National Bureau of Standards
Mass Calibration Computer Software

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This report describes the FORTRAN computer program used to generate a comprehensive report covering the sequence of operations used to assign mass values to weights submitted to the National Bureau of Standards for calibration. The assignment of these values is accomplished by the method of least squares analysis of the observation of differences between test items and reference items having the same or nearly same density and nominal size. The calculations are defined and the various weighing method options are given. To assist the user, a detailed description of the input data, an input list of error messages, a listing of a sample test case and a listing of the output resulting from the use of the sample test case are given. To assist in the implementation of the computer program, a flow chart, a description of each subprogram, a cross-reference of labeled COMMON, a list of DOUBLE PRECISION variables, a list of EQUIVALENCED variables and other pertinent information is given.

Key words: Calibration report; correction to mass measurements; error checking; FORTRAN program; least squares solution; mass calibration; mass measurements.

1.0 Introduction

This report describes the FORTRAN computer program used to generate a comprehensive report covering the sequence of operations used to assign mass values to weights submitted to the Nationl Bureau of Standards for calibration. The assignment of these values is accomplished by the least squares analysis of the observation of differences between test items and reference items having the same or nearly same density and nominal size. The calculations are defined and the various weighing method options are given. To assist the user, a detailed description of the input data, a list of error messages, a listing of a sample test case and a listing of the output resulting from the use of the sample test case are given. To assist in the implementation of the computer software, a flow chart, a description of each subprogram, a cross-reference of labeled COMMON, a list of DOUBLE PRECISION variables, a list of EQUIVALENCED variables and other pertinent information is given.

2.0 Calculations

This section describes in detail the calculations used by the computer software to assign mass values to weights which have been submitted for calibration. For a discussion of the philosphy of the procedures used, see references [1,2,6,8]. Section 2.1 lists the definition of the symbols used and their corresponding FORTRAN variable names. The use of | | in this section denotes the absolute value of the enclosed quantity. The use of [ ] denotes a matrix operation with the exception of the mentioning of a reference. The use of ' denotes the transpose of a vector or matrix. Most, but not all, of the calculations described in this section are performed by the MAIN program.

The average temperature, humidity and pressure are determined from values taken before and after each set of measurements. Because the instruments used to measure these environmental conditions may change with each weighing, the appropriate instrumental correction to the temperature, humidity and pressure are given with each set of weighings as follows:

$$\overline{T} = (T_1 + C_{T1} + T_2 + C_{T2})/2$$
$$\overline{H} = (H_1 + C_{H1} + H_2 + C_{H2})/2$$
$$\overline{P} = (P_1 + C_{P1} + P_2 + C_{P2})/2$$

All input weights (nominals) are converted to grams if they are in pounds.

$$W_j = W_j \times 453.59237 \text{ for } j = 1,\ldots,k$$

Accepted mass correction and the volume of the restraint are computed as follows:

<u>If first series</u>

$$C_R = [V_1'\tau]$$

$$V_R = [V_1'B]$$

where $B_j = \dfrac{(W_j + .001\tau_j)}{\rho_j}(1 + \alpha_j \Delta t)$ for $j = 1,\ldots,k$

and where $\Delta t = \overline{T} - T_o$, the difference between observed average temperature and nominal temperature.

<u>If not first series</u>

$$C_R = R_c$$
$$V_R = V_s(1 + S_3 \Delta t)$$

Calculations for Buoyancy Corrections

The air density using the averaged environmental conditions is computed from the equation given by Bowman and Schoonover [3].

$$\rho_A = \frac{0.464746}{T_K}\left(P - 0.00378029(H)(e_s)\right)$$

where

ρ_A = density of air in mg/cm^3

T_K = temperature of air in Kelvin

= temperature of air in degrees Celsius + 273.15

H = Relative Humidity in percent
(i.e. 20% = 20)

P = Barometric Pressure in mm of Mercury

e_s = Saturation Vapor Pressure in mm of Mercury

= Exp(p)/(13.5951 x 9.80665)

$$\begin{aligned} p = &-4.7406885 \times \mathrm{Ln}(T_K) \\ &-6.8982434 \times 10^3 \times T_K^{-1} \\ &+0.5938385 \times 10^2 \\ &-0.5797662 \times 10^{-2} \times T_K \\ &+6.2223854 \times 10^{-6} \times T_K^2 \end{aligned}$$

The above series expansion is based on an equation developed by Wexler and Greenspan [9]. Using the above equation three values of air density are computed:

$$\rho_a = f(\overline{T},\overline{P},\overline{H})$$

$$\rho_{ab} = f(T_1 + C_{T1},\ P_1 + C_{P1},\ H_1 + C_{H1})$$

$$\rho_{aa} = f(T_2 + C_{T2},\ P_2 + C_{P2},\ H_2 + C_{H2})$$

The air buoyancy correction is also applied to the sensitivity weight in computing the mass/division factor:

$$S^* = S_w - \rho_a S_v(1 + S_c \Delta t)$$

<u>Types of weighings</u>

The following calculations depend upon the type of weighing used. The program has provisions for the following six different types of weighing methods. The values of the input parameters N1 and N2 are designated, in parenthesis, for each method.

1. Single Substitution - one pan (N1 = 2, N2 = 1)
2. Single Substitution - two pan (N1 = 2, N2 = 0)
3. Single Transposition - two pan (N1 = 0, N2 = 0)
4. Double Substitution - one pan (N1 = 3, N2 = 1)
5. Double Substitution - two pan (N1 = 3, N2 = 0)
6. Double Transposition - two pan (N1 = 1, N2 = 0)

The weighing method used depends upon the type of balances and weights available, the requirements of the job at hand and/or the preference of the operator performing the calibrations. In all types of weighing, the observed difference, A-B, where A denotes the unknown weight and B denotes the standard or known weight, and the observed sensitivity denoted by S, are computed in scale divisions. The drift effect and the left-right effect may or may not be calculated depending upon the type of weighing being used. The following descriptions of each weighing method explain the pertinent calculations.

Single Substitution - one pan balance

Two or three readings are made. The sensitivity weight is not always measured.

$$\begin{aligned} O_1 &= A \\ O_2 &= B \\ O_3 &= B+S \\ (\widehat{A-B}) &= O_1 - O_2 \\ \hat{S} &= -O_2 + O_3 \quad \text{if } O_3 \neq 0 \\ \hat{S} &= 0.0 \quad \text{if } O_3 = 0 \end{aligned}$$

There is no drift or left-right effect computed.

Single Substitution - two pan balance

There are six or nine readings made for each set of A and B weights. The sensitivity weight is not always measured.

$$\left.\begin{aligned} O_1 &= A \\ O_2 &= A \\ O_3 &= A \end{aligned}\right\}$$ 3 readings are taken as the balance is approaching a stable condition.

$$\left.\begin{aligned} O_4 &= B \\ O_5 &= B \\ O_6 &= B \end{aligned}\right\}$$ 3 readings are taken as the balance is approaching a stable condition.

$$\left.\begin{aligned} O_7 &= B+S \\ O_8 &= B+S \\ O_9 &= B+S \end{aligned}\right\}$$ 3 readings are taken as the balance is approaching a stable condition. These 3 readings are sometimes omitted.

$$(\widehat{A-B}) = \frac{O_1 + 2xO_2 + O_3}{4} - \frac{O_4 + 2xO_5 + O_6}{4}$$

$$\hat{S} = \left| \frac{O_7 + 2xO_8 + O_9}{4} - \frac{O_4 + 2xO_5 + O_6}{4} \right| \text{ if } O_7,\ O_8 \text{ and } O_9 \text{ are given}$$

$\hat{S} = 0.0$ if O_7, O_8 and O_9 are not included. There is no drift of left-right effect computed.

<u>Single Transposition - two pan balance</u>

There are six or nine readings made for each set of A and B weights. If a sensitivity reading is not taken zeros must be used as input to the program.

$\left.\begin{matrix} O_1 \\ O_2 \\ O_3 \end{matrix}\right\}$ With A on one pan and B on the opposite pan, three readings are taken as the balance approaches a stable condition.

$\left.\begin{matrix} O_4 \\ O_5 \\ O_6 \end{matrix}\right\}$ Weights A and B are interchanged, three readings are taken as the balance approaches a stable condition.

$\left.\begin{matrix} O_7 \\ O_8 \\ O_9 \end{matrix}\right\}$ The sensitivity weight is added to either pan and three readings are taken as the balance approaches a stable condition. These readings may be omitted.

$$\widehat{(A-B)} = \frac{1}{2}\left(\frac{O_1 + 2xO_2 + O_3}{4} + \frac{O_4 + 2xO_5 + O_6}{4} \right)$$

$$\hat{S} = \left| \frac{O_7 + 2xO_8 + O_9}{4} - \frac{O_4 + 2xO_5 + O_6}{4} \right| \text{ if } O_7,\ O_8 \text{ and } O_9 \text{ are given}$$

$\hat{S} = 0.0$ if O_7, O_8 and O_9 are not given

$$\widehat{LR} = \frac{1}{2}\left(\frac{O_1 + 2xO_2 + O_3}{4} + \frac{O_4 + 2xO_5 + O_6}{4} \right)$$

There is no drift factor computed.

Double Substitution - one pan balance with drift

Four readings are made for each set of A and B weights where:

$0_1 = A$

$0_2 = B$

$0_3 = B+S$

$0_4 = A+S$

The least square solutions for $(\hat{A-B})$, $\hat{S}$, $\hat{\Delta}$ (drift) are:

$$(\hat{A-B}) = \frac{0_1 - 0_2 - 0_3 + 0_4}{2}$$

$$\hat{S} = \frac{0_1 - 3x0_2 + 3x0_3 - 0_4}{2}$$

$$\hat{\Delta} = \frac{-0_1 + 0_2 - 0_3 + 0_4}{2}$$

There is no left-right effect computed.

The value $\hat{\Delta}$ is based on a 1Δ change in scale readings between each reading.

Double Substitution - two pan balance with drift

A total of 12 readings are made for each set of A and B weights where:

$\left.\begin{matrix} 0_1 \\ 0_2 \\ 0_3 \end{matrix}\right\}$ Three readings are taken of weight A as the balance approaches a stable condition.

$$\left.\begin{matrix} O_4 \\ O_5 \\ O_6 \end{matrix}\right\}$$ Three readings are taken of weight B as balance approaches a stable condition.

$$\left.\begin{matrix} O_7 \\ O_8 \\ O_9 \end{matrix}\right\}$$ Three readings are taken of weight B+S as balance approaches a stable condition.

$$\left.\begin{matrix} O_{10} \\ O_{11} \\ O_{12} \end{matrix}\right\}$$ Three readings are taken of weight A+S as balance approaches a stable condition.

$$(\hat{A-B}) = \frac{1}{2}\left(\frac{O_1 + 2xO_2 + O_3}{4} - \frac{O_4 + 2xO_5 + O_6}{4} - \frac{O_7 + 2xO_8 + O_9}{4} + \frac{O_{10} + 2xO_{11} + O_{12}}{4}\right)$$

$$\hat{S} = \frac{1}{2}\left|\frac{O_1 + 2xO_2 + O_3}{4} - \frac{3(O_4 + 2xO_5 + O_6)}{4} + \frac{3(O_7 + 2xO_8 + O_9)}{4} - \frac{O_{10} + 2xO_{11} + O_{12}}{4}\right|$$

$$\hat{\Delta} = \frac{1}{2}\left(-\frac{O_1 + 2xO_2 + O_3}{4} + \frac{O_4 + 2xO_5 + O_6}{4} - \frac{O_7 + 2xO_8 + O_9}{4} + \frac{O_{10} + 2xO_{11} + O_{12}}{4}\right)$$

The value $\hat{\Delta}$ is based on a 1Δ change in scale readings between reading.

Double Transposition - two pan balance with drift

A total of twelve readings are made for each set of A and B weights where:

$$\left.\begin{matrix} 0_1 \\ 0_2 \\ 0_3 \end{matrix}\right\}$$ With A on one pan and B on the opposite pan, three readings are taken as the balance approaches a stable condition.

$$\left.\begin{matrix} 0_4 \\ 0_5 \\ 0_6 \end{matrix}\right\}$$ With A and B interchanged, three readings are taken as the balance approaches a stable condition.

$$\left.\begin{matrix} 0_7 \\ 0_8 \\ 0_9 \end{matrix}\right\}$$ With the sensitivity weight added to either A or B, three readings are taken as the balance approaches a stable condition.

$$\left.\begin{matrix} 0_{10} \\ 0_{11} \\ 0_{12} \end{matrix}\right\}$$ With the sensitivity weight added to the opposite pan from the position of the last 3 readings, 3 readings are taken as the balance approaches a stable condition.

$$(\hat{A-B}) = \frac{1}{4}\left(\frac{0_1 + 2x0_2 + 0_3}{4} - \frac{0_4 + 2x0_5 + 0_6}{4} - \frac{0_7 + 2x0_8 + 0_9}{4} + \frac{0_{10} + 2x0_{11} + 0_{12}}{4}\right)$$

$$\hat{S} = \frac{1}{2}\left|\frac{0_1 + 2x0_2 + 0_3}{4} - \frac{3(0_4 + 2x0_5 + 0_6)}{4} + \frac{3(0_7 + 2x0_8 + 0_9)}{4} - \frac{0_{10} + 2x0_{11} + 0_{12}}{4}\right|$$

$$\hat{\Delta} = \frac{1}{2}\left(-\frac{O_1 + 2\mathrm{x}O_2 + O_3}{4} + \frac{O_4 + 2\mathrm{x}O_5 + O_6}{4} - \frac{O_7 + 2\mathrm{x}O_8 + O_9}{4} + \frac{O_{10} + 2\mathrm{x}O_{11} + O_{12}}{4}\right)$$

$$\hat{LR} = \frac{1}{4}\left(\frac{3(O_1 + 2\mathrm{x}O_2 + O_3)}{4} + \frac{O_4 + 2\mathrm{x}O_5 + O_6}{4} + \frac{O_7 + 2\mathrm{x}O_8 + O_9}{4} - \frac{O_{10} + 2\mathrm{x}O_{11} + O_{12}}{4}\right)$$

The value $\hat{\Delta}$ is based on a 1Δ change in scale readings between each reading.

Preparation of data for least squares analysis

The design matrix is used to compute the load L_i for each observation.

$$L_i = \sum_{j=1}^{k} \frac{|X_{ji}|}{2} W_j \text{ for } i = 1,\ldots,n$$

and the maximum load

$$L_{max} = \max\ [L]$$

The values $(\hat{A-B})$, $\hat{S}$ and $\hat{\Delta}$ are converted from scale divisions to [illegible] units. The following calculations apply to all types of weighings. [illegible] the average of the observed sensitivity in scale divisions over all [illegible] of observations which have a constant load is computed.

a. SUM $= \Sigma\ \hat{S}_i$ for $\hat{S}_i \neq 0$ and until L_i changes its value

$\hat{S}_i = S^*/\hat{S}_i$

b. $\overline{D} = SUM/j$

where j = number of non zero values in step a.

c. $S_{mu} = |S^*/\overline{D}|$

d. $Y = \dfrac{(\hat{A-B})\ S^*}{\overline{D}}$

e. $\Lambda_{mu} = \dfrac{\hat{\Delta}\ S^*}{\overline{D}}$

f. Change the sign of S_{mu} and Y if input parameter (N4) indicates a reversed scale.

g. Flag values of

$$\left| \frac{(\hat{A-B})}{\overline{D}\sqrt{j}} \right| \text{ which are } > .25$$

where $(\hat{A-B})$ is the observed deflection and $\overline{D}\sqrt{j}$ is the sensitivity deflection.

h. Steps a. - g. are repeated for all observations.

Next, the restraint values for the series is computed. If it is the first series the following are computed:

a. Accepted Correction for restraint

$$R_c = [V'_1 \tau]$$

b. Restraint corrected for environmental condition

$$X^* = [V'_1]\ [\tau - p_a(B)]$$

where B is defined on page 2.

If not first series, the following are computed:

$$\rho_j = (W_j + .001\ R_c)/V_s \text{ for } j=1,\ldots,k \text{ and } V_{1_j} \neq 0$$

$$\alpha_j = S_3 \text{ for } j=1,\ldots,k \text{ and } V_{1_j} \neq 0$$

$$X^* = R_c = \rho_a V_s (1 + S_3\ \Delta t)$$

In general, let E(Y) denote the vector of expected values, let X denote the matrix of coefficients (the design matrix) and let β denote the column vector of parameters to be estimated. Then

$$E(Y) = [X][\beta].$$

Using the matrix of the coefficients from the equations of the expected values, a matrix representing the design and a vector, Y, for the observed values are set up.

The least squares estimates of the parameters are given by the solution of normal equations.

$$[X'X][\beta] = [X'][Y]$$

where X'X is a kxk matrix. To bring the equations to full rank the matrix of normal equations is augmented by a restraint vector denoted by V_1.

Thus:

$$[Z] = \begin{bmatrix} [X'X] & [V_1] & [X'Y] \\ [V_1'] & \lambda & X^* \\ 0 & 0 & -1 \end{bmatrix} \qquad \begin{array}{l} \lambda = 1 \text{ if } [V_1] = 0 \\ \lambda = 0 \text{ if } [V_1] \neq 0 \end{array}$$

For more details on the structure of the above matrix see refe[illegible] [7,10,11]. The inverse of the above matrix [Z] is calculated. Two [illegible] are made to determine the success or failure of the inversion.

1. A check is made for singularity.

2. The maximum value of $[I-ZZ^{-1}]$ should be $\leq .01\,\sigma_W$ where

   I is the identity matrix

   σ_W is the accepted within standard deviation of the process

   Z^{-1} is the inverse of Z.

If either of these tests fail an error message is printed and no further calculations will be made. Control will be sent to the subprogram PRINT2 and no final report will be printed.

If the matrix inversion is successful

$$[Z]^{-1} = \begin{bmatrix} [C] & \vdots & [\hat{\beta}] \\ \cdots\cdots & & \cdots\cdots \end{bmatrix}$$

where: C is the kxk matrix containing the elements of the inverse of matrix of normal equations and $\hat{\beta}$ contains the parameter estimates

The deviations (observed-predicted) are computed. In matrix notation

$$[\delta] = [Y] - [X]\,[\hat{\beta}]$$

with dimensions n x 1, n x 1, n x k and k x 1.

The corrections using the estimated parameter values corrected by the air buoyancy correction are computed. An iterative process is used to minimize the error of the estimated values. The calculations are performed using double precision arithmetic.

$$C1_j = \hat{\beta}_j + \rho_a \left(\frac{W_j}{\rho_j}\right)(1 + \alpha_j \Delta t) \quad \text{for } j = 1,\ldots,k$$

a. $$C2_j = \hat{\beta}_j + \rho_a \left(\frac{W_j + .001\ C1_j}{\rho_j}\right)(1 + \alpha_j \Delta t) \quad \text{for } j = 1,\ldots,k$$

b. If all $|\ C2_j - C1_j\ | < .01\ \sigma_W$ continue calculations.

If the above condition is not true set

$$C1_j = C2_j \quad \text{for } j = 1,\ldots,k$$

and repeat steps a. and b. above for a maximum of 10 iterations. A message is printed regarding the number of iterations required.

Determine value of restraint in terms of nominal values.

$$W_R = [V_1'W]$$

Compute volume of unknowns in terms of the estimated correction produced by the above iteration.

$$V_j = \left(\frac{W_j + .001\ C2_j}{\rho_j}\right)(1 + \alpha_j \Delta t) \quad \text{for } j = 1,\ldots,k$$

Estimates of Uncertainty

Initially, the uncertainty for the starting restraint is entered in two parts: zero for the limit to possible effect of random error, and a value, E_S, for the uncertainty of the starting standards. All subsequent uncertainty values are based on two components - one due to the uncertainties in starting standards and the other due to the uncertainties from the balance and design used.

The uncertainty in an individual weight consists of the following components:

Systematic Error

$$E_j = \left(\frac{W_j}{W_R}\right) E_s \quad \text{for } j = 1,\ldots,k$$

Random Error

$$R_j = \sqrt{(3\sigma_w)^2\ C_{jj} + \left(\frac{W_j}{W_R}\right)^2 (3\sigma)^2 + (3\sigma_T)^2} \quad \text{for } j = 1,\ldots$$

where

σ_w is the accepted within standard deviation of the

C_{jj} are the diagonal elements of the inverse of the of normal equations

3σ is random error affecting the restraint*

σ_T is the accepted between variance of the process

The total uncertainty is the sum of the systematic error and the random error.

$$U_j = E_j + R_j \quad \text{for } j = 1,\ldots,k$$

For the outgoing restraint the corresponding values are

Systematic Error

$$E_o = [V_3' \, E]$$

Random Error

$$R_o = \sqrt{(3\sigma_w)^2 \, [V_3' \, CV_3] + \left(\frac{[V_3' \, W]}{W_R}\right)^2 (3\sigma)^2 + (3\sigma_T)^2}$$

If certain weights are to be used in combination, sets of linear combinations, V_5, may be specified. If this is the case the following calculations are made:

Correction to nominals in linear combination

$$C_\ell = [V_5' \, C2]$$

Systematic error for linear combination

$$E_\ell = [|V_5'|E]$$

Random error for linear combinations

$$R_\ell = \sqrt{(3\sigma_W)^2 \, [V_5' \, C \, V_5] + \left(\frac{[V_5' \, W]}{W_R}\right)^2 (3\sigma)^2 + (3\sigma_T)^2}$$

Total uncertainty for linear combination

$$U_\ell = E_\ell + R_\ell$$

Initial restraint, the random error is zero.

Precision control is determined by computing the standard deviation

$$s = \sqrt{\frac{\Sigma\delta^2}{n-k+1}}$$

and comparing this with the accepted standard deviation, σ_w, by computing the F ratio

$$F = s^2/\sigma_w^2$$

and comparing it with the critical value for the F distribution. The critical value for the F distribution is given by

$$F_t = \left(1 - \frac{2}{9(n-k+1)} + 2.32635\sqrt{\frac{2}{9(n-k+1}}\right)^3$$

$$\text{for } (n-k+1) \geq 2$$

$$F_t = 6.64 \text{ for } (n-k+1) = 1$$

If $F > F_t$, a message is printed, on the last page of printout for a series, stating that the process is not in control.

The observed value for the check standard is given by

$$C_c = [V_2' \ C2]$$

The nominal value of the check standard is given by

$$[V_2' \ W]$$

The accepted correction value for the check standard is given by

$$[V_2' \ \tau]$$

The difference between the observed and the accepted value is divided by the standard deviation of the check standard to produce the t-test value

$$T = \frac{[V_2' \, C2] - [V_2' \, \tau]}{\sigma_c}$$

where

$$\sigma_c = \sqrt{(\sigma_w)^2 [V_2' \, C \, V_2] + \left(\frac{[V_2' \, W]}{W_R}\right)^2 \sigma^2 + (\sigma_T)^2}$$

This value is compared with T_t where

$$T_t = \frac{[V_2' \, E]}{\sigma_c}$$

If $|T - T_t| \geq 3$ a message is printed on the last page of printout for a series stating that the check standard is not in control.

Compute values for the final summary of the report as requested by the input vector V_4.

Apparent mass versus brass in milligrams

$$M_a = \left(\frac{(W + .001 \; C2)\left(1 - \frac{.0012}{\rho}\right)}{1 - \frac{.0012 \; (1 + .000054 \times 20)}{8.4}} - W \right) 1000$$

Mass of weight in grams

$$M_T = W + .001 \; C2$$

Total uncertainty in grams

$$U_f = .001 \; U$$

Volume at 20°C

$$V_f = \frac{W + .001 \; C2}{\rho}$$

Coefficient of expansion

$$C_f = \alpha$$

Apparent mass versus a standard having a density if 8.0 grams/CM3 at 20°C

$$CR_f = \left(\frac{(W + .001\ C2)\ (1 - \frac{.0012}{\rho})}{1 - \frac{.0012}{8.0}} - W \right) 1000$$

Set up values to be saved for next series if no errors were made and if another series is requested.

Systematic Error

$$E_s = E_o$$

Random Error

$$3\sigma = R_o$$

$$S_3 = \frac{[V_3' \ S_2]}{[V_3' \ S_1]}$$

where

$$S_1 = \frac{W + .001\ C2}{\rho}$$

$$S_2 = \alpha \left(\frac{W + .001\ C2}{\rho} \right)$$

Compute restraint for the next series.

$$R_c = [V_3' \ C2]$$

Compute volume of restraint for the next series.

$$V_s = [V_3'] \left(\frac{W_j + .001\ C2_j}{\rho_j} \right) \quad \text{for } j = 1, \ldots$$

2.1 Dictionary of Symbols and Corresponding FORTRAN Variable Names

The first column contains the symbol used by this documentation. The second column denotes input (I), output (O) or computed value (C). The third column gives the variable name used by computer program. The fourth column gives a brief description of the parameter. The symbols are listed in the order that they are used in the program.

Symbol		FORTRAN Name	Description
	I/O	B1	name or organization
	I/O	B2	address of organization
	I/O	B3	address of organization
	I/O	B4	description of weights being calibrated
	I/O	B5	serial number of set of weights
	I/O	B6	date of report
	I/O	B7	test folder number (used for NBS records of calibrations)
3σ	I	RANERR	3 standard deviation limit for random error affecting the restraint
E_s	I	SYSERR	Systematic error in the restraint
T_o	I	TNOM	nominal temperature
T_1	I	T1P	temperature reading in Celsius at beginning of measurements
T_2	I	T2P	temperature reading in Celsius at end of measurements
P_1	I	P1P	pressure reading in mm of Mercury at beginning of measurements
P_2	I	P2P	pressure reading in mm of Mercury at end of measurements
H_1	I	H1P	humidity reading in percent at beginning of measurements

H_2	I	H2P	humidity readings in percent at end of measurements
C_{P1}	I	CP1	correction to "before" pressure reading in mm of Mercury
C_{P2}	I	CP2	correction to "after" pressure readings in mm of Mercury
C_{T1}	I	CT1	correction to "before temperature reading in Celsius
C_{T2}	I	CT2	correction to "after" pressure reading in Celsius
C_{H1}	I	CH1	correction to "before" humidity reading in percent
C_{H2}	I	CH2	correction to "after" humidity reading in percent
$\overline{T}$	C	TBAR	average corrected temperature in Celsius
$\overline{P}$	C	PBAR	average corrected pressure in mm of Mercury
$\overline{H}$	C	HBAR	average corrected humidity in percent
n	I	NOBS	number of observations $\leq$ 50
k	I	NUNKN	number of unknowns $\leq$ 15
σ_w	I	STDEBA	accepted within standard deviation of [redacted] process in mg.
S_w	I	SWT	true mass value in mg. of sensitivit[redacted] weight
S_v	I	VSWT	volume of sensitivity weight in cm[redacted] 20°C
S_c	I	CEXSWT	coefficient of expension of sensi[redacted] weight
σ_T	I	VARBAL	accepted between standard deviat[redacted] the process in mg.
W	I	ANOM	nominal value of weight in gra[redacted] pounds
ρ	I/C	DENSTY	density of weights in g/cm^3 a[redacted]

α	I/C	COEFEX	coefficient of expansion of weight
τ	I	ACCVAL	accepted correction of weight in mg.
V_1	I	ARSTIN	vector identifying items in the restraint
V_2	I	ACKSTD	vector identifying items in the check standard
V_3	I	IRSTOU	vector identifying items to be used as restraint in the next series
V_4	I	INPRNT	print vector
X	I	DESMAT	design matrix
V_5	I	ALCOM	linear combination vector
O	I	OBSERV	observations
Δt	C	TDELT	difference between observed temperature and nominal temperature
C_R	C	CORR	mass correction for restraint in mg.
V_R	C	VOLRES	volume of weights in restraint in cm^3
B	C	TEMP	volume of weights
T_K	C	TKEL	temperature in degrees Kelvin
ρ_a	C	RHOA	air density for average environment conditions
ρ_{ab}	C	RHOAB	air density for "before" environment conditions
ρ_{aa}	C	RHOAA	air density for "after" environment conditions
L	C	ILOAD	vector of loads
L_{max}	C	ALOADP	maximum load
S^*	C	STAR	the mass of the sensitivity weight with air buoyancy correction applied
$\widehat{(A-B)}$	C	D1	predicted difference A-B in scale divisions where A is the unknown weight and B the standard
$\hat{S}$	C	DS1	predicted sensitivity in scale divisions

$\hat{\Delta}$	C	DRIFT	predicted drift in scale divisions
$\hat{LR}$	C	ZERO	predicted left-right effect in scale division
$\overline{D}$	C	DBAR	average of observed sensitivities of load of equal size
S_{mu}	C	SWTPRT	average sensitivity in mass units (mg/division)
Y	C	A	observed (A-B) in mass units where A is the unknown weight and B the standard
Δ_{mu}	C	DRIFT	drift in mass units
X*	C	XREST	accepted mass correction for retraint in mg.
R_c	C	TMSUM	computed restraint correction in mg. for the m+1 series
Z	C	Y	matrix of normal equations
C	C	Y	diagonal elements of the inverse of the matrix of normal equations
δ	C	DELTA	deviation between observed and predict weight values
C1	C	CORRP	estimated correction to the nominal in grams
C2	C	OBSCOR	observed correction after iteration
β	C	Y	estimated values of unknown from Z^{-1}
W_R	C	WR	nominal weight of restraint
V	C	COMVOP	computed volume of unknown using estimated corrections
E	C	SERROR	systematic error for each weight
R	C	TRISIG	random error for each weight
U	C	TOTUN	total uncertainty of each weight
V_s	C	SOLSUM	computed value of volume for m+1 se[illegible]
C_ℓ	C	CORR5A	corrections for linear combination[illegible]
E_ℓ	C	SER5A	systematic error for linear combin[illegible]

R_ℓ	C	SIG35A	random error for linear combination
U_ℓ	C	UNC5A	total uncertainty for linear combinations
E_o	C	SERSUM	systematic error for outgoing restraint
R_o	C	T3SIG	random error for outgoing restraint
s	C	OBSTD	observed standard deviation of the series
F	C	FRATIO	f - test ratio
F_t	C	PRETST	critical value for the F distribution
C_c	C	OBCOCK	observed check standard
σ_c	C	OBSCK	standard deviation of observed check standard
T	C	TVAL	t - test value
M_a	C	APPMAS	apparent mass verses brass for final output
M_T	C	TRMASS	mass of weight in grams or pounds for final output
U_f	C	UNCERT	total uncertainty in grams or pounds for final output
V_f	C	VOLPRT	volume at 20°C for final output
C_f	C	COEPRT	coefficient of expansion for final output
CR_f	C	CORRB	apparent mass verses density 8.0 for final output
S_3	C	SUMP	value used to compute volume of restraint for m+l series

3.0 Information For Users

This section contains information pertinent to the user of the

Description of Input

The input requirements of the computer program are defined in this section. The data entry column defines each unique data item, not each input record. The data, with a few designated exceptions where a format is given, is recorded in a free field format. The subprogram name and the FORTRAN variable name for each data entry is given along with a brief description of the input parameter. See Appendix A.1 for a listing of sample data.

DATA ENTRY	FORMAT	SUBPROGRAM	VARIABLE NAMES AND DESCRIPTION
#1*	72A1	READ1	B1 - name of company submitting test weight
#2*	72A1	READ1	B2 - address (street name and number)
#3*	72A1	READ1	B3 - address (city, state and zip code)
#4*	72A1	READ1	B4 - description of weights to be calibrated
#5*	72A1	READ1	B5 - serial number of set of weights
#6*	72A1	READ1	B6 - date of report
#7**	72A1	READ1	B7 - test folder number (used for NBS records of calibrations)
#8	Variable	READ1	RANERR, SYSERR, TNOM, IBREST
			RANERR - 3 standard deviation limit for random error in the starting restraint
			SYSERR - limit to possible systematic error in the starting restraint
			TNOM - nominal temperature at which apparent mass and volume are reported in degrees Celsius
			***IBREST - starting restraint identification number (2 digits)

* Data entries #1-17 are searched for the first non-blank character at which time all remaining characters are saved for printing on the document, i.e. leading blanks are eliminated.

** On output, only the first 18 non-blank characters are printed.

*** See Figure I.

DATA ENTRY	FORMAT	SUBPROGRAM	VARIABLES NAMES AND DESCRIPTION (continued)
#9*	Variable	READ2	N1, N2, N3, N4 (describe weighing method) N1=0 single transposition N1=1 double transposition N1=2 single transposition N1=3 double substitution N2=0 two pan balance N2=1 one pan balance N3=0 metric units (grams or milligrams) N3=1 English units (pounds) N4=0 regular balance (scale left to right) N4=1 backwards balance (scale right to left)
#10	Variable	READ2	($IDATE_i$, i=1,2,3), IOP, IBAL, ICKUSD $IDATE_1$ - month (2 digits) $IDATE_2$ - day (2 digits) $IDATE_3$ - year (2 digits) date of measurement IOP - operator number (2 digits) IBAL - balance number (3 digits) ICKUSD - check standard identification (3 digits)
#11	Variable	READ2	T1P, T2P, P1P, P2P, H1P, H2P, CP1, CP2, CT1, CT2, CH1, CH2 T1P, T2P - observed temperature in degrees Celsius before and after measurements are taken P1P, P2P - observed pressure in mm of Mercury before and after measurements are taken H1P, H2P - observed humidity in percent before and after measurements are taken

* Begin reading at this point for each new series.

DATA ENTRY	FORMAT	SUBPROGRAM	VARIABLE NAMES AND DESCRIPTION (Continued)
			CP1, CP2 - pressure corrections in mm of Mercury for observed pressure before and after measurements are taken
			CT1, CP2 - temperature corrections in degrees Celsius for observed temperature before and after measurements are taken
			CH1, CH2 - humidity corrections in percent for observed humidity before and after measurements are taken
#12	Variable	READ2	NOBS, NUNKN, ICALDS, LINVAR
			NOBS - number of observations $\leq$ 50
			NUNKN - number of unknowns $\leq$ 15
			*ICALDS - calibration design number (3 digits)
			LINVAR - number of linear combinations $\leq$ 19
#13	Variable	READ2	STDEBA, SWT, VSWT, CEXSWT, VARBAL
			STDEBA - accepted within standard deviation of the process
			SWT - mass mass value in mg. of the sensitivity weight
			VSWT - volume of sensitivity weight in cm^3 at 20 degrees Celsius
			CEXSWT - coefficient of expansion of sensitivity weight
			VARBAL - accepted between standard deviation of the process in mg.

* See Figure II.

DATA ENTRY	FORMAT	SUBPROGRAM	VARIABLE NAMES AND DESCRIPTION (Continued)
#14*	Variable (Exception- the first 15 characters are for the identification)	READ2	$AIDCST_{j,i}$, j=1,...,5, $ANOM_i$, $DENSTY_i$, $COEFEX_i$, $ACCVAL_i$, i=1,...,NUNKN $AIDCST_{j,i}$, j=1,...,5 - weight identification in positions 1-15 of the input record $ANOM_i$ - nominal weight in grams or pounds $DENSTY_i$ - density of weight in g/cm^3 at 20°C $COEFEX_i$ - coefficient of expansion of weight $**ACCVAL_i$ - accepted correction to weight in mg.
15	Variable	READ2	$ARSTIN_i$, i=1,...,NUNKN Vector identifying items in the restraint. Entries may be 0 or 1 only.
16	Variable	READ2	$ACKSTD_i$, i=1,...,NUNKN Vector identifying items in the check, standard. Entries may be 0, -1, or 1.
17	Variable	READ2	$IRSTOU_i$, i=1,...,NUNKN Vector identifying items in restraint for the m+1 series. This vector has entries of 0 or 1. If there is not another series, entries are all zero.
18	Variable	READ2	$IPRNT_i$, i=1,...,NUNKN Vector identifying items to be reported in the summary. A value of 1 means report and 0 means omit from report.
#19***	Variable	READ2	$****DESMAT_{j,i}$, j=1,...,NUNKN, i=1,...,NOBS The design matrix consists of entries of 0, 1, or -1 for the series. Each data item contains NUNKN values. Repeat NOBS times.

* Repeat this data entry for each unknown.
** This value is always given in mg., even if the nominal is in pounds.
*** Repeat this data entry for each observation.
**** The design matrix defines the method which is being used to group and intercompare the unknown weights and the check standard (the known weight).

DATA ENTRY	FORMAT	SUBPROGRAM	VARIABLE NAMES AND DESCRIPTION (Continued)
#20	Variable	READ2	$ALCOM_{j,i}$, j=1,..., NUNKN; i=1,...,LINVAR. If LINVAR $\neq$ 0 Enter LINVAR vectors containing NUNKN values per vector which describe the required linear combinations. The values in each vector consists 0, 1 or -1.
#21	Variable	READ2	$OBSERV_k$ k=1,...,kk where kk $\leq$ 600 Provide readings in scale divisions corresponding to the design and type of weighing as indicated by data entries #9 and #19. The following combinations of N1 and N2 determine the number of entries per record for each observation. If for any reason a reading is not taken, a zero must be used to so indicate.

a. N1=2 and N2=1 Enter O_1, O_2, O_3; 2 or 3 values per record

b. N1=2 and N2=0 Enter $O_1, O_2, O_3, O_4, O_5, O_6, O_7, O_8, O_9$; 6 or 9 values per record

c. N1=0 and N2=0 Enter $O_1, O_2, O_3, O_4, O_5, O_6, O_7, O_8, O_9$; 6 or 9 values per record

d. N1=3 and N2=1 Enter O_1, O_2, O_3, O_4; 4 values per record

e. N1=3 and N2=0 Enter $O_1, O_2, O_3, O_4, O_5, O_6$; 6 values per record (2 records)

$O_7, O_8, O_9, O_{10}, O_{11}, O_{12}$

f. N1=1 and N2=0 Enter same as e. above.

Any other combinations of N1 and N2 assumes f. as defined above.

#22	Variable	READ2	A value (-20000) terminates the reading of observations. It is the responsibility of user to be sure that the number of observa corresponds to the number required by the specified schedule given in data entry #19

If the vector described in data entry #17 is not equal to zero, conti input of data repeating from data entry #9. If the vector is zero terminates the input of data. This flag must appear in position 1 4 of the input record.

Figure I. Starting Restraint Identification Used at NBS

Given below is an example of frequently used restraint identifications used at NBS. The symbol g denotes grams and kg kilograms.

Restraint Identification	Weights Used in the Restraint
1	N kg_1 + N kg_2
2	NB[1] 100g + AA 100g
4	NB[1] 1g

Figure II. Calibration Design Number Used at NBS

Given below is an example of frequently used calibration identifications with the design, the number of weight and the required number of observations for each.

Design Identification	Design	No. of weights	No. of observations
1	1,1,1	3	3
16	5,2,2,1,1,1	6	8
41	1,1,1,1	4	6
51	1,1,1,1,1	5	10
53	5,3,2,1,1	5	8
62	5,3,2,1,1,1	6	11

3.2 <u>Diagnostic and Error Messages</u>

This section lists all the possible error messages and other informative messages concerning the statistical tests made by the program. The subprogram which contains the message and an explanation of the message is given. The message is given in quotes and an indication (i.e.---) is given if some computed quantity is also printed.

A. "NEG SQRT ARG = ---"

This message is printed by the MAIN program if the value under the radical is negative in the computation of the random error for a weight. If the value under the radical is negative it is assumed to be zero.

B. The following six messages appear in the subprogram ERROR. They are error messages resulting from the execution of subprogram READIT and indicate that an input value is too large or too small for the capacity of the computer being used.

(1) "***** DIAGNOTIC ***** THE NUMBER OF SIGNIFICANT DIGITS IN A NUMBER HAS REACHED ---. THIS MAY PRODUCE OVERFLOW OR UNDERFLOW."

(2) "***** ERROR ***** THE NUMBER OF SIGNIFICANT DIGITS IN A NUMBER HAS REACHED ---. THIS WILL PRODUCE OVERFLOW OR UNDERFLOW."

(3) "***** ERROR ***** NUMBER IS TOO SMALL IN ABSOLUTE VALUE AND WILL PRODUCE UNDERFLOW."

(4) "***** DIAGNOSTIC ***** NUMBER IS SMALL IN ABSOLUTE VALUE AND MAY PRODUCE UNDERFLOW."

(5) "***** DIAGNOSTIC ***** NUMBER IS LARGE IN ABSOLUTE VALUE AND MAY PRODUCE OVERFLOW."

(6) "***** ERROR ***** NUMBER IS TOO LARGE IN ABSOLUTE VALUE AND WILL PRODUCE OVERFLOW."

C. The following error message which occurs in the subprogram ERROR is printed after each of the six messages stated above. It prints out the data item containing the invalid data value.

"THIS OCCURRED IN CONNECTION WITH READING THE DATA ON THE FOLLOWING CARD."

D. The subprogram READIT has an option of specifying an alphanumeric value at the beginning of a data item. If this option does not specify the proper number of characters in the alphanumeric value the following message is printed.

"***** ERROR ***** THE VALUE OF 'KOL' IS --- AND THIS VALUE IS INVALID. KOL MUST BE GREATER THAN 0 AND MUST NOT EXCEED 80."

E. If there are problems in the matrix inversion procedure, one of the following two messages is printed:

(1) "MATRIX IS SINGULAR"

(2) "ERROR IN INVERSE".

If the first message occurs, it indicates that there is some problem with the input data. If the second message is printed it means that the condition

$$\max\ [I-AA^{-1}] \leq .01\sigma_W$$

is not met. In addition to the message; the original matrix, the inverted matrix and the $[I-AA^{-1}]$ matrix is printed. Both of these messages are printed by the subprogram PRINT2. After the printing of either of the messages the execution of the program is aborted.

F. "STOPPED AT 10 ITERATIONS"

This message is printed by subprogram PRINT2 and indicates that the iterative process used to compute the observed correction (see page 14 of calculations) was terminated at 10 iterations.

G. "INPUT ERROR IN RESTRAINT. CHECK RESTRAINT VECTOR, NOMINAL VALUE, DENSITY AND COEFFICIENT OF EXPANSION OF RESTRAINT --- MG COMPUTED CORRECTION OF RESTRAINT --- MG"

This diagnostic message is printed by subprogram PRINT2 when the following test fails.

$|[V_1'\tau]$ (accepted restraint) $-[V_1'\ C2]$ (computed restraint)$| < .1\sigma_W$

H. One of the following three diagnostic messages concerning the interpretation of the t-test is printed by subprogram PRINT2. See page 17 for calculation of the t-test.

(1) "ABSOLUTE VALUE OF T IS LESS THAN 3. THEREFORE CHECK STANDARD IS IN CONTROL."

$$|T| < 3.0$$

(2) "ALTHOUGH THE ABSOLUTE VALUE OF T IS GREATER THAN OR EQUAL TO 3, THE T VALUE CORRECTED FOR SYSTEMATIC ERROR IS LESS THAN 3, THEREFORE THE CHECK STANDARD IS IN CONTROL."

$$|T| \geq 3 \text{ AND } (T-T_t) < 3.0$$

(3) "ALTHOUGH THE ABSOLUTE VALUE OF T IS GREATER THAN OR EQUAL TO 3, THE DIFFERENCE IS STILL SIGNIFICANT AFTER ALLOWANCE FOR SYSTEMATIC ERROR, THEREFORE THE CHECK STANDARD IS NOT IN CONTROL."

$$|T| \geq 3 \text{ AND } (T-T_t) \geq 3.0$$

I. One of the following two diagnostic messages concerning the interpretation of the F-test is printed by subprogram PRINT2. The critical value is printed in the space denoted by --. See page 16 for the calculations of the F ratio.

(1) "F RATIO IS LESS THAN---(CRITICAL VALUE FOR PROBABILITY = .01). THEREFORE THE STANDARD DEVIATION IS IN CONTROL."

$$F \leq F_t$$

(2) "F RATIO IS GREATER THAN---(CRITICAL VALUE FOR PROBABILITY = .01). THEREFORE THE STANDARD DEVIATION IS NOT IN CONTROL."

$$F > F_t$$

3.3 Description of Data Output Used for Process Control

If neither the t-test or F-test fails, selected values are saved on a unformatted temporary file during the execution of the program. The temporary file is defined by the variable ITMP in the BLKDAT subprogram. See section 4.6. The subprogram FINPRT reads the temporary file, ITMP, and generates a formatted file (IP as defined by subprogram BLKDAT) of the saved parameters.

The table below defines the parameters with their corresponding format. All parameters are contained in an 80 character record. Appendix A.3 lists the process parameters saved from the sample run given in Appendix A.2.

Variable	Description	Format
$IDATE_1$ $IDATE_2$, $IDATE_3$	date	3I2
IBREST	restraint identification	I2
ICKUSD	check standard identification	I3
OBCOCK	observed check standard value	F11.5
IBAL	balance identification	I3
OBSTD	observed standard deviation	F9.5
NDGFR	degrees of freedom	I2
ICALDS	calibration identification	I3
TBAR	average corrected temperature	F5.2
DIFT	difference between "before" and "after" temperature reading	F5.2
PBAR	average corrected pressure	F6.2
DIFP	difference between "before" and "after" pressure reading	F5.2
HBAR	average corrected humidity	F7.4
DIFH	difference between "before" and "after" humidity reading	F4.1
RHOA	air density as a function of TBAR, PBAR and HBAR	F6.4
IOP	operator	I2
	denotes standard	IHS

4.0 Implementation Information

This section describes the information needed for implementing FORTRAN computer software. Information is given concerning the flow [illegible] function of the MAIN program and all subprograms. In addition, a [illegible] reference table of labeled COMMON; the use of the DATA, DOUBLE-PREC[illegible] and EQUIVALENCE statements; the function of switch variables in the various subprogram and other information which may be bothersome on implementation are given. Figure III on page 43 gives a flow chart of the program. Figure IV on page 44 gives a cross reference table of labeled COMMON.

4.1 Description of MAIN program and all Subprograms

The software consists of one main program and 23 subprograms. This section describes briefly the function of each. The subprogram descriptions are listed in the order in which they are called during the execution of the program.

4.1.01 MAIN Program

This program controls the flow of the input, calculations and output. All the calculations described in Section 2.0 are performed in this program with the exception of a few computations which are performed in subprograms PRINT2 and READ2.

4.1.02 BLKDAT Subprogram

This subprogram is a BLOCK DATA subprogram and contains values which may need to be changed to comply with the demands of a specific computer or computer operating system. The DATA statements define the following values:

a. Machine zero 1×10^{-8} (UNIVAC 1108)

b. Characters: 0-9, blank, - , . , * , + , comma, D and E

c. Input unit number, output unit numbers and number of lines per page

d. Flag STOP to detect end of data and blank

e. The number 10 which controls the number of iterations in the MAIN program. See page 13.

4.1.03 READ1 Subprogram

This subprogram reads data that is common to all series. Eight data entries are read consisting of administrative data, statistical control parameters, nominal temperature and the starting restraint identification. The first seven data entries consisting of administrative information, company name and address and description of weights being tested, are read with a 72A1 format specification. The information may occur anywhere within the 72 position limit. Leading blanks are eliminated before the information is printed on the report. The eighth data entry gives the values for random error, systematic error, nominal temperature and the starting restraint identification. The values are read by a subprogram, READIT, which permits input in a variable format. Four values are assumed to be given and no check is made for missing values.

4.1.04 READIT Subprogram

This subprogram provides for input in variable format and is used by subprograms READ1 and READ2. The input data is restricted to first 80 positions of the input record. Alphanumeric data may be given in the first n, where n is specified, positions. These characters are saved for output. Numberic values are separated by one or more blanks, a comma, any letter except D or E, or any other permitted character except a plus sign (+), a minus sign (-) or a decimal (.). Numeric values may appear in integer form or floating point form using a decimal point or an exponent in which case the letter D or E must precede the exponent. Values with a D preceding the exponent are accepted only as single precision values, not as double precision values.

4.1.05 ERROR Subprogram

This subprogram is used in conjunction with subprogram READIT described in section 4.1.04. It contains the output statements and corresponding formats for the printing of errors associated with the subprogram READIT's interpretation of meaningless input data.

4.1.06 PRINT1 Subprogram

This subprogram prints the title page and pages 1, 2, 3, 4, 5 and 6 of the report generated for each calibration. This information is pertinent only to the NBS calibration program.

4.1.07 TEXT1 Subprogram

This subprogram contains the output statements and their corresponding formats for the printing of page 1 of the calibration report.

4.1.08 TEXT2 Subprogram

This subprogram contains the output statements and their corresponding format for the printing of page 2 of the calibration report.

4.1.09 TEXT3 Subprogram

This subprogram contains the output statements and their corresponding formats for the printing of page 3 of the calibration report.

4.1.10 TEXT4 Subprogram

This subprogram contains the output statement and their corresponding formats for the printing of page 4 of the calibration report.

4.1.11 TEXT5 Subprogram

This subprogram contains the output statements and their corresponding formats for the printing of page 5 of the calibration report.

4.1.12 TEXT6 Subprogram

This subprogram contains the output statements and their corresponding formats for the printing of page 6 of the calibration report.

4.1.13 READ2 Subprogram

This subprogram uses the subprogram READIT, described in section 4.1.04, to read the following information which is needed for each series.

a. Description of the weighing method

b. Administrative data--date, operator, balance identification and check standard identification

c. Environmental conditions--temperature, pressure, humidity

d. Number of observations, number of unknowns, design identification and number of linear combinations

e. Standard deviation of balance, mass of sensitivity weight, volume of sensitivity weight, coefficient of expansion of sensitivity weight, accepted between standard deviation of the process

f. Information about test item: weight, density, coefficient of expansion and accepted correction

g. Restraint vector

h. Check standard vector

i. Restraint vector for next series

j. Report vector

k. Design matrix

l. Linear combination vector(s)

m. Observations--Reading of observations is terminated by a -20000 entry.

Information given in pounds is converted to grams. A control parameter designated by the weighing method parameter is defined. The average values for the corrected temperature, pressure and humidity are computed.

4.1.14 <u>SPINV Subprogram</u>

This subprogram inverts the augmented matrix of normal equations. A check is made for singularity. A call is made to subprogram INVCHK for the purpose of checking the success or failure of the inversion.

4.1.15 <u>SAVMTX Subprogram</u>

This subprogram is used by subprogram SPINV described in 4.1.14. The original matrix is saved before the inverse operation of subprogram SPINV begins.

4.1.16 <u>INVCHK Subprogram</u>

This subprogram called by subprogram SPINV makes a check on the success of the matrix inversion. The check $[I-AA^{-1}] < E$ is made where I is the identity matrix, A is the original matrix, A^{-1} is the inverse of A and E is the value $.01\sigma_W$ where σ_W is the accepted standard deviation of the balance. If the conditions are not met, a flag is defined.

4.1.17 <u>PRINT2 Subprogram</u>

This subprogram makes necessary calculations and contains output statements and their corresponding formats for the printing of the four or five pages of the report associated with each series. The first page of the output contains administrative information: statistical control values, restraint information, check standard information, test environmental conditions and description of weights being calibrated. The second page of the output contains the design and the observations. The third page of the output contains the computed values for the corrections and their corresponding uncertainties and pertinent information of the restraint for the next series. The fourth or fifth page of the output contains the information concerning the statistical F-test and t-test. If neither the t-test or F-test fails, values are saved for process control. See section 3.3. The fourth page, if linear combinations are requested, contains information related to the requested linear combinations.

4.1.18 CHKLN Subprogram

This subprogram makes a check between the current number of lines on a page of printout and the parameter controlling the number of lines permitted per page. If the maximum is exceeded subprogram PGCONT is called.

4.1.19 PGCONT Subprogram

This subprogram writes the information needed in the case where a continuation page is required due to output page overflow.

4.1.20 HEADPG Subprogram

This subprogram writes the headings on each page. The heading includes the company name and address, a description of the weights tested, the balance, the date, the page number and the series number

4.1.21 FINPRT Subprogram

This subprogram controls the printing of the four summary pages for each calibration report. If mass was given in English units, the values are converted to grams for the output. The reported corrections are printed in milligrams. The subprogram TEXTS1 and TEXTS2 are called to print the summary text. A subprogram called DPFD is used to print double precision values of mass and corrections in fixed notations (see Table I and Table II of the output example).

4.1.22 TEXTS1 Subprogram

This subprogram contains the output statements and their corresponding formats for printing the text of the first page of the summary.

4.1.23 TEXTS2 Subprogram

This subprogram contains the output statements and their corresponding formats for printing the text of the second page of the summary.

4.1.24 DPFD Subprogram

This subprogram converts a double precision value to a string of numeric characters representing its values to be printed as a fixed floating point data type with more than 8 accurate digits, the number permitted on the UNIVAC 1108.

4.2 Labeled COMMON

Figure IV lists all the labeled COMMON areas and the main program and all its subprograms. Check marks indicate which subprograms use which labeled COMMON areas. The numbers in parentheses indicate the amount of storage required.

4.3 Double Precision Variables

The following table defines the subprograms using double precision variables, the variable names and in which labeled COMMON area they appear. N.A. means *not* applicable.

Variable	Subprogram	COMMON
VOLP	MAIN	N.A.
CORRP	MAIN	N.A.
OBSCOR	MAIN, PRINT2	COMPUT
TRMASS	MAIN, FINPRT	REPRT
APPMAP	MAIN	N.A.
APPMAS	MAIN, FINPRT	REPRT
CORRBB	MAIN	N.A.
CORRB	MAIN, FINPRT	REPRT
SUM	MAIN	N.A.
SUM1	MAIN	N.A.
TEMPAR	FINPRT	N.A.
A	DPFD	N.A.
X	DPFD	N.A.

FIGURE III. FLOW CHART OF PROGRAM

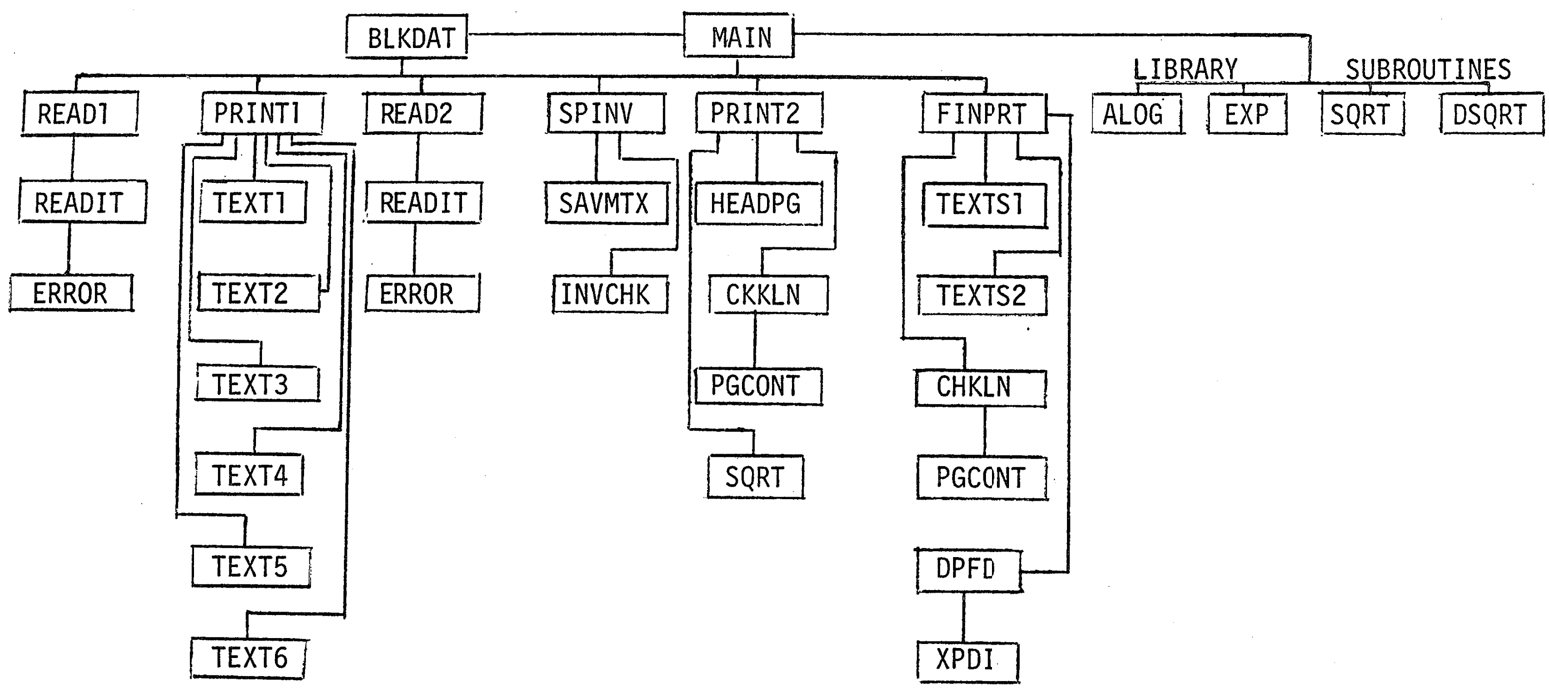

FIGURE IV - LABELED COMMON CROSS REFERENCE TABLE

	BLKDAT	CHKLN	DPFD	FINPRT	HEADPG	INVCHK	MAIN	PGCONT	PRINT1	PRINT2	READ1	READ2	READIT	SAVMTX	SPINV	TEXT1	TEXT2	TEXT3	TEXT4	TEXT5	TEXT6	TEXTS1	TEXTS2
CHECK (1544)						X	X			X				X									
COMPUT (1057)							X			X													
DPFDVL (22)	X		X				X			X			X										
INPUT (3531)				X	X		X	X		X		X											
INVCST (1)	X														X								
ITSTOP (1)	X						X																
PCHOUT (1)				X						X													
PRT1 (1005)				X	X		X	X	X	X	X	X											
PRT2 (3)		X		X	X		X	X	X	X													
PRTLB (17)										X		X											
RAREA (115)											X	X											
REPRT (1275)				X			X																
STOP (5)	X										X												
UNITIO (5)	X	X		X	X		X	X	X	X	X		X			X	X	X	X	X	[illegible]	[illegible]	[illegible]

4.4 Equivalenced Variables

The FORTRAN EQUIVALENCE statement is used only in subprogram READIT. Following is a table giving the two variables which are equivalenced.

Variable 1	Variable 2	Constant Value
IDIGIT (1)	KFD (1)	0
IDIGIT (2)	KFD (2)	1
IDIGIT (3)	KFD (3)	2
IDIGIT (4)	KFD (4)	3
IDIGIT (5)	KFD (5)	4
IDIGIT (6)	KFD (6)	5
IDIGIT (7)	KFD (7)	6
IDIGIT (8)	KFD (8)	7
IDIGIT (9)	KFD (9)	8
IDIGIT (10)	KFD (10)	9
IPLUS	KFD (15)	+
IMINUS	KFD (12)	-
ID	KFD (17)	D
IE	KFD (18)	E
IDECML	KFD (13)	.
IBLANK	KFD (11)	blank

Parameter Dependent Variables The following table gives a list of dimensioned variables whose size may be changed due to modification in the number of observations, number of unknowns or number of linear combinations. The first column gives the variable name and its current dimension, where n (the number of observations) = 50, k (the number of unknowns) = 15, ℓ (the number of linear combinations) = 19, and m (number of values saved to be printed on summary page) = 50. The second column gives the COMMON area containing the variable. The N.A. entry means that the variable is not in a labeled COMMON area. The third column lists the names of the subprogram(s) containing the variable.

Variable	Labeled COMMON	Subprograms
AIDCST (5,k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
ANOM (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
DENSTY (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
COEFEX (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
ACCVAL (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
ARSTIN (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
ACKSTD (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
IRSTOU (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
IPRNT (k)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
DESMAT (k,n)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
OBSERV (12*n)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
ALCOM (k,ℓ+1)	INPUT	MAIN, READ2, PRINT2, PGCONT, HEADPG, FINPRT
SWTPRT (n)	COMPUT	MAIN, PRINT2
A (n)	COMPUT	MAIN, PRINT2
DELTA (n)	COMPUT	MAIN, PRINT2
OBSCOR (k)	COMPUT	MAIN, PRINT2
COMVOL (k)	COMPUT	MAIN, PRINT2
SERROR (k)	COMPUT	MAIN, PRINT2
TRISIG (k)	COMPUT	MAIN, PRINT2
TOTUN (k)	COMPUT	MAIN, PRINT2
DRIFT (n)	COMPUT	MAIN, PRINT2

Variable	Labeled COMMON	Subprograms
ZERO (n)	COMPUT	MAIN, PRINT2
COMVOP (k)	COMPUT	MAIN, PRINT2
CORR5A (ℓ+1)	COMPUT	MAIN, PRINT2
SIG35A (ℓ+1)	COMPUT	MAIN, PRINT2
UNC5A (ℓ+1)	COMPUT	MAIN, PRINT2
IOTSTR (n)	COMPUT	MAIN, PRINT2
SER5A (ℓ+1)	COMPUT	MAIN, PRINT2
DS1 (n)	COMPUT	MAIN, PRINT2
VOLP (k)	N.A.	MAIN
CORRP (k)	N.A.	MAIN
TEMP (k)	N.A.	MAIN
D1 (n)	N.A.	MAIN
ILOAD (n)	N.A.	MAIN
TEMP2 (k)	N.A.	MAIN
ALOAD (n)	N.A.	MAIN
AITEM (5,m)	REPRT	MAIN, FINPRT
APPMAS (m)	REPRT	MAIN, FINPRT
TRMASS (m)	REPRT	MAIN, FINPRT
UNCERT (m)	REPRT	MAIN, FINPRT
VOLPRT (m)	REPRT	MAIN, FINPRT
CORRB (m)	REPRT	MAIN, FINPRT
CORPRT (m)	REPRT	MAIN, FINPRT
[illegible] ($2(k+2)^2$)	CHECK	MAIN, SAVMTX, INVCHK, PRINT2
[illegible] ($(k+2)^2$)	CHECK	MAIN, SAVMTX, INVCHK, PRINT2
[illegible] (k	PRTLB	MAIN, READ2, PRINT2

Variable	Labeled COMMON	Subprograms
ITEMP (k)	N.A.	PRINT2
KTEMP (k)	N.A.	PRINT2
JTEMP (k)	N.A.	PRINT2
NNP (m)	N.A.	FINPRT
TEMPAR (m)	N.A.	FINPRT
TRMASX (k)	N.A.	FINPRT

In addition to the above dimensioned variables which could be changed, a variable defined as NR = n*12 in subprogram READ2 would have to be changed if the number of observations is increased from the current assigned value of 50.

4.6 Hardware and System Dependent Variables

The following table describes the variables which may present some problems at implementation time. The table lists the variables, the subprograms defining them and the value used for the UNIVAC 1108 at NBS.

Variable Name	Defining Subprogram	Current Value and Description of Variable
ZERMAC	BLKDAT	1×10^{-8} - machine zero
IR	BLKDAT	5 - input unit
IW	BLKDAT	6 - output (printer) unit
IP	BLKDAT	1 - output (punch) unit
IPL	BLKDAT	58 - maximum number of lines allowed per printed page
ITMP	BLKDAT	7 output (temporary file)
T	READIT	This dimensioned variable contains the limits of a real variable beginning at and going up to 10^{38}

Variable Name	Defining Subprogram	Current Value and Description of Variable
IZERO	READIT	39-number of unique powers of ten represented by the machine range of a real variable given in T above
MAX	READIT	77-number of powers of ten represented by the machine range of a real variable as specified above in T
KFD	BLKDAT	Define in hollerith notation the characters 0-9, blank, -, ., *, +, comma, D and E which are used by the subprogram READIT and DPFD
FS	BLKDAT	hollerith character S
FT	BLKDAT	hollerith character T
FO	BLKDAT	hollerith character O **
FP	BLKDAT	hollerith character P
FB	BLKDAT	hollerith character Δ (blank)

4.7 Required Storage

The following table lists all subprograms and labeled common blocks. For the subprogram, the number of lines of FORTRAN statements and the number of memory locations for the code and data are given. If the entry is a labeled COMMON area, a C preceeds the entry and the memory locations needed are given under the column headed DATA.

** FO and FP are used by subprogram READ1 to check for the end of a data

PROGRAM OR COMMON		LINES OF CODE	MEMORY FOR CODE	MEMORY FOR DATA
	BLKDAT	41		
C	CHECK			868
	CHKLN	11	21	5
C	COMPUT			559
	DPFD	89	194	40
C	DPFDVL			18
	ERROR	56	160	168
	FINPRT	181	486	363
	HEADPG	36	41	26
C	INPUT			1881
C	INVCST			1
	INVCHK	69	140	36
C	ITSTOP			1
	MAIN	628	1426	352
C	PCHOUT			1
	PGCONT	53	68	32
	PRINT1	67	192	116
	PRINT2	670	1785	1212
C	PRT1			517
C	PRT2			3
C	PRTLB			15
C	RAREA			77
	READ1	120	170	23
	READ2	325	516	34
	READIT	356	586	209
C	REPRT			701
	SAVMTX	22	22	9
	SPINV	126	293	43
C	STOP			5
	TEXT1	125	64	705
	TEXT2	125	64	705
	TEXT3	125	64	705
	TEXT4	125	64	705
	TEXT5	121	64	683
	TEXT6	40	24	172
	TEXTS1	124	59	704
	TEXTS2	30	19	95
C	UNITIO			[illegible]
TOTAL (excluding text)		2850	6100	[illegible]
TOTAL (text)		815	422	[illegible]
GRAND TOTAL		3665	6522	[illegible]

Acknowledgements

The authors wish to thank Mr. J. M. Cameron for his helpful suggestions, Mrs. Sue Bussard for her typing skill and patience through many revisions of the document and Laurie Korzendorfer for her help in assembling the appendices. The authors also wish to thank Sally Peavy, Roy Wampler and Clayton Albright for their subprogram contributions.

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APPENDIX A.1--SAMPLE INPUT

```
X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
SERIAL NUMBER 12345
MANUFACTURER : TROEMNER, INC.
JUNE 21, 1979
654321
0 .076 20 80
0 0 0 0
5 24 79 84 001 002
21.98 22.22 733.68 734.08 41 41
8 5 53 0
1.15 49.98277 .00301104 .000020 0
       5KG          5000 7.953 .000045
       3KG          3000 7.953 .000045
       2KG          2000 7.9 .000045
     S 1KG-1          1000 8.0064 .000045 11.241
     S 1KG-2          1000 8.0063 .000045 11.825
0 0 0 1 1
0 0 0 1 -1
0 0 0 1 1
1 1 1
1 -1 -1 1 -1
-1 1 1 1 -1
1 -1 -1
-1 1 0 1 1
0 -1 1 1
0 1 -1 0 -1
0 0 1 -1 -1
0 0 0 1 -1
4.7 15.2 5.0 5.4 12.5 5.5 7.3 15.0 7.4
5.8 12.4 6.2 5.6 14.1 5.9 7.8 16.4 8.2
6.4 13.6 6.5 4.4 13.4 4.5 7.2 15.2 7.3
4.8 13.4 5.0 5.4 15.2 5.7 7.3 17.4 7.6
6.0 14.8 6.3 5.3 13.0 5.4 6.7 16.0 7.0
5.2 13.0 5.3 5.4 16.0 5.6 9.2 16.5 9.3
5.9 14.0 6.2 5.9 13.4 6.2 7.8 16.2 8.0
5.9 13.9 6.1 5.0 14.8 5.2 8.6 15.8 8.6
-200000
3 1 0 0
5 23 79 84 003 002
21.91 21.92 736.86 736.76 40 40
6 4 41 0
.028 49.98277 .00301104 .000020 0
     S 1KG-1          1000 8.0064 .000045 11.241
     S 1KG-2          1000 8.0063 .000045 11.825
       1KG          1000 7.953 .000045
   SUM 1KG          1000 7.92641 .000045
1 1
1 -1
0 0 0 1
```

```
0 0 1
1 -1
1 0 -1
1 0 0 -1
0 1 -1
0 1 0 -1
0 0 1 -1
16.74 17.34 67.37 66.73
16.85 11.24 61.18 66.77
16.84 13.17 63.11 66.76
17.32 11.13 61.06 67.23
17.22 13.02 62.93 67.16
10.92 12.82 62.86 60.84
-200000
3 1 0 0
5 23 79 84 003 004
21.92 21.96 736.92 736.58 40 40
11 6 62 1
.028 49.98277 .00301104 .000020 0
      500G          500 7.9 .000045
      300G          300 7.953 .000045
      200G          200 7.953 .000045
      100G          100 7.9 .000045
   S     100G          100 7.953 .000045 .9883
 SUM 100G           100 7.94234 .000045
1 1 1
0 0 0 0 1
0 0 0 0 0 1
1 1 1 1
1 -1 -1 1 -1
1 -1 -1 0 1 -1
1 -1 -1 -1 0 1
1 -1 -1
1 0 -1 -1 -1 -1
0 1 -1 1 -1 -1
0 1 -1 -1 1 -1
0 1 -1 -1 -1 1
0 0 1 -1 -1
0 0 1 -1 0 -1
0 0 1 0 -1 -1
1 0 0 1
12.78 10.62 60.63 62.86
13.02 12.59 62.54 62.96
14.86 10.75 60.73 64.88
12.86 10.61 60.54 62.82
12.91 13.58 63.54 62.81
10.87 13.44 63.33 60.84
10.94 13.33 63.26 60.82
12.69 11.44 61.38 62.66
11.18 11.71 61.68 61.14
11.18 13.50 63.38 61.11
11.09 13.44 63.40 60.96
-200000
3 1 0 0
5 17 79 84 005 006
21.99 21.96 746.60 746.00 31 31
11 6 62 0
.012 49.98277 .00301104 .000020 0
```

```
       50G          50 7.953 .000045
       30G          30 7.953 .000045
       20G          20 7.9 .000045
       10G          10 7.953 .000045
     S 10G          10 7.953 .000045 .0785
   SUM 10G          10 7.92641 .000045
1 1 1
0 0 0 0 1
0 0 0 0 0 1
1 1 1 1
1 -1 -1 1 -1
1 -1 -1 0 1 -1
1 -1 -1 -1 0 1
1 -1 -1
1 0 -1 -1 -1 -1
0 1 -1 1 -1 -1
0 1 -1 -1 1 -1
0 1 -1 -1 -1 1
0 0 1 -1 -1
0 0 1 -1 0 -1
0 0 1 0 -1 -1
6.18 4.69 54.71 56.20
6.17 4.72 54.71 56.15
6.14 4.76 54.76 56.14
6.19 4.74 54.72 56.18
6.18 4.47 54.45 56.18
4.81 4.44 54.44 54.81
4.79 4.49 54.47 54.75
4.76 4.51 54.49 54.74
4.52 4.55 54.52 54.49
4.48 4.52 54.50 54.47
4.47 4.47 54.46 54.47
-200000
3 1 0 0
5 18 79 84 007 008
21.92 21.88 743.28 742.82 35 35
11 6 62 1
.0017 5.00171 .00185248 .000069 0
       5G         5 7.9 .000045
       3G         3 7.953 .000045
       2G         2 7.953 .000045
       1G         1 7.9 .000045
     S 1G         1 7.953 .000045 -.0792
   SUM 1G         1 16.6 .000020
1 1 1
0 0 0 0 1
0 0 0 0 0 1
1 1 1 1
1 -1 -1 1 -1
1 -1 -1 0 1 -1
1 -1 -1 -1 0 1
1 -1 -1
1 0 -1 -1 -1 -1
0 1 -1 1 -1 -1
0 1 -1 -1 1 -1
0 1 -1 -1 -1 1
0 0 1 -1 -1
0 0 1 -1 0 -1
```

```
0 0 1 0 -1 -1
1 0 0 1
1.084 .926 5.927 6.084
.978 .939 5.931 5.972
.990 1.021 6.021 5.987
1.068 1.013 6.009 6.067
1.068 .875 5.870 6.063
1.062 .862 5.857 6.053
.959 .966 5.957 5.948
.969 .948 5.942 5.960
1.016 .976 5.966 6.006
1.016 .987 5.981 6.006
1.012 .881 5.872 6.004
-200000
3 1 0 0
5 18 79 84 007 008
22.21 22.99 742.52 741.86 36 35
11 6 62 0
.0005 .50156 .0018576 .000069 0
      500MG        .5 16.6 .000020
      300MG        .3 16.6 .000020
      200MG        .2 16.6 .000020
      100MG        .1 16.6 .000020
    S 100MG        .1 16.6 .000020 -.02628
  SUM 100MG        .1 8.17883 .000049
1 1 1
0 0 0 0 1
0
1 1 1 1
1 -1 -1 1 -1
1 -1 -1 0 1 -1
1 -1 -1 -1 0 1
1 -1 -1
1 0 -1 -1 -1 -1
0 1 -1 1 -1 -1
0 1 -1 -1 1 -1
0 1 -1 -1 -1 1
0 0 1 -1 -1
0 0 1 -1 0 -1
0 0 1 0 -1 -1
296.4 224.0 726.2 801.2
285.5 240.3 741.3 788.9
300.5 241.6 744.1 803.7
312.9 253.5 754.8 815.5
312.7 239.8 741.0 815.6
303.8 250.5 751.5 805.7
290.2 264.6 765.4 791.7
303.6 252.3 753.6 806.0
276.7 302.6 804.1 779.3
276.7 315.5 817.1 779.2
276.6 301.0 802.6 778.6
-200000
STOP
```

APPENDIX A.2--SAMPLE PRINTED OUTPUT

```
      U. S. DEPARTMENT CF COMMERCE
      NATIONAL BUREAU OF STANDARDS
     NATIONAL ENGINEERING LABORATORY
        WASHINGTON, D.C. 20234




              R E P O R T
                  O F
          M A S S   V A L U E S

   X Y Z CORPORATION
   SOMEWHERE, U.S.A.
   SET OF MASS STANDARDS : 5KG - 100MG
   SERIAL NUMBER 12345
   MANUFACTURER : TROEMNER, INC.
   JUNE 21, 1979




TEST NUMBER  654321


                       FOR THE DIRECTOR,


                       G. E. MATTINGLY, CHIEF
                       FLUID ENGINEERING DIVISION
                       CENTER FOR MECHANICAL ENGINEERING
                         AND PROCESS TECHNCLOGY
                       NATIONAL ENGINEERING LABORATORY
```

INTRODUCTION

THIS DOCUMENT IS A COMPREHEN- SIVE REPCRT COVERING THE SEQUENCE OF CPERATIONS USED TO ASSIGN MASS VALUES TO THE WEIGHTS IDENTIFIED ABOVE. IT INCLUDES A CCMPLETE DESCRIPTICN OF THE MEASUREMENT METHODS AND PROCEDURES WHICH WERE USED. ALL CF THE DATA. AND THE ANALYSIS OF THIS DATA. THE RESULTS ARE PRESENTED IN SEVERAL FORMATS. ASSIGNED MASS VALUES, DISPLACEMENT VOLUMES, CCEFFICIENTS OF EXPANSICN, UNCERTAINTIES, TO- GETHER WITH THE SUMMED VALUES FOR LINEAR CCMBINATIONS OF THE WEIGHTS IN EACH DECADE ARE PRESENTED AT THE END CF THE APPRCPRIATE SERIES. THIS INFCRMATION SHOULD BE USEFUL TO THOSE WHO MUST ASSIGN MASS VALUES TO OBJECTS CTHER THAN WEIGHTS. FOR CONVENIENCE, THE VALUES AND UNCERTAINTIES, TOGETHER WITH OTHER APPROPRIATE DATA AND COMMENTS ARE ALSO SUMMARIZED IN TABLES I AND II AT THE END OF THE REPORT. CERTAIN INTERMEDIATE PAGES ARE SUMMARIES OF STATISTICAL DATA WHICH RELATE TO THE MASS MEASUREMENT PROCESS USED TO PERFORM THIS WORK. THESE PAGES HAVE BEEN LEFT IN THE REPCRT TO RETAIN CONTINUITY. COPIES CF THESE PAGES BECOME PART OF A COLLECTICN OF STATISTICAL DATA WHICH REFLECTS THE MEASUREMENT PROCESS PERFORMANCE OVER A PERIOD OF TIME. SUCH A COLLECTICN HAS BEEN USED TC ESTABLISH THE CCNTROL LIMITS FCR ACCEPTING THE RESULTS OF THIS MEASUREMENT. THESE COL- LECTIONS ARE OPEN FOR INSPECTION AT CUR FACILITY.

THE MASS MEASUREMENT SYSTEM

THE MASS MEASUREMENT SYSTEM WITHIN THIS CCUNTRY CCNSISTS CF ALL OF THE MEASUREMENT PROCESSES WHICH RELY, DIRECTLY OR INDIRECT- LY, ON MASS MEASUREMENTS TO ACCOMPLISH A WIDE VARIETY OF ENDEAVORS. IN ORDER FOR THIS SYSTEM TO FUNCTION PROPERLY, EVERYONE WHO MAKES MEASUREMENTS MUST BE ABLE TO VERIFY THAT HIS MEASUREMENT PROCESS PRODUCES CCNSISTENT RESULTS WHICH ARE COMPATIBLE WITH HIS PARTICULAR REQUIREMENTS. THE WEIGHTS COVERED BY THIS REPORT, TOGETHER WITH THE ASSIGNED VALUES AND THE APPRO- PRIATE UNCERTAINTIES FCR THESE VALUES, PROVIDE IN PART A BASIS FOR CONSISTENT MEASUREMENTS WITHIN THIS SYSTEM OF RELATED MEASUREMENT PROCESSES.

APPROPRIATE CHARACTERIZATION OF ANY MEASUREMENT PROCESS IS FUNDAMENTAL TC VERIFYING THAT RESULTS ARE CONSISTENT WITH THE END REQUIREMENT WITH RESPECT TO CORRECTNESS AND ECONOMY OF THE MEASUREMENT EFFORT. WITHOUT THIS INFORMATICN, THE BENEFITS OF OWNERSHIP OF THESE WEIGHTS MAY BE COMPLETELY ILLUSORY. THE ASSIGNED UNCERTAINTIES IN THIS REPORT ARE DESCRIPTIVE OF OUR MASS MEASURE- MENT PROCESS. EFFECTIVENESS OF THE TRANSFER OF THE UNIT FROM ONE FACILITY TO ANOTHER SHOULD BE VERIFIED BY AN INDEPENDENT TES[illegible] IT IS PRESUMED THAT THESE WEIGH[illegible] WILL BE USED IN A SIMILARLY WEL[illegible] CHARACTERIZED MEASUREMENT PROC[illegible] SO THAT THE STATISTICAL FARAMET[illegible] OF BOTH PROCESSES CAN BE COMB[illegible] TO PROVIDE A REALISTIC ESTIMAT[illegible] THE UNCERTAINTY OF THE MASS [illegible] AS ACTUALLY REALIZED IN ANO[illegible] FACILITY. A COMPREHENSIVE SER[illegible] DIRECTED TOWARD THE EVALUATI[illegible] A PARTICULAR MASS MEASUR[illegible] PROCESS IS AVAILABLE THROUGH [illegible] MASS MEASUREMENT ASSURANCE [illegible] OF THE NATIONAL BUREAU [illegible] STANDARDS.

WEIGHING DESIGN

ONLY DIFFERENCES IN MASS CAN BE MEASURED. THEREFORE THE MASS VALUES FOR THE 'UNKNOWN' WEIGHTS MUST BE DETERMINED BY COMPARISON WITH OTHER WEIGHTS WHICH HAVE ACCEPTED MASS VALUES. THE 'UNKNOWN' WEIGHTS TOGETHER WITH 'CHECK STANDARDS', ARE GROUPED AND INTERCOMPARED ACCORDING TO THE DESIGN SCHEDULE GIVEN AT THE BEGINNING OF EACH SERIES OF WEIGHINGS. THE FIRST SERIES CONTAINS STANDARDS WHICH PROVIDE THE STARTING VALUES FOR THE SERIES OF WEIGHINGS AND PROVIDE THE TIE POINT FOR CONSISTENCY THROUGHOUT THE MEASUREMENT SYSTEM. THE WEIGHING METHOD USED, I.E., DOUBLE SUBSTITUTION, TRANSPOSITION, ETC., IS INDICATED ALONG WITH THE OBSERVED DATA. IN THE COMPUTATIONS, THE DISPLACEMENT VOLUMES ARE TREATED EXPLICITLY, USING THE DATA LISTED IN THE REPORT. IN ALL CASES, A REDUNDANCY IN THE NUMBER OF MEASUREMENTS PROVIDES A MEANS FOR CHECKING ON THE PRECISION OF THE PROCESS.

WHEN THERE ARE MORE EQUATIONS THAN 'UNKNOWNS', NOT ALL OBSERVATIONAL EQUATIONS CAN BE SATISFIED EXACTLY AND THE METHOD OF LEAST SQUARES IS USED TO PROVIDE ESTIMATES OF THE 'UNKNOWN' VALUES. THIS METHOD LEADS TO ESTIMATORS WHICH ARE LINEAR FUNCTIONS OF THE DATA, AND WHICH HAVE STANDARD DEVIATIONS READILY CALCULATED FROM THE COEFFICIENTS OF THE LINEAR FUNCTIONS AND THE STANDARD DEVIATION OF AN INDIVIDUAL MEASUREMENT. THE 'CHECK STANDARD' IS ALSO TREATED AS AN UNKNOWN AND THE AGREEMENT OF THE CURRENT RESULT WITH THE ACCEPTED VALUE PROVIDES A MEASURE OF THE ADEQUACY OF THE CURRENT DATA. THIS SAME CHECK STANDARD IS MEASURED WITH EACH TEST OF UNKNOWNS AND THE COLLECTION OF VALUES OVER TIME IS USED TO EVALUATE THE PERFORMANCE OF THE MEASUREMENT PROCESS.

IN THE CASE OF THE SERIES WHICH INCLUDES THE KNOWN STANDARDS, THE ACCEPTED VALUES OF THESE STANDARDS SERVE AS A RESTRAINT ON THE SOLUTION OF THE EQUATIONS FOR THE VALUES OF ALL OF THE WEIGHTS. THE RESTRAINT FOR THE SOLUTION OF SUBSEQUENT SERIES IS PROVIDED BY THE VALUES ESTABLISHED FOR ONE OR MORE WEIGHTS INCLUDED IN A PREVIOUS SERIES.

ESTIMATED VALUES FOR WEIGHTS WHICH HAVE BEEN GROUPED IN THE SAME SERIES INVOLVE THE SAME OBSERVATIONAL DATA AND ARE, IN ALMOST ALL CASES, CORRELATED. FOR EACH SERIES THERE IS A TABLE OF COMBINATIONS TOGETHER WITH THE APPROPRIATE UNCERTAINTY FOR EACH COMBINATION.

PROCESS CONTROL

THE STANDARD DEVIATION, AS COMPUTED FROM THE LEAST SQUARES SOLUTION, PROVIDES A CHECK ON THE SHORT TERM, OR 'WITHIN-RUN' PROCESS PRECISION. AN AVERAGE OF A NUMBER OF THESE STANDARD DEVIATIONS IS TAKEN AS THE ACCEPTED WITHIN-RUN STANDARD DEVIATION OF THE PROCESS AND IS USED AS A REFERENCE VALUE FOR SURVEILLANCE OF THE PROCESS PRECISION. THE VALUES OBTAINED FOR THE 'CHECK STANDARD' PROVIDE, AS TIME GOES ON, A SEQUENCE OF VALUES THAT REALISTICALLY REFLECTS THE VARIATIONS WHICH BESET PRECISE MEASUREMENTS. COLLECTIONS OF VALUES FOR BOTH THE WITHIN-RUN PRECISION AND THE VALUE OBTAINED FOR THE 'CHECK STANDARD' SHOULD

POSSESS THE PROPERTIES OF RANDOM-NESS ASSOCIATED WITH INDEPENDENT MEASUREMENTS FROM A STABLE PROBABILITY DISTRIBUTION. THE REPORTED 'F RATIO' AND 'T VALUE' ARE TESTS OF THE VALUES FROM THE CURRENT RUN FOR CONFORMITY TO THEIR RESPECTIVE DISTRIBUTIONS AND IF SATISFACTORY ARE TAKEN AS EVIDENCE THAT THE PROCESS IS IN CONTROL AND THAT PREDICTIVE STATEMENTS REGARDING UNCERTAINTY ARE VALID.

CONTROL CHARTS ON THE WITHIN-RUN PROCESS PRECISION AND THE VALUES OBTAINED FOR THE CHECK STANDARD ARE KEY ELEMENTS IN MONITORING THE STATE OF CONTROL OF ANY PRECISE MASS MEASUREMENT PROCESS. IN ADDITION TO PROVIDING A BASIS FOR JUDGMENT AS TO THE ADEQUACY OF A GIVEN PROCESS FOR A PARTICULAR REQUIREMENT, THESE DATA PROVIDE A MEANS TO JUDGE THE IMPORTANCE OF LONG TERM, OR 'BETWEEN-RUN' VARIABILITY WHICH CAN BE CHARACTERIZED BY THE STANDARD DEVIATION OF THE VALUES ABOUT THE MEAN. IF THERE IS AN ADDITIONAL COMPONENT OF VARIANCE ENTERING FROM RUN TO RUN, THIS STANDARD DEVIATION WILL BE LARGER THAN CAN BE ACCOUNTED FOR BY THE WITHIN-RUN VARIABILITY. CORRELA-TION STUDIES, AS WELL AS SUPPLE-MENTAL EXPERIMENTS, ARE USED TO DETECT AND REDUCE THE MAGNITUDE OF SIGNIFICANT SYSTEMATIC EFFECTS. APPROPRIATE ACTION, E.G., ADDI-TIONAL EMPIRICAL CORRECTIONS OR CHANGES IN TECHNIQUE, CAN REDUCE THE EFFECTS FROM KNOWN SOURCES OF SYSTEMATIC VARIABILITY TO A MAGNITUDE WHICH IS NO LONGER IDENTIFIABLE IN THE DATA. IN THE CASES WHERE A SIGNIFICANT LONG TERM, OR BETWEEN-RUN, COMPONENT REMAINS THE UNCERTAINTY HAS BEEN APPROPRIATELY ADJUSTED.

SERIES OF MEASUREMENTS JUDGED AS OUT OF CONTROL RELATIVE TO THE APPROPRIATE PARAMETER ARE CARE-FULLY EXAMINED. IF RERUNS WERE NECESSARY IN THE COURSE OF THIS WORK, THE 'OUT OF CONTROL' SERIES, WITH REMARKS AS APPROPRIATE, ARE ATTACHED AT THE END OF THE REPORT FOR YOUR INFORMATION.

UNCERTAINTY

IT IS ASSUMED THAT THE PRESENT 'ACCEPTED VALUES' OF TWO NBS STAN-DARDS AT THE 1 KILOGRAM LEVEL, DESIGNATED N1 AND N2, ARE WITHOUT ERROR. ESTIMATES OF THE UNCER-TAINTY OF THE ACCEPTED VALUES OF THE NBS STANDARDS RELATIVE TO THE INTERNATIONAL PROTOTYPE KILOGRAM CAN BE PROVIDED ON REQUEST. HOWEVER, THESE ESTIMATES HAVE NO REAL MEANING IN EITHER NATIONAL OR INTERNATIONAL COMPARISON. THIS IS BECAUSE OF THE LACK OF SUFFICIENT DATA TO PROVIDE A REALISTIC ESTIMATE OF THE UNCERTAINTY IN THE VALUES ASSIGNED TO THE PROTOTYPE KILOGRAMS K20 AND K4, PARTICULARLY IN REGARD TO LONG TERM, OR BETWEEN-RUN VARIABILITY. CHANGES IN THE ACCEPTED VALUES FOR THE NBS STANDARDS AT THE KILOGRAM LEVEL, AS AND WHEN THEY OCCUR, WILL BE REPORTED IN THE SCIENTIFIC PAPERS OF THE BUREAU AND WILL BE GIVEN WIDE DISTRIBUTION. IN CASES WHERE SUCH CHANGES MAY BE OF IMPORTANCE, OR WHERE CONTINUITY IS DESIRED, INSTRUCTIONS WILL BE INCLUDED FOR UP-DATING PREVIOUSLY REPORTED VALUES. WHEN THE VALUES REPORTED ARE BASED ON THE ACCEPTED VALUES OF STANDARDS OTHER THAN STANDARDS N1 AND N2 MENTIONED ABOVE, THE UNCERTAINTY OF THE ACCEPTED VALUE OF THE STANDARD BECOMES SYSTEMATIC ERROR IN THE ASSIGNMENT OF VALUES TO OTHER STANDARDS AND IS INCLUDED IN THE REPORT.

A BALANCE UNDER STABLE OPERAING CONDITIONS WILL EXHIBIT A ERTAIN CHARACTERISTIC VARIABILITY HICH CAN BE DESCRIBED BY THE TANDARD DEVIATION FOR SUCH EASUREMENTS. THE VALUE FOR A ARTICULAR WEIGHT DETERMINED IN EPEATED TESTS WITH THE SAME EIGHING DESIGN WILL HAVE ITS OWN TANDARD DEVIATION WHICH WILL BE OME FUNCTION OF THE BALANCE RECISION AND (POSSIBLY) OF THE ETWEEN-RUN COMPONENT. AS AN UTER LIMIT OF THE DISTRIBUTION OF RANDOM ERRORS, THREE TIMES THE STANDARD DEVIATION IS USED. SYSTEMATIC ERRORS DUE TO THE PROCEDURES USED OR TO ENVIRONMENTAL EFFECTS ARE LARGELY BALANCED OUT AND CAN USUALLY BE REGARDED AS NEGLIGIBLE. WHEN A NON-NEGLIGIBLE BOUND TO THE POSSIBLE EFFECT FROM KNOWN SOURCES IS AVAILABLE, IT IS CALCULATED AND REPORTED SEPARATELY, E.G., THE UNCERTAINTY OF ACCEPTED VALUE AT OTHER THAN THE 1 KILOGRAM LEVEL. THE DISTRIBUTION IMPLIED BY THE RANDOM ERRORS MAY THUS BE CENTERED SOMEWHERE IN THE RANGE GIVEN BY THE BOUNDS TO THE SYSTEMATIC ERROR. THE TOTAL UNCERTAINTY IS TAKEN AS THE SUM OF THESE TWO COMPONENTS.

THE UNCERTAINTY ASSOCIATED WITH THE ASSIGNED VALUE CAN BE THOUGHT OF AS A BOUND TO THE DEPARTURE OF THE ASSIGNED VALUE FROM A HYPOTHETICAL AVERAGE VALUE THAT WOULD BE OBTAINED IF IT WERE POSSIBLE TO REPEAT THE MEASUREMENT MANY TIMES OVER A WIDE VARIETY OF CONDITIONS, E.G., SUBSTITUTE THE WEIGHT FOR ONE OF THE CHECK STANDARDS. THIS MEANS THAT THE UNCERTAINTY BAND CENTERED ON THE VALUES OBTAINED FROM EACH OF TWO MEASUREMENTS OF THE SAME OBJECT OVER SOME ARBITRARY TIME INTERVAL SHOULD ALMOST ALWAYS OVERLAP. IN OTHER WORDS, WHILE A SECOND MEASUREMENT WILL PRODUCE A DIFFERENT VALUE, THIS VALUE WILL ONLY RARELY DIFFER FROM THE FIRST VALUE BY MORE THAN THE SUM OF THE TWO UNCERTAINTIES. THE UNCERTAINTY BANDS ARE NOT EXPECTED TO OVERLAP IF SOME EVENT HAS OCCURRED IN THE TIME INTERVAL BETWEEN THE TWO MEASUREMENTS WHICH WILL CHANGE THE MASS OF THE OBJECT, E.G., ABRASIONS, ABUSE, CORROSION, IMPROPER CLEANING AND THE LIKE.

THE UNCERTAINTY IN ASSIGNED VALUE CONTAINED IN THIS REPORT BECOMES A SYSTEMATIC EFFECT FOR THE MEASUREMENT PROCESS IN WHICH THESE WEIGHTS ARE TO BE USED. IN THE ABSENCE OF OTHER SIGNIFICANT SYSTEMATIC EFFECTS IN THE USER'S MEASUREMENT PROCESS (A CONDITION WHICH MUST BE DEMONSTRATED) THE UNCERTAINTY OF THE VALUE ASSIGNED BY THE USER IS AN APPROPRIATE COMBINATION OF THE SYSTEMATIC ERROR IN THE STANDARD AND THE RANDOM COMPONENT ASSOCIATED WITH HIS PROCESS. IF THE MEASUREMENT PROCESSES ARE IN CONTROL AND APPROPRIATE UNCERTAINTIES ARE ASSIGNED, THE VALUES PRODUCED BY DIFFERENT MEASUREMENT FACILITIES WILL HAVE OVERLAPPING UNCERTAINTY BANDS AS DESCRIBED ABOVE. ONE CANNOT DISCUSS DIFFERENCES IN VALUES FOR THE SAME OBJECT OBTAINED BY DIFFERENT FACILITIES WITH ANY DEGREE OF SERIOUSNESS UNLESS EACH VALUE IS ACCOMPANIED BY A REALISTIC UNCERTAINTY STATEMENT.

X Y Z CORPORATICN PAGE 5
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMEER 654321

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(EXPECTED COMPLETION: 1974)

BALANCE 1
OPERATOR 84
ACCEPTED WITHIN STANDARD DEVIATION OF THE PROCESS 1.15000 MG
ACCEPTED BETWEEN STANDARD DEVIATION OF THE PROCESS .00000 MG

CALIBRATION DESIGN 53
RESTRAINT VECTOR 0 0 0 1 1
MASS CORRECTION OF RESTRAINT 23.06600 MG
VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT 22.10 C 249.82820 CM3
SYSTEMATIC ERROR IN THE RESTRAINT .07600 MG
3 STANDARD DEVIATION LIMIT FOR RANDOM ERROR AFFECTING RESTRAINT .00000 MG

CHECK STANDARD USED 2
CHECK STANDARD VECTOR 0 0 0 1 -1
ACCEPTED MASS CORRECTION OF CHECK STANDARD -.58400 MG
REPORT VECTOR 1 1 1 0 0

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.98	22.22	22.10
CORRECTED PRESSURE IN MM HG	733.680	734.080	733.880
CORRECTED HUMIDITY IN PERCENT	41.00	41.00	41.00
COMPUTED AIR DENSITY IN MG/CM3	1.1505	1.1501	1.1503
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.98	22.22	
OBSERVED PRESSURE IN MM HG	733.680	734.080	
OBSERVED HUMIDITY IN PERCENT	41.00	41.00	

WEIGHTS BEING TESTED	NOMINAL VALUE G	DENSITY G/CM3 AT 20C	COEFFICIENT OF EXPANSION	ACCEPTED CORRECTION MG
5KG	5000.0000	7.9530	.000045	
3KG	3000.0000	7.9530	.000045	
2KG	2000.0000	7.9000	.000045	
S 1KG-1	1000.0000	8.0064	.000045	11.24100
S 1KG-2	1000.0000	8.0063	.000045	11.82500

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 1
OPERATOR 84

CALIBRATION DESIGN 53

	GRAMS 5000	3000	2000	1000	1000
A 1	+	-	-	+	-
A 2	-	+	+	+	-
A 3	+	-	-		
A 4	-	+		+	+
A 5		-	+	+	
A 6		+	-		-
A 7			+	-	-
A 8				+	-
R				+	+

OBSERVATIONS IN DIVISIONS
SINGLE TRANSPOSITION TWO PAN BALANCE

A 1	4.7000	15.2000	5.0000	5.4000	12.5000	5.5000
	7.3000	15.0000	7.4000			
A 2	5.8000	12.4000	6.2000	5.6000	14.1000	5.9000
	7.8000	16.4000	8.2000			
A 3	6.4000	13.6000	6.5000	4.4000	13.4000	4.5000
	7.2000	15.2000	7.3000			
A 4	4.8000	13.4000	5.0000	5.4000	15.2000	5.7000
	7.3000	17.4000	7.6000			
A 5	6.0000	14.8000	6.3000	5.3000	13.0000	5.4000
	6.7000	16.0000	7.0000			
A 6	5.2000	13.0000	5.3000	5.4000	16.0000	5.6000
	9.2000	16.5000	9.3000			
A 7	5.9000	14.0000	6.2000	5.9000	13.4000	6.2000
	7.8000	16.2000	8.0000			
A 8	5.9000	13.9000	6.1000	5.0000	14.8000	5.2000
	8.6000	15.8000	8.6000			

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

BALANCE 1
OPERATOR 84

CALIBRATION DESIGN 53

SENSITIVITY WEIGHT
MASS 49.98277 MG
VOLUME .00301 CM3 AT 20 C
COEFFICIENT OF EXPANSION .000020
S*=S-PV(S)= 49.97931 MG

	A(I) (MG)	DELTA(I) (MG)	AVERAGE SENSITIVITY (MG/DIV)	ZERO(I) (DIV)	OBSERVED SENSITIVITY (MG/DIV)
A 1	11.72699	.39524	22.33712	9.50000	22.71787
A 2	-8.09721	2.22116	22.33712	9.56250	21.96893
A 3	12.63844	1.81339	22.97899	9.47500	21.73013
A 4	-14.07463	-.01255	22.97899	9.76250	24.38015
A 5	14.85099	-2.10971	22.84768	9.82500	22.21303
A 6 *	-18.56374	-2.10973	22.84768	9.93750	23.51967
A 7	3.22447	-.01255	21.49648	9.87500	21.49648
A 8	.00000	-.50669	22.21302	9.95000	22.21302

* OBSERVED DEFLECTION IS GREATER THAN OR EQUAL TO ONE FOURTH THE SENSITIVITY DEFLECTION

ITEM (G)	CORRECTION (MG)	VOLUME (AT T) (CM3)	SYSTEMATIC ERROR (MG)	3 S.D. LIMIT (MG)	UNCERTAINTY LIMIT (MG)
5000.0000	63.07702	628.76090	.19000	5.45493	5.64493
3000.0000	24.01883	377.25480	.11400	3.57109	3.68509
2000.0000	30.17279	253.19230	.07600	2.60795	2.68395
1000.0000	11.78548	124.91335	.03800	.92205	.96005
1000.0000	11.28052	124.91485	.03800	.92205	.96005

TEMPERATURE T= 22.10 C

RESTRAINT FOR FOLLOWING SERIES
RESTRAINT VECTOR 0 0 0 1 1
MASS CORRECTION 23.06600 MG
VOLUME AT 20 C 249.80460 CM3
SYSTEMATIC ERROR .07600 MG
3 STANDARD DEVIATION LIMIT .00000 MG

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 1
OPERATOR 84
MAXIMUM LOAD 6000.0000 G
STARTING RESTRAINT NUMBER 80

CALIBRATION DESIGN 53

PRECISION CONTROL

OBSERVED STANDARD DEVIATION OF THE PROCESS 2.09386 MG
ACCEPTED STANDARD DEVIATION OF THE PROCESS 1.15000 MG
DEGREES OF FREEDOM 4
F RATIO 3.315

F RATIO IS LESS THAN 3.33 (CRITICAL VALUE FOR PROBABILITY = .01).
THEREFORE THE STANDARD DEVIATION IS IN CONTROL.

CHECK STANDARD VECTOR 0 0 0 1 -1
CHECK STANDARD USED 2
ACCEPTED MASS CORRECTION OF CHECK STANDARD -.58400 MG
OBSERVED CORRECTION OF CHECK STANDARD .50497 MG
STANDARD DEVIATION OF THE OBSERVED CORRECTION .61470 MG
T VALUE 1.77

ABSOLUTE VALUE OF T IS LESS THAN 3.
THEREFORE CHECK STANDARD IS IN CONTROL.

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.98	22.22	22.10
CORRECTED PRESSURE IN MM HG	733.680	734.080	733.880
CORRECTED HUMIDITY IN PERCENT	41.00	41.00	41.00
COMPUTED AIR DENSITY IN MG/CM3	1.1505	1.1501	1.1503
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.98	22.22	
OBSERVED PRESSURE IN MM HG	733.680	734.080	
OBSERVED HUMIDITY IN PERCENT	41.00	41.00	

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 3
OPERATOR 84

ACCEPTED WITHIN STANDARD DEVIATION OF THE PROCESS	.02800 MG
ACCEPTED BETWEEN STANDARD DEVIATION OF THE PROCESS	.00000 MG

CALIBRATION DESIGN 41
RESTRAINT VECTOR 1 1 0 0

MASS CORRECTION OF RESTRAINT	23.06600 MG
VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT 21.91 C	249.82613 CM3
SYSTEMATIC ERROR IN THE RESTRAINT	.07600 MG
3 STANDARD DEVIATION LIMIT FOR RANDOM ERROR AFFECTING RESTRAINT	.00000 MG

CHECK STANDARD USED 2
CHECK STANDARD VECTOR 1 -1 0 0
ACCEPTED MASS CORRECTION OF CHECK STANDARD -.58400 MG
REPORT VECTOR 0 0 1 0

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.91	21.92	21.91
CORRECTED PRESSURE IN MM HG	736.860	736.760	736.810
CORRECTED HUMIDITY IN PERCENT	40.00	40.00	40.00
COMPUTED AIR DENSITY IN MG/CM3	1.1559	1.1557	1.1558
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.91	21.92	
OBSERVED PRESSURE IN MM HG	736.860	736.760	
OBSERVED HUMIDITY IN PERCENT	40.00	40.00	

WEIGHTS BEING TESTED	NOMINAL VALUE G	DENSITY G/CM3 AT 20C	COEFFICIENT OF EXPANSION	ACCEPTED CORRECTION MG
S 1KG-1	1000.0000	8.0064	.000045	11.24100
S 1KG-2	1000.0000	8.0063	.000045	11.82500
1KG	1000.0000	7.9530	.000045	
SUM 1KG	1000.0000	7.9264	.000045	

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 3
OPERATOR 84

CALIBRATION DESIGN 41

	GRAMS			
	1000	1000	1000	1000
A 1	+	-		
A 2	+		-	
A 3	+			-
A 4		+	-	
A 5		+		-
A 6			+	-
R	+	+		

OBSERVATIONS IN DIVISIONS
DOUBLE SUBSTITUTION ONE PAN BALANCE

A 1	16.7400	17.2400	67.3700	66.7300
A 2	16.8500	11.2400	61.1800	66.7700
A 3	16.8400	13.1700	63.1100	66.7600
A 4	17.3200	11.1300	61.0600	67.2300
A 5	17.2200	13.0200	62.9300	67.1600
A 6	10.9200	12.8200	62.8600	60.8400

BALANCE 3
OPERATOR 84

CALIBRATION DESIGN 41

SENSITIVITY WEIGHT
MASS 49.98277 MG
VOLUME .00301 CM3 AT 20 C
COEFFICIENT OF EXPANSION .000020
S*=S-PV(S)= 49.97929 MG

	A(I) (MG)	DELTA(I) (MG)	AVERAGE SENSITIVITY (MG/DIV)	DRIFT(I) (MG)	OBSERVED SENSITIVITY (MG/DIV)
A 1	-.61998	-.02625	.99997	-.02000	.99859
A 2	5.59983	.00501	.99997	-.01000	1.00059
A 3	3.65989	.02125	.99997	-.01000	1.00059
A 4	6.17981	-.00875	.99997	-.01000	1.00079
A 5	4.21487	-.01750	.99997	.01500	1.00169
A 6	-1.95994	-.00375	.99997	-.06000	.99759

ITEM (G)	CORRECTION (MG)	VOLUME (AT T) (CM3)	SYSTEMATIC ERROR (MG)	3 S.D. LIMIT (MG)	UNCERTAINTY LIMIT (MG)
1000.0000	11.23519	124.91225	.03800	.02970	.06770
1000.0000	11.83082	124.91388	.03800	.02970	.06770
1000.0000	6.60911	125.75038	.03800	.05144	.08944
1000.0000	9.05323	126.17253	.03800	.05144	.08944

TEMPERATURE T= 21.91 C

RESTRAINT FOR FOLLOWING SERIES
RESTRAINT VECTOR 0 0 0 1
MASS CORRECTION 9.05323 MG
VOLUME AT 20 C 126.16166 CM3
SYSTEMATIC ERROR .03800 MG
3 STANDARD DEVIATION LIMIT .05144 MG

BALANCE 3
OPERATOR 84
MAXIMUM LOAD 1000.0000 G
STARTING RESTRAINT NUMBER 80

CALIBRATION CESIGN 41

PRECISICN CCNTRCL

OBSERVED STANDARD DEVIATION CF THE PROCESS .02282 MG
ACCEPTED STANDARD DEVIATION CF THE PROCESS .02800 MG
DEGREES CF FREEDOM 3
F RATIO .664

F RATIO IS LESS THAN 3.79 (CRITICAL VALUE FOR PROBAEILITY = .01).
THEREFORE THE STANDARD DEVIATICN IS IN CONTROL.

CHECK STANDARD VECTOR 1 -1 0 0
CHECK STANDARD USED 2
ACCEPTED MASS CORRECTICN OF CHECK STANDARD -.58400 MG
OBSERVED CORRECTION CF CHECK STANDARD -.59562 MG
STANDARD DEVIATICN OF THE OBSERVED CORRECTION .01980 MG
T VALUE -.59

ABSOLUTE VALUE OF T IS LESS THAN 3.
THEREFORE CHECK STANDARD IS IN CCNTROL.

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.91	21.92	21.91
CORRECTED PRESSURE IN MM HG	736.860	736.760	736.810
CORRECTED HUMIDITY IN PERCENT	40.00	40.00	40.00
COMPUTED AIR DENSITY IN MG/CM3	1.1559	1.1557	1.1558
TEMPERATURE CORRECTICN	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.91	21.92	
OBSERVED PRESSURE IN MM HG	736.860	736.760	
OBSERVED HUMIDITY IN PERCENT	40.00	40.00	

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SOMEWHERE, U.S.A. SERIES 3
SET OF MASS STANDARDS : 5KG - 100MG 5/23/79
TEST NUMBER 654321

BALANCE 3
OPERATOR 84
ACCEPTED WITHIN STANDARD DEVIATION OF THE PROCESS .02800 MG
ACCEPTED BETWEEN STANDARD DEVIATION OF THE PROCESS .00000 MG

CALIBRATION DESIGN 62
RESTRAINT VECTOR 1 1 1 0 0 0
MASS CORRECTION OF RESTRAINT 9.05323 MG
VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT 21.94 C 126.17267 CM3
SYSTEMATIC ERROR IN THE RESTRAINT .03800 MG
3 STANDARD DEVIATION LIMIT FOR RANDOM ERROR AFFECTING RESTRAINT .05144 MG

CHECK STANDARD USED 4
CHECK STANDARD VECTOR 0 0 0 0 1 0
ACCEPTED MASS CORRECTION OF CHECK STANDARD .98830 MG
REPORT VECTOR 1 1 1 1 0 0

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.92	21.96	21.94
CORRECTED PRESSURE IN MM HG	736.920	736.580	736.750
CORRECTED HUMIDITY IN PERCENT	40.00	40.00	40.00
COMPUTED AIR DENSITY IN MG/CM3	1.1560	1.1553	1.1556
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.92	21.96	
OBSERVED PRESSURE IN MM HG	736.920	736.580	
OBSERVED HUMIDITY IN PERCENT	40.00	40.00	

WEIGHTS BEING TESTED	NOMINAL VALUE G	DENSITY G/CM3 AT 20C	COEFFICIENT OF EXPANSION	ACCEPTED CORRECTION MG
500G	500.0000	7.9000	.000045	
300G	300.0000	7.9530	.000045	
200G	200.0000	7.9530	.000045	
100G	100.0000	7.9000	.000045	
S 100G	100.0000	7.9530	.000045	.98830
SUM 100G	100.0000	7.9423	.000045	

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 3
OPERATOR 84

CALIBRATION DESIGN 62

GRAMS	500	300	200	100	100	100
A 1	+	-	-	+	-	
A 2	+	-	-		+	-
A 3	+	-	-	-		+
A 4	+	-	-			
A 5	+		-	-	-	-
A 6		+	-	+	-	-
A 7		+	-	-	+	-
A 8		+	-	-	-	+
A 9			+	-	-	
A 10			+	-		-
A 11			+		-	-
R	+	+	+			

OBSERVATIONS IN DIVISIONS
DOUBLE SUBSTITUTION ONE PAN BALANCE

A 1	12.7800	10.6200	60.6300	62.8600
A 2	13.0200	12.5900	62.5400	62.9600
A 3	14.8600	10.7500	60.7300	64.8800
A 4	12.8600	10.6100	60.5400	62.8200
A 5	12.9100	13.5800	63.5400	62.8100
A 6	10.8700	13.4400	63.3300	60.8400
A 7	10.9400	13.3300	63.2600	60.8200
A 8	12.6900	11.4400	61.3800	62.6600
A 9	11.1800	11.7100	61.6800	61.1400
A 10	11.1800	13.5000	63.3800	61.1100
A 11	11.0900	13.4400	63.4000	60.9600

BALANCE 3
OPERATOR 84

CALIBRATION DESIGN 62

SENSITIVITY WEIGHT
MASS 49.98277 MG
VOLUME .00301 CM3 AT 20 C
COEFFICIENT OF EXPANSION .000020
S*=S-PV(S)= 49.97929 MG

	A(I) (MG)	DELTA(I) (MG)	AVERAGE SENSITIVITY (MG/DIV)	DRIFT(I) (MG)	OBSERVED SENSITIVITY (MG/DIV)
A 1	2.19570	.00092	1.00032	.03501	1.00009
A 2	.42514	-.00556	1.00032	-.00500	1.00049
A 3	4.13132	-.01335	1.00032	.02001	1.00039
A 4	2.26621	.00950	1.00054	.01501	1.00129
A 5	-.70038	.00849	1.00054	-.03002	.99979
A 6	-2.53351	-.00805	1.00139	.04006	1.00259
A 7	-2.41835	-.01675	1.00139	-.02503	1.00049
A 8	1.26676	.01632	1.00139	.01502	1.00109
A 9	-.53537	-.03332	1.00069	-.00500	1.00009
A 10	-2.29658	.03149	1.00069	.02502	1.00249
A 11	-2.39664	-.00665	1.00069	-.04503	.99949

ITEM (G)	CORRECTION (MG)	VOLUME (AT T) (CM3)	SYSTEMATIC ERROR (MG)	3 S.D. LIMIT (MG)	UNCERTAINTY LIMIT (MG)
500.0000	5.89889	63.29741	.01900	.03233	.05133
300.0000	1.75036	37.72513	.01140	.02945	.04085
200.0000	1.40395	25.15011	.00760	.02443	.03203
100.0000	1.01957	12.65946	.00380	.03027	.03407
100.0000	.98400	12.57509	.00380	.03027	.03407
100.0000	2.82980	12.59220	.00380	.03027	.03407

TEMPERATURE T= 21.94 C

RESTRAINT FOR FOLLOWING SERIES
RESTRAINT VECTOR 0 0 0 0 0 1
MASS CORRECTION 2.82980 MG
VOLUME AT 20 C 12.59110 CM3
SYSTEMATIC ERROR .00380 MG
3 STANDARD DEVIATION LIMIT .03027 MG

BALANCE 3
OPERATOR 84

CALIBRATICN DESIGN 62

SUM (G)	WEIGHTS USED FCR THE LINEAR COMBINATIONS GRAMS					
	50C	300	200	100	100	100
600	+			+		

VALUES AND UNCERTAINTIES FOR COMBINATICNS OF WEIGHTS
)NCERTAINTY IS 3 STANDARD DEVIATICN LIMIT PLUS ALLOWANCE FOR
(STEMATIC ERROR.)

SUM (G)	CORR (MG)	SYSTEMATIC (MG)	3 S.D. ERROR (MG)	UNCERTAINTY LIMIT (MG)
600	6.91847	.02280	.04750	.07030

BALANCE 3
OPERATOR 84
MAXIMUM LOAD 600.0000 G
STARTING RESTRAINT NUMBER 80

CALIBRATION DESIGN 62

PRECISION CONTROL

OBSERVED STANDARD DEVIATION OF THE PROCESS .02284 MG
ACCEPTED STANDARD DEVIATION OF THE PROCESS .02800 MG
DEGREES OF FREEDOM 6
F RATIO .665

F RATIO IS LESS THAN 2.81 (CRITICAL VALUE FOR PROBABILITY = .01).
THEREFORE THE STANDARD DEVIATION IS IN CONTROL.

CHECK STANDARD VECTOR 0 0 0 0 1 0
CHECK STANDARD USED 4
ACCEPTED MASS CORRECTION OF CHECK STANDARD .98830 MG
OBSERVED CORRECTION OF CHECK STANDARD .98400 MG
STANDARD DEVIATION OF THE OBSERVED CORRECTION .01009 MG
T VALUE -.43

ABSOLUTE VALUE OF T IS LESS THAN 3.
THEREFORE CHECK STANDARD IS IN CONTROL.

TEST CONDITIONS	BEFORE	AFTER	AVERA
CORRECTED TEMPERATURE IN DEGREES C	21.92	21.96	21.94
CORRECTED PRESSURE IN MM HG	736.920	736.580	736.750
CORRECTED HUMIDITY IN PERCENT	40.00	40.00	40.00
COMPUTED AIR DENSITY IN MG/CM3	1.1560	1.1553	1.15
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.92	21.96	
OBSERVED PRESSURE IN MM HG	736.920	736.580	
OBSERVED HUMIDITY IN PERCENT	40.00	40.00	

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

BALANCE 5
OPERATOR 84
ACCEPTED WITHIN STANDARD DEVIATION OF THE PROCESS .01200 MG
ACCEPTED BETWEEN STANDARD DEVIATION OF THE PROCESS .00000 MG

CALIBRATION DESIGN 62
RESTRAINT VECTOR 1 1 1 0 0 0
MASS CORRECTION OF RESTRAINT 2.82980 MG
VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT 21.97 C 12.59222 CM3
SYSTEMATIC ERROR IN THE RESTRAINT .00380 MG
3 STANDARD DEVIATION LIMIT FOR RANDOM ERROR AFFECTING RESTRAINT .03027 MG

CHECK STANDARD USED 6
CHECK STANDARD VECTOR 0 0 0 0 1 0
ACCEPTED MASS CORRECTION OF CHECK STANDARD .07850 MG
REPORT VECTOR 1 1 1 1 0 0

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.99	21.96	21.97
CORRECTED PRESSURE IN MM HG	746.600	746.000	746.300
CORRECTED HUMIDITY IN PERCENT	31.00	31.00	31.00
COMPUTED AIR DENSITY IN MG/CM3	1.1720	1.1712	1.1716
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.99	21.96	
OBSERVED PRESSURE IN MM HG	746.600	746.000	
OBSERVED HUMIDITY IN PERCENT	31.00	31.00	

WEIGHTS BEING TESTED	NOMINAL VALUE G	DENSITY G/CM3 AT 20C	COEFFICIENT OF EXPANSION	ACCEPTED CORRECTION MG
50G	50.0000	7.9530	.000045	
30G	30.0000	7.9530	.000045	
20G	20.0000	7.9000	.000045	
10G	10.0000	7.9530	.000045	
S 10G	10.0000	7.9530	.000045	.07850
SUM 10G	10.0000	7.9264	.000045	

X Y Z CCRPCRATICN
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMEER 654321

BALANCE 5
OPERATOR 84

CALIBRATICN CESIGN 62

	GRAMS 50	30	20	10	10	10
A 1	+	-	-	+	-	
A 2	+	-	-		+	-
A 3	+	-	-	-		+
A 4	+	-	-			
A 5	+		-	-	-	-
A 6		+	-	+	-	-
A 7		+	-	-	+	-
A 8		+	-	-	-	+
A 9			+	-	-	
A 10			+	-		-
A 11			+		-	-
R	+	+	+			

OBSERVATICNS IN DIVISICNS
DOUBLE SLBSTITUTION CNE PAN EALANCE

A 1	6.1800	4.6900	54.7100	56.2000
A 2	6.1700	4.7200	54.7100	56.1500
A 3	6.1400	4.7600	54.7600	56.1400
A 4	6.1900	4.7400	54.7200	56.1800
A 5	6.1800	4.4700	54.4500	56.1800
A 6	4.8100	4.4400	54.4400	54.8100
A 7	4.7900	4.4900	54.4700	54.7500
A 8	4.7600	4.5100	54.4900	54.7400
A 9	4.5200	4.5500	54.5200	54.4900
A 10	4.4800	4.5200	54.5000	54.4700
A 11	4.4700	4.4700	54.4600	54.4700

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

BALANCE 5
OPERATOR 84

CALIBRATION DESIGN 62

SENSITIVITY WEIGHT
MASS 49.98277 MG
VOLUME .00301 CM3 AT 20 C
COEFFICIENT OF EXPANSION .000020
S*=S-PV(S)= 49.97924 MG

	A(I) (MG)	DELTA(I) (MG)	AVERAGE SENSITIVITY (MG/DIV)	DRIFT(I) (MG)	OBSERVED SENSITIVITY (MG/DIV)
A 1	1.48923	.00353	.99948	.00000	.99919
A 2	1.44426	-.00895	.99948	-.00500	.99968
A 3	1.37929	-.00582	.99948	.00000	.99958
A 4	1.45520	.01386	1.00013	.00500	1.00008
A 5	1.72023	-.00262	1.00013	.01000	1.00018
A 6	.36992	.00046	.99978	.00000	.99958
A 7	.28994	.00920	.99978	-.01000	.99978
A 8	.24995	-.00704	.99978	.00000	.99998
A 9	-.03000	.01358	1.00005	-.00000	1.00018
A 10	-.03500	-.00330	1.00005	.00500	1.00008
A 11	.00500	-.00766	1.00005	.00500	.99988

ITEM (G)	CORRECTION (MG)	VOLUME (AT T) (CM3)	SYSTEMATIC ERROR (MG)	3 S.D. LIMIT (MG)	UNCERTAINTY LIMIT (MG)
50.0000	2.12579	6.28776	.00190	.01731	.01921
30.0000	.53569	3.77256	.00114	.01407	.01521
20.0000	.16831	2.53189	.00076	.01126	.01202
10.0000	.11825	1.25751	.00038	.01314	.01352
10.0000	.07388	1.25751	.00038	.01314	.01352
10.0000	.06695	1.26173	.00038	.01314	.01352

TEMPERATURE T= 21.97 C

RESTRAINT FOR FOLLOWING SERIES
RESTRAINT VECTOR 0 0 0 0 0 1
MASS CORRECTION .06695 MG
VOLUME AT 20 C 1.26161 CM3
SYSTEMATIC ERROR .00038 MG
STANDARD DEVIATION LIMIT .01314 MG

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 5
OPERATOR 84
MAXIMUM LOAD 60.0000 G
STARTING RESTRAINT NUMBER 80

CALIBRATION DESIGN 62

PRECISION CONTROL

OBSERVED STANDARD DEVIATION OF THE PROCESS .01091 MG
ACCEPTED STANDARD DEVIATION OF THE PROCESS .01200 MG
DEGREES OF FREEDOM 6
F RATIO .826

F RATIO IS LESS THAN 2.81 (CRITICAL VALUE FOR PROBABILITY = .01).
THEREFORE THE STANDARD DEVIATION IS IN CONTROL.

CHECK STANDARD VECTOR 0 0 0 0 1 0
CHECK STANDARD USED 6
ACCEPTED MASS CORRECTION OF CHECK STANDARD .07850 MG
OBSERVED CORRECTION OF CHECK STANDARD .07388 MG
STANDARD DEVIATION OF THE OBSERVED CORRECTION .00438 MG
T VALUE -1.06

ABSOLUTE VALUE OF T IS LESS THAN 3.
THEREFORE CHECK STANDARD IS IN CONTROL.

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.99	21.96	21.97
CORRECTED PRESSURE IN MM HG	746.600	746.000	746.[illegible]
CORRECTED HUMIDITY IN PERCENT	31.00	31.00	31.00
COMPUTED AIR DENSITY IN MG/CM3	1.1720	1.1712	1.[illegible]
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.99	21.96	
OBSERVED PRESSURE IN MM HG	746.600	746.000	
OBSERVED HUMIDITY IN PERCENT	31.00	31.00	

BALANCE 7
OPERATOR 84
ACCEPTED WITHIN STANDARD DEVIATION OF THE PROCESS .00170 MG
ACCEPTED BETWEEN STANDARD DEVIATION OF THE PROCESS .00000 MG

CALIBRATION DESIGN 62
RESTRAINT VECTOR 1 1 1 0 0 0
MASS CORRECTION OF RESTRAINT .06695 MG
VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT 21.90 C 1.26172 CM3
SYSTEMATIC ERROR IN THE RESTRAINT .00038 MG
3 STANDARD DEVIATION LIMIT FOR RANDOM ERROR AFFECTING RESTRAINT .01314 MG

CHECK STANDARD USED 8
CHECK STANDARD VECTOR 0 0 0 0 1 0
ACCEPTED MASS CORRECTION OF CHECK STANDARD -.07920 MG
REPORT VECTOR 1 1 1 1 0 0

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.92	21.88	21.90
CORRECTED PRESSURE IN MM HG	743.280	742.820	743.050
CORRECTED HUMIDITY IN PERCENT	35.00	35.00	35.00
COMPUTED AIR DENSITY IN MG/CM3	1.1666	1.1660	1.1663
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.92	21.88	
OBSERVED PRESSURE IN MM HG	743.280	742.820	
OBSERVED HUMIDITY IN PERCENT	35.00	35.00	

WEIGHTS BEING TESTED	NOMINAL VALUE G	DENSITY G/CM3 AT 20C	COEFFICIENT OF EXPANSION	ACCEPTED CORRECTION MG
5G	5.0000	7.9000	.000045	
3G	3.0000	7.9530	.000045	
2G	2.0000	7.9530	.000045	
1G	1.0000	7.9000	.000045	
S 1G	1.0000	7.9530	.000045	-.07920
SUM 1G	1.0000	16.6000	.000020	

BALANCE 7
OPERATOR 84

CALIBRATION DESIGN 62

	GRAMS 5	3	2	1	1	1
A 1	+	-	-	+	-	
A 2	+	-	-		+	-
A 3	+	-	-	-		+
A 4	+	-	-			
A 5	+		-	-	-	-
A 6		+	-	+	-	-
A 7		+	-	-	+	-
A 8		+	-	-	-	+
A 9			+	-	-	
A 10			+	-		-
A 11			+		-	-
R	+	+	+			

OBSERVATIONS IN DIVISIONS
DOUBLE SUBSTITUTION ONE PAN BALANCE

A 1	1.0840	.9260	5.9270	6.0840
A 2	.9780	.9390	5.9310	5.9720
A 3	.9900	1.0210	6.0210	5.9870
A 4	1.0680	1.0130	6.0090	6.0670
A 5	1.0680	.8750	5.8700	6.0630
A 6	1.0620	.8620	5.8570	6.0530
A 7	.9590	.9660	5.9570	5.9480
A 8	.9690	.9480	5.9420	5.9600
A 9	1.0160	.9760	5.9660	6.0060
A 10	1.0160	.9870	5.9810	6.0060
A 11	1.0120	.8810	5.8720	6.0040

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 7
OPERATOR 84

CALIBRATION DESIGN 62

SENSITIVITY WEIGHT
MASS 5.00171 MG
VOLUME .00185 CM3 AT 20 C
COEFFICIENT OF EXPANSION .000069
S*=S-PV(S)= 4.99955 MG

	A(I) (MG)	DELTA(I) (MG)	AVERAGE SENSITIVITY (MG/DIV)	DRIFT(I) (MG)	OBSERVED SENSITIVITY (MG/DIV)
A 1	.15755	-.00114	1.00031	-.00050	.99961
A 2	.04001	-.00146	1.00031	.00100	1.00171
A 3	-.03251	.00082	1.00031	-.00150	.99961
A 4	.05655	.00094	1.00096	.00150	1.00101
A 5	.19319	.00085	1.00096	.00000	1.00091
A 6	.19819	-.00001	1.00094	-.00200	1.00051
A 7	-.00801	-.00004	1.00094	-.00100	1.00151
A 8	.01952	-.00079	1.00094	-.00150	1.00081
A 9	.04006	-.00155	1.00148	.00000	1.00191
A 10	.02704	-.00043	1.00148	-.00200	1.00071
A 11	.13169	.00114	1.00148	.00050	1.00181

ITEM (G)	CORRECTION (MG)	VOLUME (AT T) (CM3)	SYSTEMATIC ERROR (MG)	3 S.D. LIMIT (MG)	UNCERTAINTY LIMIT (MG)
5.0000	.06375	.63297	.00019	.00668	.00687
3.0000	.01669	.37725	.00011	.00422	.00434
2.0000	-.01348	.25150	.00008	.00295	.00303
1.0000	.02498	.12660	.00004	.00224	.00228
1.0000	-.07910	.12574	.00004	.00224	.00228
1.0000	-.14136	.06023	.00004	.00224	.00228

TEMPERATURE T= 21.90 C

RESTRAINT FOR FOLLOWING SERIES
RESTRAINT VECTOR 0 0 0 0 0 1
MASS CORRECTION -.14136 MG
VOLUME AT 20 C .06023 CM3
SYSTEMATIC ERROR .00004 MG
3 STANDARD DEVIATION LIMIT .00224 MG

BALANCE 7
OPERATOR 84

CALIBRATION DESIGN 62

SUM (G)	WEIGHTS USED FOR THE LINEAR COMBINATIONS GRAMS					
	5	3	2	1	1	1
6	+			+		

VALUES AND UNCERTAINTIES FOR COMBINATIONS OF WEIGHTS
(UNCERTAINTY IS 3 STANDARD DEVIATION LIMIT PLUS ALLOWANCE FOR SYSTEMATIC ERROR.)

SUM (G)	CORR (MG)	SYSTEMATIC (MG)	3 S.D. ERROR (MG)	UNCERTAINTY LIMIT (MG)
6	.08873	.00023	.00818	.00841

BALANCE 7
OPERATOR 84
MAXIMUM LOAD 6.0000 G
STARTING RESTRAINT NUMBER 80

CALIBRATION DESIGN 62

PRECISION CONTROL

OBSERVED STANDARD DEVIATION OF THE PROCESS .00131 MG
ACCEPTED STANDARD DEVIATION OF THE PROCESS .00170 MG
DEGREES OF FREEDOM 6
F RATIO .591

F RATIO IS LESS THAN 2.81 (CRITICAL VALUE FOR PROBABILITY = .01).
THEREFORE THE STANDARD DEVIATION IS IN CONTROL.

CHECK STANDARD VECTOR 0 0 0 0 1 0
CHECK STANDARD USED 8
ACCEPTED MASS CORRECTION OF CHECK STANDARD -.07920 MG
OBSERVED CORRECTION OF CHECK STANDARD -.07910 MG
STANDARD DEVIATION OF THE OBSERVED CORRECTION .00075 MG
T VALUE .14

ABSOLUTE VALUE OF T IS LESS THAN 3.
THEREFORE CHECK STANDARD IS IN CONTROL.

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.92	21.88	21.90
CORRECTED PRESSURE IN MM HG	743.280	742.820	743.050
CORRECTED HUMIDITY IN PERCENT	35.00	35.00	35.00
COMPUTED AIR DENSITY IN MG/CM3	1.1666	1.1660	1.1663
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	21.92	21.88	
OBSERVED PRESSURE IN MM HG	743.280	742.820	
OBSERVED HUMIDITY IN PERCENT	35.00	35.00	

X Y Z CCRPORATICN
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 1COMG
TEST NUMEER 654321

BALANCE 7
OPERATOR 84

ACCEPTED WITHIN STANDARD DEVIATICN CF THE PROCESS	.00050 MG
ACCEPTED BETWEEN STANDARD DEVIATICN CF THE PROCESS	.00000 MG

CALIBRATICN DESIGN 62
RESTRAINT VECTOR 1 1 1 0 0 0

MASS CORRECTION OF RESTRAINT	-.14136 MG
VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT 22.60 C	.06024 CM3
SYSTEMATIC ERROR IN THE RESTRAINT	.00004 MG
3 STANDARD DEVIATION LIMIT FOR RANDCM ERROR AFFECTING RESTRAINT	.00224 MG

CHECK STANDARD USED 8
CHECK STANDARD VECTOR 0 0 0 0 1 0
ACCEPTED MASS CORRECTICN OF CHECK STANDARD -.02628 MG
REPORT VECTCR 1 1 1 1 0 0

TEST CONCITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	22.21	22.99	22.60
CORRECTEC PRESSURE IN MM HG	742.520	741.860	742.190
CORRECTED HUMIDITY IN PERCENT	36.00	35.00	35.50
COMPUTED AIR DENSITY IN MG/CM3	1.1640	1.1599	1.1620
TEMPERATURE CORRECTICN	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	22.21	22.99	
OBSERVED PRESSURE IN MM HG	742.520	741.860	
OBSERVED HUMIDITY IN PERCENT	36.00	35.00	

WEIGHTS BEING TESTED	NOMINAL VALUE G	DENSITY G/CM3 AT 20C	COEFFICIENT OF EXPANSION	ACCEPTED CORRECTION MG
500MG	.5000	16.6000	.000020	
300MG	.3000	16.6000	.000020	
200MG	.2000	16.6000	.000020	
100MG	.1000	16.6000	.000020	
S 100MG	.1000	16.6000	.000020	-.02628
SUM 100MG	.1000	8.1788	.000049	

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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BALANCE 7
OPERATOR 84

CALIBRATION DESIGN 62

MG	500	300	200	100	100	100
A 1	+	-	-	+	-	
A 2	+	-	-		+	-
A 3	+	-	-	-		+
A 4	+	-	-			
A 5	+		-	-	-	-
A 6		+	-	+	-	-
A 7		+	-	-	+	-
A 8		+	-	-	-	+
A 9			+	-	-	
A 10			+	-		-
A 11			+		-	-
R	+	+	+			

OBSERVATIONS IN DIVISIONS
DOUBLE SUBSTITUTION ONE PAN BALANCE

A 1	296.4000	224.0000	726.2000	801.2000
A 2	285.5000	240.3000	741.3000	788.9000
A 3	300.5000	241.6000	744.1000	803.7000
A 4	312.9000	253.5000	754.8000	815.5000
A 5	312.7000	239.8000	741.0000	815.6000
A 6	303.8000	250.5000	751.5000	805.7000
A 7	290.2000	264.6000	765.4000	791.7000
A 8	303.6000	252.3000	753.6000	806.0000
A 9	276.7000	302.6000	804.1000	779.3000
A 10	276.7000	315.5000	817.1000	779.2000
A 11	276.6000	301.0000	802.6000	778.6000

X Y Z CORPORATION
SOMEWHERE, U.S.A.
SET OF MASS STANDARDS : 5KG - 100MG
TEST NUMBER 654321

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SERIES 6
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BALANCE 7
OPERATOR 84

CALIBRATION DESIGN 62

SENSITIVITY WEIGHT
MASS .50156 MG
VOLUME .00186 CM3 AT 20 C
COEFFICIENT OF EXPANSION .000069
S*=S-PV(S)= .49940 MG

	A(I) (MG)	DELTA(I) (MG)	AVERAGE SENSITIVITY (MG/DIV)	DRIFT(I) (MG)	OBSERVED SENSITIVITY (MG/DIV)
A 1	.07347	-.00002	.00100	.00130	.00100
A 2	.04626	-.00026	.00100	.00120	.00100
A 3	.05907	.00029	.00100	.00035	.00099
A 4	.05992	.00032	.00100	.00065	.00100
A 5	.07359	-.00033	.00100	.00085	.00100
A 6	.05362	.00018	.00100	.00045	.00100
A 7	.02589	.00024	.00100	.00035	.00100
A 8	.05173	-.00008	.00100	.00055	.00100
A 9	-.02526	-.00004	.00100	.00055	.00100
A 10	-.03821	.00009	.00100	.00045	.00100
A 11	-.02411	.00029	.00100	.00020	.00100

ITEM (G)	CORRECTION (MG)	VOLUME (AT T) (CM3)	SYSTEMATIC ERROR (MG)	3 S.D. LIMIT (MG)	UNCERTAINTY LIMIT (MG)
.5000	-.04088	.03012	.00002	.00117	.00119
.3000	-.03697	.01807	.00001	.00081	.00082
.2000	-.06351	.01204	.00001	.00060	.00060
.1000	-.01219	.00602	.00000	.00058	.00058
.1000	-.02609	.00602	.00000	.00058	.00058
.1000	-.00580	.01223	.00000	.00058	.00058

TEMPERATURE T= 22.60 C

BALANCE 7
OPERATOR 84
MAXIMUM LCAD .6000 G
STARTING RESTRAINT NUMBER 80

CALIBRATICN DESIGN 62

PRECISION CCNTRCL

OBSERVED STANDARD DEVIATION OF THE PROCESS .00030 MG
ACCEPTED STANDARD DEVIATICN CF THE PROCESS .00050 MG
DEGREES CF FREEDOM 6
F RATIO .370

F RATIO IS LESS THAN 2.81 (CRITICAL VALUE FOR PROBABILITY = .01).
THEREFORE THE STANDARD DEVIATICN IS IN CONTROL.

CHECK STANDARD VECTOR 0 0 0 0 1 0
CHECK STANDARD USED 8
ACCEPTED MASS CORRECTION OF CHECK STANDARD -.02628 MG
OBSERVED CORRECTION CF CHECK STANDARD -.02609 MG
STANDARD DEVIATION OF THE OBSERVED CORRECTION .00019 MG
T VALUE .97

ABSOLUTE VALUE OF T IS LESS THAN 3.
THEREFORE CHECK STANDARD IS IN CONTROL.

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	22.21	22.99	22.60
CORRECTED PRESSURE IN MM HG	742.520	741.860	742.190
CORRECTED HUMIDITY IN PERCENT	36.00	35.00	35.50
COMPUTED AIR DENSITY IN MG/CM3	1.1640	1.1599	1.1620
TEMPERATURE CORRECTION	.000	.000	
PRESSURE CORRECTION	.000	.000	
HUMIDITY CORRECTION	.00	.00	
OBSERVED TEMPERATURE IN DEGREES C	22.21	22.99	
OBSERVED PRESSURE IN MM HG	742.520	741.860	
OBSERVED HUMIDITY IN PERCENT	36.00	35.00	

SUMMARY

FOR CONVENIENCE, THE RESULTS OF THIS WORK ARE SUMMARIZED IN TABLES I AND II. THE VALUES ASSIGNED ARE WITH REFERENCE TO THE STANDARDS IDENTIFIED ON THE DATA SHEETS. THE UNCERTAINTY FIGURE IS AN EXPRESSION OF THE OVERALL UNCERTAINTY USING THREE STANDARD DEVIATIONS AS A LIMIT TO THE EFFECT OF RANDOM ERRORS OF THE MEASUREMENT ASSOCIATED WITH THE MEASUREMENT PROCESSES. THE MAGNITUDE OF SYSTEMATIC ERRORS FROM SOURCES OTHER THAN THE USE OF ACCEPTED VALUES FOR CERTAIN STARTING STANDARDS ARE CONSIDERED NEGLIGIBLE. IT SHOULD BE NOTED THAT THE MAGNITUDE OF THE UNCERTAINTY REFLECTS THE PERFORMANCE OF THE MEASUREMENT PROCESS USED TO ESTABLISH THESE VALUES. THE MASS UNIT, AS REALIZABLE IN ANOTHER MEASUREMENT PROCESS, WILL BE UNCERTAIN BY AN AMOUNT WHICH IS A COMBINATION OF THE UNCERTAINTY OF THIS PROCESS AND THE PROCESS IN WHICH THESE STANDARDS ARE USED.

THE ESTIMATED MASS VALUES LISTED IN TABLE I ARE BASED ON AN EXPLICIT TREATMENT OF DISPLACEMENT VOLUMES, E.G., 'TRUE MASS', 'MASS IN VACUO', MASS IN THE NEWTONIAN SENSE. THE DISPLACEMENT VOLUME ASSOCIATED WITH EACH VALUE IS LISTED AS WELL AS THE VOLUMETRIC COEFFICIENT OF EXPANSION. THESE VALUES SHOULD BE USED, TOGETHER WITH APPROPRIATE CORRECTION FOR THE BUOYANT EFFECTS OF THE ENVIRONMENT, TO ESTABLISH CONSISTENT MASS VALUES FOR OBJECTS WHICH DIFFER SIGNIFICANTLY IN DENSITY AND/OR FOR MEASUREMENTS WHICH MUST BE MADE IN DIFFERING ENVIRONMENTS. THE RELATION 1LB AVDP=.45359237KG IS USED AS REQUIRED.

THE ESTIMATED MASS VALUES LISTED IN TABLE II ARE BASED ON AN IMPLICIT TREATMENT OF DISPLACEMENT VOLUMES, E.G., 'APPARENT MASS', 'APPARENT MASS VERSUS BRASS', 'APPARENT MASS VERSUS DENSITY 8.0'. THE VALUES ARE LISTED AS CORRECTIONS TO BE APPLIED TO THE LISTED NOMINAL VALUE (A POSITIVE CORRECTION INDICATES THAT THE MASS IS LARGER THAN THE STATED NOMINAL VALUE BY THE AMOUNT OF THE CORRECTION). THESE VALUES ARE COMPUTED FROM THE VALUES BASED ON AN EXPLICIT TREATMENT OF DISPLACEMENT VOLUMES USING THE FOLLOWING DEFINING RELATIONS AND ARE UNCERTAIN BY THE AMOUNT SHOWN IN TABLE I.

THE ADJUSTMENT OF WEIGHTS TO MINIMIZE THE DEVIATION FROM NOMINAL ON THE BASIS OF 'NORMAL BRASS' (IN ACCORDANCE WITH COR. A BELOW) IS WIDESPREAD IN THIS COUNTRY AND IN MANY PARTS OF THE WORLD. VALUES STATED ON EITHER BASIS ARE INTERNALLY CONSISTENT AND DEFINITE. THERE IS, HOWEVER, A SYSTEMATIC DIFFERENCE BETWEEN THE VALUES ASSIGNED ON EACH BASIS, THE VALUE ON THE BASIS OF 'DENSITY 8.0' BEING 7 MICROGRAMS/GRAM LARGER THAN THE VALUE ON THE BASIS OF NORMAL BRASS. THIS SYSTEMATIC DIFFERENCE IS CLEARLY DETECTABLE ON MANY DIRECT READING BALANCES.

CORRECTION A - 'APPARENT MASS VERSUS BRASS' OR 'WEIGHT IN AIR AGAINST BRASS' IS DETERMINED BY [illegible] HYPOTHETICAL WEIGHING OF [illegible] WEIGHT AT 20 CELSIUS IN AIR HAV[illegible] A DENSITY OF 1.2 MG/CM3, WI[illegible] (NORMAL BRASS) STANDARD HAV[illegible] DENSITY OF 8.4 G/CM3 AT 0 CE[illegible] WHOSE COEFFICIENT OF VOLU[illegible] EXPANSION IS 0.000054 PER [illegible] CELSIUS, AND WHOSE VALUE IS [illegible]

ON ITS TRUE MASS OR WEIGHT IN VACUO.

CORRECTION B - 'APPARENT MASS VERSUS DENSITY 8.0' IS DETERMINED BY A HYPOTHETICAL WEIGHING OF THE WEIGHT, IN AIR HAVING A DENSITY OF 1.2 MG/CM3, WITH A STANDARD HAVING A DENSITY OF 8.0 G/CM3 AT 20 CELSIUS, AND WHOSE VALUE IS BASED ON ITS TRUE MASS OR WEIGHT IN VACUO.

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SOMEWHERE, U.S.A. 5/18/79
SET OF MASS STANDARDS : 5KG - 100MG
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TABLE 1

ITEM	MASS (G)	UNCERTAINTY (G)	VOL AT 20 (CM3)	COEF OF EXP
5KG	5000.06307702	.00564493	628.70150	.000045
3KG	3000.02401883	.00368509	377.21916	.000045
2KG	2000.03017279	.00268395	253.16838	.000045
1KG	1000.00660911	.00008944	125.73955	.000045
500G	500.00589889	.00005133	63.29189	.000045
300G	300.00175036	.00004085	37.72183	.000045
200G	200.00140395	.00003203	25.14792	.000045
100G	100.00101957	.00003407	12.65836	.000045
50G	50.00212579	.00001921	6.28720	.000045
30G	30.00053569	.00001521	3.77223	.000045
20G	20.00016831	.00001202	2.53167	.000045
10G	10.00011825	.00001352	1.25740	.000045
5G	5.00006375	.00000687	.63292	.000045
3G	3.00001669	.00000434	.37722	.000045
2G	1.99998652	.00000303	.25148	.000045
1G	1.00002498	.00000228	.12659	.000045
500MG	.49995912	.00000119	.03012	.000020
300MG	.29996303	.00000082	.01807	.000020
200MG	.19993649	.00000060	.01204	.000020
100MG	.09998781	.00000058	.00602	.000020

X Y Z CORPORATION
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ITEM	COR.A (MG)	COR.B (MG)
5KG	23.69575	58.64401
3KG	.39018	21.35904
2KG	12.39537	26.37469
1KG	-1.26710	5.72251
500G	1.45455	4.94937
300G	-.61250	1.48438
200G	-.17129	1.22664
100G	.13071	.82967
50G	1.73196	2.08145
30G	.29940	.50909
20G	-.00946	.13033
10G	.03948	.10938
5G	.01930	.05425
3G	-.00694	.01403
2G	-.02924	-.01526
1G	.01609	.02308
500MG	-.00552	-.00202
300MG	-.01575	-.01366
200MG	-.04937	-.04797
100MG	-.00512	-.00442

APPENDIX A.3--SAMPLE PROCESS CONTROL OUTPUT

SEE SECTION 3.3 FOR A DESCRIPTION OF THIS DATA OUTPUT.

```
5247980  2      .50497  1  2.09386 4 5322.10  .24733.88  .4041.0000   .01.150384S
5237980  2    -.59562   3   .02282 3 4121.91  .01736.81 -.1040.0000   .01.155884S
5237980  4      .98400  3   .02284 6 6221.94  .04736.75 -.3440.0000   .01.155684S
5177980  6      .07388  5   .01C91 6 6221.97 -.03746.30 -.6031.C000   .01.171684S
5187980  8    -.07910   7   .00131 6 6221.90 -.04743.05 -.4635.0000   .01.166384S
5187980  8    -.02609   7   .00030 6 6222.60  .78742.19 -.6635.5000-1.01.162084S
```

APPENDIX B--LISTING OF COMPUTER PROGRAM

```
BLKDAT SUBPROGRAM ---
  BLOCK DATA                                                            BLD00010
*************************************************************************BLD00020
  ZERMAC IS MACHINE ZERO THUS THE QUANTITY NEEDS TO BE CHANGED        **BLD00030
  FOR DIFFERENT COMPUTERS                                              **BLD00040
  THIS VALUE IS USED BY SUBPROGRAM SPINV                               **BLD00050
*************************************************************************BLD00060
  COMMON /INVCST/ ZERMAC                                                BLD00070
*************************************************************************BLD00080
  KFD(I),I=1,14 CONTAINS THE DIGITS 0-9 AND CHARACTERS  -,* USED      **BLD00090
  BY SUBPROGRAM DPFD                                                   **BLD00100
  WILL NEED TO CHANGE TO COMPLY WITH PROPOSED NEW FORTRAN STANDARD**BLD00110
*************************************************************************BLD00120
  COMMON /DPFDVL/ KFD(18)                                               BLD00130
*************************************************************************BLD00140
  INPUT-OUTPUT CONTROL PARAMETERS                                      **BLD00150
  IR IS THE CARD READER UNIT                                           **BLD00160
  IW IS THE LINE PRINTER UNIT                                          **BLD00170
  IP IS THE CARD PUNCH UNIT                                            **BLD00180
  IPL IS THE NUMBER OF LINES PER PRINTED PAGE                          **BLD00190
*************************************************************************BLD00200
  COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                     BLD00210
*************************************************************************BLD00220
  CHARACTERS S T O P TO DETERMINE END OF RUN                           **BLD00230
*************************************************************************BLD00240
  COMMON /STOP/ FS,FT,FO,FP,FB                                          BLD00250
*************************************************************************BLD00260
  ITEND IS THE NUMBER OF ITERATIONS ALLOWED IN COMPUTING OBSERVED **BLD00270
  CORRECTION TO WEIGHT                                                 **BLD00280
  IT IS USED IN THE MAIN PROGRAM                                       **BLD00290
*************************************************************************BLD00300
  COMMON /ITSTOP/ ITEND                                                 BLD00310
  DATA ZERMAC /1.E-8/                                                   BLD00320
  DATA KFD(1),KFD(2),KFD(3),KFD(4),KFD(5),KFD(6),KFD(7),KFD(8) /1H0,BLD00330
 2 1H1,1H2,1H3,1H4,1H5,1H6,1H7/                                         BLD00340
  DATA KFD(9),KFD(10),KFD(11),KFD(12),KFD(13),KFD(14),KFD(15) /1H8, BLD00350
 2 1H9,1H ,1H-,1H.,1H*,1H+/                                             BLD00360
  DATA KFD(16),KFD(17),KFD(18) /1H,,1HD,1HE/                            BLD00370
  DATA IR,IW,IP,IPL,ITMP /5,6,1,58,7/                                   BLD00380
  DATA FS,FT,FO,FP,FE /1HS,1HT,1HO,1HP,1H /                             BLD00390
  DATA ITEND /10/                                                       BLD00400
  END                                                                   BLD00410
MAIN PROGRAM ---
*************************************************************************MAN00010
  MAIN ROUTINE OF NATIONAL BUREAU OF STANDARDS MASS CALIBRATION        **MAN00020
  PROGRAM  VERSION OF SEPT. 10,1971                                    **MAN00030
  WRITTEN BY ROBERT C. RAYBOLD , OFFICE OF MEASUREMENT SERVICES        **MAN00040
  AND MRS.R.N.VARNER , STATISTICAL ENGINEERING LABORATORY              **MAN00050
  NATIONAL BUREAU OF STANDARDS , WASHINGTON, D.C. 20234                **MAN00060
  MODIFIED BY R. N. VARNER SEPT 1979                                   **MAN00070
                                                                       **MAN00080
  THE MASS CALIBRATION PROGRAM CONTAINS ONE MAIN PROGRAM               **MAN00090
      AND 23 SUBPROGRAMS                                               **MAN00100
```

```
C**                                                                    **MAN00110
C**   PROGRAM NAME      NUMBER OF LINES OF CODE                        **MAN00120
C**                                                                    **MAN00130
C**   MAIN              628                                            **MAN00140
C**   BLKDAT             41                                            **MAN00145
C**   READ1             120                                            **MAN00150
C**   READIT            356                                            **MAN00160
C**   ERROR              56                                            **MAN00170
C**   PRINT1             67                                            **MAN00180
C**   TEXT1             125                                            **MAN00190
C**   TEXT2             125                                            **MAN00200
C**   TEXT3             125                                            **MAN00210
C**   TEXT4             125                                            **MAN00220
C**   TEXT5             121                                            **MAN00230
C**   TEXT6              40                                            **MAN00240
C**   READ2             325                                            **MAN00250
C**   SPINV             126                                            **MAN00260
C**   SAVMTX             22                                            **MAN00270
C**   INVCHK             69                                            **MAN00280
C**   PRINT2            670                                            **MAN00290
C**   PGCCNT             53                                            **MAN00300
C**   HEADPG             36                                            **MAN00310
C**   FINPRT            181                                            **MAN00320
C**   TEXTS1            124                                            **MAN00330
C**   TEXTS2             30                                            **MAN00340
C**   DPFD               89                                            **MAN00350
C**   CHKLN              11                                            **MAN00360
C**   THIS PROGRAM CONTROLS THE FLOW OF THE INPUT,                     **MAN00370
C**   CALCULATIONS AND OUTPUT                                          **MAN00380
C***********************************************************************MAN00390
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                            **MAN00400
C***********************************************************************MAN00410
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),        MAN00420
     2 IDATE(3)                                                          MAN004
C***********************************************************************MAN00
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                           **MAN00
C***********************************************************************MAN00
      DIMENSION AIDCST(5,15),ANCM(15),DENSTY(15),COEFEX(15),ACCVAL(15),  MAN0
     2 ARSTIN(15),ACKSTD(15),IRSTOU(15),IPRNT(15),DESMAT(15,50),         MAN0
     3 OBSERV(600),ALCOM(15,20)                                          MAN0
C***********************************************************************MAN
C**   DIMENSION FOR COMMON /COMPUT/ VARIABLES                          **MAN
C***********************************************************************MAN
      DIMENSION SWTPRT(50),A(50),DELTA(50),OBSCOR(15),COMVOL(15),
     2 SERROR(15),TRISIG(15),TOTUN(15),DRIFT(50),ZERO(50),COMVOP(15),
     3 CORR5A(20),SIG35A(20),UNC5A(20),IOTSTR(50),SER5A(20),DS1(50)
C*********************************************************************
C**   DIMENSION FOR MAIN PROGRAM VARIABLES
C*********************************************************************
      DIMENSION VOLP(15),CORRP(15),TEMP(15),D1(50), ILOAD(50),TEMP2(15),
     2 ALOAD(50)
C*********************************************************************
C**   DIMENSION FOR COMMON /REPRT/ VARIABLES
C*********************************************************************
      DIMENSION AITEM(5,50),APPMAS(50),TRMASS(50),UNCERT(50),VOLPRT(50),
     2 CORRB(50),COEPRT(50)
C*********************************************************************
C**   DIMENSION FOR COMMON /CHECK/ VARIABLES
```

```
C*    ***********************************************************************MAN00680
      DIMENSION BCHK(289),Y(578)                                              MAN00690
C*    ***********************************************************************MAN00700
C*    LABELED COMMON                                                        **MAN00710
C*    ***********************************************************************MAN00720
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                       MAN00730
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNCM,L1,L2,L3,L4,MAN00740
     2 L5,L6,IDATE,IBREST                                                     MAN00750
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                         MAN00760
      COMMON /INPUT/ TBAR,PBAR,HBAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM,  MAN00770
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1PMAN00780
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P,  MAN00790
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTOU,IPRNT,ITPOS,ICKUSD,ICALDS,   MAN00800
     5 LINVAR,N3,N4                                                           MAN00810
      COMMON /COMPUT/ OBSCOR,CORR,VOLRES,RHOA,SWTPRT,A,DELTA,CONVOL,       MAN00820
     2 SERROR,TRISIG,TOTUN,ACORR,CORRES,TMSUM,VOLSUM,SERSUM,T3SIG,ALOADPMAN00830
     3,OBSTD,FRATIO,OBCOCK,OBSCK,TVAL,DRIFT,ZERO,V2TAU,STAR,CONVOP,       MAN00840
     4 CORR5A,SIG35A,UNC5A,RHOAA,RHOAB,SER5A,DS1,NDGFR,ISWTCH,IFLAG,      MAN00850
     5 IRCUT,IOTSTR,JSTAR                                                     MAN00860
      COMMON /REPRT/ TRMASS,APPMAS,CORRB,AITEM,UNCERT,VOLPRT,CCEPRT,NPRTMAN00870
      COMMON /CHECK/ CHCKMA,BCHK,Y                                            MAN00880
      COMMON /ITSTOP/ ITEND                                                   MAN00890
      COMMON /DPFDVL/ KFD(18)                                                 MAN00900
C***********************************************************************MAN00910
C**   TYPE STATEMENTS                                                       **MAN00920
C***********************************************************************MAN00930
      DOUBLE PRECISION VOLP,CORRP,OBSCOR,TRMASS,APPMAP,APPMAS,CORRBB,      MAN00940
     2 CORRB,SUM,SUM1                                                         MAN00950
C***********************************************************************MAN00960
C**   READ IN ADMINISTRATIVE DATA                                           **MAN00970
C**           DATA COMMON TO ALL SERIES                                     **MAN00980
C**   INITIALIZE CONTROL VARIABLES                                          **MAN00990
C***********************************************************************MAN01000
10    CALL READ1                                                              MAN01010
      IXFLAG=0                                                                MAN01020
      IXNSIG=0                                                                MAN01030
      IPAGE=0                                                                 MAN01040
      NPRT=0                                                                  MAN01050
      NOSER=0                                                                 MAN01060
      ASSIGN 40 TO NCSERP                                                     MAN01070
      ASSIGN 410 TO NSERPP                                                    MAN01080
C***********************************************************************MAN01090
C**   PRINT TITLE PAGE FOR COMPLETE RUN                                     **MAN01100
C***********************************************************************MAN01110
      CALL PRINT1                                                             MAN01120
C***********************************************************************MAN01130
C**   READ DATA FOR ONE SERIES                                              **MAN01140
C***********************************************************************MAN01150
20    CALL READ2                                                              MAN01160
C***********************************************************************MAN01170
C**   SET UP CHCKMA=STDEBA/100.0    TO CHECK MATRIX INVERSION               **MAN01180
C***********************************************************************MAN01190
      CHCKMA=STDEBA/100.0                                                     MAN01200
C***********************************************************************MAN01210
C**   BEGIN CALCULATIONS FOR ONE SERIES                                     **MAN01220
C**   CALCULATIONS FOR FIRST PRINTED PAGE OF A SERIES                       **MAN01230
C***********************************************************************MAN01240
      JSTAR=0                                                                 MAN01250
```

```
      TDELT=TBAR-TNOM
      DO 30 I=1,NUNKN
30    TEMP2(I)=1.0+COEFEX(I)*TDELT
      GO TO NCSERP, (40,60)
40    ASSIGN 60 TO NCSERP
      CORR=0.0
      VOLRES=0.0
      DO 50 I=1,NUNKN
      TEMP(I)=((ANOM(I)+.001*ACCVAL(I))/DENSTY(I))*TEMP2(I)
      IF (ARSTIN(I).EQ.0.0) GO TO 50
      CORR=CORR+ACCVAL(I)*ARSTIN(I)
      VOLRES=VOLRES+TEMP(I)*ARSTIN(I)
50    CONTINUE
      GO TO 70
60    CORR=TMSUM
      VOLRES=VOLSUM*(1.0+(SUMP)*TDELT)
C***********************************************************************
C**   CONVERT TEMPERATURE TO KELVIN                                   **
C**   COMPUTE VAPOR PRESSURE AND AIR DENSITY                          **
C***********************************************************************
70    TKEL=TBAR+273.15E0
      CONST=13.5951E0*9.80665E0
      E1P=EXP(-4.7406885E0*ALOG(TKEL)-6.8982434E3/TKEL+.5938385E2-0.5797
     2662E-2*TKEL+6.2223854E-6*(TKEL**2))
      E1=E1P/CONST
      RHOA=(.464746E0*(PBAR-.00378029E0*HBAR*E1))/TKEL
      TKEL=T1P+273.15E0
      E1P=EXP(-4.7406885E0*ALOG(TKEL)-6.8982434E3/TKEL+.5938385E2-0.5797
     2662E-2*TKEL+6.2223854E-6*(TKEL**2))
      E1=E1P/CONST
      RHOAB=(.464746E0*(P1P-.00378029E0*H1P*E1))/TKEL
      TKEL=T2P+273.15E0
      E1P=EXP(-4.7406885E0*ALOG(TKEL)-6.8982434E3/TKEL+.5938385E2-0.5797
     2662E-2*TKEL+6.2223854E-6*(TKEL**2))
      E1=E1P/CONST
      RHOAA=(.464746E0*(P2P-.00378029E0*H2P*E1))/TKEL
C***********************************************************************
C**   BEGIN CALCULATIONS FOR SECOND AND THIRD PAGES OF A SERIES       **
C**   THE FOLLOWING OPERATIONS ARE PERFORMED TO COPE WITH             **
C**   ROUND OFF ERROR                                                 **
C**   COMPUTE LOADS USING DESIGN MATRIX                               **
C***********************************************************************
      DO 130 I=1,NOBS
      ILOAD(I)=0
      YYYYYY=0.0
      DO 80 J=1,NUNKN
      YYYYYY=YYYYYY+ABS(DESMAT(J,I))*ANOM(J)/2.0
80    CONTINUE
      ZZZZZZ=YYYYYY+.05
      IF (ZZZZZZ-1.) 100,90,90
C***********************************************************************
C**   LOAD IN GRAMS                                                   **
C***********************************************************************
90    ILOAD(I)=INT(YYYYYY+.05)
      GO TO 130
C***********************************************************************
C**   LOAD IN MILLIGRAMS OR MILLIPOUNDS                               **
C***********************************************************************
```

```
100   ZZZZZZ=YYYYYY*1000.+.05
      IF (ZZZZZZ-1.) 120,110,110
110   ILOAD(I)=INT(1000.000*YYYYYY+.05)
      GO TC 130
C*********************************************************************
C**   LOAC IN MICRO PCUNDS                                          **
C*********************************************************************
120   ILOAD(I)=INT(1000000.*YYYYYY+.05)
130   CONTINUE
      ALOADP=0.0
      DO 160 I=1,NOBS
      ALOAC(I)=0.0
      DO 140 J=1,NUNKN
      ALOAD(I)=ALOAD(I)+ABS(DESMAT(J,I))*ANOM(J)/2.0
140   CCNTINUE
      IF (ALCADP-ALCAD(I)) 150,160,160
150   ALOADP=ALCAD(I)
160   CONTINUE
C*********************************************************************
C**   COMFUTE S(STAR) SENSITIVITY VALUE (MASS/DIVISION)             **
C**   COMFUTE S(*) SENSITIVITY VALUE (MASS/DIVISICN)                **
C**   COMFUTE A-B , S , DRIFT AND/OR LEFT-RIGHT EFFECT AS REQUIRED BY **
C**   WEIGHING METHOD                                               **
C*********************************************************************
      STAR=SWT-RHOA*VSWT*(1.0+CEXSWT*(TDELT))
      J=1
      DO 290 I=1,NOBS
      GO TO (170,200,230,260,270,  280), ITPOS
C*********************************************************************
C**   SINGLE SUBSTITUTICN-SINGLE PAN BALANCE                        **
C*********************************************************************
170   D1(I)=CBSERV(J)-CBSERV(J+1)
      IF (CBSERV(J+2).NE.0.0) GC TO 180
      DS1(I)=0.0
      GO TO 190
180   DS1(I)=CBSERV(J+2)-CBSERV(J+1)
190   J=J+3
      GO TO 290
C*********************************************************************
C**   SINGLE SUBSTITUTICN-TWO-PAN BALANCE                           **
C*********************************************************************
200   XP=(OBSERV(J)+2.0*CBSERV(J+1)+CBSERV(J+2))/4.0
      YP=(CBSERV(J+3)+2.0*CBSERV(J+4)+OBSERV(J+5))/4.0
      ZP=(CBSERV(J+6)+2.0*CBSERV(J+7)+OBSERV(J+8))/4.0
      D1(I)=XP-YP
      IF (ZP.NE.0.0) GC TO 210
      DS1(I)=0.0
      GO TC 220
210   DS1(I)=ABS(ZP-YP)
220   J=J+9
      GO TC 290
C*********************************************************************
C**   SINGLE TRANSPOSITICN-TWO-PAN EALANCE                          **
C*********************************************************************
230   XP=(CBSERV(J)+2.0*CBSERV(J+1)+CBSERV(J+2))/4.0
      YP=(CBSERV(J+3)+2.0*CBSERV(J+4)+OBSERV(J+5))/4.0
      ZP=(OBSERV(J+6)+2.0*CBSERV(J+7)+OBSERV(J+8))/4.0
      D1(I)=(XP-YP)/2.0
```

```
      ZERC(I)=(XP+YP)/2.0
      IF (ZP.NE.0.0) GO TO 240
      DS1(I)=0.0
      GO TC 250
240   DS1(I)=ABS(ZP-YP)
250   J=J+9
      GO TC 290
C***********************************************************************
C**   DOUELE SUESTITUTION-CNE PAN EALANCE                             **
C***********************************************************************
260   D1(I)=(CBSERV(J)-CESERV(J+1)-OBSERV(J+2)+OBSERV(J+3))/2.0
      DS1(I)=(CBSERV(J)-3.0*OBSERV(J+1)+3.0*OBSERV(J+2)-OESERV(J+3))/2.0
      DRIFT(I)=(-OBSERV(J)+OBSERV(J+1)-OBSERV(J+2)+OBSERV(J+3))/2.0
      J=J+4
      GO TO 290
C***********************************************************************
C**   DOUELE SUESTITUTICN-TWO PAN EALANCE                             **
C***********************************************************************
270   XP=(CBSERV(J)+2.0*CBSERV(J+1)+CBSERV(J+2))/4.0
      YP=(CBSERV(J+3)+2.C*CBSERV(J+4)+OBSERV(J+5))/4.0
      ZP=(CBSERV(J+6)+2.0*OBSERV(J+7)+OBSERV(J+8))/4.0
      WP=(CBSERV(J+9)+2.0*CBSERV(J+10)+OBSERV(J+11))/4.0
      D1(I)=(XP-YP-ZP+WP)/2.0
      DS1(I)=ABS((XP-3.*YP+3.*ZP-WP)/2.0)
      DRIFT(I)=(-XP+YP-ZP+WP)/2.0
      J=J+12
      GC TO 290
C***********************************************************************
C**   DOUELE TRANSPOSITICN-TWO PAN EALANCE                            **
C***********************************************************************
280   XP=(CBSERV(J)+2.0*CBSERV(J+1)+CBSERV(J+2))/4.0
      YP=(OBSERV(J+3)+2.0*CBSERV(J+4)+OBSERV(J+5))/4.0
      ZP=(CBSERV(J+6)+2.C*CBSERV(J+7)+OBSERV(J+8))/4.0
      WP=(CBSERV(J+9)+2.0*CBSERV(J+10)+OBSERV(J+11))/4.0
      D1(I)=(XP-YP-ZP+WP)/4.0
      DS1(I)=ABS((XP-3.*YP+3.*ZP-WP)/2.0)
      ZERC(I)=(3.0*XP+YP+ZP-WP)/4.0
      DRIFT(I)=(-XP+YP-ZP+WP)/2.0
      J=J+12
290   CCNTINUE
C***********************************************************************
C**   COMPUTE  S(*)/D(S),A(I),DRIFT(I),ZERO(I)                        **
C***********************************************************************
      KA=1
      SUM=0.0
      J=0
      I=1
      ILCDPP=ILCAD(I)
C***********************************************************************
C**   CHECK FCR LOAD CHANGES                                          **
C***********************************************************************
300   IF (ILCAD(I).NE.ILCDPP) GC TC 320
      IF (DS1(I).EQ.0.0) GC TO 310
      SUM=SUM+DS1(I)
      DS1(I)=STAR/DS1(I)
      J=J+1
310   I=I+1
      IF (I.GT.NCBS) GO TO 330
```

```
      GO TO 300                                                         MAN03000
  320 ILODPP=ILOAD(I)                                                   MAN03010
  330 FLTN=J                                                            MAN03020
      DBAR=SUM/FLTN                                                     MAN03030
      FLTNSQ=SQRT(FLTN)                                                 MAN03040
      DSP=STAR/DBAR                                                     MAN03050
      KB=I-1                                                            MAN03060
      DO 360 K=KA,KB                                                    MAN03070
      SWTFRT(K)=ABS(DSP)                                                MAN03080
      A(K)=D1(K)*DSP                                                    MAN03090
      DRIFT(K)=DRIFT(K)*DSP                                             MAN03100
      IF (N4.EQ.0) GO TO 340                                            MAN03110
C***********************************************************************MAN03120
C**   CHANGE SIGN FOR REVERSED SCALE                                  **MAN03130
C***********************************************************************MAN03140
      A(K)=-1.*A(K)                                                     MAN03150
      DRIFT(K)=-1.*DRIFT(K)                                             MAN03160
  340 IF (ABS(D1(K)/(DBAR*FLTNSQ)).LE.0.25) GO TO 350                   MAN03170
C***********************************************************************MAN03180
C**   IF OBSERVED DEFLECTION IS GREATER THAN OR EQUAL TO              **MAN03190
C**   .25*SENSITIVITY DEFLECTION A FLAG IS SET UP                     **MAN03200
C***********************************************************************MAN03210
      ICTSTR(K)=KFD(14)                                                 MAN03220
      JSTAR=1                                                           MAN03230
      GO TO 360                                                         MAN03240
  350 ICTSTR(K)=KFD(11)                                                 MAN03250
  360 CONTINUE                                                          MAN03260
      IF (I.GT.NOBS) GO TO 370                                          MAN03270
      J=0                                                               MAN03280
      SUM=0.0                                                           MAN03290
      KA=I                                                              MAN03300
      GO TO 300                                                         MAN03310
C***********************************************************************MAN03320
C**   COMPUTE DENSITY AND COEFFICIENT OF EXPANSION OF WEIGHTS         **MAN03330
C**   BEING TESTED                                                    **MAN03340
C**   COMPUTE XREST (RESTRAINT VALUE) FOR Y(M,N)                      **MAN03350
C***********************************************************************MAN03360
  370 NXXSIG=0                                                          MAN03370
      DO 380 I=1,NUNKN                                                  MAN03380
      IF (ARSTIN(I).EQ.0.0) GO TO 380                                   MAN03390
      NXXSIG=NXXSIG+1                                                   MAN03400
  380 CONTINUE                                                          MAN03410
      IF (NXNSIG.LT.2) GO TO 400                                        MAN03420
      IF (NXXSIG.GT.1) GO TO 400                                        MAN03430
      DO 390 I=1,NUNKN                                                  MAN03440
      IF (ARSTIN(I).EQ.0.0) GO TO 390                                   MAN03450
      DENSTY(I)=(ANOM(I)+.001*TMSUM)/VOLSUM                             MAN03460
      COEFEX(I)=SUMP                                                    MAN03470
  390 CONTINUE                                                          MAN03480
  400 GO TO NSERFP, (410,430)                                           MAN03490
  410 ASSIGN 430 TO NSERFP                                              MAN03500
      XREST=0.0                                                         MAN03510
      TMSUM=0.0                                                         MAN03520
      DO 420 I=1,NUNKN                                                  MAN03530
      IF (ARSTIN(I).EQ.0.0) GO TO 420                                   MAN03540
      XREST=XREST+(ACCVAL(I)-RHOA*TEMP(I))*ARSTIN(I)                    MAN03550
      TMSUM=TMSUM+ACCVAL(I)*ARSTIN(I)                                   MAN03560
  420 CONTINUE                                                          MAN03570
```

```
      GO TC 440
430   XREST=TMSUM-RHCA*VOLSUM*(1.0+SUMP*TDELT)
C***********************************************************************
C**   MULTIPLY TRANSPOSE OF DESIGN MATRIX BY ITSELF AND STORE IN Y    **
C***********************************************************************
440   L=0
      DO 470 IA=1,NUNKN
      DO 460 IAA=1,NUNKN
      L=L+1
      SUM=0.0
      DO 450 JA=1,NOBS
      SUM=SUM+DESMAT(IAA,JA)*DESMAT(IA,JA)
450   CONTINUE
      Y(L)=SUM
460   CONTINUE
      L=L+2
      Y(L-1)=ARSTIN(IA)
      Y(L)=0.0
470   CONTINUE
C***********************************************************************
C**   SET UP REMAINING ELEMENTS OF MATRIX X                           **
C***********************************************************************
      IRIN=0
      DO 480 I=1,NUNKN
      L=L+1
      Y(L)=ARSTIN(I)
      IF (ARSTIN(I).EQ.0.0) GC TO 480
      IRIN=1.0
480   CONTINUE
      L=L+2
      IF (IRIN.EQ.0) GO TO 490
      Y(L-1)=0.0
      GO TO 500
490   Y(L-1)=1.0
500   Y(L)=0.0
C***********************************************************************
C**   COMPUTE X'Y                                                     **
C***********************************************************************
      DO 520 IAA=1,NUNKN
      L=L+1
      SUM=0.0
      DO 510 JA=1,NOBS
      SUM=SUM+DESMAT(IAA,JA)*A(JA)
510   CONTINUE
      Y(L)=SUM
520   CONTINUE
      Y(L+1)=XREST
      Y(L+2)=-1.0
C***********************************************************************
C**   CALL MATRIX INVERSION ROUTINE                                   **
C***********************************************************************
      CALL SPINV (Y,NUNKN+2,NUNKN+2,IFLAG)
C***********************************************************************
C**   IF MATRIX IS SINGULAR PRINT FIRST TWO PAGES OF SERIES AND       **
C**   TERMINATE RUN                                                   **
C**   IFLAG=0  INVERSE SUCCESSFUL                                     **
C**   IFLAG=4  MATRIX SINGULAR                                        **
C**   IFLAG=-1 I-AA(INV) FAILED
```

```
C*****************************************************************************MAN04160
      IF (IFLAG.EQ.0) GC TC 530                                               MAN04170
      CALL PRINT2                                                             MAN04180
      STOP                                                                    MAN04190
C*****************************************************************************MAN04200
C**   COMPUTE DELTA(I)=A(I)-DESMAT*BETA(I)                                  **MAN04210
C*****************************************************************************MAN04220
530   L=(NUNKN+2)*(NUNKN+1)+1                                                 MAN04230
      DO 550 I=1,NOBS                                                         MAN04240
      LA=L                                                                    MAN04250
      SUM=0.0                                                                 MAN04260
      DO 540 J=1,NUNKN                                                        MAN04270
      SUM=SUM+DESMAT(J,I)*Y(LA)                                               MAN04280
      LA=LA+1                                                                 MAN04290
540   CCNTINUE                                                                MAN04300
      DELTA(I)=A(I)-SUM                                                       MAN04310
550   CONTINUE                                                                MAN04320
C*****************************************************************************MAN04330
C**   CALCULATE CORRECTICN AND VOLUME FOR THIRD OUTPUT PAGE                 **MAN04340
C**   OF A SERIES                                                           **MAN04350
C*****************************************************************************MAN04360
      LA=L                                                                    MAN04370
      DO 560 I=1,NUNKN                                                        MAN04380
      VOLP(I)=(ANOM(I)/DENSTY(I))*TEMP2(I)                                    MAN04390
      CORRP(I)=Y(LA)+RHCA*VOLP(I)                                             MAN04400
      LA=LA+1                                                                 MAN04410
560   CONTINUE                                                                MAN04420
C*****************************************************************************MAN04430
C**   BEGIN ITERATION AND ITERATE   UNTIL DIFFERENCE BETWEEN OLC            **MAN04440
C**   AND NEW VALUES ARE LESS THAN .01 STDEEA                               **MAN04450
C**   ONLY 10 ITERATICNS ARE ALLOWED                                        **MAN04460
C*****************************************************************************MAN04470
      CHCK=.01*STDEEA                                                         MAN04480
      ISTCP=0                                                                 MAN04490
570   ISWTCH=0                                                                MAN04500
      LA=L                                                                    MAN04510
      DO 600 I=1,NUNKN                                                        MAN04520
      OBSCOR(I)=Y(LA)+RHOA*((ANCM(I)+.001*CORRP(I))/DENSTY(I))*TEMP2(I)      MAN04530
      LA=LA+1                                                                 MAN04540
      IF (ISWTCH.NE.0) GC TO 590                                              MAN04550
      IF (SNGL(DABS(CBSCCR(I)-CCRRP(I)))-CHCK) 590,590,580                    MAN04560
580   ISWTCH=1                                                                MAN04570
590   CORRP(I)=CBSCOR(I)                                                      MAN04580
600   CONTINUE                                                                MAN04590
      ISTCP=ISTOP+1                                                           MAN04600
      IF (ISTCP.GE.ITEND) GO TC 610                                           MAN04610
      IF (ISWTCH.NE.0) GC TO 570                                              MAN04620
610   WR=0.0                                                                  MAN04630
      DO 620 I=1,NUNKN                                                        MAN04640
      IF (ARSTIN(I).EQ.0.0) GC TC 620                                         MAN04650
      WR=WR+ANOM(I)*ARSTIN(I)                                                 MAN04660
620   CCNTINUE                                                                MAN04670
      TRISQR=RANERR**2                                                        MAN04680
      TRSQRP=(3.0*STDEBA)**2                                                  MAN04690
      TRSQVE=(3.0*VAREAL)**2                                                  MAN04700
      LA=1                                                                    MAN04710
      DC 670 I=1,NUNKN                                                        MAN04720
      COMVCL(I)=(ANOM(I)+.001*OBSCOR(I))/DENSTY(I)                            MAN04730
```

```
      COMVOP(I)=COMVOL(I)*TEMP2(I)
      SERROR(I)=(ANOM(I)/WR)*SYSERR
      TRTEMP=TRSQRP+Y(LA)+((ANOM(I)/WR)**2)*TRISQR+TRSQVB
      IF (TRTEMP) 630,640,640
630   WRITE (IW,890) TRTEMP
      GO TO 660
640   IF (TRTEMP.GE.0.0) GO TO 650
      TRTEMP=0.0
650   TRISIG(I)=SQRT(TRTEMP)
660   TOTUN(I)=SERROR(I)+TRISIG(I)
      LA=LA+NUNKN+3
670   CONTINUE
      ACORR=TMSUM
      CORRES=0.0
      TMSUM=0.0
      SERSUM=0.0
      T3SIG=0.0
      DO 690 I=1,NUNKN
      IF (ARSTIN(I).EQ.0.0) GO TO 680
      CORRES=CORRES+OBSCOR(I)*ARSTIN(I)
680   IF (IRSTOU(I).EQ.0) GO TO 690
C*************************************************************************
C**   COMPUTE MASS FOR NEXT RESTRAINT                                  **
C*************************************************************************
      TMSUM=TMSUM+OBSCOR(I)
690   CONTINUE
      VOLSUM=0.0
      IROUT=0
      NXNSIG=0
      DO 700 I=1,NUNKN
      IF (IRSTOU(I).EQ.0) GO TO 700
      IROUT=1
      VOLSUM=VOLSUM+(ANOM(I)+.001*OBSCOR(I))/DENSTY(I)
      NXNSIG=NXNSIG+1
700   CONTINUE
C*************************************************************************
C**   CALCULATIONS FOR THIRD OUTPUT PAGE OF SERIES                     **
C**   COMPUTE SYSTEMATIC AND RANDOM ERROR AND TOTAL UNCERTAINTY        **
C*************************************************************************
      LINVV=LINVAR+1
      DO 710 K=1,NUNKN
710   ALCOM(K,LINVV)=IRSTOU(K)
      DO 770 L=1,LINVV
      CORR5A(L)=0.0
      SER5A(L)=0.0
      DO 720 K=1,NUNKN
      CORR5A(L)=CORR5A(L)+OBSCOR(K)*ALCOM(K,L)
      SER5A(L)=ABS(SER5A(L)+SERROR(K)*ALCOM(K,L))
720   CONTINUE
      LA=1
      DO 740 I=1,NUNKN
      TEMP(I)=0.0
      DO 730 J=1,NUNKN
      TEMP(I)=TEMP(I)+Y(LA)*ALCOM(J,L)
730   LA=LA+1
740   LA=LA+2
      SUM=0.0
      SUM2RP=0.0
```

```
      DO 750 J=1,NUNKN
      SUM2RP=SUM2RP+ANOM(J)*ALCCM(J,L)
750   SUM=SUM+TEMP(J)*ALCCM(J,L)
      IF (SUM.GE.0.0) GO TO 760
      SUM=0.0
760   CONTINUE
      SIG35A(L)=SQRT(TRSGRP*SUM+((SUM2RP/WR)**2)*TRISGR+TRSQVE)
      UNCSA(L)=SER5A(L)+SIG35A(L)
770   CONTINUE
      SERSUM=SER5A(LINVV)
      T3SIG=SIG35A(LINVV)
C***********************************************************************
C**   BEGIN COMPUTATIONS FOR FOURTH PAGE -- F RATIO AND T-TEST        **
C***********************************************************************
      NDGFR=NOBS-NUNKN+1
      SUM=0.0
      DO 780 I=1,NOBS
      SUM=SUM+DELTA(I)**2
780   CONTINUE
      OBSTD=SQRT(SUM/FLOAT(NDGFR))
      FRATIO=OBSTD**2/STDEEA**2
      OBCCCK=0.0
      SUM1=0.0
      V2TAU=0.0
      DO 790 I=1,NUNKN
      IF (ACKSTD(I).EQ.0.0) GO TO 790
      OBCCCK=OBCOCK+OBSCCR(I)*ACKSTD(I)
      SUM1=SUM1+ANOM(I)*ACKSTD(I)
      V2TAU=V2TAU+ACCVAL(I)*ACKSTD(I)
790   CONTINUE
      LA=1
      DO 810 J=1,NUNKN
      TEMP(J)=0.0
      DO 800 I=1,NUNKN
      TEMP(J)=TEMP(J)+ACKSTD(I)*Y(LA)
800   LA=LA+1
810   LA=LA+2
      SUM=0.0
      DO 820 I=1,NUNKN
820   SUM=SUM+TEMP(I)*ACKSTD(I)
      IF (SUM.GE.0.0) GO TO 830
      SUM=0.0
830   CONTINUE
      OBSCK=SQRT(STDEEA**2*SUM+(SUM1/WR)**2*(RANERR/3.0)**2+VAREAL**2)
      IF (OBSCK.NE.0.0) GO TO 840
      TVAL=0.0
      GO TO 850
840   TVAL=(OBCOCK-V2TAU)/OBSCK
C***********************************************************************
C**   SAVE VALUES FOR FINAL REPORT                                    **
C***********************************************************************
850   DO 860 I=1,NUNKN
      IF (IFRNT(I).EQ.0) GO TO 860
      NPRT=NPRT+1
      AITEM(1,NPRT)=AIDCST(1,I)
      AITEM(2,NPRT)=AIDCST(2,I)
      AITEM(3,NPRT)=AIDCST(3,I)
      AITEM(4,NPRT)=AIDCST(4,I)
```

```
      AITEM(5,NPRT)=AIDCST(5,I)
      APPMAP=((ANOM(I)+.001*OBSCOR(I))*(1.0-.0012/DENSTY(I)))/(1.0-.0012
     2*(1.0+.000054*20.0)/8.4)
      APPMAS(NPRT)=(APPMAP-ANOM(I))*1000.
      TRMASS(NPRT)=ANOM(I)+.001*OBSCOR(I)
      UNCERT(NPRT)=.001*TOTUN(I)
      VOLPRT(NPRT)=COMVOL(I)
      CORREB=((ANOM(I)+.001*OBSCOR(I))*(1.0-.0012/DENSTY(I)))/(1.0-.0012
     2/8.0)
      CORRB(NPRT)=(CORREB-ANOM(I))*1000.
      COEPRT(NPRT)=COEFEX(I)
860   CONTINUE
C***********************************************************************
C**   SET UP VALUES FOR NEXT SERIES                                   **
C**   PRINT FOUR PAGES OF OUTPUT FOR ONE SERIES                       **
C***********************************************************************
      CALL PRINT2
      SYSERR=SERSUM
      RANERR=T3SIG
      SUM=0.0
      SUM1=0.0
      DO 870 I=1,NUNKN
      IF (IRSTOU(I).EQ.0) GO TO 870
      SUM=SUM+(ANOM(I)+.001*OBSCOR(I))/DENSTY(I)
      SUM1=SUM1+COEFEX(I)*((ANOM(I)+.001*OBSCOR(I))/DENSTY(I))
870   CONTINUE
      IF (SUM.EQ.0.0) GO TO 880
      SUMF=SUM1/SUM
880   CONTINUE
      IF (IROUT.NE.0) GO TO 20
      IF (NPRT.EQ.0) GO TO 10
      CALL FINPRT
      GO TO 10
C***********************************************************************
C**   FORMAT STATEMENT                                                **
C***********************************************************************
890   FORMAT (14H NEG SQRT ARG=E16.7)
      END
--- READ1 SUBPROGRAM ---
      SUBROUTINE READ1
C***********************************************************************
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **
C**   PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD     **
C**   AND MRS.R.N.VARNER                                              **
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **
C***********************************************************************
C**   SUBROUTINE TO READ DATA COMMON TO ALL SERIES                    **
C***********************************************************************
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                           **
C***********************************************************************
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),
     2 IDATE(3)
C***********************************************************************
C**   DIMENSION FOR COMMON /RAREA/ VARIABLES                          **
C***********************************************************************
      DIMENSION AA(72),AAITEM(5)
C***********************************************************************
C**   LABELED COMMON
```

```
C***********************************************************************RD100200
      COMMCN /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,RD100210
     2 L5,L6,IDATE,IBREST                                               RD100220
      COMMCN /RAREA/ AA,AAITEM                                          RD100230
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 RD100240
      COMMCN /STCP/ FS,FT,FO,FP,FB                                      RD100250
C***********************************************************************RD100260
C**   READ IN AND SET UP ADMINISTRATIVE DETAILS                       **RD100270
C**   READ 8 CARDS  IF ALL 8 ARE NCT USED , ADD BLANK CARDS           **RD100280
C**   THESE CARDS ARE SEARCHED FOR THE 1ST NON-BLANK CHARACTER AT     **RD100290
C**   WHICH TIME ALL REMAINING CHARACTERS ARE MOVED                   **RD100300
C**   TO A NEW LOCATICN STARTING IN POSITION 1                        **RD100310
C**   CARD 1 - NAME CF CRGANIZATICN                                   **RD100320
C**   CARD 2 - ADDRESS   STREET NUMBER AND NAME                       **RD100330
C**   CARD 3 - ADDRESS   CITY , STATE ZIP CODE                        **RD100340
C**   CARD 4 - TYPE OF SET (EG. 1-KG TO 1-MG)                         **RD100350
C**   CARD 5 - SERIAL NUMBER OF SET CF WEIGHTS BEING TESTED           **RD100360
C**   CARD 6 - DATE CF THE REPCRT                                     **RD100370
C**   CARD 7 - TEST NUMBER (MAX OF 18 CHARACTERS)                     **RD100380
C**   EXCEPT FOR THE FIRST PRINTED PAGE CNLY THE                      **RD100390
C**   FIRST 65 CHARACTERS ARE PRINTED ON OUTPUT                       **RD100400
C***********************************************************************RD100410
      DO 10 K=1,72                                                      RD100420
      B1(K)=FB                                                          RD100430
      B2(K)=FB                                                          RD100440
      B3(K)=FB                                                          RD100450
      B4(K)=FB                                                          RD100460
      B5(K)=FB                                                          RD100470
      B6(K)=FB                                                          RD100480
      B7(K)=FB                                                          RD100490
   10 CCNTINUE                                                          RD100500
      DO 130 I=1,7                                                      RD100510
      READ (IR,140) (AA(L),L=1,72)                                      RD100520
      DO 20 J=1,72                                                      RD100530
      IF (AA(J).EQ.FB) GC TO 20                                         RD100540
      N=73-J                                                            RD100550
      JJ=J                                                              RD100560
      GO TC 30                                                          RD100570
   20 CONTINUE                                                          RD100580
      GO TC 130                                                         RD100590
   30 DO 120 K=1,N                                                      RD100600
C***********************************************************************RD100610
C**   MOVE NCN-BLANK CHARACTERS TO BEGINNING OF FIELD                 **RD100620
C***********************************************************************RD100630
      GO TC (40,50,60,70,80,  90,100), I                                RD100640
   40 L1=N                                                              RD100650
      B1(K)=AA(JJ)                                                      RD100660
      IF (K.NE.4) GO TO 110                                             RD100670
C***********************************************************************RD100680
C**   TEST TO SEE IF CARD HAS STCP CN IT , IF IT DCES THEN STOP THE   **RD100690
C**   PROGRAM CTHERWISE CCNTINUE                                      **RD100700
C***********************************************************************RD100710
      IF (B1(1).EQ.FS.AND.B1(2).EQ.FT.AND.B1(3).EQ.FO.AND.B1(4).EQ.FP) SRD100720
      STOP                                                              RD100730
      GO TC 110                                                         RD100740
   50 L2=N                                                              RD100750
      B2(K)=AA(JJ)                                                      RD100760
      GO TO 110                                                         RD100770
```

```
60     L3=N
       B3(K)=AA(JJ)
       GO TO 110
70     L4=N
       B4(K)=AA(JJ)
       GO TO 110
80     L5=N
       B5(K)=AA(JJ)
       GO TO 110
90     L6=N
       B6(K)=AA(JJ)
       GO TO 110
100    B7(K)=AA(JJ)
110    JJ=JJ+1
120    CONTINUE
130    CONTINUE
C***********************************************************************
C**    READ RANDOM ERROR LIMIT, SYSTEMATIC ERROR LIMIT AND NOMINAL    **
C**    TEMPERATURE ALL ON ONE CARD FREE FIELD .FIELDS MUST BE         **
C**    SEPARATED BY A BLANK OR ANY NON-NUMERIC CHARACTER EXCEPT FOR   **
C**    D OR E OR .                                                    **
C**                                                                   **
C**    WHERE THE NUMBERS MUST BE IN THE FOLLOWING ORDER               **
C**      RANERR = 3 TIMES RANDOM ERROR IN THE STARTING RESTRAINT IN MG **
C**      SYSERR = SYSTEMATIC ERROR IN THE STARTING RESTRAINT IN MG    **
C**      TNOM   = NOMINAL TEMPERATURE AT WHICH THE APPARENT MASS      **
C**               VALUES ARE REPORTED IN DEGREES C                    **
C**      IBREST = STARTING RESTRAINT ID NUMBER                        **
C**                                                                   **
C**    FOR THE REST OF THE INPUT CARDS FOR EACH SERIES OF WEIGHINGS   **
C**    LOOK AT COMMENTS CARDS IN SUBROUTINE READ2                     **
C***********************************************************************
       CALL READIT (AA,1,AAITEM)
       RANERR=AA(1)
       SYSERR=AA(2)
       TNOM=AA(3)
       IBREST=INT(AA(4)+.5)
       RETURN
C***********************************************************************
C**    FORMAT STATEMENT                                               **
C***********************************************************************
140    FORMAT (72A1)
       END
--- READIT SUBPROGRAM ---
       SUBROUTINE READIT (Z,KCL,A)
C***********************************************************************
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **
C**    PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD    **
C**    AND MRS.R.N.VARNER                                             **
C**    MODIFIED BY R. N. VARNER SEPT 1979                             **
C***********************************************************************
C**    ANSI FORTRAN SUBROUTINE TO READ NUMBERS IN ANY FORMAT ANYWHERE **
C**    ON A CARD (BETWEEN CARD COLUMNS 'KOL' AND 80, INCLUSIVE).      **
C**    IN THIS VERSION OF THE SUBROUTINE, WHEN KOL = 16, CARD COLUMNS **
C**    1 THROUGH 15 ARE SCANNED TO PICK UP ALPHA-NUMBERIC DATA WHICH  **
C**    ARE STORED IN VARIABLE 'A'.                                    **
C**    WRITTEN BY ROY H. WAMPLER, STATISTICAL ENGINEERING LABORATORY, **
C**    NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C. 20234
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:*   VERSION OF FEBRUARY 8, 1971                                         **RDT00150
:************************************************************************RDT00160
:*   NUMBERS TO BE READ BY THIS ROUTINE SHOULD OBEY THE FOLLOWING       **RDT00170
:*   RULES.                                                              **RDT00180
:*                                                                       **RDT00190
:*   (1)  BETWEEN ANY TWO NUMBERS THERE MUST BE A SEPARATOR.  THIS       **RDT00200
:*   CAN BE ONE OR MORE BLANK SPACES, A COMMA, ANY LETTER EXCEPT D       **RDT00210
:*   OR E, OR ANY CHARACTER EXCEPT A PLUS SIGN, A MINUS SIGN, OR A       **RDT00220
:*   DECIMAL.                                                            **RDT00230
:*                                                                       **RDT00240
:*   (2)  NUMBERS CAN APPEAR IN INTEGER FORM.  EXAMPLES ARE              **RDT00250
:*   0  63  -271  +81063  01  2,71,-534,28                               **RDT00260
:*                                                                       **RDT00270
:*   (3)  NUMBERS CAN BE WRITTEN WITH A DECIMAL POINT.  EXAMPLES ARE     **RDT00280
:*   0. -1.0  38.1  -63.  .00015  +371.286                               **RDT00290
:*                                                                       **RDT00300
:*   (4)  NUMBERS CAN BE WRITTEN WITH AN EXPONENT WHICH MUST BE          **RDT00310
:*   PRECEDED BY A D OR E.  (IN THIS ROUTINE D IS CONSIDERED EQUIVA-     **RDT00320
:*   LENT TO E, AND NUMBERS WITH D ARE NOT INTERPRETED TO BE             **RDT00330
:*   DOUBLE PRECISION NUMBERS.)  EXAMPLES ARE                            **RDT00340
:*    2.1E12  2.1E 12  2.1E+12  2.1E-12                                  **RDT00350
:*   -2.1D12 -2.1D 12 -2.1D+12 -2.1D-12                                  **RDT00360
:*    0021.E02 .00021E5 2.1E0 2.1E-0                                     **RDT00370
:*    21E12  21E+12  21D-12                                              **RDT00380
:*    THE LAST THREE EXAMPLES ILLUSTRATE THAT A DECIMAL NEED NOT BE      **RDT00390
:*    USED IN CONNECTION WITH THE D OR E.                                **RDT00400
:************************************************************************RDT00410
      DIMENSION Z(40),A(1),N(80),IDIGIT(10),T(77)                          RDT00420
      COMMON /DPFDVL/ KFD(18)                                              RDT00430
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                    RDT00440
      EQUIVALENCE (IDIGIT(1),KFD(1))                                       RDT00450
      EQUIVALENCE (IPLUS,KFD(15))                                          RDT00460
      EQUIVALENCE (IMINUS,KFD(12))                                         RDT00470
      EQUIVALENCE (ID,KFD(17))                                             RDT00480
      EQUIVALENCE (IE,KFD(18))                                             RDT00490
      EQUIVALENCE (IDECML,KFD(13))                                         RDT00500
      EQUIVALENCE (IBLANK,KFD(11))                                         RDT00510
C************************************************************************RDT00520
C**   THE FOLLOWING DIMENSION STATEMENT AND THE THREE DATA STATEMENTS   **RDT00530
C**   WHICH FOLLOW THAT ARE MACHINE-DEPENDENT.                          **RDT00540
C**   T(I) CONTAINS THE MACHINE RANGE OF NUMBERS                        **RDT00550
C**      IN THIS CASE 1.E-38 TO 1.E38                                   **RDT00560
C**   IZERO = NUMBER OF UNIQUE POWERS OF TEN REPRESENTED BY             **RDT00570
C**           THE MACHINE RANGE                                          **RDT00580
C**   MAX = NUMBER OF POWERS OF TEN (NEGATIVE AND POSITIVE)             **RDT00590
C**         REPRESENTED BY THE MACHINE RANGE                             **RDT00600
C************************************************************************RDT00610
      DATA T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10),T(11),       RDT00620
     2 T(12),T(13),T(14),T(15),T(16),T(17),T(18),T(19),T(20),T(21),T(22)RDT00630
       T(23),T(24),T(25),T(26),T(27),T(28),T(29),T(30),T(31),T(32),T(33)RDT00640
       T(34),T(35),T(36),T(37),T(38),T(39),T(40),T(41),T(42),T(43),T(44)RDT00650
       T(45),T(46),T(47),T(48),T(49),T(50),T(51),T(52),T(53),T(54),T(55)RDT00660
       T(56),T(57),T(58),T(59),T(60),T(61),T(62),T(63),T(64),T(65),T(66)RDT00670
       T(67),T(68),T(69),T(70),T(71),T(72),T(73),T(74),T(75),T(76),        RDT00680
       T(77) /1.E-38,1.E-37,1.E-36,1.E-35,1.E-34,1.E-33,1.E-32,1.E-31,     RDT00690
       1.E-30,1.E-29,1.E-28,1.E-27,1.E-26,1.E-25,1.E-24,1.E-23,1.E-22,     RDT00700
       1.E-21,1.E-20,1.E-19,1.E-18,1.E-17,1.E-16,1.E-15,1.E-14,1.E-13,     RDT00710
       1.E-12,1.E-11,1.E-10,1.E-9,1.E-8,1.E-7,1.E-6,1.E-5,1.E-4,1.E-3,     RDT00720
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     2 1.E-2,1.E-1,1.,1.E1,1.E2,1.E3,1.E4,1.E5,1.E6,1.E7,1.E8,1.E9,1.E10
     3,1.E11,1.E12,1.E13,1.E14,1.E15,1.E16,1.E17,1.E18,1.E19,1.E20,1.E21
     4,1.E22,1.E23,1.E24,1.E25,1.E26,1.E27,1.E28,1.E29,1.E30,1.E31,1.E32
     5,1.E33,1.E34,1.E35,1.E36,1.E37,1.E38/
      DATA IZERO,IMAX /39,77/
C***********************************************************************
C**   THE DIMENSIONED VARIABLE T IS USED FOR ENTERING POWERS OF TEN   **
C**   INTO THE PROGRAM.                                                 **
C**   IZERO IS THE SUBSCRIPT OF T SUCH THAT T(IZERO) = 1. (= 1.E0).   **
C**   (ON THE UNIVAC 1108, T(IZERO) = T(39).)                           **
C**   IMAX IS THE LARGEST SUBSCRIPT OF T.                               **
C**   IN THE PROGRAM IT IS ASSUMED THAT (1 + IMAX)/2 = IZERO.  THAT    **
C**   IS, WE ASSUME THAT VALID SINGLE PRECISION NUMBERS RANGE IN        **
C**   ABSOLUTE VALUE FROM 10.**(1 - IZERO) TO 10.**(IZERO - 1), OR ARE**
C**   EQUAL TO ZERO.                                                    **
C**   NR IS THE COMPUTER'S READING UNIT, AND NW ITS WRITING UNIT.      **
C***********************************************************************
C**   CHARACTERS OF INTEREST ARE IN KFD                                 **
C**   THEY WILL BE COMPARED WITH N                                      **
C***********************************************************************
C***********************************************************************
C**   THE CHARACTERS ON ONE CARD ARE READ IN AN A-FORMAT AND STORED    **
C**   IN N.                                                             **
C***********************************************************************
      IF (KOL.GE.1.AND.KOL.LE.80) GO TO 10
      CALL ERROR (KOL,A,N,LL,IW,7)
      RETURN
10    IF (KOL.EQ.16) GO TO 20
      READ (IR,1010) (N(I),I=1,80)
      GO TO 30
20    READ (IR,1000) (A(I),I=1,5),(N(I),I=16,80)
C***********************************************************************
C**   ON SOME COMPUTERS THE FORMAT FOR READING A(I) MAY HAVE TO BE     **
C**   CHANGED.                                                          **
C***********************************************************************
C**   APPROPRIATE VARIABLES ARE INITIALIZED.                            **
C***********************************************************************
30    IDORE=0
      IEXP=0
      ISIGX=0
      K=0
      NDE=0
      NDEC=0
      NODEC=0
      NUME=0
      NXDIG=0
      SIG=0.
      SIGN=0.
      DO 40 I=1,40
40    Z(I)=0.
C***********************************************************************
C**   THE CHARACTERS ON THE CARD ARE EXAMINED.                          **
C**   WHEN NUMBERS ARE FOUND THEY ARE STORED IN Z(K).                   **
C***********************************************************************
      DO 980 I=KOL,80
C***********************************************************************
C**   DETERMINE IF N(I) IS A DIGIT.                                     **
C***********************************************************************
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```
      IF (N(I).GE.IDIGIT(1).AND.N(I).LE.IDIGIT(10)) GC TO 520          RDT01310
C*************************************************************************RDT01320
C**   N(I) IS NOT A DIGIT.                                              **RDT01330
C**   DETERMINE IF N(I) IS A PLUS, MINUS, DECIMAL, D, E, CR BLANK.      **RDT01340
C*************************************************************************RDT01350
      IF (NUMB) 140,50,140                                               RDT01360
50    IF (N(I)-IPLUS) 60,130,60                                          RDT01370
60    IF (N(I)-IMINUS) 70,100,70                                         RDT01380
70    IF (N(I)-IDECML) 80,90,80                                          RDT01390
80    NDE=0                                                              RDT01400
      SIG=0.                                                             RDT01410
      GO TO 780                                                          RDT01420
90    NDE=1                                                              RDT01430
      GO TC 780                                                          RDT01440
100   SIG=-1.                                                            RDT01450
110   IF (NDE) 120,780,120                                               RDT01460
120   NDE=C                                                              RDT01470
      GO TO 780                                                          RDT01480
130   SIG=1.                                                             RDT01490
      GO TC 110                                                          RDT01500
140   IF (IDCRE) 340,150,340                                             RDT01510
150   IF (NDEC) 250,160,250                                              RDT01520
160   IF (N(I)-ID) 180,170,180                                           RDT01530
170   IDORE=1                                                            RDT01540
      NODEC=1                                                            RDT01550
      GO TC 780                                                          RDT01560
180   IF (N(I)-IE) 190,170,190                                           RDT01570
190   IF (N(I)-IDECML) 21C,200,210                                       RDT01580
200   NDEC=1                                                             RDT01590
      GO TC 780                                                          RDT01600
210   IF (N(I)-IPLUS) 230,220,230                                        RDT01610
220   SIG=1.                                                             RDT01620
      GO TC 850                                                          RDT01630
230   IF (N(I)-IMINUS) 850,240,850                                       RDT01640
240   SIG=-1.                                                            RDT01650
      GO TC 850                                                          RDT01660
250   IF (N(I)-ID) 270,260,270                                           RDT01670
26C   IDORE=1                                                            RDT01680
      GO TC 780                                                          RDT01690
270   IF (N(I)-IE) 280,260,280                                           RDT01700
280   IF (N(I)-IDECML) 300,290,300                                       RDT01710
290   NDE=1                                                              RDT01720
      GO TO 870                                                          RDT01730
300   IF (N(I)-IPLUS) 320,310,320                                        RDT01740
310   SIG=1.                                                             RDT01750
      GO TO 870                                                          RDT01760
320   IF (N(I)-IMINUS) 870,330,670                                       RDT01770
330   SIG=-1.                                                            RDT01780
340   IF (N(I)-IDECML) 370,350,370                                       RDT01790
350   NDE=1                                                              RDT01800
      IF (NXDIG) 870,360,870                                             RDT01810
360   IF (NDEC) 870,850,870                                              RDT01820
370   IF (IDCRE-1) 38C,440,380                                           RDT01830
380   IF (N(I)-IFLUS) 400,390,400                                        RDT01840
390   SIG=1.                                                             RDT01850
      GO TC 420                                                          RDT01860
400   IF (N(I)-IMINUS) 420,410,420                                       RDT01870
410   SIG=-1.                                                            RDT01880
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420   IF (NXDIG) 870,430,870
430   IF (NDEC) 870,850,870
440   IF (NXDIG) 870,450,870
450   IF (N(I)-IMINUS) 460,510,460
460   IF (N(I)-IPLUS) 470,490,470
470   IF (N(I)-IBLANK) 480,490,480
480   IF (NDEC) 870,850,870
490   ISIGX=1
500   IDCRE=IDORE+1
      GO TO 780
510   ISIGX=-1
      GO TO 500
C**********************************************************************
C**   N(I) IS A DIGIT.                                              **
C**********************************************************************
520   IF (NUMB) 530,540,530
530   IF (IDCRE) 730,650,730
C**********************************************************************
C**   N(I) IS THE FIRST DIGIT OF A NUMBER.                          **
C**********************************************************************
540   IF (SIG) 550,560,550
550   SIGN=SIG
      SIG=0.
      GO TO 570
560   SIGN=1.
570   IF (NDE) 580,590,580
580   NDEC=NDE+1
      NDE=0
590   DO 600 L=1,10
      IF (N(I).NE.IDIGIT(L)) GO TO 600
      IN=L-1
      GO TO 610
600   CONTINUE
610   ZED=IN
      IF (ZED) 620,630,620
620   LL=1
      GO TO 640
630   LL=0
640   NUME=1
      GO TO 780
C**********************************************************************
C**   N(I) IS THE J-TH DIGIT OF A NUMBER WHERE J IS GREATER THAN    **
C**   ONE.                                                          **
C**********************************************************************
650   IF (NDEC) 660,670,660
660   NDEC=NDEC+1
670   DO 680 L=1,10
      IF (N(I).NE.IDIGIT(L)) GO TO 680
      IN=L-1
      GO TO 690
680   CONTINUE
690   FIN=IN
      ZED=10.*ZED+FIN
      IF (ZED) 700,780,700
700   LL=LL+1
      IF (LL.LT.IZERO) GO TO 780
      IF (LL.EQ.IZERO) GO TO 710
      GO TO 720
```

```
710   CALL ERROR (KOL,A,N,LL,IW,1)
      GO TO 780
720   CALL ERROR (KOL,A,N,LL,IW,2)
      GO TO 990
C*********************************************************************
C**   N(I) IS AN EXPONENTIAL DIGIT.                                 **
C*********************************************************************
730   IF (IDCRE-1) 750,740,750
740   ISIGX=1
750   DO 760 L=1,10
      IF (N(I).NE.IDIGIT(L)) GO TO 760
      IN=L-1
      GO TO 770
760   CONTINUE
770   IEXP=10*IEXP+IN
      NXDIG=NXDIG+1
      GO TO 780
C*********************************************************************
C**   DETERMINE IF THE LAST COLUMN OF THE CARD HAS BEEN REACHED.    **
C*********************************************************************
780   IF (I-80) 980,790,790
C*********************************************************************
C**   LAST COLUMN HAS BEEN REACHED.                                 **
C**   END-OF-CARD ROUTINE IS NOW EXECUTED.                          **
C*********************************************************************
790   IF (IDCRE) 830,800,830
800   IF (NUMB) 820,810,820
810   SIG=0.
      NDE=0
      GO TO 980
820   IF (NDEC) 870,850,870
830   IF (NXDIG) 870,840,870
840   IF (NDEC) 870,850,870
C*********************************************************************
C**   K-TH NUMBER (WHICH APPEARED IN INTEGER FORM) IS STORED AS     **
C**   Z(K).                                                         **
C*********************************************************************
850   K=K+1
      IF (ZED) 860,960,860
860   Z(K)=SIGN*ZED
      GO TO 970
C*********************************************************************
C**   K-TH NUMBER (WHICH APPEARED IN NON-INTEGER FORM) IS STORED AS **
C**   Z(K).                                                         **
C*********************************************************************
870   K=K+1
      NDEC=NDEC+NODEC
      IF (ZED) 880,960,880
880   KK=LL+ISIGX*IEXP-NDEC+1
      IF (KK.GT.(1-IZERO).AND.KK.LT.IZERO) GO TO 930
      IF (KK.LT.(1-IZERO)) GO TO 890
      IF (KK.EQ.(1-IZERO)) GO TO 900
      IF (KK.EQ.IZERO) GO TO 910
      IF (KK.GT.IZERO) GO TO 920
890   CALL ERROR (KOL,A,N,LL,IW,3)
      GO TO 930
900   CALL ERROR (KOL,A,N,LL,IW,4)
      GO TO 930
```

```
910    CALL ERROR (KOL,A,N,LL,IW,5)                                        RDT03
       GO TO 930                                                           RDT03
920    CALL ERROR (KOL,A,N,LL,IW,6)                                        RDT03
       GO TO 930                                                           RDT03
930    M=KK-LL+IZERO                                                       RDT03
       IF (M.LE.0.OR.M.GT.IMAX) GO TO 940                                  RDT03
       Z(K)=SIGN*ZED*T(M)                                                  RDT03
       GO TO 970                                                           RDT03
940    M=IZERO-LL                                                          RDT03
       IF (M.NE.0) GO TO 950                                               RDT03
C**********************************************************************RDT03
C**    M IS EQUAL TO ZERO (SPECIAL CASE)                                  **RDT03
C**********************************************************************RDT03
       M=M+1                                                               RDT03
       ZED=ZED*T(M)                                                        RDT03
       M=KK+IZERO-1                                                        RDT03
       Z(K)=SIGN*ZED*T(M)                                                  RDT03
       GO TO 970                                                           RDT03
C**********************************************************************RDT03
C**    M IS NOT EQUAL TO ZERO                                             **RDT03
C**********************************************************************RDT03
950    ZED=ZED*T(M)                                                        RDT03
       M=KK+IZERO                                                          RDT03
       Z(K)=SIGN*ZED*T(M)                                                  RDT03
       GO TO 970                                                           RDT03
960    Z(K)=0.                                                             RDT0
C**********************************************************************RDT0
C**    APPROPRIATE VARIABLES ARE RE-INITIALIZED.                          **RDT0
C**********************************************************************RDT0
970    IDORE=0                                                             RDT0
       IEXP=0                                                              RDT0
       ISIGX=0                                                             RDT0
       KK=0                                                                RDT0
       LL=0                                                                RDT0
       M=0                                                                 RDT0
       NDEC=0                                                              RDT0
       NODEC=0                                                             RDT0
       NUME=0                                                              RDT0
       NXDIG=0                                                             RDT0
       SIGN=0.                                                             RDT
980    CONTINUE                                                            RDT
       RETURN                                                              RDT
990    KK=0                                                                RDT
       LL=0                                                                RDT
       M=0                                                                 RDT
       RETURN                                                              RDT
C**********************************************************************RDT
C**    FORMAT STATEMENTS.                                                 **RDT
C**********************************************************************RDT
1000   FORMAT (5A3,65A1)                                                   RDT
1010   FORMAT (80A1)                                                       RDT
       END                                                                 RDT
--- ERROR SUBPROGRAM ---                                                   ERR
       SUBROUTINE ERROR (KOL,A,N,LL,IW,KEY)                                ERR
C**********************************************************************ERR
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **ERR
C**    PROGRAM  VERSION OF SEPT.10,1971      WRITTEN BY R.C.RAYBOLD     **ERR
C**    AND MRS.R.N.VARNER
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```
C**    MODIFIED BY R. N. VARNER SEPT 1979                                     **
C***********************************************************************
C**    SUBROUTINE OF THE DIAGNOSTIC OUTPUT FOR READIT SUBROUTINE              **
C***********************************************************************
       DIMENSION A(1),N(1)
       GO TO (10,20,30,40,50,  60,70), KEY
10     WRITE (IW,100) LL
       IF (KOL-16) 90,80,90
20     WRITE (IW,110) LL
       IF (KOL-16) 90,80,90
30     WRITE (IW,120)
       IF (KOL-16) 90,80,90
40     WRITE (IW,130)
       IF (KOL-16) 90,80,90
50     WRITE (IW,140)
       IF (KOL-16) 90,80,90
60     WRITE (IW,150)
       IF (KOL-16) 90,80,90
70     WRITE (IW,160) KOL
       RETURN
80     WRITE (IW,180)
       WRITE (IW,170) (A(I),I=1,5),(N(I),I=16,80)
       RETURN
90     WRITE (IW,180)
       WRITE (IW,190) (N(I),I=1,80)
       RETURN
C***********************************************************************
C**    FORMAT STATEMENTS                                                      **
C***********************************************************************
100    FORMAT (25H0*****  DIAGNOSTIC  *****/1X,
      2 64H*****  THE NUMBER OF SIGNIFICANT DIGITS IN A NUMBER HAS REACHE
      3D ,I3,42H.  THIS MAY PRODUCE OVERFLOW OR UNDERFLOW.)
110    FORMAT (20H0*****  ERROR  *****/1X,
      2 64H*****  THE NUMBER OF SIGNIFICANT DIGITS IN A NUMBER HAS REACHE
      3D ,I3,43H.  THIS WILL PRODUCE OVERFLOW OR UNDERFLOW.)
120    FORMAT (87H0*****  ERROR  *****  NUMBER IS TOO SMALL IN ABSOLUTE V
      2ALUE AND WILL PRODUCE UNDERFLOW.)
130    FORMAT (87H0*****  DIAGNOSTIC  *****  NUMBER IS SMALL IN ABSOLUTE
      2VALUE AND MAY PRODUCE UNDERFLOW.)
140    FORMAT (86H0*****  DIAGNOSTIC  *****  NUMBER IS LARGE IN ABSOLUTE
      2VALUE AND MAY PRODUCE OVERFLOW.)
150    FORMAT (86H0*****  ERROR  *****  NUMBER IS TOO LARGE IN ABSOLUTE V
      2ALUE AND WILL PRODUCE OVERFLOW.)
160    FORMAT (44H0*****  ERROR  *****  THE VALUE OF 'KOL' IS ,I6,
      2 27H AND THIS VALUE IS INVALID./1X,
      3 50HKOL MUST BE GREATER THAN 0 AND MUST NOT EXCEED 80.)
170    FORMAT (1H ,5A3,65A1)
180    FORMAT (72H THIS OCCURRED IN CONNECTION WITH READING THE DATA ON T
      2HE FOLLOWING CARD)
190    FORMAT (1H ,80A1)
       END
PRINT1 SUBPROGRAM ---
       SUBROUTINE PRINT1
C***********************************************************************
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **
C**    PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYBOLD     **
C**    AND MRS.R.N.VARNER                                               **
C**    MODIFIED BY R. N. VARNER SEPT 1979                               **
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C***********************************************************************PR1000
C**   SUBRCUTINE TO PRINT TITLE PAGE    1/12/70                       **PR1000
C***********************************************************************PR1000
C**    DIMENSICN FCR COMMCN /PRT1/ VARIABLES                          **PR1001
C***********************************************************************PR1001
      DIMENSICN B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),       PR1001
     2 IDATE(3)                                                         PR1001
C***********************************************************************PR1001
C**    LABELEC COMMON                                                 **PR1001
C***********************************************************************PR1001
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,PR1001
     2 L5,L6,IDATE,IBREST                                               PR1001
      COMMCN /PRT2/ IPAGE,NOSER,IPGCT                                   PR1001
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 PR100
      WRITE (IW,80)                                                     PR100
      WRITE (IW,90) (B1(K),K=1,L1)                                      PR100
      WRITE (IW,90) (B2(K),K=1,L2)                                      PR100
      WRITE (IW,90) (B3(K),K=1,L3)                                      PR100
      WRITE (IW,90) (B4(K),K=1,L4)                                      PR100
      WRITE (IW,90) (B5(K),K=1,L5)                                      PR100
      WRITE (IW,100) (B6(K),K=1,L6)                                     PR100
      WRITE (IW,100) (B7(K),K=1,18)                                     PR100
      DO 70 I=1,6                                                       PR100
      IPAGE=IPAGE+1                                                     PR100
      WRITE (IW,110) (B1(K),K=1,65),IPAGE                               PR100
      WRITE (IW,120) (B2(K),K=1,L2)                                     PR100
      WRITE (IW,120) (B3(K),K=1,L3)                                     PR100
      WRITE (IW,130) (B7(K),K=1,18)                                     PR100
      GO TO (10,20,30,40,50,  60), IPAGE                                PR100
10    CALL TEXT1                                                        PR100
      GO TO 70                                                          PR100
20    CALL TEXT2                                                        PR100
      GO TO 70                                                          PR100
30    CALL TEXT3                                                        PR10
      GO TC 70                                                          PR10
40    CALL TEXT4                                                        PR10
      GO TC 70                                                          PR10
50    CALL TEXT5                                                        PR10
      GO TC 70                                                          PR10
60    CALL TEXT6                                                        PR10
70    CONTINUE                                                          PR10
      RETURN                                                            PR10
C***********************************************************************PR10
C**    FORMAT STATEMENTS                                              **PR10
C***********************************************************************PR10
80    FORMAT (1H1,45X,28HU. S. DEPARTMENT OF COMMERCE/46X,              PR1
     2 28HNATICNAL BUREAL CF STANDARDS/45X,                             PR1
     3 31HNATIONAL ENGINEERING LABCRATORY/48X,22HWASHINGTCN, D.C. 202   PR1
     4/////////////////59X,11HR E P O R T/55X,3HO F/51X,
     5 22HM A S S     V A L U E S/)
90    FORMAT (43X,72A1)
100   FORMAT (//////////////26X,11HTEST NUMBER,2X,18A1///60X,
     2 17HFOR THE DIRECTOR,////60X,22HG. E. MATTINGLY, CHIEF/60X,
     3 26HFLUID ENGINEERING DIVISICN/60X,
     4 33HCENTER FOR MECHANICAL ENGINEERING/62X,
     5 22HAND PRCCESS TECHNOLOGY/60X,
     6 31HNATICNAL ENGINEERING LABCRATORY)
110   FORMAT (1H1,65A1,4HPAGE,I3)
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120    FORMAT (1X,72A1)                                                        PR100650
130    FORMAT (1X,13HTEST NUMBER  ,18A1)                                       PR100660
       END                                                                     PR100670
--- TEXT1 SUBPROGRAM ---
       SUBRCUTINE TEXT1                                                        TX100010
C*********************************************************************TX100020
C**    SUBROUTINE OF THE NATICNAL BUREAU OF STANDARDS MASS CALIBRATION **TX100030
C**    PROGRAM  VERSICN CF SEPT. 10,1971    WRITTEN BY R.C.RAYECLD     **TX100040
C**    AND MRS.R.N.VARNER                                               **TX100050
C**    MODIFIED BY R. N. VARNER SEPT 1979                               **TX100060
C*********************************************************************TX100070
       COMMCN/UNITIO/IR,IW,IP,IPL,ITMP                                         TX100080
       WRITE (IW,10)                                                           TX100090
       WRITE (IW,20)                                                           TX100100
       WRITE (IW,30)                                                           TX100110
       WRITE (IW,40)                                                           TX100120
       WRITE (IW,50)                                                           TX100130
       WRITE (IW,60)                                                           TX100140
       WRITE (IW,70)                                                           TX100150
       WRITE (IW,80)                                                           TX100160
       WRITE (IW,90)                                                           TX100170
       WRITE (IW,100)                                                          TX100180
       WRITE (IW,110)                                                          TX100190
       RETURN                                                                  TX100200
C  ********************************************************************TX100210
C      FORMAT STATEMENTS                                                **TX100220
C  ********************************************************************TX100230
1      FORMAT (/)                                                              TX100240
10     FORMAT (1X,36H             INTRODUCTION                                 TX100250
      236H  WHICH RELY, DIRECTLY CR  INDIRECT-/                                TX100260
      31X,36H                                  ,                               TX100270
      436H  LY,   ON    MASS    MEASUREMENTS   TO/                             TX100280
      51X,36H    THIS DOCUMENT IS A  COMPREHEN-  ,                             TX100290
      636H  ACCOMPLISH  A  WIDE   VARIETY   OF/                                TX100300
      71X,36HSIVE  REPCRT CCVERING THE SEQUENCE  ,                             TX100310
      836H  ENDEAVORS.    IN   CRDER   FOR   THIS/                             TX100320
      91X,36HCF OPERATIONS USED TO ASSIGN  MASS  ,                             TX100330
      *36H  SYSTEM    TO    FUNCTICN    PROPERLY,)                             TX100340
30     FORMAT (1X,36HVALUES  TO  THE WEIGHTS IDENTIFIED  ,                     TX100350
      236H  EVERYONE   WHC   MAKES   MEASUREMENTS/                             TX100360
      31X,36HABOVE.   IT   INCLUDES   A  COMPLETE  ,                           TX100370
      436H  MUST BE ABLE TC  VERIFY  THAT  HIS/                                TX100380
      51X,36HDESCRIPTICN   OF  THE  MEASUREMENT  ,                             TX100390
      636H  MEASUREMENT     PROCESS     PRODUCES/                              TX100400
      71X,36HMETHCDS AND PROCEDURES WHICH  WERE  ,                             TX100410
      836H  CCNSISTENT    RESULTS    WHICH    ARE/                             TX100420
      91X,36HUSED,  ALL   CF   THE   DATA, AND THE  ,                          TX100430
      *36H  CCMPATIBLE    WITH  HIS  PARTICULAR)                               TX100440
       FORMAT (1X,36HANALYSIS  CF   THIS   DATA.    THE  ,                     TX100450
      236H  REQUIREMENTS.  THE WEIGHTS COVERED/                                TX100460
      31X,36HRESULTS   ARE   PRESENTED IN SEVERAL  ,                           TX100470
      436H  BY THIS REPORT, TOGETHER WITH  THE/                                TX100480
      51X,36HFORMATS.    ASSIGNED  MASS   VALUES,  ,                           TX100490
      636H  ASSIGNED   VALUES   AND   THE   APPRO-/                            TX100500
      71X,36HDISPLACEMENT VOLUMES, COEFFICIENTS  ,                             TX100510
      836H  PRIATE  UNCERTAINTIES  FOR   THESE/                                TX100520
      91X,36HCF  EXPANSICN,  UNCERTAINTIES, TO-  ,                             TX100530
      *36H  VALUES,  PROVIDE   IN  PART A BASIS)                               TX100540
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50     FORMAT (1X,36HGETHER WITH THE SUMMED VALUES  FOR  ,         TX100
      236H  FCR CONSISTENT MEASUREMENTS WITHIN/                    TX100
      31X,36HLINEAR COMBINATIONS OF THE WEIGHTS  ,                 TX100
      436H  THIS SYSTEM OF RELATED MEASUREMENT/                    TX100
      51X,36HIN   EACH   DECADE   ARE PRESENTED AT  ,              TX100
      636H  PROCESSES.                          /                  TX100
      71X,36HTHE END OF THE APPROPRIATE SERIES.  ,                 TX10C
      836H                                      /                  TX10(
      91X,36HTHIS INFORMATION SHOULD BE  USEFUL  ,                 TX10(
      *36H       APPROPRIATE    CHARACTERIZATION)                  TX10(
60     FORMAT (1X,36HTO  THOSE  WHO  MUST  ASSIGN  MASS  ,         TX10(
      236H  OF    ANY  MEASUREMENT  PROCESS  IS/                   TX10(
      31X,36HVALUES  TO  OBJECTS   OTHER   THAN  ,                 TX10(
      436H  FUNDAMENTAL  TC   VERIFYING   THAT/                    TX10(
      51X,36HWEIGHTS.    FOR  CONVENIENCE,  THE  ,                 TX10(
      636H  RESULTS  ARE  CONSISTENT  WITH THE/                    TX10
      71X,36HVALUES AND UNCERTAINTIES, TOGETHER  ,                 TX10
      836H  END REQUIREMENT  WITH  RESPECT  TO/                    TX10
      91X,36HWITH OTHER  APPROPRIATE  DATA  AND  ,                 TX10
      *36H  CORRECTNESS  AND  ECONOMY  OF  THE)                    TX10
70     FORMAT (1X,36HCOMMENTS  ARE  ALSO  SUMMARIZED IN  ,         TX10
      236H  MEASUREMENT EFFORT.  WITHOUT  THIS/                    TX10
      31X,36HTABLES I AND II AT THE END OF  THE  ,                 TX10
      436H  INFORMATION,  THE   BENEFITS   OF/                     TX10
      51X,36HREPORT.    CERTAIN   INTERMEDIATE  ,                  TX10
      636H  OWNERSHIP OF THESE WEIGHTS MAY  BE/                    TX10
      71X,36HPAGES ARE SUMMARIES OF STATISTICAL  ,                 TX10
      836H  COMPLETELY ILLUSORY.  THE ASSIGNED/                    TX1(
      91X,36HDATA  WHICH  RELATE  TC  THE  MASS  ,                 TX1(
      *36H  UNCERTAINTIES  IN  THIS REPORT ARE)                    TX1(
80     FORMAT (1X,36HMEASUREMENT     PROCESS    USED    TC  ,      TX1(
      236H  DESCRIPTIVE OF OUR  MASS  MEASURE-/                    TX1(
      31X,36HPERFORM THIS  WORK.  THESE  PAGES  ,                  TX1(
      436H  MENT  PROCESS.   EFFECTIVENESS  OF/                    TX1(
      51X,36HHAVE  BEEN  LEFT  IN THE REPORT TO  ,                 TX1(
      636H  THE TRANSFER OF THE UNIT FROM  ONE/                    TX1
      71X,36HRETAIN  CONTINUITY.    COPIES   OF  ,                 TX1
      836H  FACILITY  TO  ANOTHER  SHOULD  BE/                     TX1
      91X,36HTHESE   PAGES  BECOME  PART  OF  A  ,                 TX1
      *36H  VERIFIED BY AN  INDEPENDENT  TEST.)                    TX1
90     FORMAT (1X,36HCOLLECTION  OF  STATISTICAL   DATA  ,         TX1
      236H  IT  IS PRESUMED THAT THESE WEIGHTS/                    TX1
      31X,36HWHICH   REFLECTS  THE  MEASUREMENT  ,                 TX1
      436H  WILL BE USED IN A SIMILARLY  WELL-/                    TX1
      51X,36HPROCESS PERFORMANCE OVER A  PERIOD  ,                 TX1
      636H  CHARACTERIZED MEASUREMENT  PROCESS/                    TX1
      71X,36HOF  TIME.   SUCH  A COLLECTION HAS  ,                 TX1
      836H  SO THAT THE STATISTICAL PARAMETERS/                    TX1
      91X,36HBEEN USED TO ESTABLISH THE CONTROL  ,                 TX1
      *36H  OF  BOTH PROCESSES CAN BE COMBINED)                    TX1
100    FORMAT (1X,36HLIMITS FOR ACCEPTING  THE  RESULTS  ,         TX1
      236H  TO PROVIDE A REALISTIC ESTIMATE OF/                    TX1
      31X,36HOF  THIS  MEASUREMENT.  THESE COL-  ,                 TX1
      436H  THE UNCERTAINTY OF THE  MASS  UNIT/                    TX1
      51X,36HLECTIONS ARE OPEN  FOR  INSPECTION  ,                 TX1
      636H  AS  ACTUALLY  REALIZED  IN ANOTHER/                    TX1
      71X,36HAT OUR FACILITY.                    ,                 TX1
      836H  FACILITY.  A COMPREHENSIVE SERVICE/
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     91X,36H                                             ,                TX101130
     *36H  DIRECTED TCWARD THE EVALUATION  OF)                            TX101140
110   FORMAT (1X,36H   THE MASS MEASUREMENT SYSTEM      ,                TX101150
     236H  A    PARTICULAR    MASS   MEASUREMENT/                         TX101160
     31X,36H                                             ,                TX101170
     436H  PROCESS IS AVAILABLE   THRCUGH  THE/                           TX101180
     51X,36H     THE   MASS   MEASUREMENT   SYSTEM       ,                TX101190
     636H  MASS MEASUREMENT ASSURANCE PROGRAM/                            TX101200
     71X,36HWITHIN THIS   CCUNTRY   CONSISTS   OF        ,                TX101210
     836H  OF    THE    NATICNAL    BUREAU     OF/                        TX101220
     91X,36HALL   OF   THE MEASUREMENT PROCESSES         ,                TX101230
     *36H  STANDARDS.                               )                     TX101240
      END                                                                 TX101250
--- TEXT2 SUBPROGRAM ---
      SUBROUTINE TEXT2                                                    TX200010
C*************************************************************************TX200020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION   **TX200030
C**   PROGRAM   VERSICN CF SEPT. 10,1971     WRITTEN BY R.C.RAYBCLD      **TX200040
C**   AND MRS.R.N.VARNER                                                **TX200050
C**   MODIFIED BY R. N. VARNER SEPT 1979                                **TX200060
C*************************************************************************TX200070
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                     TX200080
      WRITE (IW,10)                                                       TX200090
      WRITE (IW,20)                                                       TX200100
      WRITE (IW,30)                                                       TX200110
      WRITE (IW,40)                                                       TX200120
      WRITE (IW,50)                                                       TX200130
      WRITE (IW,60)                                                       TX200140
      WRITE (IW,70)                                                       TX200150
      WRITE (IW,80)                                                       TX200160
      WRITE (IW,90)                                                       TX200170
      WRITE (IW,100)                                                      TX200180
      WRITE (IW,110)                                                      TX200190
      RETURN                                                              TX200200
C*************************************************************************TX200210
C**   FORMAT STATEMENTS                                                 **TX200220
C*************************************************************************TX200230
10    FORMAT (/)                                                          TX200240
20    FORMAT (1X,36H            WEIGHING DESIGN            ,              TX200250
     236H  STANDARD   IS   MEASURED   WITH   EACH/                        TX200260
     31X,36H                                             ,                TX200270
     436H  TEST OF UNKNCWNS AND   THE   COLLEC-/                          TX200280
     51X,36H     CNLY   DIFFERENCES   IN MASS CAN        ,                TX200290
     636H  TICN   OF   VALUES CVER TIME IS USED/                          TX200300
     71X,36HEE MEASURED,   THEREFORE   THE    MASS       ,                TX200310
     836H  TC EVALUATE THE PERFCRMANCE OF THE/                            TX200320
     91X,36HVALUES   FCR   THE 'UNKNCWN' WEIGHTS         ,                TX200330
     *36H  MEASUREMENT PROCESS.                     )                     TX200340
      FORMAT (1X,36HMUST BE DETERMINED   BY   COMPARISON    ,             TX200350
     236H                                           /                     TX200360
     31X,36HWITH    OTHER   WEIGHTS   WHICH   HAVE       ,                TX200370
     436H      IN   THE   CASE   OF   THE   SERIES/                       TX200380
     51X,36HACCEPTED    MASS     VALUES.     THE         ,                TX200390
     636H  WHICH   INCLUDES   THE   KNOWN STAND-/                         TX200400
     71X,36H'UNKNOWN'   WEIGHTS   TCGETHER   WITH        ,                TX200410
     836H  ARDS. THE ACCEPTED VALUES OF THESE/                            TX200420
     91X,36H'CHECK STANDARDS', ARE GRCUPED AND           ,                TX200430
     *36H  STANDARDS SERVE AS A RESTRAINT   ON)                           TX200440
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40     FORMAT (1X,36HINTERCOMPARED  ACCORDING  TO    THE   ,
      236H  THE  SOLUTION OF THE EQUATIONS FOR/
      31X,36HDESIGN  SCHEDULE  GIVEN AT THE BE-   ,
      436H  THE VALUES OF ALL OF THE  WEIGHTS./
      51X,36HGINNING OF EACH SERIES  OF  WEIGH-   ,
      636H  THE  RESTRAINT FOR THE SOLUTION OF/
      71X,36HINGS.  THE  FIRST SERIES CONTAINS   ,
      836H  SUBSEQUENT SERIES IS  PROVIDED  BY/
      91X,36HSTANDARDS   WHICH   PROVIDE   THE   ,
      *36H  THE  VALUES ESTABLISHED FOR ONE OR)
50     FORMAT (1X,36HSTARTING  VALUES FOR THE SERIES OF  ,
      236H  MORE   WEIGHTS   INCLUDED   IN   A/
      31X,36HWEIGHINGS  AND  PROVIDE  THE   TIE   ,
      436H  PREVIOUS SERIES.                  /
      51X,36HPOINT  FOR   CONSISTENCY THROUGHOUT  ,
      636H                                    /
      71X,36HTHE    MEASUREMENT    SYSTEM.    THE   ,
      836H       ESTIMATED  VALUES  FOR WEIGHTS/
      91X,36HWEIGHING METHOD USED, I.E., DOUBLE   ,
      *36H  WHICH HAVE  BEEN  GROUPED  IN  THE)
60     FORMAT (1X,36HSUBSTITUTION, TRANSPOSITION, ETC.,  ,
      236H  SAME   SERIES   INVOLVE  THE  SAME/
      31X,36HIS   INDICATED   ALONG   WITH  THE   ,
      436H  OBSERVATIONAL  DATA  AND  ARE,  IN/
      51X,36HOBSERVED DATA.   IN  THE  COMPUTA-   ,
      636H  ALMOST ALL CASES, CORRELATED.  FOR/
      71X,36HTIONS,  THE  DISPLACEMENT  VOLUMES   ,
      836H  EACH  SERIES  THERE  IS A TABLE OF/
      91X,36HARE TREATED EXPLICITLY, USING  THE   ,
      *36H  COMBINATIONS  TOGETHER  WITH  THE)
70     FORMAT (1X,36HDATA LISTED IN THE REPORT.  IN ALL  ,
      236H  APPROPRIATE  UNCERTAINTY  FOR EACH/
      31X,36HCASES,  A REDUNDANCY IN THE NUMBER   ,
      436H  COMBINATION.                      /
      51X,36HOF MEASUREMENTS PROVIDES  A  MEANS   ,
      636H                                    /
      71X,36HFOR  CHECKING  ON THE PRECISION OF   ,
      836H            PROCESS CONTROL         /
      91X,36HTHE PROCESS.                         ,
      *36H                                    )
80     FORMAT (1X,36H                                    ,
      236H       THE  STANDARD  DEVIATION,   AS/
      31X,36H    WHEN THERE ARE MORE  EQUATIONS   ,
      436H  COMPUTED  FROM  THE  LEAST SQUARES/
      51X,36HTHAN  'UNKNOWNS', NOT ALL OBSERVA-   ,
      636H  SOLUTION, PROVIDES A CHECK ON  THE/
      71X,36HTIONAL EQUATIONS CAN BE  SATISFIED   ,
      836H  SHORT  TERM,  OR 'WITHIN-RUN' PRO-/
      91X,36HEXACTLY  AND  THE  METHOD OF LEAST   ,
      *36H  CESS PRECISION.  AN AVERAGE  OF  A)
90     FORMAT (1X,36HSQUARES   IS   USED   TO   PROVIDE  ,
      236H  NUMBER  OF  THESE  STANDARD DEVIA-/
      31X,36HESTIMATES OF THE 'UNKNOWN' VALUES.   ,
      436H  TIONS IS  TAKEN  AS  THE  ACCEPTED/
      51X,36HTHIS  METHOD  LEADS  TO ESTIMATORS   ,
      636H  WITHIN-RUN  STANDARD  DEVIATION OF/
      71X,36HWHICH ARE LINEAR FUNCTIONS OF  THE   ,
      836H  THE  PROCESS  AND  IS  USED  AS  A/
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     91X,36HDATA    AND    WHICH  HAVE  STANDARD   ,              TX201030
     *36H  REFERENCE  VALUE  FOR SURVEILLANCE)                    TX201040
 100  FORMAT (1X,36HDEVIATIONS READILY CALCULATED FROM    ,       TX201050
     236H  OF  THE  PROCESS  PRECISION.   THE/                    TX201060
     31X,36HTHE  COEFFICIENTS  OF  THE  LINEAR   ,                TX201070
     436H  VALUES  OBTAINED  FOR  THE  'CHECK/                    TX201080
     51X,36HFUNCTIONS  AND THE STANDARD DEVIA-   ,                TX201090
     636H  STANDARD' PROVIDE,  AS  TIME  GOES/                    TX201100
     71X,36HTION OF AN INDIVIDUAL MEASUREMENT.   ,                TX201110
     836H  ON,  A  SEQUENCE  OF  VALUES  THAT/                    TX201120
     91X,36HTHE  'CHECK  STANDARD'   IS   ALSO   ,                TX201130
     *36H  REALISTICALLY     REFLECTS     THE)                    TX201140
 110  FORMAT (1X,36HTREATED  AS  AN  UNKNOWN  AND   THE   ,       TX201150
     236H  VARIATIONS   WHICH  BESET  PRECISE/                    TX201160
     31X,36HAGREEMENT OF  THE  CURRENT  RESULT   ,                TX201170
     436H  MEASUREMENTS.    COLLECTIONS     OF/                   TX201180
     51X,36HWITH THE ACCEPTED VALUE PROVIDES A   ,                TX201190
     636H  VALUES  FOR  BOTH  THE  WITHIN-RUN/                    TX201200
     71X,36HTEST  OF  THE ADEQUACY OF THE CUR-   ,                TX201210
     836H  PRECISION AND THE  VALUE  OBTAINED/                    TX201220
     91X,36HRENT  DATA.    THIS   SAME   CHECK   ,                TX201230
     *36H  FOR  THE  'CHECK  STANDARD' SHOULD)                    TX201240
      END                                                         TX201250
--- TEXT3 SUBPROGRAM ---
      SUBROUTINE TEXT3                                            TX300010
C*********************************************************************TX300020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TX300030
C**   PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYBOLD    **TX300040
C**   AND MRS.R.N.VARNER                                            **TX300050
C**   MODIFIED BY R. N. VARNER SEPT 1979                            **TX300060
C*********************************************************************TX300070
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP                             TX300080
      WRITE (IW,10)                                               TX300090
      WRITE (IW,20)                                               TX300100
      WRITE (IW,30)                                               TX300110
      WRITE (IW,40)                                               TX300120
      WRITE (IW,50)                                               TX300130
      WRITE (IW,60)                                               TX300140
      WRITE (IW,70)                                               TX300150
      WRITE (IW,80)                                               TX300160
      WRITE (IW,90)                                               TX300170
      WRITE (IW,100)                                              TX300180
      WRITE (IW,110)                                              TX300190
      RETURN                                                      TX300200
C*********************************************************************TX300210
C**   FORMAT STATEMENTS                                             **TX300220
C*********************************************************************TX300230
 10   FORMAT (/)                                                  TX300240
 20   FORMAT (1X,36HPOSSESS THE PROPERTIES OF  RANDOM-   ,        TX300250
     236H          SERIES OF MEASUREMENTS  JUDGED/                TX300260
     31X,36HNESS  ASSOCIATED  WITH INDEPENDENT   ,                TX300270
     436H  AS  OUT OF CONTROL RELATIVE TO THE/                    TX300280
     51X,36HMEASUREMENTS    FROM    A    STABLE   ,               TX300290
     636H  APPROPRIATE  PARAMETER  ARE  CARE-/                    TX300300
     71X,36HPROBABILITY    DISTRIBUTION.    THE   ,               TX300310
     836H  FULLY  EXAMINED.   IF  RERUNS WERE/                    TX300320
     91X,36HREPORTED 'F RATIO' AND  'T  VALUE'   ,                TX300330
     *36H  NECESSARY IN THE  COURSE  OF  THIS)                    TX300340
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30     FORMAT (1X,36HARE  TESTS  CF THE VALUES FRCM THE     ,
      236H  WCRK, THE 'OUT CF CCNTROL' SERIES,/
      31X,36HCURRENT  RUN  FOR  CCNFORMITY   TO  ,
      436H  WITH  REMARKS  AS APPRCPRIATE, ARE/
      51X,36HTHEIR RESPECTIVE CISTRIBUTIONS AND  ,
      636H  ATTACHED AT THE END CF THE  REPORT/
      71X,36HIF    SATISFACTORY   ARE  TAKEN  AS  ,
      836H  FCR YOUR INFORMATICN.             /
      91X,36HEVIDENCE THAT THE  PRCCESS  IS  IN  ,
      *36H                                    )
40     FORMAT (1X,36HCCNTROL     AND    THAT    PREDICTIVE   ,
      236H                UNCERTAINTY         /
      31X,36HSTATEMENTS  REGARDING  UNCERTAINTY  ,
      436H                                    /
      51X,36HARE VALID.                          ,
      636H        IT IS ASSUMED THAT THE PRESENT/
      71X,36H                                    ,
      836H  'ACCEPTED VALUES' OF TWO NBS STAN-/
      91X,36H     CCNTRCL  CHARTS CN THE WITHIN-  ,
      *36H  DARDS  AT   THE  1  KILOGRAM LEVEL,)
50     FORMAT (1X,36HRUN  PROCESS  PRECISION  AND    THE   ,
      236H  DESIGNATED N1 AND N2, ARE  WITHOUT/
      31X,36HVALUES   OBTAINED  FOR  THE  CHECK  ,
      436H  ERROR.  ESTIMATES  CF  THE UNCER-/
      51X,36HSTANDARD  ARE  KEY   ELEMENTS   IN  ,
      636H  TAINTY OF THE ACCEPTED  VALUES  OF/
      71X,36HMONITORING THE STATE CF CCNTROL OF  ,
      836H  THE NBS STANDARDS RELATIVE TO  THE/
      91X,36HANY   PRECISE   MASS   MEASUREMENT  ,
      *36H  INTERNATICNAL  PROTOTYPE  KILOGRAM)
60     FORMAT (1X,36HPROCESS.  IN ADDITION TO PROVIDING    ,
      236H  CAN  BE   PROVIDED   CN    REQUEST./
      31X,36HA BASIS FCR  JUDGMENT  AS  TO  THE  ,
      436H  HOWEVER,  THESE  ESTIMATES HAVE NO/
      51X,36HADEQUACY  OF A GIVEN PROCESS FOR A  ,
      636H  REAL MEANING IN EITHER NATIONAL OR/
      71X,36HPARTICULAR REQUIREMENT, THESE DATA  ,
      836H  INTERNATICNAL CCMPARISCN.  THIS IS/
      91X,36HPROVIDE  A  MEANS  TO  JUDGE   THE  ,
      *36H  BECAUSE OF THE LACK CF  SUFFICIENT)
70     FORMAT (1X,36HIMPORTANCE    OF    LONG    TERM,  OR   ,
      236H  DATA   TO   PROVIDE   A  REALISTIC/
      31X,36H'BETWEEN-RUN'  VARIABILITY    WHICH  ,
      436H  ESTIMATE OF THE UNCERTAINTY IN THE/
      51X,36HCAN   BE   CHARACTERIZED   BY  THE  ,
      636H  VALUES ASSIGNED TO  THE  PROTOTYPE/
      71X,36HSTANDARD CEVIATICN CF   THE  VALUES  ,
      836H  KILOGRAMS K20 AND K4, PARTICULARLY/
      91X,36HABOUT  THE   MEAN.   IF THERE IS AN  ,
      *36H  IN    REGARD    TO    LCNG  TERM,  OR)
80     FORMAT (1X,36HADDITICNAL CCMPCNENT  OF  VARIANCE   ,
      236H  BETWEEN-RUN VARIABILITY.   CHANGES/
      31X,36HENTERING  FRCM  RUN  TO  RUN, THIS  ,
      436H  IN THE ACCEPTED VALUES FOR THE NBS/
      51X,36HSTANDARD DEVIATION WILL BE  LARGER  ,
      636H  STANDARDS  AT  THE KILCGRAM LEVEL,/
      71X,36HTHAN  CAN  BE ACCCUNTED FOR BY THE  ,
      836H  AS AND WHEN THEY  OCCUR,  WILL  BE/
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     91X,36HWITHIN-RUN VARIABILITY.   CORRELA-   ,                          TX300930
     *36H  REPORTED   IN THE SCIENTIFIC PAPERS)                             TX300940
90    FORMAT (1X,36HTION  STUDIES,  AS WELL AS SUPPLE-   ,                   TX300950
     236H  OF THE BUREAU AND  WILL  BE  GIVEN/                              TX300960
     31X,36HMENTAL EXPERIMENTS,  ARE  USED  TO   ,                          TX300970
     436H  WIDE DISTRIBUTION.  IN CASES WHERE/                              TX300980
     51X,36HDETECT AND REDUCE THE MAGNITUDE OF   ,                          TX300990
     636H  SUCH CHANGES MAY BE OF IMPORTANCE,/                              TX301000
     71X,36HSIGNIFICANT   SYSTEMATIC  EFFECTS.   ,                          TX301010
     836H  OR  WHERE  CONTINUITY  IS DESIRED,/                              TX301020
     91X,36HAPPROPRIATE  ACTION,  E.G.,  ADDI-   ,                          TX301030
     *36H  INSTRUCTIONS WILL BE INCLUDED  FOR)                              TX301040
100   FORMAT (1X,36HTIONAL  EMPIRICAL  CORRECTIONS  OR   ,                  TX301050
     236H  UP-DATING   PREVIOUSLY   REPORTED/                               TX301060
     31X,36HCHANGES IN TECHNIQUE,  CAN  REDUCE   ,                          TX301070
     436H  VALUES.  WHEN THE VALUES  REPORTED/                              TX301080
     51X,36HTHE  EFFECTS FROM KNOWN SOURCES OF   ,                          TX301090
     636H  ARE  BASED  ON THE ACCEPTED VALUES/                              TX301100
     71X,36HSYSTEMATIC   VARIABILITY   TO   A    ,                          TX301110
     836H  OF STANDARDS OTHER THAN  STANDARDS/                              TX301120
     91X,36HMAGNITUDE   WHICH   IS  NO  LONGER   ,                          TX301130
     *36H  N1  AND  N2  MENTIONED  ABOVE, THE)                              TX301140
110   FORMAT (1X,36HIDENTIFIABLE IN THE DATA.  IN   THE   ,                 TX301150
     236H  UNCERTAINTY OF THE ACCEPTED  VALUE/                              TX301160
     31X,36HCASES  WHERE  A  SIGNIFICANT  LONG   ,                          TX301170
     436H  OF    THE    STANDARD    BECOMES   A/                            TX301180
     51X,36HTERM,  OR  BETWEEN-RUN,  COMPONENT   ,                          TX301190
     636H  SYSTEMATIC ERROR IN THE ASSIGNMENT/                              TX301200
     71X,36HREMAINS  THE  UNCERTAINTY HAS BEEN   ,                          TX301210
     836H  OF VALUES TO OTHER  STANDARDS  AND/                              TX301220
     91X,36HAPPROPRIATELY ADJUSTED.              ,                          TX301230
     *36H  IS INCLUDED IN THE REPORT.        )                              TX301240
      END                                                                   TX301250
C --- TEXT4 SUBPROGRAM ---
      SUBROUTINE TEXT4                                                      TX400010
C***********************************************************************TX400020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TX400030
C**   PROGRAM  VERSION OF SEPT. 10,1971    WRITTEN BY R.C.RAYBOLD      **TX400040
C**   AND MRS.R.N.VARNER                                               **TX400050
C**   MODIFIED BY R. N. VARNER SEPT 1979                               **TX400060
C***********************************************************************TX400070
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                       TX400080
      WRITE (IW,10)                                                         TX400090
      WRITE (IW,20)                                                         TX400100
      WRITE (IW,30)                                                         TX400110
      WRITE (IW,40)                                                         TX400120
      WRITE (IW,50)                                                         TX400130
      WRITE (IW,60)                                                         TX400140
      WRITE (IW,70)                                                         TX400150
      WRITE (IW,80)                                                         TX400160
      WRITE (IW,90)                                                         TX400170
      WRITE (IW,100)                                                        TX400180
      WRITE (IW,110)                                                        TX400190
      RETURN                                                                TX400200
C***********************************************************************TX400210
C**   FORMAT STATEMENTS                                                **TX400220
C***********************************************************************TX400230
10    FORMAT (/)                                                            TX400240
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20    FORMAT (1X,36H    A  BALANCE UNDER STABLE OPERA-   ,
     236H  SHCULD ALMCST ALWAYS CVERLAP.   IN/
     31X,36HTING  CONDITICNS  WILL  EXHIBIT  A   ,
     436H  CTHER WORDS, WHILE A  SECCND  MEA-/
     51X,36HCERTAIN CHARACTERISTIC VARIABILITY   ,
     636H  SUREMENT WILL PRCDUCE A  DIFFERENT/
     71X,36HWHICH  CAN  BE  DESCRIBED  BY  THE   ,
     836H  VALUE, THIS VALUE WILL CNLY RARELY/
     91X,36HSTANCARD   DEVIATICN   FCR    SUCH   ,
     *36H  DIFFER FRCM  THE  FIRST  VALUE  BY)
30    FORMAT (1X,36HMEASUREMENTS.   THE  VALUE   FOR  A   ,
     236H  MCRE  THAN  THE  SUM  CF  THE  TWO/
     31X,36HPARTICULAR  WEIGHT  DETERMINED  IN   ,
     436H  UNCERTAINTIES.   THE  UNCERTAINTY/
     51X,36HREPEATED   TESTS   WITH  THE  SAME   ,
     636H  BANDS ARE NOT EXPECTED TO  OVERLAP/
     71X,36HWEIGHING CESIGN WILL HAVE ITS  CWN   ,
     836H  IF SCME EVENT HAS CCCURRED IN  THE/
     91X,36HSTANDARD  DEVIATICN  WHICH WILL BE   ,
     *36H  TIME INTERVAL BETWEEN THE TWO MEA-)
40    FORMAT (1X,36HSCME  FUNCTICN  CF   THE    BALANCE   ,
     236H  SUREMENTS WHICH  WILL  CHANGE  THE/
     31X,36HPRECISION  AND  (PCSSIBLY)  OF THE   ,
     436H  MASS CF THE OBJECT,  E.G.,   ABRA-/
     51X,36HBETWEEN-RUN  CCMPCNENT.    AS   AN   ,
     636H  SICNS, ABUSE, CCRRCSICN,  IMPROPER/
     71X,36HCUTER LIMIT CF THE DISTRIBUTION OF   ,
     836H  CLEANING AND THE LIKE.           /
     91X,36HRANDCM  ERRCRS,  THREE  TIMES  THE   ,
     *36H                                   )
50    FORMAT (1X,36HSTANCARC   DEVIATION   IS    USED.   ,
     236H       THE  UNCERTAINTY  IN  ASSIGNED/
     31X,36HSYSTEMATIC    ERRORS    DUE  TO  THE   ,
     436H  VALUE  CCNTAINED  IN  THIS  REPORT/
     51X,36HPROCEDURES  USED  CR  TO  ENVIRCN-   ,
     636H  BECOMES A  SYSTEMATIC  EFFECT  FOR/
     71X,36HMENTAL     EFFECTS    ARE   LARGELY   ,
     836H  THE  MEASUREMENT  PRCCESS IN WHICH/
     91X,36HBALANCED CUT AND  CAN  USUALLY  BE   ,
     *36H  THESE WEIGHTS ARE TC BE USED.   IN)
60    FORMAT (1X,36HREGARDED  AS  NEGLIGIBLE.   WHEN A   ,
     236H  THE  ABSENCE  CF CTHER SIGNIFICANT/
     31X,36HNCN-NEGLIGIBLE   BCUND   TO    THE   ,
     436H  SYSTEMATIC EFFECTS IN  THE  USER'S/
     51X,36HPCSSIBLE EFFECT FROM KNCWN SOURCES   ,
     636H  MEASUREMENT  PRCCESS  (A CCNDITION/
     71X,36HIS AVAILABLE, IT IS CALCULATED AND   ,
     836H  WHICH MUST  BE  DEMCNSTRATED)  THE/
     91X,36HREPORTED    SEPARATELY,  E.G.,  THE   ,
     *36H  UNCERTAINTY  CF THE VALUE ASSIGNED)
70    FORMAT (1X,36HUNCERTAINTY CF ACCEPTED  VALUE  AT   ,
     236H  BY  THE  USER  IS  AN  APPRCPRIATE/
     31X,36HCTHER  THAN  THE 1 KILOGRAM LEVEL.   ,
     436H  CCMBINATICN   OF   THE  SYSTEMATIC/
     51X,36HTHE DISTRIBUTION IMPLIEC  BY  THE   ,
     636H  ERROR  IN  THE  STANCARD  AND  THE/
     71X,36HRANDCM ERRCRS MAY THUS BE CENTERED   ,
     836H  RANDOM  CCMPCNENT  ASSCCIATED WITH/
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     91X,36HSOMEWHERE  IN  THE  RANGE GIVEN BY   ,                    TX400830
     *36H  HIS PROCESS.  IF  THE  MEASUREMENT)                        TX400840
80    FORMAT (1X,36HTHE  BOUNDS  TO   THE   SYSTEMATIC  ,             TX400850
     236H  PROCESSES   ARE   IN  CONTROL  AND/                        TX400860
     31X,36HERROR.  THE  TOTAL UNCERTAINTY IS  ,                      TX400870
     436H  APPROPRIATE  UNCERTAINTIES    ARE/                         TX400880
     51X,36HTAKEN AS  THE  SUM  OF  THESE  TWO  ,                     TX400890
     636H  ASSIGNED,  THE  VALUES PRODUCED BY/                        TX400900
     71X,36HCOMPONENTS.                          ,                    TX400910
     836H  DIFFERENT  MEASUREMENT  FACILITIES/                        TX400920
     91X,36H                                     ,                    TX400930
     *36H  WILL  HAVE OVERLAPPING UNCERTAINTY)                        TX400940
90    FORMAT (1X,36H    THE   UNCERTAINTY   ASSOCIATED  ,             TX400950
     236H  BANDS  AS  DESCRIBED  ABOVE.  ONE/                         TX400960
     31X,36HWITH THE  ASSIGNED  VALUE  CAN  BE  ,                     TX400970
     436H  CANNOT   DISCUSS   DIFFERENCES  IN/                        TX400980
     51X,36HTHOUGHT  OF  AS  A  BOUND  TO  THE  ,                     TX400990
     636H  VALUES   FOR   THE   SAME   OBJECT/                        TX401000
     71X,36HDEPARTURE OF  THE  ASSIGNED  VALUE  ,                     TX401010
     836H  OBTAINED  BY  DIFFERENT FACILITIES/                        TX401020
     91X,36HFROM  A HYPOTHETICAL AVERAGE VALUE  ,                     TX401030
     *36H  WITH ANY DEGREE OF SERIOUSNESS UN-)                        TX401040
100   FORMAT (1X,36HTHAT WOULD BE OBTAINED IF IT  WERE  ,             TX401050
     236H  LESS EACH VALUE IS ACCOMPANIED  BY/                        TX401060
     31X,36HPOSSIBLE TO REPEAT THE MEASUREMENT  ,                     TX401070
     436H  A REALISTIC UNCERTAINTY STATEMENT./                        TX401080
     51X,36HMANY  TIMES OVER A WIDE VARIETY OF  ,                     TX401090
     636H                                    /                        TX401100
     71X,36HCONDITIONS. E.G.,  SUBSTITUTE  THE  ,                     TX401110
     836H                                    /                        TX401120
     91X,36HWEIGHT   FOR   ONE  OF  THE  CHECK  ,                     TX401130
     *36H                                    )                        TX401140
110   FORMAT (1X,36HSTANDARDS.   THIS  MEANS THAT  THE  ,             TX401150
     236H                                    /                        TX401160
     31X,36HUNCERTAINTY BAND  CENTERED  ON THE  ,                     TX401170
     436H                                    /                        TX401180
     51X,36HVALUES OBTAINED FROM EACH  OF  TWO  ,                     TX401190
     636H                                    /                        TX401200
     71X,36HMEASUREMENTS OF  THE  SAME  OBJECT  ,                     TX401210
     836H                                    /                        TX401220
     91X,36HOVER SOME ARBITRARY TIME  INTERVAL  ,                     TX401230
     *36H                                    )                        TX401240
      END                                                             TX401250
   TEXT5 SUBPROGRAM ---
      SUBROUTINE TEXT5                                                TX500010
C*********************************************************************TX500020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TX500030
C**   PROGRAM VERSION OF SEPT. 10, 1971   WRITTEN BY R.C. RAYBOLD    **TX500040
C**   AND MRS.R.N.VARNER                                             **TX500050
C**   MODIFIED BY R. N. VARNER SEPT 1977                             **TX500060
C*********************************************************************TX500070
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                 TX500080
      WRITE (IW,10)                                                   TX500090
      WRITE (IW,20)                                                   TX500100
      WRITE (IW,30)                                                   TX500110
      WRITE (IW,40)                                                   TX500120
      WRITE (IW,50)                                                   TX500130
      WRITE (IW,60)                                                   TX500140
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      WRITE (IW,70)                                                     TX500150
      WRITE (IW,80)                                                     TX500160
      WRITE (IW,90)                                                     TX500170
      WRITE (IW,100)                                                    TX500180
      WRITE (IW,110)                                                    TX500190
      RETURN                                                            TX500200
C***********************************************************************TX500210
C**   FORMAT STATEMENTS                                               **TX500220
C***********************************************************************TX500230
10    FORMAT (1X,36H                                    ,               TX500240
     236H                                    )                          TX500250
20    FORMAT (1X,36H                          REFERENCES,               TX500260
     236H                                    /                          TX500270
     31X,36H                                    ,                       TX500280
     436H                                    /                          TX500290
     51X,36HTHE FOLLOWING REFERENCES ARE SUGGEST,                       TX500300
     636HED FOR DETAILED DESCRIPTION OF      /                          TX500310
     71X,36HPORTIONS OF THIS REPORT , AND FOR GE,                       TX500320
     836HNERAL INFORMATION CONCERNING THE    /                          TX500330
     91X,36HMASS MEASUREMENT PROCESS:           ,                       TX500340
     *36H                                    )                          TX500350
30    FORMAT (1X,36H                                    ,               TX500360
     236H                                    /                          TX500370
     31X,36H 1.PONTIUS, P. E., AND CAMERON, J. M,                       TX500380
     436H.                                   /                          TX500390
     51X,36H   REALISTIC UNCERTAINTIES AND THE M,                       TX500400
     636HASS MEASUREMENT PROCESS             /                          TX50041
     71X,36H   NAT. BUR. STAND. (U.S.), MONOGR. ,                       TX50042
     836H103                                 /                          TX50043
     91X,36H   (AUG. 15, 1967)                  ,                       TX50044
     *36H                                    )                          TX50045
40    FORMAT (1X,36H                                    ,               TX50046
     236H                                    /                          TX50047
     31X,36H 2.PONTIUS, P. E.                   ,                       TX50048
     436H                                    /                          TX50049
     51X,36H   MEASUREMENT PHILOSOPHY OF THE PIL,                       TX50050
     636HOT PROGRAM FOR MASS CALIBRATION     /                          TX50051
     71X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,                       TX50052
     836HE 288                               /                          TX50053
     91X,36H   (MAY 6, 1966)                    ,                       TX50054
     *36H                                    )                          TX50055
50    FORMAT (1X,36H                                    ,               TX50056
     236H                                    /                          TX50057
     31X,36H 3.BOWMAN, H. A., AND SCHOONOVER, R.,                       TX50058
     436H M. WITH APPENDIX BY MILDRED JONES  /                          TX50059
     51X,36H   PROCEDURE FOR HIGH PRECISION DENS,                       TX5006
     636HITY DETERMINATIONS BY HYDROSTATIC   /                          TX5006
     71X,36H   WEIGHING                         ,                       TX5006
     836H                                    /                          TX5006
     91X,38H   J. RES. NAT. BUR. STAND. (U.S.) 71C,                     TX5006
     *36H. ENGINEERING AND INSTRUMENTATION   )                          TX5006
60    FORMAT (1X,36H   NO. 3, 179-198 (JULY-AUG. 1967)  ,               TX5006
     236H                                    /                          TX5006
     31X,36H                                    ,                       TX5006
     436H                                    /                          TX5006
     51X,36H 4.NATRELLA, M. G.                  ,                       TX5006
     636H                                    /                          TX5006
     71X,36H   EXPERIMENTAL STATISTICS          ,
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     836H                                    /                          TX500730
     91X,36H   NAT. BUR. STAND. (U.S.) HANDBOOK ,                       TX500740
     *36H91                                  )                          TX500750
  70  FORMAT (1X,36H   (AUGUST 1, 1963)                                 TX500760
     236H                                    /                          TX500770
     31X,36H                                   .                        TX500780
     436H                                    /                          TX500790
     51X,36H 5.KU, H. H.                       .                        TX500800
     636H                                    /                          TX500810
     71X,36H   PRECISION MEASUREMENT AND CALIBRA.                       TX500820
     836HTION - SELECTED NBS PAPERS ON       /                          TX500830
     91X,36H   STATISTICAL CONCEPTS AND PROCEDUR.                       TX500840
     *36HES                                  )                          TX500850
  80  FORMAT (1X,36H   NAT. BUR. STAND. (U.S.) SPEC. PUB,               TX500860
     236HL. 300                              /                          TX500870
     31X,36H   VOL. 1 (FEB. 1969)              .                        TX500880
     436H                                    /                          TX500890
     51X,36H                                   )                        TX500900
  90  FORMAT (1X,36H 6.PONTIUS, P. E.                                   TX500910
     236H                                    /                          TX500920
     31X,36H   MASS AND MASS VALUES            .                        TX500930
     436H                                    /                          TX500940
     51X,36H   NAT. BUR. STAND. (U.S.) MONOGR. 1,                       TX500950
     636H33                                  /                          TX500960
     71X,36H   (JAN. 1974)                     .                        TX500970
     836H                                    /                          TX500980
     91X,36H                                   .                        TX500990
     *36H                                    )                          TX501000
 100  FORMAT (1X,36H 7.CAMERON, J. M., CROARKIN, C. C. A,               TX501010
     236HND RAYBOLD, R. C.                   /                          TX501020
     31X,36H   DESIGNS FOR THE CALIBRATION OF ST,                       TX501030
     436HANDARDS OF MASS                     /                          TX501040
     51X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,                       TX501050
     636HE 952                               /                          TX501060
     71X,36H   (JUNE 1977)                     .                        TX501070
     836H                                    /                          TX501080
     91X,36H                                   .                        TX501090
     *36H                                    )                          TX501100
 110  FORMAT (1X,36H 8.VARNER, R. N., AND RAYBOLD, R. C.,               TX501110
     236H                                    /                          TX501120
     31X,36H   NATIONAL BUREAU OF STANDARDS MASS,                       TX501130
     436H CALIBRATION COMPUTER SOFTWARE      /                          TX501140
     51X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,                       TX501150
     636HE                                   /                          TX501160
     71X,36H   (IN PROCESS)                    .                        TX501170
     836H                                    /                          TX501180
     91X,36H                                   .                        TX501190
     *36H                                    )                          TX501200
      END                                                               TX501210
C     TEXT6 SUBPROGRAM ---
      SUBROUTINE TEXT6                                                  TX600010
C*********************************************************************TX600020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TX600030
C**   PROGRAM VERSION OF SEPT. 10, 1971   WRITTEN BY R.C. RAYBOLD     **TX600040
C**   AND MRS.R.N. VARNER                                             **TX600050
C**   MODIFIED BY R. N. VARNER SEPT 1977                              **TX600060
C*********************************************************************TX600070
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                   TX600080
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      WRITE (IW,10)
      WRITE (IW,20)
      WRITE (IW,30)
      RETURN
C***********************************************************************
C**   FORMAT STATEMENTS                                               **
C***********************************************************************
10    FORMAT (1X,36HTO BE PUBLISHED:                    ,
     236H                                    /
     31X,36H                                    ,
     436H                                    /
     51X,36H 9.PONTIUS, P. E.                   ,
     636H                                    /
     71X,36H   THE ACCEPTED VALUES AND ASSOCIATE,
     836HD UNCERTAINTY ESTIMATES OF THE NBS  /
     91X,36H   STANDARDS AT THE 1 KG LEVEL      ,
     *36H                                    )
20     FORMAT (1X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,
     236HE                                   /
     31X,36H   (EXPECTED COMPLETION:  1975)     ,
     436H                                    /
     51X,36H                                    ,
     636H                                    /
     71X,36H 10.PONTIUS, P. E.                  ,
     836H                                    /
     91X,36H   DOCUMENTATION FOR THE MASS MEASUR,
     *36HEMENT PROCESS AT NBS                )
30     FORMAT (1X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,
     236HE                                   /
     31X,36H   (EXPECTED COMPLETION: 1974)      ,
     436H                                    )
       END
--- READ2 SUBPROGRAM ---
       SUBROUTINE READ2
C***********************************************************************
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **
C**    PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD    **
C**    AND MRS.R.N.VARNER                                             **
C**    MODIFIED BY R. N. VARNER SEPT 1979                             **
C***********************************************************************
C**    SUBROUTINE TO READ DATA FOR EACH NEW SERIES                    **
C***********************************************************************
C**    DIMENSION FOR COMMON /PRT1/ VARIABLES                          **
C***********************************************************************
       DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),
      2 IDATE(3)
C***********************************************************************
C**    DIMENSION FOR COMMON /INPUT/ VARIABLES                         **
C***********************************************************************
       DIMENSION AIDCST(5,15),ANOM(15),DENSTY(15),COEFEX(15),ACCVAL(15),
      2 ARSTIN(15),ACKSTD(15),IRSTCU(15),IPRNT(15),DESMAT(15,50),
      3 OBSERV(600),ALCOM(15,20)
C***********************************************************************
C**    DIMENSION FOR COMMON /RAREA/ VARIABLES                         **
C***********************************************************************
       DIMENSION AA(72),AAITEM(5)
C***********************************************************************
C**    DIMENSION FOR COMMON /PRTLB/ VARIABLE
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C***********************************************************************RD200260
      DIMENSION PRTLEX(15)                                              RD200270
C***********************************************************************RD200280
C**   LABELED COMMON                                                  **RD200290
C***********************************************************************RD200300
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,RD200310
     2 L5,L6,IDATE,IEREST                                               RD200320
      COMMON /INPUT/ TEAR,PBAR,HEAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM, RD200330
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1PRD200340
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P, RD200350
     4 OH1P,OH2P,IOP,IBAL,NCES,NUNKN,IRSTCU,IPRNT,ITPOS,ICKUSD,ICALDS,  RD200360
     5 LINVAR,N3,N4                                                     RD200370
      COMMON /RAREA/ AA,AAITEM                                          RD200380
      COMMON /PRTLB/ PRTLEX                                             RD200390
C***********************************************************************RD200400
C**   SET UP VARIABLE FOR MAXIMUM NUMBER OF READINGS NR=50*12         **RD200410
C***********************************************************************RD200420
      NR=50*12                                                          RD200430
C***********************************************************************RD200440
C**   READ ONE CARD--FREE FIELD                                       **RD200450
C**        TYPE OF WEIGHING (N1)                                      **RD200460
C**        TYPE OF BALANCE (N2)                                       **RD200470
C**        TYPE OF UNITS OF INPUT (N3)                                **RD200480
C**        DIRECTION OF SCALE LEFT TO RIGHT OR RIGHT TO LEFT (N4)     **RD200490
C**                                                                   **RD200500
C**   WHERE                                                           **RD200510
C**     N1 = 0      SINGLE TRANSPOSITION                              **RD200520
C**     N1 = 1      DOUBLE TRANSPOSITION                              **RD200530
C**     N1 = 2      SINGLE SUBSTITUTION                               **RD200540
C**     N1 = 3      DOUBLE SUBSTITUTION                               **RD200550
C**                                                                   **RD200560
C**     N2 = 0      TWO PAN BALANCE                                   **RD200570
C**     N2 = 1      ONE PAN BALANCE                                   **RD200580
C**                                                                   **RD200590
C**     N3 = 0      METRIC UNITS                                      **RD200600
C**     N3 = 1      ENGLISH UNITS                                     **RD200610
C**                                                                   **RD200620
C**     N4 = 0      SCALE LEFT TO RIGHT (EG. 0 TO 100  OR -1 TO 1)    **RD200630
C**     N4 = 1      SCALE RIGHT TO LEFT (EG. 100 TO 0  OR 1 TO -1)    **RD200640
C***********************************************************************RD200650
      CALL READIT (AA,1,AAITEM)                                         RD200660
      N1=INT(AA(1)+.1)                                                  RD200670
      N2=INT(AA(2)+.1)                                                  RD200680
      N3=INT(AA(3)+.1)                                                  RD200690
      N4=INT(AA(4)+.1)                                                  RD200700
C***********************************************************************RD200710
C**   READ DATE OF OBSERVATION,OPERATOR,BALANCE AND CHECK STANDARD    **RD200720
C**   USED                                                            **RD200730
C**   WHERE    NUMBERS ARE FREE FIELD ON THIS CARD  6 NUMBERS         **RD200740
C**        MONTH AND DAY (2 DIGITS) YEAR (4 DIGITS)                   **RD200750
C**      OPERATOR CODE (INTEGER)                                      **RD200760
C**      BALANCE CODE (INTEGER)                                       **RD200770
C**      CHECK STANDARD CODE (INTEGER)                                **RD200780
C***********************************************************************RD200790
      CALL READIT (AA,1,AAITEM)                                         RD200800
      IDATE(1)=INT(AA(1)+.1)                                            RD200810
      IDATE(2)=INT(AA(2)+.1)                                            RD200820
      IDATE(3)=INT(AA(3)+.1)                                            RD200830
```

```
      IOP=INT(AA(4)+.1)
      IBAL=INT(AA(5)+.1)
      ICKUSD=INT(AA(6)+.1)
C*********************************************************************
C**    READ TEMPERATURE,PRESSURE,HUMIDITY AND THEIR CORRECTIONS      **
C**   ONE RECORD FREE FIELD WITH ENTRIES IN THE FOLLOWING ORDER      **
C**     1-TEMPERATURE AT BEGINNING OF THE SERIES IN DEGREES C        **
C**     2-TEMPERATURE AT END OF THE SERIES IN DEGREES C              **
C**     3-PRESSURE AT BEGINNING IN MM HG                             **
C**     4-PRESSURE AT END IN MM HG                                   **
C**     5-HUMIDITY AT BEGINNING IN PERCENT                           **
C**     6-HUMIDITY AT END IN PERCENT                                 **
C**     7-PRESSURE CORRECTION BEGINNING IN MM HG                     **
C**     8-PRESSURE CORRECTION END IN MM HG                           **
C**     9-TEMPERATURE CORRECTION BEGINNING IN DEGREES C              **
C**    10-TEMPERATURE CORRECTION END IN DEGREES C                    **
C**    11-HUMIDITY CORRECTION BEGINNING IN PERCENT                   **
C**    12-HUMIDITY CORRECTION END IN PERCENT                         **
C*********************************************************************
      CALL READIT (AA,1,AAITEM)
      T1P=AA(1)
      T2P=AA(2)
      P1P=AA(3)
      P2P=AA(4)
      H1P=AA(5)
      H2P=AA(6)
      CP1=AA(7)
      CP2=AA(8)
      CT1=AA(9)
      CT2=AA(10)
      CH1=AA(11)
      CH2=AA(12)
C*********************************************************************
C**   SAVE VALUES FOR OUTPUT                                         **
C**   COMPUTE AVERAGE CORRECTED TEMPERATURE, PRESSURE AND HUMIDITY   **
C*********************************************************************
      OT1P=T1P
      OT2P=T2P
      OP1P=P1P
      OP2P=P2P
      OH1P=H1P
      OH2P=H2P
      T1P=T1P+CT1
      T2P=T2P+CT2
      P1P=P1P+CP1
      P2P=P2P+CP2
      H1P=H1P+CH1
      H2P=H2P+CH2
      TBAR=(T1P+T2P)/2.
      PBAR=(P1P+P2P)/2.
      HBAR=(H1P+H2P)/2.
C*********************************************************************
C**   ONE CARD IN THE FOLLOWING ORDER FREE FIELD                     **
C**    1. NUMBER OF OBSERVATION  ( MAX. = 50 )                       **
C**    2. NUMBER OF UNKNOWNS  ( MAX. = 15 )                          **
C**    3. CALIBRATION DESIGN CODE  ( INTEGER 0000 TO 9999 )          **
C**    4. NUMBER OF LINEAR COMBINATION ( MAX. = 20 )                 **
C*********************************************************************
```

```
      CALL READIT (AA,1,AAITEM)                                         RD201420
      NOBS=INT(AA(1)+.1)                                                RD201430
      NUNKN=INT(AA(2)+.1)                                               RD201440
      ICALDS=INT(AA(3)+.1)                                              RD201450
      LINVAR=INT(AA(4)+.1)                                              RD201460
C***********************************************************************RD201470
C**   ONE RECORD-FREE FIELD-WITH ENTRIES IN THE FOLLOWING ORDER       **RD201480
C**    1. WITHIN STANDARD DEVIATION OF THE BALANCE IN MG               **RD201490
C**    2. MASS VALUE IN MG OF THE SENSITIVITY WEIGHT                   **RD201500
C**    3. VOLUME OF THE SENSITIVITY WEIGHT IN CM3                      **RD201510
C**    4. COEFFICIENT OF EXPANSION OF SENSITIVITY WEIGHT               **RD201520
C**    5. BETWEEN STANDARD DEVIATION OF THE BALANCE IN MG              **RD201530
C***********************************************************************RD201540
      CALL READIT (AA,1,AAITEM)                                         RD201550
      STDEBA=AA(1)                                                      RD201560
      SWT=AA(2)                                                         RD201570
      VSWT=AA(3)                                                        RD201580
      CEXSWT=AA(4)                                                      RD201590
      VAREAL=AA(5)                                                      RD201600
C***********************************************************************RD201610
C**   A GROUP OF N RECORDS (N=NUMBER OF UNKNOWNS), EACH RECORD HAS    **RD201620
C**   INFORMATION IN THE FOLLOWING ORDER, ABOUT EACH WEIGHT           **RD201630
C**     1. IN COLUMNS 1-15 IDENTIFICATION OF WEIGHTS (ALPHA-NUMERIC)  **RD201640
C**                                                                   **RD201650
C**   THE REST OF THE INFORMATION ON EACH RECORD IS FREE FIELD        **RD201660
C**                                                                   **RD201670
C**     2. WEIGHTS NOMINAL VALUE IN GRAMS ( POUNDS IF N3 = 1 )        **RD201680
C**     3. DENSITY OF THE WEIGHT IN CM3                               **RD201690
C**     4. COEFFICIENT OF EXPANSION OF THE WEIGHT                     **RD201700
C**     5. ACCEPTED CORRECTION OF THE WEIGHT IN MG                    **RD201710
C***********************************************************************RD201720
      DO 20 I=1,NUNKN                                                   RD201730
      CALL READIT (AA,16,AAITEM)                                        RD201740
      AIDCST(1,I)=AAITEM(1)                                             RD201750
      AIDCST(2,I)=AAITEM(2)                                             RD201760
      AIDCST(3,I)=AAITEM(3)                                             RD201770
      AIDCST(4,I)=AAITEM(4)                                             RD201780
      AIDCST(5,I)=AAITEM(5)                                             RD201790
      ANOM(I)=AA(1)                                                     RD201800
      IF (N3.EQ.0) GO TO 10                                             RD201810
      PRTLBX(I)=ANOM(I)                                                 RD201820
C***********************************************************************RD201830
C**   CONVERT POUNDS TO GRAMS                                         **RD201840
C***********************************************************************RD201850
      ANOM(I)=ANOM(I)*453.59237                                         RD201860
   10 CONTINUE                                                          RD201870
      DENSTY(I)=AA(2)                                                   RD201880
      COEFEX(I)=AA(3)                                                   RD201890
      ACCVAL(I)=AA(4)                                                   RD201900
   20 CONTINUE                                                          RD201910
C***********************************************************************RD201920
C**   READ, FREE FIELD, ONE RECORD A VECTOR CONSISTING OF 1'S OR 0'S  **RD201930
C**   USE A 1 IF WEIGHT IS INCLUDED IN RESTRAINT                      **RD201940
C**   USE A 0 IF WEIGHT IS NOT INCLUDED IN THE RESTRAINT              **RD201950
C**   FOLLOW ORDER OF INPUT                                           **RD201960
C***********************************************************************RD201970
      CALL READIT (AA,1,AAITEM)                                         RD201980
      DO 30 I=1,NUNKN                                                   RD201990
```

```
30     ARSTIN(I)=AA(I)                                                       RD202
C***************************************************************************RD202
C**    READ, FREE FIELD, ONE RECORD CONSISTING OF 1'S AND 0'S              **RD202
C**    USE 1 IF WEIGHT IS INCLUDED IN CHECK STANDARD                       **RD202
C**    USE 0 IF WEIGHT IS NOT INCLUDED IN CHECK STANDARD                   **RD202
C**    FOLLOW ORDER OF INPUT                                               **RD202
C***************************************************************************RD202
       CALL READIT (AA,1,AAITEM)                                             RD202
       DO 40 I=1,NUNKN                                                       RD202
40     ACKSTD(I)=AA(I)                                                       RD202
C***************************************************************************RD202
C**    READ, FREE FIELD, ONE RECORD CONSISTING OF 1'S AND 0'S              **RD202
C**    USE 1 IF WEIGHT IS USED IN RESTRAINT FOR NEXT SERIES                **RD202
C**    USE 0 IF WEIGHT IS NOT USED IN RESTRAINT FOR NEXT SERIES            **RD202
C**    FOLLOW ORDER ON INPUT                                               **RD202
C***************************************************************************RD202
       CALL READIT (AA,1,AAITEM)                                             RD202
       DO 50 I=1,NUNKN                                                       RD202
50     IRSTOU(I)=INT(AA(I)+.1)                                               RD202
C***************************************************************************RD202
C**    READ IN FREE FIELD A CARD WITH A VECTOR OF 1 IF WEIGHT IS ONE       **RD202
C**    WHICH IS TO BE PRINTED IN THE REPORT AND 0 IF IT IS NOT , THE       **RD202
C**    READ, FREE FIELD, ONE RECORD CONSISTING OF 1'S AND 0'S              **RD202
C**    USE 1 IF WEIGHT IS TO BE PRINTED IN REPORT                          **RD202
C**    USE 0 IF WEIGHT IS OMITTED IN REPORT                                **RD202
C**    USE ORDER OF INPUT                                                  **RD202
C***************************************************************************RD202
       CALL READIT (AA,1,AAITEM)                                             RD202
       DO 60 I=1,NUNKN                                                       RD202
60     IPRNT(I)=INT(AA(I)+.1)                                                RD20
C***************************************************************************RD20
C**    READ DESIGN MATRIX                                                  **RD20
C**    READ IN N (NUMBER OF OBSERVATIONS) RECORDS WITH K (NUMBER           **RD20
C**    OF UNKNOWNS)                                                        **RD20
C**    ENTRIES PER RECORD IN THE ORDER OF THE                              **RD20
C**    IDENTIFICATION CARDS WHERE THE WEIGHING EQUATION ARE SET UP BY      **RD20
C**    A SERIES OF 0,-1 AND 1 .                                              RD20
C***************************************************************************RD20
       DO 80 I=1,NOBS                                                        RD20
       CALL READIT (AA,1,AAITEM)                                             RD20
       DO 70 J=1,NUNKN                                                       RD20
       DESMAT(J,I)=AA(J)                                                     RD20
70     CONTINUE                                                              RD20
80     CONTINUE                                                              RD20
C***************************************************************************RD20
C**    READ IN LINVAR (NUMBER OF LINEAR COMBINATIONS) RECORDS              **RD20
C**    TO COMPUTE VARIANCE OF LINEAR COMBINATIONS OF WEIGHTS               **RD20
C**    EACH RECORD CONTAINS K (NUMBER OF UNKNOWNS) ENTRIES                 **RD20
C**    ENTRIES OF 0'S, -1'S, AND 1'S ARE USED                              **RD20
C**    FOLLOW ORDER OF INPUT                                               **RD20
C***************************************************************************RD20
       IF (LINVAR.EQ.0) GO TO 110
       DO 100 I=1,LINVAR
       CALL READIT (AA,1,AAITEM)
       DO 90 J=1,NUNKN
       ALCOM(J,I)=AA(J)
90     CONTINUE
100    CONTINUE
```

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C***********************************************************************RD202580
C**   READ CBSERVATICNS FREE FIELC IN THE ORDER THAT THE DESIGN        **RD202590
C**   MATRIX IS READ                                                  **RD202600
C**   READ ENTRIES AS DENOTED BY N1 AND N2 BELOW                      **RD202610
C**                                                                   **RD202620
C**     N1 N2                                                         **RD202630
C**     2  1    X Y Z                                                 **RD202640
C**     2  0    X1 X2 X3 Y1 Y2 Y3 Z1 Z2 Z3                            **RD202650
C**     0  0    X1 X2 X3 Y1 Y2 Y3 Z1 Z2 Z3                            **RD202660
C**     3  1    X Y Z W                                               **RD202670
C**     3  0    2-CARDS   X1 X2 X3 Y1 Y2 Y3                           **RD202680
C**                       Z1 Z2 Z3 W1 W2 W3                           **RD202690
C**     1  0    2-CARDS   X1 X2 X3 Y1 Y2 Y3                           **RD202700
C**                       Z1 Z2 Z3 W1 W2 W3                           **RD202710
C**                                                                   **RD202720
C**   NOTES                                                           **RD202730
C**      1. ANY CTHER COMBINATICN CF N1 AND N2 ASSUMES THERE ARE TWO  **RD202740
C**   RECCRDS, SIX ITEMS PER RECORD                                   **RD202750
C**      2. THE MAXIMUM NUMBER CF CBSERVATIONS IS 50 SO YOU MAY HAVE UP RD202760
C**         TC 600 READINGS GIVEN HERE                                **RD202770
C**      3. NC MCRE CESERVATICNS ARE STORED WHEN                      **RD202780
C**         -20000 IS ENCOUNTERED                                     **RD202790
C***********************************************************************RD202800
110   DO 120 K=1,NR                                                     RD202810
      OBSERV(K)=0.0                                                     RD202820
120   CCNTINUE                                                          RD202830
      K=1                                                               RD202840
C***********************************************************************RD202850
C**   SET UP FLAGS FOR TYPE CF WEIGHING                               **RD202860
C***********************************************************************RD202870
      IF (N1.EQ.2.AND.N2.EQ.1) GO TO 130                                RD202880
      IF (N1.EQ.2.ANC.N2.EQ.0) GO TO 140                                RD202890
      IF (N1.EQ.0.AND.N2.EQ.0) GO TC 150                                RD202900
      IF (N1.EQ.3.AND.N2.EQ.1) GC TO 160                                RD202910
      IF (N1.EQ.3.AND.N2.EC.0) GC TO 170                                RD202920
      IF (N1.EQ.1.AND.N2.EC.0) GO TO 180                                RD202930
      GO TC 180                                                         RD202940
130   IA=3                                                              RD202950
      ITPCS=1                                                           RD202960
      GO TO 190                                                         RD202970
140   IA=9                                                              RD202980
      ITPCS=2                                                           RD202990
      GO TO 190                                                         RD203000
150   IA=9                                                              RD203010
      ITPCS=3                                                           RD203020
      GO TC 190                                                         RD203030
[illegible] IA=4                                                        RD203040
      ITPCS=4                                                           RD203050
      GO TO 190                                                         RD203060
[illegible] IA=6                                                        RD203070
      ITPCS=5                                                           RD203080
      GO TO 190                                                         RD203090
[illegible] IA=6                                                        RD203100
      ITPCS=6                                                           RD203110
      GO TO 190                                                         RD203120
C***********************************************************************RD203130
C**   READ CBSERVATICNS--FREE FIELD INPUT                             **RD203140
C**   THE NUMBER -20000  DENCTES LAST CARD FOR A SERIES               **RD203150
```

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C*********************************************************************RD203
190   CALL READIT (AA,1,AAITEM)                                        RD203
      IF (AA(1).LE.-19999.) GO TO 210                                  RD203
      DO 200 I=1,IA                                                    RD203
      OBSERV(K)=AA(I)                                                  RD203
      K=K+1                                                            RD203
200   CONTINUE                                                         RD203
      GO TO 190                                                        RD203
210   RETURN                                                           RD203
      END                                                              RD203
--- SPINV SUBPROGRAM ---
      SUBROUTINE SPINV (A,M,KK,ISIG)                                   INVO(
C**********************************************************************INVO(
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **INVO(
C**   PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD     **INVO(
C**   AND MRS.R.N.VARNER                                              **INVO(
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **INVO(
C**********************************************************************INVO(
C**   MATRIX INVERSION WITH MINIMUM ROUNDOFF ERROR ACCUMULATION.      **INVO
C**   WRITTEN BY MRS.S.T.PEAVY ,STATISTICAL ENGINEERING LABORATORY ,  **INVO
C**   NATIONAL BUREAU OF STANDARDS ,WASHINGTON , D.C. 20234           **INVO
C**   A IS THE MATRIX TO BE INVERTED                                  **INVO
C**   M IS THE NUMBER OF ROWS IN MATRIX                               **INVO
C**   KK IS THE NUMBER OF COLUMNS IN MATRIX                           **INVO
C**   ISIG=0 INVERSE SUCCESSFUL                                       **INVO
C**   ISIG=4 SINGULAR MATRIX                                          **INVO
C**   ISIG=-1 CHECK ON I(IDENTITY)-A*A(INVERSE) FAILED                **INVO
C**********************************************************************INVO
      DIMENSION A(1)                                                   INVO
      COMMON /INVCST/ ZERMAC                                           INVO
C**********************************************************************INVO
C**   SAVE ORIGINAL MATRIX                                            **INVO
C**********************************************************************INVO
      CALL SAVMTX (M)                                                  INVO
      ISIG=0                                                           INVO
      N=M                                                              INVO
      NN=KK                                                            INVO
      N2=N+N                                                           INVO
      DO 30 J=1,N                                                      INVO
      NJCOL=(N+J-1)*NN                                                 INVO
      DO 30 I=1,N                                                      INVO
      KINJ=NJCOL+I                                                     INVO
      IF (I-J) 10,20,10                                                INVO
10    A(KINJ)=0.                                                       INVO
      GO TO 30                                                         INVO
20    A(KINJ)=1.                                                       INVO
30    CONTINUE                                                         INVO
C**********************************************************************INVO
C**   DETERMINE MAXIMUM ABSOLUTE OF VARIABLE BEING ELIMINATED.        **INVO
C**********************************************************************INVO
      L=0
40    L=L+1
      LCOL=NN*L-NN
      KLL=LCOL+L
      IF (L-N) 50,100,200
C**********************************************************************INVO
C**   FIND THE LARGEST ELEMENT IN THE LTH COLUMN.                     **INVO
C**********************************************************************INVO
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50    J1=L                                                               INV00480
      C=ABS(A(KLL))                                                      INV00490
      L1=L+1                                                             INV00500
      DO 70 I=L1,N                                                       INV00510
      KIL=LCCL+I                                                         INV00520
      X=ABS(A(KIL))                                                      INV00530
      IF (C-X) 60,70,70                                                  INV00540
C*********************************************************************** INV00550
C**   RECCRD THE NUMBER CF THE RCW HAVING THE GREATER ELEMENT.        ** INV00560
C*********************************************************************** INV00570
60    J1=I                                                               INV00580
C*********************************************************************** INV00590
C**   C BECCMES THE GREATER.                                          ** INV00600
C*********************************************************************** INV00610
      C=X                                                                INV00620
70    CCNTINUE                                                           INV00630
C*********************************************************************** INV00640
C**   INTERCHANGE ROW J1 WITH RCW L. J1 IS THE ROW WITH THE LARGEST   ** INV00650
C**   ELEMENT TEST TO SEE IF INTERCHANGING IS NECESSARY.              ** INV00660
C*********************************************************************** INV00670
      IF (J1-L) 80,100,80                                                INV00680
80    DO 90 J=L,N2                                                       INV00690
      JCOL=NN*J-NN                                                       INV00700
      KJIJ=JCCL+J1                                                       INV00710
      HOLD=A(KJIJ)                                                       INV00720
      KLJ=JCCL+L                                                         INV00730
      A(KJIJ)=A(KLJ)                                                     INV00740
      A(KLJ)=HCLD                                                        INV00750
90    CONTINUE                                                           INV00760
C*********************************************************************** INV00770
C**   IF THE LARGEST ABSOLUTE ELEMENT IN A CCLUMN IS ZERC WE HAVE     ** INV00780
C**   A SINGULAR MATRIX                                               ** INV00790
C*********************************************************************** INV00800
100   IF (ABS(A(KLL))-ZERMAC) 110,110,120                                INV00810
110   ISIG=4                                                             INV00820
      GO TO 200                                                          INV00830
C*********************************************************************** INV00840
C**   ZERC ALL THE ELEMENTS IN THE LTH COLUMN BUT THE PIVCTAL ELEMENT ** INV00850
C*********************************************************************** INV00860
120   L1=1                                                               INV00870
      L2=L-1                                                             INV00880
      IF (L2) 130,130,15C                                                INV00890
130   IF (L-N) 140,170,140                                               INV00900
140   L1=L+1                                                             INV00910
      L2=N                                                               INV00920
      DO 160 I=L1,L2                                                     INV00930
      KIL=LCCL+I                                                         INV00940
      Z=-A(KIL)/A(KLL)                                                   INV00950
      DO 160 J=L,N2                                                      INV00960
      JCOL=NN*J-NN                                                       INV00970
      KIJ=JCCL+I                                                         INV00980
      KLJ=JCCL+L                                                         INV00990
      A(KIJ)=A(KIJ)+Z*A(KLJ)                                             INV01000
      IF (N-L2) 40,40,130                                                INV01010
C*********************************************************************** INV01020
C**   DIVIDE BY DIAGCNAL ELEMENTS.                                    ** INV01030
C*********************************************************************** INV01040
      DO 180 I=1,N                                                       INV01050
```

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      KKK=NN*I-NN+I                                                      INVO1
      ZZ=A(KKK)                                                          INVO1
      DO 180 J=1,N2                                                      INVO1
      KKI=NN*J-NN+I                                                      INVO1
180   A(KKI)=A(KKI)/ZZ                                                   INVO1
C************************************************************************INVO1
C**   RETURN AFTER PUTTING A INVERSE INTO B                            **INVO1
C************************************************************************INVO1
      DO 190 J=1,N                                                       INVO1
      JCOL=NN*J-NN                                                       INVO1
      NJCOL=NN*N+JCOL                                                    INVO1
      DO 190 I=1,N                                                       INVO1
      KIJ=JCOL+I                                                         INVO1
      KINJ=NJCOL+I                                                       INVO1
190   A(KIJ)=A(KINJ)                                                     INVO1
C************************************************************************INVO1
C**   CHECK SUCCESS OR FAILURE OF MATRIX INVERSION                     **INVO1
C************************************************************************INVO1
      CALL INVCHK (A,M,KK,ISIG)                                          INVO1
200   RETURN                                                             INVO
      END                                                                INVO
--- SAVMTX SUBPROGRAM ---
      SUBROUTINE SAVMTX (M)                                              SVMO
C************************************************************************SVMO
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **SVMO
C**   PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD      **SVMO
C**   AND MRS.R.N.VARNER                                               **SVMO
C**   MODIFIED BY R. N. VARNER SEPT 1979                               **SVMO
C************************************************************************SVMO
C**   SUBROUTINE TO SAVE ORIGINAL MATRIX BEFORE INVERSION              **SVMO
C**   MATRIX IS IN Y AND IS STORED IN B                                **SVMO
C************************************************************************SVMO
C**   DIMENSION FOR COMMON /CHECK/ VARIABLES                           **SVMO
C************************************************************************SVMO
      DIMENSION B(289),Y(578)                                            SVMO
C************************************************************************SVMO
C**   LABELED COMMON                                                   **SVMO
C************************************************************************SVMO
      COMMON /CHECK/ CHCKMA,B,Y                                          SVMO
      MA=M*M                                                             SVMO
      DO 10 I=1,MA                                                       SVMO
10    B(I)=Y(I)                                                          SVMO
      RETURN                                                             SVMO
      END                                                                SVMO
--- INVCHK SUBPROGRAM ---
      SUBROUTINE INVCHK (A,M,KK,ISIG)                                    IVC
C***********************************************************************
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **
C**   PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD      **
C**   AND MRS.R.N.VARNER                                               **
C**   MODIFIED BY R. N. VARNER SEPT 1979                               **
C***********************************************************************
C**   SUBROUTINE TO CHECK  I-AA(INV)
C**   A IS INVERTED MATRIX
C**   B IS ORIGINAL MATRIX
C**   M IS NUMBER OF ROWS IN MATRIX
C**   KK IS NUMBER OF COLUMNS IN MATRIX
C**   ISIG=-1 IF I-A*A(INV) FAILS
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```
C*********************************************************************IVC00140
      DIMENSICN A(1)                                                   IVC00150
C*********************************************************************IVC00160
C**   DIMENSION FOR CCMMCN /CHECK/                                   **IVC00170
C*********************************************************************IVC00180
      DIMENSICN B(289),Y(578)                                          IVC00190
C*********************************************************************IVC00200
C**   LABELEC COMMON                                                 **IVC00210
C**                                                                  **IVC00220
      COMMON /CHECK/ CHCKMA,B,Y                                        IVC00230
      N=M                                                              IVC00240
      NN=KK                                                            IVC00250
C*********************************************************************IVC00260
C**   RESTCRE ORIGINAL MATRIX                                        **IVC00270
C*********************************************************************IVC00280
      NP=N*N                                                           IVC00290
      DO 10 J=1,NP                                                     IVC00300
      NP2=NP+J                                                         IVC00310
   10 A(NP2)=B(J)                                                      IVC00320
C*********************************************************************IVC00330
C**   B=I-AA(INV)                                                    **IVC00340
C*********************************************************************IVC00350
      IBP=1                                                            IVC00360
      K=1                                                              IVC00370
      DO 60 J=1,NN                                                     IVC00380
      IAP=N*N+1                                                        IVC00390
      DO 50 KA=1,N                                                     IVC00400
      IA=IAP                                                           IVC00410
      IB=IBP                                                           IVC00420
      B(K)=0.0                                                         IVC00430
      DO 20 I=1,NN                                                     IVC00440
      B(K)=B(K)+A(IA)*A(IB)                                            IVC00450
      IB=IB+1                                                          IVC00460
   20 IA=IA+N                                                          IVC00470
      IF (J.EQ.KA) GO TC 30                                            IVC00480
      B(K)=-B(K)                                                       IVC00490
      GO TO 40                                                         IVC00500
   30 B(K)=1.0-B(K)                                                    IVC00510
   40 IAP=IAP+1                                                        IVC00520
   50 K=K+1                                                            IVC00530
   60 IBP=IBP+N                                                        IVC00540
C*********************************************************************IVC00550
C**   PICK UP THE LARGEST ABSCLUTE VALUE FROM  I-AA(INV)             **IVC00560
C*********************************************************************IVC00570
      BIG=ABS(B(1))                                                    IVC00580
      J=N*N                                                            IVC00590
      DO 70 I=2,J                                                      IVC00600
   70 BIG=AMAX1(BIG,ABS(B(I)))                                         IVC00610
C*********************************************************************IVC00620
C**   IF CCNDITICN IS NCT MET SET SIGNAL (ISIG)=-1                   **IVC00630
C**   CHCKMA=.01*S.D. OF BALANCE(INPUT VALUE)                        **IVC00640
C*********************************************************************IVC00650
      IF (BIG.LE.CHCKMA) RETURN                                        IVC00660
      ISIG=-1                                                          IVC00670
      RETURN                                                           IVC00680
      END                                                              IVC00690
C --- PRINT2 SUBPROGRAM ---
      SUBROUTINE PRINT2                                                PR200010
```

```
C*************************************************************************PR2000
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **PR2000
C**   PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYBOLD     **PR2000
C**   AND MRS.R.N.VARNER                                               **PR2000
C**   MODIFIED BY R. N. VARNER SEPT 1979                               **PR2000
C*************************************************************************PR2000
C**   SUBROUTINE TO PRINT PAGES FOR ONE SERIES                         **PR2000
C*************************************************************************PR2000
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                            **PR2001
C*************************************************************************PR2001
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),         PR2001
     2 IDATE(3)                                                            PR2001
C*************************************************************************PR2001
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                           **PR200
C*************************************************************************PR200
      DIMENSION AIDCST(5,15),ANOM(15),DENSTY(15),COEFEX(15),ACCVAL(15),  PR200
     2 ARSTIN(15),ACKSTD(15),IRSTCU(15),IPRNT(15),DESMAT(15,50),          PR200
     3 OBSERV(600),ALCOM(15,20)                                            PR200
C*************************************************************************PR200
C**   DIMENSION FOR COMMON /COMPUT/ VARIABLES                          **PR200
C*************************************************************************PR200
      DIMENSION SWTPRT(50),A(50),DELTA(50),OBSCOR(15),COMVOL(15),         PR200
     2 SERROR(15),TRISIG(15),TCTUN(15),DRIFT(50),ZERO(50),COMVOP(15),     PR200
     3 CORR5A(20),SIG35A(20),UNC5A(20),IOTSTR(50),SER5A(20),DS1(50)       PR200
C*************************************************************************PR200
C**   DIMENSION FOR SUBROUTINE PRINT2                                  **PR200
C*************************************************************************PR200
      DIMENSION ITEMP(15),KTEMP(15),JTEMP(20)                              PR200
C*************************************************************************PR200
C*************************************************************************PR200
C**   DIMENSION FOR COMMON /CHECK/ VARIABLES                           **PR200
C*************************************************************************PR200
      DIMENSION B(289),Y(578)                                              PR200
C*************************************************************************PR200
C**   DIMENSION FOR COMMON /PRTLB/ VARIABLES                           **PR200
C*************************************************************************PR200
      DIMENSION PRTLBX(15)                                                 PR200
C*************************************************************************PR200
C**   LABELED COMMON                                                   **PR20
C*************************************************************************PR20
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,PR20
     2 L5,L6,IDATE,IEREST                                                  PR20
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                      PR20
      COMMON /INPUT/ TBAR,PBAR,HBAR,STDBBA,SWT,VSWT,CEXSWT,AIDCST,ANOM,   PR20
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1PPR20
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,DT1P,DT2P,DP1P,DP2P,   PR20
     4 DH1P,DH2P,IOP,IBAL,NOBS,NUNKN,IRSTCU,IPRNT,ITPOS,ICKUSD,ICALDS,
     5 LINVAR,N3,N4
      COMMON /COMPUT/ DESCOR,CORR,VOLRES,RHOA,SWTPRT,A,DELTA,COMVOL,
     2 SERROR,TRISIG,TCTUN,ACCRR,CORRES,TMSUM,VOLSUM,SERSUM,T3SIG,ALOAD
     3,OBSTD,FRATIO,OBCOCK,OBSCK,TVAL,DRIFT,ZERO,V2TAU,STAR,COMVOP,
     4 CORR5A,SIG35A,UNC5A,RHOAA,RHOAB,SER5A,DS1,NDGFR,ISWTCH,IFLAG,
     5 IRCUT,IOTSTR,JSTAR
      COMMON /PRTLB/ PRTLBX
      COMMON /CHECK/ CHCKMA,B,Y
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP
      COMMON /DPFDVL/ KFD(18)
      COMMON /PCHOUT/ NTCP
```

```
C***********************************************************************PR200600
C**   TYPE STATEMENT                                                  **PR200610
C***********************************************************************PR200620
      DOUBLE PRECISION CESCOR                                           PR200630
C***********************************************************************PR200640
      NOSER=NOSER+1                                                     PR200650
      ITST=1                                                            PR200660
      IF (NOSER.NE.1) GO TO 10                                          PR200670
      NTOP=0                                                            PR200680
      REWIND ITMP                                                       PR200690
C***********************************************************************PR200700
C**   WRITE FIRST PAGE OF SERIES                                      **PR200710
C***********************************************************************PR200720
10    CALL HEADPG                                                       PR200730
      CALL CHKLN (2)                                                    PR200740
      WRITE (IW,1140) STDE6A,VAREAL                                     PR200750
      CALL CHKLN (3)                                                    PR200760
      WRITE (IW,1150) ICALDS                                            PR200770
      DO 15 I=1,NUNKN                                                   PR200780
15    ITEMP(I)=ARSTIN(I)                                                PR200785
      CALL CHKLN (1)                                                    PR200790
      WRITE (IW,1160) (ITEMP(I),I=1,NUNKN)                              PR200800
      CALL CHKLN (6)                                                    PR200810
      WRITE (IW,1170) CCRR,TEAR,VOLRES,SYSERR,RANERR                    PR200820
      DO 20 I=1,NUNKN                                                   PR200830
20    ITEMP(I)=ACKSTD(I)                                                PR200840
      CALL CHKLN (1)                                                    PR200850
      WRITE (IW,1190) ICKUSD                                            PR200860
      CALL CHKLN (1)                                                    PR200870
      WRITE (IW,1180) (ITEMP(I),I=1,NUNKN)                              PR200880
      CALL CHKLN (1)                                                    PR200890
      WRITE (IW,1200) V2TAU                                             PR200900
      DO 30 I=1,NUNKN                                                   PR200910
30    ITEMP(I)=IPRNT(I)                                                 PR200920
      CALL CHKLN (1)                                                    PR200930
      WRITE (IW,1040) (ITEMP(I),I=1,NUNKN)                              PR200940
      CALL CHKLN (15)                                                   PR200950
      WRITE (IW,1210) T1P,T2P,TEAR,P1P,P2P,PBAR,H1P,H2P,HBAR,RHCAB,RHOAAPR200960
     2,RHCA,CT1,CT2,CP1,CP2,CH1,CH2,CT1P,OT2P,OP1P,OP2P,OH1P,OH2P       PR200970
      CALL CHKLN (3)                                                    PR200980
      IF (N3.EQ.0) GO TO 70                                             PR200990
C***********************************************************************PR201000
C**   OUTPUT IN ENGLISH (POUNDS)                                      **PR201010
C***********************************************************************PR201020
      WRITE (IW,1220)                                                   PR201030
      DO 60 I=1,NUNKN                                                   PR201040
      CALL CHKLN (1)                                                    PR201050
      IF (ACCVAL(I)) 40,50,40                                           PR201060
40    WRITE (IW,1230) (AIDCST(IU,I),IU=1,5),PRTLBX(I),DENSTY(I),COEFEX(IPR201070
     2),ACCVAL(I)                                                       PR201080
      GO TO 60                                                          PR201090
50    WRITE (IW,1230) (AIDCST(IU,I),IU=1,5),PRTLBX(I),DENSTY(I),COEFEX(IPR201100
     2)                                                                 PR201110
60    CONTINUE                                                          PR201120
      GO TO 110                                                         PR201130
C***********************************************************************PR201140
C**   OUTPUT IN METRIC (GRAMS)                                        **PR201150
C***********************************************************************PR201160
```

```
70    WRITE (IW,1250)
      DO 100 I=1,NUNKN
      CALL CHKLN (1)
      IF (ACCVAL(I)) 80,90,80
80    WRITE (IW,1240) (AIDCST(IU,I),IU=1,5),ANOM(I),DENSTY(I),CCEFEX(I),
     2ACCVAL(I)
      GO TO 100
90    WRITE (IW,1240) (AIDCST(IU,I),IU=1,5),ANOM(I),DENSTY(I),CCEFEX(I)
100   CONTINUE
C***********************************************************************
C**   WRITE SECOND PAGE OF SERIES                                     **
C***********************************************************************
110   CALL HEADPG
      CALL CHKLN (3)
      WRITE (IW,1150) ICALDS
      CALL CHKLN (2)
      IF (N3.EQ.0) GO TO 210
C***********************************************************************
C**   OUTPUT IN ENGLISH UNITS                                         **
C**   JFLAG=1 POUNDS                                                  **
C**   JFLAG=2 MILLI-POUNDS                                            **
C**   JFLAG=3 MICRO-POUNDS                                            **
C***********************************************************************
      JFLAG=1
      IF (PRTLBX(1).LT.0.001) GO TO 120
      IF (PRTLBX(1).LT.1.0) JFLAG=2
      GO TO 130
120   JFLAG=3
130   DO 170 I=1,NUNKN
      GO TO (140,150,160), JFLAG
140   KTEMP(I)=INT(PRTLBX(I)+.5)
      GO TO 170
150   KTEMP(I)=INT(1000.*PRTLBX(I)+.5)
      GO TO 170
160   KTEMP(I)=INT(1000000.*PRTLBX(I)+.5)
170   CONTINUE
      GO TO (180,190,200), JFLAG
180   WRITE (IW,1050) (KTEMP(I),I=1,NUNKN)
      GO TO 270
190   WRITE (IW,1060) (KTEMP(I),I=1,NUNKN)
      GO TO 270
200   WRITE (IW,1070) (KTEMP(I),I=1,NUNKN)
      GO TO 270
C***********************************************************************
C**   OUTPUT IN METRIC                                                **
C**   JFLAG=1 GRAMS                                                   **
C**   JFLAG=2 MILLIGRAMS                                              **
C***********************************************************************
210   JFLAG=1
      IF (ANOM(1).LT.1.0) JFLAG=2
      DO 240 I=1,NUNKN
      GO TO (220,230), JFLAG
220   KTEMP(I)=INT(ANOM(I)+.5)
      GO TO 240
230   KTEMP(I)=INT(ANOM(I)*1000.+.5)
240   CONTINUE
      GO TO (250,260), JFLAG
250   WRITE (IW,1260) (KTEMP(I),I=1,NUNKN)
```

```
      GO TO 270                                                         PR201750
260   WRITE (IW,1270) (KTEMP(I),I=1,NUNKN)                              PR201760
C***********************************************************************PR201770
C**   SET UP AND PRINT DESIGN MATRIX                                  **PR201780
C***********************************************************************PR201790
270   DO 310 I=1,NOBS                                                   PR201800
      DO 300 J=1,NUNKN                                                  PR201810
      IF (DESMAT(J,I).EQ.0.0) GO TO 280                                 PR201820
      IF (DESMAT(J,I).EQ.1.0) GO TO 290                                 PR201830
      ITEMP(J)=KFD(12)                                                  PR201840
      GO TO 300                                                         PR201850
280   ITEMP(J)=KFD(11)                                                  PR201860
      GO TO 300                                                         PR201870
290   ITEMP(J)=KFD(15)                                                  PR201880
300   CONTINUE                                                          PR201890
      CALL CHKLN (1)                                                    PR201900
      WRITE (IW,1280) I,(ITEMP(J),J=1,NUNKN)                            PR201910
310   CONTINUE                                                          PR201920
      DO 340 J=1,NUNKN                                                  PR201930
      IF (ARSTIN(J).EQ.0.0) GO TO 320                                   PR201940
      IF (ARSTIN(J).EQ.1.0) GO TO 330                                   PR201950
      ITEMP(J)=KFD(12)                                                  PR201960
      GO TO 340                                                         PR201970
320   ITEMP(J)=KFD(11)                                                  PR201980
      GO TO 340                                                         PR201990
330   ITEMP(J)=KFD(15)                                                  PR202000
340   CONTINUE                                                          PR202010
      CALL CHKLN (1)                                                    PR202020
      WRITE (IW,1290) (ITEMP(J),J=1,NUNKN)                              PR202030
C***********************************************************************PR202040
C**   WRITE OBSERVATIONS AS READ                                      **PR202050
C***********************************************************************PR202060
      CALL CHKLN (3)                                                    PR202070
      WRITE (IW,1300)                                                   PR202080
      J=1                                                               PR202090
      CALL CHKLN (2)                                                    PR202100
      GO TO (350,390,400,450,470,  480), ITPOS                          PR202110
350   WRITE (IW,1310)                                                   PR202120
      DO 380 I=1,NOBS                                                   PR202130
      CALL CHKLN (1)                                                    PR202140
      IF (DS1(I).EQ.0.0) GO TO 360                                      PR202150
      WRITE (IW,1370) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2)               PR202160
      GO TO 370                                                         PR202170
360   WRITE (IW,1370) I,OBSERV(J),OBSERV(J+1)                           PR202180
370   J=J+3                                                             PR202190
380   CONTINUE                                                          PR202200
      GO TO 510                                                         PR202210
C***********************************************************************PR202220
390   WRITE (IW,1320)                                                   PR202230
      GO TO 410                                                         PR202240
400   WRITE (IW,1330)                                                   PR202250
410   DO 440 I=1,NOBS                                                   PR202260
      CALL CHKLN (2)                                                    PR202270
      IF (DS1(I).EQ.0.0) GO TO 420                                      PR202280
      WRITE (IW,1380) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2),OBSERV(J+3),OBPR202290
     2SERV(J+4),OBSERV(J+5),OBSERV(J+6),OBSERV(J+7),OBSERV(J+8)         PR202300
      GO TO 430                                                         PR202310
420   WRITE (IW,1380) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2),OBSERV(J+3),OBPR202320
```

```
     2SERV(J+4),CBSERV(J+5)
430   J=J+9
440   CCNTINUE
      GO TO 510
C*************************************************************************
450   WRITE (IW,1340)
      DO 460 I=1,NOBS
      CALL CHKLN (1)
      WRITE (IW,1390) I,CBSERV(J),OBSERV(J+1),OBSERV(J+2),OBSERV(J+3)
      J=J+4
460   CCNTINUE
      GO TC 510
C*************************************************************************
470   WRITE (IW,1350)
      GO TC 490
480   WRITE (IW,1360)
490   JB=12
      DO 500 I=1,NOBS
      CALL CHKLN (2)
      WRITE (IW,1400) I,(OBSERV(JA),JA=J,JB)
      JB=JB+12
      J=J+12
500   CCNTINUE
510   IF (IFLAG) 530,540,520
C*************************************************************************
C**   RETURN IF MATRIX IS SINGULAR                                      **
C**       OR INVERSE IS IN ERRCR                                        **
C*************************************************************************
520   CALL CHKLN (3)
      WRITE (IW,1410)
      RETURN
530   CALL CHKLN (3)
      WRITE (IW,1420)
      M=NUNKN+2
      MA=M*M+1
      MB=MA+M*M-1
      ABC=FLCAT(MB-MA+1)/5.0+3.0
      IABC=(MB-MA+1)/5+3
      IF (ABC.GT.FLOAT(IABC)) IABC=IABC+1
      CALL CHKLN (IABC)
      WRITE (IW,1430) (Y(I),I=MA,MB)
      MA=1
      MB=M*M
      ABC=FLCAT(MB-MA+1)/5.0+3.0
      IABC=(MB-MA+1)/5+3
      IF (ABC.GT.FLOAT(IABC)) IABC=IABC+1
      CALL CHKLN (IABC)
      WRITE (IW,1440) (Y(I),I=MA,MB)
      MB=M*M
      ABC=FLCAT(MB)/5.0+3.0
      IABC=MB/5+3
      IF (ABC.GT.FLOAT(IABC)) IABC=IABC+1
      CALL CHKLN (IABC)
      WRITE (IW,1450) (B(I),I=1,MB)
      RETURN
C*************************************************************************
C**   WRITE THIRD PAGE CF SERIES                                        **
C*************************************************************************
```

```
540   CALL HEADPG                                                       PR202910
      CALL CHKLN (3)                                                    PR202920
      WRITE (IW,1150) ICALDS                                            PR202930
      CALL CHKLN (5)                                                    PR202940
      WRITE (IW,1460) SWT,VSWT,CEXSWT,STAR                              PR202950
      CALL CHKLN (5)                                                    PR202960
      GO TO (550,550,580,610,610,  630), ITPOS                          PR202970
550   WRITE (IW,1470)                                                   PR202980
      DO 570 I=1,NOBS                                                   PR202990
      CALL CHKLN (1)                                                    PR203000
      IF (DS1(I).EQ.0.0) GO TO 560                                      PR203010
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),DS1(I)        PR203020
      GO TO 570                                                         PR203030
560   WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I)               PR203040
570   CONTINUE                                                          PR203050
      GO TO 650                                                         PR203060
C***********************************************************************PR203070
580   WRITE (IW,1480)                                                   PR203080
      CALL CHKLN (1)                                                    PR203090
      DO 600 I=1,NOBS                                                   PR203100
      IF (DS1(I).EQ.0.0) GO TO 590                                      PR203110
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),ZERO(I),DS1(I)PR203120
      GO TO 600                                                         PR203130
590   WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),ZERO(I)       PR203140
600   CONTINUE                                                          PR203150
      GO TO 650                                                         PR203160
C***********************************************************************PR203170
610   WRITE (IW,1490)                                                   PR203180
      DO 620 I=1,NOBS                                                   PR203190
      CALL CHKLN (1)                                                    PR203200
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),DRIFT(I),DS1(IPR203210
     2)                                                                 PR203220
620   CONTINUE                                                          PR203230
      GO TO 650                                                         PR203240
C***********************************************************************PR203250
630   WRITE (IW,1500)                                                   PR203260
      DO 640 I=1,NOBS                                                   PR203270
      CALL CHKLN (1)                                                    PR203280
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),DRIFT(I),ZERO(PR203290
     2I),DS1(I)                                                         PR203300
640   CONTINUE                                                          PR203310
650   IF (JSTAR.EQ.0) GO TO 660                                         PR203320
      CALL CHKLN (3)                                                    PR203330
      WRITE (IW,1510)                                                   PR203340
660   CALL CHKLN (6)                                                    PR203350
      IF (N3.EQ.0) GO TO 680                                            PR203360
C***********************************************************************PR203370
C**   ENGLISH UNITS                                                   **PR203380
C***********************************************************************PR203390
      WRITE (IW,1530)                                                   PR203400
      DO 670 I=1,NUNKN                                                  PR203410
      CALL CHKLN (1)                                                    PR203420
      FOBSCR=OBSCOR(I)                                                  PR203430
      WRITE (IW,1560) PRTLEX(I),FOBSCR,COMVOP(I),SERROR(I),TRISIG(I),TOTPR203440
     2UN(I)                                                             PR203450
670   CONTINUE                                                          PR203460
      GO TO 700                                                         PR203470
C***********************************************************************PR203480
```

```
C**    METRIC UNITS                                                    **
C***********************************************************************
680    WRITE (IW,1520)
       DO 690 I=1,NUNKN
       CALL CHKLN (1)
       FOBSCR=OBSCOR(I)
       WRITE (IW,1550) ANCM(I),FOBSCR,COMVOP(I),SERROR(I),TRISIG(I),TOTUN
      2(I)
690    CONTINUE
700    IF (ISWTCH.EQ.0) GO TO 710
       CALL CHKLN (3)
       WRITE (IW,1570)
710    CALL CHKLN (3)
       WRITE (IW,1580) TEAR
       XXXX=0.1*STDEBA
       XXXXX=ABS(ACORR-CORRES)
       IF (XXXXX.LE.XXXX) GO TO 720
       CALL CHKLN (7)
       WRITE (IW,1590) ACORR,CORRES
720    IF (IROUT.EQ.0.0) GO TO 730
       CALL CHKLN (6)
       WRITE (IW,1600) (IRSTOU(I),I=1,NUNKN)
       WRITE (IW,1610) TMSUM,VOLSUM,SERSUM,T3SIG
C***********************************************************************
C**    WRITE LAST PAGE OF SERIES  IF LINVAR NOT EQUAL TO ZERO          **
C***********************************************************************
730    IF (LINVAR.EQ.0) GO TO 930
       CALL HEADPG
       CALL CHKLN (3)
       WRITE (IW,1150) ICALOS
       CALL CHKLN (3)
       WRITE (IW,1620)
       CALL CHKLN (1)
       IF (N3.EQ.0) GO TO 770
C***********************************************************************
C**    ENGLISH UNITS                                                   **
C***********************************************************************
       GO TO (740,750,760), JFLAG
740    WRITE (IW,1080)
       GO TO 800
750    WRITE (IW,1090)
       GO TO 800
760    WRITE (IW,1100)
       GO TO 800
C***********************************************************************
C**    METRIC UNITS                                                    **
C***********************************************************************
770    GO TO (780,790), JFLAG
780    WRITE (IW,1630)
       GO TO 800
790    WRITE (IW,1640)
800    CALL CHKLN (1)
       WRITE (IW,1650) (KTEMP(I),I=1,NUNKN)
       DO 840 I=1,LINVAR
       JTEMP(I)=0
       DO 830 J=1,NUNKN
       JTEMP(I)=JTEMP(I)+KTEMP(J)*INT(ALCOM(J,I))
       IF (ALCOM(J,I).EQ.0.0) GO TO 810
```

```
      IF (ALCOM(J,I).EQ.1.0) GO TO 820                                  PR204070
      ITEMP(J)=KFD(12)                                                  PR204080
      GO TO 830                                                         PR204090
810   ITEMP(J)=KFD(11)                                                  PR204100
      GO TO 830                                                         PR204110
820   ITEMP(J)=KFD(15)                                                  PR204120
830   CONTINUE                                                          PR204130
      CALL CHKLN (1)                                                    PR204140
      WRITE (IW,1660) JTEMP(I),(ITEMP(K),K=1,NUNKN)                     PR204150
840   CONTINUE                                                          PR204160
      CALL CHKLN (8)                                                    PR204170
      WRITE (IW,1670)                                                   PR204180
      WRITE (IW,1680)                                                   PR204190
      CALL CHKLN (2)                                                    PR204200
      IF (N3.EQ.0) GO TO 880                                            PR204210
      GO TO (850,860,870), JFLAG                                        PR204220
850   WRITE (IW,1110)                                                   PR204230
      GO TO 910                                                         PR204240
860   WRITE (IW,1120)                                                   PR204250
      GO TO 910                                                         PR204260
870   WRITE (IW,1130)                                                   PR204270
      GO TO 910                                                         PR204280
880   GO TO (890,900), JFLAG                                            PR204290
890   WRITE (IW,1690)                                                   PR204300
      GO TO 910                                                         PR204310
900   WRITE (IW,1700)                                                   PR204320
910   DO 920 I=1,LINVAR                                                 PR204330
      CALL CHKLN (1)                                                    PR204340
      WRITE (IW,1710) JTEMP(I),CORR5A(I),SER5A(I),SIG35A(I),UNC5A(I)    PR204350
920   CONTINUE                                                          PR204360
C*********************************************************************PR204370
C**   WRITE LAST PAGE OF SERIES                                      **PR204380
C*********************************************************************PR204390
930   CALL HEADPG                                                       PR204400
      CALL CHKLN (2)                                                    PR204410
      WRITE (IW,1720) ALCADP,IBREST                                     PR204420
      CALL CHKLN (3)                                                    PR204430
      WRITE (IW,1150) ICALDS                                            PR204440
      CALL CHKLN (9)                                                    PR204450
      WRITE (IW,1730) OBSTD,STDEBA,NDGFR,FRATIO                         PR204460
C*********************************************************************PR204470
C**   COMPUTE F - VALUE                                              **PR204480
C*********************************************************************PR204490
      PRETST=6.64                                                       PR204500
      CALL CHKLN (4)                                                    PR204510
      IF (NDGFR.EQ.1) GO TO 940                                         PR204520
      ANDGFR=NDGFR                                                      PR204530
      PRETST=(1.0-2.0/(9.*ANDGFR)+2.32635*SQRT(2.0/(9.0*ANDGFR)))**3    PR204540
940   IF (FRATIO.GT.PRETST) GO TO 950                                   PR204550
      WRITE (IW,1740) PRETST                                            PR204560
      GO TO 960                                                         PR204570
950   WRITE (IW,1750)                                                   PR204580
      WRITE (IW,1760) PRETST                                            PR204590
      WRITE (IW,1750)                                                   PR204600
      ITST=0                                                            PR204610
960   DO 970 I=1,NUNKN                                                  PR204620
970   ITEMP(I)=ACKSTD(I)                                                PR204630
      CALL CHKLN (3)                                                    PR204640
```

```
      WRITE (IW,1810)
      CALL CHKLN (1)
      WRITE (IW,1180) (ITEMP(I),I=1,NUNKN)
      CALL CHKLN (1)
      WRITE (IW,1190) ICKUSD
      CALL CHKLN (1)
      WRITE (IW,1200) V2TAU
      CALL CHKLN (6)
      WRITE (IW,1770) OBCOCK,OESCK,TVAL
      CALL CHKLN (1)
      IF (OBSCK.NE.0.0) GO TO 980
      WRITE (IW,1820)
980   IF (ABS(TVAL).GE.3.) GO TO 990
      CALL CHKLN (3)
      WRITE (IW,1780)
      GO TO 1030
990   WRITE (IW,1750)
      ITST=0
      YXYX=0.0
      DO 1000 I=1,NUNKN
1000  YXYX=YXYX+(ACKSTD(I)*SERRCR(I))
      XYYX=ABS(TVAL)-(YXYX/OBSCK)
      CALL CHKLN (3)
      IF (XYYX.GE.3.) GO TO 1010
      WRITE (IW,1790)
      GO TO 1020
1010  WRITE (IW,1800)
      ITST=0
1020  CONTINUE
      CALL CHKLN (16)
      WRITE (IW,1750)
1030  WRITE (IW,1210) T1P,T2P,TEAR,P1P,P2P,PBAR,H1P,H2P,HEAR,RHCAB,RHOA
     2,RHCA,CT1,CT2,CP1,CP2,CH1,CH2,CT1P,CT2P,OP1P,OP2P,OH1P,CH2P
      DIFT=T2P-T1P
      DIFP=P2P-P1P
      DIFH=H2P-H1P
C***********************************************************************
C**   PUNCH CONTROL DATA RECORDS                                     **
C***********************************************************************
      NTOP=NTOP*ITST
      IF (ITST.EQ.0) RETURN
      WRITE (ITMP) (IDATE(K),K=1,3),IBREST,ICKUSD,OBCOCK,IBAL,OESTD,NDGF
     2R,ICALDS,TBAR,DIFT,PBAR,DIFP,HEAR,DIFH,RHOA,IOP
      NTOP=NTOP+1
      RETURN
C***********************************************************************
C**   FORMAT STATEMENTS                                              **
C***********************************************************************
1040  FORMAT (1X,13HREPORT VECTOR,1X,15I5)
1050  FORMAT (6X,3H LB/6X,15I6)
1060  FORMAT (6X,9H MILLI-LB/6X,15I6)
1070  FORMAT (6X,9H MICRO-LB/6X,15I6)
1080  FORMAT (2X,4H(LB),6X,2HLB)
1090  FORMAT (1X,8HMILLI-LB,6X,8HMILLI-LB)
1100  FORMAT (1X,8HMICRO-LB,6X,8HMICRO-LB)
1110  FORMAT (2X,4H(LB),6X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)/)
1120  FORMAT (1X,10H(MILLI-LB),3X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)
     2/)
```

```
1130  FORMAT (1X,10H(MICRO-LB),3X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)PR205230
     2/)                                                                PR205240
1140  FORMAT (50H ACCEPTED WITHIN STANDARD DEVIATION CF THE PROCESS,2X, PR205250
     2 F13.5,3H MG/51H ACCEPTED BETWEEN STANDARD DEVIATION OF THE PRCCESPR205260
     3S,1X,F13.5,3H MG)                                                 PR205270
1150  FORMAT (//20H CALIBRATION DESIGN ,I4)                             PR205280
1160  FORMAT (17H RESTRAINT VECTOR,1X,15I5)                             PR205290
1170  FORMAT (31H MASS CCRRECTICN OF RESTRAINT   ,31X,F13.5,3H MG/      PR205300
     2 46H VOLUME OF WEIGHTS BEING USED IN RESTRAINT AT F6.2,3H C ,7X,  PR205310
     3 F13.5,4H CM3/36H SYSTEMATIC ERROR IN THE RESTRAINT   ,26X,F13.5, PR205320
     4 3H MG/65H 3 STANDARD DEVIATICN LIMIT FOR RANDCM ERROR AFFECTING RPR205330
     5ESTRAINT ,F10.5,3H MG//)                                          PR205340
1180  FORMAT (22H CHECK STANDARD VECTOR,1X,15I5)                        PR205350
1190  FORMAT (22H CHECK STANDARC USED  ,I4)                             PR205360
1200  FORMAT (44H ACCEPTED MASS CORRECTICN OF CHECK STANDARD ,F13.5,    PR205370
     2 3H MG)                                                           PR205380
1210  FORMAT (//16H TEST CONDITICNS,29X,6HBEFORE,7X,5HAFTER,7X,7HAVERAGEPR205390
     2/36H CORRECTED TEMPERATURE IN DEGREES C ,3F13.2/                  PR205400
     3 28H CORRECTED PRESSURE IN MM HG,9X,3F13.3/                       PR205410
     4 30H CORRECTED HUMIDITY IN PERCENT,6X,3F13.2/                     PR205420
     5 31H COMPUTED AIR DENSITY IN MG/CM3,7X,3F13.4/                    PR205430
     6 23H TEMPERATURE CCRRECTICN,14X,2F13.3/20H PRESSURE CORRECTION,17XPR205440
     7,2F13.3/20H HUMIDITY CORRECTICN,16X,2F13.2/                       PR205450
     8 34H OBSERVED TEMPERATURE IN DEGREES C,2X,2F13.2/                 PR205460
     9 28H OBSERVED PRESSURE IN MM HG ,9X,2F13.3/                       PR205470
     * 30H OBSERVED HUMIDITY IN PERCENT ,6X,2F13.2//)                   PR205480
1220  FORMAT (4X,13HWEIGHTS BEING,5X,7HNOMINAL,6X,7HDENSITY,5X,         PR205490
     2 11HCOEFFICIENT,3X,8HACCEPTED/8X,6HTESTED,7X,8HVALUE LB,3X,       PR205500
     3 12HG/CM3 AT 20C,2X,12HCF EXPANSION,2X,13HCCRRECTION MG/)         PR205510
1230  FORMAT (1X,5A3,1X,F12.7,3X,F7.4,6X,F7.6,3X,F13.5)                 PR205520
1240  FORMAT (1X,5A3,1X,F12.4,3X,F7.4,6X,F7.6,3X,F13.5)                 PR205530
1250  FORMAT (4X,13HWEIGHTS BEING,5X,7HNOMINAL,6X,7HDENSITY,5X,         PR205540
     2 11HCOEFFICIENT,3X,8HACCEPTED/8X,6HTESTED,7X,8HVALUE G ,3X,       PR205550
     3 12HG/CM3 AT 20C,2X,12HOF EXPANSION,2X,13HCCRRECTION MG/)         PR205560
1260  FORMAT (6X,6H GRAMS/6X,15I6)                                      PR205570
1270  FORMAT (6X,3H MG/6X,15I6)                                         PR205580
1280  FORMAT (3H A ,I2,1X,15(5X,A1))                                    PR205590
1290  FORMAT (3H R 3X,15(5X,A1))                                        PR205600
1300  FORMAT (//26H OBSERVATICNS IN DIVISIONS)                          PR205610
1310  FORMAT (39H SINGLE SUBSTITUTICN SINGLE PAN BALANCE/)              PR205620
1320  FORMAT (36H SINGLE SUBSTITUTICN TWO PAN BALANCE/)                 PR205630
1330  FORMAT (37H SINGLE TRANSPCSITICN TWC PAN BALANCE/)                PR205640
1340  FORMAT (36H DOUBLE SUBSTITUTION ONE PAN BALANCE/)                 PR205650
1350  FORMAT (36H DOUBLE SUBSTITUTION TWO PAN BALANCE/)                 PR205660
[illegible] FORMAT (37H DOUBLE TRANSPCSITICN TWO PAN BALANCE/)          PR205670
[illegible] FORMAT (3H A ,I2,1X,3F11.4)                                 PR205680
[illegible] FORMAT (3H A ,I2,1X,6F11.4/6X,3F11.4)                       PR205690
[illegible] FORMAT (3H A ,I2,1X,4F11.4)                                 PR205700
[illegible] FORMAT (3H A ,I2,1X,6F11.4/6X,6F11.4)                       PR205710
[illegible] FORMAT (//19H MATRIX IS SINGULAR)                           PR205720
[illegible] FORMAT (//17H1ERRCR IN INVERSE)                             PR205730
[illegible] FORMAT (//4H A =/(5E16.8))                                  PR205740
[illegible] FORMAT (//12H A(INVERSE)=/(5E16.8))                         PR205750
[illegible] FORMAT (//15H I-AA(INVERSE)=/(5E16.8))                      PR205760
[illegible] FORMAT (/19H SENSITIVITY WEIGHT/5H MASS,2X,F13.5,3H MG/7H VOLUME, PR205770
     [illegible]2X,F13.5,12H CM3 AT 20 C/25H COEFFICIENT OF EXPANSION,2X,F8.6/5X,PR205780
     [illegible]1HS*=S-PV(S)=,1X,F13.5,3H MG)                           PR205790
[illegible] FORMAT (/36X,7HAVERAGE,6X,8HOBSERVED/13X,4HA(I),6X,8HDELTA(I),3X, PR205800
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     2 11HSENSITIVITY,2X,11HSENSITIVITY/13X,4H(MG),8X,4H(MG),6X,        PR2058
     3 8H(MG/DIV),6X,8H(MG/DIV/)                                        PR2058
1480  FORMAT (/35X,7HAVERAGE,16X,8HOBSERVED/13X,4HA(I),6X,8HDELTA(I),3X,PR2058
     2 11HSENSITIVITY,4X,7HZERO(I),2X,11HSENSITIVITY/13X,4H(MG),9X,     PR2058
     3 4H(MG),5X,8H(MG/DIV),6X,5H(DIV),6X,8H(MG/DIV)/)                 PR2058
1490  FORMAT (/37X,7HAVERAGE,16X,8HOBSERVED/13X,4HA(I),5X,8HDELTA(I),5X,PR2058
     2 11HSENSITIVITY,2X,8HDRIFT(I),2X,11HSENSITIVITY/13X,4H(MG),7X,    PR2058
     3 4H(MG),8X,8H(MG/DIV),6X,4H(MG),6X,8H(MG/DIV)/)                   PR2058
1500  FORMAT (/37X,7HAVERAGE,27X,8HOBSERVED/13X,4HA(I),6X,8HDELTA(I),4X,PR2058
     2 11HSENSITIVITY,2X,8HDRIFT(I),3X,7HZERO(I),3X,11HSENSITIVITY/13X, PR2059
     3 4H(MG),8X,4H(MG),7X,8H(MG/DIV),5X,4H(MG),6X,5H(DIV),6X,8H(MG/DIV)PR2059
     4/)                                                                PR2059
1510  FORMAT (/6X,64H* OBSERVED DEFLECTION IS GREATER THAN OR EQUAL TO OPR2059
     2NE FOURTH THE/8X,22HSENSITIVITY DEFLECTION)                       PR2059
1520  FORMAT (//31X,6HVOLUME,5X,10HSYSTEMATIC,3X,6H3 S.D.,3X,           PR2059
     2 11HUNCERTAINTY/5X,4HITEM,8X,10HCORRECTION,4X,6H(AT T),8X,,5HERRORPR2059
     3,6X,5HLIMIT,6X,5HLIMIT/6X,3H(G),12X,4H(MG),7X,5H(CM3),9X,4H(MG),7XPR2059
     4,4H(MG),7X,4H(MG)/)                                               PR2059
1530  FORMAT (//31X,6HVOLUME,5X,10HSYSTEMATIC,3X,6H3 S.D.,3X,           PR2059
     2 11HUNCERTAINTY/5X,4HITEM,8X,10HCORRECTION,4X,6H(AT T),8X,5HERROR,PR2060
     3 6X,5HLIMIT,6X,5HLIMIT/5X,4H(LB),12X,4H(MG),7X,5H(CM3),9X,4H(MG), PR2060
     4 7X,4H(MG),7X,4H(MG)/)                                            PR2060
1540  FORMAT (3H A ,I2,1X,A1,6F12.5)                                    PR2060
1550  FORMAT (1X,F12.4,2F13.5,3F11.5)                                   PR2060
1560  FORMAT (1X,F12.7,2F13.5,3F11.5)                                   PR2060
1570  FORMAT (/25H STOPPED AT 10 ITERATIONS/)                           PR2060
1580  FORMAT (/15H TEMPERATURE T=,F6.2,3H  C/)                          PR2060
1590  FORMAT (1X,72H****************************************************PR2060
     2********************/1X,                                          PR2060
     3 72HINPUT ERROR IN RESTRAINT. CHECK RESTRAINT VECTOR, NOMINAL VALUPR2061
     4E, DENSITY/1X,                                                    PR2061
     5 72HAND COEFFICIENT OF EXPANSION IN THIS AND PREVIOUS SERIES.     PR2061
     6              /2X,30H INPUT CORRECTION OF RESTRAINT,4X,F11.4,3H MG/2X,PR2061
     7 33H COMPUTED CORRECTION OF RESTRAINT,1X,F11.4,3H MG/1X,          PR2061
     8 72H******************************************************************PR2061
     9**********/)                                                      PR2061
1600  FORMAT (31H RESTRAINT FOR FOLLOWING SERIES/17H RESTRAINT VECTOR,1XPR2061
     2,15I5)                                                            PR2061
1610  FORMAT (16H MASS CORRECTION,17X,F13.5,3H MG/15H VOLUME AT 20 C,18XPR2061
     2,F13.5,4H CM3/17H SYSTEMATIC ERROR,16X,F13.5,3H MG/               PR2062
     3 27H 3 STANDARD DEVIATION LIMIT,6X,F13.5,3H MG)                   PR2062
1620  FORMAT (//3X,3HSUM,6X,40HWEIGHTS USED FOR THE LINEAR COMBINATIONS)PR2062
1630  FORMAT (3X,3H(G),6X,5HGRAMS)                                      PR2062
1640  FORMAT (2X,4H(MG),6X,2HMG)                                        PR2062
1650  FORMAT (6X,15I5)                                                  PR2062
1660  FORMAT (1X,I5,15(4X,A1))                                          PR2062
1670  FORMAT (//10X,                                                    PR2062
     2 52HVALUES AND UNCERTAINTIES FOR COMBINATIONS OF WEIGHTS/1X,      PR2062
     3 61H(UNCERTAINTY IS 3 STANDARD DEVIATION LIMIT PLUS ALLOWANCE FOR/PR20[illegible]
     4 19H SYSTEMATIC ERROR.))                                          PR20[illegible]
1680  FORMAT (/39X,6H3 S.D.,5X,11HUNCERTAINTY/3X,3HSUM,8X,4HCORR,4X,    PR20[illegible]
     2 10HSYSTEMATIC,7X,5HERROR,8X,5HLIMIT)                             PR20[illegible]
1690  FORMAT (3X,3H(G),8X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)/)      PR20[illegible]
1700  FORMAT (2X,4H(MG),8X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)/)     PR20[illegible]
1710  FORMAT (1X,I5,4F13.5)                                             PR20[illegible]
1720  FORMAT (13H MAXIMUM LOAD,F15.4,2H G/1X,
     2 25HSTARTING RESTRAINT NUMBER,2X,I2)
1730  FORMAT (//18H PRECISION CONTROL///
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     2 43H OBSERVED STANDARD DEVIATION OF THE PROCESS,F12.5,4H  MG/     PR206390
     3 43H ACCEPTED STANDARD DEVIATION OF THE PROCESS,F12.5,4H  MG/     PR206400
     4 19H DEGREES OF FREEDOM,I5/8H F RATIO,F12.3)                      PR206410
 1740 FORMAT (/21H F RATIO IS LESS THAN,F6.2,                          PR206420
     2 40H (CRITICAL VALUE FOR PROBABILITY = .01)./                     PR206430
     3 48H THEREFORE THE STANDARD DEVIATION IS IN CONTROL./)            PR206440
 1750 FORMAT (80H ****************************************************PR206450
     2***************************)                                      PR206460
 1760 FORMAT (24H F RATIO IS GREATER THAN,F6.2,                         PR206470
     2 40H (CRITICAL VALUE FOR PROBABILITY = .01)./                     PR206480
     3 52H THEREFORE THE STANDARD DEVIATION IS NOT IN CONTROL.)         PR206490
 1770 FORMAT (38H OBSERVED CORRECTION OF CHECK STANDARD,F19.5,3H MG/    PR206500
     2 46H STANDARD DEVIATION OF THE OBSERVED CORRECTION,F11.5,3H MG/   PR206510
     3 8H T VALUE,F8.2///)                                              PR206520
 1780 FORMAT (36H ABSOLUTE VALUE OF T IS LESS THAN 3./                  PR206530
     2 40H THEREFORE CHECK STANDARD IS IN CONTROL./)                    PR206540
 1790 FORMAT (1X,72HALTHOUGH THE ABSOLUTE VALUE OF T IS GREATER THAN OR PR206550
     2EQUAL TO 3 ,           /1X,                                       PR206560
     3 72HTHE T VALUE CORRECTED FOR SYSTEMATIC ERROR IS LESS THAN 3,    PR206570
     4            /1X,                                                  PR206580
     5 72HTHEREFORE THE CHECK STANDARD IS IN CONTROL .                  PR206590
     6             )                                                    PR206600
 1800 FORMAT (1X,72HALTHOUGH THE ABSOLUTE VALUE OF T IS GREATER THAN OR PR206610
     2EQUAL TO 3 ,           /1X,                                       PR206620
     3 72HTHE DIFFERENCE IS STILL SIGNIFICANT AFTER ALLOWANCE FOR SYSTEMPR206630
     4ATIC       /1X,                                                   PR206640
     5 72HERROR , THEREFORE THE CHECK STANDARD IS NOT IN CONTROL .      PR206650
     6             )                                                    PR206660
 1810 FORMAT (//)                                                       PR206670
 1820 FORMAT (52H T VALUE EQUALS ZERO--CHECK STANDARD VECTOR IS ZERO.)  PR206680
      END                                                               PR206690
--- PGCONT SUBPROGRAM ---
      SUBROUTINE PGCONT                                                 PGC00090
C***********************************************************************PGC00020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **PGC00030
C**   PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYBOLD    **PGC00040
C**   AND MRS.R.N.VARNER                                              **PGC00050
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **PGC00060
C***********************************************************************PGC00070
C**   SUBROUTINE TO WRITE CONTINUATION PAGE                           **PGC00080
C***********************************************************************PGC00090
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                           **PGC00100
C***********************************************************************PGC00110
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),       PGC00120
     2 IDATE(3)                                                         PGC00130
C***********************************************************************PGC00140
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                          **PGC00150
C***********************************************************************PGC00160
      DIMENSION AIDCST(5,15),ANOM(15),DENSTY(15),COEFEX(15),ACCVAL(15), PGC00170
     2 ARSTIN(15),ACKSTD(15),IRSTCU(15),IPRNT(15),DESMAT(15,50),        PGC00180
     3 OBSERV(600),ALCOM(15,20)                                         PGC00190
C***********************************************************************PGC00200
C**   LABELED COMMON                                                  **PGC00210
C***********************************************************************PGC00220
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,PGC00230
     2 L5,L6,IDATE,IBREST                                               PGC00240
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                   PGC00250
      COMMON /INPUT/ TEAR,PBAR,HEAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM, PGC00260
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     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,CBSERV,VARBAL,ALCOM,T1PPGC00270
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P, PGC00280
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTOU,IPRNT,ITPOS,ICKUSD,ICALDS,  PGC00290
     5 LINVAR,N3,N4                                                     PGC00300
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 PGC00310
      WRITE (IW,30) IPAGE                                               PGC00320
C***********************************************************************PGC00330
C**   NOSER IS SET EQUAL TO 200 IN FINPRT                             **PGC00340
C***********************************************************************PGC00350
      IF (NOSER.LT.200) GO TO 10                                        PGC00360
      IPAGE=IPAGE+1                                                     PGC00370
      WRITE (IW,50) (B1(K),K=1,65),IPAGE,(B2(K),K=1,65),(IDATE(K),K=1,3)PGC00380
     2,(B3(K),K=1,65)                                                   PGC00390
      GO TO 20                                                          PGC00400
10    IPAGE=IPAGE+1                                                     PGC00410
      WRITE (IW,40) (B1(K),K=1,65),IPAGE,(B2(K),K=1,65),NOSER,(B3(K),K=1PGC00420
     2,65),(IDATE(K),K=1,3)                                             PGC00430
20    IPGCT=6                                                           PGC00440
      RETURN                                                            PGC00450
C***********************************************************************PGC00460
C**   FORMAT STATEMENTS                                               **PGC00470
C***********************************************************************PGC00480
30    FORMAT (1H1,30X,19HCONTINUED FROM PAGEI3)                         PGC00490
40    FORMAT (1H ,65A1,4HPAGE,I3/1X,65A1,6HSERIES,I2/1X,65A1,I2,1H/,I2, PGC00500
     2 1H/,I2//)                                                        PGC00510
50    FORMAT (1X,65A1,4HPAGE,I3/1X,65A1,I2,1H/,I2,1H/,I2/1X,65A1//)     PGC00520
      END                                                               PGC00530
--- HEADPG SUBPROGRAM ---
      SUBROUTINE HEADPG                                                 HDP00010
C***********************************************************************HDP00020
C**   SUBROUTINE TO PRINT PAGE HEADINGS                               **HDP00030
C**   ADDED BY R. N. VARNER SEPT 1979                                 **HDP00040
C***********************************************************************HDP00050
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                           **HDP00060
C***********************************************************************HDP00070
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),       HDP00080
     2 IDATE(3)                                                         HDP00090
C***********************************************************************HDP00100
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                          **HDP00110
C***********************************************************************HDP00120
      DIMENSION AIDCST(5,15),ANCM(15),DENSTY(15),COEFEX(15),ACCVAL(15), HDP00130
     2 ARSTIN(15),ACKSTD(15),IRSTOU(15),IPRNT(15),DESMAT(15,50),        HDP00140
     3 OBSERV(600),ALCOM(15,20)                                         HDP00150
C***********************************************************************HDP00160
C**   LABELED COMMON                                                  **HDP00170
C***********************************************************************HDP00180
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,HDP00190
     2 L5,L6,IDATE,IEREST                                               HDP00200
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                   HDP00210
      COMMON /INPUT/ TBAR,PBAR,HBAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANCM, HDP00220
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1PHDP00230
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P, HDP00240
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTOU,IPRNT,ITPOS,ICKUSD,ICALDS,  HDP00250
     5 LINVAR,N3,N4                                                     HDP00260
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 HDP00270
      IPAGE=IPAGE+1                                                     HDP00280
      WRITE (IW,10) (B1(K),K=1,65),IPAGE,(B2(K),K=1,65),NOSER,(B3(K),K=1HDP00290
     2,65),(IDATE(K),K=1,3),(B7(K),K=1,18),IBAL,IOP                     HDP00300
```

```
      IPGCT=8                                                           HDP00310
      RETURN                                                            HDP00320
10    FORMAT (1H1,65A1,4HPAGE,I3/1X,65A1,6HSERIES,I2/1X,65A1,I2,1H/I2,  HDP00330
     2 1H/I2/1X,11HTEST NUMBER,2X,18A1///8H BALANCE,1X,I3/9H OPERATOR,1XHDP00340
     3,I2)                                                              HDP00350
      END                                                               HDP00360
--- FINPRT SUBPROGRAM ---
      SUBROUTINE FINPRT                                                 FPR00010
C*********************************************************************FPR00020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **FPR00030
C**   PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYBOLD    **FPR00040
C**   AND MRS.R.N.VARNER                                              **FPR00050
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **FPR00060
C*********************************************************************FPR00070
C**   SUBROUTINE TO PRINT  REPORT                                     **FPR00080
C*********************************************************************FPR00090
C**   DIMENSION FOR COMMON /REPRT/ VARIABLES                          **FPR00100
C*********************************************************************FPR00110
      DIMENSION AITEM(5,50),APPMAS(50),TRMASS(50),UNCERT(50),VOLPRT(50),FPR00120
     2 COEFRT(50),CORRB(50)                                             FPR00130
C*********************************************************************FPR00140
C**   DIMENSION FOR SUBROUTINE FINPRT                                 **FPR00150
C*********************************************************************FPR00160
      DIMENSION TRMASX(15),AAAMAS(13),BBBMAS(13),NNP(50),TEMPAR(50)     FPR00170
      DIMENSION IAP(9),TAP(9)                                           FPR00180
C*********************************************************************FPR00190
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                           **FPR00200
C*********************************************************************FPR00210
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),       FPR00220
     2 IDATE(3)                                                         FPR00230
C*********************************************************************FPR00240
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                          **FPR00250
C*********************************************************************FPR00260
      DIMENSION AIDCST(5,15),ANOM(15),DENSTY(15),COEFEX(15),ACCVAL(15), FPR00270
     2 ARSTIN(15),ACKSTD(15),IRSTCU(15),IPRNT(15),DESMAT(15,50),        FPR00280
     3 OBSERV(600),ALCOM(15,20)                                         FPR00290
C*********************************************************************FPR00300
C**   LABELED COMMON                                                  **FPR00310
C*********************************************************************FPR00320
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNCM,L1,L2,L3,L4,FPR00330
     2 L5,L6,IDATE,IBREST                                               FPR00340
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                   FPR00350
      COMMON /REPRT/ TRMASS,APPMAS,CORRB,AITEM,UNCERT,VOLPRT,COEFRT,NPRTFPR00360
      COMMON /INPUT/ TEAR,PBAR,HEAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM, FPR00370
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1PFPR00380
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P, FPR00390
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTCU,IPRNT,ITPOS,ICKUSC,ICALDS,  FPR00400
     5 LINVAR,N3,N4                                                     FPR00410
      COMMON /UNITIC/ IR,IW,IP,IPL,ITMP                                 FPR00420
      COMMON /PCHCUT/ NTCP                                              FPR00430
C*********************************************************************FPR00440
C**   TYPE STATEMENTS                                                 **FPR00450
C*********************************************************************FPR00460
      DOUBLE PRECISION TRMASS,APPMAS,CORRB,TEMPAR                       FPR00470
      INTEGER TRMASX,BBBMAS,AAAMAS                                      FPR00480
      IF (NTCP.NE.NOSER) GO TO 20                                       FPR00490
      IFLAG=999                                                         FPR00500
      WRITE (ITMP) IFLAG,(IAP(I),I=2,5),TAP(1),IAP(6),TAP(2),IAP(7),IAP(FPR00510
```

```
      28),(TAP(I),I=3,9),IAP(9)                                        FPR00
       END FILE ITMP                                                   FPR00
       REWIND ITMP                                                     FPR00
10     READ (ITMP) (IAP(I),I=1,5),TAP(1),IAP(6),TAP(2),IAP(7),IAP(8),(TAPFPR00
      2(I),I=3,9),IAP(9)                                               FPR00
       IF (IAP(1).EQ.IFLAG) GO TO 20                                   FPR00
       WRITE (IP,200) (IAP(I),I=1,5),TAP(1),IAP(6),TAP(2),IAP(7),IAP(8),(FPR00
      2TAP(I),I=3,9),IAP(9)                                            FPR00
       GO TO 10                                                        FPR00
20     KKK=0                                                           FPR00
       NOSER=200                                                       FPR00
       IF (N3.EQ.0) GO TO 40                                           FPR00
C***********************************************************************FPR00
C**    MASS WAS GIVEN IN ENGLISH UNITS                               **FPR00
C**    CONVERT TO GRAMS                                              **FPR00
C***********************************************************************FPR00
       DO 30 I=1,NPRT                                                  FPR00
       TRMASS(I)=TRMASS(I)*(1.D0/453.59237D0)                          FPR00
       APPMAS(I)=APPMAS(I)*(1.D0/453.59237D0)*1000.0D0                 FPR00
       CORRB(I)=CORRB(I)*(1.D0/453.59237D0)*1000.0D0                   FPR00
       UNCERT(I)=UNCERT(I)*(1./453.59237)                              FPR00
       VOLPRT(I)=VOLPRT(I)*.06102374                                   FPR00
30     CONTINUE                                                        FPR00
C***********************************************************************FPR00
C**    MASS WAS GIVEN IN METRIC UNITS                                **FPR00
C***********************************************************************FPR00
40     IF (NPRT.EQ.1) GO TO 80                                         FPR00
       DO 50 I=1,NPRT                                                  FPR00
       TEMPAR(I)=TRMASS(I)                                             FPR00
       NNP(I)=I                                                        FPR00
50     CONTINUE                                                        FPR00
       NNN=NPRT-1                                                      FPR00
       DO 70 I=1,NNN                                                   FPR00
       IP1=I+1                                                         FPR00
       DO 70 J=IP1,NPRT                                                FPR00
       IF (TEMPAR(I)-TEMPAR(J)) 70,70,60                               FPR00
60     TEMP=TEMPAR(I)                                                  FPR00
       TEMPAR(I)=TEMPAR(J)                                             FPR00
       TEMPAR(J)=TEMP                                                  FPR00
       TEMP=NNP(I)                                                     FPR00
       NNP(I)=NNP(J)                                                   FPR00
       NNP(J)=TEMP                                                     FPR00
70     CONTINUE                                                        FPR00
80     NN=1                                                            FPR00
       IF (NPRT.NE.1) GO TO 90                                         FPR00
       NNP(1)=1                                                        FPR00
90     IPAGE=IPAGE+1                                                   FPR00
       WRITE (IW,260) (B1(K),K=1,65),IPAGE                             FPR00
       WRITE (IW,270) (B2(K),K=1,65),(IDATE(K),K=1,3)                  FPR00
       WRITE (IW,280) (B3(K),K=1,65)                                   FPR00
       WRITE (IW,290) (B7(K),K=1,18)                                   FPR00
       IPGCT=8                                                         FPR00
       IF (NN.EQ.2) GO TO 110                                          FPR00
       IF (NN.EQ.3) GO TO 160                                          FPR00
       JA=1                                                            FPR00
       JB=12                                                           FPR00
       IF (KKK.EQ.1) GO TO 100                                         FPR00
       CALL TEXTS1
```

```
      KKK=1                                                              FPR01100
100   CONTINUE                                                           FPR01110
      IPAGE=IPAGE+1                                                      FPR01120
      WRITE (IW,260) (B1(K),K=1,65),IPAGE                                FPR01130
      WRITE (IW,270) (B2(K),K=1,65),(IDATE(K),K=1,3)                     FPR01140
      WRITE (IW,280) (B3(K),K=1,65)                                      FPR01150
      WRITE (IW,290) (B7(K),K=1,18)                                      FPR01160
      CALL TEXTS2                                                        FPR01170
      NN=2                                                               FPR01180
      GO TO 90                                                           FPR01190
110   CALL CHKLN (4)                                                     FPR01200
      WRITE (IW,210)                                                     FPR01210
      NN=3                                                               FPR01220
      CALL CHKLN (4)                                                     FPR01230
      IF (N3.EQ.0) GO TO 120                                             FPR01240
      WRITE (IW,300)                                                     FPR01250
      GO TO 130                                                          FPR01260
120   WRITE (IW,220)                                                     FPR01270
130   DO 150 J=1,NPRT                                                    FPR01280
      NNPP=NPRT+1-J                                                      FPR01290
      I=NNP(NNPP)                                                        FPR01300
      CALL CHKLN (1)                                                     FPR01310
      IF (N3.EQ.0) GO TO 140                                             FPR01320
C*********************************************************************FPR01330
C**   CONVERT DOUBLE PRECISION VALUE TO FLOATING POINT                **FPR01340
C*********************************************************************FPR01350
      CALL DPFD (TRMASS(I),TRMASX,15,11)                                 FPR01360
      WRITE (IW,310) (AITEM(IU,I),IU=1,5),TRMASX,UNCERT(I),VOLPRT(I),COEFPR01370
     2PRT(I)                                                             FPR01380
      GO TO 150                                                          FPR01390
140   CALL DPFD (TRMASS(I),TRMASX,15,8)                                  FPR01400
      WRITE (IW,230) (AITEM(IU,I),IU=1,5),TRMASX,UNCERT(I),VOLPRT(I),COEFPR01410
     2PRT(I)                                                             FPR01420
150   CONTINUE                                                           FPR01430
      GO TO 90                                                           FPR01440
160   CALL CHKLN (1)                                                     FPR01450
      IF (N3.EQ.0) GO TO 170                                             FPR01460
      WRITE (IW,320)                                                     FPR01470
      GO TO 180                                                          FPR01480
170   WRITE (IW,240)                                                     FPR01490
180   DO 190 J=1,NPRT                                                    FPR01500
      NNPP=NPRT+1-J                                                      FPR01510
      I=NNP(NNPP)                                                        FPR01520
      CALL DPFD (APPMAS(I),AAAMAS,13,5)                                  FPR01530
      CALL DPFD (CORRB(I),BBBMAS,13,5)                                   FPR01540
      CALL CHKLN (1)                                                     FPR01550
      WRITE (IW,250) (AITEM(IU,I),IU=1,5),AAAMAS,BBBMAS                  FPR01560
190   CONTINUE                                                           FPR01570
      WRITE (IW,330)                                                     FPR01580
      RETURN                                                             FPR01590
C*********************************************************************FPR01600
C**   FORMAT STATEMENTS                                               **FPR01610
C*********************************************************************FPR01620
200   FORMAT (3I2,I2,I3,F11.5,I3,F9.5,I2,I3,2F5.2,F6.2,F5.2,F7.4,F4.1,   FPR01630
     2 F6.4,I2,1HS)                                                      FPR01640
210   FORMAT (//20X,7HTABLE 1//)                                         FPR01650
220   FORMAT (/24X,4HMASS,8X,11HUNCERTAINTY,2X,9HVOL AT 20,2X,           FPR01660
     2 11HCOEF OF EXP/5X,4HITEM,16X,3H(G),13X,3H(G),6X,5H(CM3)/)         FPR01670
```

```
230    FORMAT (2X,5A3,1X,15A1,1X,F13.8,1X,F10.5,1X,F8.3)                      FPRO
240    FORMAT (/2X,4HITEM,18X,22HCOR.A (MG)   COR.B (MG)/)                     FPRO
250    FORMAT (2X,5A3,1X,13A1,1X,13A1)                                         FPRO
260    FORMAT (1H1,65A1,4HPAGE,I3)                                             FPRO
270    FORMAT (1X,65A1,I2,1H/I2,1H/I2)                                         FPRO
280    FORMAT (1X,65A1)                                                        FPRO
290    FORMAT (1X,11HTEST NUMBER,2X,18A1//)                                    FPRO
300    FORMAT (/24X,4HMASS,8X,11HUNCERTAINTY,2X,9HVOL AT 20,2X,                FPRO
      2 11HCOEF OF EXP/5X,4HITEM,15X,4H(LB),12X,4H(LB),6X,5H(IN3)/)            FPRO
310    FORMAT (2X,5A3,1X,15A1,1X,F13.11,1X,F10.6,1X,F8.6)                      FPRO
320    FORMAT (12X,4HITEM,8X,5HCOR.A,7X,5HCOR.B/23X,10H(MICRO-LB),3X,          FPRO
      2 10H(MICRO-LB))                                                         FPRO
330    FORMAT (1H1)                                                            FPRO
       END                                                                     FPRO
--- TEXTS1 SUBPROGRAM ---
       SUBROUTINE TEXTS1                                                       TS10
C*************************************************************************TS10
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TS10
C**    PROGRAM  VERSION OF SEPT.10,1971       WRITTEN BY R.C.RAYBOLD       **TS10
C**    AND MRS.R.N.VARNER                                                **TS10
C**    PRINT FIRST OF LAST TWO PAGES OF REPORT                           **TS10
C**    MODIFIED BY R. N. VARNER SEPT 1979                                **TS10
C*************************************************************************TS10
       COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                         TS10
       WRITE (IW,10)                                                           TS10
       WRITE (IW,20)                                                           TS10
       WRITE (IW,30)                                                           TS10
       WRITE (IW,40)                                                           TS10
       WRITE (IW,50)                                                           TS10
       WRITE (IW,60)                                                           TS10
       WRITE (IW,70)                                                           TS10
       WRITE (IW,80)                                                           TS10
       WRITE (IW,90)                                                           TS10
       WRITE (IW,100)                                                          TS10
       RETURN                                                                  TS10
C*************************************************************************TS10
C**   FORMAT STATEMENTS                                                  **TS10
C*************************************************************************TS10
10     FORMAT (1X,36H                SUMMARY                                   TS10
     236H        THE    ESTIMATED    MASS   VALUES/                            TS10
     31X,36H
     436H  LISTED IN TABLE II ARE BASED ON AN/
     51X,36H     FOR   CONVENIENCE,  THE RESULTS
     636H  IMPLICIT TREATMENT OF DISPLACEMENT/
     71X,36HOF THIS   WORK   ARE   SUMMARIZED  IN
     836H  VOLUMES,  E.G., 'APPARENT   MASS',/
     91X,36HTABLES    I   AND   II.   THE   VALUES
     *36H  'APPARENT    MASS   VERSUS   BRASS',)
20     FORMAT (1X,36HASSIGNED ARE WITH REFERENCE TO THE
     236H  'APPARENT    MASS   VERSUS   DENSITY/
     31X,36HSTANDARDS IDENTIFIED ON  THE  DATA
     436H  8.0'.  THE VALUES  ARE  LISTED  AS/
     51X,36HSHEETS.  THE UNCERTAINTY FIGURE IS
     636H  CORRECTIONS TO BE APPLIED  TO  THE/
     71X,36HAN   EXPRESSION   OF  THE  OVERALL
     836H  LISTED  NOMINAL  VALUE (A POSITIVE/
     91X,36HUNCERTAINTY USING  THREE  STANDARD
     *36H  CORRECTION INDICATES THAT THE MASS)
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30    FORMAT (1X,36HDEVIATIONS   AS  A  LIMIT  TC  THE  ,            TS100440
     236H  IS LARGER THAN THE STATED  NOMINAL/                        TS100450
     31X,36HEFFECT OF  RANDOM  ERRORS  OF  THE  ,                     TS100460
     436H  VALUE  BY  THE  AMCUNT  OF  THE/                           TS100470
     51X,36HMEASUREMENT  ASSOCIATED WITH  THE  ,                      TS100480
     636H  CORRECTION).  THESE  VALUES  ARE/                          TS100490
     71X,36HMEASUREMENT PROCESSES.  THE MAGNI-  ,                     TS100500
     836H  COMPUTED  FRCM THE VALUES BASED CN/                        TS100510
     91X,36HTUDE  OF  SYSTEMATIC  ERRORS  FROM  ,                     TS100520
     *36H  AN EXPLICIT TREATMENT OF DISPLACE-)                        TS100530
40    FORMAT (1X,36HSOURCES  CTHER  THAN  THE  USE  OF  ,             TS100540
     236H  MENT VOLUMES USING  THE  FOLLOWING/                        TS100550
     31X,36HACCEPTED   VALUES   FOR    CERTAIN  ,                    TS100560
     436H  DEFINING    RELATIONS    AND   ARE/                        TS100570
     51X,36HSTARTING  STANDARDS ARE CONSIDERED  ,                     TS100580
     636H  UNCERTAIN BY THE AMCUNT  SHOWN  IN/                        TS100590
     71X,36HNEGLIGIBLE.  IT  SHCULD  BE  NOTED  ,                     TS100600
     836H  TABLE I.                          /                        TS100610
     91X,36HTHAT  THE MAGNITUDE CF THE  UNCER-  ,                     TS100620
     *36H                                    )                        TS100630
50    FORMAT (1X,36HTAINTY REFLECTS THE PERFORMANCE OF  ,             TS100640
     236H      THE  ADJUSTMENT  CF WEIGHTS TO/                        TS100650
     31X,36HTHE MEASUREMENT  PROCESS  USED  TO  ,                     TS100660
     436H  MINIMIZE THE DEVIATICN FROM  NCMI-/                        TS100670
     51X,36HESTABLISH  THESE VALUES.  THE MASS  ,                     TS100680
     636H  NAL ON THE BASIS OF 'NORMAL BRASS'/                        TS100690
     71X,36HUNIT,  AS  REALIZABLE  IN  ANCTHER  ,                     TS100700
     836H  (IN  ACCORDANCE WITH COR. A BELOW)/                        TS100710
     91X,36HMEASUREMENT   PROCESS,   WILL   BE  ,                     TS100720
     *36H  IS WIDESPREAD IN THIS COUNTRY  AND)                        TS100730
60    FORMAT (1X,36HUNCERTAIN BY AN AMOUNT WHICH IS  A  ,             TS100740
     236H  IN   MANY   PARTS  CF  THE  WORLD./                        TS100750
     31X,36HCOMBINATICN  OF THE UNCERTAINTY OF  ,                     TS100760
     436H  VALUES STATED CN EITHER BASIS  ARE/                        TS100770
     51X,36HTHIS PROCESS AND  THE  PROCESS  IN  ,                     TS100780
     636H  INTERNALLY      CCNSISTENT      AND/                       TS100790
     71X,36HWHICH THESE STANDARDS ARE USED.     ,                     TS100800
     836H  DEFINITE.  THERE  IS,  HOWEVER,  A/                        TS100810
     91X,36H                                    ,                     TS100820
     *36H  SYSTEMATIC  DIFFERENCE BETWEEN THE)                        TS100830
70    FORMAT (1X,36H    THE   ESTIMATED   MASS  VALUES  ,             TS100840
     236H  VALUES ASSIGNED ON EACH BASIS, THE/                        TS100850
     31X,36HLISTED IN TABLE I ARE BASED CN  AN  ,                     TS100860
     436H  VALUE CN  THE  BASIS  CF  'DENSITY/                        TS100870
     51X,36HEXPLICIT TREATMENT CF DISPLACEMENT  ,                     TS100880
     636H  8.0'  BEING 7 MICROGRAMS/GRAM LAR-/                        TS100890
     71X,36HVOLUMES,  E.G., 'TRUE MASS', 'MASS  ,                     TS100900
     836H  GER THAN THE VALUE CN THE BASIS OF/                        TS100910
     91X,36HIN VACUO', MASS IN  THE  NEWTCNIAN  ,                     TS100920
     *36H  NCRMAL  BRASS.  THIS  SYSTEMATIC)                          TS100930
80    FORMAT (1X,36HSENSE.  THE  DISPLACEMENT  VOLUME  ,              TS100940
     236H  DIFFERENCE  IS  CLEARLY DETECTABLE/                        TS100950
     31X,36HASSOCIATED  WITH  EACH  VALUE  IS  ,                      TS100960
     436H  ON MANY DIRECT READING BALANCES.  /                        TS100970
     51X,36HLISTED  AS  WELL AS THE VOLUMETRIC  ,                     TS100980
     [illegible]                             /                        TS100990
     [illegible]HCOEFFICIENT CF  EXPANSICN.  THESE  ,                 TS101000
     [illegible]  CORRECTION A - 'APPARENT  MASS/                     TS101010
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     91X,36HVALUES  SHOULD  BE  USED, TOGETHER  ,
     *36H  VERSUS  BRASS' OR  'WEIGHT  IN AIR)
90    FORMAT (1X,36HWITH  APPROPRIATE  CORRECTION  FOR  ,
     236H  AGAINST BRASS' IS DETERMINED BY  A/
     31X,36HTHE   BUOYANT   EFFECTS   OF   THE   ,
     436H  HYPOTHETICAL   WEIGHING   OF   THE/
     51X,36HENVIRONMENT, TO ESTABLISH CONSIST-  ,
     636H  WEIGHT AT 20 CELSIUS IN AIR HAVING/
     71X,36HENT MASS VALUES FOR OBJECTS  WHICH  ,
     836H  A DENSITY OF 1.2  MG/CM3,  WITH  A/
     91X,36HDIFFER  SIGNIFICANTLY  IN  DENSITY  ,
     *36H  (NORMAL  BRASS)  STANDARD HAVING A)
100   FORMAT (1X,36HAND/OR FOR MEASUREMENTS WHICH MUST
     236H  DENSITY OF 8.4 G/CM3 AT 0  CELSIUS/
     31X,36HBE MADE IN DIFFERING ENVIRONMENTS.  ,
     436H  WHOSE  COEFFICIENT  OF  VOLUMETRIC/
     51X,36HTHE RELATION  1LB AVDP=.45359237KG  ,
     636H  EXPANSION IS 0.000054  PER  DEGREE/
     71X,36HIS USED AS REQUIRED.                ,
     836H  CELSIUS,  AND WHOSE VALUE IS BASED/
     91X,36H                                    ,
     *36H                                   )
      END
--- TEXTS2 SUBPROGRAM ---
      SUBROUTINE TEXTS2
C*************************************************************************
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **
C**   PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD     **
C**   AND MRS.R.N.VARNER                                              **
C**   PRINT LAST PAGE OF REPORT                                       **
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **
C*************************************************************************
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP
      WRITE (IW,10)
      WRITE (IW,20)
      RETURN
C*************************************************************************
C**      FORMAT STATEMENTS                                            **
C*************************************************************************
10    FORMAT (
     236H                                   /
     31X,36HON ITS  TRUE  MASS  OR  WEIGHT  IN  ,
     436H WEIGHT, IN AIR HAVING A DENSITY OF /
     51X,36HVACUO.                              ,
     636H 1.2 MG/CM3, WITH A STANDARD HAVING /
     71X,36H                                    ,
     836H A  DENSITY  OF  8.0  G/CM3  AT 20  )
20    FORMAT (1X,36H    CORRECTION  B - 'APPARENT MASS
     236H CELSIUS,  AND WHOSE VALUE IS BASED /
     31X,36HVERSUS DENSITY 8.0' IS  DETERMINED  ,
     436H ON ITS  TRUE  MASS  OR  WEIGHT  IN /
     51X,36HBY  A HYPOTHETICAL WEIGHING OF THE  ,
     636H VACUO.                            )
      END
--- DPFD SUBPROGRAM ---
      SUBROUTINE DPFD (A,B,N,D)
C*************************************************************************
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION
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C**   PROGRAM  VERSION OF SEPT.10.1971     WRITTEN BY R.C.RAYFOLD        **
C**   AND MRS.R.N.VARNER                                                 **
C**   MODIFIED BY R. N. VARNER SEPT 1979                                 **
C***********************************************************************
C**   WRITTEN BY CLAYTON ALBRIGHT OF CSD                                 **
C**   A ROUTINE TO CONVERT A DOUBLE PRECISION NUMBER TO A BLOCK OF       **
C**   CHARACTERS WHICH WHEN OUTPUT WITH SUITABLE FORMAT (EG. 30A1)       **
C**   WILL YIELD THE NUMBER IN F-TYPE FORMAT (NO EXPONENT).              **
C**    THE OUTPUT NUMBER WILL BE RIGHT ADJUSTED IN THE FIELD             **
C**                                                                      **
C**   A = THE DOUBLE PRECISION NUMBER TO BE CONVERTED                    **
C**   B = A BLOCK OF N WORDS TO CONTAIN THE RESULTS. THE CHARACTERS      **
C**   ARE STORED ONE TO A WORD IN B, LEFT ADJUSTED IN THE WORD           **
C**   N = FIELD WIDTH DESIRED                                            **
C**   D = NUMBER OF PLACES DESIRED TO RIGHT OF DECIMAL POINT.            **
C**                                                                      **
C**   IF NUMBER OVERFLOWS FIELD WIDTH, FIELD IS FILLED WITH *'S          **
C**    IF UNDERFLOW OCCURS RESULT WILL BE ZERO                           **
C**                                                                      **
C**   *RESTRICTION- AT LEAST ONE CHARACTER POSITION MUST BE ALLOWED      **
C**                 FOR SIGN REGARDLESS OF + OR -. IF USER OBJECTS       **
C**                 TO THIS RESTRICTION. HE NEED ONLY USE THE            **
C**                 RESULTING OUTPUT CHARACTERS BEGINNING AT B(2)        **
C**                 INSTEAD OF B(1).                                     **
C**                                                                      **
C***********************************************************************
C**   TYPE STATEMENTS                                                    **
C***********************************************************************
      INTEGER B,D
      DOUBLE PRECISION A,X
C***********************************************************************
C**   DIMENSION STATEMENT                                                **
C***********************************************************************
      DIMENSION B(1)
      COMMON /DPFDVL/ KFD(18)
      IF (D+1.GE.N) GO TO 60
C***********************************************************************
C**   ROUND THE NUMBER AT DESIRED DECIMAL PLACE                          **
C***********************************************************************
      X=DABS(A)+.5*10.**(-D)
      MM=N-D-2
      X=X*10.**(-MM)
      IF (X.GE.1.D0) GO TO 60
      IF (X.GE.0.1D0.AND.A.LT.0.D0) GO TO 60
      MM=MM+1
      DO 10 I=1,MM
      B(I)=KFD(11)
      K=IDINT(X*10.D0)
      X=X*10.-FLOAT(K)
      IF (K.NE.0) GO TO 20
   10 CONTINUE
      I=MM
C***********************************************************************
C**   PREFIX MINUS SIGN IF A NEGATIVE                                    **
C***********************************************************************
   20 IF (A.LT.0.D0) B(I)=KFD(12)
      IF (I.EQ.MM) GO TO 40
C***********************************************************************
```

```
C**    CONVERT INTEGER PART                                              **DPF006
C************************************************************************DPF006
      I=I+1                                                               DPF00(
      DO 30 J=I,MM                                                        DPF00(
      B(J)=KFD(K+1)                                                       DPF00(
      K=IDINT(X*10.D0)                                                    DPF00(
30    X=X*10.-FLOAT(K)                                                    DPF00(
C************************************************************************DPF00(
C**    STORE DECIMAL POINT                                               **DPF00
C************************************************************************DPF00
40    MM=MM+2                                                             DPF00
      B(MM-1)=KFD(13)                                                     DPF00
C************************************************************************DPF00
C**    CONVERT FRACTIONAL PART                                           **DPF00
C************************************************************************DPF00
      DO 50 I=1,D                                                         DPF00
      B(MM)=KFD(K+1)                                                      DPF00
      MM=MM+1                                                             DPF00
      K=IDINT(X*10.D0)                                                    DPF00
50    X=X*10.-FLOAT(K)                                                    DPF00
      RETURN                                                              DPF00
C************************************************************************DPF00
C**    STORE *'S IF OVERFLOW                                             **DPF00
C************************************************************************DPF00
60    DO 70 I=1,N                                                         DPF0(
70    B(I)=KFD(14)                                                        DPF0(
      RETURN                                                              DPF0(
      END                                                                 DPF0(
--- CHKLN SUBPROGRAM ---
      SUBROUTINE CHKLN (N)                                                CHK0(
C************************************************************************CHK0(
C**   SUBROUTINE TO CHECK BEGINNING OF A NEW PAGE                       **CHK0(
C**   ADDED BY R. N. VARNER SEPT 1979                                   **CHK0(
C************************************************************************CHK0(
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                     CHK0
      COMMON /UNITIC/ IR,IW,IP,IPL,ITMP                                   CHK0
      IF (IPGCT+N.GT.IPL) CALL PGCONT                                     CHK0
      IPGCT=IPGCT+N                                                       CHK0
      RETURN                                                              CHK0
      END                                                                 CHK0
```