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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ELECTRON MICROPROBE ANALYSIS  
PROGRAM FOR BIOLOGICAL SPECIMENS - BIOMAP

Program J201

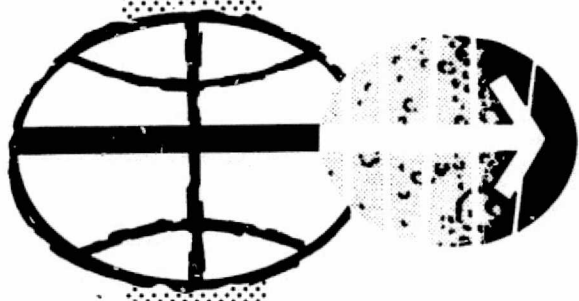
by

Ben F. Edwards

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ANALYSIS PROGRAM FOR BIOLOGICAL SPECIMENS:  
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ELECTRON MICROPROBE ANALYSIS  
PROGRAM FOR BIOLOGICAL SPECIMENS — BIOMAP


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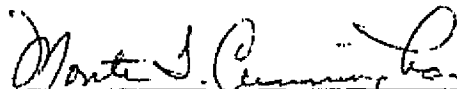
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01 4		01 7 PROGRAM ID			COMPUTER PROGRAM ABSTRACT				01 14 DATE	
MSC		J201							1-25-72	
01 20 TITLE OF PROGRAM (61 CHARACTERS MAXIMUM)							PARENT PROGRAM			
MICROPROBE ANALYSIS PROGRAM FOR BIOLOGICAL SPECIMENS							02 14 CATEGORY	02 15 SITE	02 18 PROGRAM NO	
02 26 CATEGORY	02 27 LANGUAGE NO. 1	02 32 LANGUAGE NO. 2	02 37 KEY WORDS (8 MAXIMUM SEPARATED BY COMMAS)							
J	FOR5		X-ray microanalysis, correction analysis, microchemical analysis							
WHO TO CONTACT ABOUT THE PROGRAM							05 48 STATUS		05 49	
05 14 CONTACT		05 28 SITE	05 31 ORGN CODE	05 39 PROJECT NO		05 45 (NASA CENTER)	<input type="checkbox"/> A UNDER DEVELOPMENT	<input type="checkbox"/> B OPERATIONAL	<input checked="" type="checkbox"/> C COMPLETED	<input type="checkbox"/> A THIS PROGRAM IS NOT FOR SHARING
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DATES		05 58 REVISION CODE			TIME AND COST FOR DEVELOPMENT					
05 50 INITIATED	05 54 COMPLETED	<input type="checkbox"/> A REVISION	<input type="checkbox"/> B CANCELLATION	05 59 MAN/MONTHS	05 64 MACHINE HOURS	05 69 COMPUTER TYPE		05 74 TOTAL COST (DOLLARS)		
10-15-70	6-10-71			8.1	2.0	1108				
CARD NUMBER	COLUMN 11	ABSTRACT								
06		This program, BIOMAP, is a Univac 1108 compatible program								
07		which facilitates the electron probe microanalysis of								
08		biological specimens. Input data are x-ray intensity data								
09		from biological samples, the x-ray intensity and composition								
10		data from a standard sample and the electron probe operating								
11		parameters. Output are estimates of the weight percentages								
12		of the analyzed elements, the distribution of these estimates								
13		for sets of red blood cells and the probabilities for								
14		correlation between elemental concentrations. An optional								
15		feature statistically estimates the x-ray intensity and								
16		residual background of a principal standard relative to a								
17		series of standards.								
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## 1. INTRODUCTION

The purpose of this program, BIOMAP, is to facilitate the electron microprobe analysis of biological specimens by computing from microprobe intensity count data and other parameters the quantity of specified chemical elements contained in formed elements of the blood and in micro-thin sections of tissue and gelatin. In addition, BIOMAP estimates background and concentration intensity counts for chemical elements in standards and computes and plots the distributions of elemental concentrations in red blood cell samples.

BIOMAP was developed as part of the Preventative Medicine Division Project 1030, Intracellular Chemical Characterization, which calls for research and development in areas of cellular chemical analysis by micro-X-ray spectrometry and UV microspectrometry. Direction of this effort was provided by Dr. Stephen L. Kimzey, Chief of the Cellular Analytical Section of the Clinical Laboratory, Preventative Medicine Division, NASA-MSC. Electron microprobe data used to test the mathematical model were provided by Mrs. Linda Burns, electron microscopist, The University of Texas Medical School at Galveston. The physical analysis, mathematical modeling, and programming were done by the author.

The atomic constant data and the Fortran-coded algorithm for calculating mass absorption coefficients are from the quantitative electron microprobe analysis program, MAGIC, written by J. W. Colby of Bell Telephone Laboratories, Inc., Allentown, Pennsylvania.

## 2. PROGRAM DESCRIPTION

### 2.1 General Description

The central feature of BIOMAP is the computation of absorption factors and the iterative computation of unknown elemental concentrations. Absorption factors quantify the amounts of characteristic X-radiation absorbed by the sample or standard and correctly relate X-ray intensity counts with elemental concentrations in the microprobe equation. Computation of unknown elemental concentrations is accomplished by solving the quantitative equation. This equation is functionally similar to the microprobe equation but involves instead ratios of the intensity counts, absorption factors, and elemental concentrations from unknown and standard samples.

Since a significant degree of variation is characteristic of both input and output data, certain statistical features have also been built into the program. First is a general linear hypothesis subroutine which inputs intensity count and absorption corrected area density data and computes estimates of the residual background and the rate of count increase with area density, along with associated variances. From these estimates and variances an estimate of the most probable intensity count for a given standard and its associated variance can be made. Second, if the unknown sample analyzed is a set of red blood cells (RBC), certain statistical parameters of the sample elemental concentrations are computed and cumulative and frequency functions of these concentrations are plotted.



BIOMAP can be set up to provide the following types of individual or combination analyses:

- (1) Analyze microprobe data from a set of standards to statistically estimate the residual background intensity count and the concentration intensity count for the analyzed elements.
- (2) Analyze microprobe data from a set of gelatin samples of known or unknown chemical content, obtaining concentration of specified elements.
- (3) Analyze microprobe data from a set of red blood cells, obtaining weight percentages and weight percentage distribution plots.

Analyses (2) and (3) depend on input data from a previous type (1) analysis; however, combination analyses of types (1) and (2) and of types (1) and (3) can be made.

The logical sequence of program operations is as follows:

- (1) References atomic constant data from block data storage.
- (2) Provides by data statement the weight fractions of chemical elements in normal red blood cells and plain gelatin
- (3) Reads data cards to input problem information, microprobe parameters, sample and standard data, and program mode
- (4) Constructs atomic number arrays for analyzed elements and elements added to standards
- (5) Forms symbol, atomic number, and area density arrays for elements in dry gelatin standards

- (6) Computes the mass absorption coefficients of the sample and standard elements for the X-ray wavelengths analyzed
- (7) Computes partial and total mass absorption coefficients of standard for each analyzed X-ray wavelength
- (8) Computes absorption factors for each analyzed X-ray wavelength of standard
- (9) Computes area densities of analyzed elements in standard
- (10) Computes estimates of statistical parameters for a set of standards and the best linear unbiased estimate of the accumulated count for a specified standard.

For analysis of red blood cells and thin gelatin or tissue samples, the program performs the following operations:

- (11) Inputs chemical symbols and intensity counts for analyzed elements in each sample
- (12) Forms initial area density arrays for each sample
- (13) Computes mass absorption coefficient of sample for lines analyzed
- (14) Computes absorption factors for analyzed lines in sample
- (15) Computes the absorption correction for each element analyzed
- (16) Computes the area density of each analyzed element in the sample
- (17) Updates area density and tests against reiteration criterion
- (18) Computes the volume density of analyzed elements in gelatin samples

- (19) Computes weight fractions of analyzed elements in red blood cell sample set
- (20) Computes weight-percentage range, average, variance, and percentage standard deviation over red blood cell set for each analyzed element
- (21) Provides cumulative distribution and histogram plots of the weight-percentage distributions.

In operation (1), the atomic constants read from the data tape for each element are the atomic number, the elemental symbol, the critical excitation potentials for the K, L, and M X-ray states, the wavelengths of the  $K\alpha$ ,  $L\alpha$ , and  $M\alpha$  spectral lines, the absorption edge wavelengths, exponents, and empirical constants for mass absorption coefficient equations, and fifth-degree polynomial coefficients for the backscatter factor.

In operation (3), problem information consists of alpha- numerics for problem type, problem number, date, submitter's name, and a descriptive title. Microprobe parameters are accelerating potential, beam diameter, beam current, counting time, and counter dead time. Sample information consists of a sample type index, the number of samples to be analyzed, the number of analyzed elements in each sample, and the wet thickness of the samples in microns. Standard information consists of the grams of gelatin per liter used in preparing the standards, the water fraction in the gelatin, the thickness of the wet standard sections, the number of standards input for statistical evaluation, and the symbols of the analyzed elements. If a single standard is used the estimated residual background and intensity

count for each standard element is read in with the standard symbols. The program parameters specify whether to print out intermediate results in namelists and the weight options in subroutine GLHFR2. If multiple standards are analyzed to obtain a linear unbiased estimate of the residual background and intensity count for each standard element, the number of elements added to each standard, and their chemical symbol and amounts in grams are read in at the top of the standard analysis loop. Also, at the top of this loop is read the flag for the primary standard and the chemical symbols of the analyzed standard elements and their concentration intensity count. If multiple standards are processed to estimate the primary standard intensity count, microfilm plots are produced of the data points and the fitted line.

## 2.2 Technical Description

### 2.2.1 Analysis

In general, X-ray states are excited in microprobe specimens primarily by incident electrons and secondarily by sufficiently energetic X-ray photons resulting from the fluorescent decay of X-ray states. The average number  $n$  of specified X-ray states excited in a given atomic species per single-incident electron can be represented as

$$n = n' + n'' \quad (1)$$

where  $n'$  is the average number resulting from primary excitation and  $n''$  is the average number resulting from secondary excitation.

Equation (1) can be expressed in the alternate form

$$n = n' \left( 1 + \frac{n''}{n'} \right) = n' f \quad (2)$$

where  $f > 0$  is defined as the fluorescence factor.

The derivation of an expression for  $n'$  is of central importance in quantitative microprobe theory and proceeds as follows:

In differential form, the average number of specified X-ray states  $dn'$  of energy  $E_c$  excited within an electron path length  $dx$  is

$$dn' = \delta Q(E(x), E_c) dx \quad (3)$$

where  $E$  is the average electron energy over  $dx$ ;  $Q$  is the ionization cross-section of the given atomic X-ray state, a function of  $E$  and  $E_c$ ; and  $\delta$  is the number of specified atoms per unit volume of specimen.

In a thick specimen where the energy of the penetrating electron may decay below  $3E_c$  while traversing a path length  $x$ ,  $Q$  cannot be considered constant, and

$$n' = \delta \int_0^x Q dx = \delta \int_{E_0}^E [Q/(dE/dx)] dE$$

For a thin low-density specimen, however, one can reasonably assume that entering electrons completely penetrate the

target with little loss of energy or scattering. As a consequence,  $Q$  is effectively constant and the path length  $dx$  can be equated to the sample thickness  $z$ . These approximations enable writing Equation (3) as

$$n' = \delta Qz \quad (4)$$

The average number of states produced in time  $t$  by a beam current  $i_b$ , considering a fraction of ionizations  $(1 - R)$  to be lost as a result of electron backscattering, can be expressed as

$$N' = \phi t R \delta Qz \quad (5)$$

where  $\phi$  the electron flux equals  $i_b$  divided by the electronic charge  $q_e$ .

Since the microprobe measures ionizing events caused by X-ray photons resulting from the decay of the excited X-ray states, the microprobe equation relating measured intensity and atomic concentration is

$$I = (\Omega/4\pi) D w p \phi t a f R \delta Qz \quad (6)$$

These additional factors are defined as follows:

$(\Omega/4\pi)$  is the fraction of the total solid angle intercepted by the X-ray spectrometer,  $D$  is the spectrometer-detector efficiency,  $w$  is the fluorescence yield of the particular X-ray state, and  $p$  is the probability that the photon emitted will be that specified. The factors  $a$  and  $f$  are the absorption and fluorescence factors respectively and both

depend on the chemical and physical configuration of the specimen. The absorption factor  $a$  is the probability of a photon not being absorbed as it passes through the sample, and is less than one. The fluorescence factor  $f$  accounts for the number of states produced secondarily by X-ray photons with energy greater than  $E_c$ , and is greater than one.

A thin standard sample having a known concentration of the specified chemical element would yield a measured intensity

$$I_0 = (\Omega/4\pi) D w p \phi t a_0 f_0 R_0 z_0 Q \delta_0 \quad (7)$$

By forming the ratios  $I/I_0$  the common factors may be eliminated by division, leaving

$$I_0/I = (a_0/a) (f_0/f) (R_0/R) (z_0/z) \delta_0/\delta \quad (8)$$

If the standard is chemically constituted sufficiently similar to the unknown sample, the value of the factors  $(f_0/f)$  and  $(R_0/R)$ , known as the fluorescence and backscatter corrections respectively, become essentially one, leaving

$$I_0/I = (a_0/a) (z_0/z) \delta_0/\delta \quad (9)$$

Gelatin-based standards can be chemically constituted similar to a biological specimen but cannot be cut as thin as a red blood cell for instance and, therefore, expressions must be derived for the absorption factor which depends on sample thickness.

An expression for the absorption factor can be simply derived by assuming that X-ray states are produced uniformly over the thickness  $z$ , a reasonable assumption since  $Q$  is essentially constant for  $E \geq 3E_c$ . One can start with the differential relation

$$dI = qN \cdot dz \quad (10)$$

when  $dI'$  are the number of photons observed by the detector,  $N$  is the number of photons generated per unit path length, and  $q$  is the probability of a photon not being absorbed or scattered.

The probability  $q$  can be identified from Beer's law

$$i = i_0 e^{-\chi \rho z}$$

as the exponential factor  $e^{-\chi \rho z}$  where

$$\chi = \csc \psi \sum w_i \mu_i \quad (11)$$

and  $\psi$  is the angle of emergence of the photons,  $w_i$  is the weight fraction of the  $i$ th element in the sample and  $\mu_i$  is the mass absorption coefficient of the  $i$ th element for the specified X-ray photon.

By "integrating over the thickness  $z$  the number of photons detected  $I$  are

$$I = N \int_0^z e^{-\chi \rho z'} dz' = N(1 - e^{-\chi \rho z})/\chi \rho$$



and the fraction detected (not absorbed) is

$$a = \frac{I}{Nz} = (1 - e^{-\chi\rho z})/\chi\rho z$$

The absorption correction can be expressed as

$$(a_0/a) = \frac{(1 - e^{-\chi_0\rho_0 z_0})\chi\rho z}{(1 - e^{-\chi\rho z})\chi_0\rho_0 z_0} \quad (12)$$

which, when substituted into the quantitative equation, Equation (9), yields

$$\frac{I_0}{I} = \frac{(1 - e^{-\chi_0\rho_0 z_0})(\chi\rho z)}{(1 - e^{-\chi\rho z})(\chi_0\rho_0 z_0)} \frac{\delta_0 z_0}{\delta z} \quad (13)$$

Since biological specimens are prepared wet and dry under vacuum, it is no longer possible to know the resulting thickness or dry-volume density of a standard element. However, if there is no lateral redistribution of the sample material, the dry area densities  $\sigma_0^i = \rho_0^i z_0$  of the standard elements remain invariant and Equation (13) can be written and solved in terms of area densities

$$\sigma^i = \frac{(1 - e^{-\chi_0^i \sigma_0^i})\chi^i \sigma}{(1 - e^{-\chi^i \sigma})\chi_0^i \sigma_0^i} \frac{I^i}{I_0^i} \sigma_0^i \quad (14)$$

Here  $\sigma$  and  $\sigma_0$  without superscripts represent the total area density of sample and standard respectively, and the

superscript  $i$  designates quantities specific for the  $i$ th element.

### 2.2.2 Method of Solution

If one knows as a zero order approximation the normal average-weight fractions of elements in a biological sample, its total area density, and can analyze simultaneously any elements whose concentrations deviate significantly from normal, then the quantitative microprobe equation used with an iterative computational procedure will provide a higher order estimate of the area densities of the analyzed elements. The iterative procedure is made necessary by the nature of the absorption coefficient which cannot be computed exactly before the solution is obtained. Convergence to solutions lying within the precision of experimental measurement is rapidly achieved, however, by recomputing the absorption factor of the sample subsequent to each iterative area density computation.

A summary of the input data and computational method in mathematical notation is as follows:

#### I. Computations related to the standard

##### A. Input data

1.  $w_i$  - weight fractions of elements in gelatin  
( $i = 1, \dots, L$ )
2.  $h$  - fraction of water in gelatin
3.  $g$  - grams gelatin per liter standard solution

4.  $t$  — thickness of wet gelatin slice
5.  $a_j$  — gram atoms of standard elements added  
( $j = 1, \dots, M$ )
6.  $B_k$  — accumulated background intensity count for  
 $k$ th analyzed element ( $k = 1, \dots, N$ )
7.  $N_k$  — accumulated intensity count for  $k$ th  
analyzed element ( $k = 1, \dots, N$ )
8. Atomic constants (J. W. Colby)

#### B. Computations

1. Compute mass of each element in gelatin.

$$m_i' = w_i(1 - h)g \quad (i = 1, \dots, L)$$

2. Compute mass of each added element.

$$m_j'' = a_j A_j \quad (j = 1, \dots, M)$$

3. Compute total mass of each element in liter of  
standard solution.

$$m_i = m_i' + m_i''$$

4. Compute volume density of each element in  
standard solution.

$$\rho_i = m_i/1000$$

5. Compute area density of each element in dry mounted standard.

$$\sigma_i = \rho_i t$$

6. Compute total area density of dry mounted standard.

$$\sigma = \sum \sigma_i$$

7. Compute weight fraction of each element in dry mounted standard.

$$w_i = m_i / \sum m_i = \rho_i / \sum \rho_i = \sigma_i / \sigma$$

8. Compute mass absorption (attenuation) coefficients of *i*th element for *K* $\alpha$  line of *k*th element analyzed.

$$\mu_i^k = c(z_i) \lambda_k^n(z_i) ; \quad (k = 1, \dots, N)$$

*c* and *n* are constants obtained from J. W. Colby's set of atomic constants.

9. Compute mass absorption coefficient of sample for each element analyzed.

$$\chi^k_\sigma = \csc \psi \sum \sigma_i (\mu/\rho_i)^k$$

10. Compute absorption factor of standard for each element analyzed.

$$a_k^0 = (1 - e^{-\chi^k \sigma}) / \chi^k \sigma$$

## II. Computation related to the red blood cells

### A. Input data

- $w_i$  — approximate weight fractions of elements in dry RBCs ( $i = 1, \dots, L$ )
- $\bar{\sigma}$  — average area density of dry RBC
- $N_k$  — accumulated count for  $k$ th element analyzed, corrected for background ( $k = 1, \dots, N$ )

### B. Computations

1. Compute approximate average area density of each element in dry red blood cells.

$$\bar{\sigma}_i = w_i \bar{\sigma}$$

2. Compute average mass absorption coefficient of RBC for each element analyzed.

$$\chi^{k\bar{\sigma}} = \text{csc } \psi \sum \sigma_i (\mu/\rho_i)^k$$

3. Compute average absorption factor of dry red blood cells for  $k$ th element analyzed.

$$a_k = (1 - e^{-\chi^{k\bar{\sigma}}}) / \chi^{k\bar{\sigma}}$$

4. Compute area density  $\sigma_k$  of  $k$ th element analyzed using quantitative equation.

$$\sigma_k = \sigma_k^0 \left( \frac{a_k^0}{a_k} \right) \frac{N_k}{N_k^0}$$

5. Recompute total area density of RBC using new area density values of the  $N$  analyzed elements.

$$\bar{\sigma} = \sum_{k=1}^N \sigma_k + \sum_{i=1}^{L-N} \sigma_i$$

6. Repeat computations (2) through (5) until the largest  $\sigma_k$  update is less than some arbitrary percent (0.1 percent for example).
7. Compute the final weight fractions of the elements in the RBC.

$$w_i = \frac{\sigma_i}{\bar{\sigma}}$$

### 3. USAGE

#### 3.1 Input Description

##### 3.1.1 Data and Card Specifications

All integer (I) input is right-justified, alphanumeric (A) input is left-justified, and real number (F) input is unrestricted in its specified fields.

##### 3.1.1.1 Card 1: Title and Run Information

FORMAT(A1,I4,2X,5A3,2X,5A4,2X,6A4)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
IDATE	I	1,10	Date
MISS	I	11,15	Mission identification
MAN	I	16,20	Subject code
JSET	I	21,25	Sample code

##### 3.1.1.2 Card 2: Program Parameters

FORMAT(3I5,F5.0)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
IPRINT	I	1,5	Namelist; write indicator for diagnostic purposes (IPRINT $\leq$ 0 for "no write")
IWT	I	6,10	Weight index for subroutine GLHFR2 [0 - weights are input through calling arguments as 1/(sample variance). 1 - weights are defined as 1. in the subroutine. 2 - weights are calculated in the subroutine as 1/Y(I)].

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3.1.1.3 Card 3: Microprobe Parameters

FORMAT(4F10.2)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
AP	F	1,10	Accelerating potential (Kv)
BD	F	11,20	Beam diameter ( $10^{-4}$ cm)
CT	F	21,30	Count time (sec)
DT	F	31,40	Dead time ( $10^{-3}$ sec)

3.1.1.4 Card 4: Sample Parameters

FORMAT(3I5,F5.0)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
ITYPE	I	1,5	Sample type (1 - RBC, 2-tissue, 3-gelatin standard)
NSAMP	I	6,10	Number of samples
NA	I	11,15	Number elements analyzed
TBIO	F	16,20	Thickness of samples ( $10^{-4}$ cm)

3.1.1.5 Card 5: Standard Parameters

FORMAT(3F10.5,I5)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
GEL	F	1,10	Gelatin in liter of standard solution (grams)
H2O	F	11,20	Fraction of water in stock gelatin ( $0. \leq H2O \leq 1.$ )
TSTD	F	21,30	Thickness of standard section ( $10^{-4}$ cm)
NSTD	I	31,35	Number of standard intensity counts



3.1.1.6 Card 6: Single Standard Estimated Data  
 FORMAT(A2,3X,3F10.0)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
AE(I)	A	1,2	Chemical symbol for Ith analyzed element (right justified)
BG(I)	F	6,15	Statistically estimated background for Ith analyzed element
ESC(I)	F	16,25	Statistically estimated intensity count for Ith analyzed element
SDVESC(I)	F	26,35	Standard deviation of estimated intensity count for Ith analyzed element.

*Note: Program requires one card 6 for each element analyzed. These cards are punched out when program runs statistical analysis of standard data, ITYPE = 0 .*

3.1.1.7 Card 7: Standard Chemical Composition  
 FORMAT(I1,3X,6(A2,1X,F6.1,1X))

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
NAD	I	1	Number elements added to standard
ASE(I)	A	5,6	Chemical symbol of added element (right justified)
AMTASE(I)	F	8,13	Amount added element (meq/l)
ASE(n)	A	10n -5, 10n -4	nth chemical symbol

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
AMTASE(n)	F	10n -2, 10n +3	n <sup>th</sup> amount

*Note: Program dimension limitation, n ≤ 6 .*

### 3.1.1.8 Card 8: Standard Intensity Counts

FORMAT(I2,2X,4(A2,1X,F6.0,1X,F6.0,1X))

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
IPS	I	1,2	Principal standard indicator (IPS = 1 designates principal standard)
ADSE(1)	A	5,6	Chemical symbol of first analyzed element
SCT(1,ND)		8,13	Intensity count of first analyzed element in ND <sup>th</sup> standard
SCTSD(1,ND)		15,20	Standard deviation of estimated count
ADSE(n)		17n -12, 17n -11	For n <sup>th</sup> element
SCT(n,ND)		17n -9, 17n -8	For n <sup>th</sup> element

*Note: Program dimension limitation is n ≤ 10 , and card  
space limitation is four elements per card.*

3.1.1.9 Card 9: Biological Elements Analyzed  
FORMAT(6(8X,A2))

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
ABE(1)	A	9,10	Chemical symbol of first analyzed element
ABE(n)	A	10n - 1, 10n	For <i>n</i> th analyzed element

3.1.1.10 Card 10: Sample Intensity Counts  
FORMAT(6F10.0)

<u>Code</u>	<u>Type</u>	<u>Columns</u>	<u>Description and Units</u>
CTB(1)	F	1,10	Intensity count of first analyzed element
CTB(n)	F	10n - 9, 10n	For <i>n</i> th analyzed element

*Note: Program dimension limitation is  $n \leq 10$  , and card space limitation is  $n \leq 7$  for cards 9 and 10.*

### 3.1.2 Tape Specifications

Program tape, NASA-MSC Computation and Analysis Division No. A06690 has one file containing the program with subroutines.

## 3.2 Program Run Preparation

### 3.2.1 Deck Setup

### 3.2.1.1 Punched Program Deck Run

Running the program from a punched program deck requires the following card sequence:

1. NASA-MSD run card (V RUN)
2. Message card specifying one tape (VN MSG 1 TAPE)
3. Microfilm plot control card (V PLT)
4. Input tape assign card (V ASG A=4483)
5. BIOMAP control card (V FOR BIOMAP)
6. BIOMAP program deck
7. GLHFR2 control card (V FOR GLHFR2)
8. GLHFR2 subroutine deck
9. IGIVE control card (V FOR IGIVE)
10. IGIVE subroutine deck
11. GROPI control card (V FOR GROPI)
12. GROPI subroutine deck
13. PLOT3 control card (V FOR PLOT3)
14. PLOT3 subroutine deck
15. HIS1 control card (V FOR HIS1)
16. HIS1 subroutine deck
17. PCORRE control card (V FOR PCORRE)
18. PCORRE subroutine deck
19. GAMMA control card (V FOR GAMMA)
20. GAMMA subroutine deck
21. FACTOR control card (V FOR FACTOR)
22. FACTOR subroutine deck

23. Program execute control card (V XQT BIOMAP)
24. Data deck
25. End-of-file control card (V EQF)
26. Optional post mortem dump control card (VE PMD)

#### 3.2.1.2 Tape Run

Running the program from a tape requires the following:

1. NASA-MSD run card (V RUN)
2. Message card specifying two tapes (VN MSG 2 TAPES)
3. Microfilm plot control card (V PLT)
4. Input tape assign card (V ASG E=\$STATP)
5. Program tape assign card (V ASG B= )
6. Complex utility program execute control (V XQT CUR)  
and the four following CUR statements
7. TRW B
8. IN B
9. TRI B
10. TOC
11. Control cards for listing or changing the program or  
subroutine statements (V FOR,\* NAME, NAME)
12. Follow with cards described in paragraph 3.2.1.1,  
sections (23), (24), (25), and (26), as for program  
deck run.

### 3.2.2 Special Control Cards

Card 2, the program parameter card, contains (1) IPRINT which must be assigned a nonzero integral value to obtain a name-list printout for diagnostic purposes, and (2) the weighting index IWT to specify the weighting option for subroutine GLHFR2.

### 3.2.3 Special I/O Devices

None.

### 3.2.4 Overlay Structure

None.

## 3.3 Output Description

### 3.3.1 Printer Output Identification

A run which analyzes a number of standard intensity counts to statistically estimate the intensity count of the primary standard will print out a table giving, for each added element of each standard, the total milli-equivalent amount (residual plus added), the measured intensity count, the area density, the weight percent, the absorption factor; and, for the primary standard, the estimated intensity count with standard deviation, the estimated background count with standard deviation, and the estimated intensity count less the background.

For a run analyzing standard samples relative to a primary sample a table is printed out giving for each analyzed element in each sample the measured intensity count, the absorption factor, the absorption correction, the area density, the

weight percent and the calculated concentration of the standard samples.

For a run analyzing a set of red blood cells relative to a primary sample, a table is printed out giving for each analyzed element in each red blood cell the measured intensity count, the area density, and the weight percent; and, for the set, the weight percent range. In addition, a cumulative plot and a histogram of the weight-percent distribution over the set is printed.

### 3.3.2 Microfilm Output

For each analyzed element in a set of standards a microfilm plot is made which relates the estimated linear relation between the intensity count and the absorption-corrected area density for that element.

## 3.4 Execution Characteristics

### 3.4.1 Restrictions

The following analytic restrictions must be observed:

- (1) When analyzing a set of standards to estimate a most probable intensity count for the principal standard, assign the integer value of one to the program parameter IWT if the standard data are single-point microprobe intensity counts. If the standard data are average intensity counts over samples taken from each standard and the sample variances, assign the integer value two to IWT.

- (2) The number of standard data must be greater than two. If not, the program will stop in the subroutine GLHFR2 after writing a diagnostic message noting this error.
- (3) When specific standard or sample data are input (card 10), they are accompanied by the chemical symbol of the corresponding elements (card 9). If these symbols are not found when checked against the array of analyzed element symbols the program stops after writing out a diagnostic statement noting this error.
- (4) Principal standard data *must* be last in the sequence of standards.

#### 3.4.2 Running Time/Lines of Output

A multiple-execute analysis of sodium and potassium in sets of 100, 35, 35, and 35 red blood cells ran 1.5 minutes. A combined statistical analysis of five standard averages and sodium and potassium analysis of nine standard samples ran 0.5 minute. Lines of output can be calculated as one line per element analyzed in each standard or red blood cell analyzed. A run performing all analyses of red cell sets outputs cumulative distribution and frequency distribution plots over weight percentage, each of which require three pages per element analyzed.

#### 3.4.3 Accuracy/Validity

Arithmetic operations are single-precision, which is quite adequate for the four significant figure iterative criterion of the area density computation. This computational precision is an order of magnitude better than the precision of experimental measurement.



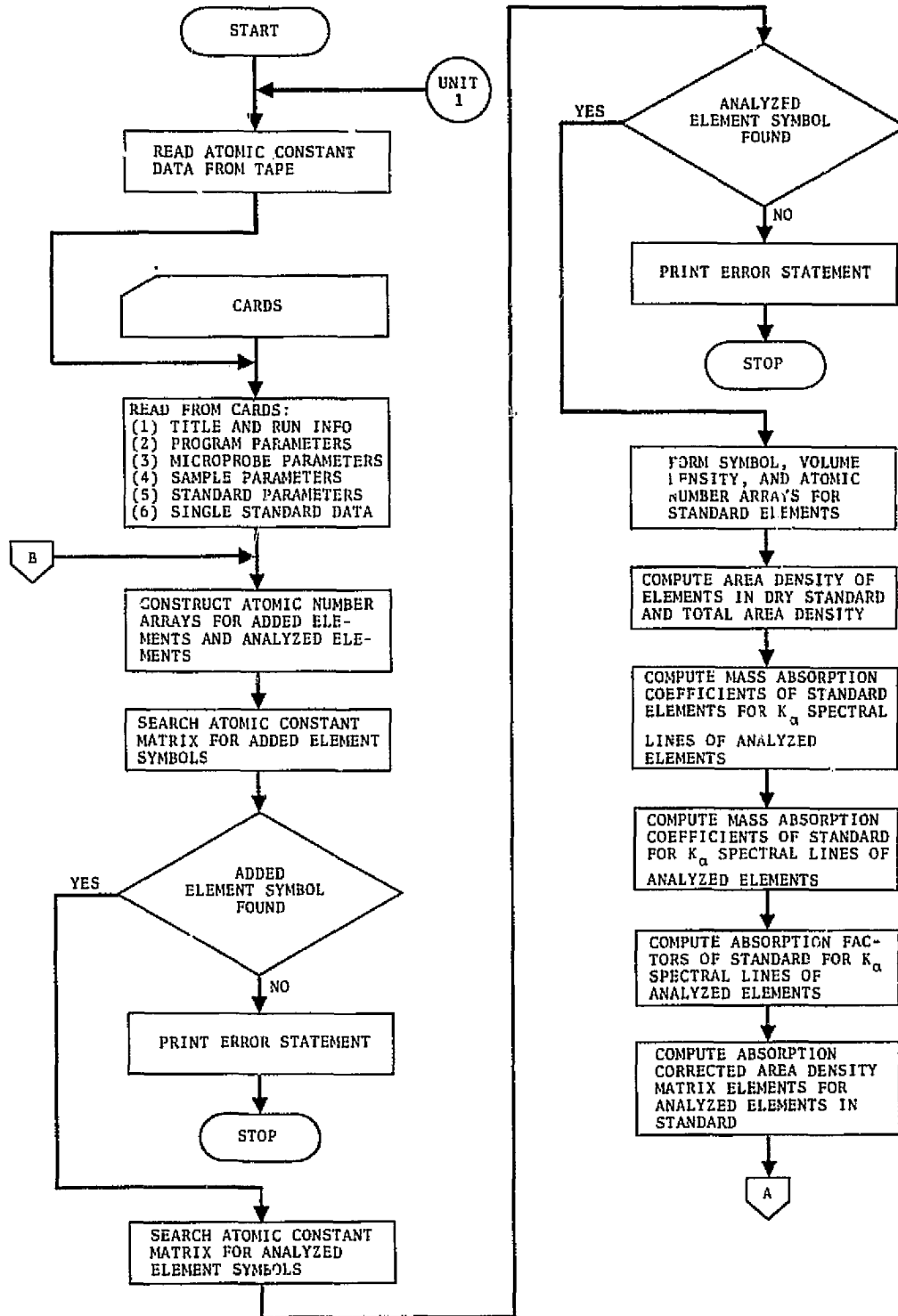
#### 4. REFERENCE INFORMATION

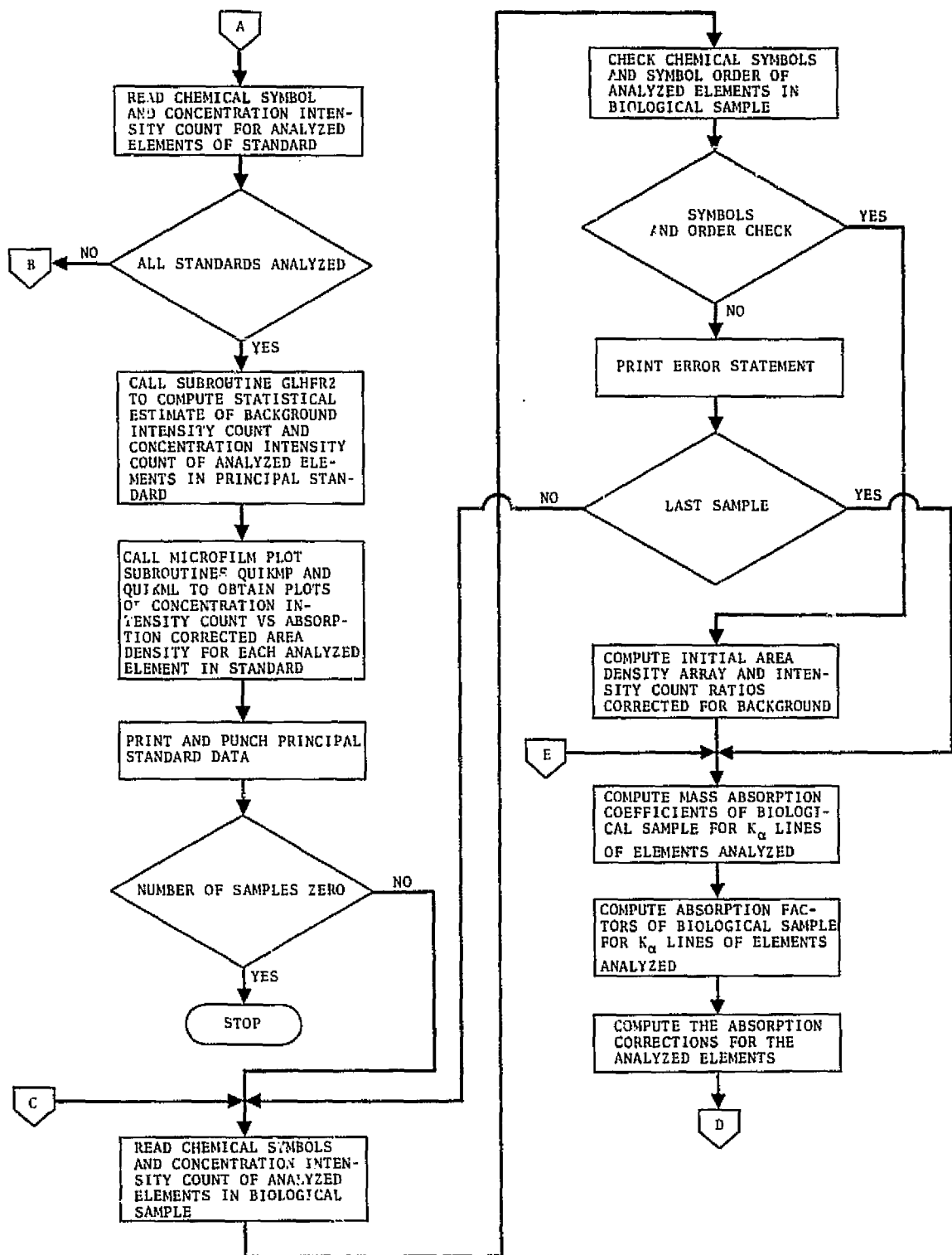
##### 4.1 Detailed Flow Chart of BIOMAP

The detailed flow chart of BIOMAP is shown on the following pages.

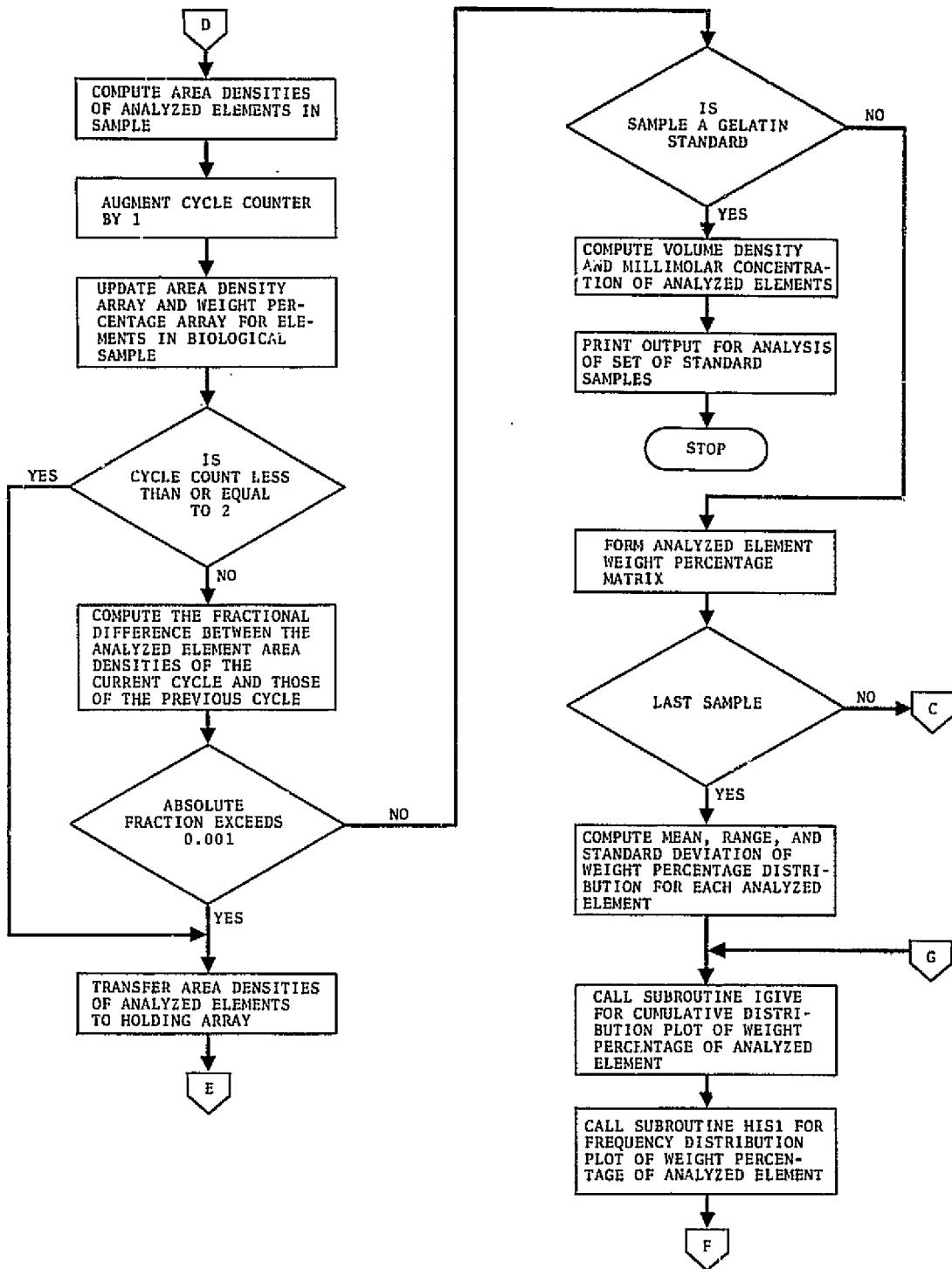
**PRECEDING PAGE BLANK NOT FILMED**

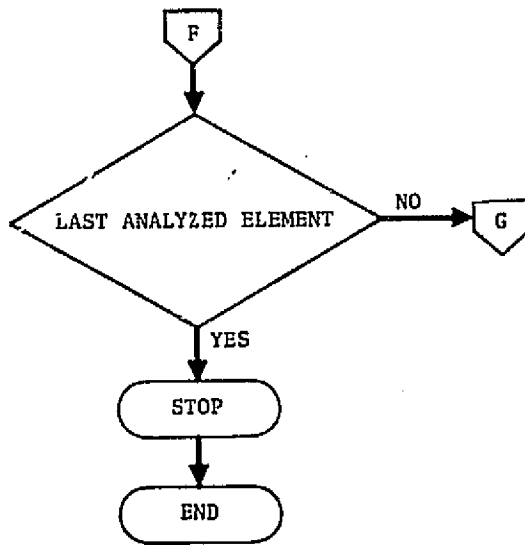
DETAILED FLOW CHART OF BIOMAP





ORIGINAL PAGE IS  
OF POOR QUALITY





## 4.2 Symbol Definitions

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
$x^n_\sigma$	ABC(n)	F	Mass absorption coefficient of biological sample for <i>n</i> th analyzed element.
$(a_0/a)_n$	ABCO(n)	F	Absorption correction for <i>n</i> th analyzed element.
	ABCS(n)	F	Mass absorption coefficient of standard for <i>n</i> th analyzed element.
	ABE(n)	I	Chemical symbol of <i>n</i> th analyzed element in biological sample.
$\mu_m^n$	AC(n,m)	F	Mass absorption coefficient of <i>m</i> th element for $K\alpha$ line of <i>n</i> th analyzed element.
$\sigma$	ADB	F	Area density of biological sample.
$\sigma_n$	ADNB(m)	F	Area density of <i>m</i> th element in biological sample.
$\sigma_m^0$	ADNS(m)	F	Area density of <i>m</i> th element in standard.
$\sigma^0$	ADS	F	Area density of standard.
	ADSE(n)	I	Chemical symbol of <i>n</i> th analyzed element in standard.
	AE(n)	I	Chemical symbol of <i>n</i> th analyzed element in single standard.

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
$a_n$	AFB(n)	F	Absorption factor of biological sample for $n$ th analyzed element.
$a_n^0$	AFS(n)	F	Absorption factor of standard for $n$ th analyzed element.
	AMTASE( $l$ )	F	Amount in millimoles per liter of $l$ th element added to standard.
$w_m^0$	AMTGEL(m)	F	Approximate weight percentage of $m$ th element in dry gelatin. Literal list in data statement.
$w_{nc}$	AMTRBD(m)	F	Approximate weight fraction of $m$ th element in normal dry red blood cell. Literal list in data statement.
$E_0$	AP	F	Kinetic energy of focused electrons given in Kev. Also electron gun accelerating potential. Not used in calculation.
	ARATIO	F	Ratio of effective area of excitation on the standard to that of the biological sample. Assigned a value of 1.0 for this version of BIOMAP.

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
	ASE(l)	I	Chemical symbol of <i>l</i> th element added to standard.
	BD	F	Beam diameter ( $10^{-4}$ cm).
	BG(n)	F	Background intensity count for <i>n</i> th analyzed element in standard. <i>Note: Concentration intensity count for biological samples are assumed to be background corrected.</i>
	BIOEL(m)	I	Chemical symbol of <i>m</i> th element in normal biological cells. Literal list in data statement.
$z_m$	BIOZ(m)	I	Atomic number of <i>m</i> th element in normal biological cells. Literal list in data statement.
	COEF(k)	F	<i>k</i> th component of coefficient array for given analyzed element returned to BIOMAP from GLHFR2. COEF(1) is the estimated background intensity count (intercept) and COEF(2) is the estimated rate of concentration intensity count increase with absorption corrected area density (slope).



<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
C	CON	F	Empirical constant C used in computing mass absorption coefficient ( $\mu^k = C\lambda_k^\eta$ ). Obtained from atomic constants.
	CONC(n)	F	Concentration of <i>n</i> th analyzed element in gelatin sample (millimoles/liter).
I/I <sub>0</sub>	CR(n)	F	Concentration intensity count ratio for <i>n</i> th analyzed element (sample count/standard count).
cscψ	CSCTH	F	Cosecant of 52.5 degrees the angle of X-ray emergence. Fixed parameter set equal to 1.2605.
	CT	F	Counting time for sample and standard (seconds).
I <sub>n</sub>	CTB(n)	F	Concentration intensity count of <i>n</i> th analyzed element in biological sample.
	DATE	A	Date of computer run request.
	DEL(n)	F	Fractional difference between area densities of <i>n</i> th analyzed element as computed in two adjacent iterative cycles.
ρ <sub>ℓ</sub>	PENAD(ℓ)	F	Volume density of ℓth element added to standard (grams/cm <sup>3</sup> ).
ρ <sub>m</sub>	DENS(m)	F	Volume density of <i>m</i> th element in gelatin (grams/cm <sup>3</sup> ).

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
	DRYGEL	F	Concentration of anhydrous gelatin in standard base (grams/cm <sup>3</sup> ).
	DT	F	Counter dead time (10 <sup>-6</sup> seconds). Not used in computation.
$\lambda$	EDGE	F	Absorption edge wavelengths $\lambda$ used in computation of mass absorption coefficients ( $\mu^k = C\lambda_{\kappa}^{\eta}$ ). Obtained from atomic constants.
	ESC(n)	F	Statistically estimated concentration intensity count for $n$ th analyzed element of single standard.
$\eta$	EX	F	Exponent $\eta$ of absorption wavelength $\lambda$ used in computation of mass absorption coefficients ( $\mu^k = C\lambda_{\kappa}^{\eta}$ ). Obtained from atomic constants.
	F	F	An array of weight percentage frequencies falling in each interval or group. Returned from statistical subroutines IGIVE and HIS1.
	GEL	F	Concentration of stock gelatin in gelatin standard (grams/liter).
	HZO	F	Fraction of water in stock gelatin.

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
	ICOUNT	I	Iterative cycle counter for sample element area density computation.
	ICS	I	Array of chemical symbols for the chemical elements.
	INDX	I	Holder for sample number of principal standard. Always last standard in sequence.
	IPS	I	Flag identifying principal standard. Always last standard in sequence.
	ITITX ITITY	I and I	Data statement arrays containing abscissa and ordinate titles for microfilm plot of concentration intensity count vs absorption corrected area density.
	ITIT1 ITIT2	I and I	Data statements containing histogram of print plot headings.
	ITYPE	I	Type designator for sample to be analyzed (RBC-1, TISSUE-2, GELATIN-3).
	MDIM	I	Dimension of concentration intensity count and absorption corrected area density array input to subroutine GLHFR2.
	NA	I	Number elements analyzed.
	NAD	I	Number elements added to standard.

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
	NAME	A	Name of run requester.
	NBE	I	Number of biological elements.
	NG	I	Number of weight percentage groups. Fixed in program.
	NPROB	I	Problem number in title and run information (Card 1).
	NSAMP	I	Number of biological samples to be analyzed.
	NSE	I	Number of elements in standard.
	NSTD	I	Number sets of standard concentration intensity count data used in statistical estimates.
	NZ	I	Atomic number symbol used in computation of mass absorption coefficient.
	NZA(l)	I	Atomic number of <i>l</i> th chemical element added to standard.
	NZAE(n)	I	Atomic number of <i>n</i> th analyzed element in standard.
	NZSE(m)	I	Atomic number of <i>m</i> th chemical element in standard.
	P(i,j)	F	<i>j</i> th atomic constant of <i>i</i> th atomic number chemical element ( <i>i</i> = 1,100 and <i>j</i> = 1,36).
	PABC	F	Partial absorption coefficient of standard or sample.

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
	POE	F	Power of e (base of natural log); used in computing absorption factors.
	Q	F and	Arrays containing coordinates of endpoints of microfilm plotted line fitted to concentration intensity count vs absorption corrected area density data.
	R	F	
	RHOB2(n)	F	Computed volume density of <i>n</i> th analyzed element in gelatin sample.
	SCT(n)	F	Concentration intensity count of <i>n</i> th analyzed element in standard.
	SDEV	F	Standard deviation of RBC population distribution.
	SDVERR(n)	F	Estimated standard deviation of error in intensity count measurements for <i>n</i> th analyzed element.
	SDVESC(n)	F	Standard deviation of error in estimated concentration intensity count for <i>n</i> th analyzed element.
	SE	A	Chemical symbol array for elements in gelatin.
	SIGB1(n)	F and	Area density of <i>n</i> th analyzed element in sample as computed
	SIGB2(n)	F	

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
			in current and previous iterative cycles, respectively.
$\sigma_n^0$	SIGS(n)	F	Area density of <i>n</i> th analyzed element in standard.
	STEP	F	Width of weight percentage groups in cumulative and frequency distribution plots.
	SUM1	F and	Cumulative sums used in computing RBC distribution statistics.
	SUM2	F	
	SX(i,j)	F	Absorption corrected area density of <i>j</i> th element in <i>i</i> th standard.
	TAG	A	Problem type identification.
	TBIO	F	Thickness of biological sample ( $10^{-4}$ cm).
	TITLE	A	Descriptive title of run.
	TSTD	F	Thickness of gelatin standard ( $10^{-4}$ cm).
	VAR	F	Variance of weight percentage distribution of analyzed element in RBC sample.
	VARCOV(i,j)	F	<i>ij</i> element of covariance matrix returned from GLHFR2.
	VARERR	F	Estimated measurement error variance returned from GLHFR2.
$\lambda_K$	WAVE	F	Wavelength of $K\alpha$ X-ray photon emitted by analyzed element.

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
$w_m$	WFBE(m)	F	Weight fraction of $m$ th element in biological sample.
	WM	F	Array of statistical weights used in GLHFR2.
	WTPMX(i,s)	F	Weight percentage of $j$ th analyzed element in $i$ th RBC.
	X(i)	F	Weight percentage of specified element in $i$ th RBC.
	XBAR	F	Mean weight percentage of specified element in RBC set.
	XL,XR	F	Left and right marginal values of absorption corrected area density in microfilm plot.
	XM	F	Array of absorption corrected area densities.
	XMAX XMIN	F	Maximum and minimum weight percentage of specified analyzed element in RBC sample.
	XMx	F	Maximum absorption corrected area density of specified analyzed element in set of standards.
	YB,YT	F	Top and bottom marginal values of intensity count for microfilm plot.
	YM	F	Array of intensity counts for specified analyzed element over set of standards.
	YMX	F	Maximum intensity count of specified analyzed element in set of standards.

### 4.3 Subprogram Documentation

#### 4.3.1 STAT-CAT Statistical Subroutine

Documentation of the following subroutines can be found in the NASA-MSD Computation and Analysis Division Statistical Catalogue: IGIVE, GROT1, TLOT3, HIS1.

#### 4.3.2 Subroutine GLHFR2

Documentation follows.



## SUBROUTINE GLHFR2

### IDENTIFICATION

Name/Title	- GLHFR2 (General Linear Hypothesis Statistical Model of Full Rank Two)
Author/Date	- B. F. Edwards, March 1971
Documented by/Date	- B. F. Edwards, March 1971
Organization/Installation	- LEC/NASA-MSD
Machine Identification	- UNIVAC 1108
Source Language	- FORTRAN V

### PURPOSE

The purpose of this subroutine is to compute best linear unbiased estimates (BLUE) of parameters associated with a linear statistical model of full rank two. This model has the form  $y = X\beta + e$  where  $Y$  is a random  $n$ -vector of weighted observations (measurements),  $X$  is an  $n \times 2$ -matrix of weighted known fixed independent quantities (experimental parameters),  $\beta$  is a 2-vector of unknown coefficients (intercept and slope), and  $e$  is an unknown random  $n$ -vector of measurement errors which satisfies either Case (1):  $e$  is distributed  $N(0, \sigma^2 I)$ , with  $\sigma^2$  unknown, or Case (2):  $e$  is a random vector such that  $E(e) = 0$  and  $\text{cov}(e) = E(ee') = \sigma^2 I$ , with  $\sigma^2$  unknown.

## USAGE

- Calling Sequence

CALL GLHFR2(N,X,Y,W,M,EB,EVAR,VAREB)

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Description</u>
n	N	I	Number of observations.
{x <sub>i</sub> }	X	F	n-array of known experimental constants.
{y <sub>i</sub> }	Y	F	n-array of observations.
{w <sub>i</sub> }	W	F	n-array of weighting coefficients.
	M	I	Calling program dimension of the X, Y, and W arrays.
$\hat{\beta}$	EB	F	2-array of linear coefficient estimate.
$\hat{\sigma}^2$	EVAR	F	Estimate of equivalent homogeneous error variance.
cov( $\hat{\beta}$ )	VAREB	F	4-array of variance-covariance matrix elements for cov $\hat{\beta}$ in the order: 11, 12, 21, 22.

- Data In/Out

Data is input or output through argument lists and the printed namelist HATS which contains N and EVAR and the elements of EB and VAREB.

- Error Messages

An error message is printed out and the program stops if N is not greater than 2.

- Storage

Code: 252 octal

Data: 143 octal (M = 25)

### METHOD

If a quantity to be measured ( $\mu$ ) is known to depend linearly on a quantity ( $x$ ) over a given range ( $x'$ ,  $x''$ ), the functional relationship between  $\mu$  and  $x$  is given by

$$\mu = a + bx \quad ; \quad (x' \leq x \leq x'') \quad (1)$$

where  $a$  and  $b$  are constant parameters. If a pair of points  $(x_1, \mu_1)$  and  $(x_2, \mu_2)$  are known which satisfy the relation (1), then  $a$  and  $b$  can be computed.

If, however, for fixed  $x$ , say  $x_i$ , one successively attempts to measure  $\mu(x_i)$  but obtains fluctuating values  $y_{ij}$  where the subscript  $j$  denotes the  $j$ th measurement at  $x_i$ , then  $y_{ij}$  can be equated to the true value  $\mu(x_i)$  plus an error  $e_{ij}$ ,

$$y_{ij} = \mu(x_i) + e_{ij}$$

or

$$y_{ij} = a + bx_i + e_{ij} \quad (2)$$

Solving Equation (2) for the error term yields

$$e_{ij} = y_{ij} - a - bx_i \quad (3)$$

If (A), the  $e_{ij}$  are normally distributed with mean 0 and variance  $\sigma_i^2$ , that is  $e_{ij} \sim N(0, \sigma_i^2)$ , or (B), the expectation of  $e_{ij}$  is 0 and the expectation of  $(e_{ij})^2$  is  $\sigma_i^2$ ; and, furthermore, for either (A) or (B) the  $\sigma_i^2$  are equal for every  $i$ , then point and interval estimates of the parameters  $a$  and  $b$  and  $\mu(x)$  can be made provided that the total number of measurement is greater than two and  $i > 1$ .

If the  $\sigma_i^2$  are not equal,  $e_{ij}$  in Equation (3) may be transformed to  $e_{ij}^* \sim N(0,1)$  so that all  $\sigma_i^2$  are equal to unity. This transformation consists of multiplying (3) by  $1/\sigma_i$  to obtain

$$e_{ij}^* = y_{ij}/\sigma_i - (a + bx_i)/\sigma_i$$

In general the  $\sigma_i$  are not known and estimates of  $\sigma_i$ ,  $s_i$  must be obtained from independent measurements or as functions of  $y_i$

$$e_{ij}^* = y_{ij}/s_i - (a + bx_i)/s_i \quad (4)$$

with  $e_{ij}^*$  distributed with variance  $\sigma^{*2}$  only approximately equal to one.

The  $n$  measurements (4) can be combined into the matrix equation

$$e = Y - X\beta \quad (5)$$

where  $e$  and  $Y$  are  $n$ -vectors;

$X$  is a  $n \times 2$ -matrix with row elements  $(\sqrt{w_i}, x_i \sqrt{w_i})$  where  $w_i$ , the weighting factor, is  $1/s_i^2$ ; and  $\beta$  is the 2-vector of parameters  $a$  and  $b$ . Estimates of  $a$  and  $b$  can be obtained from estimators derived, in case (A) by the maximum-likelihood method or, in case (B), by the least-squares method. In the least-squares method

$$\sum_1^n e_k^{*2} = e'e = (Y - X\beta)'(Y - X\beta) \quad (6)$$

Differentiating with respect to  $\beta$  and setting to zero yields

$$\partial(e'e)/\partial\beta = 2X'Y - 2X'X\beta = 0$$

and the unbiased estimate of  $\beta$ ,  $\hat{\beta}$  is the matrix solution

$$\hat{\beta} = (X'X)^{-1}X'Y \quad (7)$$

An estimate of  $\sigma^{*2}$ , the expectation of  $(e_{ij}^{*2})$  following from (6), is  $\sigma^{*2} = (Y - X\hat{\beta})'(Y - X\hat{\beta})/n$ . Slight modification produces an unbiased estimate:

$$\sigma^{*2} = (Y - X\hat{\beta})'(Y - X\hat{\beta})/(n - 2)$$

or

$$(Y'Y - \hat{\beta}'X'Y)/(n - 2) \quad (8)$$

Expansion of (7) yields:

$$a = \hat{\beta}_1 = \left( \sum w_i y_i \sum w_i x_i^2 - \sum w_i x_i \sum w_i x_i y_i \right) / D$$

$$b = \hat{\beta}_2 = \left( \sum w_i \sum w_i x_i y_i - \sum w_i x_i \sum w_i y_i \right) / D$$

with

$$D = \sum w_i \sum w_i x_i^2 - \left( \sum w_i x_i \right)^2 \quad (9)$$

Expansion of (8) yields:

$$\hat{\sigma}^{*2} = \left( \sum w_i y_i^2 - a \sum w_i y_i - b \sum w_i x_i y_i \right) \quad (10)$$

The variance-covariance matrix of  $\hat{\beta}$  is given by

$$\text{cov}(\hat{\beta}) = (X'X)^{-1} \hat{\sigma}^{*2} \cong (X'X)^{-1} \hat{\sigma}^{*2}$$

and yields

$$\begin{aligned} \hat{\sigma}_a^2 &= \hat{\sigma}^{*2} \sum w_i x_i^2 / D \\ \hat{\sigma}_{ab}^2 &= \hat{\sigma}_{ba}^2 = -\hat{\sigma}^{*2} \sum w_i x_i / D \\ \hat{\sigma}_b^2 &= \hat{\sigma}^{*2} \sum w_i / D \end{aligned} \quad (11)$$

In this subroutine the n-arrays of measurements  $Y$ , known fixed constants  $X$ , and precalculated weighting coefficients  $W$  are input through the calling arguments and the estimates in equations (9), (10), and (11) are calculated and output, also through the calling arguments.

● Symbol Definition

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Definition</u>
$D^{-1}$	DETINV	F	Reciprocal of the determinant $D =  X'X  =  S $ .
$(X'X)^{-1}$	SINV11, SINV12, SINV22	F	The 11, 12, and 22 elements of the $(X'X)^{-1}$ or $S^{-1}$ matrix.
$w_i$	WW	F	Working symbol for the weighting coefficient $w_i$ .
$x_i$	XX	F	Working symbol for the fixed parameter $x_i$ .
$y_i$	YY	F	Working symbol for the measure- ment $y_i$ .
$w_i x_i$	WX	F	Product symbol.
$w_i x_i^2$	WXX	F	Product symbol.
$w_i x_i y_i$	WXY	F	Product symbol.
$w_i y_i$	WY	F	Product symbol.
$w_i y_i^2$	WYY	F	Product symbol.
$\sum w_i$	SUMW	F	Sum of the $w_i$ .
$\sum w_i x_i$	SUMWX	F	Sum of the products $w_i x_i$ .
$\sum w_i x_i^2$	SUMWXX	F	Sum of the products $w_i x_i^2$ .
$\sum w_i x_i y_i$	SUMWXY	F	Sum of the products of $w_i x_i y_i$ .

<u>Math</u>	<u>Code</u>	<u>Type</u>	<u>Definition</u>
$\sum w_i y_i^2$	SUMWYY	F	Sum of the products $w_i y_i^2$ .
$\sum w_i^2$	SUMWW	F	Sum of the products $w_i^2$ .
X'Y	XTY1, XTY2	F	Components of the vector (X'Y).

- References

F. A. Graybill, *An Introduction to Linear Statistical Models*, Vol. 1, McGraw-Hill Book Company, Inc., New York (1961), Chapter 6.

C. A. Bennett and N. L. Franklin, *Statistical Analyses in Chemistry and the Chemical Industry*, John Wiley and Sons, New York (1954), Section 6.27.

### RESTRICTIONS

- Analytic

The number of observations (measurements) must be greater than two.

- Hardware

None.

- Operational

None.



### ACCURACY

The subprogram uses single-precision accuracy. There is no loss of significance in the output.

### VALIDATION PLAN

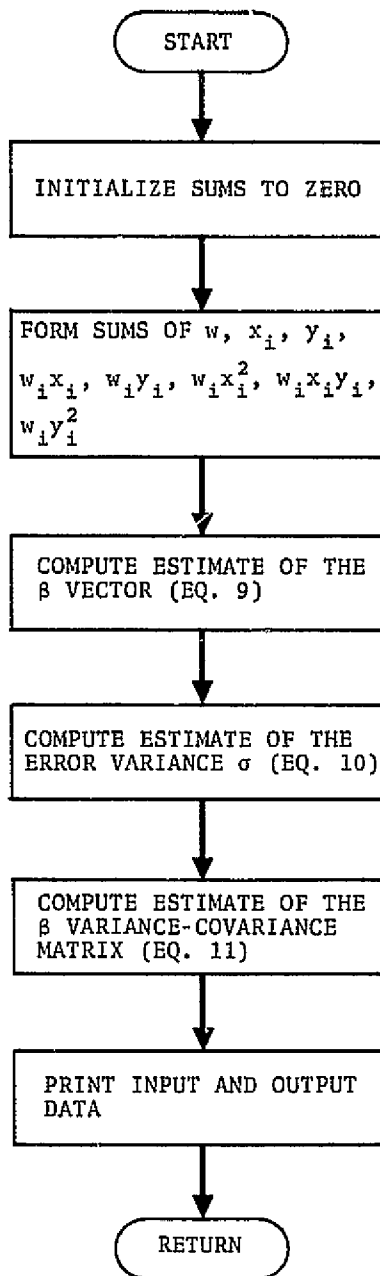
Mathematical equations were checked out by showing, when the weighting coefficients were equal to unity, that they reduced to the least-squares line-fitting formula. Operational checks were made by showing that the straight line estimates correctly fit the data sets.

### CODING INFORMATION

- Special Program Constants  
None.
  
- Timing  
The subroutine has not been timed.

### DETAILED FLOW CHART

- See the following page.



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GLHFR2-10

SOURCE LISTING

See the following pages.

3/71

\* FOR: GLHFR2, GLHFR2  
UNIVAC 1108 FORTRAN V LEVEL 2206 0029A (EXECB LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:11

19 NOV 71

10:21:11+187

SUBROUTINE GLHFR2 ENTRY POINT 000241

STORAGE USED: CODE(1) 000305; DATA(0) 000150; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 NWD05  
0004 N1025  
0005 NWNL5  
0006 NSTOP  
0007 NERR35

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000	000065	IF	0001	000050	10L	0001	000035	117G	0001	000205	12L	0001	000045	127G
0001	000214	13L	0001	000065	144G	0000	000105	2F	0000	000074	3F	0001	000042	8L
0000	R 000017	DETINV	0000	000033	HATS	0000	I 000000	I	0000	000121	INJPS	0000	R 000020	SINVI1
0000	R 000021	SINVI2	0000	R 000022	SINV22	0000	R 000001	SUMW	0000	R 000002	SUMWX	0000	R 000004	SUMWXX
0000	R 000005	SUMWXY	0000	R 000003	SUMWY	0000	R 000006	SUMWYY	0000	R 000011	WY	0000	R 000012	WX
0000	R 000014	WXY	0000	R 000015	WXY	0000	R 000013	WY	0000	R 000016	WYY	0000	R 000023	XTY1
0000	R 000024	XTY2	0000	R 000007	XX	0000	R 000010	YY						

GLHFR2-12  
4-28

```

00101 1* SUBROUTINE GLHFR2(N,X,Y,W,M,IN,EB,EVAR,VAREB)
00101 2* C * N * NUMBER OF OBSERVATIONS
00101 3* C * X * ARRAY OF KNOWN INDEPENDENT VARIABLE VALUES
00101 4* C * Y * ARRAY OF OBSERVED DEPENDENT VARIABLE VALUES
00101 5* C * W * ARRAY OF WEIGHT VALUES
00101 6* C * H * DIMENSION OF INPUT ARRAYS: X,Y,W.
00101 7* C * EB * ESTIMATES OF LINEAR COEFFICIENTS
00101 8* C * EVAR * ESTIMATE OF ERROR VARIANCE
00101 9* C * VAREB * ELEMENTS OF VARIANCE MATRIX FOR ESTIMATED LIN. COEFFICIENTS
00101 10* C
00101 11* C IN = 0 WEIGHTS ARE INPUT THROUGH CALLING ARGUMENTS (1/SAMPLE VAR)
00101 12* C IN = 1 WEIGHTS ARE DEFINED AS 1. IN GLHFR2
00101 13* C IN = 2 WEIGHTS ARE CALCULATED IN GLHFR2 AS 1./Y(I) (1/POISSON VAR)
00101 14* C
00103 15* DIMENSION X(H),Y(H),W(H),EB(2),VAREB(2,2)
00104 16* NAMELIST/HATS/H,EB(1),EB(2),EVAR,VAREB(1,1),VAREB(1,2),VAREB(2,1),
00104 17* VAREB(2,2)
00105 18* WRITE(6,1)
00107 19* I FORMAT(1H0,///,10X,'SUBROUTINE GLHFR2',///)
00110 20* IF(IN.EQ.2) GO TO 12
00112 21* IF(IN.EQ.1) GO TO 8
00114 22* IF(I.HGT.1) GO TO 10
00116 23* DO 7 I = 1,N
00121 24* W(I) = 1./Y(I)
00122 25* / CONTINUE

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```

S/71 00124 26* GO TO 10
00125 27* 8 CONTINUE
00126 28* DO 9 I = 1,N
00131 29* A(I) = 1.
00132 30* 9 CONTINUE
00134 31* 10 CONTINUE
00135 32* SUMM = 0.
00136 33* SUMWX = 0.
00137 34* SUMWY = 0.
00140 35* SUMWXX = 0.
00141 36* SUMWXY = 0.
00142 37* SUMWYY = 0.
00142 38* C * FORM SUMS
00143 39* DO 11 I = 1,N
00146 40* XX = X(I)
00147 41* YY = Y(I)
00150 42* WW = W(I)
00151 43* WX = WW * XX
00152 44* WY = WW * YY
00153 45* WXX = WX * XX
00154 46* WXY = WX * YY
00155 47* WYY = WY * YY
00156 48* SUMW = SUMW + WW
00157 49* SUMWX = SUMWX + WX
00160 50* SUMWY = SUMWY + WY
00161 51* SUMWXX = SUMWXX + WXX
00162 52* SUMWXY = SUMWXY + WXY
00163 53* SUMWYY = SUMWYY + WYY
00164 54* 11 CONTINUE
00164 55* C * FORM S-INVERSE MATRIX (S = X*X) AND X*Y VECTOR
00166 56* DETINV = 1./ (SUMW * SUMWXX - SUMWX * SUMWX)
00167 57* SINV11 = SUMWXX * DETINV
00170 58* SINV12 = -SUMWX * DETINV
00171 59* SINV22 = SUMW * DETINV
00172 60* XTY1 = SUMWY
00173 61* XTY2 = SUMWXY
00173 62* C * COMPUTE BETA VECTOR, ERROR VARIANCE, AND VARIANCE-COVARIANCE MATRIX
00173 63* C FOR BETA VECTOR
00174 64* EB(1) = SINV11 * XTY1 + SINV12 * XTY2
00175 65* EB(2) = SINV12 * XTY1 + SINV22 * XTY2
00176 66* EVAR = (SUMWYY + (EB(1) * XTY1 + EB(2) * XTY2)) / FLOAT(N - 2)
00177 67* VAREB(1,1) = EVAR * SINV11
00200 68* VAREB(1,2) = -EVAR * SINV12
00201 69* VAREB(2,1) = VAREB(1,2)
00202 70* VAREB(2,2) = EVAR * SINV22
00202 71* C * PRINT INPUT AND OUTPUT DATA
00203 72* WRITE(6,HATS)
00206 73* GO TO 13
00207 74* 12 CONTINUE
00210 75* WRITE(6,3)
00212 76* 3 FORMAT(1H1,///,10X,'ERROR = N MUST BE GREATER THAN 2')
00213 77* STOP
00214 78* 13 CONTINUE
00215 79* WRITE(6,2)
00217 80* 2 FORMAT(1H0,///,10X,'RETURN TO CALLING ROUTINE',///)
00220 81* RETURN
00221 82* END

```

GLHPR-13  
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END OF COMPILATION NO DIAGNOSTICS  
GLHFR2 SYMBOLIC  
GLHFR2 CODE RELOCATABLE

19 NOV 71	10:20:33	0	01641245	14	82	(DELETED)
19 NOV 71	10:20:33	1	01644251	18	1	(DELETED)
		0	01643441	14	28	

GLHFR2-14  
4-30

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#### 4.4 Program Listings

The program listings are shown on the following pages.

UNIVAC 1108 FORTRAN V LEVEL 2206 0024A - (EXECB LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:20:51

MAIN PROGRAM

STORAGE USED: CODE(1) 002710; DATA(0) 015091; BLANK COMMON(2) 000000

COMMON BLOCKS:

0003 P 007020

EXTERNAL REFERENCES (BLOCK, NAME)

0004 GEMFR2  
 0005 QUIKHP  
 0006 QUIKHE  
 0007 HIS1  
 0010 IGIVE  
 0011 CDRAN  
 0012 PCORRE  
 0013 NRDU5  
 0014 NI019  
 0015 NI025  
 0016 NRDU5  
 0017 EXP  
 0020 NWNLS  
 0021 NEXP65  
 0022 SQRT  
 0023 NWDOS  
 0024 NSTOP5

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STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000	014145	101F	0000	014157	102F	0001	001522	10270	0000	014401	103F	0000	014176	104F
0001	001537	1091G	0001	001630	1075G	0001	000527	11L	0001	001636	1103G	0001	001171	111L
0001	001657	1117G	0001	000566	112L	0001	001666	1123G	0001	001034	113L	0001	001702	1136G
0001	001711	1145G	0001	001726	1157G	0001	001573	116L	0001	001737	1165G	0001	001762	1177G
0001	000514	12L	0001	001765	1203G	0001	002003	1213G	0001	002034	1225G	0001	002037	1230G
0001	002072	1246G	0001	002105	1256G	0001	002114	1264G	0001	002140	1275G	0001	000563	13L
0001	002152	1307G	0001	001170	1320G	0001	002176	1326G	0001	002250	1356G	0001	002266	1371G
0001	000550	14L	0001	001224	1415G	0001	000010	142G	0001	002355	1430G	0001	002377	1445G
0001	002407	1455G	0001	002417	1470G	0001	002547	1514G	0001	002550	1517G	0001	002615	1535G
0001	000026	154G	0001	002633	1541G	0000	014052	2F	0000	014055	202F	0000	014046	203F
0000	014040	204F	0000	014066	205F	0000	014103	206F	0000	014032	207F	0000	014020	208F
0000	014025	210F	0000	014214	211F	0000	014231	212F	0000	014241	213F	0000	014313	215F
0000	014330	216F	0000	014417	221F	0000	014427	222F	0000	014445	223F	0000	014517	224F
0000	014661	225F	0000	014673	226F	0000	014726	227F	0001	000660	23L	0000	014534	231F
0000	014606	232F	0000	014616	233F	0000	014113	241F	0001	000654	25L	0001	000162	253G
0001	000177	265G	0000	014377	3F	0000	014075	305F	0001	000246	311L	0001	000306	312L
0001	000466	32L	0001	000470	321L	0001	000345	322G	0001	000364	327G	0001	000400	340G
0001	000315	35L	0001	000422	353G	0001	000441	365G	0001	000451	375G	0001	002662	38L
0001	002664	39L	0000	014036	4F	0001	000501	415G	0001	000504	420G	0001	000762	44L
0001	000535	442G	0001	000540	445G	0001	001022	45L	0001	000777	47L	0001	000573	470G
0001	001003	48L	0001	001010	49L	0000	014062	5F	0001	001013	50L	0001	000607	501G



0001	000424	511G	0001	000632	514G	0001	000672	536G	0001	000703	545G	0001	000714	555G
0001	000733	562G	0001	000743	566G	0001	001120	57L	0000	014415	58F	0000	014094	6F
0001	001652	61L	0001	001047	626G	0001	001052	632G	0001	001720	64L	0001	001070	642G
0001	001721	65L	0001	001106	651G	0001	001111	654G	0001	001130	667G	0001	001766	67L
0000	014030	7F	0001	001747	70L	0001	001150	703G	0001	001214	721G	0001	001235	724G
0001	002136	73L	0001	001300	737G	0001	001361	767G	0001	002046	77L	0000	014015	8F
0001	002144	81L	0001	002164	86L	0001	002313	98L	0001	002227	99L	0001	002704	999L
0000	R 011363	ABC	0000	R 011407	ABCO	0000	R 011255	ABCS	0000	I 000064	ARE	0000	R 010663	AC
0000	R 013527	ADB	0000	R 011203	ADNB	0000	R 011551	ADNS	0000	R 013531	ADS	0000	I 000032	AE
0000	R 011375	AFB	0000	R 011301	AFS	0000	R 011503	AMTASE	0000	R 011457	AMTGEL	0000	R 011471	AMYRBC
0000	R 000110	ANIO	0000	I 000076	ANSE	0000	R 013547	AP	0000	R 013530	ARAT10	0000	I 000024	ASE
0000	R 013550	BD	0000	013734	BDATA	0000	R 011313	BG	0000	I 000000	BIOEL	0000	I 000012	BIOZ
0000	R 013481	CC	0000	R 010021	COEF	0000	R 013576	CON	0000	R 011537	CONC	0000	R 013501	CP
0000	R 011351	CR	0000	R 013541	CSCTH	0000	R 013551	CT	0000	R 011325	CTB	0000	R 013441	CV
0000	R 013524	C1	0000	R 013525	C12	0000	R 013526	C2	0000	R 011433	DEL	0000	R 011517	DENAD
0000	R 011143	DENS	0000	013622	DIST	0000	R 013566	DRYGEL	0000	R 013552	DT	0000	R 013575	EDGE
0000	R 011337	ESC	0000	R 007130	ESCMX	0000	R 013577	EX	0000	R 012524	F	0000	R 013557	GEL
0000	013702	GLH10	0000	R 013560	H20	0000	I 013523	I	0000	I 013533	ICOUNT	0000	I 000144	ICS
0000	I 013521	IDATE	0000	I 013602	INDX	0000	I 013545	IPRINT	0000	I 013564	IPS	0000	I 010633	ITITX
0000	I 010647	ITITY	0000	I 013553	ITYPE	0000	I 013546	INT	0000	I 013565	J	0000	I 013621	JA
0000	I 013544	JSET	0000	I 013570	K	0000	I 013574	K	0000	I 013543	KAN	0000	I 013603	MDIM
0000	I 013542	MISS	0000	I 013567	N	0000	I 013555	NA	0000	I 013563	NAD	0000	I 013614	NBE
0000	I 013562	ND	0000	I 013617	NG	0000	I 013613	NS	0000	I 013554	NSAMP	0000	I 013571	NSE
0000	I 013532	NSTD	0000	I 013573	NZ	0000	I 011511	NZA	0000	I 011243	NZAE	0000	I 011123	NZSE
0000	R 000000	P	0000	R 013600	PABE	0000	R 013620	PCOR	0012	R 000000	PCORRE	0000	R 013601	PDE
0000	R 010631	Q	0000	R 010627	R	0000	R 011421	RHOBZ	0000	R 010114	SCT	0000	R 011615	SCTSD
0000	013645	SDATA	0000	R 013540	SDEV	0000	R 011603	SDVERR	0000	R 011571	SDVESC	0000	I 000044	SE
0000	R 011445	SIGB1	0000	R 011525	SIGB2	0000	R 011267	SIGS	0000	013774	STAT	0000	R 013615	SUMI
0000	R 013616	SUM2	0000	R 007522	SX	0000	R 013556	TB10	0000	R 012575	TITLE1	0000	R 013561	TSTD
0000	R 013537	VAR	0000	R 010623	VARCOV	0000	R 013604	VARERR	0000	R 013572	WAVE	0000	R 011223	WFBE
0000	R 010570	WM	0000	R 011163	WPSE	0000	R 012207	X	0000	R 013536	XBAR	0000	R 013607	XL
0000	R 010506	XH	0000	R 013535	XHAX	0000	R 013534	XMIN	0000	R 013605	YMX	0000	R 013610	XR
0000	R 012611	Y	0000	R 013435	YAVG	0000	R 013611	YB	0000	R 010537	YM	0000	R 013606	YMX
0000	R 013612	YT												

4.15

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00100 10 C * INIT,ALIZE AND INPUT BASIC PARAMETERS
00101 20 INTEGER BIOEL,BIOZ,ASE,AE,SE,ABE,ANSE
00103 30 DIMENSION ANIO(6,6,100),ESCMX(10,25)
00104 40 DIMENSION SX(10,25),SCT(10,25),XH(25),YM(25),WM(25),ANSE(10),
00104 50 I-----COEF(2),VARCOV(2,2),R(2),Q(2),ITITX(12),ITITY(12)
00105 60 COMMON/P/P
00106 70 DIMENSION P(100,36),AC(10,16),SE(16),NZSE(16),DENS(16),WPSE(16),
00106 80 I AUN(16),AFBE(16),AE(10),NZAE(10),ABCS(10),SIGS(10),AFS(10),
00106 90 2 ABE(10),BG(10),C1(10),ESC(10),CR(10),ABC(10),AFB(10),ABCO(10),
00106 100 3 RHOR2(10),DEL(10),SIGB(10),BIOEL(10),BIOZ(10),AMTGEL(10),
00106 110 4 AMTRBE(10),ASE(6),AMTASE(6),NZA(6),DENAD(6),SIGB2(10),CONC(10),
00106 120 5 AUN5(16),SDVESC(10),SDVERR(10),SCTSD(10,25)
00107 130 DIMENSION X(205),F(4),TITLE1(12)
00110 140 DIMENSION Y(10),4),YAVG(4),CV(4,4),CC(4,4),CP(4,4)
00111 150 DIMENSION ICS(100)
00112 160 DIMENSION IDATE(2)
00113 170 EQUIVALENCE TP(1,2),ICS(1)
00114 180 DATA BIOEL /'H','C','M','U','VA','P','S','CL','K','FE'/
00116 190 DATA BIOZ /1,6,7,8,11,15,16,17,19,26/
00120 200 DATA AMTGEL /07,29,42,72,15,03,34,74,00,00,00,00,22,00,00,00,00,

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00120 21 1 00.00/
00122 22 DATA AHTBCL,0721,5368,1671,2006,0012,0030,0038,0048,0114,
00122 23 1 0031/
00124 24 DATA TITLE,'CONCENTRATION FREQUENCY DISTRIBUTION',6,1 /
00126 25 DATA (ITITX(I),I=1,12)/72H ABSORPTION-FACTOR * AREA-DENSITY (10**-
00126 26 16) /
00130 27 DATA (TTTTY(I),I=1,12)/72H ACCUMULATED COUNT (10**3) /
00130 28 1 /
00132 29 NAMELIST/UITF/C1,C12,C2,ADB,ARATIO
00133 30 NAMELIST/SDATA/DENAD,DENS,ADNS,ADS,SIGS,AC,ABCS,AFS,WPSE
00134 31 NAMELIST/GLH10/NSTD,XM,YM,WM,BG,ESC,SDVESC,SDVERR
00135 32 NAMELIST/BUATA/ABC,AFB,ABCO,CR,SIG5,SIGB2,ADNB,ADB,WFB,ICOUNT
00136 33 NAMELIST/STAT/XMIN,XMAX,XBAR,VAR,SDEV
00137 34 CSCX = 1.2605
00137 35 C
00137 36 C * LIST OF OPTIONS
00137 37 C IPRINT = 0 NO NAMELIST PRINTOUT (TYPICAL)
00137 38 C IPRINT = 1 PRINT NAMELISTS CONTAINING INTERMEDIATE CALCULATIONS
00137 39 C IWT = 0 WEIGHTS ARE INPUT THROUGH CALLING ARGUMENTS (1/SAMPLE VAR)
00137 40 C IWT = 1 WEIGHTS ARE DEFINED AS 1, IN GLHFR2
00137 41 C IWT = 2 WEIGHTS ARE CALCULATED IN GLHFR2 AS 1./Y(I) (1/POISSON VAR)
00137 42 C ITYPE = 0 ONLY STATISTICAL ANALYSIS OF STANDARD DATA PERFORMED
00137 43 C ITYPE = 1 SAMPLES ARE RED BLOOD CELLS
00137 44 C ITYPE = 2 SAMPLES ARE BIOLOGICAL TISSUE SECTIONS
00137 45 C ITYPE = 3 SAMPLES ARE GELATIN SECTIONS
00137 46 C
00137 47 C * INPUT PROBLEM INFORMATION
00140 48 READ(5,8) IDATE,MISS,MAN,JSSET
00151 49 8 FORMAT(2A5,15,A5,A5)
00152 50 WRITE(6,208) IDATE,MISS,MAN,JSSET
00163 51 208 FORMAT(' CARD 1 ',2A5,15,A5,A5)
00163 52 C
00163 53 C * INPUT PROGRAM PARAMETERS
00164 54 READ(5,4) IPRINT,IWT
00170 55 WRITE(6,210) IPRINT,IWT
00174 56 210 FORMAT(' CARD 2 ',3I5)
00174 57 C
00174 58 C * INPUT MICROPROBE PARAMETERS
00175 59 READ(5,7) AP,BD,CT,DT
00203 60 7 FORMAT(4F10,2)
00204 61 WRITE(6,207) AP,BD,CT,DT
00212 62 207 FORMAT(' CARD 3 ',4F10,2)
00212 63 C
00212 64 C * INPUT SAMPLE INFORMATION
00213 65 READ(5,4) ITYPE,NSAMP,NA,TB10
00221 66 4 FORMAT(3I5,F5,0)
00222 67 WRITE(6,204) ITYPE,NSAMP,NA,TB10
00230 68 204 FORMAT(' CARD 4 ',3I5,F5,0)
00231 69 TB10 = TB10*.0E+04
00231 70 C
00231 71 C * INPUT STANDARD DATA
00232 72 READ(5,6) GEL,H20,TSTD,NSTD
00240 73 6 FORMAT(3F10,5,15)
00241 74 WRITE(6,203) GEL,H20,TSTD,NSTD
00247 75 203 FORMAT(' CARD 5 ',3F10,5,15)
00250 76 TSTD = TSTD*.10E+04
00251 77 READ(5,2) (AE(I),BG(I),ESC(I),SDVESC(I),I=1,NA)
00262 78 2 FORMAT(2,3X,3F10,0)

```

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00263 79* WRITE(6,202) (AE(I),84(I),ESC(I),SDVESC(I),I=1,NA)
00274 80* 202 FORMAT(' CARD 6 ',A2,3X,3F10.0)
00274 81* C
00274 82* C * COMPUTE RBC AREA DENSITY AND CURRENT INTERCEPT RATIO
00275 83* IF(ITYPE.NE.1) GO TO 35
00277 *DIAHOSTIC THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
00277 84* IF(BD.EQ.0) GO TO 311
00301 85* C1 = 1. - EXP(-0.5/0.75**2)
00302 86* C12 = 1. - EXP(-4*5/0.75**2)
00303 87* C2 = C12 - C1
00304 88* ADB = 32.*(1.01728*C1 + .48272*C2/8.)*.0001/C12/3.14159
00305 89* GO TO 312
00306 90* 311 CONTINUE
00307 91* C1 = 1. - EXP(-4.5/((1.5*BD)**2))
00310 92* C12 = 1. - EXP(-0.5*(3.75**2)/((1.5*BD)**2))
00311 93* C2 = C12 - C1
00312 94* ADB = 32.*(10.5*C1/9. + 0.5*C2/13.75**2 - 9.)*0.0001/C12/3.14159
00313 95* 312 CONTINUE
00314 96* ARATIO = 1.07E12
00315 97* WRITE(6,DIST)
00320 98* 35 CONTINUE
00320 99* C
00320 100* C
00320 101* C * THIS LOOP FORMS ATOMIC NUMBER AND SYMBOL ARRAYS, AND COMPUTES AREA
00320 102* DENSITY AND ABSORPTION COEFFICIENTS FOR EACH ANALYZED ELEMENT IN
00320 103* EACH STANDARD
00320 104* C
00321 105* DO 111 ND = 1,NSTD
00324 106* READ(5,5) NAD,(ASE(I),AMTASE(I),I = 1,NAD)
00334 107* 5 FORMAT(11,3X,6(A2,1X,F6.0,1X))
00335 108* WRITE(6,205) NAD,(ASE(I),AMTASE(I),I=1,NAD)
00345 109* 205 FORMAT(' CARD 7 ',11,3X,6(A2,1X,F6.0,1X))
00346 110* IF(NSTD.EQ.1) GO TO 321
00350 111* READ(5,305) IPS,(ANSE(I),SCT(1,ND),SCTSD(1,ND),I=1,NA)
00361 112* 305 FORMAT(12,2X,4(A2,1X,F6.0,1X,F6.0,1X))
00362 113* WRITE(6,206) IPS,(ANSE(I),SCT(1,ND),SCTSD(1,ND),I=1,NA)
00373 114* 206 FORMAT(' CARD 8 ',12,2X,4(A2,1X,F6.0,1X,F6.0,1X))
00374 115* DO 321 I = 1,NA
00377 116* IF(ANSE(I).EQ.AE(I)) GO TO 32
00401 117* WRITE(6,241) ND,NSTD
00405 118* 241 FORMAT(110,5X,'ANALYZED ELEMENT CHECK ARRAYS ANSE(I) AND AE(I), I
00405 119* 1 = 1,NA, ARE NOT IDENTICAL.',1/5X,'CHECK CARDS 7 AND 8 FOR STANDAR
00405 120* 205.',131*THROUGH',131)
00406 121* GO TO 999
00407 122* 32 CONTINUE
00411 123* 321 CONTINUE
00411 124* C
00411 125* C * CONSTRUCT ATOMIC NUMBER ARRAYS NZA(I) AND NZAE(I) FOR ADDED ELEMENTS
00411 126* AND ANALYZED ELEMENTS
00412 127* IF(ND.NE.1) GO TO 112
00414 128* DO 11 I = 1,NAD
00417 129* DO 12 J = 1,100
00424 130* IF((CS(J).NE.ASE(I)) GO TO 12
00424 131* NZA(I) = J
00425 132* GO TO 11
00426 133* 12 CONTINUE
00430 134* IF(NZA(I).NE.0) GO TO 11
00432 135* WRITE(6,101) I

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00435 136* 101 FORMAT(1H,10X,'ADDED ELEMENT SYMBOL',13,1X,'WAS NOT FOUND')
00436 137* GO TO 999
00437 138* 11 CONTINUE
00441 139* DO 13 I = 1,NA
00444 140* DO 14 J = 1,100
00447 141* IF(ICS(J).NE.AE(I)) GO TO 14
00451 142* NZAE(I) = J
00452 143* GO TO 13
00453 144* 14 CONTINUE
00455 145* IF(NZAE(I).NE.0) GO TO 13
00457 146* WRITE(6,102) I
00462 147* 102 FORMAT(1H,10X,'ANALYZED ELEMENT SYMBOL',13,1X,'WAS NOT FOUND')
00463 148* GO TO 999
00464 149* 13 CONTINUE
00464 150* C
00464 151* C * FORM SYMBOL, DENSITY AND ATOMIC NUMBER ARRAYS FOR STANDARD ELEMENTS
00466 152* 112 CONTINUE
00467 153* DO 21 I = 1,10
00472 154* DRYGEL = GEL*(1+D * H2O)*1.0E-03
00473 155* SE(I) = BIOEL(I)
00474 156* NZSE(I) = BIOZ(I)
00475 157* DENS(I) = DRYGEL*AMTGEL(I)*1.0E-02
00476 158* 21 CONTINUE
00500 159* DO 22 I = 1,NAD
00503 160* N = NZA(I)
00504 161* DENAD(I) = AMTASE(I)*P(N,1)*1.0E-06
00505 162* 22 CONTINUE
00507 163* K = 10
00510 164* DO 23 I = 1,NAD
00513 165* DO 24 J = 1,K
00516 166* IF(ASE(I).EQ.SE(J)) GO TO 25
00520 167* 24 CONTINUE
00522 168* K = K+1
00523 169* NZSE(K) = NZA(I)
00524 170* SE(K) = ASE(I)
00525 171* DENS(K) = DENAD(I)
00526 172* GO TO 23
00527 173* 25 CONTINUE
00530 174* DENS(J) = DENS(J) + DENAD(I)
00531 175* 23 CONTINUE
00531 176* C
00531 177* C * CALCULATE AREA DENSITY OF DRY STANDARD
00533 178* NSE = K
00534 179* ADS = 0.
00535 180* DO 51 I = 1,NSE
00540 181* ADNS(I) = DENS(I)*TSTD
00541 182* ADS = ADS + ADNS(I)
00542 183* 51 CONTINUE
00544 184* DO 52 I = 1,NSE
00547 185* WPSE(I) = 100.*ADNS(I)/ADS
00550 186* 52 CONTINUE
00552 187* IF(N0.NE.1) GO TO 113
00552 188* C
00552 189* C * COMPUTE ELEMENTAL MASS ABSORPTION COEFFICIENTS FOR ANALYZED LINES
00554 190* DO 41 I = 1,NA
00557 191* N = NZAE(I)
00560 192* WAVE = P(N,6)
00561 193* DO 41 J = 1,NSE

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00564 194*      NZ = NZSE(I)
00565 195*      DO 43 M = 9,17
00570 196*      EDGE = P(NZ,M)
00571 197*      IF(WAVE.LT.EDGE) GO TO 44
00573 198*      43 CONTINUE
00575 199*      CON = P(NZ,30)
00576 200*      EX = 2.22
00577 201*      GO TO 45
00600 202*      44 CON = P(NZ,M+12)
00601 203*      IF(M=10)46,47,48
00604 204*      46 EX = P(NZ,19)
00605 205*      GO TO 45
00606 206*      47 EX = P(NZ,20)
00607 207*      GO TO 45
00610 208*      48 IF(M=13)47,49,50
00613 209*      49 EX = 2.60
00614 210*      GO TO 45
00615 211*      50 IF(M.LT.17) GO TO 49
00617 212*      EX = 2.33
00620 213*      45 AC(I,J) = CON*WAVE**EX
00621 214*      41 CONTINUE
00621 215*      C
00621 216*      C * COMPUTE MASS ABSORPTION COEFFICIENT OF STANDARD FOR ANALYZED LINES
00624 217*      113 CONTINUE
00625 218*      DO 53 I = 1,NA
00630 219*      ABCS(I) = 0.
00631 220*      DO 53 J = 1,NSE
00634 221*      PABC = AC(I,J)*ADMS(J)
00635 222*      ABCS(I) = ABCS(I) + PABC
00636 223*      53 CONTINUE
00636 224*      C
00636 225*      C * COMPUTE ABSORPTION FACTORS FOR ANALYZED LINES IN STANDARD
00641 226*      DO 54 I = 1,NA
00644 227*      POE = ABCS(I)*CSCSH
00645 228*      AFS(I) = (1 - EXP(-POE))/POE
00646 229*      54 CONTINUE
00646 230*      C
00646 231*      C * COMPUTE AREA DENSITIES FOR ANALYZED ELEMENTS IN STANDARD
00650 232*      DO 55 I = 1,NA
00653 233*      DO 56 J = 1,NSE
00656 234*      IF(NZXE(I).EQ.NZSE(J)) GO TO 57
00660 235*      56 CONTINUE
00662 236*      57 CONTINUE
00663 237*      SIGS(I) = ADMS(J)
00664 238*      55 CONTINUE
00666 239*      DO 114 I = 1,NA
00671 240*      SX(I,ND) = AFS(I) * SIGS(I)
00672 241*      114 CONTINUE
00674 242*      IF(I.PRINT.NE.0) WRITE(6,SUATA)
00700 243*      IF(NSTD.EW.1) GO TO 116
00700 244*      C * LOAD ANALYSIS INPUT-OUTPUT MATRIX
00702 245*      DO 31 I = 1,NA
00705 246*      ANIO(I,1,ND) = ANIASE(I)
00706 247*      ANIO(I,2,ND) = 100.*SIGS(I)/ADS
00707 248*      ANIO(I,3,ND) = SIGS(I)
00710 249*      ANIO(I,4,ND) = AFS(I)
00711 250*      31 CONTINUE
00713 251*      IF(I.PS.NE.1) GO TO 111

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00715 252* INDX = ND
00716 253* 111 CONTINUE
00716 254* C
00716 255* C = COMPUTE ESTIMATES OF STATISTICAL PARAMETERS FOR SET OF STANDARDS
00716 256* C AND COMPUTE MOST PROBABLE COUNT FOR THE PRINCIPAL STANDARD
00720 257* DO 115 I = 1,NA
00723 258* DO 117 ND = 1,NSTD
00726 259* XM(ND) = SX(1,ND)
00727 260* YM(ND) = SCT(1,ND)
00730 261* IF(IHT.EQ.0) WM(I) = 1.0/SCTSD(1,ND)**2
00732 262* 117 CONTINUE
00734 263* MDIM = 25
00735 264* CALL GLHPR2(NSTD,XM,YM,WM,MDIM,IHT,COEF,VARERR,VARCOV)
00736 265* DO 34 ND=1,NSTD
00741 266* ESCMX(1,ND) = COEF(1) + COEF(2)*SX(1,ND)
00742 267* ANIO(1,5,ND) = SCT(1,ND)
00743 268* ANIO(1,6,ND) = ESCMX(1,ND)
00744 269* 34 CONTINUE
00746 270* BG(I) = COEF(I)
00747 271* ESC(I) = COEF(1) + COEF(2)*SX(1,INDX)
00750 272* SDVESC(I) = SQRT(ABS(VARCOV(1,1) + VARCOV(2,2)*SX(1,INDX)**2))
00751 273* SDVERR(I) = SQRT(ABS(VARERR))
00752 274* IF(I.PRINT.NE.0) WRITE(6,GLHIQ)
00756 275* PUNCH 2,(AE(I),BG(I),ESC(I),SDVESC(I))
00756 276* C
00756 277* C * MICROFILM STANDARD COUNT VS. ABSORPTION-FACTOR * AREA-DENSITY
00764 278* XMX = 0.
00765 279* YMX = 0.
00766 280* DO 118 J = 1,NSTD
00771 281* XM(J) = XM(J)*1.0E+06
00772 282* YM(J) = YM(J)*1.0E+03
00773 283* IF(XM(J).GT.XMX) XMX = XM(J)
00775 284* IF(YM(J).GT.YMX) YMX = YM(J)
00777 285* 118 CONTINUE
01001 286* XL = 0.
01002 287* XR = XMX
01003 288* YB = 0.
01004 289* IF(COEF(1).LT.0.) YB = COEF(1)*1.0E-03
01006 290* YT = YMX
01007 291* Q(1) = 0.
01010 292* Q(2) = XMX
01011 293* R(1) = COEF(1)*1.0E-03
01012 294* R(2) = R(1) + COEF(2)*1.0E-09*XMX
01013 295* CALL QUIKMP(-1,XL,XR,YB,YT,1H,ITIX,ITITY,NSTD,XM,YM)
01014 296* CALL QUIKML(0,XL,XR,YB,YT,1H,ITIX,ITITY,-2,Q,R)
01015 297* WRITE(17,104) NZA(1)
01020 298* 104 FORMAT(1H*,3BX,'ACCUMULATED-COUNT VS CORRECTED AREA-DENSITY FOR EL
01020 299* ELEMENT WITH Z = ',I2)
01021 300* 115 CONTINUE
01023 301* WRITE(6,211)
01025 302* 211 FORMAT(1H,' STATISTICAL ANALYSIS OF MICROPROBE DATA FROM A SET OF
01025 303* 1 STANDARDS')
01026 304* DO 89 I=1,5
01031 305* WRITE(6,212) AE(I)
01034 306* 212 FORMAT(1H,77,1X,12,' IS THE ELEMENT ANALYZED')
01035 307* WRITE(6,213)
01037 308* 213 FORMAT(1H,' NUMBER ',6X,' CONCENTRATION',2X,' WEIGHT ',5X,
01037 309* ' AREA ',8X,' ABSORPTION',5X,' MEASURED',7X,' ESTIMATED',/,1X,

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01037 310* 2 1 STANDARD , 6X, 1 IN ME4/L 1, 2X, PERCENTAGE , 5X, DENSITY , 8X,
01037 311* 3 1 FACTOR , 5X, COUNT , 7X, COUNT 1)
01040 312* DO 94 ND = 1, NSTD
01043 313* WR, TE(6, 215) ND, ANIO(1, 1, ND), ANIO(1, 2, ND), ANIO(1, 3, ND),
01043 314* 1- ANIO(1, 4, ND), ANIO(1, 5, ND), ANIO(1, 6, ND)
01054 315* 215 FORMAT(1HD, 3X, 13, 9X, 3X, F5.1, 7X, 1X, E8.3, 6X, 2X, E8.3, 5X, 3X, F6.5, 6X,
01054 316* 1 2X, F6.0, 7X, 2X, F6.0)
01055 317* 94 CONTINUE
01057 318* WRITE(6, 216) BG(1), CT, SDVESC(1), NSTD
01065 319* 216 FORMAT(1HD, 1X, F6.0, ' IS THE ESTIMATED RESIDUAL BACKGROUND FOR A ',
01065 320* ' F4.0, ' SECOND COUNT TIME, ' //, 1X, F6.0, ' IS THE ESTIMATED ERROR ST
01065 321* 2ANDARD DEVIATION FOR INTENSITY COUNT ON', /, 8X, 'THE PRINCIPAL STAND
01065 322* 3ARD (STANDARD NUMBER ', 13, ')')
01066 323* 89 CONTINUE
01070 324* 116 CONTINUE
01071 325* IF(NSAMP.EQ.0) GO TO 999
01071 326* C
01071 327* C
01071 328* C * PERFORM ANALYSIS OF ONE SAMPLE EACH TIME THROUGH LOOP
01071 329* C
01071 330* C
01071 331* C * CHECK SYMBOLS AND SYMBOL ORDER OF COUNT DATA
01073 332* READ(5, 3) (ABE(I), I=1, NA)
01101 333* J FORMAT (6(8X, A2))
01102 334* DO 61 I = 1, NA
01105 335* IF(ABE(I).EQ.ABE(1)) GO TO 61
01107 336* WRITE(6, 103) NA
01112 337* 103 FORMAT (1HD, 10X, 'CHEMICAL SYMBOL OR SYMBOL ORDER IS IN ERROR FOR N
01112 338* *A = ', 12)
01113 339* GO TO 999
01114 340* 61 CONTINUE
01116 341* DO 99 NS = 1, NSAMP
01121 342* READ(5, 58) (CTB(I), I=1, NA)
01127 343* 58 FORMAT (6F10.0)
01127 344* C
01127 345* C * FORM INITIAL DENSITY ARRAY FOR BIOLOGICAL ELEMENTS,
01127 346* C CORRECT COUNTS FOR BACKGROUND AND FORM COUNT RATIOS
01130 347* NBE = NSE
01131 348* IF(ITYPE = 2) 63, 64, 65
01134 349* 63 CONTINUE
01135 350* DO 66 I = 1, 10
01140 351* WFBE(I) = AMTRBC(I)
01141 352* ADDB(I) = WFBE(I) * ADB
01142 353* 66 CONTINUE
01144 354* DO 69 I = 1, NA
01147 355* CR(I) = CTB(I) / (ESC(I) * BG(I))
01150 356* 69 CONTINUE
01152 357* GO TO 67
01152 358* C
01152 359* C * SPACE LEFT HERE FOR COMPUTING TISSUE DENSITY ARRAY
01153 360* 64 CONTINUE
01154 361* GO TO 67
01154 362* C
01155 363* 65 CONTINUE
01156 364* DO 62 I = 1, NA
01161 365* CR(I) = (CTB(I) - BG(I)) / (ESC(I) - BG(I))
01162 366* 62 CONTINUE
01162 367* C

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01164 368 DO 68 I = 1, NBE
01167 369 ADNB(I) = ADNS(I)*TB10/TSTD
01170 370 68 CONTINUE
01172 371 ADB = ADS*TB10/TSTD
01173 372 67 CONTINUE
01173 373 C
01173 374 C * COMPUTE MASS ABSORPTION COEFF OF BIO. SAMPLE FOR LINES ANALYZED
01174 375 ICOUNT = 0
01175 376 70 CONTINUE
01176 377 DO 71 I = 1, NA
01201 378 ABC(I) = 0
01202 379 DO 71 J = 1, NDE
01205 380 PABC = AC(I,J)*ADNB(J)
01206 381 ABC(I) = ABC(I) + PABC
01207 382 71 CONTINUE
01207 383 C
01207 384 C * COMPUTE ABSORPTION FACTORS FOR ANALYZED LINES IN BIOLOGICAL SAMPLE
01212 385 DO 72 I = 1, NA
01215 386 POE = ABC(I)*655TH
01216 387 AFB(I) = (1. - EXP(-POE))/POE
01216 388 C
01216 389 C * COMPUTE THE ABSORPTION CORRECTION ARRAY FOR THE ANALYZED ELEMENTS
01217 390 ABCO(I) = AFS(I)/AFB(I)
01217 391 C
01217 392 C * COMPUTE AREA DENSITY ARRAY OF ANALYZED ELEMENTS IN BIOLOGICAL SAMPLE
01220 393 SIGB2(I) = SIGS(I)*CR(I)*ARATIO*ABCO(I)
01221 394 72 CONTINUE
01223 395 ICOUNT = ICOUNT + 1
01223 396 C
01223 397 C * UPDATE AREA DENSITY AND WEIGHT FRACTION ARRAYS OF BIOLOGICAL SAMPLE
01224 398 DO 75 I = 1, NA
01227 399 DO 76 J = 1, NBE
01232 400 IF(NZAE(I)*EQ*NZSE(J)) GO TO 77
01234 401 76 CONTINUE
01236 402 77 CONTINUE
01237 403 ADNB(J) = SIGB2(I)
01240 404 75 CONTINUE
01242 405 IF(I*TYPE.EQ.3) ADNB(I) = (ADNB(I)/22.997+ADNB(91/39.100))*35.457
01244 406 ADB = 0
01245 407 DO 78 I = 1, NBE
01250 408 ADB = ADB + ADNB(I)
01251 409 78 CONTINUE
01251 410 C
01251 411 C * TEST FOR REITERATION CRITERION
01253 412 IF(ICOUNT.LE.2) GO TO 73
01255 413 DO 74 I = 1, NA
01260 414 DEL(I) = (SIGB2(I)-SIGB1(I))/SIGB2(I)
01261 415 74 CONTINUE
01263 416 DO 75 I = 1, NA
01266 417 IF(ABS(DEL(I)).GT.0.001.AND.ICOUNT.LT.10) GO TO 73
01270 418 33 CONTINUE
01272 419 GO TO 81
01273 420 73 CONTINUE
01274 421 DO 80 I = 1, NA
01277 422 SIGB1(I) = SIGB2(I)
01300 423 80 CONTINUE
01302 424 GO TO 70
01303 425 81 CONTINUE

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01304 426* IF(IITYPE.EQ.3) GO TO 86
01306 427* DO 82 I = 1,NA
01311 428* N = NZA(I)
01311 429* C
01311 430* C * COMPUTE THE VOLUME DENSITY OF ANALYZED ELEMENTS IN GELATIN SAMPLES
01312 431* RH082(I) = SIGB2(I)/TB10
01313 432* CONC(I) = RH082(I)*1.0E+06/P(N,I)
01314 433* 82 CONTINUE
01316 434* 86 CONTINUE
01316 435* C
01316 436* C * FORM WEIGHT PERCENT MATRIX ATPMX(NSAMP,NA)
01317 437* DO 79 I = 1,NBE
01322 438* WTE(I) = ADNB(I)/ADB
01323 439* 79 CONTINUE
01323 440* C * LOAD ANALYSIS INPUT-OUTPUT MATRIX
01325 441* DO 88 I = 1,NA
01330 442* ANI0(I,1,NS) = CT0(I)
01331 443* ANI0(I,2,NS) = AF0(I)
01332 444* ANI0(I,3,NS) = ABC0(I)
01333 445* ANI0(I,4,NS) = SIGB2(I)
01334 446* ANI0(I,5,NS) = 100.*SIGB2(I)/ADB
01335 447* ANI0(I,6,NS) = CONC(I)
01336 448* 88 CONTINUE
01340 449* IF(NS.GT.2) GO TO 90
01342 450* IF(IPRINT.EQ.0) WRITE(6,DATA)
01346 451* 99 CONTINUE
01350 452* IF(IITYPE.EQ.1) GO TO 98
01352 453* WRITE(6,221)
01354 454* 221 FORMAT(1H1,' ANALYSIS OF GELATIN-BASE SAMPLES')
01355 455* DO 87 I = 1,NA
01360 456* WRITE(6,222) ABE(I),BG(I)
01364 457* 222 FORMAT(1H0,///,30X,A2,' IS THE ELEMENT ANALYZED',
01364 458* 1 /,30X,I5,' IS THE BACKGROUND COUNT')
01365 459* WRITE(6,223)
01367 460* 223 FORMAT(1H0,' SAMPLE',6X,' INTENSITY',6X,' ABSORPTION',5X,' ABSORPTION
01367 461* 1',8X,' AREA ',5X,' WEIGHT ',5X,' CONCENTRATION',/,1X,' NUMBER',
01367 462* 2',8X,' COUNT ',7X,' FACTOR ',5X,' CORRECTION',8X,' DENSITY',5X,
01367 463* 3 'PERCENTAGE',5X,' IN MEQ/L ')
01370 464* DO 87 NS = 1,NSAMP
01373 465* WRITE(6,244) NS,ANI0(I,1,NS),ANI0(I,2,NS),ANI0(I,3,NS),
01373 466* 1 ANI0(I,4,NS),ANI0(I,5,NS),ANI0(I,6,NS)
01404 467* 224 FORMAT(1H 1X,2X,13,10X,1X,F6.0,8X,2X,F6.5,7X,2X,F6.5,7X,E10.5,5X,
01404 468* 1 2X,F4.2,4X,F5.1)
01405 469* 87 CONTINUE
01410 470* GO TO 999
01411 471* 98 CONTINUE
01412 472* WRITE(6,231)
01414 473* ) 90 K = 1,NA
01417 474* 231 FORMAT(1H1,16I/,45X,' QUANTITATIVE ANALYSIS OF RBC-SET',5I/,40X,'
01417 475* INPUT-OUTPUT TABLE',3I/,40X,' 2. CONCENTRATION FREQUENCY DIST
01417 476* RIBUTION',3I/,40X,' 3. CONCENTRATION CUMULATIVE DISTRIBUTION',3I/
01417 477* ),40X,' 4. CONCENTRATION CORRELATION ANALYSIS')
01420 478* WRITE(6,232) ABE(K)
01423 479* 232 FORMAT(1H1,///,30X,A2,' IS THE ELEMENT ANALYZED')
01424 480* WRITE(6,233)
01424 481* 233 FORMAT(1H0,' SAHPLE',8X,' INTENSITY',6X,' ABSORPTION',5X,' ABSORPTION
01426 482* 1',8X,' AREA ',5X,' WEIGHT ',5X,/,1X,' NUMBER',
01426 483* 2 8X,' COUNT ',7X,' FACTOR ',5X,' CORRECTION',8X,' DENSITY',5X,

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01426 484* 3 *PERCENTAGE*)
01427 485* DO 97 NS = 1,NSAMP
01432 486* WRITE(6,224) NS,ANIO(K,1,NS),ANIO(K,2,NS),ANIO(K,3,NS),ANIO(K,4,NS
01432 487* *) ,ANIO(K,5,NS)
01442 488* 97 CONTINUE
01442 489* C
01442 490* C * COMPUTE STATISTICAL PARAMETERS AND PRINT CUMULATIVE DISTRIBUTION AND
01442 491* C HISTOGRAM OF SAMPLE SET DISTRIBUTION
01444 492* DO 91 J = 1,NSAMP
01447 493* X(J) = ANIO(K,5,J)
01450 494* 91 CONTINUE
01452 495* XMAX = X(1)
01453 496* XMIN = X(1)
01454 497* DO 92 I = 2,NSAMP
01457 498* IF(X(I).GT.XMAX) XMAX = X(I)
01461 499* IF(X(I).LT.XMIN) XMIN = X(I)
01463 500* 92 CONTINUE
01465 501* SUM1 = 0.
01466 502* SUM2 = 0.
01467 503* DO 93 I = 1,NSAMP
01472 504* SUM1 = SUM1 + X(I)
01473 505* SUM2 = SUM2 + X(I)*X(I)
01474 506* 93 CONTINUE
01476 507* XBAR = SUM1/NSAMP
01477 508* VAR = (SUM2 - NSAMP*XBAR*ABAR)/(NSAMP-1)
01500 509* SDEV = SQRT(VAR)
01501 510* NG = NSAMP/5
01502 511* CALL H15(IX,NSAMP,NG,XMIN,XMAX,F,0,TITLE1)
01503 512* CALL IGIVE(X,NSAMP,NG,XMIN,XMAX,F,1,0)
01504 513* WRITE(6,STAT)
01507 514* 90 CONTINUE
01511 515* IF(NA.EQ.1) GO TO 999
01511 516* C
01511 517* C * PERFORM CORRELATION ANALYSIS BETWEEN ANALYZED CHEMICAL ELEMENTS
01511 518* C
01513 519* DO 36 I = 1,NA
01516 520* DO 36 K = 1,NSAMP
01521 521* Y(K,I) = ANIO(I,5,K)
01522 522* 36 CONTINUE
01525 523* CALL CORAN(Y,NSAMP,NA,0,0,YAVG,CV,PCOR,101,4)
01526 524* WRITE(6,225)
01530 525* 225 FORMAT(1H1,///,30X,'CONCENTRATION CORRELATION ANALYSIS',///)
01531 526* WRITE(6,225)
01533 527* 226 FORMAT(1HU,10X,1'CHEMICAL',10X,1' VARIANCE ',10X,1'CORRELATION',10X,
01533 528* 1 'CORRELATION',/,11X,1'ELEMENTS',10X,1'COVARIANCE',10X,1'COEFFICIENT'
01533 529* 2 ,10X,1'PROBABILITY')
01534 530* DO 37 I = 1,NA
01537 531* JA = 1
01540 532* DO 37 J = JA,NA
01543 533* CC(I,J) = CV(I,J)/SQRT(CV(I,I)*CV(J,J))
01544 534* IF(I.EQ.J) GO TO 38
01546 535* CP(I,J) = 1.0 - PCORR(CC(I,J),NSAMP)
01547 536* GO TO 39
01550 537* 38 CONTINUE
01551 538* CP(I,J) = 1.0
01552 539* 39 CONTINUE
01553 540* WRITE(6,227) ABE(I),ABE(J),CV(I,J),CC(I,J),CP(I,J)
01562 541* 227 FORMAT(1HU,10X,A2,' - ',A2,F19.4,2F21.4)

```

01563 542\* 37 CONTINUE  
01566 543\* 999 STOP  
01567 544\* END

END OF COMPILATION: 1 DIAGNOSTICS.  
BIOMAP SYMBOLIC  
BIOMAP CODE RELOCATABLE

19 NOV 71 10:20:22 0 01550342 14 544 (DELETED)  
19 NOV 71 10:20:22 1 01575466 31 1 (DELETED)  
0 01567242 14 230

UNIVAC 1108 FORTRAN V LEVEL 2206 0024A (EXEC8 LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:03

BLOCK DATA

STORAGE USED: CODE(1) 000000; DATA(0) 000001; BLANK COMMON(2) 000000

COMMON BLOCKS:

0003 P 007020

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000 I 000000 J 0003 R 000000 P

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00101	1*	BLOCK DATA							
00102	2*	COMMON/P/P(100,36)							
00103	3*	DATA(P( 1,J),J=1,36)/ 1.008,2H H, .014, .000, .000,							
00103	4*	.000, .000, .000, .999.000, .999.000, .999.000,							
00103	5*	.000, .000, .000, .000, .000, .000, .000, .000,							
00103	6*	.00, .00, .000, .00,							
00103	7*	.00, .00, .00, .00, .00, .00, .00, .00, .00,							
00103	8*	.000, .000, .000, .000, .000, .000, .000, .000,							
00103	9*	.000, .000, .000, .000, .000, .000, .000, .000,							
00105	10*	DATA(P( 2,J),J=1,36)/ 4.003,2H H, .025, .000, .000,							
00105	11*	.000, .000, .000, .999.000, .999.000, .999.000,							
00105	12*	.000, .000, .000, .000, .000, .000, .000, .000,							
00105	13*	.00, .00, .000, .00,							
00105	14*	.00, .00, .00, .00, .00, .00, .00, .00, .00,							
00105	15*	.00597:0E01, .72186701E-2, .14225233E-2,							
00105	16*	.14111172E-3, .66914290E-5, .11980717E-6/							
00107	17*	DATA(P( 3,J),J=1,36)/ 6.939,2H H, .055, .000, .000,							
00107	18*	.228.000, .000, .000, .228.500, .999.000, .999.000,							
00107	19*	.000, .000, .000, .000, .000, .000, .000, .000,							
00107	20*	.2.89,2.73, .135, .00,							
00107	21*	.00, .00, .00, .00, .00, .00, .00, .00, .00,							
00107	22*	.0085917E01, .10267098E-1, .17859764E-2,							
00107	23*	.19498321E-3, .91950060E-5, .16415851E-6/							
00111	24*	DATA(P( 4,J),J=1,36)/ 9.012,2H H, .11, .000, .000,							
00111	25*	.114.000, .000, .000, .11.000, .999.000, .999.000,							
00111	26*	.000, .000, .000, .000, .000, .000, .000, .000,							
00111	27*	.2.06,2.73, .350, .03,							
00111	28*	.00, .00, .00, .00, .00, .00, .00, .00, .00,							
00111	29*	.10118990E01, .14245909E-1, .28139926E-2,							
00111	30*	.28115022E-3, .13437611E-4, .24230872E-6/							
00113	31*	DATA(P( 5,J),J=1,36)/ 10.811,2H H, .188, .000, .000,							
00113	32*	.67.600, .000, .000, .65.000, .999.000, .999.000,							
00113	33*	.000, .000, .000, .000, .000, .000, .000, .000,							
00113	34*	.2.85,2.73, .740, .05,							
00113	35*	.00, .00, .00, .00, .00, .00, .00, .00, .00,							
00113	36*	.10153513E01, .18509068E-1, .36845955E-2,							
00113	37*	.36906500E-3, .17648432E-4, .31814955E-6/							

00115	38*	DATA(P( 6,J),J=1,36)/ 12.01172H C, 284, 000, 000,
00115	39*	* 44.700, 000, 000, 43.680,646.000,837.000,
00115	40*	* 000, 000, 000, 000, 000, 000, 000, 000,
00115	41*	* 2.84,2.73, 1.350, .07,
00115	42*	* 00, 00, 00, 00, 00, 00, 00, 00,
00115	43*	* 10194912E01, -.23691256E-1, .48297246E-2,
00115	44*	* 4916749E-3, .23763496E-4, -.43147854E-6/
00117	45*	DATA(P( 7,J),J=1,36)/ 14.0072H N, 402, 000, 000,
00117	46*	* 31.600, 000, 000, 30.990,435.000,554.000,
00117	47*	* 000, 000, 000, 000, 000, 000, 000, 000,
00117	48*	* 2.83,2.73, 2.210, .11,
00117	49*	* 00, 00, 00, 00, 00, 00, 00, 00,
00117	50*	* 10240059E01, -.29437535E-1, .61336705E-2,
00117	51*	* .63335989E-3, .30898140E-4, -.56450887E-6/
00121	52*	DATA(P( 8,J),J=1,36)/ 15.9992H O, 532, 000, 000,
00121	53*	* 23.620, 000, 000, 23.320,309.000,390.000,
00121	54*	* 000, 000, 000, 000, 000, 000, 000, 000,
00121	55*	* 2.82,2.73, 3.800, .17,
00121	56*	* 00, 00, 00, 00, 00, 00, 00, 00,
00121	57*	* 10284491E01, -.35199635E-1, .74029714E-2,
00121	58*	* 76721469E-3, .37474747E-4, -.68485508E-6/
00123	59*	DATA(P( 9,J),J=1,36)/ 18.9982H F, 685, 000, 000,
00123	60*	* 18.320, 000, 000, 17.800,228.000,285.000,
00123	61*	* 000, 000, 000, 000, 000, 000, 000, 000,
00123	62*	* 2.81,2.73, 4.980, .23,
00123	63*	* 00, 00, 00, 00, 00, 00, 00, 00,
00123	64*	* 10335088E01, -.41864660E-1, .89623295E-2,
00123	65*	* 93928911E-3, .46210902E-4, -.84851553E-6/
00125	66*	DATA(P( 10,J),J=1,36)/ 20.1832HNE, 867, 000, 000,
00125	67*	* 14.610, 000, 000, 14.302,174.000,216.000,
00125	68*	* 000, 000, 000, 000, 000, 000, 000, 000,
00125	69*	* 2.80,2.73, 6.770, .43,
00125	70*	* 00, 00, 00, 00, 00, 00, 00, 00,
00125	71*	* 10390854E01, -.49116664E-1, .10703538E-1,
00125	72*	* 11347223E-2, .56245408E-4, -.10379363E-5/
00127	73*	DATA(P( 11,J),J=1,36)/ 22.9902HNA, 1.072, 000, 000,
00127	74*	* 11.910, 000, 000, 11.480,136.000,168.000,
00127	75*	* 000, 000, 000, 000, 000, 000, 000, 000,
00127	76*	* 2.79,2.73, 9.050, .55,
00127	77*	* 00, 00, 00, 00, 00, 00, 00, 00,
00127	78*	* 10442524E01, -.56049932E-1, .12310874E-1,
00127	79*	* 13096987E-2, .65021843E-4, -.12007688E-5/
00131	80*	DATA(P( 12,J),J=1,36)/ 24.3122HMG, 1.305, 000, 000,
00131	81*	* 9.890, 000, 000, 9.512,109.000,133.000,
00131	82*	* 000, 000, 000, 000, 000, 000, 000, 000,
00131	83*	* 2.79,2.73, 11.750, .89,
00131	84*	* 00, 00, 00, 00, 00, 00, 00, 00,
00131	85*	* 10499678E01, -.63725293E-1, .14165778E-1,
00131	86*	* 5179592E-2, .75781770E-4, -.14020889E-5/
00133	87*	DATA(P( 13,J),J=1,36)/ 26.9822HAL, 1.560, 000, 000,
00133	88*	* 8.339, 000, 000, 7.951, 89.000,108.000,
00133	89*	* 94.000, 000, 000, 000, 000, 000, 000, 000,
00133	90*	* 2.78,2.73, 14.870, 1.18,
00133	91*	* 00, 00, 00, 00, 00, 00, 00, 00,
00133	92*	* 10555087E01, -.71366787E-1, .15998293E-1,
00133	93*	* 17221065E-2, .86106462E-4, -.15973201E-5/
00135	94*	DATA(P( 14,J),J=1,36)/ 28.0862H5I, 1.839, 000, 000,
00135	95*	* 7.125, 000, 000, 6.745, 73.000, 88.000,

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ORIGINAL PAGE IS  
OF POOR QUALITY

00135	96*	* 78.100, 000, 000, 000, 000, 000, 000, 000,
00135	97*	* 2.77, 2.73, 18.500, 1.54,
00135	98*	* -1.92, -1.40, 00, 00, 00, 00, 00, 00,
00135	99*	* 1.0614996E+1, -.79481125E-1, .17990243E-1,
00135	100*	* -1.9476968E-2, .97735756E-4, -.18172641E-5/
00137	101*	DATA(P(15,J),J=1,36)/ 30.974, 2H P, 2.146, 000, 000,
00137	102*	* 6.157, 000, 000, 5.787, 61.000, 74.000,
00137	103*	* 65.700, 448.000, 000, 000, 000, 000, 000, 000,
00137	104*	* 2.77, 2.73, 22.500, 1.96,
00137	105*	* 2.32, 1.70, 00, 00, 00, 00, 00, 00,
00137	106*	* 1.0669823E01, -.87160349E-1, .19826554E-1,
00137	107*	* -2.1511782E-2, .10805634E-3, -.20101752E-5/
00141	108*	DATA(P(16,J),J=1,36)/ 32.064, 2H S, 2.472, 000, 000,
00141	109*	* 5.372, 000, 000, 5.018, 52.000, 62.000,
00141	110*	* 55.900, 371.000, 000, 000, 000, 000, 000, 000,
00141	111*	* 2.76, 2.73, 27.000, 2.43,
00141	112*	* 2.78, 2.03, 00, 00, 00, 00, 00, 00,
00141	113*	* 1.0730906E+1, -.95653415E-1, .21945883E-1,
00141	114*	* -2.934257E-2, .12061383E-3, .22485010E-5/
00143	115*	DATA(P(17,J),J=1,36)/ 35.453, 2HCL, 2.822, .200, 000,
00143	116*	* 4.728, 000, 000, 4.379, 44.400, 53.000,
00143	117*	* 48.100, 311.000, 000, 000, 000, 000, 000, 000,
00143	118*	* 2.76, 2.73, 21.700, 2.98,
00143	119*	* 3.29, 2.40, 00, 00, 00, 00, 00, 00,
00143	120*	* 1.0785886E+1, -.10350823E-0, .23847383E-1,
00143	121*	* -2.6056655E-2, .13142932E-3, -.24513120E-5/
00145	122*	DATA(P(18,J),J=1,36)/ 39.948, 2HAR, 3.203, .245, 000,
00145	123*	* 4.192, 000, 000, 3.871, 38.400, 45.400,
00145	124*	* 41.700, 263.000, 000, 000, 000, 000, 000, 000,
00145	125*	* 2.75, 2.73, 36.900, 3.62,
00145	126*	* 3.86, 2.81, 1.02, 00, 00, 00, 00, 00,
00145	127*	* 1.0843163E+1, -.11171609E-0, .25877882E-1,
00145	128*	* -2.8357953E-2, .14327976E-3, -.26751186E-5/
00147	129*	DATA(P(19,J),J=1,36)/ 39.102, 2H K, 3.607, .294, 000,
00147	130*	* 3.741, 000, 000, 3.437, 33.400, 39.300,
00147	131*	* 36.400, 225.000, 000, 000, 000, 000, 000, 000,
00147	132*	* 2.75, 2.73, 42.500, 4.31,
00147	133*	* 4.49, 3.27, 1.04, 00, 00, 00, 00, 00,
00147	134*	* 1.0905924E+1, -.12063515E-0, .28167494E-1,
00147	135*	* -3.1023589E-2, .15726734E-3, -.29428020E-5/
00151	136*	DATA(P(20,J),J=1,36)/ 40.080, 2HCA, 4.038, .346, 000,
00151	137*	* 3.358, 36.330, 000, 3.070, 29.300, 34.300,
00151	138*	* 32.000, 194.000, 000, 000, 000, 000, 000, 000,
00151	139*	* 2.74, 2.73, 48.400, 5.10,
00151	140*	* 5.18, 3.77, 1.09, 00, 00, 00, 00, 00,
00151	141*	* 1.0957041E+1, -.12824494E-0, .30004781E-1,
00151	142*	* -3.3062601E-2, .16760103E-3, -.31357004E-5/
00153	143*	DATA(P(21,J),J=1,36)/ 44.956, 2HSC, 4.493, .402, 000,
00153	144*	* 3.031, 31.350, 000, 2.757, 25.800, 30.100,
00153	145*	* 28.300, 168.000, 000, 000, 000, 000, 000, 000,
00153	146*	* 2.74, 2.73, 55.100, 5.99,
00153	147*	* 5.93, 4.31, 1.16, 00, 00, 00, 00, 00,
00153	148*	* 1.1017056E+1, -.13696826E-0, .32247540E-1,
00153	149*	* -3.5671497E-2, .18128079E-3, -.3972774E-5/
00155	150*	DATA(P(22,J),J=1,36)/ 47.400, 2HTI, 4.966, .456, 000,
00155	151*	* 2.749, 27.420, 000, 2.497, 22.900, 26.600,
00155	152*	* 25.200, 147.000, 000, 000, 000, 000, 000, 000,
00155	153*	* 2.73, 2.73, 62.100, 7.00,

00155	154*	• 6.75, 4.90, 1.27, .00, .00, .00, .00, .00,
00155	155*	• .11071053E+1, -.14503819E-0, .34272999E-1,
00155	156*	• -.37984818E-2, .19324299E-3, -.36238298E-5/
00157	157*	DATA(P( 23,J),J=1,36)/ 50.942,2H V, 5.465, .513, .000,
00157	158*	• 2.504, 2.4250, .000, 2.269, 20.480, 23.700,
00157	159*	• 22.600,129.000, .000, .000, .000, .000, .000,
00157	160*	• 2.73,2.73, 69.800, 8.02,
00157	161*	• 7.64, 5.55, 1.90, .00, .00, .00, .00, .00,
00157	162*	• .1122885E+1, -.15291673E-0, -.34249910E-1,
00157	163*	• -.40240437E-2, .20490146E-3, -.38444978E-5/
00161	164*	DATA(P( 24,J),J=1,36)/ 51.996,2HCR, 5.989, .575, .000,
00161	165*	• 2.290, 21.640, .000, 2.070, 18.300, 21.200,
00161	166*	• 20.300,114.000, .000, .000, .000, .000, .000,
00161	167*	• 2.73,2.73, 78.000, 9.18,
00161	168*	• 8.60, 6.24, 1.55, .00, .00, .00, .00, .00,
00161	169*	• .11173811E+1, -.16072637E-0, .38216673E-1,
00161	170*	• -.42488985E-2, .21653707E-3, -.40649120E-5/
00163	171*	DATA(P( 25,J),J=1,36)/ 54.938,2HMN, 6.539, .640, .000,
00163	172*	• 2.102, 19.450, .000, 1.896, 16.500, 19.000,
00163	173*	• 18.900,101.000, .000, .000, .000, .000, .000,
00163	174*	• 2.72,2.73, 84.700, 10.45,
00163	175*	• 9.64, 6.99, 1.74, .00, .00, .00, .00, .00,
00163	176*	• .11228161E+1, -.16898721E-0, .40360369E-1,
00163	177*	• -.44993125E-2, .22969024E-3, -.43166765E-5/
00165	178*	DATA(P( 26,J),J=1,36)/ 55.847,2HFE, 7.112, .708, .000,
00165	179*	• 1.936, 17.590, .000, 1.743, 14.900, 17.100,
00165	180*	• 16.600, 90.400, .000, .000, .000, .000, .000,
00165	181*	• 2.72,2.73, 95.800, 11.75,
00165	182*	• 10.75, 7.79, 1.95, .00, .00, .00, .00, .00,
00165	183*	• .11276951E+1, -.17663497E-0, .42308399E-1,
00165	184*	• -.47238532E-2, .24135446E-3, -.45383431E-5/
00167	185*	DATA(P( 27,J),J=1,36)/ 58.933,2HCO, 7.709, .779, .000,
00167	186*	• 1.789, 15.972, .000, 1.608, 13.500, 15.300,
00167	187*	• 15.100, 81.000, .000, .000, .000, .000, .000,
00167	188*	• 2.71,2.73,105.500, 13.25,
00167	189*	• 11.94, 8.65, 2.17, 1.62, 1.33, 1.13, 1.21, .00,
00167	190*	• .11322651E+1, -.18398174E-0, .44157222E-1,
00167	191*	• -.49350709E-2, .25228900E-3, -.47453614E-5/
00171	192*	DATA(P( 28,J),J=1,36)/ 58.710,2HNI, 8.333, .855, .000,
00171	193*	• 1.658, 14.561, .000, 1.488, 12.300, 14.100,
00171	194*	• 13.800, 72.800, 89.800, .000, .000, .000, .000,
00171	195*	• 2.71,2.73,115.900, 14.80,
00171	196*	• 13.22, 9.57, 2.44, 1.83, 1.51, 1.27, 1.35, .00,
00171	197*	• .11371069E+1, -.19162685E-0, .46154723E-1,
00171	198*	• -.51685125E-2, .26454800E-3, -.49799246E-5/
00173	199*	DATA(P( 29,J),J=1,36)/ 63.540,2HCU, 8.979, .931, .000,
00173	200*	• 1.541, 13.336, .000, 1.380, 11.270, 12.800,
00173	201*	• 12.600, 65.800, 80.700, .000, .000, .000, .000,
00173	202*	• 2.71,2.73,126.800, 16.45,
00173	203*	• 14.06, 10.54, 2.73, 2.06, 1.70, 1.44, 1.50, .00,
00173	204*	• .11413851E+1, -.19865793E-0, .47943894E-1,
00173	205*	• -.53739138E-2, .27519651E-3, -.51818297E-5/
00175	206*	DATA(P( 30,J),J=1,36)/ 65.370,2HZN, 9.659, 1.020, .000,
00175	207*	• 1.435, 12.254, .000, 1.283, 10.330, 11.870,
00175	208*	• 11.600, 59.500, 72.800, .000, .000, .000, .000,
00175	209*	• 2.70,2.73,138.000, 18.25,
00175	210*	• 15.60, 11.20, 3.05, 2.31, 1.90, 1.61, 1.67, .00,
00175	211*	• .11459284E+1, -.20602679E-0, .49873140E-1,

00175	212	• 56000203E-2, 20708880E-3, 54095790E-5/
00177	213	DATA(P( 31,J),J=1,36)/ 69.720,2HGA,10.367, 1.115, 000,
00177	214	• 1.340, 1.292, 000, 1.196, 9.540, 10.930,
00177	215	• 11.100, 54.200, 65.900, 000, 000, 000, 000,
00177	216	• 2.70, 2.73, 149.800, 20.20,
00177	217	• 17.25, 12.40, 3.39, 2.58, 2.12, 1.80, 1.84, 00,
00177	218	• 1.1498995E+1, -2.1274740E-0, 5.1595230E-1,
00177	219	• -5.7985485E-2, 2.9740762E-3, -5.6055460E-5/
00201	220	DATA(P( 32,J),J=1,36)/ 72.590,2HGE,11.103, 1.217, 000,
00201	221	• 1.254, 10.436, 000, 1.117, 8.730, 9.940,
00201	222	• 10.190, 49.400, 59.900, 59.900, 87.200, 87.500,
00201	223	• 2.70, 2.73, 162.200, 22.15,
00201	224	• 10.55, 1.160, 3.78, 2.87, 2.36, 2.01, 2.63, 00,
00201	225	• 1.1536303E+1, -0.21919364E-0, 5.3240959E-1,
00201	226	• -5.9875809E-2, 3.0720397E-3, -5.7911966E-5/
00203	227	DATA(P( 33,J),J=1,36)/ 74.922,2HAS,11.867, 1.323, 000,
00203	228	• 1.176, 9.671, 000, 1.045, 8.107, 9.124,
00203	229	• 9.390, 45.100, 54.500, 54.500, 79.300, 79.600,
00203	230	• 2.67, 2.73, 175.400, 24.25,
00203	231	• 20.75, 14.90, 4.28, 3.18, 2.62, 2.23, 2.23, 00,
00203	232	• 1.1573725E+1, -0.22566962E-0, 5.4918893E-1,
00203	233	• -6.1823614E-2, 3.1737448E-3, -5.9849408E-5/
00205	234	DATA(P( 34,J),J=1,36)/ 78.960,2HSE,12.658, 1.436, 000,
00205	235	• 1.105, 8.990, 000, 0.980, 7.506, 8.416,
00205	236	• 8.670, 41.400, 47.800, 49.800, 72.400, 72.700,
00205	237	• 2.69, 2.73, 189.400, 26.40,
00205	238	• 22.55, 16.20, 4.69, 3.52, 2.90, 2.46, 2.45, 00,
00205	239	• 1.1614038E+1, -0.23259068E-0, 5.6772836E-1,
00205	240	• -6.4026937E-2, 3.2906607E-3, -6.2101708E-5/
00207	241	DATA(P( 35,J),J=1,36)/ 79.909,2HBR,13.474, 1.550, 000,
00207	242	• 1.040, 8.975, 000, 0.920, 6.970, 7.800,
00207	243	• 8.000, 38.000, 45.600, 45.600, 66.200, 66.500, 435.000,
00207	244	• 2.69, 2.73, 205.000, 28.80,
00207	245	• 24.60, 17.70, 5.13, 3.88, 3.20, 2.72, 2.67, 00,
00207	246	• 1.1647587E+1, -0.23852879E-0, 5.8300775E-1,
00207	247	• -6.5788478E-2, 3.3821259E-3, -6.3836742E-5/
00211	248	DATA(P( 36,J),J=1,36)/ 82.800,2HKR,14.326, 1.675, 000,
00211	249	• 0.980, 7.817, 000, 0.866, 6.460, 7.210,
00211	250	• 7.430, 35.000, 41.900, 41.900, 60.700, 61.000, 388.000,
00211	251	• 2.68, 2.73, 219.300, 31.25,
00211	252	• 26.90, 19.15, 5.60, 4.26, 3.52, 2.99, 2.91, 00,
00211	253	• 1.1691128E+1, -0.24456573E-0, 5.9884880E-1,
00211	254	• -6.7641085E-2, 3.4793024E-3, -6.5693448E-5/
00213	255	DATA(P( 37,J),J=1,36)/ 85.470,2HRB,15.200, 1.804, 110,
00213	256	• 9.26, 7.318, 000, 0.816, 5.998, 6.643,
00213	257	• 6.890, 32.400, 38.600, 38.600, 55.700, 56.000, 347.000,
00213	258	• 2.68, 2.73, 235.500, 33.90,
00213	259	• 28.80, 20.80, 6.10, 4.68, 3.86, 3.28, 3.17, 00,
00213	260	• 1.1709929E+1, -0.25004494E-0, 6.1292183E-1,
00213	261	• -6.9259219E-2, 3.5631424E-3, -6.7281844E-5/
00215	262	DATA(P( 38,J),J=1,36)/ 87.620,2HSR,16.105, 1.940, 133,
00215	263	• 8.75, 6.863, 000, 0.770, 5.583, 6.172,
00215	264	• 6.387, 29.900, 35.600, 35.600, 51.300, 51.600, 312.000,
00215	265	• 2.68, 2.73, 251.300, 36.50,
00215	266	• 31.20, 22.40, 6.62, 5.12, 4.22, 3.59, 3.44, 00,
00215	267	• 1.1741581E+1, -0.25685365E-0, 6.2832654E-1,
00215	268	• -7.1071908E-2, 3.6585727E-3, -6.9109110E-5/
00217	269	DATA(P( 39,J),J=1,36)/ 88.905,2HY,17.038, 2.080, 157,

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00217 270 \* .828, 6.449, .000, .728, 5.232, 6.755  
00217 271 \* 5.961, 27.800, 32.900, 32.900, 47.400, 47.700, 280.000  
00217 272 \* 2.67, 2.73, 268.108, 39.30  
00217 273 \* 33.50, 24.0, 7.18, 5.58, 4.61, 3.92, 3.73, .00  
00217 274 \* .1770344E+1, -.26131707E-0, .64271033E-1  
00217 275 \* -.72754659E-2, .37467899E-3, -.70793358E-5/  
00221 276 DATA(P( 40,J),J=1,36)/ 91.220,2HR,17.998, 2.22, .180  
00221 277 \* .786, 6.071, .000, .000, 4.867, 5.378,  
00221 278 \* 5.538, 25.800, 30.400, 30.400, 43.800, 44.100, 253.000  
00221 279 \* .00, 2.73, .000, 42.30,  
00221 280 \* 36.15, 25.95, 7.78, 6.08, 5.02, 4.28, 4.03, 4.71,  
00221 281 \* .11796608E+1, -.26647782E-0, .65619469E-1  
00221 282 \* .74320920E-2, .38284436E-3, -.72346211E-6/  
00223 283 DATA(P( 41,J),J=1,36)/ 92.906,2HNB,18.986, 2.371, .205,  
00223 284 \* .746, 5.724, .000, .000, 4.581, 5.026,  
00223 285 \* 5.223, 24.000, 28.200, 28.200, 40.600, 40.900, 229.000,  
00223 286 \* .00, 2.73, .000, 45.50,  
00223 287 \* 38.90, 21.90, 8.39, 6.61, 5.46, 4.65, 4.34, 4.99,  
00223 288 \* .11822348E+1, -.2757331E-0, .66965759E-1  
00223 289 \* -.75897910E-2, .39181497E-3, -.73925412E-5/  
00225 290 DATA(P( 42,J),J=1,36)/ 95.940,2HMO,20.000, 2.520, .227,  
00225 291 \* .709, 5.407, .000, .000, 4.298, 4.718,  
00225 292 \* 4.913, 22.400, 26.380, 26.380, 37.700, 38.000, 208.000,  
00225 293 \* .00, 2.72, .000, 48.50,  
00225 294 \* 41.4, 24.75, .005, 7.17, 5.42, 5.05, 4.68, 5.28,  
00225 295 \* .11345522E+1, -.27685940E-0, .68213642E-1,  
00225 296 \* -.77345334E-2, .39865100E-3, -.75356802E-5/  
00227 297 DATA(P( 43,J),J=1,36)/ 99.000,2HTC,21.044, 2.677, .253,  
00227 298 \* .675, 5.015, .030, .000, 4.000, 4.436,  
00227 299 \* 4.632, 20.900, 24.400, 24.400, 35.000, 35.300, 189.000,  
00227 300 \* .00, 2.72, .000, 52.10,  
00227 301 \* 44.50, 31.95, 9.74, 7.75, 6.41, 5.47, 5.03, 5.58,  
00227 302 \* .11865511E+1, -.28073108E-0, .69337845E-1,  
00227 303 \* -.78629479E-2, .40525687E-3, -.76600245E-5/  
00231 304 DATA(P( 44,J),J=1,36)/ 101.070,2HRU,22.117, 2.838, .279,  
00231 305 \* .643, 4.846, .000, .000, 3.830, 4.180,  
00231 306 \* 4.369, 19.500, 22.800, 22.800, 32.600, 32.900, 172.600,  
00231 307 \* .00, 2.72, .000, 55.60,  
00231 308 \* 47.50, 34.10, 10.47, 8.39, 6.93, 5.91, 5.39, 5.88,  
00231 309 \* .11891661E+1, -.28582484E-0, .70728004E-1,  
00231 310 \* -.80292821E-2, .41410560E-3, -.78306457E-5/  
00233 311 DATA(P( 45,J),J=1,36)/ 102.905,2HRH,23.220, 3.004, .307,  
00233 312 \* .613, 4.597, .000, .000, 3.626, 3.942,  
00233 313 \* 4.130, 18.300, 21.300, 21.400, 30.500, 30.800, 157.000,  
00233 314 \* .00, 2.72, .000, 59.30,  
00233 315 \* 50.70, 36.40, 11.24, 9.05, 7.47, 6.38, 5.78, 6.20,  
00233 316 \* .11910248E+1, -.29001153E-0, .71813822E-1,  
00233 317 \* -.81541762E-2, .42055990E-3, -.79525062E-5/  
00235 318 DATA(P( 46,J),J=1,36)/ 104.400,2HPD,24.350, 3.173, .335,  
00235 319 \* .585, 4.368, .000, .000, 3.428, 3.724,  
00235 320 \* 3.908, 17.200, 19.900, 20.200, 28.500, 28.800, 144.000,  
00235 321 \* .00, 2.72, .000, 63.10,  
00235 322 \* 53.95, 38.70, 12.03, 9.74, 8.05, 6.87, 6.18, 6.52,  
00235 323 \* .11927643E+1, -.29403836E-0, .72858036E-1,  
00235 324 \* .82741678E-2, .42675529E-3, -.80694272E-5/  
00237 325 DATA(P( 47,J),J=1,36)/ 107.870,2HAG,25.514, 3.351, .367,  
00237 326 \* .559, 4.154, .000, .000, 3.254, 3.514,  
00237 327 \* 3.698, 16.100, 18.700, 19.000, 26.600, 26.900, 132.000,

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00237 328 \* .00,2.71, .000, 67.30,  
00237 329 \* 57.50, 41.30, 12.87, 10.47, 8.65, 7.39, 6.60, 6.86,  
00237 330 \* .11947527E+1, -.29833812E-0, .74010313E-1,  
00237 331 \* -.84098317E-2, .43388270E-3, -.82056113E-5/  
00241 332 DATA(P( 48,J),J=1,36)/112.400,2HCO,26.711, 3.538, .404,  
00241 333 \* .535, 3.956, .000, .000, 3.085, 3.324,  
00241 334 \* 3.504, 15.200, 17.500, 17.900, 25.000, 25.300, 121.000,  
00241 335 \* .00,2.71, .000, 71.00,  
00241 336 \* 60.70, 43.60, 13.76, 11.24, 9.29, 7.94, 7.04, 7.20,  
00241 337 \* .11963425E+1, -.30214036E-0, .74997902E-1,  
00241 338 \* .65231364E-2, .43972116E-3, -.83155519E-5/  
00243 339 DATA(P( 49,J),J=1,36)/114.820,2HIN,27.940, 3.730, .443,  
00243 340 \* .512, 3.772, .000, .000, 2.926, 3.147,  
00243 341 \* 3.324, 14.300, 16.500, 16.900, 23.400, 23.700, 111.000,  
00243 342 \* .00,2.71, .000, 75.50,  
00243 343 \* 64.50, 46.30, 14.68, 12.05, 9.96, 8.51, 7.50, 7.55,  
00243 344 \* .11979666E+1, -.30597371E-0, .76011181E-1,  
00243 345 \* -.86410679E-2, .44586184E-3, -.84321082E-5/  
00245 346 DATA(P( 50,J),J=1,36)/118.690,2HSNT,29.200, 3.729, .485,  
00245 347 \* .491, 3.600, .000, .000, 2.777, 2.982,  
00245 348 \* 3.156, 13.500, 15.500, 16.000, 22.000, 22.300, 102.000,  
00245 349 \* .00,2.71, .000, 79.60,  
00245 350 \* 68.00, 48.80, 15.65, 12.90, 10.66, 9.12, 7.98, 7.92,  
00245 351 \* .11993437E+1, -.30948490E-0, .76919675E-1,  
00245 352 \* .87447912E-2, .45119225E-3, -.85319507E-5/  
00247 353 DATA(P( 51,J),J=1,36)/121.750,2HSB,30.491, 4.132, .528,  
00247 354 \* .470, 3.439, .000, .000, 2.639, 2.830,  
00247 355 \* 3.000, 12.700, 14.600, 15.100, 20.700, 21.000, 94.500,  
00247 356 \* .00,2.70, .000, 84.20,  
00247 357 \* 71.95, 51.70, 16.66, 13.79, 11.40, 9.75, 8.48, 8.29,  
00247 358 \* .12009430E+1, -.31323344E-0, .77921033E-1,  
00247 359 \* -.88619739E-2, .45730267E-3, -.86483224E-5/  
00251 360 DATA(P( 52,J),J=1,36)/127.600,2HTE,31.814, 4.341, .572,  
00251 361 \* .000, 3.289, .000, .000, 2.511, 2.687,  
00251 362 \* 2.855, 12.000, 13.700, 14.300, 19.500, 19.800, 87.400,  
00251 363 \* .00,2.70, .000, 88.50,  
00251 364 \* 75.65, 54.30, 17.72, 14.73, 12.17, 10.42, 9.00, 8.67,  
00251 365 \* .12018719E+1, -.31616079E-0, .78646660E-1,  
00251 366 \* -.89414455E-2, .46124193E-3, -.87202734E-5/  
00253 367 DATA(P( 53,J),J=1,36)/126.904,2H I,33.169, 4.557, .619,  
00253 368 \* .000, 3.149, .000, .000, 2.389, 2.553,  
00253 369 \* 2.719, 11.400, 13.000, 13.600, 18.400, 18.600, 89.900,  
00253 370 \* .00,2.70, .000, 94.00,  
00253 371 \* 80.35, 57.70, 18.82, 15.70, 12.98, 11.11, 9.54, 9.07,  
00253 372 \* .12033234E+1, -.31969351E-0, .79586506E-1,  
00253 373 \* -.90510771E-2, .46695024E-3, -.88285360E-5/  
00255 374 DATA(P( 54,J),J=1,36)/131.300,2HxE,34.561, 4.782, .672,  
00255 375 \* .000, 3.017, .000, .000, 2.274, 2.429,  
00255 376 \* 2.592, 10.800, 12.300, 12.900, 17.300, 17.600, 75.800,  
00255 377 \* .00,2.69, .000, 98.30,  
00255 378 \* 84.90, 60.30, 19.97, 16.72, 13.82, 11.84, 10.11, 9.47,  
00255 379 \* .12043484E+1, -.32269275E-0, .80351472E-1,  
00255 380 \* -.91369972E-2, .47129416E-3, -.89091136E-5/  
00257 381 DATA(P( 55,J),J=1,36)/132.905,2H(C,35.985, 5.012, .726,  
00257 382 \* .000, 2.893, .000, .000, 2.167, 2.314,  
00257 383 \* 2.474, 10.202, 11.600, 12.300, 16.400, 16.700, 69.600,  
00257 384 \* .00,2.69, .000, 103.40,  
00257 385 \* 88.40, 63.44, 21.16, 18.20, 14.70, 12.60, 10.69, 9.88,

00257 386 • -12050486E+1, -32530850E-0, -80988977E-1,  
00257 387 • -.92051588E-2, .47460641E-3, -.89685973E-5/  
00261 388 DATA(P(56,J),J=1,36)/137.340,2HBA,37.441, 5.247, .781,  
00261 389 • .000, 2.776, .000, .000, 2.068, 2.204,  
00261 390 • 2.363, 9.557, 10.845, 11.700, 15.500, 15.800, 64.700,  
00261 391 • .00,2.69, .000,109.00,  
00261 392 • 93.15, 6.90, 22.41, 19.30, 16.08, 13.48, 11.30, 10.33,  
00261 393 • .12067242E+1, -.32900286E-0, .82008362E-1,  
00261 394 • -.93273968E-2, .48108562E-3, -.90930444E-5/  
00263 395 DATA(P(57,J),J=1,36)/138.910,2HLA,38.925, 5.483, .832,  
00263 396 • .000, -2.646, 14.880, .000, 1.973, 2.103,  
00263 397 • 2.258, 9.042, 10.321, 11.100, 14.700, 15.300, 60.200,  
00263 398 • .88,2.68, -.000,114.48,  
00263 399 • 97.80, 70.20, 23.70, 20.40, 16.90, 14.23, 11.93, 10.77,  
00263 400 • .12073441E+1, -.33145458E-0, .82601011E-1,  
00263 401 • -.93905069E-2, .48413151E-3, -.91473894E-5/  
00265 402 DATA(P(58,J),J=1,36)/140.120,2HCE,40.443, 5.723, .883,  
00265 403 • .000, 2.562, 14.040, .000, 1.889, 2.011,  
00265 404 • 2.164, 8.614, 9.697, 10.488, 13.900, 14.288, 56.100,  
00265 405 • .00,2.68, .000,120.60,  
00265 406 • 102.58, 73.60, 25.05, 21.60, 17.90, 15.50, 12.58, 11.21,  
00265 407 • .12081738E+1, -.33412713E-0, .83274484E-1,  
00265 408 • -.94649978E-2, .48784260E-3, -.92153705E-5/  
00267 409 DATA(P(59,J),J=1,36)/140.907,2HPR,41.991, 5.964, .931,  
00267 410 • .000, 2.463, 13.343, .000, 1.811, 1.924,  
00267 411 • 2.077, 8.188, 9.258, 9.957, 13.200, 13.500, 52.400,  
00267 412 • .00,2.68, .000,125.50,  
00267 413 • 107.30, 77.00, 26.47, 22.80, 18.90, 16.30, 13.26, 11.66,  
00267 414 • .12092009E+1, -.33701009E-0, .84027708E-1,  
00267 415 • -.95508844E-2, .49222610E-3, -.92971968E-5/  
00271 416 DATA(P(60,J),J=1,36)/144.240,2HND,43.669, 6.207, .978,  
00271 417 • .000, 2.370, 12.680, .000, 1.735, 1.843,  
00271 418 • 1.995, 7.831, 8.773, 9.499, 12.500, 12.800, 48.900,  
00271 419 • .00,2.67, .000,132.00,  
00271 420 • 112.80, 81.00, 27.93, 24.10, 20.00, 17.20, 13.96, 12.13,  
00271 421 • .12099524E+1, -.33954793E-0, .84664822E-1,  
00271 422 • -.96289422E-2, .49569714E-3, -.93804813E-5/  
00273 423 DATA(P(61,J),J=1,36)/147.000,2HPH,45.184, 6.459, 1.027,  
00273 424 • .000, 2.282, 12.000, .000, 1.665, 1.767,  
00273 425 • 1.918, 7.513, 8.376, 9.115, 11.900, 12.200, 45.800,  
00273 426 • .00,2.67, .000,138.50,  
00273 427 • 118.50, 85.00, 29.44, 25.40, 21.00, 18.20, 14.69, 12.60,  
00273 428 • .12105265E+1, -.34185231E-0, .85223556E-1,  
00273 429 • -.96803457E-2, .49855048E-3, -.94111665E-5/  
00275 430 DATA(P(62,J),J=1,36)/150.350,2HSH,46.834, 6.716, 1.080,  
00275 431 • .000, 2.200, 11.470, .000, 1.599, 1.703,  
00275 432 • 1.845, 7.178, 8.023, 8.705, 11.300, 11.600, 42.800,  
00275 433 • .00,2.67, .000,143.50,  
00275 434 • 122.50, 88.00, 31.01, 26.70, 22.20, 19.10, 15.44, 13.09,  
00275 435 • .12112732E+1, -.34432930E-0, .85842550E-1,  
00275 436 • -.97478889E-2, .50187181E-3, -.94713023E-5/  
00277 437 DATA(P(63,J),J=1,36)/151.960,2HEU,48.519, 6.977, 1.131,  
00277 438 • .000, 2.121, 10.960, .000, 1.536, 1.626,  
00277 439 • 1.775, 6.856, 7.642, 8.331, 10.604, 10.893, 40.100,  
00277 440 • .00,2.66, .000,150.00,  
00277 441 • 128.00, 92.00, 32.63, 28.10, 23.30, 20.10, 16.22, 13.85,  
00277 442 • .12120667E+1, -.34684891E-0, .86483300E-1,  
00277 443 • -.98189600E-2, .50541107E-3, -.95360529E-5/

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00301	444	DATA(P( 64,J),J=1,36)/157.250,2460,50.239, 7.243, 1.185,
00301	445	• .000, 2.047, 10.460, .000, 1.477, 1.561,
00301	446	• 1.710, 6.566, 7.322, 7.997, 10.111, 10.408, 37.700,
00301	447	• .00,2.66, .000,157.00,
00301	448	• 134.00, 96.30, 34.31, 29.60, 24.50, 21.20, 17.02, 14.30,
00301	449	• .12127247E+1, -.34919322E-0, .87066293E-1,
00301	450	• .78022415E-2, .50850472E-3, -.95918031E-5/
00303	451	DATA(P( 65,J),J=1,36)/158.924,2478,51.996, 7.514, 1.241,
00303	452	• .000, 1.977, 10.000, .000, 1.421, 1.501,
00303	453	• 1.649, 6.292, 7.011, 7.685, 9.692, 9.957, 35.400,
00303	454	• .00,2.65, .000,163.50,
00303	455	• 140.00,100.30, 36.06, 31.10, 25.80, 22.30, 17.85, 14.80,
00303	456	• .12127314E+1, -.35074627E-0, .87372184E-1,
00303	457	• -.99069886E-2, .50934800E-3, -.96014292E-5/
00305	458	DATA(P( 66,J),J=1,36)/162.500,240Y,53.789, 7.790, 1.295,
00305	459	• .000, 1.909, 9.590, .000, 1.365, 1.438,
00305	460	• 1.579, 6.088, 6.715, 7.383, 9.258, 9.528, 33.200,
00305	461	• .00,2.65, .000,170.50,
00305	462	• 146.00,164.50, 37.85, 32.60, 27.00, 23.40, 18.70, 15.30,
00305	463	• .12133589E+1, -.35301358E-0, .87932110E-1,
00305	464	• -.99672005E-2, .51226374E-3, -.96535232E-5/
00307	465	DATA(P( 67,J),J=1,36)/164.930,2400,55.618, 8.071, 1.351,
00307	466	• .000, 1.845, 9.200, .000, 1.317, 1.390,
00307	467	• 1.535, 5.820, 6.453, 7.128, 8.899, 9.155, 31.300,
00307	468	• .00,2.65, .000,176.50,
00307	469	• 151.00,108.50, 39.76, 34.30, 28.50, 24.50, 19.59, 15.85,
00307	470	• .12139149E+1, -.35518014E-0, .88459015E-1,
00307	471	• -.10022942E-1, .51492197E-3, -.97003804E-5/
00311	472	DATA(P( 68,J),J=1,36)/167.260,2408,57.486, 8.358, 1.409,
00311	473	• .000, 1.784, 8.820, .000, 1.268, 1.338,
00311	474	• 1.482, 5.501, 6.174, 6.834, 8.508, 8.773, 29.500,
00311	475	• .00,2.64, .000,184.00,
00311	476	• 157.00,113.00, 41.69, 35.90, 29.80, 25.70, 20.50, 16.30,
00311	477	• .12146044E+1, -.35747802E-0, .89032710E-1,
00311	478	• -.10086203E-1, .51795901E-3, -.97549555E-5/
00313	479	DATA(P( 69,J),J=1,36)/168.934,2404,59.390, 8.648, 1.468,
00313	480	• .000, 1.727, 8.480, .000, 1.221, 1.288,
00313	481	• 1.433, 5.366, 5.931, 6.559, 8.155, 8.433, 27.800,
00313	482	• .00,2.64, .000,192.50,
00313	483	• 165.00,118.00, 43.69, 37.70, 31.20, 27.00, 21.44, 16.85,
00313	484	• .12148819E+1, -.35927922E-0, .89432538E-1,
00313	485	• -.10123145E-1, .51957020E-3, -.97802340E-5/
00315	486	DATA(P( 70,J),J=1,36)/173.040,2408,61.332, 8.944, 1.528,
00315	487	• .000, 1.672, 8.149, .000, 1.182, 1.243,
00315	488	• 1.386, 5.161, 5.686, 6.331, 7.836, 8.086, 26.200,
00315	489	• .00,2.63, .000,199.00,
00315	490	• 170.00,122.00, 45.79, 39.60, 32.70, 28.30, 22.40, 17.45,
00315	491	• .12153540E+1, -.36129034E-0, .89909077E-1,
00315	492	• -.10172036E-1, .52162912E-3, -.98188948E-5/
00317	493	DATA(P( 71,J),J=1,36)/174.970,2400,63.314, 9.244, 1.589,
00317	494	• .000, 1.620, 7.840, .000, 1.140, 1.199,
00317	495	• 1.341, 4.972, 5.475, 6.112, 7.545, 7.777, 24.700,
00317	496	• .00,2.63, .000,206.00,
00317	497	• 176.00,126.00, 47.92, 41.30, 34.20, 29.60, 23.40, 18.00,
00317	498	• .12156497E+1, -.36307693E-0, .90307117E-1,
00317	499	• -.10209896E-1, .52343868E-3, -.98441733E-5/
00321	500	DATA(P( 72,J),J=1,36)/178.90,2404,65.351, 9.561, 1.662,
00321	501	• .000, 1.570, 7.539, .000, 1.100, 1.155,

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00321 502 \* 1.273, 4.753, 5.211, 5.861, 7.190, 7.427, 23.400,  
00321 503 \* .00, 2.62, .000, 214.00,  
00321 504 \* 1.03, 0.0, 1.31, 0.0, 5.0, 1.3, 4.3, 2.0, 3.5, 8.0, 3.0, 9.0, 2.4, 4.3, 1.8, 5.5,  
00321 505 \* .12154608E+1, -.36428607E-0, .90505064E-1,  
00321 506 \* .10220122E-1, .52344101E-3, -.98366072E-5/  
00323 507 DATA(P( 73,J),J=1,36)/180.948,2HTA,57.916, 9.881, 1.735,  
00323 508 \* .000, 1.523, 7.252, .000, 1.061, 1.114,  
00323 509 \* 1.255, 4.569, 5.015, 5.637, 6.898, 7.128, 4.100,  
00323 510 \* .00, 2.62, .000, 222.00,  
00323 511 \* 1.90, 0.0, 1.36, 0.0, 5.2, 4.4, 4.5, 2.0, 3.7, 5.0, 3.2, 4.0, 2.5, 4.8, 1.9, 0.5,  
00323 512 \* .12159710E+1, -.36629272E-0, .90982914E-1,  
00323 513 \* .10269132E-1, .52569993E-3, -.98751425E-5/  
00325 514 DATA(P( 74,J),J=1,36)/183.850,2HW,69.525,10.267, 1.809,  
00325 515 \* .000, 1.476, 6.983, .000, 1.025, 1.075,  
00325 516 \* 1.216, 4.405, 4.823, 5.751, 6.640, 6.871, 20.900,  
00325 517 \* .00, 2.61, .000, 231.00,  
00325 518 \* 1.97, 0.0, 1.42, 0.0, 5.4, 7.9, 4.7, 2.0, 3.9, 1.0, 3.3, 8.0, 2.6, 5.7, 1.9, 6.6,  
00325 519 \* .12160664E+1, -.36780047E-0, .91288388E-1,  
00325 520 \* .10274393E-1, .52658096E-3, -.98855744E-5/  
00327 521 DATA(P( 75,J),J=1,36)/186.200,2HRE,71.676,10.535, 1.883,  
00327 522 \* .000, 1.433, 6.729, .000, 1.790, 1.037,  
00327 523 \* 1.177, 4.231, 4.625, 5.253, 6.357, 6.594, 19.800,  
00327 524 \* .00, 2.61, .000, 239.00,  
00327 525 \* 2.04, 0.0, 1.47, 0.0, 5.7, 2.1, 4.9, 3.0, 4.0, 9.0, 3.5, 3.0, 2.7, 6.8, 2.0, 1.0,  
00327 526 \* .12162924E+1, -.36744044E-0, .91638446E-1,  
00327 527 \* .10325529E-1, .52778749E-3, -.99024310E-5/  
00331 528 DATA(P( 76,J),J=1,36)/190.200,2HOS,73.870,10.871, 1.960,  
00331 529 \* .000, 1.391, 6.490, .000, .956, 1.001,  
00331 530 \* 1.140, 4.064, 4.443, 5.060, 6.106, 6.357, 18.800,  
00331 531 \* .00, 2.60, .000, 247.00,  
00331 532 \* 2.11, 0.0, 1.52, 0.0, 5.9, 7.0, 5.1, 6.0, 4.2, 6.0, 3.6, 9.0, 2.8, 8.3, 2.0, 4.5,  
00331 533 \* .12164927E+1, -.37103456E-0, .91975689E-1,  
00331 534 \* .10395104E-1, .52891276E-3, -.99177405E-5/  
00333 535 DATA(P( 77,J),J=1,36)/192.200,2HIR,76.111,11.215, 2.040,  
00333 536 \* .000, 1.351, 6.262, .000, .923, .967,  
00333 537 \* 1.106, 3.915, 4.273, 4.873, 5.880, 6.094, 17.800,  
00333 538 \* .00, 2.60, .000, 256.00,  
00333 539 \* 2.19, 0.0, 1.57, .7, 6.2, 2.7, 5.3, 7.0, 4.4, 5.0, 3.8, 4.0, 3.0, 0.1, 2.1, 3.5,  
00333 540 \* .1216448, 1, -.37232566E-0, .92286717E-1,  
00333 541 \* .10389834E-1, .52916608E-3, -.99150839E-5/  
00335 542 DATA(P( 78,J),J=1,36)/195.090,2HPT,78.395,11.564, 2.122,  
00335 543 \* .000, 1.313, 6.097, .000, .893, .934,  
00335 544 \* 1.072, 3.774, 4.114, 4.710, 5.665, 5.888, 16.900,  
00335 545 \* .00, 2.59, .000, 263.00,  
00335 546 \* 2.25, 0.0, 1.61, 0.0, 6.4, 9.2, 5.6, 0.0, 4.6, 4.0, 4.0, 1.0, 3.1, 2.2, 2.1, 9.5,  
00335 547 \* .12166262E+1, -.37385374E-0, .92521310E-1,  
00335 548 \* .104076112E-1, .53008972E-3, -.99261415E-5/  
00337 549 DATA(P( 79,J),J=1,36)/196.967,2HAU,80.725,11.919, 2.206,  
00337 550 \* .000, 1.276, 5.840, .000, .863, .903,  
00337 551 \* 1.040, 3.620, 3.939, 4.522, 5.415, 5.629, 16.000,  
00337 552 \* .00, 2.59, .000, 272.00,  
00337 553 \* 2.32, 0.0, 1.67, 0.0, 6.7, 6.4, 5.8, 3.0, 4.8, 3.0, 4.1, 8.0, 3.2, 4.7, 2.2, 5.0,  
00337 554 \* .12166537E+1, -.37506962E-0, .92727244E-1,  
00337 555 \* .10407273E-1, .53013023E-3, -.99190720E-5/  
00341 556 DATA(P( 80,J),J=1,36)/200.590,2HMG,83.102,12.284, 2.295,  
00341 557 \* .000, 1.241, 5.648, .000, .835, .872,  
00341 558 \* 1.008, 3.482, 3.779, 4.349, 5.280, 5.413, 15.200,  
00341 559 \* .00, 2.58, .000, 281.00,

00341	568	*240.00,172.00, 70.55, 60.40, 50.48, 43.60, 33.74, 23.10,
00341	561	*.12168427E+1, -.37668729E-0, .93074918E-1,
00341	562	*.10438059E-1, .53130952E-3, -.99352219E-5/
00343	563	DATA(P( 81,J),J=1,361/204.370,2HTL,85.530,12.658, 2.389,
00343	564	*.000, 1.207, 5.460, .000, .000, .843,
00343	565	*.979, 3.349, 3.632, 4.201, 4.998, 5.200, 14.500,
00343	566	*.00,2.56, .000,289.00,
00343	567	*247.00,177.00, 73.60, 63.50, 52.60, 45.40, 35.05, 23.80,
00343	568	*.12163708E+1, -.37738162E-0, .93097798E-1,
00343	569	*.10423575E-1, .52983896E-3, -.98970304E-5/
00345	570	DATA(P( 82,J),J=1,361/207.190,2HPB,88.004,13.035, 2.484,
00345	571	*.000, 1.175, 5.286, .000, .782, .815,
00345	572	*.950, 3.218, 3.484, 4.042, 4.797, 4.994, 13.800,
00345	573	*.00,2.57, .000,298.00,
00345	574	*255.00,183.00, 76.64, 66.10, 54.70, 47.30, 36.40, 24.40,
00345	575	*.12165289E+1, -.37879550E-0, .93375385E-1,
00345	576	*.10444440E-1, .53043012E-3, -.99009676E-5/
00347	577	DATA(P( 83,J),J=1,361/208.980,2HBI,90.526,13.419, 2.580,
00347	578	*.000, 1.144, 5.118, .000, .757, .789,
00347	579	*.923, 3.099, 3.355, 3.902, 4.612, 4.808, 13.100,
00347	580	*.00,2.56, .000,307.00,
00347	581	*262.00,188.00, 79.94, 68.90, 57.10, 49.30, 37.78, 25.10,
00347	582	*.12163048E+1, -.37972516E-0, .93481243E-1,
00347	583	*.10441240E-1, .52960776E-3, -.98756701E-5/
00351	584	DATA(P( 84,J),J=1,361/210.000,2HPD,93.105,13.814, 2.683,
00351	585	*.000, 1.114, .000, .000, .732, .763,
00351	586	*.897, 2.997, 3.228, 3.768, 4.443, 4.625, 12.500,
00351	587	*.00,2.56, .000,316.00,
00351	588	*270.00,194.00, 83.51, 72.00, 59.70, 51.60, 39.19, 25.80,
00351	589	*.12162142E+1, -.38078475E-0, .9363544 E-1,
00351	590	*.10444839E-1, .52918168E-3, -.98580644E-5/
00353	591	DATA(P( 85,J),J=1,361/210.000,2HAT,95.730,14.214, 2.787,
00353	592	*.000, 1.085, .000, .000, .709, .739,
00353	593	*.872, 2.876, 3.099, 3.635, 4.274, 4.459, 11.900,
00353	594	*.00,2.55, .000,325.00,
00353	595	*278.00,199.00, 87.27, 75.20, 62.30, 53.90, 40.64, 26.60,
00353	596	*.12159491E+1, -.38159627E-0, .93700707E-1,
00353	597	*.10435835E-1, .52801124E-3, -.98265155E-5/
00355	598	DATA(P( 86,J),J=1,361/222.000,2HRN,98.404,14.619, 2.892,
00355	599	*.000, 1.057, .000, .000, .000, .715,
00355	600	*.848, 2.767, 2.987, 3.512, 4.118, 4.304, 11.400,
00355	601	*.00, .00, .000, .00,
00355	602	*288.00,204.00, 91.21, 78.50, 65.20, 56.30, 42.12, 27.40,
00355	603	*.12157031E+1, -.38245738E-0, .93781710E-1,
00355	604	*.10428660E-1, .52693137E-3, -.97957573E-5/
00357	605	DATA(P( 87,J),J=1,361/223.000,2HFR,99.999,15.031, 3.000,
00357	606	*.000, 1.030, .000, .000, .000, .000,
00357	607	*.825, 2.672, 2.876, 3.387, 3.960, 4.146, 10.900,
00357	608	*.00, .00, .000, .00,
00357	609	*.00,210.00, 95.35, 82.20, 68.10, 58.90, 43.64, 28.30,
00357	610	*.12154980E+1, -.38317627E-0, .93812287E-1,
00357	611	*.10414340E-1, .52542775E-3, -.97562306E-5/
00361	612	DATA(P( 88,J),J=1,361/226.000,2HRA,99.999,15.444, 3.105,
00361	613	*.000, 1.005, .000, .000, .000, .000,
00361	614	*.803, 2.577, 2.773, 3.279, 3.826, 4.012, 10.330,
00361	615	*.00, .00, .000, .00,
00361	616	*.00, .00, 99.70, 86.00, 71.20, 61.50, 45.20, 29.60,
00361	617	*.12152710E+1, -.38389122E-0, .93841732E-1,

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00361	610	* +10399787E-1, +52389489E-3, +97160320E-5/
00363	619	DATA(P( 89,J),J=1,36)/227.000,2HAC,99.999,15.871, 3.219,
00363	620	* +000, +980, +000, +000, +000, +000,
00363	621	* +782, 2.484, 2.672, 3.170, 3.689, 3.874, 9.917,
00363	622	* +00, +00, +000, +00,
00363	623	* +00, +00,104.30, 89.90, 74.50, 64.40, 46.80, 30.80,
00363	624	* +12147446E+1, +38422579E-0, +93736649E-1,
00363	625	* +10366131E-1, +52125077E-3, +96528447E-5/
00365	626	DATA(P( 90,J),J=1,36)/232.038,2HTH,99.999,16.300, 3.332,
00365	627	* +000, +956, 4.138, +000, +000, +000,
00365	628	* +761, 2.401, 2.577, 3.080, 3.573, 3.745, 9.492,
00365	629	* +00, +00, +000, +00,
00365	630	* +00, +00,109.40, 74.30, 78.10, 67.50, 48.43, 31.30,
00365	631	* +12144461E+1, +38470334E-0, +93676150E-1,
00365	632	* +10338165E-1, +51890803E-3, +9595593E-5/
00367	633	DATA(P( 91,J),J=1,36)/231.000,2HPA,99.999,16.733, 3.442,
00367	634	* +000, +933, 4.022, +000, +000, +000,
00367	635	* +741, 2.313, 2.479, 2.980, 3.443, 3.614, 9.048,
00367	636	* +00, +00, +000, +00,
00367	637	* +00, +00,114.50, 98.70, 81.80, 70.70, 50.10, 32.40,
00367	638	* +12141867E+1, +38518625E-0, +93618155E-1,
00367	639	* +10310382E-1, +51656738E-3, +95381638E-5/
00371	640	DATA(P( 92,J),J=1,36)/238.030,2H U,99.999,17.166, 3.552,
00371	641	* +000, +911, 3.910, +000, +000, +000,
00371	642	* +722, 2.235, 2.394, 2.882, 3.300, 3.496, 8.614,
00371	643	* +00, +00, +000, +00,
00371	644	* +00, +00,120.70,104.00, 86.20, 74.50, 51.80, 33.60,
00371	645	* +12136374E+1, +38523477E-0, +93400300E-1,
00371	646	* +10259636E-1, +51284025E-3, +94524676E-5/
00373	647	DATA(P( 93,J),J=1,36)/237.000,2HNP,99.999,17.610, 3.666,
00373	648	* +000, +889, +000, +000, +000, +000,
00373	649	* +704, 2.160, 2.313, 2.798, 3.220, 3.387, 8.264,
00373	650	* +00, +00, +000, +00,
00373	651	* +00, +00,127.10,109.50, 90.80, 78.50, 53.55, 34.90,
00373	652	* +12132721E+1, +38541490E-0, +93224943E-1,
00373	653	* +10214318E-1, +50944719E-3, +93724567E-5/
00375	654	DATA(P( 94,J),J=1,36)/244.000,2HPU,99.999,18.057, 3.778,
00375	655	* +000, +868, +000, +000, +000, +000,
00375	656	* +000, 2.090, 2.229, 2.718, 3.114, 3.279, 7.946,
00375	657	* +00, +00, +000, +00,
00375	658	* +00, +00,135.40,116.50, 96.70, 83.60, 55.34, 36.40,
00375	659	* +12129555E+1, +38554609E-0, +93025923E-1,
00375	660	* +10165025E-1, +50577731E-3, +92868595E-5/
00377	661	DATA(P( 95,J),J=1,36)/243.000,2HAM,99.999,18.504, 3.887,
00377	662	* +000, +848, +000, +000, +000, +000,
00377	663	* +090, +000, +000, +000, +000, +000,
00377	664	* +00, +00, +000, +00,
00377	665	* +00, +00, +00, +00, +00, +00, 57.16, +00,
00377	666	* +1212478E+1, +38503844E-0, +92595935E-1,
00377	667	* +10082912E-1, +50016353E-3, +91610882E-5/
00401	668	DATA(P( 96,J),J=1,36)/247.000,2HCK,99.999,19.930, 3.971,
00401	669	* +000, +000, +000, +000, +000, +000,
00401	670	* +000, +000, +000, +000, +000, +000,
00401	671	* +00, +00, +000, +00,
00401	672	* +00, +00, +00, +00, +00, +00, 59.02, +00,
00401	673	* +12120562E+1, +38515389E-0, +92377782E-1,
00401	674	* +10029525E-1, +49619796E-3, +90686690E-5/
00403	675	DATA(P( 97,J),J=1,36)/247.000,2HBK,99.999,19.452, 4.132,

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00403 676* * .000, .000, .000, .000, .000, .000, .000,
00403 677* * .000, .000, .000, .000, .000, .000, .000, .000,
00403 678* * .00, .00, .000, .00,
00403 679* * .00, .00, .00, .00, .00, .00, .00, 60.93, .00,
00403 680* * .12119570E+1, -.38516915E-0, .92113495E-1,
00403 681* * -.99886496E-2, .49175555E-3, -.89659807E-5/
00405 682* DATA(P1 99,J),J=1,361/251*.000,2HCF,99.999,19.930, 4.253,
00405 683* * .000, .000, .000, .000, .000, .000, .000,
00405 684* * .000, .000, .000, .000, .000, .000, .000, .000,
00405 685* * .00, .00, .000, .00,
00405 686* * .00, .00, .00, .00, .00, .00, .00, 62.88, .00,
00405 687* * .12116747E+1, -.38481987E-0, .91711283E-1,
00405 688* * -.97887782E-2, .48610964E-3, -.38382285E-5/
00407 689* DATA(P1 99,J),J=1,361/254*.000,2HES,99.999,20.410, 4.374,
00407 690* * .000, .000, .000, .000, .000, .000, .000,
00407 691* * .000, .000, .000, .000, .000, .000, .000, .000,
00407 692* * .00, .00, .000, .00,
00407 693* * .00, .00, .00, .00, .00, .00, .00, 64.87, .00,
00407 694* * .12112094E+1, -.38416493E-0, .91188729E-1,
00407 695* * -.97887777E-2, .47936640E-3, -.86873597E-5/
00411 696* DATA(P1100,J),J=1,361/253*.000,2HFM,99.999,20.900, 4.498,
00411 697* * .000, .000, .000, .000, .000, .000, .000,
00411 698* * .000, .000, .000, .000, .000, .000, .000, .000,
00411 699* * .00, .00, .000, .00,
00411 700* * .00, .00, .00, .00, .00, .00, .00, 66.90, .00,
00411 701* * .12111340E+1, -.38363683E-0, .90693355E-1,
00411 702* * -.96920170E-2, .47269068E-3, -.85370948E-5/
00413 703* END

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END OF COMPILATION: NO DIAGNOSTICS.

DBLOCK	SYMBOLIC	19 NOV 71	10:20:38	0	01575525	14	703 (DELETED)
DBLOCK	CODE	19 NOV 71	10:20:30	1	01641227	14	1 (DELETED)
	RELOCATABLE			0	01620707	14	600

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UNIVAC 1108 FORTRAN V LEVEL 2206 0024A -(EXEC8 LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:14

SUBROUTINE HIST ENTRY POINT 000271

STORAGE USED: CODE(1) 000342; DATA(0) 000460; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 GRP1  
0004 PLOT3  
0005 UMPBUF  
0006 NWDUS  
0007 N1015  
0010 N1025  
0011 MERR35

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000021	121G	0001	000054	133G	0001	000132	154G	0001	000150	165G	0001	000161	172G
0000	000337	20F	0001	000207	200G	0000	000375	21F	0001	000235	211G	0000	000410	23F
0000	000333	30F	0001	000064	4L	0001	000101	5L	0000	R 000000	B	0000	R 000145	FF
0000	R 000315	FMT	0000	I 000322	I	0000	I 000332	IND	0000	000430	INJPS	0000	I 000312	IR
0000	I 000331	IS	0000	I 000321	J	0000	I 000327	NN	0000	I 000323	NT	0000	H 000326	R
0000	R 000324	STEP	0000	R 000325	VK	0000	R 000330	XX						

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00101 1* SUBROUTINE HIST(X,N,NG,XMIN,XMAX,F,INX,TITLE)
00101 2* C-----
00101 3* C CALCULATES AND PLOTS ON THE PRINTER A HISTOGRAM FROM A SET
00101 4* C OF DATA POINTS FROM GROUPED OR UNGROUPED DATA POINTS.
00101 5* C-----
00103 6* DIMENSION A(N),F(ING ),B(101),FF(101),IR(3),FMT(4)
00103 7* I,TITLE(12)
00104 8* DATA FMT(1)/6H113X,1/,FMT(2)/6HPE8.3,/,FMT(3)/6H2X /,FMT(4)/6H
00104 9* /,(B(1),J=1,101)/,HI/
00112 10* DATA(IR(1),I=1,3)/0,1,1/
00112 11* C-----
00112 12* C TESTS WHETHER THE DATA POINTS ARE GROUPED OR UNGROUPED, IF THE LATTER,
00112 13* C CALLS GROUP SUBROUTINE TO GROUP THE DATA POINTS.
00112 14* C-----
00114 15* NT = 17
00115 16* IF(INX.EQ.0) NT = 6
00117 17* WRITE(HT,30) TITLE
00125 18* 30 FORMAT(1H1,///,50X,12A6,///)
00126 19* CALL GROUP(X,N,NG,XMIN,XMAX,F)
00127 20* STEP = (XMAX - XMIN)/NG
00127 21* C-----
00127 22* C FINDS MAXIMUM FREQUENCY AND COMPUTES THE K FACTOR FOR EXPANDING OF PLOT.
00127 23* C-----
00130 24* VK=1.

```

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00131 25* R = F(1)
00132 26* DO 3 I=2,NG
00135 27* 3 R=MAX(1R,F(1))
00137 28* 4 IF((R/N=VK).GT.1.) GO TO 5
00141 29* VK=VK+1
00142 30* GO TO 4
00143 31* 5 VK=VK-1.
00143 32* C-----
00143 33* C WRIT OUT ARGUMENTS AND HEADING FOR PLOT.
00143 34* C-----
00144 35* 20 FORMAT(20X,5HSTEP=F15.8/20X,29HCENTERPOINT OF INITIAL GROUP=F15.8,
00144 36* 110X,20HNO OF OBSERVATIONS=15 /20X,27HCENTERPOINT OF FINAL GROUP
00144 37* 2=F15.8,10X,14HNO OF GROUPS=15/20X,9HK FACTOR=F6.0/7)
00145 38* WRITE(NT,20)STEP,AMIN,N,AMAX,NG,VK
00155 39* DO 1 I=1,101
00160 40* 1 FF(I)=1
00162 41* 21 FORMAT(10X,10HPERCENTAGE,5X,1H0,10(7X,13)/23X,10(1H+,9H*****),1,
00162 42* 1H+)
00163 43* WRITE(NT,21) (1,1=10,100,10)
00163 44* C-----
00163 45* C COMPUTES VALUE FOR EACH GROUP AND PLOTS THREE LINES FOR EACH GROUP WITH
00163 46* C THE VALUE PRINTED OUT ON THE SECOND LINE.
00163 47* C-----
00171 48* DO 2 I=1,NG
00174 49* NN=100*VK*(F(1)/N)
00175 50* XX=AMIN+(I-1)*STEP
00176 51* IS=0
00177 52* DO 2 J=1,3
00202 53* IND=IR(I)
00203 54* 2 CALL PLOT3(IND,IS,XX,B,FF,NN,FMT,INX)
00203 55* C-----
00203 56* C WRITES OUT TRAILER INFORMATION ON GRAPH.
00203 57* C-----
00206 58* 23 FORMAT(23X,10(1H+,9H*****),1H+/8X,10HPERCENTAGE,5X,1H0,10(7X,1
00206 59* 13))
00207 60* WRITE(NT,23) (1,1=10,100,10)
00215 61* IF(NT.EQ.17) CALL DMPBUF
00217 62* RETURN
00220 63* END

```

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```

END OF COMPILATION: NO DIAGNOSTICS
HIS1 SYMBOLIC 19 NOV 71 10:20:36 0 01644273 14 63 (DELETED)
HIS1 CODE RELOCATABLE 19 NOV 71 10:20:36 1 01647117 20 1 (DELETED)
0 01646055 14 39

```

UNIVAC 1108 FORTRAN V LEVEL 2206 0024A (EXEC8 LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:16

SUBROUTINE IGIVE ENTRY POINT 000353

STORAGE USED: CODE(1) 000424; DATA(0) 000145; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 GROP1  
0004 PLOT3  
0005 DMPBUF  
0006 NWDUS  
0007 N1025  
0010 N1015  
0011 NERR35

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0000	000034 10F	0000	000033 101F	0001	000036 124G	0001	000076 146G	0001	000105 152G
0001	000164 167G	0000	000046 20F	0001	000212 201G	0000	000100 21F	0001	000243 212G
0001	000213 225G	0000	000114 23F	0001	000320 231G	0001	000124 5L	0001	000131 4L
0000	R 000000 B	0000	R 000001 FF	0000	R 000014 FHT	0000	I 000022 I	0000	I 000002 IF
0000	I 000030 1ND	0000	000136 1NJP*	0000	I 000130 1R	0000	I 000026 1S	0000	I 000024 11
0000	I 000026 12	0000	I 000032 J	0000	I 000027 NG1	0000	I 000023 NN	0000	I 000020 NT
0000	000130 K	0000	R 000021 STEP	0000	R 000031 XX				

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```

00101 1* SUBROUTINE IGIVE(X,N,NG,XMIN,XMAX,F,TCUM,INX)
00101 2* C
00101 3* C CALCULATES AND PLOTS ON THE PRINTER A CUMULATIVE FREQUENCY POLYGON
00101 4* C FROM A SET OF DATA POINTS.
00101 5* C
00103 6* C DIMENSION X(1),F(1),B(1),FF(1),IF(10),FHT(4)
00104 7* C EQUIVALENCE (R,IR)
00104 8* C
00104 9* C FILLS THE B ARRAY WITH 'X' TO BE PRINTED FOR THE PLOT.
00104 10* C
00105 11* DATA FHT(1)/6H(13X,1/,FHT(2)/6HPER.3,/,FHT(3)/6H2X /,FHT(4)/6H
00105 12* 1 /,B(1)/1HX/
00113 13* NT=17
00114 14* IF(INX.EQ.0) NT=6
00116 15* WRITE (NT,10)
00120 16* 10 FORMAT(1H)
00121 17* WRITE(6,10)
00123 18* 10 FORMAT(1///,50X,'CONCENTRATION CUMULATIVE DISTRIBUTION',///)
00123 19* C
00123 20* C COMPUTE FREQUENCY VALUES AT EACH PERCENTILE FOR PRINTOUT AT TOP
00123 21* C OF PLOT
00123 22* C
00124 23* STEP=(XMAX-XMIN)/NG

```

```

00125 34* DO 3 I=1,10
00130 25* 3 IF(I)=1*N/10
00130 26* C-----
00130 27* C TESTS WHETHER DATA POINTS ARE GROUPED OR UNGROUPED, IF THE LATTER,
00130 28* C CALLS GROUP-SUBROUTINE TO GROUP THE DATA POINTS.
00130 29* C-----
00132 30* CALL GRP1(X,N,NG,XMIN,XMAX,F)
00132 31* C-----
00132 32* C WRITES OUT ARGUMENTS AND HEADING FOR THE PLOT.
00132 33* C-----
00133 34* 20 FORMAT(20X,5HSTEP=F15.8/20X,29HCENTERPOINT OF INITIAL GROUP=F15.8,
00133 35* 110X,20HNO. OF OBSERVATIONS=15 /20X,27HCENTERPOINT OF FINAL GROUP
00133 36* 2=F15.8,10X,14HNO. OF GROUPS=15//)
00134 37* WRITE (NT,20) STEP,XMIN,N,XMAX,NG
00143 38* 21 FORMAT(8X,10HPERCENTAGE,5X,1H0,10(7X,13)//8X,9HFREQUENCY,6X,1H0,1D
00143 39* 1(7X,13))
00143 40* C-----
00143 41* C COMPUTES ACCUMULATED FREQUENCIES BOTTOM UP, OR TOP DOWN
00143 42* C-----
00144 43* WRITE (NT,21) (I, I=10,100,10), (IF(I), I=1,10)
00156 44* NN=1
00157 45* IF(ICUM.EQ.-1) GO TO 5
00161 46* I=2
00162 47* I2=NG
00163 48* GO TO 6
00164 49* 5 I1=NG-1
00165 50* I2=1
00166 51* 6 DO 1 I=1,12,ICUM
00171 52* 1 F(I)=F(I-1)+F(I-1CUM)
00171 53* C-----
00171 54* C COMPUTES VALUE FOR EACH GROUP AND PLOTS EACH FREQUENCY WITH FIVE
00171 55* C CONNECTING POINTS.
00171 56* C-----
00173 57* IR=4
00174 58* IS=1
00175 59* NG1=NG+1
00176 60* IF(1CUM.EQ.-1) NG1=NG
00200 61* DO 2 I=1,NG1
00203 62* IND=0
00204 63* XX = XMIN + I*STEP
00205 64* IF(1CUM.EQ.-1) XX = XMIN + (I-1)*STEP
00207 65* IF(I.EQ.NG1) IR=0
00211 66* DO 2 J=0,IR
00214 67* FF(I)=(IS*0-J)*F(I)+J*(F(I+1))/5.0
00215 68* FF(I+1)=FF(I)/N*100.
00216 69* CALL PLOT3(IND,IS,XX,B,FF,NN,FMT,INX)
00217 70* 2 IND=I
00217 71* C-----
00217 72* C WRITES OUT FREQUENCY AND PERCENTAGE AT BOTTOM OF GRAPH
00217 73* C-----
00222 74* 23 FORMAT(8X,9HFREQUENCY,6X,1H0,10(7X,13)//8X,10HPERCENTAGE,5X,1H0,1D
00222 75* 1(7X,13))
00223 76* WRITE (NT,23) (IF(I), I=1,10), (I, I=10,100,10)
00235 77* IF(NT.EQ.17) CALL DMPBUF
00237 78* RETURN
00240 79* END

```

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IGIVE SYMBOLIC  
IGIVE CODE RLOCATABLE

19 NOV 71 10:20:39 0 01647143 14 79 (DELETED)  
19 NOV 71 10:20:39 1 01652255 20 1 (DELETED)  
0 01651265 14 36

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UNIVAC 1108 FORTRAN V LEVEL 2206 0024A -(EXEC8 LEVEL E(2010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:19

SUBROUTINE GROPI ENTRY POINT 000114

STORAGE USED: CODE(1) 000131; DATA(0) 000027; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 NERR35

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001 000022 104G 0001 000026 113G 0001 000100 9L 0000 000001 1 0000 000010 INJF#  
0009 000003 K 0000 R 000000 STEP 0000 R 000002 Z 0000 R 000004 ZK

4-62

```

00101 1* SUBROUTINE GROPI(K,N,NG,XMIN,XMAX,F)
00103 2* DIMENSION X(1),F(1) GROUP
00104 3* STEP=(XMAX-XMIN)/NG
00105 4* DO 6 J=1,NG
00110 5* F(J)=0+0
00112 6* DO 9 I=1,N GROUP
00112 7* C
00112 8* C IN WHICH GROUP DOES THE POINT FALL GROUP
00112 9* C
00115 10* Z=(X(I)-XMIN)/STEP
00116 11* K=Z
00117 *DIAGNOSTIC THE TEST FOR EQUALITY BETWEEN NON-INTEGERS MAY NOT BE MEANINGFUL.
00117 12* IF(X(I)-EQ,XMIN)-K=1
00121 13* ZK=K
00122 14* IF(ZK=I,Z) K=K+1
00124 15* IF(K,LE,0) GO TO 9
00126 16* IF(K,GT,NG) GO TO 9
00126 17* C
00126 18* C CALCULATION OF FREQUENCIES FOR EACH POINT FOR EACH GROUP GROUP
00126 19* C
00130 20* F(K)=F(K)+1+0
00131 21* 9 CONTINUE
00133 22* RETURN GROUP
00134 23* END GROUP

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END OF COMPILATION: 1 DIAGNOSTICS\*  
GROPI SYMBOLIC  
GROPI CODE RELOCATABLE

19 NOV 71	10:20:41	0	01652301	14	23	(DELETED)
19 NOV 71	10:20:41	1	01653217	14	1	(DELETED)
		0	01653003	14	10	

UNIVAC 1108 FORTRAN V LEVEL 2206 0029A -(EXEC8 LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:21

SUBROUTINE PLOT3 ENTRY POINT 000240

STORAGE USED: CODE(1), 000243; DATA(6) 000213; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 NWDUS  
0004 NIO15  
0005 NIO25  
0006 NERR35

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001	000211	10L	0000	000163	101F	0001	000015	122G	0001	000036	134G	0001	000061	147G
0001	000064	153G	0001	000076	162G	0001	000101	166G	0001	000112	174G	0001	000052	2L
0001	000202	214G	0001	000220	224G	0001	000073	4L	0001	000107	6L	0001	000165	7L
0001	000162	9L	0000 R	000000	A	0000 R	000154	AXIS	0000 R	000153	BLANK	0000 R	000145	FMT
0000	000161	1	0000	000172	INJP5	0000	000162	J	0000	000160	NT	0000 R	000155	PLUS
0000 R	000156	STAR	0000 R	000157	ZERO									

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```

00101 1* SUBROUTINE PLOT3(INO,IS,X,B,F,N,FRM,INX)
00103 2* DIMENSION A(101),B(1),F(1),FRM(4),FMT(6)
00104 3* DATA FMT(5) /6H,101A1/,FMT(6) /1H/
00107 4* TO FORMAT(123X,101A1) PLOT1
00110 5* DATA BLANK/1H /,AXIS/1H/,PLUS/1H+/,STAR/1H*/,ZERO/1H0/ PLOT1
00116 6* NT = 17
00117 7* IF(INX.EQ.0) NT = 6
00121 8* DO 11 I=1,4
00124 9* 11 FMT(I)=FRM(I)
00126 10* A(101)=AXIS PLOT1
00127 11* IF(INO.EQ.1)A(101)=PLUS PLOT1
00131 12* IF(I15.EQ.1) GO TO 2 PLOT1
00133 13* DO 1 I=2,100 PLOT1
00136 14* 1 A(I)=BLANK PLOT1
00140 15* A(I) =AXIS PLOT1
00141 16* IF(INO.EQ.1)-A(I)=PLUS PLOT1
00143 17* GO TO 6 PLOT1
00144 18* 2 IF (IND.EQ.1) GO TO 4 PLOT1
00146 19* DO 3 I=1,91,10 PLOT1
00151 20* A(I)=AXIS PLOT1
00152 21* DO 3 J=1,9 PLOT1
00155 22* 3 A(I+J)=STAR PLOT1
00160 23* GO TO 6 PLOT1
00161 24* 4 DO 5 J=1,91,10 PLOT1
00164 25* A(J)=PLUS PLOT1
00165 26* DO 5 J=1,9 PLOT1
00170 27* 5 A(I+J)=BLANK PLOT1

```

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00173 28*      6 DO 7 I=1,N                      PLOT1
00174 29*      J=F(I)*1.5                      PLOT1
00177 30*      IF(IJ=LT+1),OR=(J>GT+10)) GO TO 7 PLOT1
00201 31*      IF(A(J)+LT,BLANK,OR,A(J)+GT,BLANK) GOTO9 PLOT1
00203 32*      A(J)=B(I)                          PLOT1
00204 33*      GO TO 7                          PLOT1
00205 34*      7 A(J)=ZERO                      PLOT1
00206 35*      7 CONTINUE                    PLOT1
00210 36*      IF(I=ND=NE+1) GO TO 10        PLOT1
00212 37*      WRITE(NT,10) (A(I),I=1,10)
00220 38*      RETURN                          PLOT1
00221 39*      10 WRITE(NT,FMT) X,(A(I),I=1,10)
00220 40*      RETURN                          PLOT1
00231 41*      END                          PLOT1

```

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END OF COMPILATION:      NO DIAGNOSTICS
PLOT3      SYMBOLIC
PLOT3      CODE      RELOCATABLE

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19 NOV 71 10:20:43  0 01653235 14 41 (DELETED)
19 NOV 71 10:20:43  1 01654783 17  1 (DELETED)
0 01654333 14 20

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PCORRE, PCORRE

19 NOV 71

10:21:24,111

UNIVAC 1108 FORTRAN V LEVEL 2206 DD24A - (EXECB LEVEL E12010009A)

THIS CORRELATION WAS DONE ON 19 NOV 71 AT 10:21:24

FUNCTION PCORRE ENTRY POINT 000267

STORAGE USED: CODE(1) 000274; DATA(10) 000052; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 GAMMA  
0004 DSQNT  
0005 DATAN  
0006 NERRS

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001 000025 13L 0001 000052 134G 0001 000007 15L 0001 000214 161G 0001 000046 31L  
0001 000146 41L 0001 000202 51L 0001 000247 57L 0001 000254 60L 0000 D 000013 DENOM  
0000 D 000007 F1 0000 D 000011 FNUM 0000 R 000020 FREE 0003 R 000000 GAMMA 0000 I 000021 I  
0000 I 000017 INAX 0000 I 000033 NEVEN 0000 I 000015 NFREE 0000 R 000000 PCORRE  
0000 D 000001 R2 0000 D 000005 SUM 0000 D 000003 TERM

4-35

00101 1\* FUNCTION PCORRE (R, NPYS)  
00103 2\* DOUBLE PRECISION R2, TERM, SUM, F1, FNUM, DENOM  
00103 3\* C  
00103 4\* C PURPOSE  
00103 5\* C EVALUATE PROBABILITY FOR NO CORRELATION BETWEEN TWO VARIABLES  
00103 6\* C  
00103 7\* C USAGE  
00103 8\* C RESULT = PCORRE (R, NPYS)  
00103 9\* C  
00103 10\* C DESCRIPTION OF PARAMETERS  
00103 11\* C R - LINEAR CORRELATION COEFFICIENT  
00103 12\* C NPYS - NUMBER OF DATA POINTS  
00103 13\* C  
00103 14\* C  
00103 15\* C EVALUATE NUMBER OF DEGREES OF FREEDOM  
00103 16\* C  
00104 17\* C NFREE = NPYS - 2  
00105 18\* C IF (NFREE) 13,13,15  
00110 19\* C 13 PCORRE = J,  
00111 20\* C GO TO 60  
00112 21\* C 15 R2 = R\*\*2  
00113 22\* C IF (1.=R2) 13,13,17  
00114 23\* C 17 NEVEN = 2\*(NFREE/2)  
00117 24\* C IF (NFREE = NEVEN) 21,21,41  
00117 25\* C  
00117 26\* C NUMBER OF DEGREES OF FREEDOM IS EVEN  
00117 27\* C  
00122 28\* C 21 INAX = INFREE-21/2

FORM 4113

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00123 29* FREE = NFREE
00124 30* TERM = ABS (R)
00125 31* SUM = TERM
00126 32* IF (IMAX) 60,26,31
00131 33* 28 PCORRE = 1, -TERM
00132 34* GO TO 60
00133 35* 31 DO 36 I=1,IMAX
00136 36* F1 = I
00137 37* FNUM = IMAX = I + 1
00140 38* DENOM = 2*I + 1
00141 39* TERM = TERM * R2 * FNUM/FI
00142 40* 36 SUM = SUM + TERM/DENOM
00144 41* PCORRE = 1, (2037+1)* (GAMMA(FREE+1)/2)/GAMMA(FREE/2)
00145 42* PCORRE = 1, -PCORRE*SUM
00146 43* GO TO 60
00146 44* C
00146 45* C NUMBER OF DEGREES OF FREEDOM IS ODD
00146 46* C
00147 47* 41 IMAX = (NFREE-3)/2
00150 48* TERM = ABS(R) * DSQRT(1,-R2)
00151 49* SUM = DATAN(R2/TERM)
00152 50* IF (IMAX) 57,45,51
00155 51* 45 SUM = SUM + TERM
00156 52* GO TO 57
00157 53* 51 SUM = SUM + TERM
00160 54* DO 56 I=1,IMAX
00163 55* FNUM = 2*I
00164 56* DENOM = 2*I + 1
00165 57* TERM = TERM * (1,-R2) * FNUM/DENOM
00166 58* 56 SUM = SUM + TERM
00170 59* 57 PCORRE = 1, 0.6366197724*SUM
00171 60* 60 RETURN
00172 61* END

```

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END OF COMPILATION: NO DIAGNOSTICS.

PCORRE	SYMBOLIC	19 NOV 71	10:20:46	0	01655004	14	61	(DELETED)
PCORRE	CODE	RELOCATABLE	19 NOV 71	10:20:46	1	01657200	17	1 (DELETED)
				0	01656532	14	21	

FORM 141-1

31 MICROFILMS

UNIVAC 1108 FORTRAN V LEVEL 2206 0029A - (EXECB LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:27

FUNCTION GAMMA ENTRY POINT 000131

STORAGE USED: CODE(1) 000135; DATA(0) 000041; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 FACTOR  
0004 DEBG  
0005 DEXP  
0006 NERR3S

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001 000042 123G 0001 000067 134G 0001 000026 31L 0001 000056 44L 0001 000061 51L  
0001 000117 60L 0003 R 000000 FACTOR 0000 D 000005 FI 0000 R 000000 GAMMA 0000 I 000011 I  
0000 000027 INJS 0000 I 000007 N 0000 D 000001 PROD 0000 D 000003 SUM 0000 R 000010 XN

4-87

00101 1\* FUNCTION GAMMA (X)  
00103 2\* DOUBLE PRECISION PROD,SUM,FI  
00103 3\* C  
00103 4\* C PURPOSE  
00103 5\* C CALCULATE THE GAMMA FUNCTION FOR INTEGERS AND HALF-INTEGERS  
00103 6\* C  
00103 7\* C USAGE  
00103 8\* C RESULT = GAMMA (X)  
00103 9\* C  
00103 10\* C DESCRIPTION OF PARAMETERS  
00103 11\* C X - INTEGER OR HALF-INTEGERS  
00103 12\* C  
00103 13\* C INTEGERIZE ARGUMENT  
00103 14\* C  
00104 15\* N = X - .25  
00105 16\* XN = N  
00106 17\* IF (X - XN = .75) 31,31,21  
00106 18\* C  
00106 19\* C ARGUMENT IS INTEGER  
00106 20\* C  
00111 21\* 21 GAMMA = FACTOR(N)  
00112 22\* GO TO 60  
00112 23\* C  
00112 24\* C ARGUMENT IS HALF-INTEGERS  
00112 25\* C  
00113 26\* 31 PROD = 1.77245385  
00114 27\* IF (N) 41,41,33  
00117 28\* 33 IF (N-10) 41,41,51  
00122 29\* 41 DO 43 I=1,N  
00125 30\* FI = 1

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00124 31* 43 PRD = PRD * (FI=5)
00130 32* 44 GAMMA = PRD
00131 33* 50 TO 60
00132 34* 51 SUM = 0
00133 35* 52 DO-54 I=1,N
00134 36* 53 FI = I
00137 37* 54 SUM = SUM + DLOG(FI=5)
00141 38* 55 GAMMA = PRD * 639383.8623 * DEXP(SUM)
00142 39* 60 RETURN
00143 40* END

```

END OF COMPILATION; NO DIAGNOSTICS.

GAMMA	SYMBOLIC	19 NOV 71	10:20:48	0	01657221	14	40	(DELETED)
GAMMA	CODE	19 NOV 71	10:20:48	1	01660551	17	1	(DELETED)
				0	01660301	14	12	

UNIVAC 1108 FORTRAN V LEVEL 2206 0029A (EXECB LEVEL E12010009A)  
THIS COMPILATION WAS DONE ON 19 NOV 71 AT 10:21:29

FUNCTION FACTOR ENTRY POINT 000102

STORAGE USED: CODE(1) 000104; DATA(0) 000027; BLANK COMMON(2) 000000

EXTERNAL REFERENCES (BLOCK, NAME)

0003 DLOG  
0004 DEXP  
0005 NERR3s

STORAGE ASSIGNMENT (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001 000022 114G 0001 000044 124G 0001 000040 31L 0001 000070 40L 0000 R 000000 FACTOR  
0000 D 000001 F1 0000 I 000005 I 0000 000015 INJP5 0000 D 000003 SUM

```

00101 1* FUNCTION FACTOR (N)
00103 2* DOUBLE PRECISION F1,SUM
00103 3* C
00103 4* C PURPOSE
00103 5* C CALCULATES FACTORIAL FUNCTION FOR INTEGERS
00103 6* C
00103 7* C USAGE
00103 8* C RESULT = FACTOR (N)
00103 9* C
00103 10* C DESCRIPTION OF PARAMETERS
00103 11* C N = INTEGER ARGUMENT
00103 12* C
00104 13* FACTOR = 1
00105 14* IF (N=1) 40,40,13
00110 15* 13 IF (N=10) 21,21,31
00110 16* C
00110 17* C N LESS THAN 11
00110 18* C
00113 19* 21 00 23 1=2*N
00116 20* F1 = 1
00117 21* 23 FACTOR = FACTOR * F1
00121 22* GO TO 40
00121 23* C
00121 24* C N GREATER THAN 10
00121 25* C
00122 26* 31 SUM = 0
00123 27* DO 34 I=1,N
00126 28* F1 = I
00127 29* 34 SUM = SUM + DLOG(F1)
00131 30* FACTOR = J628800. * DEXP(SUM)
00132 31* 40 RETURN
00133 32* END

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FORM 1111

FORM 1111 5A

END OF COMPILATION! NO DIAGNOSTICS.  
FACTOR SYBOLIC  
FACTOR CODE RELOCATABLE

19 NOV 71 10:20:50 0 01660572 14 32 (DELETED)  
19 NOV 71 10:20:50 1 01661670 16 1 (DELETED)  
0 01661472 14 9

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FORM 1011-5

PRINTED IN U.S.A.

3  
14  
5  
6  
7  
8  
9  
10  
11  
12

19 NOV 71 10:21:30 IDENT H3 ACCOUNT LO4878 CARDS IN 40 CARDS OUT 0 PAGES 92 ELAPSED TIME 0 1 37

FORM 141-1

4-771

UNIVAC-1106-PROCESSOR-1-EXEC-11-LEVEL-4-5-MSC117A-NASA-SPECIAL

FORM 141-1

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OF POOR QUALITY

.....UNIVAC-1106-PROCESSOR-1-EXEC-11-LEVEL-6-5-MS-117A-NASA-SPECIAL-.....

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#### 4.5 Sample Input/Output

Sample input and output are shown on the following pages.

```

CARD 1 10=13=71 15 A R+00
CARD 2 0 0
CARD 3 10.00 1.50 50.00 1.00
CARD 4 1 35 2 0.
CARD 5 112.00000 .14000 14.00000 1
CARD 6 K 0. 2366. 94.
CARD 6 S 0. 947. 50.
EPIST
C1 = .99964455E+00,
C12 = .99979627E+00,
C2 = .33172945E-03,
ADB = .56603072E-04,
ARATIO = .10000021E-03,
*END
CARD 7 4 NA 5. 5 0. K 10. CL 15.

```

QUANTITATIVE ANALYSIS OF RBC SET

1. INPUT-OUTPUT TABLE
2. CONCENTRATION FREQUENCY DISTRIBUTION
3. CONCENTRATION CUMULATIVE DISTRIBUTION
4. CONCENTRATION CORRELATION ANALYSIS

ORIGINAL PAGE IS  
OF POOR QUALITY

K IS THE ELEMENT ANALYZED

SAMPLE NUMBER	INTENSITY COUNT	ABSORPTION FACTOR	ABSORPTION CORRECTION	AREA DENSITY	WEIGHT PERCENTAGE
1	648.	.99669	.99336	.17021-06	.30
2	179.	.99682	.99323	.47012-07	.08
3	181.	.99668	.99338	.47544-07	.09
4	563.	.99670	.99335	.14768-06	.27
5	383.	.99670	.99335	.10060-06	.18
6	762.	.99668	.99338	.20016-06	.36
7	354.	.99667	.99339	.92988-07	.17
8	244.	.99672	.99333	.64090-07	.12
9	811.	.99674	.99331	.21302-06	.39
10	683.	.99683	.99322	.17938-06	.33
11	980.	.99674	.99332	.25741-06	.47
12	2317.	.99666	.99339	.60863-06	1.11
13	1663.	.99672	.99333	.48934-06	.89
14	1840.	.99669	.99336	.48332-06	.87
15	1924.	.99670	.99335	.50538-06	.91
16	269.	.99679	.99327	.70652-07	.13
17	243.	.99680	.99326	.63822-07	.12
18	245.	.99692	.99313	.64340-07	.12
19	1758.	.99673	.99332	.46176-06	.85
20	1815.	.99671	.99334	.47674-06	.87
21	2143.	.99676	.99330	.56287-06	1.02
22	1647.	.99672	.99333	.43261-06	.79
23	1381.	.99677	.99328	.36272-06	.66
24	1126.	.99664	.99342	.29578-06	.54
25	486.	.99680	.99325	.12764-06	.23
26	441.	.99675	.99331	.12109-06	.22
27	873.	.99675	.99330	.22930-06	.42
28	400.	.99678	.99328	.15759-06	.29
29	984.	.99672	.99333	.25846-06	.47
30	150.	.99673	.99332	.39399-07	.07
31	693.	.99694	.99311	.18199-06	.34
32	590.	.99679	.99327	.15496-06	.29
33	272.	.99680	.99326	.71439-07	.13
34	543.	.99685	.99321	.14261-06	.27
35	699.	.99687	.99319	.18358-06	.34

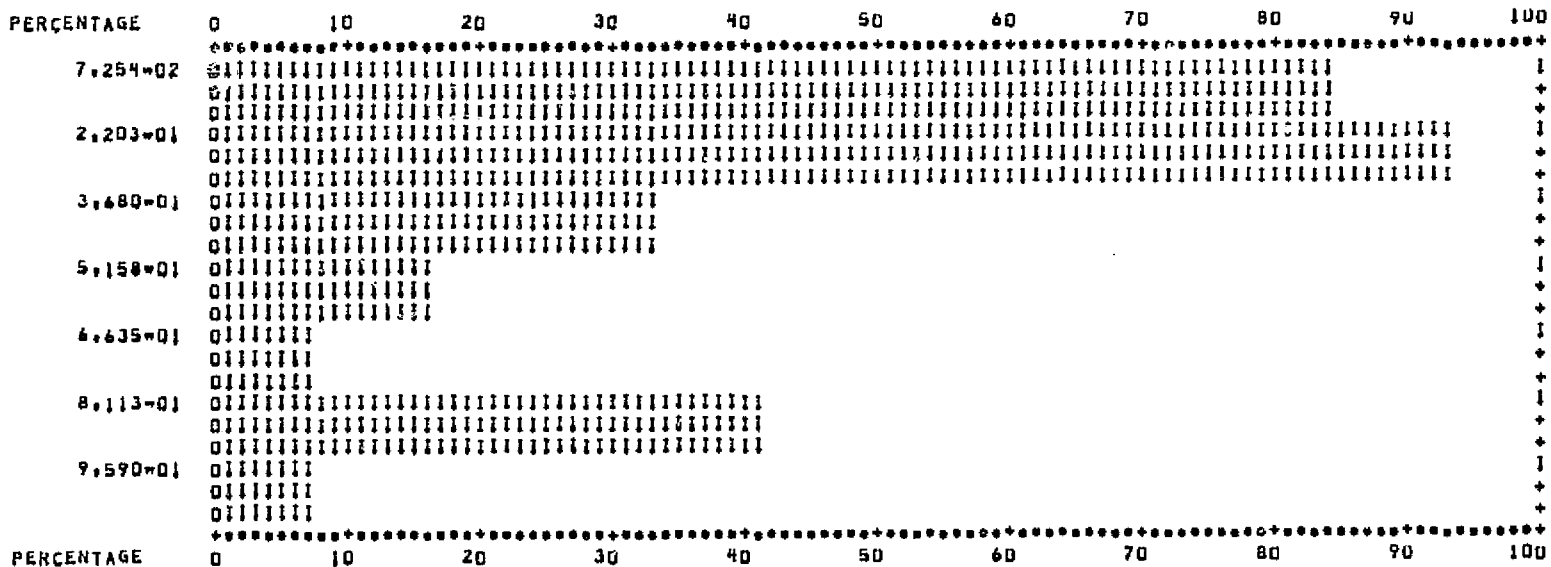
4-76

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CONCERN FREQUENCY DISTRIBUTION

\*\*\*\*\*

STEP# .14774365  
 CENTERPOINT OF INITIAL GROUP# .07254016 NO. OF OBSERVATIONS# 35  
 CENTERPOINT OF FINAL GROUP# 1.10674572 NO. OF GROUPS# 7  
 K FACTOR# 3.

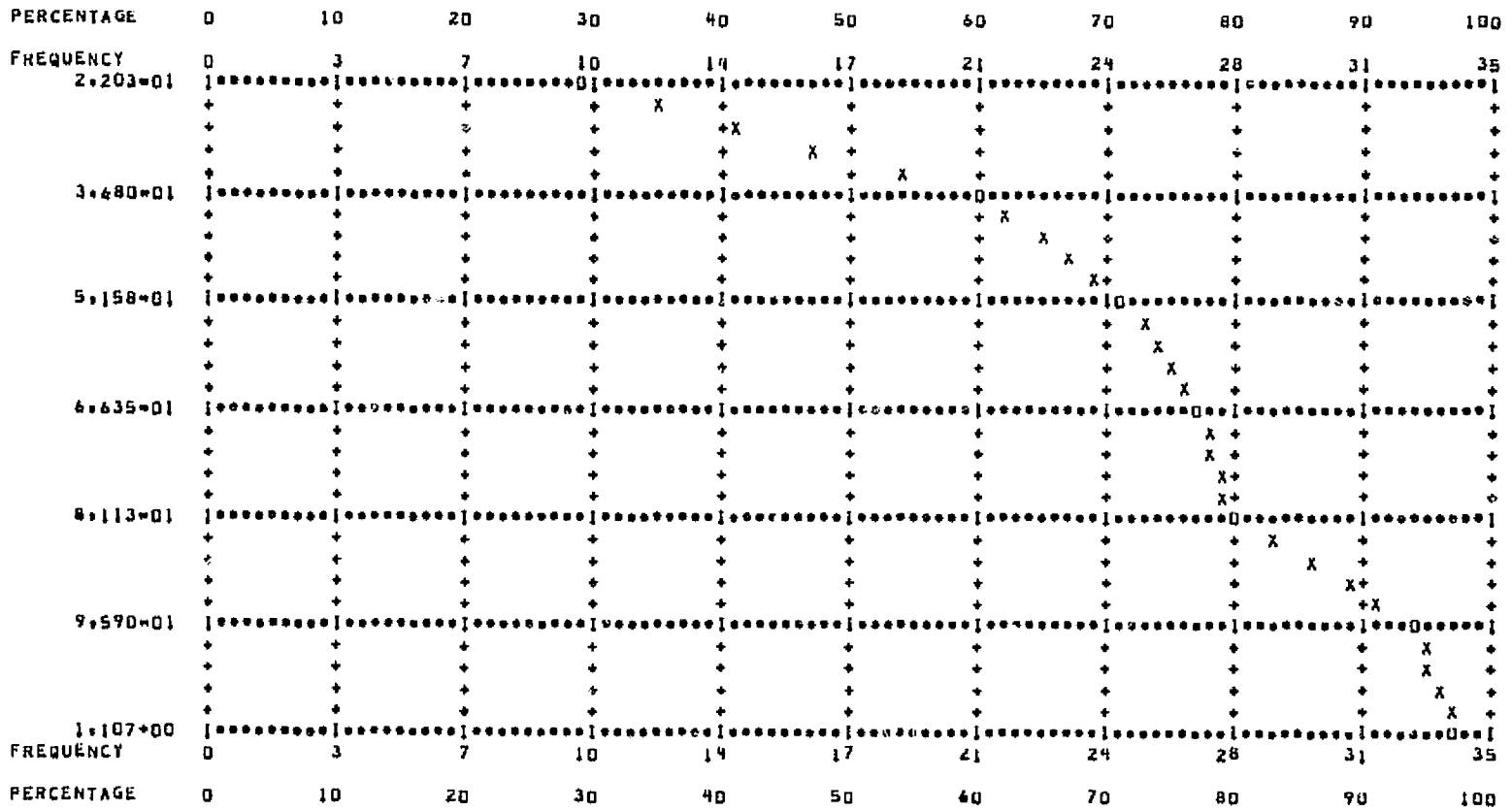


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ORIGINAL PAGE IS  
 OF POOR QUALITY

STEP= .14774365  
 CENTERPOINT OF INITIAL GROUP= .07254016  
 CENTERPOINT OF FINAL GROUP= 1.10674572

NO. OF OBSERVATIONS= 35  
 NO. OF GROUPS= 7



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SSTAT  
 XMIN = .72540159E+01,  
 XMAX = 1.1067457E+01,  
 XBAR = .41988858E+00,  
 YAR = .94091450E+01,  
 SDEy = .30674330E+00,  
 SEND

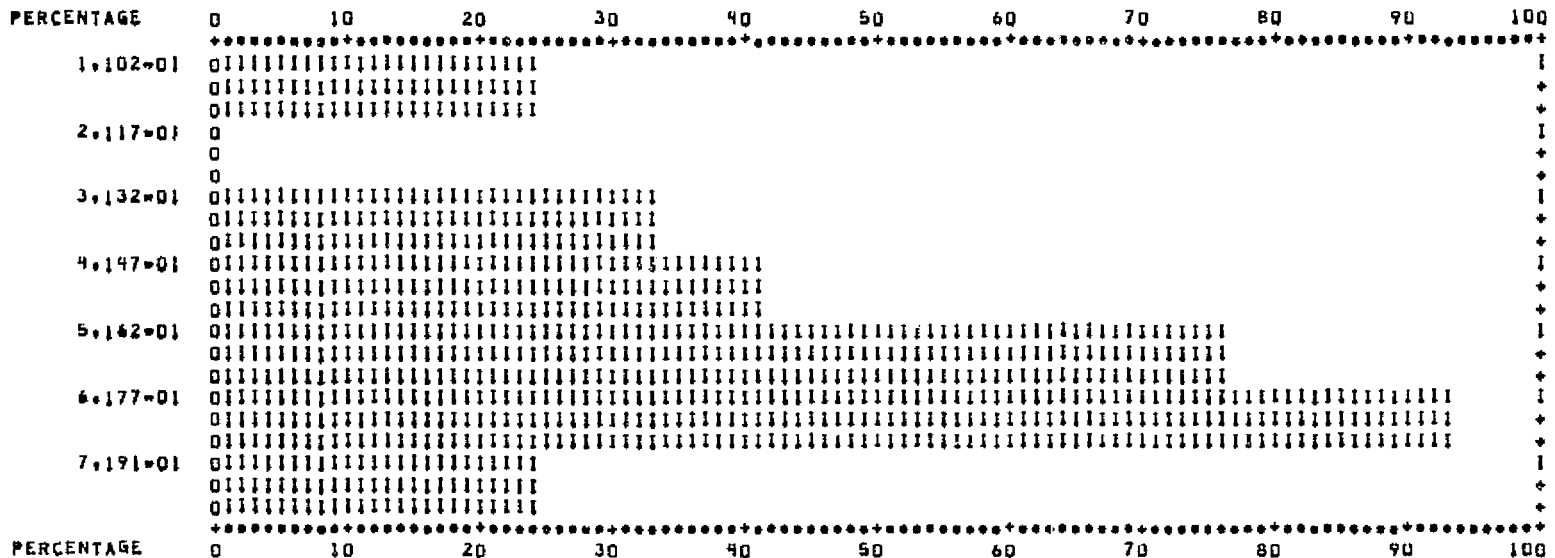
5 IS THE ELEMENT ANALYZED

SAMPLE NUMBER	INTENSITY COUNT	ABSORPTION FACTOR	ABSORPTION CORRECTION	AREA DENSITY	WEIGHT PERCENTAGE
1	715.	.99178	.98294	.25162-06	.45
2	268.	.99186	.98286	.94305-07	.17
3	1019.	.99189	.98283	.35856-06	.64
4	915.	.99191	.98281	.32196-06	.58
5	989.	.99194	.98278	.34799-06	.63
6	1094.	.99193	.98279	.38494-06	.70
7	1194.	.99196	.98276	.42011-06	.76
8	995.	.99199	.98273	.35008-06	.64
9	887.	.99199	.98273	.31208-06	.57
10	522.	.99203	.98269	.18365-06	.34
11	980.	.99202	.98270	.34479-06	.63
12	1147.	.99192	.98280	.40359-06	.73
13	836.	.99192	.98280	.29416-06	.53
14	935.	.99189	.98283	.32900-06	.59
15	845.	.99186	.98286	.29734-06	.54
16	621.	.99196	.98276	.21850-06	.40
17	644.	.99201	.98271	.22658-06	.41
18	181.	.99208	.98264	.63877-07	.12
19	967.	.99201	.98271	.34022-06	.62
20	1005.	.99197	.98275	.35396-06	.65
21	712.	.99194	.98278	.25052-06	.46
22	890.	.99193	.98279	.31316-06	.57
23	673.	.99194	.98278	.23640-06	.43
24	1287.	.99193	.98279	.45284-06	.82
25	614.	.99200	.98272	.21603-06	.39
26	925.	.99202	.98270	.32544-06	.59
27	883.	.99202	.98270	.31067-06	.57
28	832.	.99205	.98267	.29271-06	.54
29	1068.	.99204	.98268	.37575-06	.69
30	1103.	.99209	.98263	.38804-06	.71
31	169.	.99213	.98259	.59453-07	.11
32	964.	.99215	.98257	.33912-06	.63
33	986.	.99219	.98254	.34685-06	.65
34	768.	.99220	.98252	.27015-06	.51
35	726.	.99222	.98250	.25538-06	.48

CONCERN FREQUENCY DISTRIBUTION

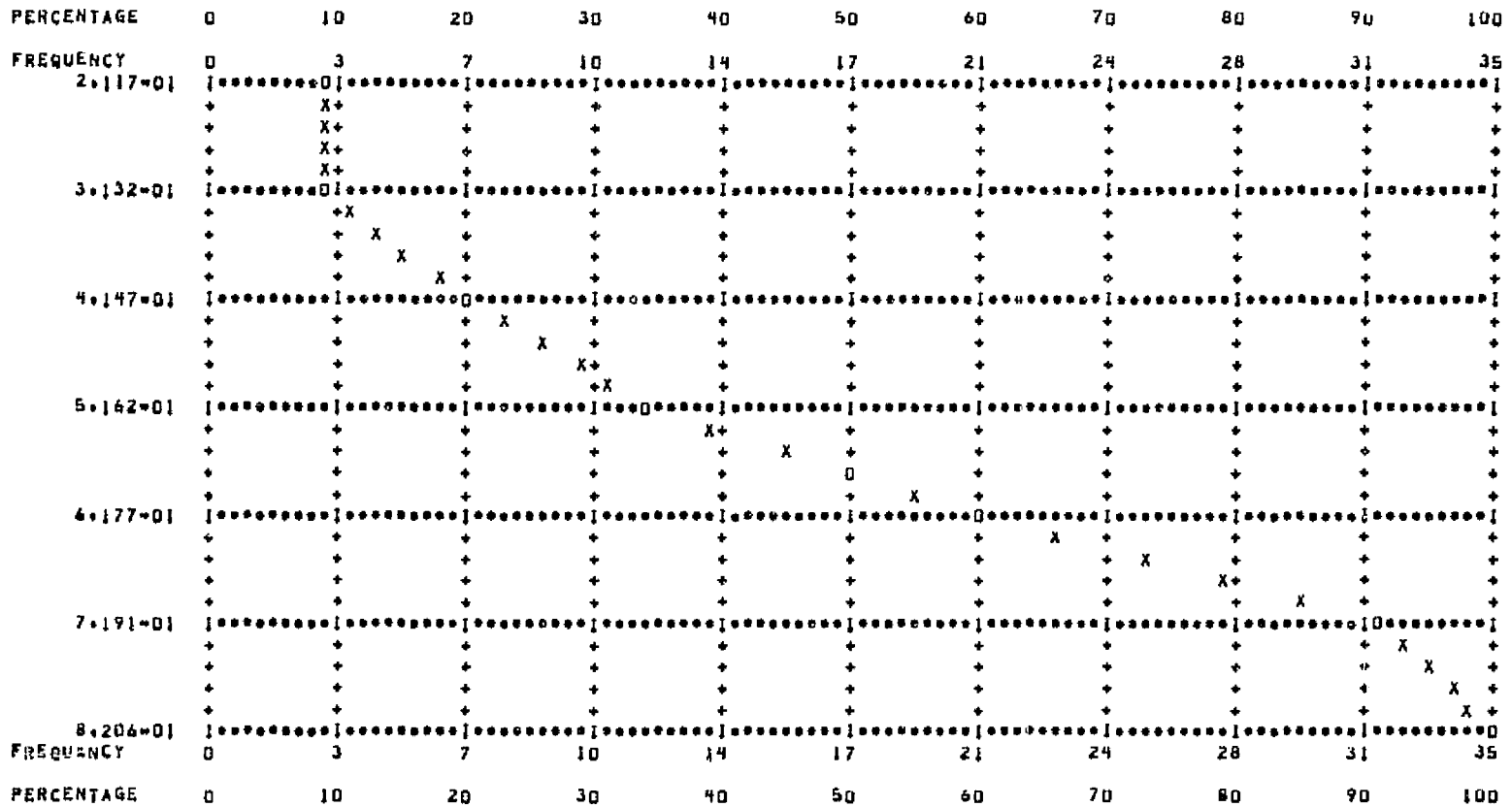
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STEP= .10148651  
 CENTERPOINT OF INITIAL GROUP= .11021756 NO. OF OBSERVATIONS= 35  
 CENTERPOINT OF FINAL GROUP= .82062310 NO. OF GROUPS= 7  
 K FACTOR= 3.





STEP# 1014845;  
 CENTERPOINT OF INITIAL GROUP# 11021756 NO. OF OBSERVATIONS# 35  
 CENTERPOINT OF FINAL GROUP# 82062310 NU. OF GROUPS# 7



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\$STAT  
 XMIN = .11021756E+00,  
 XHAX = .82062310E+00,  
 XBAR = .53821459E+00,  
 VAR = .28260567E-01,  
 SDEV = .16810880E+00,  
 \$END

CONCENTRATION CORRELATION ANALYSIS

CHEMICAL ELEMENTS	VARIANCE COVARIANCE	CORRELATION COEFFICIENT	CORRELATION PROBABILITY
K - K	.0941	1.0000	1.0000
K - S	.0112	.2164	.7883
S - S	.0283	1.0000	1.0000

#### 4.6 References

1. Andersen, C. A., "An Introduction to the Electron Probe Microanalyzer and its Applications to Biochemistry," Methods of Biochemical Analysis, Vol. XV, Interscience Publ. (1967), p. 147.
2. Colby, J. W., Advances in X Ray Analysis, 11, 287 (1968).
3. Earle, K. M. and Tousimis, A. J., "X-Ray and Electron Probe Analysis in Biomedical Research," Prog. in Anal. Chem., Vol. 3, Plenum Press, N. Y. (1969).
4. Heinrich, K.F.J., Ed., "Quantitative Electron Probe Microanalysis," NBS Spec. Publ. 298, 1968.