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U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

National Bureau of Standards Mass Calibration Computer Software

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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.

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

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 $B_j = \frac{(W_j + .001\tau_j)}{\rho_j}(1 + \alpha_j\Delta t)$ 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)

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

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:

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

Types of weighings

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.

$$
\begin{aligned}
0_1 &= A \\
0_2 &= B \\
0_3 &= B+S \\
(\hat{A-B}) &= 0_1 - 0_2 \\
\hat{S} &= - 0_2 + 0_3 \quad \text{if } 0_3 \neq 0 \\
\hat{S} &= 0.0 \quad \text{if } 0_3 = 0
\end{aligned}
$$

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.

$$
\left.\begin{aligned} 0_1 &= A \\ 0_2 &= A \\ 0_3 &= A \end{aligned}\right\}
$$

3 readings are taken as the balance is approaching a stable condition.

$$
\left.\begin{aligned} 0_4 &= B \\ 0_5 &= B \\ 0_6 &= B \end{aligned}\right\}
$$

3 readings are taken as the balance is approaching a stable condition.

$$
\left.\begin{aligned} 0_7 &= B+S \\ 0_8 &= B+S \\ 0_9 &= B+S \end{aligned}\right\}
$$

3 readings are taken as the balance is approaching a stable condition. These 3 readings are sometimes omitted.

$$
(\hat{A-B}) = \frac{0_1 + 2x0_2 + 0_3}{4} - \frac{0_4 + 2x0_5 + 0_6}{4}
$$

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

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

Single Transposition - two pan balance

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.

O_1, O_2, O_3 — With A on one pan and B on the opposite pan, three readings are taken as the balance approaches a stable condition.

O_4, O_5, O_6 — Weights A and B are interchanged, three readings are taken as the balance approaches a stable condition.

O_7, O_8, O_9 — 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.

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

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

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

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

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 $\widehat{(A-B)}$, $\hat{S}$, $\hat{\Delta}$ (drift) are:

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

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

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

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:

0_1, 0_2, 0_3 } Three readings are taken of weight A as the balance approaches a stable condition.

$$\left.\begin{array}{l}0_4\\0_5\\0_6\end{array}\right\}$$ Three readings are taken of weight B as balance approaches a stable condition.

$$\left.\begin{array}{l}0_7\\0_8\\0_9\end{array}\right\}$$ Three readings are taken of weight B+S as balance approaches a stable condition.

$$\left.\begin{array}{l}0_{10}\\0_{11}\\0_{12}\end{array}\right\}$$ Three readings are taken of weight A+S as balance approaches a stable condition.

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

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

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

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

Double Transposition - two pan balance with drift

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

0_1, 0_2, 0_3 — With A on one pan and B on the opposite pan, three readings are taken as the balance approaches a stable condition.

0_4, 0_5, 0_6 — With A and B interchanged, three readings are taken as the balance approaches a stable condition.

0_7, 0_8, 0_9 — With the sensitivity weight added to either A or B, three readings are taken as the balance approaches a stable condition.

0_{10}, 0_{11}, 0_{12} — 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.

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

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

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

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

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

<u>Preparation of data for least squares analysis</u>

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

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

and the maximum load

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

The values $(\hat{A-B})$, $\hat{S}$ and $\hat{\Delta}$ are converted from scale divisions to mass units. The following calculations apply to all types of weighings. First the average of the observed sensitivity in scale divisions over all sets 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. $$Y = \frac{(\hat{A-B})\ S^*}{\overline{D}}$$

e. $$\Delta_{mu} = \frac{\hat{\Delta}\ S^*}{\overline{D}}$$

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 references [7,10,11]. The inverse of the above matrix [Z] is calculated. Two checks 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. $$C2_j = \hat{\beta}_j + \rho_a \left(\frac{W_j + .001\,C1_j}{\rho_j}\right)(1 + \alpha_j \Delta t) \text{ for } j = 1,\ldots,k$$

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.

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

<u>Estimates of Uncertainty</u>

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 two components:

Systematic Error

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

Random Error

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

where

σ_w is the accepted within standard deviation of the process

C_{jj} are the diagonal elements of the inverse of the matrix 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

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

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

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

---

*on the 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

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

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.

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

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 ≤ 50
k	I	NUNKN	number of unknowns ≤ 15
σ_w	I	STDEBA	accepted within standard deviation of the process in mg.
S_w	I	SWT	true mass value in mg. of sensitivity weight
S_v	I	VSWT	volume of sensitivity weight in cm^3 at 20°C
S_c	I	CEXSWT	coefficient of expension of sensitivity weight
σ_T	I	VARBAL	accepted between standard deviation of the process in mg.
W	I	ANOM	nominal value of weight in grams or pounds
ρ	I/C	DENSTY	density of weights in g/cm^3 at 20°C

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 predicted 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 series
C_ℓ	C	CORR5A	corrections for linear combination
E_ℓ	C	SER5A	systematic error for linear combination

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+1 series

3.0 Information For Users

This section contains information pertinent to the user of the software.

3.1 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 ≠ 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 ≤ 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 $0_1,0_2,0_3$; 2 or 3 values per record

b. N1=2 and N2=0 Enter $0_1,0_2,0_3,0_4,0_5,0_6,0_7,0_8,0_9$; 6 or 9 values per record

c. N1=0 and N2=0 Enter $0_1,0_2,0_3,0_4,0_5,0_6,0_7,0_8,0_9$; 6 or 9 values per record

d. N1=3 and N2=1 Enter $0_1,0_2,0_3,0_4$; 4 values per record

e. N1=3 and N2=0 Enter $0_1,0_2,0_3,0_4,0_5,0_6$; 6 values per record (2 records)

$0_7,0_8,0_9,0_{10},0_{11},0_{12}$

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 the observations. It is the responsibility of the user to be sure that the number of observations 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, continue input of data repeating from data entry #9. If the vector is zero a STOP terminates the input of data. This flag must appear in position 1 through 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 Diagnostic and Error Messages

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

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

was 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	1HS

4.0 Implementation Information

This section describes the information needed for implementing the FORTRAN computer software. Information is given concerning the flow and function of the MAIN program and all subprograms. In addition, a cross reference table of labeled COMMON; the use of the DATA, DOUBLE-PRECISION 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 SPINV Subprogram

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 SAVMTX Subprogram

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 INVCHK Subprogram

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 PRINT2 Subprogram

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 being 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

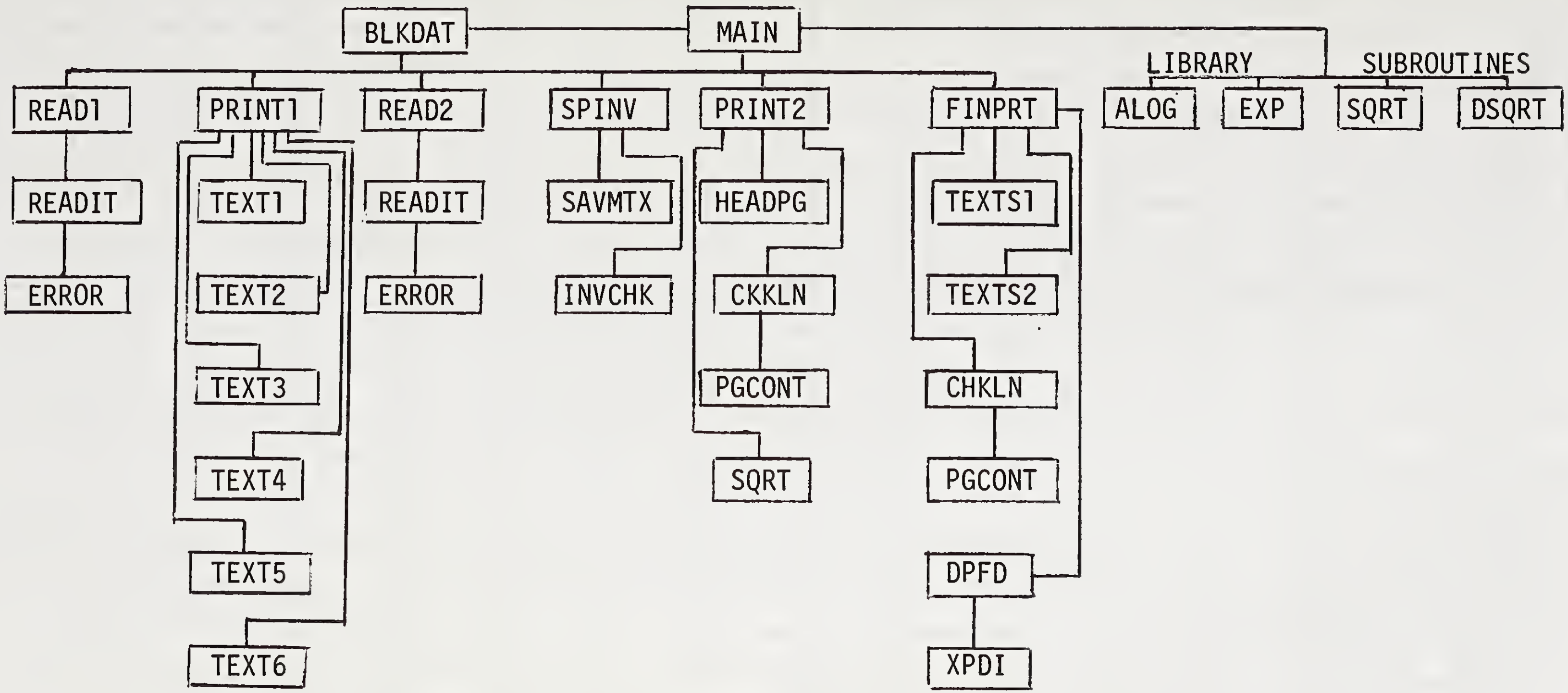

FIGURE IV - LABELED COMMON CROSS REFERENCE TABLE

	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	X	X	X

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

4.5 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
COEPRT (m)	REPRT	MAIN, FINPRT
BCHK $(2(k+2)^2)$	CHECK	MAIN, SAVMTX, INVCHK, PRINT2
Y $((k+2)^2)$	CHECK	MAIN, SAVMTX, INVCHK, PRINT2
PRTLBX (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 problem 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 10^{-38} 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.

**FS, FT, FO and FP are used by subprogram READ1 to check for the end of a set of 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			5
TOTAL (excluding text)		2850	6100	7320
TOTAL (text)		815	422	4474
GRAND TOTAL		3665	6522	11794

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
0 -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 OF 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 TECHNOLOGY
NATIONAL ENGINEERING LABORATORY

INTRODUCTION

THIS DOCUMENT IS A COMPREHENSIVE REPORT COVERING THE SEQUENCE OF OPERATIONS USED TO ASSIGN MASS VALUES TO THE WEIGHTS IDENTIFIED ABOVE. IT INCLUDES A COMPLETE DESCRIPTION OF THE MEASUREMENT METHODS AND PROCEDURES WHICH WERE USED, ALL OF THE DATA, AND THE ANALYSIS OF THIS DATA. THE RESULTS ARE PRESENTED IN SEVERAL FORMATS. ASSIGNED MASS VALUES, DISPLACEMENT VOLUMES, COEFFICIENTS OF EXPANSION, UNCERTAINTIES, TOGETHER WITH THE SUMMED VALUES FOR LINEAR COMBINATIONS OF THE WEIGHTS IN EACH DECADE ARE PRESENTED AT THE END OF THE APPROPRIATE SERIES. THIS INFORMATION SHOULD BE USEFUL TO THOSE WHO MUST ASSIGN MASS VALUES TO OBJECTS OTHER 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 REPORT TO RETAIN CONTINUITY. COPIES OF THESE PAGES BECOME PART OF A COLLECTION OF STATISTICAL DATA WHICH REFLECTS THE MEASUREMENT PROCESS PERFORMANCE OVER A PERIOD OF TIME. SUCH A COLLECTION HAS BEEN USED TO ESTABLISH THE CONTROL LIMITS FOR ACCEPTING THE RESULTS OF THIS MEASUREMENT. THESE COLLECTIONS ARE OPEN FOR INSPECTION AT OUR FACILITY.

THE MASS MEASUREMENT SYSTEM

THE MASS MEASUREMENT SYSTEM WITHIN THIS COUNTRY CONSISTS OF ALL OF THE MEASUREMENT PROCESSES WHICH RELY, DIRECTLY OR INDIRECTLY, 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 CONSISTENT RESULTS WHICH ARE COMPATIBLE WITH HIS PARTICULAR REQUIREMENTS. THE WEIGHTS COVERED BY THIS REPORT, TOGETHER WITH THE ASSIGNED VALUES AND THE APPROPRIATE UNCERTAINTIES FOR 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 TO VERIFYING THAT RESULTS ARE CONSISTENT WITH THE END REQUIREMENT WITH RESPECT TO CORRECTNESS AND ECONOMY OF THE MEASUREMENT EFFORT. WITHOUT THIS INFORMATION, THE BENEFITS OF OWNERSHIP OF THESE WEIGHTS MAY BE COMPLETELY ILLUSORY. THE ASSIGNED UNCERTAINTIES IN THIS REPORT ARE DESCRIPTIVE OF OUR MASS MEASUREMENT PROCESS. EFFECTIVENESS OF THE TRANSFER OF THE UNIT FROM ONE FACILITY TO ANOTHER SHOULD BE VERIFIED BY AN INDEPENDENT TEST. IT IS PRESUMED THAT THESE WEIGHTS WILL BE USED IN A SIMILARLY WELL-CHARACTERIZED MEASUREMENT PROCESS SO THAT THE STATISTICAL PARAMETERS OF BOTH PROCESSES CAN BE COMBINED TO PROVIDE A REALISTIC ESTIMATE OF THE UNCERTAINTY OF THE MASS UNIT AS ACTUALLY REALIZED IN ANOTHER FACILITY. A COMPREHENSIVE SERVICE DIRECTED TOWARD THE EVALUATION OF A PARTICULAR MASS MEASUREMENT PROCESS IS AVAILABLE THROUGH THE MASS MEASUREMENT ASSURANCE PROGRAM OF THE NATIONAL BUREAU OF 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 TEST 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 RANDOMNESS 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. CORRELATION STUDIES, AS WELL AS SUPPLEMENTAL EXPERIMENTS, ARE USED TO DETECT AND REDUCE THE MAGNITUDE OF SIGNIFICANT SYSTEMATIC EFFECTS. APPROPRIATE ACTION, E.G., ADDITIONAL 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 CAREFULLY 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 STANDARDS AT THE 1 KILOGRAM LEVEL, DESIGNATED N1 AND N2, ARE WITHOUT ERROR. ESTIMATES OF THE UNCERTAINTY 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 A SYSTEMATIC ERROR IN THE ASSIGNMENT OF VALUES TO OTHER STANDARDS AND IS INCLUDED IN THE REPORT.

A BALANCE UNDER STABLE OPERATING CONDITIONS WILL EXHIBIT A CERTAIN CHARACTERISTIC VARIABILITY WHICH CAN BE DESCRIBED BY THE STANDARD DEVIATION FOR SUCH MEASUREMENTS. THE VALUE FOR A PARTICULAR WEIGHT DETERMINED IN REPEATED TESTS WITH THE SAME WEIGHING DESIGN WILL HAVE ITS OWN STANDARD DEVIATION WHICH WILL BE SOME FUNCTION OF THE BALANCE PRECISION AND (POSSIBLY) OF THE BETWEEN-RUN COMPONENT. AS AN OUTER 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.

REFERENCES

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THE ACCEPTED VALUES AND ASSCCIATED UNCERTAINTY ESTIMATES CF THE NBS STANDARDS AT THE 1 KG LEVEL
NAT. BUR. STAND. (U.S.) TECH. NOTE
(EXPECTED CCMPLETICN: 1975)

10.PONTIUS, P. E.
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NAT. BUR. STAND. (U.S.) TECH. NOTE
(EXPECTED CCMPLETICN: 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

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			

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

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	

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

PAGE 12
SERIES 2
5/23/79

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	17.3400	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

X Y Z CORPORATION PAGE 13
SOMEWHERE, U.S.A. SERIES 2
SET OF MASS STANDARDS : 5KG - 100MG 5/23/79
TEST NUMBER 654321

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 DESIGN 41

PRECISION CONTROL

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

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

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

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

TEST CONDITIONS	BEFORE	AFTER	AVERAGE
CORRECTED TEMPERATURE IN DEGREES C	21.91	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	

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 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 CESIGN 62

SENSITIVITY WEIGHT
MASS 49.98277 MG
VOLUME .00301 CM3 AT 20 C
COEFFICIENT OF EXPANSICN .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)	CORRECTICN (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 FCR FCLLCWING SERIES
RESTRAINT VECTCR 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

CALIBRATION DESIGN 62

SUM (G)	WEIGHTS USED FOR THE LINEAR COMBINATIONS GRAMS					
	500	300	200	100	100	100
600	+			+		

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)
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	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	

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	

BALANCE 5
OPERATOR 84

CALIBRATION DESIGN 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	+	+	+			

OBSERVATIONS IN DIVISIONS
DOUBLE SUBSTITUTION ONE PAN BALANCE

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

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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
3 STANDARD DEVIATION LIMIT .01314 MG

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	746.300
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	

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

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 LCAD 6.C000 G
STARTING RESTRAINT NUMBER 80

CALIBRATION DESIGN 62

PRECISICN CCNTRCL

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

F RATIO IS LESS THAN 2.81 (CRITICAL VALUE FOR PROBAEILITY = .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 -.07920 MG
OBSERVED CORRECTION CF CHECK STANDARD -.07910 MG
STANDARD DEVIATICN OF THE CBSERVED CORRECTION .00075 MG
T VALUE .14

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

TEST CCNDITICNS	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 CORRECTICN	.000	.000	
PRESSURE CCRRECTICN	.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	

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 CCNDITIONS	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 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

PAGE 30
SERIES 6
5/18/79

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

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

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X Y Z CORPORATION                                              PAGE 32
SOMEWHERE, U.S.A.                                              SERIES 6
SET OF MASS STANDARDS : 5KG - 100MG                             5/18/79
TEST NUMBER  654321


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


CALIBRATION DESIGN   62


PRECISION CONTROL


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

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        -.02628 MG
OBSERVED CORRECTION OF 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 A HYPOTHETICAL WEIGHING OF THE WEIGHT AT 20 CELSIUS IN AIR HAVING A DENSITY OF 1.2 MG/CM3, WITH A (NORMAL BRASS) STANDARD HAVING A DENSITY OF 8.4 G/CM3 AT 0 CELSIUS WHOSE COEFFICIENT OF VOLUMETRIC EXPANSION IS 0.000054 PER DEGREE CELSIUS, AND WHOSE VALUE IS BASED

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.

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

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   .01091 6 6221.97 -.03746.30 -.6031.0000  .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
C***********************************************************************
C**   ZERMAC IS MACHINE ZERO THUS THE QUANTITY NEEDS TO BE CHANGED    **
C**   FOR DIFFERENT COMPUTERS                                         **
C**   THIS VALUE IS USED BY SUBPROGRAM SPINV                          **
C***********************************************************************
      COMMON /INVCST/ ZERMAC
C***********************************************************************
C**   KFD(I),I=1,14 CONTAINS THE DIGITS 0-9 AND CHARACTERS  -,* USED  **
C**   BY SUBPROGRAM DPFD                                              **
C**   WILL NEED TO CHANGE TO COMPLY WITH PROPOSED NEW FORTRAN STANDARD**
C***********************************************************************
      COMMON /DPFDVL/ KFD(18)
C***********************************************************************
C**   INPUT-OUTPUT CONTROL PARAMETERS                                 **
C**   IR IS THE CARD READER UNIT                                      **
C**   IW IS THE LINE PRINTER UNIT                                     **
C**   IP IS THE CARD PUNCH UNIT                                       **
C**   IPL IS THE NUMBER OF LINES PER PRINTED PAGE                     **
C***********************************************************************
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP
C***********************************************************************
C**   CHARACTERS S T O P TO DETERMINE END OF RUN                      **
C***********************************************************************
      COMMON /STOP/ FS,FT,FO,FP,FE
C***********************************************************************
C**   ITEND IS THE NUMBER OF ITERATIONS ALLOWED IN COMPUTING OBSERVED **
C**   CORRECTION TO WEIGHT                                            **
C**   IT IS USED IN THE MAIN PROGRAM                                  **
C***********************************************************************
      COMMON /ITSTOP/ ITEND
      DATA ZERMAC /1.E-8/
      DATA KFD(1),KFD(2),KFD(3),KFD(4),KFD(5),KFD(6),KFD(7),KFD(8) /1H0,
     2 1H1,1H2,1H3,1H4,1H5,1H6,1H7/
      DATA KFD(9),KFD(10),KFD(11),KFD(12),KFD(13),KFD(14),KFD(15) /1H8,
     2 1H9,1H ,1H-,1H.,1H*,1H+/
      DATA KFD(16),KFD(17),KFD(18) /1H,,1HD,1HE/
      DATA IR,IW,IP,IPL,ITMP /5,6,1,58,7/
      DATA FS,FT,FO,FP,FE /1HS,1HT,1HO,1HP,1H /
      DATA ITEND /10/
      END
--- MAIN PROGRAM ---
C***********************************************************************
C**   MAIN ROUTINE OF NATIONAL BUREAU OF STANDARDS MASS CALIBRATION   **
C**   PROGRAM  VERSION OF SEPT. 10,1971                               **
C**   WRITTEN BY ROBERT C. RAYBOLD , OFFICE OF MEASUREMENT SERVICES   **
C**   AND MRS.R.N.VARNER , STATISTICAL ENGINEERING LABORATORY         **
C**   NATIONAL BUREAU OF STANDARDS , WASHINGTON, D.C. 20234           **
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **
C**                                                                   **
C**   THE MASS CALIBRATION PROGRAM CONTAINS ONE MAIN PROGRAM          **
C**        AND 23 SUBPROGRAMS                                         **
```

```
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**   PGCONT           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)                                                         MAN00430
C*********************************************************************MAN00440
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                           **MAN00450
C*********************************************************************MAN00460
      DIMENSION AIDCST(5,15),ANOM(15),DENSTY(15),COEFEX(15),ACCVAL(15), MAN00470
     2 ARSTIN(15),ACKSTD(15),IRSTOU(15),IPRNT(15),DESMAT(15,50),        MAN00480
     3 OBSERV(600),ALCOM(15,20)                                         MAN00490
C*********************************************************************MAN00500
C**   DIMENSION FOR COMMON /COMPUT/ VARIABLES                          **MAN00510
C*********************************************************************MAN00520
      DIMENSION SWTPRT(50),A(50),DELTA(50),OBSCOR(15),COMVOL(15),       MAN00530
     2 SERROR(15),TRISIG(15),TOTUN(15),DRIFT(50),ZERO(50),COMVOP(15),   MAN00540
     3 CORR5A(20),SIG35A(20),UNC5A(20),IOTSTR(50),SERSA(20),DS1(50)     MAN00550
C*********************************************************************MAN00560
C**   DIMENSION FOR MAIN PROGRAM VARIABLES                             **MAN00570
C*********************************************************************MAN00580
      DIMENSION VOLP(15),CORRP(15),TEMP(15),D1(50), ILOAD(50),TEMP2(15), MAN00590
     2 ALOAD(50)                                                        MAN00600
C*********************************************************************MAN00610
C**   DIMENSION FOR COMMON /REPRT/ VARIABLES                           **MAN00620
C*********************************************************************MAN00630
      DIMENSION AITEM(5,50),APPMAS(50),TRMASS(50),UNCERT(50),VOLPRT(50),MAN00640
     2 CORRE(50),COEPRT(50)                                             MAN00650
C*********************************************************************MAN00660
C**   DIMENSION FOR COMMON /CHECK/ VARIABLES                           **MAN00670
```

```
C*************************************************************************
      DIMENSION BCHK(289),Y(578)
C*************************************************************************
C**   LABELED COMMON                                                   **
C*************************************************************************
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNCM,L1,L2,L3,L4,
     2 L5,L6,IDATE,IBREST
      COMMON /PRT2/ IPAGE,NOSER,IPGCT
      COMMON /INPUT/ TBAR,PBAR,HBAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM,
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1P
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P,
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTCU,IPRNT,ITPOS,ICKUSD,ICALDS,
     5 LINVAR,N3,N4
      COMMON /COMPUT/ OBSCOR,CORR,VOLRES,RHOA,SWTPRT,A,DELTA,CONVOL,
     2 SERROR,TRISIG,TCTUN,ACCRR,CORRES,TMSUM,VOLSUM,SERSUM,T3SIG,ALOADP
     3,OBSTD,FRATIO,OBCCCK,OBSCK,TVAL,DRIFT,ZERO,V2TAU,STAR,CCMVOP,
     4 CORR5A,SIG35A,UNC5A,RHOAA,RHOAB,SER5A,DS1,NDGFR,ISWTCH,IFLAG,
     5 IRCUT,IOTSTR,JSTAR
      COMMON /REPRT/ TRMASS,APPMAS,CORRB,AITEM,UNCERT,VOLPRT,CCEPRT,NPRT
      COMMON /CHECK/ CHCKMA,BCHK,Y
      COMMON /ITSTOP/ ITEND
      COMMON /DPFDVL/ KFD(18)
C*************************************************************************
C**   TYPE STATEMENTS                                                  **
C*************************************************************************
      DOUBLE PRECISION VOLP,CORRP,OBSCOR,TRMASS,APPMAP,APPMAS,CORRBB,
     2 CORRB,SUM,SUM1
C*************************************************************************
C**   READ IN ADMINISTRATIVE DATA                                      **
C**           DATA COMMON TO ALL SERIES                                **
C**   INITIALIZE CONTROL VARIABLES                                     **
C*************************************************************************
10    CALL READ1
      NXFLAG=0
      NXNSIG=0
      IPAGE=0
      NPRT=0
      NOSER=0
      ASSIGN 40 TO NOSERP
      ASSIGN 410 TO NSERPP
C*************************************************************************
C**   PRINT TITLE PAGE FOR COMPLETE RUN                                **
C*************************************************************************
      CALL PRINT1
C*************************************************************************
C**   READ DATA FOR ONE SERIES                                         **
C*************************************************************************
20    CALL READ2
C*************************************************************************
C**   SET UP CHCKMA=STDEBA/100.0   TO CHECK MATRIX INVERSION           **
C*************************************************************************
      CHCKMA=STDEBA/100.0
C*************************************************************************
C**   BEGIN CALCULATIONS FOR ONE SERIES                                **
C**   CALCULATIONS FOR FIRST PRINTED PAGE OF A SERIES                  **
C*************************************************************************
      JSTAR=0
```

```
      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                                                  MAN01840
      IF (ZZZZZZ-1.) 120,110,110                                               MAN01850
110   ILOAD(I)=INT(1000.000*YYYYYY+.05)                                        MAN01860
      GO TC 130                                                                MAN01870
C***********************************************************************MAN01880
C**   LOAC IN MICRO FCUNCS                                                   **MAN01890
C***********************************************************************MAN01900
120   ILOAD(I)=INT(10000C0.*YYYYYY+.05)                                        MAN01910
130   CONTINUE                                                                 MAN01920
      ALOADP=0.0                                                               MAN01930
      DO 160 I=1,NOBS                                                          MAN01940
      ALOAC(I)=0.0                                                             MAN01950
      DO 140 J=1,NUNKN                                                         MAN01960
      ALOAD(I)=ALOAD(I)+ABS(DESMAT(J,I))*ANOM(J)/2.0                           MAN01970
140   CCNTINUE                                                                 MAN01980
      IF (ALCADP-ALCAD(I)) 150,160,160                                         MAN01990
150   ALOADP=ALCAD(I)                                                          MAN02000
160   CONTINUE                                                                 MAN02010
C***********************************************************************MAN02020
C**   COMPUTE S(STAR) SENSITIVITY VALUE (MASS/DIVISION)                      **MAN02030
C**   COMPUTE S(*) SENSITIVITY VALUE (MASS/DIVISICN)                         **MAN02040
C**   COMPUTE A-B , S , DRIFT AND/OR LEFT-RIGHT EFFECT AS REQUIRED BY        **MAN02050
C**   WEIGHING METHOD                                                        **MAN02060
C***********************************************************************MAN02070
      STAR=SWT-RHOA*VSWT*(1.0+CEXSWT*(TDELT))                                  MAN02080
      J=1                                                                      MAN02090
      DO 290 I=1,NOBS                                                          MAN02100
      GO TO (170,200,230,260,270,  280), ITPOS                                 MAN02110
C***********************************************************************MAN02120
C**   SINGLE SUBSTITUTICN-SINGLE PAN BALANCE                                 **MAN02130
C***********************************************************************MAN02140
170   D1(I)=CBSERV(J)-CBSERV(J+1)                                              MAN02150
      IF (CBSERV(J+2).NE.0.0) GC TO 180                                        MAN02160
      DS1(I)=0.0                                                               MAN02170
      GO TC 190                                                                MAN02180
180   DS1(I)=CBSERV(J+2)-CBSERV(J+1)                                           MAN02190
190   J=J+3                                                                    MAN02200
      GC TC 290                                                                MAN02210
C***********************************************************************MAN02220
C**   SINGLE SUBSTITUTICN-TWO-PAN BALANCE                                    **MAN02230
C***********************************************************************MAN02240
200   XP=(CBSERV(J)+2.0*CBSERV(J+1)+CBSERV(J+2))/4.0                           MAN02250
      YP=(CBSERV(J+3)+2.0*CBSERV(J+4)+OBSERV(J+5))/4.0                         MAN02260
      ZP=(CBSERV(J+6)+2.0*CBSERV(J+7)+OBSERV(J+8))/4.0                         MAN02270
      D1(I)=XP-YP                                                              MAN02280
      IF (ZP.NE.0.0) GC TO 210                                                 MAN02290
      DS1(I)=0.0                                                               MAN02300
      GO TC 220                                                                MAN02310
210   DS1(I)=ABS(ZP-YP)                                                        MAN02320
220   J=J+9                                                                    MAN02330
      GC TC 290                                                                MAN02340
C***********************************************************************MAN02350
C**   SINGLE TRANSPOSITICN-TWC-PAN BALANCE                                   **MAN02360
C***********************************************************************MAN02370
230   XP=(CBSERV(J)+2.0*CBSERV(J+1)+CBSERV(J+2))/4.0                           MAN02380
      YP=(CBSERV(J+3)+2.0*CBSERV(J+4)+OBSERV(J+5))/4.0                         MAN02390
      ZP=(OBSERV(J+6)+2.0*CBSERV(J+7)+OBSERV(J+8))/4.0                         MAN02400
      D1(I)=(XP-YP)/2.0                                                        MAN02410
```

```
      ZERC(I)=(XP+YP)/2.0                                               MAN02420
      IF (ZP.NE.0.0) GO TO 240                                          MAN02430
      DS1(I)=0.0                                                        MAN02440
      GO TC 250                                                         MAN02450
240   DS1(I)=ABS(ZP-YP)                                                 MAN02460
250   J=J+9                                                             MAN02470
      GO TC 290                                                         MAN02480
C***********************************************************************MAN02490
C**   DOUBLE SUBSTITUTION-ONE PAN BALANCE                             **MAN02500
C***********************************************************************MAN02510
260   D1(I)=(OBSERV(J)-OBSERV(J+1)-OBSERV(J+2)+OBSERV(J+3))/2.0         MAN02520
      DS1(I)=(OBSERV(J)-3.0*OBSERV(J+1)+3.0*OBSERV(J+2)-OBSERV(J+3))/2.0MAN02530
      DRIFT(I)=(-OBSERV(J)+OBSERV(J+1)-OBSERV(J+2)+OBSERV(J+3))/2.0     MAN02540
      J=J+4                                                             MAN02550
      GO TO 290                                                         MAN02560
C***********************************************************************MAN02570
C**   DOUBLE SUBSTITUTION-TWO PAN BALANCE                             **MAN02580
C***********************************************************************MAN02590
270   XP=(OBSERV(J)+2.0*OBSERV(J+1)+OBSERV(J+2))/4.0                    MAN02600
      YP=(OBSERV(J+3)+2.0*OBSERV(J+4)+OBSERV(J+5))/4.0                  MAN02610
      ZP=(OBSERV(J+6)+2.0*OBSERV(J+7)+OBSERV(J+8))/4.0                  MAN02620
      WP=(OBSERV(J+9)+2.0*OBSERV(J+10)+OBSERV(J+11))/4.0                MAN02630
      D1(I)=(XP-YP-ZP+WP)/2.0                                           MAN02640
      DS1(I)=ABS((XP-3.*YP+3.*ZP-WP)/2.0)                               MAN02650
      DRIFT(I)=(-XP+YP-ZP+WP)/2.0                                       MAN02660
      J=J+12                                                            MAN02670
      GO TO 290                                                         MAN02680
C***********************************************************************MAN02690
C**   DOUBLE TRANSPOSITION-TWO PAN BALANCE                            **MAN02700
C***********************************************************************MAN02710
280   XP=(OBSERV(J)+2.0*OBSERV(J+1)+OBSERV(J+2))/4.0                    MAN02720
      YP=(OBSERV(J+3)+2.0*OBSERV(J+4)+OBSERV(J+5))/4.0                  MAN02730
      ZP=(OBSERV(J+6)+2.0*OBSERV(J+7)+OBSERV(J+8))/4.0                  MAN02740
      WP=(OBSERV(J+9)+2.0*OBSERV(J+10)+OBSERV(J+11))/4.0                MAN02750
      D1(I)=(XP-YP-ZP+WP)/4.0                                           MAN02760
      DS1(I)=ABS((XP-3.*YP+3.*ZP-WP)/2.0)                               MAN02770
      ZERO(I)=(3.0*XP+YP+ZP-WP)/4.0                                     MAN02780
      DRIFT(I)=(-XP+YP-ZP+WP)/2.0                                       MAN02790
      J=J+12                                                            MAN02800
290   CONTINUE                                                          MAN02810
C***********************************************************************MAN02820
C**   COMPUTE  S(*)/D(S),A(I),DRIFT(I),ZERO(I)                        **MAN02830
C***********************************************************************MAN02840
      KA=1                                                              MAN02850
      SUM=0.0                                                           MAN02860
      J=0                                                               MAN02870
      I=1                                                               MAN02880
      ILODPP=ILOAD(I)                                                   MAN02890
C***********************************************************************MAN02900
C**   CHECK FOR LOAD CHANGES                                          **MAN02910
C***********************************************************************MAN02920
300   IF (ILOAD(I).NE.ILODPP) GO TO 320                                 MAN02930
      IF (DS1(I).EQ.0.0) GO TO 310                                      MAN02940
      SUM=SUM+DS1(I)                                                    MAN02950
      DS1(I)=STAR/DS1(I)                                                MAN02960
      J=J+1                                                             MAN02970
310   I=I+1                                                             MAN02980
      IF (I.GT.NOBS) GO TO 330                                          MAN02990
```

```
      GO TO 300
320   ILODPF=ILOAD(I)
330   FLTN=J
      DBAR=SUM/FLTN
      FLTNSQ=SQRT(FLTN)
      DSP=STAR/DBAR
      KB=I-1
      DO 360 K=KA,KB
      SWTFRT(K)=ABS(DSP)
      A(K)=D1(K)*DSP
      DRIFT(K)=DRIFT(K)*DSP
      IF (N4.EQ.0) GO TO 340
C*************************************************************************
C**   CHANGE SIGN FOR REVERSED SCALE                                   **
C*************************************************************************
      A(K)=-1.*A(K)
      DRIFT(K)=-1.*DRIFT(K)
340   IF (ABS(D1(K)/(DBAR*FLTNSQ)).LE.0.25) GO TO 350
C*************************************************************************
C**   IF OBSERVED DEFLECTION IS GREATER THAN OR EQUAL TO               **
C**   .25*SENSITIVITY DEFLECTION A FLAG IS SET UP                      **
C*************************************************************************
      ICTSTR(K)=KFD(14)
      JSTAR=1
      GO TO 360
350   ICTSTR(K)=KFD(11)
360   CONTINUE
      IF (I.GT.NOBS) GO TO 370
      J=0
      SUM=0.0
      KA=I
      GO TO 300
C*************************************************************************
C**   COMPUTE DENSITY AND COEFFIEIENT OF EXPANSION OF WEIGHTS          **
C**   BEING TESTED                                                     **
C**   COMPUTE XREST (RESTRAINT VALUE) FOR Y(M,N)                       **
C*************************************************************************
370   NXXSIG=0
      DO 380 I=1,NUNKN
      IF (ARSTIN(I).EQ.0.0) GO TO 380
      NXXSIG=NXXSIG+1
380   CONTINUE
      IF (NXNSIG.LT.2) GO TO 400
      IF (NXXSIG.GT.1) GO TO 400
      DO 390 I=1,NUNKN
      IF (ARSTIN(I).EQ.0.0) GO TO 390
      DENSTY(I)=(ANOM(I)+.001*TMSUM)/VOLSUM
      COEFEX(I)=SUMP
390   CONTINUE
400   GO TO NSERFP, (410,430)
410   ASSIGN 430 TO NSERFP
      XREST=0.0
      TMSUM=0.0
      DO 420 I=1,NUNKN
      IF (ARSTIN(I).EQ.0.0) GO TO 420
      XREST=XREST+(ACCVAL(I)-RHCA*TEMP(I))*ARSTIN(I)
      TMSUM=TMSUM+ACCVAL(I)*ARSTIN(I)
420   CONTINUE
```

```
      GO TO 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) GO 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                                       **
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C***********************************************************************MAN04160
      IF (IFLAG.EQ.0) GO TO 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   CONTINUE                                                          MAN04300
      DELTA(I)=A(I)-SUM                                                 MAN04310
550   CONTINUE                                                          MAN04320
C***********************************************************************MAN04330
C**   CALCULATE CORRECTION 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)+RHOA*VOLP(I)                                       MAN04400
      LA=LA+1                                                           MAN04410
560   CONTINUE                                                          MAN04420
C***********************************************************************MAN04430
C**   BEGIN ITERATION AND ITERATE   UNTIL DIFFERENCE BETWEEN OLD      **MAN04440
C**   AND NEW VALUES ARE LESS THAN .01 STDEBA                         **MAN04450
C**   ONLY 10 ITERATIONS ARE ALLOWED                                  **MAN04460
C***********************************************************************MAN04470
      CHCK=.01*STDEBA                                                   MAN04480
      ISTOP=0                                                           MAN04490
570   ISWTCH=0                                                          MAN04500
      LA=L                                                              MAN04510
      DO 600 I=1,NUNKN                                                  MAN04520
      OBSCOR(I)=Y(LA)+RHOA*((ANOM(I)+.001*CORRP(I))/DENSTY(I))*TEMP2(I) MAN04530
      LA=LA+1                                                           MAN04540
      IF (ISWTCH.NE.0) GO TO 590                                        MAN04550
      IF (SNGL(DABS(OBSCOR(I)-CORRP(I)))-CHCK) 590,590,580              MAN04560
580   ISWTCH=1                                                          MAN04570
590   CORRP(I)=OBSCOR(I)                                                MAN04580
600   CONTINUE                                                          MAN04590
      ISTOP=ISTOP+1                                                     MAN04600
      IF (ISTOP.GE.ITEND) GO TO 610                                     MAN04610
      IF (ISWTCH.NE.0) GO TO 570                                        MAN04620
610   WR=0.0                                                            MAN04630
      DO 620 I=1,NUNKN                                                  MAN04640
      IF (ARSTIN(I).EQ.0.0) GO TO 620                                   MAN04650
      WR=WR+ANOM(I)*ARSTIN(I)                                           MAN04660
620   CONTINUE                                                          MAN04670
      TRISQR=RANERR**2                                                  MAN04680
      TRSQRP=(3.0*STDEBA)**2                                            MAN04690
      TRSQVE=(3.0*VAREAL)**2                                            MAN04700
      LA=1                                                              MAN04710
      DO 670 I=1,NUNKN                                                  MAN04720
      COMVOL(I)=(ANOM(I)+.001*OBSCOR(I))/DENSTY(I)                      MAN04730
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      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)*ALCOM(J,L)
750   SUM=SUM+TEMP(J)*ALCOM(J,L)
      IF (SUM.GE.0.0) GO TO 760
      SUM=0.0
760   CONTINUE
      SIG35A(L)=SQRT(TRSGRP*SUM+((SUM2RP/WR)**2)*TRISGR+TRSGVE)
      UNC5A(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/STDEBA**2
      OBCCCK=0.0
      SUM1=0.0
      V2TAU=0.0
      DO 790 I=1,NUNKN
      IF (ACKSTD(I).EQ..0) GO TO 790
      OBCCCK=OBCCCK+OBSCOR(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(STDEBA**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 (IPRNT(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)
      CORRBB=((ANOM(I)+.001*OBSCOR(I))*(1.0-.0012/DENSTY(I)))/(1.0-.0012
     2/8.0)
      CORRB(NPRT)=(CORRBB-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
      SUMP=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                                                  **
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C***********************************************************************RD100200
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,RD100210
     2 L5,L6,IDATE,IBREST                                               RD100220
      COMMON /RAREA/ AA,AAITEM                                          RD100230
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 RD100240
      COMMON /STOP/ 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 NOT 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 LOCATION STARTING IN POSITION 1                        **RD100310
C**   CARD 1 - NAME OF ORGANIZATION                                   **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 OF WEIGHTS BEING TESTED           **RD100360
C**   CARD 6 - DATE OF THE REPORT                                     **RD100370
C**   CARD 7 - TEST NUMBER (MAX OF 18 CHARACTERS)                     **RD100380
C**   EXCEPT FOR THE FIRST PRINTED PAGE ONLY 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    CONTINUE                                                          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) GO TO 20                                         RD100540
      N=73-J                                                            RD100550
      JJ=J                                                              RD100560
      GO TO 30                                                          RD100570
20    CONTINUE                                                          RD100580
      GO TO 130                                                         RD100590
30    DO 120 K=1,N                                                      RD100600
C***********************************************************************RD100610
C**   MOVE NON-BLANK CHARACTERS TO BEGINNING OF FIELD                 **RD100620
C***********************************************************************RD100630
      GO TO (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 STOP ON IT , IF IT DOES THEN STOP THE    **RD100690
C**  PROGRAM OTHERWISE CONTINUE                                       **RD100700
C***********************************************************************RD100710
      IF (B1(1).EQ.FS.AND.B1(2).EQ.FT.AND.B1(3).EQ.FO.AND.B1(4).EQ.FP) SRD100720
     2TOP                                                               RD100730
      GO TO 110                                                         RD100740
50    L2=N                                                              RD100750
      B2(K)=AA(JJ)                                                      RD100760
      GO TO 110                                                         RD100770
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60     L3=N                                                             RD100780
       B3(K)=AA(JJ)                                                     RD100790
       GO TO 110                                                        RD100800
70     L4=N                                                             RD100810
       B4(K)=AA(JJ)                                                     RD100820
       GO TO 110                                                        RD100830
80     L5=N                                                             RD100840
       B5(K)=AA(JJ)                                                     RD100850
       GO TO 110                                                        RD100860
90     L6=N                                                             RD100870
       B6(K)=AA(JJ)                                                     RD100880
       GO TO 110                                                        RD100890
100    B7(K)=AA(JJ)                                                     RD100900
110    JJ=JJ+1                                                          RD100910
120    CONTINUE                                                         RD100920
130    CONTINUE                                                         RD100930
C***********************************************************************RD100940
C**    READ RANDOM ERROR LIMIT, SYSTEMATIC ERROR LIMIT AND NOMINAL    **RD100950
C**    TEMPERATURE ALL ON ONE CARD FREE FIELD ,FIELDS MUST BE         **RD100960
C**    SEPARATED BY A BLANK OR ANY NON-NUMERIC CHARACTER EXCEPT FOR   **RD100970
C**    D OR E OR .                                                    **RD100980
C**                                                                   **RD100990
C**    WHERE THE NUMBERS MUST BE IN THE FOLLOWING ORDER               **RD101000
C**      RANERR = 3 TIMES RANDOM ERROR IN THE STARTING RESTRAINT IN MG **RD101010
C**      SYSERR = SYSTEMATIC ERROR IN THE STARTING RESTRAINT IN MG    **RD101020
C**      TNOM   = NOMINAL TEMPERATURE AT WHICH THE APPARENT MASS      **RD101030
C**               VALUES ARE REPORTED IN DEGREES C                    **RD101040
C**      IBREST = STARTING RESTRAINT ID NUMBER                        **RD101050
C**                                                                   **RD101060
C**    FOR THE REST OF THE INPUT CARDS FOR EACH SERIES OF WEIGHINGS   **RD101070
C**    LOOK AT COMMENTS CARDS IN SUBROUTINE READ2                     **RD101080
C***********************************************************************RD101090
       CALL READIT (AA,1,AAITEM)                                        RD101100
       RANERR=AA(1)                                                     RD101110
       SYSERR=AA(2)                                                     RD101120
       TNOM=AA(3)                                                       RD101130
       IBREST=INT(AA(4)+.5)                                             RD101140
       RETURN                                                           RD101150
C***********************************************************************RD101160
C**    FORMAT STATEMENT                                               **RD101170
C***********************************************************************RD101180
140    FORMAT (72A1)                                                    RD101190
       END                                                              RD101200
--- READIT SUBPROGRAM ---
       SUBROUTINE READIT (Z,KOL,A)                                      RDT00010
C***********************************************************************RDT00020
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **RDT00030
C**    PROGRAM  VERSION OF SEPT.10,1971      WRITTEN BY R.C.RAYBOLD   **RDT00040
C**    AND MRS.R.N.VARNER                                             **RDT00050
C**    MODIFIED BY R. N. VARNER SEPT 1979                             **RDT00060
C***********************************************************************RDT00070
C**    ANSI FORTRAN SUBROUTINE TO READ NUMBERS IN ANY FORMAT ANYWHERE **RDT00080
C**    ON A CARD (BETWEEN CARD COLUMNS 'KOL' AND 80, INCLUSIVE).      **RDT00090
C**    IN THIS VERSION OF THE SUBROUTINE, WHEN KOL = 16, CARD COLUMNS **RDT00100
C**    1 THROUGH 15 ARE SCANNED TO PICK UP ALPHA-NUMBERIC DATA WHICH  **RDT00110
C**    ARE STORED IN VARIABLE 'A'.                                    **RDT00120
C**    WRITTEN BY ROY H. WAMPLER, STATISTICAL ENGINEERING LABORATORY, **RDT00130
C**    NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C. 20234          **RDT00140
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C**   VERSION OF FEBRUARY 8, 1971                                            **RDT00150
C*******************************************************************************RDT00160
C**   NUMBERS TO BE READ BY THIS ROUTINE SHOULD OBEY THE FOLLOWING           **RDT00170
C**   RULES.                                                                 **RDT00180
C**                                                                          **RDT00190
C**   (1)  BETWEEN ANY TWO NUMBERS THERE MUST BE A SEPARATOR.  THIS          **RDT00200
C**   CAN BE ONE OR MORE BLANK SPACES, A COMMA, ANY LETTER EXCEPT D          **RDT00210
C**   OR E, OR ANY CHARACTER EXCEPT A PLUS SIGN, A MINUS SIGN, OR A          **RDT00220
C**   DECIMAL.                                                               **RDT00230
C**                                                                          **RDT00240
C**   (2)  NUMBERS CAN APPEAR IN INTEGER FORM.  EXAMPLES ARE                 **RDT00250
C**   0  63  -271  +81063  01  2,71,-534,28                                  **RDT00260
C**                                                                          **RDT00270
C**   (3)  NUMBERS CAN BE WRITTEN WITH A DECIMAL POINT.  EXAMPLES ARE **RDT00280
C**   0. -1.0  38.1  -63.  .00015  +371.286                                  **RDT00290
C**                                                                          **RDT00300
C**   (4)  NUMBERS CAN BE WRITTEN WITH AN EXPONENT WHICH MUST BE             **RDT00310
C**   PRECEDED BY A D OR E.  (IN THIS ROUTINE D IS CONSIDERED EQUIVA- **RDT00320
C**   LENT TO E, AND NUMBERS WITH D ARE NOT INTERPRETED TO BE                **RDT00330
C**   DOUBLE PRECISION NUMBERS.)  EXAMPLES ARE                               **RDT00340
C**    2.1E12  2.1E 12  2.1E+12  2.1E-12                                     **RDT00350
C**   -2.1D12 -2.1D 12 -2.1D+12 -2.1D-12                                     **RDT00360
C**   0021.E02 .00021E5 2.1E0 2.1E-0                                         **RDT00370
C**   21E12  21E+12  21D-12                                                  **RDT00380
C**   THE LAST THREE EXAMPLES ILLUSTRATE THAT A DECIMAL NEED NOT BE          **RDT00390
C**   USED IN CONNECTION WITH THE D OR E.                                    **RDT00400
C*******************************************************************************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
     3,T(23),T(24),T(25),T(26),T(27),T(28),T(29),T(30),T(31),T(32),T(33)RDT00640
     4,T(34),T(35),T(36),T(37),T(38),T(39),T(40),T(41),T(42),T(43),T(44)RDT00650
     5,T(45),T(46),T(47),T(48),T(49),T(50),T(51),T(52),T(53),T(54),T(55)RDT00660
     6,T(56),T(57),T(58),T(59),T(60),T(61),T(62),T(63),T(64),T(65),T(66)RDT00670
     7,T(67),T(68),T(69),T(70),T(71),T(72),T(73),T(74),T(75),T(76),          RDT00680
     8 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
     9 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 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    IDONE=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)) GO 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, OR 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 TO 780                                                         RDT01440
100   SIG=-1.                                                           RDT01450
110   IF (NDE) 120,780,120                                              RDT01460
120   NDE=0                                                             RDT01470
      GO TO 780                                                         RDT01480
130   SIG=1.                                                            RDT01490
      GO TO 110                                                         RDT01500
140   IF (IDORE) 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 TO 780                                                         RDT01560
180   IF (N(I)-IE) 190,170,190                                          RDT01570
190   IF (N(I)-IDECML) 210,200,210                                      RDT01580
200   NDEC=1                                                            RDT01590
      GO TO 780                                                         RDT01600
210   IF (N(I)-IPLUS) 230,220,230                                       RDT01610
220   SIG=1.                                                            RDT01620
      GO TO 850                                                         RDT01630
230   IF (N(I)-IMINUS) 850,240,850                                      RDT01640
240   SIG=-1.                                                           RDT01650
      GO TO 850                                                         RDT01660
250   IF (N(I)-ID) 270,260,270                                          RDT01670
260   IDORE=1                                                           RDT01680
      GO TO 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) 870,330,870                                      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 (IDORE-1) 380,440,380                                          RDT01830
380   IF (N(I)-IPLUS) 400,390,400                                       RDT01840
390   SIG=1.                                                            RDT01850
      GO TO 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                                          RDT01890
430    IF (NDEC) 870,850,870                                           RDT01900
440    IF (NXDIG) 870,450,870                                          RDT01910
450    IF (N(I)-IMINUS) 460,510,460                                    RDT01920
460    IF (N(I)-IPLUS) 470,490,470                                     RDT01930
470    IF (N(I)-IBLANK) 480,490,480                                    RDT01940
480    IF (NDEC) 870,850,870                                           RDT01950
490    ISIGX=1                                                         RDT01960
500    IDCRE=ICORE+1                                                   RDT01970
       GO TO 780                                                       RDT01980
510    ISIGX=-1                                                        RDT01990
       GO TO 500                                                       RDT02000
C***********************************************************************RDT02010
C**    N(I) IS A DIGIT.                                              **RDT02020
C***********************************************************************RDT02030
520    IF (NUMB) 530,540,530                                           RDT02040
530    IF (IDCRE) 730,650,730                                          RDT02050
C***********************************************************************RDT02060
C**    N(I) IS THE FIRST DIGIT OF A NUMBER.                          **RDT02070
C***********************************************************************RDT02080
540    IF (SIG) 550,560,550                                            RDT02090
550    SIGN=SIG                                                        RDT02100
       SIG=0.                                                          RDT02110
       GO TO 570                                                       RDT02120
560    SIGN=1.                                                         RDT02130
570    IF (NDE) 580,590,580                                            RDT02140
580    NDEC=NDE+1                                                      RDT02150
       NDE=0                                                           RDT02160
590    DO 600 L=1,10                                                   RDT02170
       IF (N(I).NE.IDIGIT(L)) GO TO 600                                RDT02180
       IN=L-1                                                          RDT02190
       GO TO 610                                                       RDT02200
600    CONTINUE                                                        RDT02210
610    ZED=IN                                                          RDT02220
       IF (ZED) 620,630,620                                            RDT02230
620    LL=1                                                            RDT02240
       GO TO 640                                                       RDT02250
630    LL=0                                                            RDT02260
640    NUMB=1                                                          RDT02270
       GO TO 780                                                       RDT02280
C***********************************************************************RDT02290
C**    N(I) IS THE J-TH DIGIT OF A NUMBER WHERE J IS GREATER THAN    **RDT02300
C**    ONE.                                                          **RDT02310
C***********************************************************************RDT02320
650    IF (NDEC) 660,670,660                                           RDT02330
660    NDEC=NDEC+1                                                     RDT02340
670    DO 680 L=1,10                                                   RDT02350
       IF (N(I).NE.IDIGIT(L)) GO TO 680                                RDT02360
       IN=L-1                                                          RDT02370
       GO TO 690                                                       RDT02380
680    CONTINUE                                                        RDT02390
690    FIN=IN                                                          RDT02400
       ZED=10.*ZED+FIN                                                 RDT02410
       IF (ZED) 700,780,700                                            RDT02420
700    LL=LL+1                                                         RDT02430
       IF (LL.LT.IZERO) GO TO 780                                      RDT02440
       IF (LL.EQ.IZERO) GO TO 710                                      RDT02450
       GO TO 720                                                       RDT02460
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710   CALL ERROR (KOL,A,N,LL,IW,1)                                              RDT02470
      GO TO 780                                                                 RDT02480
720   CALL ERROR (KOL,A,N,LL,IW,2)                                              RDT02490
      GO TO 990                                                                 RDT02500
C***************************************************************************RDT02510
C**   N(I) IS AN EXPONENTIAL DIGIT.                                           **RDT02520
C***************************************************************************RDT02530
730   IF (IDCRE-1) 750,740,750                                                  RDT02540
740   ISIGX=1                                                                   RDT02550
750   DO 760 L=1,10                                                             RDT02560
      IF (N(I).NE.IDIGIT(L)) GO TO 760                                          RDT02570
      IN=L-1                                                                    RDT02580
      GO TO 770                                                                 RDT02590
760   CONTINUE                                                                  RDT02600
770   IEXP=10*IEXP+IN                                                           RDT02610
      NXDIG=NXDIG+1                                                             RDT02620
      GO TO 780                                                                 RDT02630
C***************************************************************************RDT02640
C**   DETERMINE IF THE LAST COLUMN OF THE CARD HAS BEEN REACHED.              **RDT02650
C***************************************************************************RDT02660
780   IF (I-80) 980,790,790                                                     RDT02670
C***************************************************************************RDT02680
C**   LAST COLUMN HAS BEEN REACHED.                                           **RDT02690
C**   END-OF-CARD ROUTINE IS NOW EXECUTED.                                    **RDT02700
C***************************************************************************RDT02710
790   IF (IDCRE) 830,800,830                                                    RDT02720
800   IF (NUMB) 820,810,820                                                     RDT02730
810   SIG=0.                                                                    RDT02740
      NDE=0                                                                     RDT02750
      GO TO 980                                                                 RDT02760
820   IF (NDEC) 870,850,870                                                     RDT02770
830   IF (NXDIG) 870,840,870                                                    RDT02780
840   IF (NDEC) 870,850,870                                                     RDT02790
C***************************************************************************RDT02800
C**   K-TH NUMBER (WHICH APPEARED IN INTEGER FORM) IS STORED AS               **RDT02810
C**   Z(K).                                                                   **RDT02820
C***************************************************************************RDT02830
850   K=K+1                                                                     RDT02840
      IF (ZED) 860,960,860                                                      RDT02850
860   Z(K)=SIGN*ZED                                                             RDT02860
      GO TO 970                                                                 RDT02870
C***************************************************************************RDT02880
C**   K-TH NUMBER (WHICH APPEARED IN NON-INTEGER FORM) IS STORED AS           **RDT02890
C**   Z(K).                                                                   **RDT02900
C***************************************************************************RDT02910
870   K=K+1                                                                     RDT02920
      NDEC=NDEC+NODEC                                                           RDT02930
      IF (ZED) 880,960,880                                                      RDT02940
880   KK=LL+ISIGX*IEXP-NDEC+1                                                   RDT02950
      IF (KK.GT.(1-IZERO).AND.KK.LT.IZERO) GO TO 930                            RDT02960
      IF (KK.LT.(1-IZERO)) GO TO 890                                            RDT02970
      IF (KK.EQ.(1-IZERO)) GO TO 900                                            RDT02980
      IF (KK.EQ.IZERO) GO TO 910                                                RDT02990
      IF (KK.GT.IZERO) GO TO 920                                                RDT03000
890   CALL ERROR (KOL,A,N,LL,IW,3)                                              RDT03010
      GO TO 930                                                                 RDT03020
900   CALL ERROR (KOL,A,N,LL,IW,4)                                              RDT03030
      GO TO 930                                                                 RDT03040
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910   CALL ERROR (KOL,A,N,LL,IW,5)                                      RDT03050
      GO TO 930                                                         RDT03060
920   CALL ERROR (KOL,A,N,LL,IW,6)                                      RDT03070
      GO TO 930                                                         RDT03080
930   M=KK-LL+IZERO                                                     RDT03090
      IF (M.LE.0.OR.M.GT.IMAX) GO TO 940                                RDT03100
      Z(K)=SIGN*ZED*T(M)                                                RDT03110
      GO TO 970                                                         RDT03120
940   M=IZERO-LL                                                        RDT03130
      IF (M.NE.0) GO TO 950                                             RDT03140
C***********************************************************************RDT03150
C**   M IS EQUAL TO ZERO (SPECIAL CASE)                               **RDT03160
C***********************************************************************RDT03170
      M=M+1                                                             RDT03180
      ZED=ZED*T(M)                                                      RDT03190
      M=KK+IZERO-1                                                      RDT03200
      Z(K)=SIGN*ZED*T(M)                                                RDT03210
      GO TO 970                                                         RDT03220
C***********************************************************************RDT03230
C**   M IS NOT EQUAL TO ZERO                                          **RDT03240
C***********************************************************************RDT03250
950   ZED=ZED*T(M)                                                      RDT03260
      M=KK+IZERO                                                        RDT03270
      Z(K)=SIGN*ZED*T(M)                                                RDT03280
      GO TO 970                                                         RDT03290
960   Z(K)=0.                                                           RDT03300
C***********************************************************************RDT03310
C**   APPROPRIATE VARIABLES ARE RE-INITIALIZED.                       **RDT03320
C***********************************************************************RDT03330
970   IDORE=0                                                           RDT03340
      IEXP=0                                                            RDT03350
      ISIGX=0                                                           RDT03360
      KK=0                                                              RDT03370
      LL=0                                                              RDT03380
      M=0                                                               RDT03390
      NDEC=0                                                            RDT03400
      NODEC=0                                                           RDT03410
      NUME=0                                                            RDT03420
      NXDIG=0                                                           RDT03430
      SIGN=0.                                                           RDT03440
980   CONTINUE                                                          RDT03450
      RETURN                                                            RDT03460
990   KK=0                                                              RDT03470
      LL=0                                                              RDT03480
      M=0                                                               RDT03490
      RETURN                                                            RDT03500
C***********************************************************************RDT03510
C**   FORMAT STATEMENTS.                                              **RDT03520
C***********************************************************************RDT03530
1000  FORMAT (5A3,65A1)                                                 RDT03540
1010  FORMAT (80A1)                                                     RDT03550
      END                                                               RDT03560
--- ERROR SUBPROGRAM ---
      SUBROUTINE ERROR (KOL,A,N,LL,IW,KEY)                              ERR00010
C***********************************************************************ERR00020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **ERR00030
C**   PROGRAM  VERSION OF SEPT.10,1971       WRITTEN BY R.C.RAYBOLD   **ERR00040
C**   AND MRS.R.N.VARNER                                              **ERR00050
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C**    MODIFIED BY R. N. VARNER SEPT 1979                                      **ERR00060
C************************************************************************ERR00070
C**    SUBROUTINE OF THE DIAGNOSTIC OUTPUT FOR READIT SUBROUTINE         **ERR00080
C************************************************************************ERR00090
       DIMENSION A(1),N(1)                                                    ERR00100
       GO TO (10,20,30,40,50,  60,70), KEY                                    ERR00110
10     WRITE (IW,100) LL                                                      ERR00120
       IF (KOL-16) 90,80,90                                                   ERR00130
20     WRITE (IW,110) LL                                                      ERR00140
       IF (KOL-16) 90,80,90                                                   ERR00150
30     WRITE (IW,120)                                                         ERR00160
       IF (KOL-16) 90,80,90                                                   ERR00170
40     WRITE (IW,130)                                                         ERR00180
       IF (KOL-16) 90,80,90                                                   ERR00190
50     WRITE (IW,140)                                                         ERR00200
       IF (KOL-16) 90,80,90                                                   ERR00210
60     WRITE (IW,150)                                                         ERR00220
       IF (KOL-16) 90,80,90                                                   ERR00230
70     WRITE (IW,160) KOL                                                     ERR00240
       RETURN                                                                 ERR00250
80     WRITE (IW,180)                                                         ERR00260
       WRITE (IW,170) (A(I),I=1,5),(N(I),I=16,80)                             ERR00270
       RETURN                                                                 ERR00280
90     WRITE (IW,180)                                                         ERR00290
       WRITE (IW,190) (N(I),I=1,80)                                           ERR00300
       RETURN                                                                 ERR00310
C************************************************************************ERR00320
C**    FORMAT STATEMENTS                                                 **ERR00330
C************************************************************************ERR00340
100    FORMAT (25H0*****  DIAGNOSTIC  *****/1X,                               ERR00350
      2 64H*****  THE NUMBER OF SIGNIFICANT DIGITS IN A NUMBER HAS REACHEERR00360
      3D ,I3,42H.  THIS MAY PRODUCE OVERFLOW OR UNDERFLOW.)                  ERR00370
110    FORMAT (20H0*****  ERROR  *****/1X,                                    ERR00380
      2 64H*****  THE NUMBER OF SIGNIFICANT DIGITS IN A NUMBER HAS REACHEERR00390
      3D ,I3,43H.  THIS WILL PRODUCE OVERFLOW OR UNDERFLOW.)                 ERR00400
120    FORMAT (87H0*****  ERROR  *****  NUMBER IS TOO SMALL IN ABSOLUTE VERR00410
      2ALUE AND WILL PRODUCE UNDERFLOW.)                                      ERR00420
130    FORMAT (87H0*****  DIAGNOSTIC  *****  NUMBER IS SMALL IN ABSOLUTE ERR00430
      2VALUE AND MAY PRODUCE UNDERFLOW.)                                      ERR00440
140    FORMAT (86H0*****  DIAGNOSTIC  *****  NUMBER IS LARGE IN ABSOLUTE ERR00450
      2VALUE AND MAY PRODUCE OVERFLOW.)                                       ERR00460
150    FORMAT (86H0*****  ERROR  *****  NUMBER IS TOO LARGE IN ABSOLUTE VERR00470
      2ALUE AND WILL PRODUCE OVERFLOW.)                                       ERR00480
160    FORMAT (44H0*****  ERROR  *****  THE VALUE OF 'KOL' IS ,I6,          ERR00490
      2 27H AND THIS VALUE IS INVALID./1X,                                    ERR00500
      3 50HKOL MUST BE GREATER THAN 0 AND MUST NOT EXCEED 80.)                ERR00510
170    FORMAT (1H ,5A3,65A1)                                                  ERR00520
180    FORMAT (72H THIS OCCURRED IN CONNECTION WITH READING THE DATA ON TERR00530
      2HE FOLLOWING CARD)                                                     ERR00540
190    FORMAT (1H ,80A1)                                                      ERR00550
       END                                                                    ERR00560
--- PRINT1 SUBPROGRAM ---
       SUBROUTINE PRINT1                                                      PR100010
C************************************************************************PR100020
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **PR100030
C**    PROGRAM  VERSION OF SEPT. 10,1971    WRITTEN BY R.C.RAYBOLD        **PR100040
C**    AND MRS.R.N.VARNER                                                **PR100050
C**    MODIFIED BY R. N. VARNER SEPT 1979                                **PR100060
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C*********************************************************************PR100070
C**  SUBROUTINE TO PRINT TITLE PAGE   1/12/70                       **PR100080
C*********************************************************************PR100090
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                         **PR100100
C*********************************************************************PR100110
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),       PR100120
     2 IDATE(3)                                                         PR100130
C*********************************************************************PR100140
C**   LABELED COMMON                                                **PR100150
C*********************************************************************PR100160
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,PR100170
     2 L5,L6,IDATE,IBREST                                               PR100180
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                   PR100190
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 PR100200
      WRITE (IW,80)                                                     PR100210
      WRITE (IW,90) (B1(K),K=1,L1)                                      PR100220
      WRITE (IW,90) (B2(K),K=1,L2)                                      PR100230
      WRITE (IW,90) (B3(K),K=1,L3)                                      PR100240
      WRITE (IW,90) (B4(K),K=1,L4)                                      PR100250
      WRITE (IW,90) (B5(K),K=1,L5)                                      PR100260
      WRITE (IW,90) (B6(K),K=1,L6)                                      PR100270
      WRITE (IW,100) (B7(K),K=1,18)                                     PR100280
      DO 70 I=1,6                                                       PR100290
      IPAGE=IPAGE+1                                                     PR100300
      WRITE (IW,110) (B1(K),K=1,65),IPAGE                               PR100310
      WRITE (IW,120) (B2(K),K=1,L2)                                     PR100320
      WRITE (IW,120) (B3(K),K=1,L3)                                     PR100330
      WRITE (IW,130) (B7(K),K=1,18)                                     PR100340
      GO TO (10,20,30,40,50,  60), IPAGE                                PR100350
10    CALL TEXT1                                                        PR100360
      GO TO 70                                                          PR100370
20    CALL TEXT2                                                        PR100380
      GO TO 70                                                          PR100390
30    CALL TEXT3                                                        PR100400
      GO TO 70                                                          PR100410
40    CALL TEXT4                                                        PR100420
      GO TO 70                                                          PR100430
50    CALL TEXT5                                                        PR100440
      GO TO 70                                                          PR100450
60    CALL TEXT6                                                        PR100460
70    CONTINUE                                                          PR100470
      RETURN                                                            PR100480
C*********************************************************************PR100490
C**   FORMAT STATEMENTS                                             **PR100500
C*********************************************************************PR100510
80    FORMAT (1H1,45X,28HU. S. DEPARTMENT OF COMMERCE/46X,              PR100520
     2 28HNATIONAL BUREAU OF STANDARDS/45X,                             PR100530
     3 31HNATIONAL ENGINEERING LABORATORY/48X,22HWASHINGTON, D.C. 20234/PR100540
     4///////////////59X,11HR E P O R T/55X,3HO F/51X,                  PR100550
     5 22HM A S S    V A L U E S/)                                      PR100560
90    FORMAT (43X,72A1)                                                 PR100570
100   FORMAT (////////////26X,11HTEST NUMBER,2X,18A1///60X,             PR100580
     2 17HFOR THE DIRECTOR,////60X,22HG. E. MATTINGLY, CHIEF/60X,       PR100590
     3 26HFLUID ENGINEERING DIVISION/60X,                               PR100600
     4 33HCENTER FOR MECHANICAL ENGINEERING/62X,                        PR100610
     5 22HAND PROCESS TECHNOLOGY/60X,                                   PR100620
     6 31HNATIONAL ENGINEERING LABORATORY)                              PR100630
110   FORMAT (1H1,65A1,4HPAGE,I3)                                       PR100640
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120    FORMAT (1X,72A1)                                                  PR100650
130    FORMAT (1X,13HTEST NUMBER  ,18A1)                                 PR100660
       END                                                               PR100670
--- TEXT1 SUBPROGRAM ---
       SUBROUTINE TEXT1                                                  TX100010
C***********************************************************************TX100020
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TX100030
C**    PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYBOLD    **TX100040
C**    AND MRS.R.N.VARNER                                              **TX100050
C**    MODIFIED BY R. N. VARNER SEPT 1979                              **TX100060
C***********************************************************************TX100070
       COMMON/UNITIO/IR,IW,IP,IPL,ITMF                                   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
10     FORMAT (/)                                                        TX100240
20     FORMAT (1X,36H              INTRODUCTION              ,           TX100250
      236H  WHICH RELY, DIRECTLY OR  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  REPORT COVERING THE SEQUENCE  ,                       TX100310
      836H  ENDEAVORS.   IN  ORDER  FOR  THIS/                           TX100320
      91X,36HOF OPERATIONS USED TO ASSIGN  MASS  ,                       TX100330
      *36H  SYSTEM   TO   FUNCTION   PROPERLY,)                          TX100340
30     FORMAT (1X,36HVALUES  TO  THE WEIGHTS IDENTIFIED  ,               TX100350
      236H  EVERYONE  WHO  MAKES  MEASUREMENTS/                          TX100360
      31X,36HABOVE.   IT  INCLUDES  A  COMPLETE  ,                       TX100370
      436H  MUST BE ABLE TO  VERIFY  THAT  HIS/                          TX100380
      51X,36HDESCRIPTION   OF  THE  MEASUREMENT  ,                       TX100390
      636H  MEASUREMENT    PROCESS    PRODUCES/                          TX100400
      71X,36HMETHODS AND PROCEDURES WHICH  WERE  ,                       TX100410
      836H  CONSISTENT   RESULTS   WHICH   ARE/                          TX100420
      91X,36HUSED,  ALL  OF  THE  DATA, AND THE  ,                       TX100430
      *36H  COMPATIBLE   WITH  HIS  PARTICULAR)                          TX100440
40     FORMAT (1X,36HANALYSIS  OF   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,36HOF  EXPANSION,  UNCERTAINTIES, TO-  ,                       TX100530
      *36H  VALUES,  PROVIDE  IN  PART A BASIS)                          TX100540
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50    FORMAT (1X,36HGETHER WITH THE SUMMED VALUES  FOR  ,        TX100550
     236H  FCR CONSISTENT MEASUREMENTS WITHIN/                   TX100560
     31X,36HLINEAR COMBINATICNS OF THE WEIGHTS  ,                TX100570
     436H  THIS SYSTEM OF RELATED MEASUREMENT/                   TX100580
     51X,36HIN  EACH  DECADE  ARE PRESENTED AT  ,                TX100590
     636H  PROCESSES.                         /                  TX100600
     71X,36HTHE END CF THE APPRCPRIATE SERIES.  ,                TX100610
     836H                                     /                  TX100620
     91X,36HTHIS INFORMATICN SHCULD BE  USEFUL  ,                TX100630
     *36H        APPROPRIATE    CHARACTERIZATION)                TX100640
60    FORMAT (1X,36HTO  THOSE  WHO  MUST  ASSIGN  MASS  ,        TX100650
     236H  OF    ANY  MEASUREMENT  PRCCESS  IS/                  TX100660
     31X,36HVALUES  TO  OBJECTS  CTHER   THAN  ,                 TX100670
     436H  FUNDAMENTAL  TC   VERIFYING   THAT/                   TX100680
     51X,36HWEIGHTS.    FCR  CCNVENIENCE,  THE  ,                TX100690
     636H  RESULTS  ARE  CONSISTENT  WITH THE/                   TX100700
     71X,36HVALUES AND UNCERTAINTIES, TOGETHER  ,                TX100710
     836H  END REQUIREMENT  WITH  RESPECT  TO/                   TX100720
     91X,36HWITH OTHER  APPROPRIATE  DATA  AND  ,                TX100730
     *36H  CCRRECTNESS  AND  ECCNOMY  OF  THE)                   TX100740
70    FORMAT (1X,36HCOMMENTS  ARE  ALSC  SUMMARIZED IN  ,        TX100750
     236H  MEASUREMENT EFFORT.  WITHOUT  THIS/                   TX100760
     31X,36HTABLES I AND II AT THE END OF  THE  ,                TX100770
     436H  INFORMATION,   THE   BENEFITS   OF/                   TX100780
     51X,36HREPORT.    CERTAIN   INTERMEDIATE  ,                 TX100790
     636H  CWNERSHIP OF THESE WEIGHTS MAY  BE/                   TX100800
     71X,36HPAGES ARE SUMMARIES OF STATISTICAL  ,                TX100810
     836H  COMPLETELY ILLUSORY.  THE ASSIGNED/                   TX100820
     91X,36HDATA   WHICH  RELATE  TC  THE  MASS  ,               TX100830
     *36H  UNCERTAINTIES  IN  THIS REPORT ARE)                   TX100840
80    FORMAT (1X,36HMEASUREMENT    PROCESS   USED   TC  ,        TX100850
     236H  DESCRIPTIVE CF CUR  MASS  MEASURE-/                   TX100860
     31X,36HPERFCRM THIS  WORK.  THESE  PAGES  ,                 TX100870
     436H  MENT  PROCESS.  EFFECTIVENESS  OF/                    TX100880
     51X,36HHAVE  BEEN  LEFT  IN THE REPORT TO  ,                TX100890
     636H  THE TRANSFER CF THE UNIT FROM  ONE/                   TX100900
     71X,36HRETAIN  CCNTINUITY.    CCPIES   OF  ,                TX100910
     836H  FACILITY   TC  ANOTHER  SHOULD  BE/                   TX100920
     91X,36HTHESE   PAGES  BECOME  PART  OF  A  ,                TX100930
     *36H  VERIFIED BY AN  INDEPENDENT  TEST.)                   TX100940
90    FORMAT (1X,36HCOLLECTICN  CF  STATISTICAL   DATA  ,        TX100950
     236H  IT  IS PRESUMED THAT THESE WEIGHTS/                   TX100960
     31X,36HWHICH   REFLECTS  THE  MEASUREMENT  ,                TX100970
     436H  WILL BE USED IN A SIMILARLY  WELL-/                   TX100980
     51X,36HPRCCESS PERFORMANCE OVER A  PERIOD  ,                TX100990
     636H  CHARACTERIZED MEASUREMENT  PROCESS/                   TX101000
     71X,36HCF  TIME.   SUCH  A CCLLECTION HAS  ,                TX101010
     836H  SC THAT THE STATISTICAL PARAMETERS/                   TX101020
     91X,36HBEEN USED TC ESTABLISH THE CONTROL  ,                TX101030
     *36H  OF  BCTH PROCESSES CAN BE COMBINED)                   TX101040
100   FORMAT (1X,36HLIMITS FCR ACCEPTING  THE  RESULTS  ,        TX101050
     236H  TC PROVIDE A REALISTIC ESTIMATE OF/                   TX101060
     31X,36HCF  THIS  MEASUREMENT.  THESE COL-  ,                TX101070
     436H  THE UNCERTAINTY OF THE  MASS  UNIT/                   TX101080
     51X,36HLECTIONS ARE CPEN  FCR  INSPECTION  ,                TX101090
     636H  AS  ACTUALLY  REALIZED  IN ANOTHER/                   TX101100
     71X,36HAT CUR FACILITY.                    ,                TX101110
     836H  FACILITY.  A COMPREHENSIVE SERVICE/                   TX101120
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     91X,36H                                     ,                      TX101130
     *36H  DIRECTED TOWARD 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  THROUGH  THE/                          TX101180
     51X,36H    THE  MASS  MEASUREMENT  SYSTEM   ,                      TX101190
     636H  MASS MEASUREMENT ASSURANCE PROGRAM/                          TX101200
     71X,36HWITHIN THIS  COUNTRY  CONSISTS  OF   ,                      TX101210
     836H  OF    THE    NATIONAL   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  VERSION OF SEPT. 10,1971    WRITTEN BY R.C.RAYBOLD     **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 UNKNOWNS AND  THE  COLLEC-/                          TX200280
     51X,36H    ONLY  DIFFERENCES  IN MASS CAN   ,                      TX200290
     636H  TION  OF  VALUES OVER TIME IS USED/                          TX200300
     71X,36HBE MEASURED,  THEREFORE  THE  MASS   ,                      TX200310
     836H  TO EVALUATE THE PERFORMANCE OF THE/                          TX200320
     91X,36HVALUES  FOR  THE 'UNKNOWN' WEIGHTS   ,                      TX200330
     *36H  MEASUREMENT PROCESS.                 )                       TX200340
30    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  TOGETHER  WITH   ,                      TX200410
     836H  ARDS, THE ACCEPTED VALUES OF THESE/                          TX200420
     91X,36H'CHECK STANDARDS', ARE GROUPED AND   ,                      TX200430
     *36H  STANDARDS SERVE AS A RESTRAINT  ON)                          TX200440
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40    FORMAT (1X,36HINTERCOMPARED  ACCORDING  TO   THE  ,          TX200450
     236H  THE  SOLUTION OF THE EQUATIONS FOR/                     TX200460
     31X,36HDESIGN  SCHEDULE  GIVEN AT THE BE-  ,                  TX200470
     436H  THE VALUES OF ALL OF THE  WEIGHTS./                     TX200480
     51X,36HGINNING OF EACH SERIES  OF  WEIGH-  ,                  TX200490
     636H  THE  RESTRAINT FOR THE SOLUTION OF/                     TX200500
     71X,36HINGS.  THE  FIRST SERIES CONTAINS  ,                   TX200510
     836H  SUBSEQUENT SERIES IS  PROVIDED  BY/                     TX200520
     91X,36HSTANDARDS   WHICH   PROVIDE   THE  ,                   TX200530
     *36H  THE  VALUES ESTABLISHED FOR ONE OR)                     TX200540
50    FORMAT (1X,36HSTARTING  VALUES FOR THE SERIES OF  ,          TX200550
     236H  MORE   WEIGHTS   INCLUDED   IN   A/                     TX200560
     31X,36HWEIGHINGS  AND  PROVIDE  THE   TIE  ,                  TX200570
     436H  PREVIOUS SERIES.              /                         TX200580
     51X,36HPOINT  FOR  CONSISTENCY THROUGHOUT  ,                  TX200590
     636H                                    /                     TX200600
     71X,36HTHE   MEASUREMENT   SYSTEM.   THE  ,                   TX200610
     836H       ESTIMATED  VALUES  FOR WEIGHTS/                    TX200620
     91X,36HWEIGHING METHOD USED, I.E., DOUBLE  ,                  TX200630
     *36H  WHICH HAVE BEEN  GROUPED  IN  THE)                      TX200640
60    FORMAT (1X,36HSUBSTITUTION, TRANSPOSITION, ETC.,  ,          TX200650
     236H  SAME   SERIES   INVOLVE  THE  SAME/                     TX200660
     31X,36HIS   INDICATED   ALONG   WITH  THE  ,                  TX200670
     436H  OBSERVATIONAL  DATA  AND  ARE,  IN/                     TX200680
     51X,36HOBSERVED DATA.   IN  THE  COMPUTA-  ,                  TX200690
     636H  ALMOST ALL CASES, CORRELATED.  FOR/                     TX200700
     71X,36HTIONS, THE  DISPLACEMENT  VOLUMES  ,                   TX200710
     836H  EACH  SERIES  THERE  IS A TABLE OF/                     TX200720
     91X,36HARE TREATED EXPLICITLY, USING  THE  ,                  TX200730
     *36H  COMBINATIONS  TOGETHER  WITH   THE)                     TX200740
70    FORMAT (1X,36HDATA LISTED IN THE REPORT.  IN ALL  ,          TX200750
     236H  APPROPRIATE  UNCERTAINTY  FOR EACH/                     TX200760
     31X,36HCASES, A REDUNDANCY IN THE NUMBER  ,                   TX200770
     436H  COMBINATION.                      /                     TX200780
     51X,36HOF MEASUREMENTS PROVIDES  A  MEANS  ,                  TX200790
     636H                                    /                     TX200800
     71X,36HFOR  CHECKING  ON THE PRECISION OF  ,                  TX200810
     836H            PROCESS CONTROL         /                     TX200820
     91X,36HTHE PROCESS.                        ,                  TX200830
     *36H                                    )                     TX200840
80    FORMAT (1X,36H                                    ,          TX200850
     236H        THE  STANDARD  DEVIATION,   AS/                   TX200860
     31X,36H    WHEN THERE ARE MORE  EQUATIONS  ,                  TX200870
     436H  COMPUTED  FROM  THE  LEAST SQUARES/                     TX200880
     51X,36HTHAN  'UNKNOWNS', NOT ALL OBSERVA-  ,                  TX200890
     636H  SOLUTION, PROVIDES A CHECK ON  THE/                     TX200900
     71X,36HTIONAL EQUATIONS CAN BE  SATISFIED  ,                  TX200910
     836H  SHORT  TERM,  OR 'WITHIN-RUN' PRO-/                     TX200920
     91X,36HEXACTLY  AND  THE  METHOD OF LEAST  ,                  TX200930
     *36H  CESS PRECISION.  AN AVERAGE  OF  A)                     TX200940
90    FORMAT (1X,36HSQUARES   IS   USED   TO   PROVIDE  ,          TX200950
     236H  NUMBER  OF  THESE  STANDARD DEVIA-/                     TX200960
     31X,36HESTIMATES OF THE 'UNKNOWN' VALUES.  ,                  TX200970
     436H  TIONS IS  TAKEN  AS  THE  ACCEPTED/                     TX200980
     51X,36HTHIS  METHOD  LEADS  TO ESTIMATORS  ,                  TX200990
     636H  WITHIN-RUN  STANDARD  DEVIATION OF/                     TX201000
     71X,36HWHICH ARE LINEAR FUNCTIONS OF  THE  ,                  TX201010
     836H  THE  PROCESS  AND  IS  USED  AS  A/                     TX201020
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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   ,            TX300350
     236H  WCRK, THE 'OUT OF CCNTROL' SERIES,/                        TX300360
     31X,36HCURRENT  RUN  FOR  CCNFORMITY   TO  ,                     TX300370
     436H  WITH  REMARKS  AS APPRCPRIATE, ARE/                        TX300380
     51X,36HTHEIR RESPECTIVE CISTRIBUTIONS AND  ,                     TX300390
     636H  ATTACHED AT THE END CF THE  REPORT/                        TX300400
     71X,36HIF   SATISFACTORY   ARE  TAKEN  AS  ,                     TX300410
     836H  FCR YOUR INFORMATICN.           /                          TX300420
     91X,36HEVIDENCE THAT THE  PRCCESS  IS  IN  ,                     TX300430
     *36H                                  )                          TX300440
40    FORMAT (1X,36HCCNTROL    AND   THAT   PREDICTIVE  ,             TX300450
     236H              UNCERTAINTY         /                          TX300460
     31X,36HSTATEMENTS  REGARDING  UNCERTAINTY  ,                     TX300470
     436H                                  /                          TX300480
     51X,36HARE VALID.                          ,                     TX300490
     636H       IT IS ASSUMED THAT THE PRESENT/                       TX300500
     71X,36H                                    ,                     TX300510
     836H  'ACCEPTED VALUES' OF TWO NBS STAN-/                        TX300520
     91X,36H    CCNTRCL  CHARTS CN THE WITHIN-  ,                     TX300530
     *36H  DARDS  AT  THE  1  KILOGRAM LEVEL.)                        TX300540
50    FORMAT (1X,36HRUN  PROCESS  PRECISION  AND   THE  ,             TX300550
     236H  DESIGNATED N1 AND N2, ARE  WITHOUT/                        TX300560
     31X,36HVALUES   OBTAINED  FOR  THE  CHECK  ,                     TX300570
     436H  ERROR.  ESTIMATES  CF  THE UNCER-/                         TX300580
     51X,36HSTANDARD  ARE  KEY   ELEMENTS   IN  ,                     TX300590
     636H  TAINTY OF THE ACCEPTED  VALUES  OF/                        TX300600
     71X,36HMONITORING THE STATE CF CCNTROL OF  ,                     TX300610
     836H  THE NBS STANDARDS RELATIVE TO  THE/                        TX300620
     91X,36HANY   PRECISE   MASS   MEASUREMENT  ,                     TX300630
     *36H  INTERNATICNAL  PROTOTYPE  KILOGRAM)                        TX300640
60    FORMAT (1X,36HPROCESS.  IN ADDITICN TO PROVIDING  ,             TX300650
     236H  CAN  BE   PROVIDED   CN   REQUEST./                        TX300660
     31X,36HA BASIS FCR  JUDGMENT  AS  TO  THE  ,                     TX300670
     436H  HOWEVER,  THESE  ESTIMATES HAVE NO/                        TX300680
     51X,36HADEQUACY  OF A GIVEN PROCESS FOR A  ,                     TX300690
     636H  REAL MEANING IN EITHER NATIONAL OR/                        TX300700
     71X,36HPARTICULAR REQUIREMENT, THESE DATA  ,                     TX300710
     836H  INTERNATICNAL CCMPARISCN.  THIS IS/                        TX300720
     91X,36HPROVIDE  A  MEANS  TO  JUDGE   THE  ,                     TX300730
     *36H  BECAUSE OF THE LACK CF  SUFFICIENT)                        TX300740
70    FORMAT (1X,36HIMPORTANCE   OF   LONG   TERM,  OR  ,             TX300750
     236H  DATA   TO   PROVIDE   A  REALISTIC/                        TX300760
     31X,36H'BETWEEN-RUN'  VARIABILITY   WHICH  ,                     TX300770
     436H  ESTIMATE OF THE UNCERTAINTY IN THE/                        TX300780
     51X,36HCAN   BE   CHARACTERIZEC   BY  THE  ,                     TX300790
     636H  VALUES ASSIGNED TC  THE  PROTOTYPE/                        TX300800
     71X,36HSTANDARD CEVIATICN CF  THE  VALUES  ,                     TX300810
     836H  KILOGRAMS K20 AND K4, PARTICULARLY/                        TX300820
     91X,36HABOUT  THE  MEAN.   IF THERE IS AN  ,                     TX300830
     *36H  IN   REGARD   TO   LONG  TERM,  OR)                        TX300840
80    FORMAT (1X,36HADDITICNAL CCMPCNENT  OF  VARIANCE  ,             TX300850
     236H  BETWEEN-RUN VARIABILITY.  CHANGES/                         TX300860
     31X,36HENTERING  FRCM  RUN  TO  RUN, THIS  ,                     TX300870
     436H  IN THE ACCEPTED VALUES FOR THE NBS/                        TX300880
     51X,36HSTANDARD DEVIATION WILL BE  LARGER  ,                     TX300890
     636H  STANDARDS  AT  THE KILCGRAM LEVEL,/                        TX300900
     71X,36HTHAN  CAN  BE ACCCUNTED FOR BY THE  ,                     TX300910
     836H  AS AND WHEN THEY  CCCUR, WILL  BE/                         TX300920
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     91X,36HWITHIN-RUN VARIABILITY,   CORRELA-   ,
     *36H  REPORTED  IN THE SCIENTIFIC PAPERS)
90    FORMAT (1X,36HTION  STUDIES,  AS WELL AS SUPPLE-  ,
     236H  OF THE BUREAU AND  WILL  BE  GIVEN/
     31X,36HMENTAL EXPERIMENTS,  ARE  USED  TO   ,
     436H  WIDE DISTRIBUTION.  IN CASES WHERE/
     51X,36HDETECT AND REDUCE THE MAGNITUDE OF   ,
     636H  SUCH CHANGES MAY BE OF IMPORTANCE,/
     71X,36HSIGNIFICANT   SYSTEMATIC  EFFECTS.   ,
     836H  OR  WHERE  CONTINUITY  IS DESIRED,/
     91X,36HAPPROPRIATE  ACTION,  E.G.,  ADDI-   ,
     *36H  INSTRUCTIONS WILL BE INCLUDED  FOR)
100   FORMAT (1X,36HTIONAL  EMPIRICAL  CORRECTIONS  OR  ,
     236H  UP-DATING    PREVIOUSLY   REPORTED/
     31X,36HCHANGES IN TECHNIQUE,  CAN  REDUCE   ,
     436H  VALUES.  WHEN THE VALUES  REPORTED/
     51X,36HTHE  EFFECTS FROM KNOWN SOURCES OF   ,
     636H  ARE  BASED  ON THE ACCEPTED VALUES/
     71X,36HSYSTEMATIC   VARIABILITY   TO    A   ,
     836H  OF STANDARDS OTHER THAN  STANDARDS/
     91X,36HMAGNITUDE    WHICH   IS  NO  LONGER  ,
     *36H  N1  AND  N2  MENTIONED  ABOVE, THE)
110   FORMAT (1X,36HIDENTIFIABLE IN THE DATA.  IN  THE  ,
     236H  UNCERTAINTY OF THE ACCEPTED  VALUE/
     31X,36HCASES  WHERE  A  SIGNIFICANT  LONG   ,
     436H  OF     THE    STANDARD    BECOMES   A/
     51X,36HTERM,  OR  BETWEEN-RUN,  COMPONENT   ,
     636H  SYSTEMATIC ERROR IN THE ASSIGNMENT/
     71X,36HREMAINS  THE  UNCERTAINTY HAS BEEN   ,
     836H  OF VALUES TO OTHER  STANDARDS  AND/
     91X,36HAPPROPRIATELY ADJUSTED.              ,
     *36H  IS INCLUDED IN THE REPORT.        )
      END
--- TEXT4 SUBPROGRAM ---
      SUBROUTINE TEXT4
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*************************************************************************
      COMMON/UNITIO/IR,IW,IP,IPL,ITMF
      WRITE (IW,10)
      WRITE (IW,20)
      WRITE (IW,30)
      WRITE (IW,40)
      WRITE (IW,50)
      WRITE (IW,60)
      WRITE (IW,70)
      WRITE (IW,80)
      WRITE (IW,90)
      WRITE (IW,100)
      WRITE (IW,110)
      RETURN
C*************************************************************************
C**   FORMAT STATEMENTS                                                **
C*************************************************************************
10    FORMAT (/)
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20    FORMAT (1X,36H    A  BALANCE UNDER STABLE OPERA-   ,
     236H  SHOULD ALMOST ALWAYS OVERLAP.    IN/
     31X,36HTING  CONDITIONS  WILL  EXHIBIT  A   ,
     436H  OTHER WORDS, WHILE A  SECOND  MEA-/
     51X,36HCERTAIN CHARACTERISTIC VARIABILITY  ,
     636H  SUREMENT WILL PRODUCE A  DIFFERENT/
     71X,36HWHICH  CAN  BE  DESCRIBED  BY  THE   ,
     836H  VALUE, THIS VALUE WILL ONLY RARELY/
     91X,36HSTANDARD   DEVIATION    FOR    SUCH   ,
     *36H  DIFFER FROM  THE  FIRST  VALUE  BY)
30    FORMAT (1X,36HMEASUREMENTS.   THE  VALUE  FOR  A  ,
     236H  MORE  THAN  THE  SUM  OF  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 DESIGN WILL HAVE ITS  OWN   ,
     836H  IF SOME EVENT HAS OCCURRED IN  THE/
     91X,36HSTANDARD  DEVIATION  WHICH WILL BE   ,
     *36H  TIME INTERVAL BETWEEN THE TWO MEA-)
40    FORMAT (1X,36HSOME  FUNCTION  OF   THE   BALANCE  ,
     236H  SUREMENTS WHICH  WILL  CHANGE  THE/
     31X,36HPRECISION  AND  (POSSIBLY)  OF THE   ,
     436H  MASS OF THE OBJECT.  E.G.,   ABRA-/
     51X,36HBETWEEN-RUN  COMPONENT.    AS   AN   ,
     636H  SIONS, ABUSE, CORROSION, IMPROPER/
     71X,36HOUTER LIMIT OF THE DISTRIBUTION OF   ,
     836H  CLEANING AND THE LIKE.            /
     91X,36HRANDOM  ERRORS,  THREE  TIMES  THE   ,
     *36H                                    )
50    FORMAT (1X,36HSTANDARD   DEVIATION   IS    USED.  ,
     236H       THE  UNCERTAINTY  IN  ASSIGNED/
     31X,36HSYSTEMATIC   ERRORS   DUE  TO  THE   ,
     436H  VALUE  CONTAINED  IN  THIS  REPORT/
     51X,36HPROCEDURES  USED  OR  TO  ENVIRON-   ,
     636H  BECOMES A  SYSTEMATIC  EFFECT  FOR/
     71X,36HMENTAL    EFFECTS    ARE   LARGELY   ,
     836H  THE  MEASUREMENT  PROCESS IN WHICH/
     91X,36HBALANCED OUT AND  CAN  USUALLY  BE   ,
     *36H  THESE WEIGHTS ARE TO BE USED.   IN)
60    FORMAT (1X,36HREGARDED  AS  NEGLIGIBLE.   WHEN A  ,
     236H  THE  ABSENCE  OF OTHER SIGNIFICANT/
     31X,36HNON-NEGLIGIBLE   BOUND   TO    THE   ,
     436H  SYSTEMATIC EFFECTS IN  THE  USER'S/
     51X,36HPOSSIBLE EFFECT FROM KNOWN SOURCES   ,
     636H  MEASUREMENT  PROCESS  (A CONDITION/
     71X,36HIS AVAILABLE, IT IS CALCULATED AND   ,
     836H  WHICH MUST  BE  DEMONSTRATED)  THE/
     91X,36HREPORTED    SEPARATELY,  E.G.,  THE   ,
     *36H  UNCERTAINTY  OF THE VALUE ASSIGNED)
70    FORMAT (1X,36HUNCERTAINTY OF ACCEPTED  VALUE  AT  ,
     236H  BY  THE  USER  IS  AN  APPROPRIATE/
     31X,36HOTHER  THAN  THE 1 KILOGRAM LEVEL.   ,
     436H  COMBINATION   OF   THE  SYSTEMATIC/
     51X,36HTHE DISTRIBUTION  IMPLIED  BY  THE   ,
     636H  ERROR  IN  THE  STANDARD  AND  THE/
     71X,36HRANDOM ERRORS MAY THUS BE CENTERED   ,
     836H  RANDOM  COMPONENT  ASSOCIATED 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
--- TEXTS SUBPROGRAM ---
      SUBROUTINE TEXTS                                                 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)
      WRITE (IW,80)
      WRITE (IW,90)
      WRITE (IW,100)
      WRITE (IW,110)
      RETURN
C***********************************************************************
C**   FORMAT STATEMENTS                                               **
C***********************************************************************
10    FORMAT (1X,36H                                    ,
     236H                                    )
20    FORMAT (1X,36H                          REFERENCES,
     236H                                    /
     31X,36H                                    ,
     436H                                    /
     51X,36HTHE FOLLOWING REFERENCES ARE SUGGEST,
     636HED FOR DETAILED DESCRIPTION OF      /
     71X,36HPORTIONS OF THIS REPORT , AND FOR GE,
     836HNERAL INFORMATION CONCERNING THE    /
     91X,36HMASS MEASUREMENT PROCESS:            ,
     *36H                                    )
30    FORMAT (1X,36H                                    ,
     236H                                    /
     31X,36H 1.PONTIUS, P. E., AND CAMERON, J. M,
     436H.                                   /
     51X,36H   REALISTIC UNCERTAINTIES AND THE M,
     636HASS MEASUREMENT PROCESS             /
     71X,36H   NAT. BUR. STAND. (U.S.), MONOGR. ,
     836H103                                 /
     91X,36H   (AUG. 15, 1967)                  ,
     *36H                                    )
40    FORMAT (1X,36H                                    ,
     236H                                    /
     31X,36H 2.PONTIUS, P. E.                   ,
     436H                                    /
     51X,36H   MEASUREMENT PHILOSOPHY OF THE PIL,
     636HOT PROGRAM FOR MASS CALIBRATION     /
     71X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,
     836HE 288                               /
     91X,36H   (MAY 6, 1966)                    ,
     *36H                                    )
50    FORMAT (1X,36H                                    ,
     236H                                    /
     31X,36H 3.BOWMAN, H. A., AND SCHOONOVER, R.,
     436H M. WITH APPENDIX BY MILDRED JONES  /
     51X,36H   PROCEDURE FOR HIGH PRECISION DENS,
     636HITY DETERMINATIONS BY HYDROSTATIC   /
     71X,36H   WEIGHING                         ,
     836H                                    /
     91X,38H   J. RES. NAT. BUR. STAND. (U.S.) 71C,
     *36H. ENGINEERING AND INSTRUMENTATION   )
60    FORMAT (1X,36H   NO. 3, 179-198 (JULY-AUG. 1967)  ,
     236H                                    /
     31X,36H                                    ,
     436H                                    /
     51X,36H 4.NATRELLA, M. G.                  ,
     636H                                    /
     71X,36H   EXPERIMENTAL STATISTICS          ,
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     836H                                     /
     91X,36H   NAT. BUR. STAND. (U.S.) HANDBOOK ,
     *36H91                                     )
70    FORMAT (1X,36H   (AUGUST 1, 1963)                    ,
     236H                                     /
     31X,36H                                    ,
     436H                                     /
     51X,36H 5.KU, H. H.                        ,
     636H                                     /
     71X,36H   PRECISION MEASUREMENT AND CALIBRA,
     836HTION - SELECTED NBS PAPERS ON        /
     91X,36H   STATISTICAL CONCEPTS AND PROCEDUR,
     *36HES                                     )
80    FORMAT (1X,36H   NAT. BUR. STAND. (U.S.) SPEC. PUB,
     236HL. 300                               /
     31X,36H   VOL. 1 (FEB. 1969)               ,
     436H                                     /
     51X,36H                                    )
90    FORMAT (1X,36H 6.PONTIUS, P. E.                      ,
     236H                                     /
     31X,36H   MASS AND MASS VALUES             ,
     436H                                     /
     51X,36H   NAT. BUR. STAND. (U.S.) MONOGR. 1,
     636H33                                   /
     71X,36H   (JAN. 1974)                      ,
     836H                                     /
     91X,36H                                    ,
     *36H                                     )
100   FORMAT (1X,36H 7.CAMERON, J. M., CROARKIN, C. C. A,
     236HND RAYBOLD, R. C.                    /
     31X,36H   DESIGNS FOR THE CALIBRATION OF ST,
     436HANDARDS OF MASS                      /
     51X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,
     636HE 952                                /
     71X,36H   (JUNE 1977)                      ,
     836H                                     /
     91X,36H                                    ,
     *36H                                     )
110   FORMAT (1X,36H 8.VARNER, R. N., AND RAYBOLD, R. C.,
     236H                                     /
     31X,36H   NATIONAL BUREAU OF STANDARDS MASS,
     436H CALIBRATION COMPUTER SOFTWARE       /
     51X,36H   NAT. BUR. STAND. (U.S.) TECH. NOT,
     636HE                                    /
     71X,36H   (IN PROCESS)                     ,
     836H                                     /
     91X,36H                                    ,
     *36H                                     )
      END
--- TEXT6 SUBPROGRAM ---
      SUBROUTINE TEXT6
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 1977                               **
C*************************************************************************
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP
```

```
      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 /PRTLE/ VARIABLE                         **
```

```
C***********************************************************************
      DIMENSION PRTLEX(15)
C***********************************************************************
C**   LABELED COMMON                                                  **
C***********************************************************************
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,
     2 L5,L6,IDATE,IEREST
      COMMON /INPUT/ TEAR,PBAR,HEAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM,
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1P
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P,
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTCU,IPRNT,ITPOS,ICKUSD,ICALDS,
     5 LINVAR,N3,N4
      COMMON /RAREA/ AA,AAITEM
      COMMON /PRTLB/ PRTLEX
C***********************************************************************
C**   SET UP VARIABLE FOR MAXIMUM NUMBER OF READINGS NR=50*12         **
C***********************************************************************
      NR=50*12
C***********************************************************************
C**   READ ONE CARD--FREE FIELD                                       **
C**          TYPE OF WEIGHING (N1)                                    **
C**          TYPE OF BALANCE (N2)                                     **
C**          TYPE OF UNITS OF INPUT (N3)                              **
C**          DIRECTION OF SCALE LEFT TO RIGHT OR RIGHT TO LEFT (N4)   **
C**                                                                   **
C**   WHERE                                                           **
C**     N1 = 0      SINGLE TRANSPOSITION                              **
C**     N1 = 1      DOUBLE TRANSPOSITION                              **
C**     N1 = 2      SINGLE SUBSTITUTION                               **
C**     N1 = 3      DOUBLE SUBSTITUTION                               **
C**                                                                   **
C**     N2 = 0      TWO PAN BALANCE                                   **
C**     N2 = 1      ONE PAN BALANCE                                   **
C**                                                                   **
C**     N3 = 0      METRIC UNITS                                      **
C**     N3 = 1      ENGLISH UNITS                                     **
C**                                                                   **
C**     N4 = 0      SCALE LEFT TO RIGHT (EG. 0 TO 100  OR -1 TO 1)    **
C**     N4 = 1      SCALE RIGHT TO LEFT (EG. 100 TO 0  OR 1 TO -1)    **
C***********************************************************************
      CALL READIT (AA,1,AAITEM)
      N1=INT(AA(1)+.1)
      N2=INT(AA(2)+.1)
      N3=INT(AA(3)+.1)
      N4=INT(AA(4)+.1)
C***********************************************************************
C**   READ DATE OF OBSERVATION,OPERATOR,BALANCE AND CHECK STANDARD    **
C**   USED                                                            **
C**   WHERE   NUMBERS ARE FREE FIELD ON THIS CARD  6 NUMBERS          **
C**          MONTH AND DAY (2 DIGITS) YEAR (4 DIGITS)                 **
C**     OPERATOR CODE (INTEGER)                                       **
C**     BALANCE CODE (INTEGER)                                        **
C**     CHECK STANDARD CODE (INTEGER)                                 **
C***********************************************************************
      CALL READIT (AA,1,AAITEM)
      IDATE(1)=INT(AA(1)+.1)
      IDATE(2)=INT(AA(2)+.1)
      IDATE(3)=INT(AA(3)+.1)
```

```
      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)
      NOBS=INT(AA(1)+.1)
      NUNKN=INT(AA(2)+.1)
      ICALDS=INT(AA(3)+.1)
      LINVAR=INT(AA(4)+.1)
C***********************************************************************
C**   ONE RECORD-FREE FIELD-WITH ENTRIES IN THE FOLLOWING ORDER       **
C**    1. WITHIN STANDARD DEVIATION OF THE BALANCE IN MG              **
C**    2. MASS VALUE IN MG OF THE SENSITIVITY WEIGHT                  **
C**    3. VOLUME OF THE SENSITIVITY WEIGHT IN CM3                     **
C**    4. COEFFICIENT OF EXPANSION OF SENSITIVITY WEIGHT              **
C**    5. BETWEEN STANDARD DEVIATION OF THE BALANCE IN MG             **
C***********************************************************************
      CALL READIT (AA,1,AAITEM)
      STDEBA=AA(1)
      SWT=AA(2)
      VSWT=AA(3)
      CEXSWT=AA(4)
      VAREAL=AA(5)
C***********************************************************************
C**   A GROUP OF N RECORDS (N=NUMBER OF UNKNOWNS), EACH RECORD HAS    **
C**   INFORMATION IN THE FOLLOWING ORDER, ABOUT EACH WEIGHT           **
C**     1. IN COLUMNS 1-15 IDENTIFICATION OF WEIGHTS (ALPHA-NUMERIC)  **
C**                                                                   **
C**   THE REST OF THE INFORMATION ON EACH RECORD IS FREE FIELD        **
C**                                                                   **
C**     2. WEIGHTS NOMINAL VALUE IN GRAMS ( POUNDS IF N3 = 1 )        **
C**     3. DENSITY OF THE WEIGHT IN CM3                               **
C**     4. COEFFICIENT OF EXPANSION OF THE WEIGHT                     **
C**     5. ACCEPTED CORRECTION OF THE WEIGHT IN MG                    **
C***********************************************************************
      DO 20 I=1,NUNKN
      CALL READIT (AA,16,AAITEM)
      AIDCST(1,I)=AAITEM(1)
      AIDCST(2,I)=AAITEM(2)
      AIDCST(3,I)=AAITEM(3)
      AIDCST(4,I)=AAITEM(4)
      AIDCST(5,I)=AAITEM(5)
      ANOM(I)=AA(1)
      IF (N3.EQ.0) GO TO 10
      PRTLBX(I)=ANOM(I)
C***********************************************************************
C**    CONVERT POUNDS TO GRAMS                                        **
C***********************************************************************
      ANOM(I)=ANOM(I)*453.59237
10    CONTINUE
      DENSTY(I)=AA(2)
      COEFEX(I)=AA(3)
      ACCVAL(I)=AA(4)
20    CONTINUE
C***********************************************************************
C**    READ, FREE FIELD, ONE RECORD A VECTOR CONSISTING OF 1'S OR 0'S **
C**    USE A 1 IF WEIGHT IS INCLUDED IN RESTRAINT                     **
C**    USE A 0 IF WEIGHT IS NOT INCLUDED IN THE RESTRAINT             **
C**    FOLLOW ORDER OF INPUT                                          **
C***********************************************************************
      CALL READIT (AA,1,AAITEM)
      DO 30 I=1,NUNKN
```

```
30    ARSTIN(I)=AA(I)                                                        RD202000
C***********************************************************************RD202010
C**   READ, FREE FIELD, ONE RECORD CONSISTING OF 1'S AND 0'S           **RD202020
C**   USE 1 IF WEIGHT IS INCLUDED IN CHECK STANDARD                    **RD202030
C**   USE 0 IF WEIGHT IS NOT INCLUDED IN CHECK STANDARD                **RD202040
C**   FOLLOW ORDER OF INPUT                                            **RD202050
C***********************************************************************RD202060
      CALL READIT (AA,1,AAITEM)                                              RD202070
      DO 40 I=1,NUNKN                                                        RD202080
40    ACKSTD(I)=AA(I)                                                        RD202090
C***********************************************************************RD202100
C**   READ, FREE FIELD, ONE RECORD CONSISTING OF 1'S AND 0'S           **RD202110
C**   USE 1 IF WEIGHT IS USED IN RESTRAINT FOR NEXT SERIES             **RD202120
C**   USE 0 IF WEIGHT IS NOT USED IN RESTRAINT FOR NEXT SERIES         **RD202130
C**   FOLLOW ORDER ON INPUT                                            **RD202140
C***********************************************************************RD202150
      CALL READIT (AA,1,AAITEM)                                              RD202160
      DO 50 I=1,NUNKN                                                        RD202170
50    IRSTOU(I)=INT(AA(I)+.1)                                                RD202180
C***********************************************************************RD202190
C**   READ IN FREE FIELD A CARD WITH A VECTOR OF 1 IF WEIGHT IS ONE    **RD202200
C**   WHICH IS TO BE PRINTED IN THE REPORT AND 0 IF IT IS NOT , THE    **RD202210
C**   READ, FREE FIELD, ONE RECORD CONSISTING OF 1'S AND 0'S           **RD202220
C**   USE 1 IF WEIGHT IS TO BE PRINTED IN REPORT                       **RD202230
C**   USE 0 IF WEIGHT IS OMITTED IN REPORT                             **RD202240
C**   USE ORDER OF INPUT                                               **RD202250
C***********************************************************************RD202260
      CALL READIT (AA,1,AAITEM)                                              RD202270
      DO 60 I=1,NUNKN                                                        RD202280
60    IPRNT(I)=INT(AA(I)+.1)                                                 RD202290
C***********************************************************************RD202300
C**   READ DESIGN MATRIX                                               **RD202310
C**   READ IN N (NUMBER OF OBSERVATIONS) RECORDS WITH K (NUMBER        **RD202320
C**   OF UNKNOWNS)                                                     **RD202330
C**   ENTRIES PER RECORD IN THE ORDER OF THE                           **RD202340
C**   IDENTIFICATION CARDS WHERE THE WEIGHING EQUATION ARE SET UP BY   **RD202350
C**   A SERIES OF 0,-1 AND 1 .                                               RD202360
C***********************************************************************RD202370
      DO 80 I=1,NOBS                                                         RD202380
      CALL READIT (AA,1,AAITEM)                                              RD202390
      DO 70 J=1,NUNKN                                                        RD202400
      DESMAT(J,I)=AA(J)                                                      RD202410
70    CONTINUE                                                               RD202420
80    CONTINUE                                                               RD202430
C***********************************************************************RD202440
C**   READ IN LINVAR (NUMBER OF LINEAR COMBINATIONS) RECORDS           **RD202450
C**   TO COMPUTE VARIANCE OF LINEAR COMBINATIONS OF WEIGHTS            **RD202460
C**   EACH RECORD CONTAINS K (NUMBER OF UNKNOWNS) ENTRIES              **RD202470
C**   ENTRIES OF 0'S, -1'S, AND 1'S ARE USED                           **RD202480
C**   FOLLOW ORDER OF INPUT                                            **RD202490
C***********************************************************************RD202500
      IF (LINVAR.EQ.0) GO TO 110                                             RD202510
      DO 100 I=1,LINVAR                                                      RD202520
      CALL READIT (AA,1,AAITEM)                                              RD202530
      DO 90 J=1,NUNKN                                                        RD202540
      ALCOM(J,I)=AA(J)                                                       RD202550
90    CONTINUE                                                               RD202560
100   CONTINUE                                                               RD202570
```

```
C***********************************************************************
C**   READ OBSERVATICNS FREE FIELD IN THE ORDER THAT THE DESIGN        **
C**   MATRIX IS READ                                                   **
C**   READ ENTRIES AS DENOTED BY N1 AND N2 BELOW                       **
C**                                                                    **
C**    N1 N2                                                           **
C**    2   1   X Y Z                                                   **
C**    2   0   X1 X2 X3 Y1 Y2 Y3 Z1 Z2 Z3                              **
C**    0   0   X1 X2 X3 Y1 Y2 Y3 Z1 Z2 Z3                              **
C**    3   1   X Y Z W                                                 **
C**    3   0   2-CARDS    X1 X2 X3 Y1 Y2 Y3                            **
C**                       Z1 Z2 Z3 W1 W2 W3                            **
C**    1   0   2-CARDS    X1 X2 X3 Y1 Y2 Y3                            **
C**                       Z1 Z2 Z3 W1 W2 W3                            **
C**                                                                    **
C**   NOTES                                                            **
C**      1. ANY OTHER COMBINATION OF N1 AND N2 ASSUMES THERE ARE TWO   **
C**   RECORDS, SIX ITEMS PER RECORD                                    **
C**      2. THE MAXIMUM NUMBER OF OBSERVATIONS IS 50 SO YOU MAY HAVE UP
C**         TO 600 READINGS GIVEN HERE                                 **
C**      3. NO MORE OBSERVATIONS ARE STORED WHEN                       **
C**         -20000 IS ENCOUNTERED                                      **
C***********************************************************************
110   DO 120 K=1,NR
      OBSERV(K)=0.0
120   CONTINUE
      K=1
C***********************************************************************
C**   SET UP FLAGS FOR TYPE OF WEIGHING                                **
C***********************************************************************
      IF (N1.EQ.2.AND.N2.EQ.1) GO TO 130
      IF (N1.EQ.2.AND.N2.EQ.0) GO TO 140
      IF (N1.EQ.0.AND.N2.EQ.0) GO TO 150
      IF (N1.EQ.3.AND.N2.EQ.1) GO TO 160
      IF (N1.EQ.3.AND.N2.EQ.0) GO TO 170
      IF (N1.EQ.1.AND.N2.EQ.0) GO TO 180
      GO TO 180
130   IA=3
      ITPCS=1
      GO TO 190
140   IA=9
      ITPCS=2
      GO TO 190
150   IA=9
      ITPCS=3
      GO TO 190
160   IA=4
      ITPCS=4
      GO TO 190
170   IA=6
      ITPCS=5
      GO TO 190
180   IA=6
      ITPCS=6
      GO TO 190
C***********************************************************************
C**   READ OBSERVATIONS--FREE FIELD INPUT                              **
C**   THE NUMBER -20000  DENOTES LAST CARD FOR A SERIES                **
```

```
C*****************************************************************************
190   CALL READIT (AA,1,AAITEM)
      IF (AA(1).LE.-19999.) GO TO 210
      DO 200 I=1,IA
      OBSERV(K)=AA(I)
      K=K+1
200   CONTINUE
      GO TO 190
210   RETURN
      END
--- SPINV SUBPROGRAM ---
      SUBROUTINE SPINV (A,M,KK,ISIG)
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**   MATRIX INVERSION WITH MINIMUM ROUNDOFF ERROR ACCUMULATION.        **
C**   WRITTEN BY MRS.S.T.PEAVY ,STATISTICAL ENGINEERING LABORATORY ,   **
C**   NATIONAL BUREAU OF STANDARDS ,WASHINGTON , D.C. 20234            **
C**   A IS THE MATRIX TO BE INVERTED                                    **
C**   M IS THE NUMBER OF ROWS IN MATRIX                                 **
C**   KK IS THE NUMBER OF COLUMNS IN MATRIX                             **
C**   ISIG=0 INVERSE SUCCESSFUL                                         **
C**   ISIG=4 SINGULAR MATRIX                                            **
C**   ISIG=-1 CHECK ON I(IDENTITY)-A*A(INVERSE) FAILED                  **
C*****************************************************************************
      DIMENSION A(1)
      COMMON /INVCST/ ZERMAC
C*****************************************************************************
C**   SAVE ORIGINAL MATRIX                                              **
C*****************************************************************************
      CALL SAVMTX (M)
      ISIG=0
      N=M
      NN=KK
      N2=N+N
      DO 30 J=1,N
      NJCOL=(N+J-1)*NN
      DO 30 I=1,N
      KINJ=NJCOL+I
      IF (I-J) 10,20,10
10    A(KINJ)=0.
      GO TO 30
20    A(KINJ)=1.
30    CONTINUE
C*****************************************************************************
C**   DETERMINE MAXIMUM ABSOLUTE OF VARIABLE BEING ELIMINATED.          **
C*****************************************************************************
      L=0
40    L=L+1
      LCOL=NN*L-NN
      KLL=LCOL+L
      IF (L-N) 50,100,200
C*****************************************************************************
C**   FIND THE LARGEST ELEMENT IN THE LTH COLUMN.                       **
C*****************************************************************************
```

```
50    J1=L
      C=ABS(A(KLL))
      L1=L+1
      DO 70 I=L1,N
      KIL=LCOL+I
      X=ABS(A(KIL))
      IF (C-X) 60,70,70
C***********************************************************************
C**   RECORD THE NUMBER OF THE ROW HAVING THE GREATER ELEMENT.        **
C***********************************************************************
60    J1=I
C***********************************************************************
C**   C BECOMES THE GREATER.                                          **
C***********************************************************************
      C=X
70    CONTINUE
C***********************************************************************
C**   INTERCHANGE ROW J1 WITH ROW L. J1 IS THE ROW WITH THE LARGEST   **
C**   ELEMENT TEST TO SEE IF INTERCHANGING IS NECESSARY.              **
C***********************************************************************
      IF (J1-L) 80,100,80
80    DO 90 J=L,N2
      JCOL=NN*J-NN
      KJIJ=JCOL+J1
      HOLD=A(KJIJ)
      KLJ=JCOL+L
      A(KJIJ)=A(KLJ)
      A(KLJ)=HOLD
90    CONTINUE
C***********************************************************************
C**   IF  THE LARGEST ABSOLUTE ELEMENT IN A COLUMN IS ZERO WE HAVE    **
C**   A SINGULAR MATRIX                                               **
C***********************************************************************
100   IF (ABS(A(KLL))-ZERMAC) 110,110,120
110   ISIG=4
      GO TO 200
C***********************************************************************
C**   ZERO ALL THE ELEMENTS IN THE LTH COLUMN BUT THE PIVOTAL ELEMENT **
C***********************************************************************
120   L1=1
      L2=L-1
      IF (L2) 130,130,150
130   IF (L-N) 140,170,140
140   L1=L+1
      L2=N
150   DO 160 I=L1,L2
      KIL=LCOL+I
      Z=-A(KIL)/A(KLL)
      DO 160 J=L,N2
      JCOL=NN*J-NN
      KIJ=JCOL+I
      KLJ=JCOL+L
160   A(KIJ)=A(KIJ)+Z*A(KLJ)
      IF (N-L2) 40,40,130
C***********************************************************************
C**   DIVIDE BY DIAGONAL ELEMENTS.                                    **
C***********************************************************************
170   DO 180 I=1,N
```

```
      KKK=NN*I-NN+I                                                     INV01060
      ZZ=A(KKK)                                                         INV01070
      DO 180 J=1,N2                                                     INV01080
      KKI=NN*J-NN+I                                                     INV01090
180   A(KKI)=A(KKI)/ZZ                                                  INV01100
C***********************************************************************INV01110
C**   RETURN AFTER PUTTING A INVERSE INTO B                           **INV01120
C***********************************************************************INV01130
      DO 190 J=1,N                                                      INV01140
      JCOL=NN*J-NN                                                      INV01150
      NJCOL=NN*N+JCOL                                                   INV01160
      DO 190 I=1,N                                                      INV01170
      KIJ=JCOL+I                                                        INV01180
      KINJ=NJCOL+I                                                      INV01190
190   A(KIJ)=A(KINJ)                                                    INV01200
C***********************************************************************INV01210
C**   CHECK SUCCESS OR FAILURE OF MATRIX INVERSION                    **INV01220
C***********************************************************************INV01230
      CALL INVCHK (A,M,KK,ISIG)                                         INV01240
200   RETURN                                                            INV01250
      END                                                               INV01260
--- SAVMTX SUBPROGRAM ---
      SUBROUTINE SAVMTX (M)                                             SVM00010
C***********************************************************************SVM00020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **SVM00030
C**   PROGRAM  VERSION OF SEPT.10,1971      WRITTEN BY R.C.RAYBOLD    **SVM00040
C**   AND MRS.R.N.VARNER                                              **SVM00050
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **SVM00060
C***********************************************************************SVM00070
C**   SUBROUTINE TO SAVE ORIGINAL MATRIX BEFORE INVERSION             **SVM00080
C**   MATRIX IS IN Y AND IS STORED IN B                               **SVM00090
C***********************************************************************SVM00100
C**   DIMENSION FOR COMMON /CHECK/ VARIABLES                          **SVM00110
C***********************************************************************SVM00120
      DIMENSION B(289),Y(578)                                           SVM00130
C***********************************************************************SVM00140
C**   LABELED COMMON                                                  **SVM00150
C***********************************************************************SVM00160
      COMMON /CHECK/ CHCKMA,B,Y                                         SVM00170
      MA=M*M                                                            SVM00180
      DO 10 I=1,MA                                                      SVM00190
10    B(I)=Y(I)                                                         SVM00200
      RETURN                                                            SVM00210
      END                                                               SVM00220
--- INVCHK SUBPROGRAM ---
      SUBROUTINE INVCHK (A,M,KK,ISIG)                                   IVC00010
C***********************************************************************IVC00020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **IVC00030
C**   PROGRAM  VERSION OF SEPT.10,1971      WRITTEN BY R.C.RAYBOLD    **IVC00040
C**   AND MRS.R.N.VARNER                                              **IVC00050
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **IVC00060
C***********************************************************************IVC00070
C**   SUBROUTINE TO CHECK  I-AA(INV)                                  **IVC00080
C**   A IS INVERTED MATRIX                                            **IVC00090
C**   B IS ORIGINAL MATRIX                                            **IVC00100
C**   M IS NUMBER OF ROWS IN MATRIX                                   **IVC00110
C**   KK IS NUMBER OF COLUMNS IN MATRIX                               **IVC00120
C**   ISIG=-1 IF I-A*A(INV) FAILS                                     **IVC00130
```

```
C***********************************************************************
      DIMENSION A(1)
C***********************************************************************
C**   DIMENSION FOR COMMON /CHECK/                                    **
C***********************************************************************
      DIMENSION B(289),Y(578)
C***********************************************************************
C**   LABELED COMMON                                                  **
C**                                                                   **
      COMMON /CHECK/ CHCKMA,B,Y
      N=M
      NN=KK
C***********************************************************************
C**   RESTORE ORIGINAL MATRIX                                         **
C***********************************************************************
      NP=N*N
      DO 10 J=1,NP
      NP2=NP+J
10    A(NP2)=B(J)
C***********************************************************************
C**   B=I-AA(INV)                                                     **
C***********************************************************************
      IBP=1
      K=1
      DO 60 J=1,NN
      IAP=N*N+1
      DO 50 KA=1,N
      IA=IAP
      IB=IBP
      B(K)=0.0
      DO 20 I=1,NN
      B(K)=B(K)+A(IA)*A(IB)
      IB=IB+1
20    IA=IA+N
      IF (J.EQ.KA) GO TO 30
      B(K)=-B(K)
      GO TO 40
30    B(K)=1.0-B(K)
40    IAP=IAP+1
50    K=K+1
60    IBP=IBP+N
C***********************************************************************
C**    PICK UP THE LARGEST ABSOLUTE VALUE FROM  I-AA(INV)             **
C***********************************************************************
       BIG=ABS(B(1))
       J=N*N
       DO 70 I=2,J
70     BIG=AMAX1(BIG,ABS(B(I)))
C***********************************************************************
C**    IF CONDITION IS NOT MET SET SIGNAL (ISIG)=-1                   **
C**    CHCKMA=.01*S.D. OF BALANCE(INPUT VALUE)                        **
C***********************************************************************
       IF (BIG.LE.CHCKMA) RETURN
       ISIG=-1
       RETURN
       END
--- PRINT2 SUBPROGRAM ---
       SUBROUTINE PRINT2
```

```
C***********************************************************************PR200020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **PR200030
C**   PROGRAM  VERSION OF SEPT. 10,1971     WRITTEN BY R.C.RAYECLD      **PR200040
C**   AND MRS.R.N.VARNER                                              **PR200050
C**   MODIFIED BY R. N. VARNER SEPT 1979                              **PR200060
C***********************************************************************PR200070
C**   SUBROUTINE TO PRINT PAGES FOR ONE SERIES                        **PR200080
C***********************************************************************PR200090
C**   DIMENSION FOR COMMON /PRT1/ VARIABLES                           **PR200100
C***********************************************************************PR200110
      DIMENSION B1(72),B2(72),B3(72),B4(72),B5(72),B6(72),B7(72),       PR200120
     2 IDATE(3)                                                         PR200130
C***********************************************************************PR200140
C**   DIMENSION FOR COMMON /INPUT/ VARIABLES                          **PR200150
C***********************************************************************PR200160
      DIMENSION AIDCST(5,15),ANOM(15),DENSTY(15),COEFEX(15),ACCVAL(15), PR200170
     2 ARSTIN(15),ACKSTD(15),IRSTOU(15),IPRNT(15),DESMAT(15,50),        PR200180
     3 OBSERV(600),ALCOM(15,20)                                         PR200190
C***********************************************************************PR200200
C**   DIMENSION FOR COMMON /COMPUT/ VARIABLES                         **PR200210
C***********************************************************************PR200220
      DIMENSION SWTPRT(50),A(50),DELTA(50),OBSCOR(15),COMVOL(15),       PR200230
     2 SERROR(15),TRISIG(15),TCTUN(15),DRIFT(50),ZERO(50),COMVOF(15),   PR200240
     3 CORR5A(20),SIG35A(20),UNC5A(20),IOTSTR(50),SER5A(20),DS1(50)     PR200250
C***********************************************************************PR200260
C**   DIMENSION FOR SUBROUTINE PRINT2                                 **PR200270
C***********************************************************************PR200280
      DIMENSION ITEMP(15),KTEMP(15),JTEMP(20)                           PR200290
C***********************************************************************PR200300
C***********************************************************************PR200310
C**   DIMENSION FOR COMMON /CHECK/ VARIABLES                          **PR200320
C***********************************************************************PR200330
      DIMENSION B(289),Y(578)                                           PR200340
C***********************************************************************PR200350
C**   DIMENSION FOR COMMON /PRTLB/ VARIABLES                          **PR200360
C***********************************************************************PR200370
      DIMENSION PRTLBX(15)                                              PR200380
C***********************************************************************PR200390
C**   LABELED COMMON                                                  **PR200400
C***********************************************************************PR200410
      COMMON /PRT1/ B1,B2,B3,B4,B5,B6,B7,RANERR,SYSERR,TNOM,L1,L2,L3,L4,PR200420
     2 L5,L6,IDATE,IBREST                                               PR200430
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                   PR200440
      COMMON /INPUT/ TBAR,PBAR,HBAR,STDEBA,SWT,VSWT,CEXSWT,AIDCST,ANOM, PR200450
     2 DENSTY,COEFEX,ACCVAL,ARSTIN,ACKSTD,DESMAT,OBSERV,VARBAL,ALCOM,T1PPR200460
     3,T2P,P1P,P2P,H1P,H2P,CP1,CP2,CT1,CT2,CH1,CH2,OT1P,OT2P,OP1P,OP2P, PR200470
     4 OH1P,OH2P,IOP,IBAL,NOBS,NUNKN,IRSTOU,IPRNT,ITPOS,ICKUSD,ICALDS,  PR200480
     5 LINVAR,N3,N4                                                     PR200490
      COMMON /COMPUT/ OBSCOR,CORR,VOLRES,RHOA,SWTPRT,A,DELTA,COMVOL,    PR200500
     2 SERROR,TRISIG,TCTUN,ACCRR,CORRES,TMSUM,VOLSUM,SERSUM,T3SIG,ALOADPPR200510
     3,OBSTD,FRATIO,OBCOCK,OBSCK,TVAL,DRIFT,ZERO,V2TAU,STAR,COMVOP,     PR200520
     4 CORR5A,SIG35A,UNC5A,RHOAA,RHOAB,SER5A,DS1,NDGFR,ISWTCH,IFLAG,    PR200530
     5 IRCUT,IOTSTR,JSTAR                                               PR200540
      COMMON /PRTLB/ PRTLBX                                             PR200550
      COMMON /CHECK/ CHCKMA,B,Y                                         PR200560
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 PR200570
      COMMON /DPFDVL/ KFD(18)                                           PR200580
      COMMON /PCHOUT/ NTCP                                              PR200590
```

```
C*************************************************************************PR200600
C**   TYPE STATEMENT                                                    **PR200610
C*************************************************************************PR200620
      DOUBLE PRECISION DESCOR                                             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) STDEBA,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) CORR,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,OT1P,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),COEFEX(I),
      2ACCVAL(I)
       GO TO 100
90     WRITE (IW,1240) (AIDCST(IU,I),IU=1,5),ANOM(I),DENSTY(I),COEFEX(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
260   WRITE (IW,1270) (KTEMP(I),I=1,NUNKN)
C*************************************************************************
C**   SET UP AND PRINT DESIGN MATRIX                                    **
C*************************************************************************
270   DO 310 I=1,NOBS
      DO 300 J=1,NUNKN
      IF (DESMAT(J,I).EQ.0.0) GO TO 280
      IF (DESMAT(J,I).EQ.1.0) GO TO 290
      ITEMP(J)=KFD(12)
      GO TO 300
280   ITEMP(J)=KFD(11)
      GO TO 300
290   ITEMP(J)=KFD(15)
300   CONTINUE
      CALL CHKLN (1)
      WRITE (IW,1280) I,(ITEMP(J),J=1,NUNKN)
310   CONTINUE
      DO 340 J=1,NUNKN
      IF (ARSTIN(J).EQ.0.0) GO TO 320
      IF (ARSTIN(J).EQ.1.0) GO TO 330
      ITEMP(J)=KFD(12)
      GO TO 340
320   ITEMP(J)=KFD(11)
      GO TO 340
330   ITEMP(J)=KFD(15)
340   CONTINUE
      CALL CHKLN (1)
      WRITE (IW,1290) (ITEMP(J),J=1,NUNKN)
C*************************************************************************
C**   WRITE OBSERVATIONS AS READ                                        **
C*************************************************************************
      CALL CHKLN (3)
      WRITE (IW,1300)
      J=1
      CALL CHKLN (2)
      GO TO (350,390,400,450,470,  480), ITPOS
350   WRITE (IW,1310)
      DO 380 I=1,NOBS
      CALL CHKLN (1)
      IF (DS1(I).EQ.0.0) GO TO 360
      WRITE (IW,1370) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2)
      GO TO 370
360   WRITE (IW,1370) I,OBSERV(J),OBSERV(J+1)
370   J=J+3
380   CONTINUE
      GO TO 510
C*************************************************************************
390   WRITE (IW,1320)
      GO TO 410
400   WRITE (IW,1330)
410   DO 440 I=1,NOBS
      CALL CHKLN (2)
      IF (DS1(I).EQ.0.0) GO TO 420
      WRITE (IW,1380) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2),OBSERV(J+3),OB
     2SERV(J+4),OBSERV(J+5),OBSERV(J+6),OBSERV(J+7),OBSERV(J+8)
      GO TO 430
420   WRITE (IW,1380) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2),OBSERV(J+3),OB
```

```
     2SERV(J+4),OBSERV(J+5)
430   J=J+9
440   CONTINUE
      GO TO 510
C**********************************************************************
450   WRITE (IW,1340)
      DO 460 I=1,NOBS
      CALL CHKLN (1)
      WRITE (IW,1390) I,OBSERV(J),OBSERV(J+1),OBSERV(J+2),OBSERV(J+3)
      J=J+4
460   CONTINUE
      GO TO 510
C**********************************************************************
470   WRITE (IW,1350)
      GO TO 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   CONTINUE
510   IF (IFLAG) 530,540,520
C**********************************************************************
C**   RETURN IF MATRIX IS SINGULAR                                   **
C**       OR INVERSE IS IN ERROR                                     **
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=FLOAT(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=FLOAT(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=FLOAT(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 OF SERIES                                     **
C**********************************************************************
```

```
540   CALL HEADPG
      CALL CHKLN (3)
      WRITE (IW,1150) ICALDS
      CALL CHKLN (5)
      WRITE (IW,1460) SWT,VSWT,CEXSWT,STAR
      CALL CHKLN (5)
      GO TO (550,550,580,610,610,  630), ITPOS
550   WRITE (IW,1470)
      DO 570 I=1,NOBS
      CALL CHKLN (1)
      IF (DS1(I).EQ.0.0) GO TO 560
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),DS1(I)
      GO TO 570
560   WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I)
570   CONTINUE
      GO TO 650
C*************************************************************************
580   WRITE (IW,1480)
      CALL CHKLN (1)
      DO 600 I=1,NOBS
      IF (DS1(I).EQ.0.0) GO TO 590
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),ZERO(I),DS1(I)
      GO TO 600
590   WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),ZERO(I)
600   CONTINUE
      GO TO 650
C*************************************************************************
610   WRITE (IW,1490)
      DO 620 I=1,NOBS
      CALL CHKLN (1)
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),DRIFT(I),DS1(I
     2)
620   CONTINUE
      GO TO 650
C*************************************************************************
630   WRITE (IW,1500)
      DO 640 I=1,NOBS
      CALL CHKLN (1)
      WRITE (IW,1540) I,IOTSTR(I),A(I),DELTA(I),SWTPRT(I),DRIFT(I),ZERO(
     2I),DS1(I)
640   CONTINUE
650   IF (JSTAR.EQ.0) GO TO 660
      CALL CHKLN (3)
      WRITE (IW,1510)
660   CALL CHKLN (6)
      IF (N3.EQ.0) GO TO 680
C*************************************************************************
C**   ENGLISH UNITS                                                    **
C*************************************************************************
      WRITE (IW,1530)
      DO 670 I=1,NUNKN
      CALL CHKLN (1)
      FOBSCR=OBSCOR(I)
      WRITE (IW,1560) PRTLEX(I),FOBSCR,COMVOP(I),SERROR(I),TRISIG(I),TOT
     2UN(I)
670   CONTINUE
      GO TO 700
C*************************************************************************
```

```
C**   METRIC UNITS                                                    **PR203490
C***********************************************************************PR203500
680   WRITE (IW,1520)                                                   PR203510
      DO 690 I=1,NUNKN                                                  PR203520
      CALL CHKLN (1)                                                    PR203530
      FOBSCR=OBSCOR(I)                                                  PR203540
      WRITE (IW,1550) ANCM(I),FOBSCR,COMVOP(I),SERROR(I),TRISIG(I),TOTUNPR203550
     2(I)                                                               PR203560
690   CONTINUE                                                          PR203570
700   IF (ISWTCH.EQ.0) GO TO 710                                        PR203580
      CALL CHKLN (3)                                                    PR203590
      WRITE (IW,1570)                                                   PR203600
710   CALL CHKLN (3)                                                    PR203610
      WRITE (IW,1580) TEAR                                              PR203620
      XXXX=0.1*STDEBA                                                   PR203630
      XXXXX=ABS(ACORR-CORRES)                                           PR203640
      IF (XXXXX.LE.XXXX) GO TO 720                                      PR203650
      CALL CHKLN (7)                                                    PR203660
      WRITE (IW,1590) ACORR,CORRES                                      PR203670
720   IF (IRCUT.EQ.0.0) GO TO 730                                       PR203680
      CALL CHKLN (6)                                                    PR203690
      WRITE (IW,1600) (IRSTOU(I),I=1,NUNKN)                             PR203700
      WRITE (IW,1610) TMSUM,VOLSUM,SERSUM,T3SIG                         PR203710
C***********************************************************************PR203720
C**   WRITE LAST PAGE OF SERIES  IF LINVAR NOT EQUAL TO ZERO          **PR203730
C***********************************************************************PR203740
730   IF (LINVAR.EQ.0) GO TO 930                                        PR203750
      CALL HEADPG                                                       PR203760
      CALL CHKLN (3)                                                    PR203770
      WRITE (IW,1150) ICALDS                                            PR203780
      CALL CHKLN (3)                                                    PR203790
      WRITE (IW,1620)                                                   PR203800
      CALL CHKLN (1)                                                    PR203810
      IF (N3.EQ.0) GO TO 770                                            PR203820
C***********************************************************************PR203830
C**   ENGLISH UNITS                                                   **PR203840
C***********************************************************************PR203850
      GO TO (740,750,760), JFLAG                                        PR203860
740   WRITE (IW,1080)                                                   PR203870
      GO TO 800                                                         PR203880
750   WRITE (IW,1090)                                                   PR203890
      GO TO 800                                                         PR203900
760   WRITE (IW,1100)                                                   PR203910
      GO TO 800                                                         PR203920
C***********************************************************************PR203930
C**   METRIC UNITS                                                    **PR203940
C***********************************************************************PR203950
770   GO TO (780,790), JFLAG                                            PR203960
780   WRITE (IW,1630)                                                   PR203970
      GO TO 800                                                         PR203980
790   WRITE (IW,1640)                                                   PR203990
800   CALL CHKLN (1)                                                    PR204000
      WRITE (IW,1650) (KTEMP(I),I=1,NUNKN)                              PR204010
      DO 840 I=1,LINVAR                                                 PR204020
      JTEMP(I)=0                                                        PR204030
      DO 830 J=1,NUNKN                                                  PR204040
      JTEMP(I)=JTEMP(I)+KTEMP(J)*INT(ALCOM(J,I))                        PR204050
      IF (ALCOM(J,I).EQ.0.0) GO TO 810                                  PR204060
```

```
      IF (ALCOM(J,I).EQ.1.0) GO TO 820
      ITEMP(J)=KFD(12)
      GO TO 830
810   ITEMP(J)=KFD(11)
      GO TO 830
820   ITEMP(J)=KFD(15)
830   CONTINUE
      CALL CHKLN (1)
      WRITE (IW,1660) JTEMP(I),(ITEMP(K),K=1,NUNKN)
840   CONTINUE
      CALL CHKLN (8)
      WRITE (IW,1670)
      WRITE (IW,1680)
      CALL CHKLN (2)
      IF (N3.EQ.0) GO TO 880
      GO TO (850,860,870), JFLAG
850   WRITE (IW,1110)
      GO TO 910
860   WRITE (IW,1120)
      GO TO 910
870   WRITE (IW,1130)
      GO TO 910
880   GO TO (890,900), JFLAG
890   WRITE (IW,1690)
      GO TO 910
900   WRITE (IW,1700)
910   DO 920 I=1,LINVAR
      CALL CHKLN (1)
      WRITE (IW,1710) JTEMP(I),CORR5A(I),SER5A(I),SIG35A(I),UNCEA(I)
920   CONTINUE
C*********************************************************************
C**   WRITE LAST PAGE OF SERIES                                     **
C*********************************************************************
930   CALL HEADPG
      CALL CHKLN (2)
      WRITE (IW,1720) ALCADP,IBREST
      CALL CHKLN (3)
      WRITE (IW,1150) ICALDS
      CALL CHKLN (9)
      WRITE (IW,1730) OBSTD,STDEBA,NDGFR,FRATIO
C*********************************************************************
C**   COMPUTE F - VALUE                                             **
C*********************************************************************
      PRETST=6.64
      CALL CHKLN (4)
      IF (NDGFR.EQ.1) GO TO 940
      ANDGFR=NDGFR
      PRETST=(1.0-2.0/(9.*ANDGFR)+2.32635*SQRT(2.0/(9.0*ANDGFR)))**3
940   IF (FRATIO.GT.PRETST) GO TO 950
      WRITE (IW,1740) PRETST
      GO TO 960
950   WRITE (IW,1750)
      WRITE (IW,1760) PRETST
      WRITE (IW,1750)
      ITST=0
960   DO 970 I=1,NUNKN
970   ITEMP(I)=ACKSTD(I)
      CALL CHKLN (3)
```

```
      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,TBAR,P1P,P2P,PBAR,H1P,H2P,HBAR,RHOAB,RHOAA
     2,RHOA,CT1,CT2,CP1,CP2,CH1,CH2,CT1P,CT2P,OP1P,OP2P,OH1P,OH2P
      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,HBAR,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),8X,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/)
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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 OF THE PROCESS,2X, PR205250
     2 F13.5,3H MG/51H ACCEPTED BETWEEN STANDARD DEVIATION OF THE PROCESPR205260
     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 CORRECTION 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 DEVIATION LIMIT FOR RANDOM ERROR AFFECTING RPR205330
     5ESTRAINT ,F10.5,3H MG//)                                          PR205340
1180  FORMAT (22H CHECK STANDARD VECTOR,1X,15I5)                        PR205350
1190  FORMAT (22H CHECK STANDARD USED  ,I4)                             PR205360
1200  FORMAT (44H ACCEPTED MASS CORRECTION OF CHECK STANDARD ,F13.5,    PR205370
     2 3H MG)                                                           PR205380
1210  FORMAT (//16H TEST CONDITIONS,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 CORRECTION,14X,2F13.3/20H PRESSURE CORRECTION,17XPR205440
     7,2F13.3/20H HUMIDITY CORRECTION,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,12HOF EXPANSION,2X,13HCORRECTION 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,13HCORRECTION 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 OBSERVATIONS IN DIVISIONS)                          PR205610
1310  FORMAT (39H SINGLE SUBSTITUTION SINGLE PAN BALANCE/)              PR205620
1320  FORMAT (36H SINGLE SUBSTITUTION TWO PAN BALANCE/)                 PR205630
1330  FORMAT (37H SINGLE TRANSPOSITION TWO PAN BALANCE/)                PR205640
1340  FORMAT (36H DOUBLE SUBSTITUTION ONE PAN BALANCE/)                 PR205650
1350  FORMAT (36H DOUBLE SUBSTITUTION TWO PAN BALANCE/)                 PR205660
1360  FORMAT (37H DOUBLE TRANSPOSITION TWO PAN BALANCE/)                PR205670
1370  FORMAT (3H A ,I2,1X,3F11.4)                                       PR205680
1380  FORMAT (3H A ,I2,1X,6F11.4/6X,3F11.4)                             PR205690
1390  FORMAT (3H A ,I2,1X,4F11.4)                                       PR205700
1400  FORMAT (3H A ,I2,1X,6F11.4/6X,6F11.4)                             PR205710
1410  FORMAT (//19H MATRIX IS SINGULAR)                                 PR205720
1420  FORMAT (//17H1ERROR IN INVERSE)                                   PR205730
1430  FORMAT (//4H A =/(5E16.8))                                        PR205740
1440  FORMAT (//12H A(INVERSE)=/(5E16.8))                               PR205750
1450  FORMAT (//15H I-AA(INVERSE)=/(5E16.8))                            PR205760
1460  FORMAT (/19H SENSITIVITY WEIGHT/5H MASS,2X,F13.5,3H MG/7H VOLUME, PR205770
     2 2X,F13.5,12H CM3 AT 20 C/25H COEFFICIENT OF EXPANSION,2X,F8.6/5X,PR205780
     3 11HS*=S-PV(S)=,1X,F13.5,3H MG)                                   PR205790
1470  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,         PR205810
     3 8H(MG/DIV),6X,8H(MG/DIV/)                                         PR205820
1480  FORMAT (/35X,7HAVERAGE,16X,8HOBSERVED/13X,4HA(I),6X,8HDELTA(I),3X,PR205830
     2 11HSENSITIVITY,4X,7HZERO(I),2X,11HSENSITIVITY/13X,4H(MG),9X,      PR205840
     3 4H(MG),5X,8H(MG/DIV),6X,5H(DIV),6X,8H(MG/DIV)/)                   PR205850
1490  FORMAT (/37X,7HAVERAGE,16X,8HOBSERVED/13X,4HA(I),5X,8HDELTA(I),5X,PR205860
     2 11HSENSITIVITY,2X,8HDRIFT(I),2X,11HSENSITIVITY/13X,4H(MG),7X,     PR205870
     3 4H(MG),8X,8H(MG/DIV),6X,4H(MG),6X,8H(MG/DIV)/)                    PR205880
1500  FORMAT (/37X,7HAVERAGE,27X,8HOBSERVED/13X,4HA(I),6X,8HDELTA(I),4X,PR205890
     2 11HSENSITIVITY,2X,8HDRIFT(I),3X,7HZERO(I),3X,11HSENSITIVITY/13X, PR205900
     3 4H(MG),8X,4H(MG),7X,8H(MG/DIV),5X,4H(MG),6X,5H(DIV),6X,8H(MG/DIV)PR205910
     4/)                                                                 PR205920
1510  FORMAT (/6X,64H* OBSERVED DEFLECTION IS GREATER THAN OR EQUAL TO OPR205930
     2NE FOURTH THE/8X,22HSENSITIVITY DEFLECTION)                        PR205940
1520  FORMAT (//31X,6HVOLUME,5X,10HSYSTEMATIC,3X,6H3 S.D.,3X,           PR205950
     2 11HUNCERTAINTY/5X,4HITEM,8X,10HCORRECTION,4X,6H(AT T),8X,,5HERRORPR205960
     3,6X,5HLIMIT,6X,5HLIMIT/6X,3H(G),12X,4H(MG),7X,5H(CM3),9X,4H(MG),7XPR205970
     4,4H(MG),7X,4H(MG)/)                                                PR205980
1530  FORMAT (//31X,6HVOLUME,5X,10HSYSTEMATIC,3X,6H3 S.D.,3X,           PR205990
     2 11HUNCERTAINTY/5X,4HITEM,8X,10HCORRECTION,4X,6H(AT T),8X,5HERROR,PR206000
     3 6X,5HLIMIT,6X,5HLIMIT/5X,4H(LB),12X,4H(MG),7X,5H(CM3),9X,4H(MG), PR206010
     4 7X,4H(MG),7X,4H(MG)/)                                             PR206020
1540  FORMAT (3H A ,I2,1X,A1,6F12.5)                                     PR206030
1550  FORMAT (1X,F12.4,2F13.5,3F11.5)                                    PR206040
1560  FORMAT (1X,F12.7,2F13.5,3F11.5)                                    PR206050
1570  FORMAT (/25H STOPPED AT 10 ITERATIONS/)                            PR206060
1580  FORMAT (/15H TEMPERATURE T=,F6.2,3H  C/)                           PR206070
1590  FORMAT (1X,72H*****************************************************PR206080
     2*******************/1X,                                            PR206090
     3 72HINPUT ERROR IN RESTRAINT. CHECK RESTRAINT VECTOR, NOMINAL VALUPR206100
     4E, DENSITY/1X,                                                     PR206110
     5 72HAND COEFFICIENT OF EXPANSION IN THIS AND PREVIOUS SERIES.      PR206120
     6          /2X,30H INPUT CORRECTION OF RESTRAINT,4X,F11.4,3H MG/2X,PR206130
     7 33H COMPUTED CORRECTION OF RESTRAINT,1X,F11.4,3H MG/1X,           PR206140
     8 72H*****************************************************PR206150
     9**********/)                                                       PR206160
1600  FORMAT (31H RESTRAINT FOR FOLLOWING SERIES/17H RESTRAINT VECTOR,1XPR206170
     2,15I5)                                                             PR206180
1610  FORMAT (16H MASS CORRECTION,17X,F13.5,3H MG/15H VOLUME AT 20 C,18XPR206190
     2,F13.5,4H CM3/17H SYSTEMATIC ERROR,16X,F13.5,3H MG/                PR206200
     3 27H 3 STANDARD DEVIATION LIMIT,6X,F13.5,3H MG)                    PR206210
1620  FORMAT (//3X,3HSUM,6X,40HWEIGHTS USED FOR THE LINEAR COMBINATIONS)PR206220
1630  FORMAT (3X,3H(G),6X,5HGRAMS)                                       PR206230
1640  FORMAT (2X,4H(MG),6X,2HMG)                                         PR206240
1650  FORMAT (6X,15I5)                                                   PR206250
1660  FORMAT (1X,I5,15(4X,A1))                                           PR206260
1670  FORMAT (//10X,                                                     PR206270
     2 52HVALUES AND UNCERTAINTIES FOR COMBINATIONS OF WEIGHTS/1X,       PR206280
     3 61H(UNCERTAINTY IS 3 STANDARD DEVIATION LIMIT PLUS ALLOWANCE FOR/PR206290
     4 19H SYSTEMATIC ERROR.))                                           PR206300
1680  FORMAT (/39X,6H3 S.D.,5X,11HUNCERTAINTY/3X,3HSUM,8X,4HCORR,4X,     PR206130
     2 10HSYSTEMATIC,7X,5HERROR,8X,5HLIMIT)                              PR206320
1690  FORMAT (3X,3H(G),8X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)/)       PR206330
1700  FORMAT (2X,4H(MG),8X,4H(MG),7X,4H(MG),10X,4H(MG),10X,4H(MG)/)      PR206340
1710  FORMAT (1X,I5,4F13.5)                                              PR206350
1720  FORMAT (13H MAXIMUM LOAD,F15.4,2H G/1X,                            PR206360
     2 25HSTARTING RESTRAINT NUMBER,2X,I2)                               PR206370
1730  FORMAT (//18H PRECISION CONTROL///                                 PR206380
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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/ TBAR,PBAR,HBAR,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,IBREST                                                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,CBSERV,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
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      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 COEPRT(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,TNOM,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,COEPRT,NPRTFPR00360
      COMMON /INPUT/ TBAR,PBAR,HBAR,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,ICKUSD,ICALDS,  FPR00400
     5 LINVAR,N3,N4                                                     FPR00410
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                 FPR00420
      COMMON /PCHOUT/ 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)
      END FILE ITMP
      REWIND ITMP
10    READ (ITMP) (IAP(I),I=1,5),TAP(1),IAP(6),TAP(2),IAP(7),IAP(8),(TAP
     2(I),I=3,9),IAP(9)
      IF (IAP(1).EQ.IFLAG) GO TO 20
      WRITE (IP,200) (IAP(I),I=1,5),TAP(1),IAP(6),TAP(2),IAP(7),IAP(8),(
     2TAP(I),I=3,9),IAP(9)
      GO TO 10
20    KKK=0
      NOSER=200
      IF (N3.EQ.0) GO TO 40
C***********************************************************************
C**   MASS WAS GIVEN IN ENGLISH UNITS                                 **
C**   CONVERT TO GRAMS                                                **
C***********************************************************************
      DO 30 I=1,NPRT
      TRMASS(I)=TRMASS(I)*(1.D0/453.59237D0)
      APPMAS(I)=APPMAS(I)*(1.D0/453.59237D0)*1000.0D0
      CORRB(I)=CORRB(I)*(1.D0/453.59237D0)*1000.0D0
      UNCERT(I)=UNCERT(I)*(1./453.59237)
      VOLPRT(I)=VOLPRT(I)*.06102374
30    CONTINUE
C***********************************************************************
C**   MASS WAS GIVEN IN METRIC UNITS                                  **
C***********************************************************************
40    IF (NPRT.EQ.1) GO TO 80
      DO 50 I=1,NPRT
      TEMPAR(I)=TRMASS(I)
      NNP(I)=I
50    CONTINUE
      NNN=NPRT-1
      DO 70 I=1,NNN
      IP1=I+1
      DO 70 J=IP1,NPRT
      IF (TEMPAR(I)-TEMPAR(J)) 70,70,60
60    TEMP=TEMPAR(I)
      TEMPAR(I)=TEMPAR(J)
      TEMPAR(J)=TEMP
      TEMP=NNP(I)
      NNP(I)=NNP(J)
      NNP(J)=TEMP
70    CONTINUE
80    NN=1
      IF (NPRT.NE.1) GO TO 90
      NNP(1)=1
90    IPAGE=IPAGE+1
      WRITE (IW,260) (B1(K),K=1,65),IPAGE
      WRITE (IW,270) (B2(K),K=1,65),(IDATE(K),K=1,3)
      WRITE (IW,280) (B3(K),K=1,65)
      WRITE (IW,290) (B7(K),K=1,18)
      IPGCT=8
      IF (NN.EQ.2) GO TO 110
      IF (NN.EQ.3) GO TO 160
      JA=1
      JB=12
      IF (KKK.EQ.1) GO TO 100
      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,I2,1H3)                                                     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
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230    FORMAT (2X,5A3,1X,15A1,1X,F13.8,1X,F10.5,1X,F8.6)                  FPR01680
240    FORMAT (/2X,4HITEM,18X,22HCOR.A (MG)  COR.B (MG)/)                  FPR01690
250    FORMAT (2X,5A3,1X,13A1,1X,13A1)                                     FPR01700
260    FORMAT (1H1,65A1,4HPAGE,I3)                                         FPR01710
270    FORMAT (1X,65A1,I2,1H/I2,1H/I2)                                     FPR01720
280    FORMAT (1X,65A1)                                                    FPR01730
290    FORMAT (1X,11HTEST NUMBER,2X,18A1//)                                FPR01740
300    FORMAT (/24X,4HMASS,8X,11HUNCERTAINTY,2X,9HVOL AT 20,2X,            FPR01570
     2 11HCOEF OF EXP/5X,4HITEM,15X,4H(LB),12X,4H(LB),6X,5H(IN3)/)         FPR01760
310    FORMAT (2X,5A3,1X,15A1,1X,F13.11,1X,F10.6,1X,F8.6)                  FPR01770
320    FORMAT (12X,4HITEM,8X,5HCOR.A,7X,5HCOR.B/23X,10H(MICRO-LB),3X,      FPR01780
     2 10H(MICRO-LB))                                                      FPR01790
330    FORMAT (1H1)                                                        FPR01800
       END                                                                 FPR01810
--- TEXTS1 SUBPROGRAM ---
       SUBROUTINE TEXTS1                                                   TS100010
C***********************************************************************TS100020
C**    SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TS100030
C**    PROGRAM  VERSION OF SEPT.10,1971     WRITTEN BY R.C.RAYBOLD     **TS100040
C**    AND MRS.R.N.VARNER                                              **TS100050
C**    PRINT FIRST OF LAST TWO PAGES OF REPORT                         **TS100060
C**    MODIFIED BY R. N. VARNER SEPT 1979                              **TS100070
C***********************************************************************TS100080
       COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                     TS100090
       WRITE (IW,10)                                                       TS100100
       WRITE (IW,20)                                                       TS100110
       WRITE (IW,30)                                                       TS100120
       WRITE (IW,40)                                                       TS100130
       WRITE (IW,50)                                                       TS100140
       WRITE (IW,60)                                                       TS100150
       WRITE (IW,70)                                                       TS100160
       WRITE (IW,80)                                                       TS100170
       WRITE (IW,90)                                                       TS100180
       WRITE (IW,100)                                                      TS100190
       RETURN                                                              TS100200
C***********************************************************************TS100210
C**   FORMAT STATEMENTS                                                **TS100220
C***********************************************************************TS100230
10     FORMAT (1X,36H                 SUMMARY                         ,    TS100240
     236H       THE   ESTIMATED   MASS  VALUES/                            TS100250
     31X,36H                                   ,                           TS100260
     436H  LISTED IN TABLE II ARE BASED ON AN/                             TS100270
     51X,36H    FOR  CONVENIENCE,  THE RESULTS  ,                          TS100280
     636H  IMPLICIT TREATMENT OF DISPLACEMENT/                             TS100290
     71X,36HOF THIS  WORK  ARE  SUMMARIZED  IN  ,                          TS100300
     836H  VOLUMES,  E.G.,  'APPARENT   MASS',/                            TS100310
     91X,36HTABLES    I  AND  II.  THE  VALUES  ,                          TS100320
     *36H  'APPARENT   MASS  VERSUS   BRASS',)                             TS100330
20     FORMAT (1X,36HASSIGNED ARE WITH REFERENCE TO THE  ,                 TS100340
     236H  'APPARENT   MASS  VERSUS   DENSITY/                             TS100350
     31X,36HSTANDARDS IDENTIFIED ON  THE  DATA  ,                          TS100360
     436H  8.0'. THE VALUES  ARE  LISTED  AS/                              TS100370
     51X,36HSHEETS.  THE UNCERTAINTY FIGURE IS  ,                          TS100380
     636H  CORRECTIONS TO BE APPLIED  TO  THE/                             TS100390
     71X,36HAN   EXPRESSION   OF  THE  OVERALL  ,                          TS100400
     836H  LISTED  NOMINAL  VALUE (A POSITIVE/                             TS100410
     91X,36HUNCERTAINTY USING  THREE  STANDARD  ,                          TS100420
     *36H  CORRECTION INDICATES THAT THE MASS)                             TS100430
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30     FORMAT (1X,36HDEVIATICNS   AS  A  LIMIT  TC  THE   ,                TS100440
      236H  IS LARGER THAN THE STATED  NOMINAL/                             TS100450
      31X,36HEFFECT OF  RANDOM  ERRCRS  OF  THE  ,                          TS100460
      436H  VALUE   BY   THE   AMCUNT  OF  THE/                             TS100470
      51X,36HMEASUREMENT   ASSOCIATED WITH  THE  ,                          TS100480
      636H  CCRRECTION).  THESE  VALUES  ARE/                               TS100490
      71X,36HMEASUREMENT PROCESSES.  THE MAGNI-  ,                          TS100500
      836H  CCMPUTED  FRCM THE VALUES BASED CN/                             TS100510
      91X,36HTUDE  OF  SYSTEMATIC  ERRORS  FRCM  ,                          TS100520
      *36H  AN EXPLICIT TREATMENT OF CISPLACE-)                             TS100530
40     FORMAT (1X,36HSCURCES  CTHER  THAN  THE  USE  OF  ,                  TS100540
      236H  MENT VOLUMES USING  THE  FOLLOWING/                             TS100550
      31X,36HACCEPTED   VALUES   FCR    CERTAIN  ,                          TS100560
      436H  DEFINING    RELATICNS    AND   ARE/                             TS100570
      51X,36HSTARTING  STANCARCS 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  PRCCESS  USED  TO  ,                          TS100660
      436H  MINIMIZE THE CEVIATICN FRCM  NCMI-/                             TS100670
      51X,36HESTABLISH  THESE VALUES.  THE MASS  ,                          TS100680
      636H  NAL ON THE EASIS OF 'NORMAL BRASS'/                             TS100690
      71X,36HUNIT,  AS  REALIZABLE  IN  ANCTHER  ,                          TS100700
      836H  (IN  ACCORDANCE WITH COR. A BELOW)/                             TS100710
      91X,36HMEASUREMENT   PRCCESS,   WILL   BE  ,                          TS100720
      *36H  IS WIDESPREAC IN THIS CCUNTRY  AND)                             TS100730
60     FORMAT (1X,36HUNCERTAIN BY AN AMCUNT WHICH IS  A  ,                  TS100740
      236H  IN    MANY   PARTS  CF  THE  WORLD./                            TS100750
      31X,36HCOMBINATICN  OF THE UNCERTAINTY CF  ,                          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 STANDARCS 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 EASIS. THE/                             TS100850
      31X,36HLISTED IN TAELE 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 MICRCGRAMS/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  CISPLACEMENT  VCLUME  ,                   TS100940
      236H  DIFFERENCE  IS  CLEARLY DETECTABLE/                             TS100950
      31X,36HASSCCIATED  WITH  EACH  VALUE   IS  ,                          TS100960
      436H  ON MANY DIRECT READING EALANCES.  /                             TS100970
      51X,36HLISTED  AS  WELL AS THE VOLUMETRIC  ,                          TS100980
      636H                                    /                             TS100990
      71X,36HCCEFFICIENT CF  EXPANSICN.   THESE  ,                          TS101000
      836H      CCRRECTICN A - 'APPARENT  MASS/                             TS101010
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     91X,36HVALUES  SHOULD  BE  USED, TOGETHER  ,                    TS101020
     *36H  VERSUS  BRASS' OR  'WEIGHT  IN AIR)                       TS101030
90    FORMAT (1X,36HWITH  APPROPRIATE  CORRECTION  FOR  ,            TS101040
     236H  AGAINST BRASS' IS DETERMINED BY  A/                       TS101050
     31X,36HTHE   BUOYANT   EFFECTS   OF   THE  ,                    TS101060
     436H  HYPOTHETICAL   WEIGHING   OF   THE/                       TS101070
     51X,36HENVIRONMENT, TO ESTABLISH CONSIST-  ,                    TS101080
     636H  WEIGHT AT 20 CELSIUS IN AIR HAVING/                       TS101090
     71X,36HENT MASS VALUES FOR OBJECTS  WHICH  ,                    TS101100
     836H  A DENSITY OF 1.2  MG/CM3,  WITH  A/                       TS101110
     91X,36HDIFFER  SIGNIFICANTLY  IN  DENSITY  ,                    TS101120
     *36H  (NORMAL  BRASS)  STANDARD HAVING A)                       TS101130
100   FORMAT (1X,36HAND/OR FOR MEASUREMENTS WHICH MUST               TS101140
     236H  DENSITY OF 8.4 G/CM3 AT 0  CELSIUS/                       TS101150
     31X,36HBE MADE IN DIFFERING ENVIRONMENTS.  ,                    TS101160
     436H  WHOSE  COEFFICIENT  OF  VOLUMETRIC/                       TS101170
     51X,36HTHE RELATION  1LB AVDP=.45359237KG  ,                    TS101180
     636H  EXPANSION IS 0.000054  PER  DEGREE/                       TS101190
     71X,36HIS USED AS REQUIRED.                ,                    TS101200
     836H  CELSIUS,  AND WHOSE VALUE IS BASED/                       TS101210
     91X,36H                                    ,                    TS101220
     *36H                                    )                       TS101230
      END                                                            TS101240
--- TEXTS2 SUBPROGRAM ---
      SUBROUTINE TEXTS2                                              TS200010
C*********************************************************************TS200020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **TS200030
C**   PROGRAM  VERSION OF SEPT.10,1971      WRITTEN BY R.C.RAYBOLD    **TS200040
C**   AND MRS.R.N.VARNER                                             **TS200050
C**   PRINT LAST PAGE OF REPORT                                      **TS200060
C**   MODIFIED BY R. N. VARNER SEPT 1979                             **TS200070
C*********************************************************************TS200080
      COMMON/UNITIO/IR,IW,IP,IPL,ITMP                                TS200090
      WRITE (IW,10)                                                  TS200100
      WRITE (IW,20)                                                  TS200110
      RETURN                                                         TS200120
C*********************************************************************TS200130
C**     FORMAT STATEMENTS                                            **TS200140
C*********************************************************************TS200150
10    FORMAT (                                                       TS200160
     236H                                    /                       TS200170
     31X,36HON ITS  TRUE  MASS  OR  WEIGHT  IN  ,                    TS200180
     436H WEIGHT, IN AIR HAVING A DENSITY OF /                       TS200190
     51X,36HVACUO.                              ,                    TS200200
     636H 1.2 MG/CM3, WITH A STANDARD HAVING /                       TS200210
     71X,36H                                    ,                    TS200220
     836H A  DENSITY  OF  8.0  G/CM3  AT 20  )                       TS200230
20    FORMAT (1X,36H    CORRECTION  B - 'APPARENT MASS               TS200240
     236H CELSIUS,  AND WHOSE VALUE IS BASED /                       TS200250
     31X,36HVERSUS DENSITY 8.0' IS  DETERMINED  ,                    TS200260
     436H ON ITS  TRUE  MASS  OR  WEIGHT  IN /                       TS200270
     51X,36HBY  A HYPOTHETICAL WEIGHING OF THE  ,                    TS200280
     636H VACUO.                             )                       TS200290
      END                                                            TS200300
--- DPFD SUBPROGRAM ---
      SUBROUTINE DPFD (A,B,N,D)                                      DPF00010
C*********************************************************************DPF00020
C**   SUBROUTINE OF THE NATIONAL BUREAU OF STANDARDS MASS CALIBRATION **DPF00030
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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***********************************************************************
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C**     CONVERT INTEGER PART                                             **DPF00620
C************************************************************************DPF00630
      I=I+1                                                               DPF00640
      DO 30 J=I,MM                                                        DPF00650
      B(J)=KFD(K+1)                                                       DPF00660
      K=IDINT(X*10.D0)                                                    DPF00670
30    X=X*10.-FLOAT(K)                                                    DPF00680
C************************************************************************DPF00690
C**     STORE DECIMAL POINT                                              **DPF00700
C************************************************************************DPF00710
40    MM=MM+2                                                             DPF00720
      B(MM-1)=KFD(13)                                                     DPF00730
C************************************************************************DPF00740
C**     CONVERT FRACTIONAL PART                                          **DPF00750
C************************************************************************DPF00760
      DO 50 I=1,D                                                         DPF00770
      B(MM)=KFD(K+1)                                                      DPF00780
      MM=MM+1                                                             DPF00790
      K=IDINT(X*10.D0)                                                    DPF00800
50    X=X*10.-FLOAT(K)                                                    DPF00810
      RETURN                                                              DPF00820
C************************************************************************DPF00830
C**     STORE *'S IF OVERFLOW                                            **DPF00840
C************************************************************************DPF00850
60    DO 70 I=1,N                                                         DPF00860
70    B(I)=KFD(14)                                                        DPF00870
      RETURN                                                              DPF00880
      END                                                                 DPF00890
--- CHKLN SUBPROGRAM ---
      SUBROUTINE CHKLN (N)                                                CHK00010
C************************************************************************CHK00020
C**   SUBROUTINE TO CHECK BEGINNING OF A NEW PAGE                        **CHK00030
C**   ADDED BY R. N. VARNER SEPT 1979                                    **CHK00040
C************************************************************************CHK00050
      COMMON /PRT2/ IPAGE,NOSER,IPGCT                                     CHK00060
      COMMON /UNITIO/ IR,IW,IP,IPL,ITMP                                   CHK00070
      IF (IPGCT+N.GT.IPL) CALL PGCONT                                     CHK00080
      IPGCT=IPGCT+N                                                       CHK00090
      RETURN                                                              CHK00100
      END                                                                 CHK00110
```

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15. SUPPLEMENTARY NOTES

☐ Document describes a computer program, SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

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.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

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

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