ESS04	327
4300	FORMAT(YE10.6)					ESS04	328
5003	FORMAT(1M1, 25X, 12A6)					ESS04	329
4000	FORMAT(12A6)					ESS04	330
80	FORMAT(7X , F12.5,2X,F12.5,3X,F12.5, 2X,F12.5,2X,F12.5)					ESS04	331
85	FORMAT(14#D43H	PREDICTED VS ACTUAL RESULTS	/75\$H			ESS04	332
	RUM NO.	ACTUAL	PREDICTED	DEVIATION	CUMULATIV	ESS04	333
BE SUM						ESS04	334
9000	FORMAT(6F12.5)					ESS04	335
END						ESS04	344

MONSANTO RESEARCH CORPORATION FLAME SPEED REGRESSION - ROUTINE 1922 - MODIFICATION 1 - RUN 3

MONSANTO RESEARCH CORPORATION TEST DATA FOR ROUTINE 1922

RUN	3	NUMBER OF PROBLEMS IN THIS RUN	3	HIGHEST CONTRIBUTOR CODE NUMBER IN USE	200
		ACCEPTABLE DATA SOURCE NUMBER	0	ACCEPTABLE EXPERIMENTAL CONDITIONS NUMBER	0

ENTRIES TO BE READ FROM THE INPUT DATA CARDS

CARD TYPE	NUMBER OF ENTRIES	LIST SIGNIFICANCE
-1-	0	- UNACCEPTABLE DATA GROUP SERIAL NUMBERS
-2-	0	- ACCEPTABLE FUEL CLASS NUMBERS
-3-	0	- ACCEPTABLE FUEL CLASS-GROUP NUMBERS
-4-	0	- UNACCEPTABLE FUEL-CLASS-GROUP-MEMBER NUMBERS
-5-	3	- CONTRIBUTOR COUNT TEST NUMBERS
-6-	1	- CONDITIONAL COUNT TEST CRITERIA
-7-	0	- OVERRIDING DECIMAL REGRESSION CONTROL DATA
-8-	0	- OVERRIDING INTEGER REGRESSION CONTROL DATA

LIST OF CONTRIBUTOR COUNT TESTS

1 0 37 4 40 0

LIST OF COUNT TEST CRITERIA

1

ESD REGRESSION CONTROL LIST

0.00100 0.00002 0.00001 1 0 1 1 1 1 0 1

LIST OF ACCEPTED DATA SERIAL NUMBERS AND FUEL NAMES

2 ETHANE	3 PROPANE	4 N-HEPTANE	5 N-HEPTANE	6 N-HEPTANE	7 N-HEPTANE
8 NOCTANE	9 N-DECANE	10 N-UNDECANE	11 N-TRIDECANE	12 ISOBUTANE	13 ISO-PENTANE
14 2-METHYLPENTANE	15 2-ME-PENTANE	16 3-ME-PENTANE	17 2-METHYLBUTANE	18 2-METHYLBUTANE	19 2-METHYLBUTANE
20 2-METHYLBUTANE	21 2-METHYLBUTANE	22 2-METHYLBUTANE	23 CYCLOPROPANE	24 CYCLOPENTANE	25 CYCLOHEXANE
26 ME-CYCLOPENTANE	27 ME-CYCLOHEXANE	28 12-ME-CYCLOHEX-2	29 12-ME-CYCLOHEX-2	30 PROPYLENE	31 BUTENE-1
32 CIS-BUTENE-2	33 TRANS-BUTENE-2	34 TRANS-BUTENE-2	35 N-PENTENE-1	36 N-PENTENE-2	37 ISO-BUTYLENE
38 2-METHYLBUTENE-1	39 2-METHYLBUTENE-2	40 2-METHYLBUTENE-2	41 4-METHYLBUTENE-2	42 4-METHYLBUTENE-2	43 2-METHYLBUTENE-1
44 CYCLOHEXENE	45 4-VINYL-CYCLOHEX-1	46 CYCLOHEXENE	47 4-VINYL-CYCLOHEX-1	48 4-VINYL-CYCLOHEX-1	49 4-VINYL-CYCLOHEX-1
50 4-VINYL-CYCLOHEX-1	51 4-VINYL-CYCLOHEX-1	52 4-VINYL-CYCLOHEX-1	53 4-VINYL-CYCLOHEX-1	54 4-VINYL-CYCLOHEX-1	55 4-VINYL-CYCLOHEX-1
56 4-VINYL-CYCLOHEX-1	57 4-VINYL-CYCLOHEX-1	58 4-VINYL-CYCLOHEX-1	59 4-VINYL-CYCLOHEX-1	60 4-VINYL-CYCLOHEX-1	61 4-VINYL-CYCLOHEX-1
62 4-VINYL-CYCLOHEX-1	63 4-VINYL-CYCLOHEX-1	64 4-VINYL-CYCLOHEX-1	65 4-VINYL-CYCLOHEX-1	66 4-VINYL-CYCLOHEX-1	67 4-VINYL-CYCLOHEX-1
68 4-VINYL-CYCLOHEX-1	69 4-VINYL-CYCLOHEX-1	70 4-VINYL-CYCLOHEX-1	71 4-VINYL-CYCLOHEX-1	72 4-VINYL-CYCLOHEX-1	73 4-VINYL-CYCLOHEX-1
74 4-VINYL-CYCLOHEX-1	75 4-VINYL-CYCLOHEX-1	76 4-VINYL-CYCLOHEX-1	77 4-VINYL-CYCLOHEX-1	78 4-VINYL-CYCLOHEX-1	79 4-VINYL-CYCLOHEX-1
80 4-VINYL-CYCLOHEX-1	81 4-VINYL-CYCLOHEX-1	82 4-VINYL-CYCLOHEX-1	83 4-VINYL-CYCLOHEX-1	84 4-VINYL-CYCLOHEX-1	85 4-VINYL-CYCLOHEX-1
86 4-VINYL-CYCLOHEX-1	87 4-VINYL-CYCLOHEX-1	88 4-VINYL-CYCLOHEX-1	89 4-VINYL-CYCLOHEX-1	90 4-VINYL-CYCLOHEX-1	91 4-VINYL-CYCLOHEX-1
92 4-VINYL-CYCLOHEX-1	93 4-VINYL-CYCLOHEX-1	94 4-VINYL-CYCLOHEX-1	95 4-VINYL-CYCLOHEX-1	96 4-VINYL-CYCLOHEX-1	97 4-VINYL-CYCLOHEX-1
98 4-VINYL-CYCLOHEX-1	99 4-VINYL-CYCLOHEX-1	100 4-VINYL-CYCLOHEX-1	101 4-VINYL-CYCLOHEX-1	102 4-VINYL-CYCLOHEX-1	103 4-VINYL-CYCLOHEX-1
104 4-VINYL-CYCLOHEX-1	105 4-VINYL-CYCLOHEX-1	106 4-VINYL-CYCLOHEX-1	107 4-VINYL-CYCLOHEX-1	108 4-VINYL-CYCLOHEX-1	109 4-VINYL-CYCLOHEX-1
110 4-VINYL-CYCLOHEX-1	111 4-VINYL-CYCLOHEX-1	112 4-VINYL-CYCLOHEX-1	113 4-VINYL-CYCLOHEX-1	114 4-VINYL-CYCLOHEX-1	115 4-VINYL-CYCLOHEX-1
116 4-VINYL-CYCLOHEX-1	117 4-VINYL-CYCLOHEX-1	118 4-VINYL-CYCLOHEX-1	119 4-VINYL-CYCLOHEX-1	120 4-VINYL-CYCLOHEX-1	121 4-VINYL-CYCLOHEX-1
122 4-VINYL-CYCLOHEX-1	123 4-VINYL-CYCLOHEX-1	124 4-VINYL-CYCLOHEX-1	125 4-VINYL-CYCLOHEX-1	126 4-VINYL-CYCLOHEX-1	127 4-VINYL-CYCLOHEX-1
128 4-VINYL-CYCLOHEX-1	129 4-VINYL-CYCLOHEX-1	130 4-VINYL-CYCLOHEX-1	131 4-VINYL-CYCLOHEX-1	132 4-VINYL-CYCLOHEX-1	133 4-VINYL-CYCLOHEX-1
134 4-VINYL-CYCLOHEX-1	135 4-VINYL-CYCLOHEX-1	136 4-VINYL-CYCLOHEX-1	137 4-VINYL-CYCLOHEX-1	138 4-VINYL-CYCLOHEX-1	139 4-VINYL-CYCLOHEX-1
140 4-VINYL-CYCLOHEX-1	141 4-VINYL-CYCLOHEX-1	142 4-VINYL-CYCLOHEX-1	143 4-VINYL-CYCLOHEX-1	144 4-VINYL-CYCLOHEX-1	145 4-VINYL-CYCLOHEX-1

MONSANTO RESEARCH CORPORATION FLAME SPEED REGRESSION - ROUTINE 1922 - MODIFICATION 1 - RUN 3

PROBLEM 1

DEPENDENT VARIABLE = 3 UMAX/5 CMAX X10

LIST OF INDEPENDENT CONTRIBUTORS WITH THEIR CORRESPONDING REGRESSION INDICES

0 1 2 3 4 5 6 7 8 9
37 PRIM-H 38 SEC-H 39 TERT-H

1 TITLE CARD FOR ESSO REGRESSION PROGRAM

STEPWISE REGRESSION

PROBLEM NO 1

NO OF DATA = 118

NO OF VARIABLES = 4

WEIGHTED DEGREES OF FREEDOM = 118.00

F LEVEL TO ENTER VARIABLE = 0.00002

F LEVEL TO REMOVE VARIABLE = 0.00001

STANDARD ERROR OF Y = 170.257925

STEP NO. 1

VARIABLE ENTERING 1

F LEVEL 315.8649

STANDARD ERROR OF Y = 88.6189

CONSTANT 0.

VARIABLE COEFFICIENT STD ERROR OF COEF COEF/STD ERROR

X- 1 0.23560E 02 0.13200E 01 0.17773E 02

STEP NO. 2

VARIABLE ENTERING 2

F LEVEL 110.1560

STANDARD ERROR OF Y = 63.6083

CONSTANT 0.

VARIABLE COEFFICIENT STD ERROR OF COEF COEF/STD ERROR

X- 1 0.18738E 02 0.10489E 01 0.17864E 02

X- 2 0.12318E 02 0.11736E 01 0.10496E 02

STEP NO. 3

VARIABLE ENTERING 3

F LEVEL 0.5730

STANDARD ERROR OF Y = 63.7267

CONSTANT 0.

VARIABLE COEFFICIENT STD ERROR OF COEF COEF/STD ERROR

X- 1 0.19356E 02 0.13313E 01 0.14540E 02

X- 2 0.12241E 02 0.11802E 01 0.10372E 02

X- 3 -0.84304E 01 0.11137E 02 -0.75695E 00

COMPLETED 3 STEPS OF REGRESSION

APPENDIX C

Fortran Programs for Routines
FSRTL and FSRDM

ROUTINE PSRTL

MASTER LIBRARY TAPE PREPARATION FROM CARD LIBRARY

CPSRTL	MASTER TAPE PREPARATION FOR FLAME SPEED REGRESSION ROUTINE	PSRTL	1
	DIMENSION D(16), LPSCCN(200), PSCL(200), SML(200), DNN(16)	PSRTL	2
C	INPUT DATA FROM CARD IMAGES ON TAPE 2	PSRTL	3
C	MASTER TAPE LOGICAL UNIT 6	PSRTL	4
	REWIND 6	PSRTL	5
C	TITLE CARD	PSRTL	6
	READ INPUT TAPE 2, 1000	PSRTL	7
	WRITE OUTPUT TAPE 6, 1000	PSRTL	8
C	NUMBER OF GROUPS ON TAPE	PSRTL	9
	READ INPUT TAPE 2, 1001, IPI	PSRTL	10
	WRITE OUTPUT TAPE 6, 1001, IPI	PSRTL	11
C	MAIN DATA GROUPS	PSRTL	12
	DO 20 I=1, IPI	PSRTL	13
	READ INPUT TAPE 2, 1002, ISFN, FN1, FN2, IPNC, IPNG, IPNM,	PSRTL	14
	1 INDS, INEC, (D(K), K=2,6), IPFGC, (LPGCCN(K), PGCL(K), K=1,	PSRTL	15
	2 IPFGC)	PSRTL	16
	20 WRITE OUTPUT TAPE 6, 2002, ISFN, FN1, FN2, IPNC, IPNG, IPNM,	PSRTL	17
	1 INDS, INEC, (D(K), K=2,6), IPFGC, (LPGCCN(K), PGCL(K), K=1,	PSRTL	18
	2 IPFGC)	PSRTL	19
C	CONTRIBUTOR NAMES	PSRTL	20
	READ INPUT TAPE 2, 1003, (GML(I), I=1, 200)	PSRTL	21
	WRITE OUTPUT TAPE 6, 2003, (GML(I), I=1, 200)	PSRTL	22
C	DEPENDENT VARIABLES	PSRTL	23
	READ INPUT TAPE 2, 1003, (DNN(I), I=1, 6)	PSRTL	24
	WRITE OUTPUT TAPE 6, 2003, (DNN(I), I=1, 6)	PSRTL	25
	END FILE 6	PSRTL	26
	REWIND 6	PSRTL	27
	WRITE OUTPUT TAPE 3, 2005	PSRTL	28
	CALL EXIT	PSRTL	29
	1000 FORMAT(1H1, 11X, 60H)	PSRTL	30
	1	PSRTL	31
	1001 FORMAT(1H0, 16)	PSRTL	32
	1002 FORMAT(16, 2A6, 516, 2F12.5 / 3F12.5, 16, 16, F12.5 / (16, F12.6,	PSRTL	33
	1 16, F12.6, 16, F12.6, 16, F12.6)	PSRTL	34
	1003 FORMAT(12A6)	PSRTL	35
	2002 FORMAT(1H0, 16, 2A6, 516, 1P5E12.4, 16/ 11H , 16, E12.4, 16, E12.4	PSRTL	36
	1 , 16, E12.4, 16, E12.4, 16, E12.4, 16, E12.4)	PSRTL	37
	2003 FORMAT(1H0, 9(6X, A61/ 11H , 6X A6, 6X A6, 6X A6, 6X A6, 6X A6, 6X A6,	PSRTL	38
	1 6X A6, 6X A6, 6X A6)	PSRTL	39
	2005 FORMAT(1H1, 25X, 28HTAPE 6 PREPARATION COMPLETE)	PSRTL	40
	END	PSRTL	41

ROUTINE PSRDM		
MASTER CARD LIBRARY MODIFICATION		
CPSRDM	MASTER DECK MODIFICATION FOR FLAME SPEED REGRESSION ROUTINE	PSRDM 1
C	PREPARE TAPE 14 FOR PUNCHING OF CHANGES IN MASTER TAPE	PSRDM 2
C	NOMENCLATURE	PSRDM 3
C	NDGPOT - NUMBER OF DATA GROUPS PREVIOUSLY ON TAPE	PSRDM 4
C	NDGCOT - NUMBER OF DATA GROUPS CURRENTLY ON TAPE	PSRDM 5
C	NDGCMG - NUMBER OF DATA GROUPS ALTERED	PSRDM 6
C	IDGCMG(K) - CODE NUMBER OF ALTERED DATA GROUPS	PSRDM 7
C	NADD - NUMBER OF DATA GROUPS ADDED TO MASTER DECK	PSRDM 8
C	ICONAM - CONTRIBUTOR NAME PUNCH SWITCH 1-PUNCH 2-OMIT	PSRDM 9
C	IDPHAM - DEPENDENT VARIABLE PUNCH SWITCH 1-PUNCH 2-OMIT	PSRDM 10
	DIMENSION IDGCMG(10000), IFGCCN(90), FGCL(90), GNL(200), DMN(6)	PSRDM 11
	1, D(6)	PSRDM 12
	REWIND 6	PSRDM 13
C	READ INPUT CONTROL DATA	PSRDM 14
	READ INPUT TAPE 2, 3000, NDGPOT, NDGCMG, ICONAM, IDPHAM	PSRDM 15
	IF(NDGCMG) 10, 20, 10	PSRDM 16
10	READ INPUT TAPE 2, 3001, (IDGCMG(K), K=1, NDGCMG)	PSRDM 17
C	READ TITLE AND NUMBER OF GROUPS FROM MASTER TAPE AND PUNCH	PSRDM 18
20	READ INPUT TAPE 6, 1000	PSRDM 19
	READ INPUT TAPE 6, 1001, NDGCOT	PSRDM 20
	WRITE OUTPUT TAPE 14, 1000	PSRDM 21
	WRITE OUTPUT TAPE 3, 1000	PSRDM 22
	L = 1	PSRDM 23
	WRITE OUTPUT TAPE 14, 1001, NDGCOT	PSRDM 24
	WRITE OUTPUT TAPE 3, 1001, NDGCOT	PSRDM 25
	IF(NDGCOT - NDGPOT) 100, 30, 30	PSRDM 26
30	DO 45 I=1, NDGCOT	PSRDM 27
	READ INPUT TAPE 4, 2002, ISFN, FN1, FN2, IFNC, IFNG, IFNH	PSRDM 28
1	INDS, INEC, (D(K), K=2,6), IPFGC, (IFGCCN(K), FGCL(K), K=1,	PSRDM 29
2	IPFGC)	PSRDM 30
	IF(I - NDGPOT) 32, 32, 30	PSRDM 31
32	IF(I - IDGCMG(L)) 40, 33, 40	PSRDM 32
33	L = L + 1	PSRDM 33
34	WRITE OUTPUT TAPE 14, 1002, ISFN, FN1, FN2, IFNC, IFNG, IFNH	PSRDM 34
1	INDS, INEC, (D(K), K=2,6), IPFGC, (IFGCCN(K), FGCL(K), K=1,	PSRDM 35
2	IPFGC)	PSRDM 36
40	WRITE OUTPUT TAPE 3, 2002, ISFN, FN1, FN2, IFNC, IFNG, IFNH	PSRDM 37
1	INDS, INEC, (D(K), K=2,6), IPFGC, (IFGCCN(K), FGCL(K), K=1,	PSRDM 38
2	IPFGC)	PSRDM 39
45	CONTINUE	PSRDM 40
	READ INPUT TAPE 6, 2003, (GNL(I), I=1, 200)	PSRDM 41
	READ INPUT TAPE 6, 2003, (DMN(I), I=1, 6)	PSRDM 42
	GO TO 150, 601, ICONAM	PSRDM 43
50	WRITE OUTPUT TAPE 14, 1003, (GNL(I), I=1, 200)	PSRDM 44
	WRITE OUTPUT TAPE 3, 1003, (GNL(I), I=1, 200)	PSRDM 45
60	GO TO (70, 80), IDPHAM	PSRDM 46
70	WRITE OUTPUT TAPE 14, 1003, (DMN(I), I=1, 6)	PSRDM 47
	WRITE OUTPUT TAPE 3, 1003, (DMN(I), I=1, 6)	PSRDM 48
80	WRITE OUTPUT TAPE 3, 4000	PSRDM 49
90	CALL EXIT	PSRDM 50
100	WRITE OUTPUT TAPE 3, 4001	PSRDM 51
	GO TO 90	PSRDM 52
1000	FORMAT(1H1,11X,60H	PSRDM 53
1	)	PSRDM 54
1001	FORMAT(1H0,1A1	PSRDM 55
1002	FORMAT(16,2A6,5I6,2E12.5 / 3E12.5,16,16,E12.5 / (16,E12.5,	PSRDM 56
1	16,E12.5),16,E12.5,16,E12.5))	PSRDM 57
1003	FORMAT(12A6)	PSRDM 58
2002	FORMAT(1H0,16,2A6,5I6,1P5E12.4,16Z(1H,16,E12.4,16,E12.4	PSRDM 59
1	,16,E12.4,16,E12.4,16,E12.4,16,E12.4))	PSRDM 60
2003	FORMAT(1H0,91A6,6E12.1H,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,	PSRDM 61
1	6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,6XAA,	PSRDM 62
3000	FORMAT(416)	PSRDM 63
3001	FORMAT(1276)	PSRDM 64
4000	FORMAT(1H1,25X,35HMASTER DECK MODIFICATION COMPLETE)	PSRDM 65
4001	FORMAT(1H1,25X,40HERROR - MORE DATA GROUPS IN LIBRARY THAN ON TAP	PSRDM 66
1	)	PSRDM 67
	END	PSRDM 68

○ Aeronautical Systems Division, Dir/Aeromechanics Flight Accessories Lab, Wright-Patterson AFB, Ohio Rpt No. ASD-TDR-63-182, FLAME SPEED DATA REDUCTION AND CORRELATION USING A DIGITAL COMPUTER. Final report, Feb 63, 89 p. Incl illus., tables, 6 refs. Unclassified Report Two digital computer routines were developed to process flame speed data resulting from the burning of compounds in air oxygen, and to correlate par- ticular structural configuration with flame speed. In both routines, a high degree of flexibility has been incorporated to assure efficient utilization under several foreseeable circumstances. The first routine, FSC, processes the raw experi- mental data to obtain flame speeds, equivalence ratios, and the equivalence ratio at the maximum flame speed. This information is stored on a master magnetic tape for subsequent calculations. The second routine, FSR, permits se- lection of specific data groups from the master tape for analysis. A linear model was chosen for the correlation. ○	Computer & Data Systems 1. Flame Speed Data 2. Correlation Technique 3. AFSC Project 6075, Task 607505 II. Contract AF33(657)-7617 III. Monsanto Research Corp., Dayton, Ohio IV. O. H. Ringrose, et al. V. Aval fr OTS VI. In ASTIA collection	○ Aeronautical Systems Division, Dir/Aeromechanics Flight Accessories Lab, Wright-Patterson AFB, Ohio Rpt No. ASD-TDR-63-182, FLAME SPEED DATA REDUCTION AND CORRELATION USING A DIGITAL COMPUTER. Final report, Feb 63, 89 p. Incl illus., tables, 6 refs. Unclassified Report Two digital computer routines were developed to process flame speed data resulting from the burning of compounds in air oxygen, and to correlate par- ticular structural configuration with flame speed. In both routines a high degree of flexibility has been incorporated to assure efficient utilization under several foreseeable circumstances. The first routine, FSC, processes the raw experi- mental data to obtain flame speeds, equivalence ratios, and the equivalence ratio at the maximum flame speed. This information is stored on a master magnetic tape for subsequent calculations. The second routine, FSR, permits se- lection of specific data groups from the master tape for analysis. A linear model was chosen for the correlation. ○	Computer & Data Systems 1. Flame Speed Data 2. Correlation Technique 3. AFSC Project 6075, Task 607505 II. Contract AF33(657)-7617 III. Monsanto Research Corp., Dayton, Ohio IV. O. H. Ringrose, et al. V. Aval fr OTS VI. In ASTIA collection
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