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

Computer Software for Measurement Assurance of Gage Blocks

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Computer Software for Measurement Assurance of Gage Blocks

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Disclaimer

The run procedures described herein pertain to the UNIVAC 1100/82 system. Accordingly, this system is identified. Such identification is for communication purposes and should not be construed as an endorsement.

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Computer Software for Measurement Assurance of Gage Blocks*

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ABSTRACT

This document is intended for those who are interested in computer software needed to provide, on a continual basis, a measurement assurance procedure for calibrating gage blocks where a test set of gage blocks is measured against two standard sets with control being on the difference of the two standards. A thorough discussion is given of the software including its implementation and usage. A hard copy or a magnetic tape of the software is available on request.

Key words: computer software; FORTRAN; gage blocks; measurement assurance; statistical control; statistical tests.

1. Introduction.

The statistical techniques needed to provide, on a continuing basis, the knowledge of the uncertainty of a gage block calibration procedure include initialization of process paramaters, maintaining process control through the use of a check standard and periodic updating of the process parameters [1]. The computer software described in this document was developed to provide an automatic method of implementing these techniques in the environment where a test set of gage blocks is measured against two standard laboratory calibrating sets with control on the difference between the standards. This is the second level of measurement assurance for gage blocks as described in NBS Monograph 163 [1]. Description of the software modules, file manipulation, input and output parameters, execution procedures, implementation procedures and error diagnostic messages are given. The software was developed on a UNIVAC 1100/82 computer at the National Bureau of Standards. Therefore, all examples of run procedures are those pertaining to the UNIVAC 1100/82 system. Examples of how to use the software are given in Appendix A. A hard copy or a magnetic tape of the software is available on request.

The software was developed in a modular fashion where each subprogram was designed to perform a specific operation. The software language (language used to develop the software) is FORTRAN 77 [2]. All machine dependent parameters are defined in two subprograms, thus making it easy for the user to adapt the software to any computer configuration. The software consists of a driver module, a block data module and 19 subprogram modules.

Each subprogram has DIMENSION statements which appear as FORTRAN comment statements. The purpose for this is to provide the implementor with the information needed when dimensions for certain variables must be increased or decreased. Included also, as FORTRAN comment statements, are FORTRAN PARAMETERS statements giving values for the variables designating current dimensions. These parameters if modified must also be changed in the BLKDAT subprogram.

*This work was initiated and supported, respectively, by two other organizational units of the National Bureau of Standards, the Automated Production Technology Division of the Center for Manufacturing Engineering, and the Office of Measurement Services.

In order to aid the implementor in assuring that the software is performing as designed, a set of test problems is given to test each phase of the measurement assurance procedure.

1.2 Data File Requirements

In order to guarantee that the measurement process is in continual control it is necessary to maintain several different data files. The first step is to create a file of pertinent information about the laboratory standards. Secondly, a file of initial control values needs to be created. A third data file contains the current process parameters. A fourth data file is needed to collect control data as calibrations are being made. A discussion of the run procedures will describe how these data files interact with each other. See Section 2.

The media used for the data file manipulations depends on the values set for the logical input-output units defined in the software module BLKDAT. See section 1.6.01 for details. Each data file is assumed to contain unit records of 80 alphanumeric characters where the format depends upon the specific function of that file. See section 2. The end of data, in most cases, is flagged by the integer value 99999.

1.3 General Philosophy of Input.

The computer software was developed with ease of use as a top priority. Consequently, every endeavor was made to make the input as simple as possible. In most cases input information whether requested from the runstream or from a data file is assumed to be in free field format. This means that the information is presented in a sequential fashion as requested but the values need not be in any specific format within the input records. Values are separated from each other by a space or a comma. In the cases where alphanumeric values are needed, as in the identification of the blocks, this information must be contained in the first six positions of the input record. If for any reason six alphanumeric characters are not sufficient to provide a unique identification for each block, a parameter called NPOSID defined in BLKDAT subprogram may be changed. The data for each record is assumed to be contained within 80 positions. If this restriction is not acceptable a parameter called NOPOSI defined in BLKDAT subprogram may be changed. When a flag is needed to indicate the end of a data file the value 99999 is used. This flag denoted by variable name IEND may also be changed. See section 1.6.02 for all of the above possible modifications. The software is designed for either interactive or batch mode input.

1.4 General Philosophy of Output

There are four kinds of output from each step described; error (fatal and/or informative) or detection messages when applicable, messages describing current step and its expected input and output, a printed page if pertinent and information written on a data file. The printed output corresponds to the worksheets given in NBS Mongraph 163 [1] on pages 31 through 39. The information recorded on data files will be described in detail in Section 2. Error messages will usually indicate that there is a problem with the input data. See section 1.7 for a discussion of error messages and corrective actions.

1.5 Description of Each Subprogram Module

Each subprogram is written to carry out a specific function. Listed below are brief descriptions of each subprogram and their specific functions.

1.5.01 BLKDAT Subprogram

This subprogram module is the initialization module for values of variables which remain constant and are used by the other subprogram modules. This module, a FORTRAN block data subprogram, defines the following acceptable alphanumeric characters: 0-9, A-Z, blank, =, +, -, *, /, (,), comma, . and '; the logical input and output units; the number of lines per page; various parameters relating to dimensions of variables; parameters designating block groupings by block size; parameter for tolerance in comparing gage block lengths; machine dependent values, and parameters relating to input record size. For a discussion of the current values of these parameters see Sections 1.6.01 and 1.6.02.

1.5.02 DRIVER Subprogram

This is the main program which controls the program flow for each step. Messages are written by this program before each step. These messages indicate which step is being performed and what input and output is required.

1.5.03 VARRD Subprogram

This module is the subprogram used to read input values using a free-field format. Eighty positions of data from an input record are read and each position is stored in one computer word. (The eighty is the contents of a variable whose value may be changed. See Section 1.6.02.) The input characters are converted to corresponding numeric values or certain groups of characters are stored when required as in gage block identifications. All non-numeric characters are ignored except for those at the beginning of the record which are designated as block identifications.

1.5.04 DATCON Subprogram

This module converts data read by subprogram VARRD to numeric values. Each input character is converted to its corresponding numeric value as defined in the subprogram BLKDAT. If no match is found, the character is assumed to be an asterisk (*).

1.5.05 CONID Subprogram

This module converts the alphanumeric characters (which have been converted to a numeric values by subprogram DATCON) of the block identification to numeric values, one for each identification. Only the first NOPOSI, identified in Section 1.6.02, specified characters are converted. These numeric values are used in making checks to be sure block identifications match.

1.5.06 SORTLN Subprogram

This module is used to perform any required sorting of data. The original input vector remains unchanged. The sorting order is contained in another vector. Sorting is done in an ascending order.

1.5.07 CONDAT Subprogram

This module converts the date to a numeric value which is used to sort control data.

1.5.08 FCDF Subprogram

This module computes the cumulative distribution function value for the F distribution and is used to compute the critical value for the F-test.

1.5.09 NORCDF Subprogram

This module computes the cumulative distribution value for the normal (Gaussian) distribution with mean = 0 and standard deviation = 1. It is called as a subprogram by the FCDF module.

1.5.10 CHSCDF Subprogram

This module computes the cumulative distribution function value for the Chi-squared distribution and is called as a subprogram by the FCDF module.

1.5.11 RDN1N2 Subprogram

This module reads the input data required by Step 5 in section 2.6. Each input record for the step requires a length, three block identifications and four observations. This module selects and saves the block identifications which are in free field format.

1.5.12 STNDR2 Subprogram

This module accepts the input values for a laboratory's standards and creates a sorted data file of those given values. Its function is to carry out the requirements of Step 1 as defined in Section 2.2.

1.5.13 S1MS22 Subprogram

This module reads the control data recorded in a format as indicated in Step 2 in Section 2.3 and produces a data file of control values. The value computed for the control is $t_2 - S_2 - t_1 + S_1$ where t_2 is the second reading of the test block, S_2 is the reading of standard 2 block, t_1 is the first reading of the test block and S_1 is the reading of the standard 1 block.

1.5.14 RAWFL2 Subprogram

This module reads the control data file and creates a sorted and weighted control data file to be used to generate the process parameters. See section 2.4. This created file is also used to plot the control values.

1.5.15 PPFIL2 Subprogram

This module reads the sorted and weighted control data file and produces process control parameters to be used in routine calibrations. See section 2.4.

1.5.16 PLOTCK Subprogram

This module uses the sorted and weighted control data file and sets up the x, y and plot character values to be used by PLOT to plot the control data either by group or by length. See section 2.5.

1.5.17 PLOT Subprogram

This module plots vectors generated by the PLOTCK module.

1.5.18 OBSCS2 Subprogram

This module controls the flow of data files needed to check process control when a calibration is being done. The input observed values for the control are checked against the accepted values. See section 2.6.

1.5.19 PRTOB2 Subprogram

This module prints the values calculated by the module OBSCS2. T-tests and F-tests are made to determine if the calibration is in statistical control. This subprogram records on a data file all those observations of the control which are in statistical control. See section 2.6.

1.5.20 PPUPD2 Subprogram

This module performs the steps needed to update the process control data file. See section 2.7

1.5.21 MRGPP2 Subprogram

This module reads the data file containing the old control data and augments it with the newly collected control data. The latter is used to update the process parameters.

1.6 Implementation of Software

As stated previously the software consists of one driver program and 20 subprograms written in FORTRAN 77 language [2]. Its portability was tested by use of the PFORT verifier [3] and the Univac FTN10R1 compiler which checks for statements not complying with the 77 standard. Every effort was made to make the software virtually machine independent thus making it more transportable. In order to produce the desired effects from the software, all the subprograms must be compiled and treated as one unit. The subprogram named DRIVER controls the flow required by each possible step. The manner in which they interact is illustrated by a flow diagram in Section 1.6.06.

The input and output is all contained within an 80 character per record constraint. Where alphanumeric characters are needed they are defined as one character per variable. The following section describes how to make necessary changes for compatability with the user's environment.

1.6.01 Machine Dependent Parameters

The software requires the use of six unique input/output devices. Listed below are the logical unit definitions as used on the NBS UNIVAC 1100/82 computer system. These need to be changed to correspond with the user's computer configuration. The definition of these units is contained in subprogram BLKDAT.

Logical Unit	Definition
5	Card reader (runstream input device)
6	Printer
7	Mass Storage File
8	Mass Storage File
9	Mass Storage File
10	Mass Storage File

Two other variables, MAXEXP and ZERVAL, are defined in the subprogram BLKDAT. These need to be changed to agree with the approximate magnitude of a real constant in the user's computer. Currently MAXEXP, the maximum absolute value of the exponent of a real constant, is set equal to 38 and ZERVAL, the equivalent of machine zero, is set equal to 1×10^{-8}.

1.6.02 Parameters Set for User's Requirements

Because the software may be used to process variable amounts of data divided in specified groupings there are a number of changes that need to be made only if the user cannot accept the current parameter settings. The software is currently set up to process 100 unique gage block lengths divided into six different groups with a maximum of 20 lengths in each group. Groupings are discussed in reference 1. The identification for each unique block is assumed to be only six characters in length. Each input record is assumed to be 80 characters in length. The number of lines of output per page is set to 56. The flag denoting the end of a set of data is currently set to 99999. Listed on the following pages is each parameter, its definition and current value as defined in subprogram BLKDAT. Some of these parameter values control the size of dimensioned variables, so the subprograms containing these dimensional variables are given in the fourth column of the table. If the parameters controlling the dimension of variables are modified only the main module DRIVER and the subprogram BLKDAT need to be recompiled because all such variables are either transmitted to the subprogram through the calling sequence or through labeled common. There is one exception to the above statement and that is if the number of groups (NGPS) is modified the labeled COMMON LIMITS must be changed in the 6 subprograms as denoted below.

Variable Name	Description	Current Value	Subprograms
ILNMAX	Maximum Number of Lines Per Output Page	56	BLKDAT
IEND	Flag Denoting End of Data	99999	BLKDAT

NGPS	Number of Groups Required	6	BLKDAT, DRIVER, PPFIL2, PLOTCK, OBSCS2, PPUPD2
ALMIN (1)	Minimum Length in Group 1	.050	BLKDAT
ALMAX (1)	Maximum Length in Group 1	.09375	BLKDAT
ALMIN (2)	Minimum Length in Group 2	.100	BLKDAT
ALMAX (2)	Maximum Length in Group 2	.107	BLKDAT
ALMIN (3)	Minimum Length in Group 3	.108	BLKDAT
ALMAX (3)	Maximum Length in Group 3	.126	BLKDAT
ALMIN (4)	Minimum Length in Group 4	.127	BLKDAT
ALMAX (4)	Maximum Length in Group 4	.146	BLKDAT
ALMIN (5)	Minimum Length in Group 5	.147	BLKDAT
ALMAX (5)	Maximum Length in	.500	BLKDAT
ALMIN (6)	Minimum Length in Group 6	.550	BLKDAT
ALMAX (6)	Maximum Length in Group 6	4.0	BLKDAT
NOPOSI	Number of Positions on Input Record	80	DRIVER
NPOS	Position Where Data Begins After Identification	7	DRIVER
NOV	Maximum Number of Possible Values on an Input Record	40	DRIVER
NPOSID	Maximum Number of Characters in Identification	6	DRIVER

NOLENS	Maximum Number of Unique Lengths to be Processed	100	DRIVER
NOCHID	Number of Characters in Identification to be Converted and Saved	5	DRIVER
NTOTOB	Number of Initial Collected Control Values (6*NOLENS)	600	DRIVER
NOBSPL	Maximum Number of Initial Control Values Per Length	6	DRIVER

Several subprograms contain formats which are dependent on the value of the parameter NPOSID. The formats which need to be changed are proceeded by a FORTRAN comment statement containing slashes (/). The subprograms are OBSCS2, PRTOB2 and STNDR2.

1.6.03 Cross Reference of Interaction Between Subprograms

Listed in the table below are all the subprograms listed in alphabetic order followed by the subprograms they call. The called subprograms include both the subprogram included with this software and those which need to be supplied by the operating system. The latter are so indicated by an asterisk (*), where the letter D preceeding the subprogram name denotes a double precision subprogram.

Subprogram	Called Subprogram
BLKDAT	
CHSCDF	DEXP* DLOG* DSQRT* NORCDF SQRT*
CONDAT	
CONID	
DATCON	
DRIVER	STNDR2 SIMS22 RAWFL2 PPFIL2 PLOTCK OBSCS2 PPUPD2 VARRD
FCDF	CHSCDF DATAN* DSQRT* NORCDF SQRT*
NORCDF	EXP*
MRGPP2	
OBSCS2	CONID PRTOB2 RDNIN2 SORTLN VARRD
PLOT	

PLOTCK.........................CONDAT PLOT SORTLN VARRD

PPFIL2.........................SQRT* VARRD

PPUPD2.........................FCDF MRGPP2 SQRT* VARRD

PRTOB2.........................FCDF SQRT*

RAWFL2.........................CONDAT SORTLN VARRD

RDNIN2.........................DATCON

S1MS22.........................VARRD

SORTLN

STNDR2.........................CONID SORTLN VARRD

VARRD..........................DATCON

1.6.04 Cross Reference Between Subprograms and Labeled Common

The subprograms are listed below in alphabetic order followed by the labeled common blocks referenced by each one:

Subprogram	Labeled Common Blocks Referenced
BLKDAT.....................	CHAR CHARP DIM DIM2 GBEPSI IOCON LIMITS MACCON
CHSCDF	
CONDAT	
CONID	
DATCON.....................	CHAR CHARP
DRIVER.....................	CHAR CHARP DIM GBEPSI IOCON LIMITS
FCDF	
NORCDF	
MRGPP2	
OBSCS2.....................	CHAR CHARP DIM GBEPSI IOCON LIMITS
PLOT	
PLOTCK.....................	CHAR CHARP DIM DIM2 GBEPSI IOCON LIMITS MACCON
PPFIL2.....................	DIM DIM2 IOCON LIMITS

PPUPD2.....................CHAR CHARP DIM GBEPSI IOCON LIMITS

PRTOB2.....................DIM

RAWFL2.....................DIM DIM2 IOCON

RDNIN2

S1MS22.....................DIM IOCON

SORTLN

STNDR2.....................CHAR CHARP DIM IOCON

VARRD......................CHAR CHARP MACCON

1.6.05 Double Precision Usage

Two subprograms, FCDF and CHSCDF use double precision constants and calculations. It should also be noted that these two subprograms also reference some double precision system mathematical subprograms. See Section 1.6.03.

1.6.06 Flow Diagram of Software

The diagram given in this section shows the input needed, subprograms used and output from each step described in Section 2. This diagram should prove to be helpful if segmentation is required due to a computer with a small memory. The boxes outlined with asterisks (*) denote input and those with dots (.) denote output. The values in ( ) indicate the input/output logical units. An asterisk (*) behind a subprogram name denotes a mathematical subprogram which is to be supplied by the computer operating system.

```
                                   STEP1
                                 - - - - - -
* * * * * * * * * *              - BLKDAT- -             . . . . . . . . .
* Standards       *              - DRIVER  -             . Standards      .
* Information (IN)* ------>      - STNDR2  - ------>     . Information    .
* * * * * * * * * *              - VARRD   -             . Data File(IFA).
                                 - DATCON  -             . . . . . . . . .
                                 - CONID   -
                                 - SORTLN  -
                                 - - - - - -

                                   STEP 2
                                 - - - - - -
* * * * * * * * *                - BLKDAT- -            . . . . . . .
* Comparator    *                - DRIVER  -            . Raw        .
* Readings (IN) *    ---->       - S1MS22  - ---->      . Control    .
* * * * * * * * *                - VARRD   -            . Data (IFD).
                                 - DATCON  -            . . . . . . .
                                 - - - - - -
```

STEP 3

```
* * * * * * *     - - - - - -    . . . . . . .    - - - - - -    . . . . . . .
* Raw       *     - BLKDAT  -    . Control    .   - BLKDAT  -    . Process    .
* Control   *     - DRIVER  -    . Sorted     .   - DRIVER  -    . Control    .
* Data (IFD)* --> - RAWFL2  - -->. Data (IFB).--> - PPFIL2  - -->. Data       .
*           *     - VARRD   -    . . . . . . .    - VARRD   -    . File (IFC).
* * * * * * *     - CONDAT  -                     - DATCON  -    . . . . . . .
                  - SORTLN  -                     - SQRT*   -
                  - DATCON  -                     - - - - - -
                  - - - - - -
```

STEP 4

```
* * * * * * *                - - - - - -
* Control   *                - BLKDAT  -
* Sorted    * ---------->    - DRIVER  -
* Data (IFB)*                - PLOTCK  -
* * * * * * *                - PLOT    -
                             - DATCON  -
                             - CONDAT  -
                             - VARRD   -
                             - SORTLN  -
                             - - - - - -
```

STEP 5

```
                               - - - - - -
* * * * * * * * * * *          - BLKDAT  -
* Standards         *          - DRIVER  -
* Information(IFA)* ----->     - OBSCS2  -
* * * * * * * * * * *          - VARRD   -
                               - DATCON  -              . . . . . . .
                               - CONID   -              . Raw         .
* * * * * * *                  - PRTOB2  - ------->     . Control     .
* Process   *                  - SOLTLN  -              . Data (IFD).
* Control   * ----------->     - RDNIN2  -              . . . . . . .
* File(IFC) *                  - FCDF    -
* * * * * * *                  - CHSCDF  -
                               - DATAN*  -
                               - DSQRT*  -
* * * * * * * * * * * *        - NORCDF  -
* Calibration          *       - SQRT*   -
* Observations (IN) * -->      - EXP*    -
* * * * * * * * * * * *        - - - - - -
```

STEP 6

```
* * * * * * *                   - - - - - -              . . . . . . . .
* New       *                   - BLKDAT  -              . New          .
* Control   * ----------->      - DRIVER  - -------->    . Control      .
* Data (IFD)*                   - RAWFL2  -              . Data         .
* * * * * * *                   - VARRD   -              . Sorted (IFB).
                                - CONDAT  -              . . . . . . . .
                                - SORTLN  -
                                - DATCON  -
                                - - - - - -


* * * * * * * *                 - - - - - -              . . . . . . .
* New         *                 - BLKDAT  -              . Merged     .
* Control     *                 - DRIVER  -              . Control    .
* Data        * ----------->    - PPUPD2  - -------->    . Data       .
* Sorted(IFB) *                 - FCDF    -              . File (IFD).
* * * * * * * *                 - MRGPP2  -              . . . . . . .
                                - VARRD   -
                                - SQRT*   -
* * * * * * *                   - DATCON  -
* Process   *                   - CHSCDF  -
* Control   *                   - NORCDF  -
* Data (IFC)*   ----------->    - DATAN*  -              . . . . . . . . . .
* * * * * * *                   - DSQRT*  -              . Updated            .
                                - SQRT*   -              . Process            .
                    ------>     - EXP*    - -------->    . Parameters (IFC).
* * * * * * *       ↑           - - - - - -              . . . . . . . . . .
* Old       *       |
* Control   *       |
* Sorted    * ------>
* Data (IFA)*
* * * * * * *
```

1.6.07 Storage Requirements - Computer Software and Data Files

The software as mapped on the UNIVAC 1100/82 system occupies approximately 1000 memory locations for the instructions and approximately 25000 memory locations for data storage. The data storage requirements are based on the parameter values controlling dimensions of variables as defined in Section 1.6.02. See Section 2.1 for the required data files.

1.7 Error Checking

The software provides methods for checking the input data and for giving the user informative and fatal diagnostics. Although the error checking procedures are fairly comprehensive, the user should not assume that the software is capable of detecting all possible errors.

The error messages are of two types, informative and fatal. Informative messages are solely for the user's information and when encountered during the execution of the software do not cause the execution to terminate. Fatal error messages are indicative of a condition that cannot be tolerated and after the message is written the execution of the software terminates. All the messages indicate which subprogram or module detected the error or possible error. In some cases the message suggests corrective action and in other cases the user should consult Sections 1.7.01 and 1.7.02.

1.7.01 Informative Diagnostic Messages

All the informative type diagnostics are listed in this section along with a brief description of their causes and possible corrective measures. Each message is preceeded by a line of dashes (---) and the following statement

INFORMATIVE DIAGNOSTIC FROM (SUB)PROGRAM X

Where X is the name of the module producing the diagnostic
The message is terminated by a line of dashes (---).

a. INFORMATIVE DIAGNOSTIC FROM PROGRAM <u>DRIVER</u>.

a.1. INPUT DATA LISTED BELOW IS INCORRECT! TRY AGAIN!

The input record is listed below the message. The input should be the word STEP in positions 1-4 of the input record followed by an integer 1-6 which indicates the current step. See Section 2.

b. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM <u>STNDR2</u>.

b.1. INPUT DATA LISTED BELOW IS INCORRECT! TRY AGAIN!

The input record is listed below the message. The input should either be the number of lengths in the standard file or a record consisting of the four values required for each record of standards information. See Section 2.

b.2. THE NUMBER OF LENGTHS IN THE TWO SETS OF STANDARDS NO NOT AGREE.

The number of lengths in each set of standards should agree. This informative condition allows the software to continue checking the input records for the second set of standards. However, the execution of Step 1 will be terminated when all the data has been read in.

b.3. AN IDENTIFICATION IS BLANK.

There are one or more block identifications of the standard set which are blank or nonexisting. If all standards have unique identifications correct the data and reinitialize Step 1.

c. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM VARRD.

c.1. PROCESSING WILL CONTINUE.
EXPONENT IS TOO LARGE. CHECK THE FOLLOWING INPUT RECORD.

The input record is listed below the message. There is a value on this record which contains an exponent whose absolute value is too large for your computer. The exponent is checked against the variable MAXEXP defined in subprogram BLKDAT. See Section 1.6.01. The intended input value is set to 0.0. If this is not correct, make the necessary changes in the input data record and reinitialize the current step.

d. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM SORTLN.

d.1. PROCESSING WILL CONTINUE.
NO SORTING WILL BE DONE BECAUSE N IS LESS THAN 2.

This diagnostic is a check in the sort routine which does not allow a sort to take place when there is only one value in the vector to be sorted.

e. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM S1MS22.

e.1. THERE ARE NOT 8 VALUES ON THE FOLLOWING INPUT RECORD.
INPUT DATA LISTED BELOW IS INCORRECT! TRY AGAIN!
THE VALUES READ ARE:

The input record is printed as well as the values selected from the input record. As stated, 8 values were expected on the input record. If data is entered in an interactive mode, the user is allowed five attempts to input the data correctly. If operating in a batch mode, the next input record will be read. See Section 2.3.

f. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM RAWFL2.

f.1. THERE ARE NOT 5 VALUES ON THE FOLLOWING INPUT RECORD.
INPUT DATA LISTED BELOW IS INCORRECT! TRY AGAIN!

The input record is printed below the message. There is an error on the control data file.

g. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM PLOTCK.

g.1. ALL REQUESTED LENGTHS WERE NOT PLOTTED.
SOME LENGTHS WERE NOT FOUND ON INPUT FILE n.

Requests have been made in Step 4 for lengths to be plotted which do not exist in the file denoted by n.

h. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM OBSCS2.

h.1. INPUT DATA LISTED BELOW IS INCORRECT! TRY AGAIN!

This diagnostic is caused by incorrect data input for Step 5. The input expected is operator name, month, day, year and a flag. See Section 2.6. The user has 5 chances to input the data correctly.

h.2. THERE WERE NOT 3 IDENTIFICATIONS ON INPUT RECORD.
PROCESSING WILL CONTINUE.

See Section 2.6 for required format of input data.

h.3. THERE ARE NOT 5 VALUES ON THE FOLLOWING INPUT RECORD.
PROCESSING WILL CONTINUE.

The five values expected in Step 5 consist of length and four readings. See Section 2.6.

h.4. LENGTH n NOT FOUND ON PROCESS CONTROL FILE.
PROCESSING WILL CONTINUE.
THE FOLLOWING INPUT WILL NOT BE PROCESSED.

The value of n denotes an incorrect length to be processed. The input record is listed below this message. This data will not be processed.

h.5. T-TEST IS GREATER THAN THREE FOR THE FOLLOWING INPUT RECORD.
CHECKING OF DATA WILL CONTINUE.

This indicates an out-of-control condition in the measurement process. Perhaps the data was entered incorrectly or it is truly an out-of-control condition. In any event this data, although it appears on the printout, will not be used to compute the group standard deviation.

i. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM CHSCDF.

i.1. THE SECOND INPUT ARGUMENT TO THE CHSCDF SUBPROGRAM IS NEGATIVE.
THE VALUE OF THE ARGUMENT IS n.

The value of n denotes an unexpected negative argument. The value of the cummulative distribution function is set equal to 0.0.

i.2. THE THIRD INPUT ARGUMENT TO THE CHSCDF SUBPROGRAM IS NON-POSITIVE.
THE VALUE OF THE ARGUMENT IS n.

The value of n denotes an unexpected argument indicating a negative value for degrees of freedom. The value of the cumulative distribution function is set equal to 0.0.

i.3. IMPOSSIBLE BRANCH CONDITION AT BRANCH POINT = n.

This is an internal error.

j. INFORMATIVE DIAGNOSTIC FROM SUBPROGRAM FCDF.

j.1. THE THIRD INPUT ARGUMENT TO THE SUBPROGRAM IS NON-POSITIVE.
THE VALUE OF THE ARGUMENT IS n.

The value of n denotes the unexpected non-positive argument. The cumulative distribution function value is set equal to 0.0.

j.2. THE FOURTH INPUT ARGUMENT TO THE SUBPROGRAM IS NON-POSITIVE.
THE VALUE OF THE ARGUMENT IS n.

The value of n denotes the unexpected non-positive argument. The cumulative distribution function value is set equal to 0.0.

j.3. THE SECOND INPUT ARGUMENT TO THE SUBPROGRAM IS NEGATIVE.
THE VALUE OF THE ARGUMENT IS n

The value of n denotes an unexpected negative argument. The cumulative distribution function value is set equal to 0.0.

j.4. IMPOSSIBLE BRANCH CONDITION AT BRANCH POINT = n.

There is an internal error.

1.7.02 Fatal Diagnostic Messages

All the fatal diagnostics are listed in this section along with a brief description, if deemed necessary, of the situation which caused it. Each message is preceeded by a line of asterisks (***) and the following statement

FATAL ERROR FROM (SUB)PROGRAM X where

X is the name of the module producing the error message
The message is followed by a line of asterisks (***).

a. FATAL ERROR FROM PROGRAM DRIVER.

a.1. 5 ATTEMPTS HAVE BEEN MADE TO INPUT REQUIRED DATA CORRECTLY.
EXECUTION IS TERMINATED.

Five attempts were made to read the requested input STEP followed by an integer 1-6. Reinitialize execution of current step.

b. FATAL ERROR FROM SUBPROGRAM STNDR2.

b.1. 5 ATTEMPTS HAVE BEEN MADE TO INPUT REQUIRED DATA CORRECTLY.
EXECUTION IS TERMINATED.

Five attempts were made to read the requested input of either the number of standards in a set or the four values required for each standard's information input record. Reinitialize execution of Step 1.

b.2. VARIABLES USING NOLENS AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

The dimensions of some variables have been exceeded. See Section 1.6.02. Follow procedure of message and reinitialize execution of Step 1.

b.3. THE NUMBER OF LENGTHS IN THE TWO SETS OF STANDARDS DO NOT AGREE. MAKE CORRECTIONS AND RERUN PROGRAM TO GENERATE A LAB STANDARDS FILE.

The execution of Step 1 is terminated. Correct input data and reinitialize execution of Step 1.

c. FATAL ERROR FROM SUBPROGRAM <u>VARRD</u>.

c.1. NO NUMERIC VALUES FOUND ON INPUT RECORD.
EXECUTION IS TERMINATED.
THERE IS AN ERROR IN THE FOLLOWING INPUT RECORD.

The input record is listed below the message. Numeric values were expected but none were present on the input record. Correct data input and reinitialize execution of the current step.

c.2. RUN IS TERMINATED.
THERE IS AN ERROR IN THE FOLLOWING INPUT RECORD.

The input record is listed below the message. The message is generated when there is an error in the input data, e.g., a misplaced decimal point. Correct data and reinitialize current step.

d. FATAL ERROR FROM SUBPROGRAM <u>S1MS22</u>.

d.1. 5 ATTEMPTS HAVE BEEN MADE TO INPUT REQUIRED DATA CORRECTLY.

A previous informative diagnostic appeared and should have indicated what error was detected. When correction to data is made, reinitialize Step 2.

e. FATAL ERROR FROM SUBPROGRAM <u>RAWFL2</u>.

e.1. 5 ATTEMPTS HAVE BEEN MADE TO INPUT REQUIRED DATA CORRECTLY.
EXECUTION IS TERMINATED.

A previous informative diagnostic appeared and should have indicated what error was detected.

e.2. THE NUMBER OF INPUT MEASURED VALUES FOR ESTABLISHING PROCESS PARAMETERS IS GREATER THAN <u>n</u>.
CHANGE VALUE OF NTOTOB IN SUBPROGRAMS DRIVER AND BLKDAT.
RECOMPILE AND RERUN.

The value of n denotes how many values are being used to establish the process control file in Step 3. Make necessary modifications and rerun. See Section 1.6.02.

e.3. VARIABLES USING NOBSPL AS THEIR DIMENSION NEED TO BE CHANGED. CHANGE VALUE OF NOBSPL IN SUBPROGRAMS DRIVER AND BLKDAT. RECOMPILE AND RERUN.

See Section 1.6.02.

f. FATAL ERROR FROM SUBPROGRAM PPFIL2.

f.1. THERE ARE NOT 6 VALUES ON THE FOLLOWING INPUT RECORD. BE SURE THAT THE INPUT FILE WHICH IS LOGICAL UNIT n HAS BEEN CORRECTLY DEFINED.

The input file causing this message is denoted by n. Take corrective action and reinitialize Step 3.

f.2. VARIABLES USING NOLENS AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

See Section 1.6.02.

f.3. VARIABLES USING NOBSPL AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

See Section 1.6.02.

f.4. LENGTH n DOES NOT BELONG TO ANY GROUP SPECIFIED.

The nominal length causing this error is denoted by n. See Section 1.6.02 for designation of groups.

g. FATAL ERROR FROM SUBPROGRAM PLOTCK.

g.1. VARIABLES USING NOLENS AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

The number of input length to be plotted must be less than the value of NOLENS. See 1.6.02.

g.2. VARIABLES USING NTOTOB AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

The number of observations to be plotted on one graph is greater than the value of NTOTOB. See Section 1.6.02.

g.3. LENGTH n IS NOT IN SPECIFIED GROUPINGS. EXECUTION IS TERMINATED.

Length n on logical unit 8 (IFB) is incorrect. See Section 1.6.02 for designation of groups.

g.4. AN UNEXPECTED END OF FILE HAS BEEN FOUND ON LOGICAL UNIT n.
EXECUTION IS TERMINATED.

Logical unit 8 has 99999 as its first record of information.

h. FATAL ERROR FROM SUBPROGRAM OBSCS2.

h.1. 5 ATTEMPTS HAVE BEEN MADE TO INPUT REQUIRED DATA CORRECTLY.
EXECUTION IS TERMINATED.

A previous informative diagnostic should indicate the current problem.

h.2. LENGTH n NOT FOUND ON PROCESS CONTROL FILE.
PROCESSING IS TERMINATED.

There is no corresponding data on the process control file for measurements made on a gage block of length n in Step 5.

h.3. LENGTH n NOT FOUND ON FILE OF STANDARDS.
EXECUTION IS TERMINATED.

There is no corresponding data on the standards information file for measurements made on a gage block of length n in Step 5.

h.4. IDENTIFICATION OF BLOCKS OF LENGTH n DON'T MATCH. CHECK IDS.
FILE S1 ID = ____ OBSERVED S1 ID = ____
FILE S2 ID = ____ OBSERVED S2 ID = ____
EXECUTION IS TERMINATED AFTER ALL IDS ARE CHECKED.

There are some inconsistencies in the block identifications for length n. Make corrections and reinitialize Step 5.

h.5. LENGTH n NOT IN SPECIFIED GROUPINGS.
EXECUTION IS TERMINATED.

Length n is not in the designated groupings.
See Section 1.6.02.

h.6. VARIABLES USING NOLENS AS THEIR DIMENSION NEED TO BE CHANGED.
RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

See Section 1.6.02.

i. FATAL ERROR FROM SUBPROGRAM PRTOB2.

i.1. F-TEST IS NOT COMPUTED CORRECTLY.

A previous informative diagnostic indicates the current problem.

i.2. VARIABLES USING NOLENS AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER AND RERUN.

See Section 1.6.02. Follow the procedure of the message and reinitialize step 5.

j. FATAL ERROR FROM SUBPROGRAM PPUPD2.

j.1. THERE ARE NOT 6 VALUES ON THE FOLLOWING INPUT RECORD. THE INPUT VALUES ARE:

The data file on logical unit 8 is in error. Be sure the correct data file has been assigned.

j.2. VARIABLES USING NOLENS AS THEIR DIMENSION NEED TO BE CHANGED. RECOMPILE SUBPROGRAMS BLKDAT AND DRIVER.

See Section 1.6.02. Follow the procedures of the message and reinitialize Step 6.

j.3. LENGTH n DOES NOT BELONG TO ANY SPECIFIED GROUP.

See Section 1.6.02 for designation of groups.

j.4. THE NUMBER OF LENGTHS ON OLD PROCESS PARAMETER FILE DOES NOT MATCH NUMBER ON NEW FILE.
UPDATE ASSUMES LENGTHS MATCH WITH THOSE ON NEWLY COLLECTED DATA FILE.

The update procedure of Step 6 assumes all lengths are present for the purpose of updating.

j.5. NEW LENGTH n DOES NOT MATCH LENGTH m FROM PROCESS PARAMETER FILE. CHECK FILES o AND p.

The update procedure of Step 6 assumes all lengths are present for the purpose of updating and assumes the lengths on the newly collected data file match those on the process control file. The lengths in question are denoted by n and m while the files in question are denoted by o and p.

j.6. F-TEST IS NOT COMPUTED CORRECTLY.

A previous informative diagnostic indicates the current problem.

2. Procedures for a MAP Using Option II.

This section describes in detail the various steps required in developing and maintaining a MAP in gage block measurements. The steps discussed are in accordance with method 2 as described in NBS Mongraph 163 [1] where a test set of gage blocks is measured against two standard sets with the control being on the differences between the standards. All gage blocks are assumed to be of the same material and no temperature corrections are made. The format of the input as well as the output is described. In each step the user is expected to input the word STEP followed by the step number. The data file manipulation is described. A sample of each step is included in Appendix A.

2.1 Files Needed to Obtain and Update Information.

There are four data files which need to be created and manipulated. They are as follows:

File A - Values for the Laboratory Standards
File B - Control Values - Sorted and Weighted (See section 2.4)
File C - Process Control Values
File D - Observed Control Values

The following sections (2.2 through 2.7) describe in detail how these files are created and used. All information given assumes the current parameter values as described in Section 1.6.02.

2.2 Step 1 - Create a Data File Containing Laboratory Standards Information

The first step required is to create a data file containing pertinent information about the two sets of gage blocks used as laboratory standards. The required information includes the number of blocks in each set, block identifications, nominal lengths in inches, assigned correction values in microinches, assigned uncertainties in microinches and the coefficients of expansion in microinches per inch per degree Celsius. The DRIVER module and six subprograms (BLKDAT, STNDR2, VARRD, DATCON, CONID and SORTLN) of the computer software are needed to create the required data file.

The format of the input data is free field with two exceptions. The block identification must be no more than six alphanumeric characters long and must be contained in the first 6 positions of the input record. For a modification of this requirement see Section 1.6.02. The values on each record must be separated by blanks or commas. The input records containing the information for each length in a set do not need to be in any special order because they are sorted later. However, all the information for standard set 1 precedes all the information for standard set 2.

The input data has the following format:

Record 1 - (n) where n is the number of blocks in standard set 1.

Records 2 through record 2+n-1

block identification, nominal length (in inches), assigned correction value (in microinches), assigned uncertainty (in microinches) and the coefficient of expansion (in microinches per inch per degree Celsius).

Record 2+n - (m) where m is the number of blocks in standard set 2.

Records 2+n through record 2+n+m-1

> block identification, nominal length (in inches), assigned correction value (in microinches), assigned uncertainty (in microinches) and the coefficient of expansion (in microinches per inch per degree Celsius).

The output of the computer software consists of two parts: a printed tabular presentation of the input information and a data file written on logical unit 7 containing the input information. The input information is sorted by length and recorded on the output file from the smallest to the largest length. This file contains the current values for the laboratory standards which may be updated at some later time. The identifications for the blocks are recorded as numeric values as well as alphanumeric values on the data file.

2.3 Step 2 - Create a Raw Data File of Control Values ($S_1 - S_2$)

Before establishing a data file of process control, it is necessary to establish an accepted value of the control ($S_1 - S_2$) for each nominal length. To do this a set of six measurements for each length is taken where each measurement consists of the following information: the nominal length, test block reading, S_1 block reading, S_2 block reading, test block reading, month, day, and year. The DRIVER module and four subprograms (BLKDAT, S1MS22, VARRD and CONID) are needed to process this data.

The input data consists of 6*k (where k is the number of unique nominal lengths) records of information followed by a flag of 99999 which denotes the end of data. Each record contains, in a free field format, the eight values: nominal length, test block reading, S_1 block reading, S_2 block reading, test block reading, month, day and year. The value of the control is computed as $-X_1+S_1-S_2+X_2$ where X_1 is first reading of the test block, S_1 is the reading of standard 1, X_2 is the second reading of the test block and S_2 is the reading of standard 2.

The output is recorded on logical unit 10 as a raw data file of control information with the following format. Each record contains the nominal length, measured control value ($S_1 - S_2$) and date of measurement. The end of data flag is 99999.

2.4 Step 3 - Create a Process Control Data File

After step 2 has been completed there exists a raw data file of control values which is used to establish process parameters. Before this file can be used it is sorted by length and date and recorded onto another data file on logical unit 8. This file contains the raw data sorted by length and date and is augmented by a flag of 0 or 1 where 0 denotes that the corresponding measurement should not be included in the analysis and 1 denotes that it should be included. The rationale for this flag will be obvious at a later step. The DRIVER module and the six subprograms required by the above process are: RAWFL2, VARRD, CONDAT, SORTLN, BLKDAT and DATCON.

The input needed at this point is the raw data file of control values, as created in step 2, on logical unit 10.

The output is a data file on logical unit 8 of the input data whose characteristics have been described above. This data file is used to compute a control value and its corresponding standard deviation for each length. For each group there is a group standard deviation computed. See section 1.6.02 for a discussion of groups. The subprograms needed to compute these quantities and generate a data file containing process parameters are: PPFIL2, VARRD, DATCON and BLKDAT.

The input data file on logical unit 8 is the sorted and flagged file as described above.

There are two parts to the output; a table of printed process parameters similar to the worksheet in NBS Monograph 163 [4] and a data file on logical unit 9 of process parameters which will be used for measurement process control and updates of process parameters. This file contains each nominal length with its corresponding control value, number of repeated measurements, observed standard deviation, group standard deviation and degrees of freedom associated with the group standard deviation.

2.5 Step 4 - Plot Sorted Control Data File

To easily visualize the behavior of the control data, software for plotting the control data either by length or group is provided. The data to be plotted is in the data file containing the sorted and flagged control data. The data entries carrying with them a flag with value 0 (see section 2.4) are denoted on the plot as outliers or measurements not included in the analysis. Flags with a value of 0 may be generated in step 6. The subprograms needed for this procedure are: DRIVER, PLOTCK, VARRD, CONDAT, BLKDAT, SORTLN, DATCON and PLOT.

The input data file on logical unit 8 is the sorted and flagged control data file. In addition to the input data file some information needs to be given via the runstream. If plots are to be made for individual nominal lengths the input consists of all the nominal lengths to be plotted. All such lengths are terminated by a flag of 99999. To request plots by groups only the flag of value 99999 is needed. If the value of IEND is changed in subprogram BLKDAT, this flag is the modified value. See section 1.6.02.

2.6 Step 5 - Maintaining Measurement Process Control.

To perform this step it is assumed that the user has available the data file containing the laboratory standards information generated in step 1, the data file containing the process control parameters generated in step 3 and a data file which is used to collect control data from calibrations. The latter file is used to update the process control parameters in Step 6. Data collected from measurements of a test block versus the two standards is analyzed to determine whether or not the measurement process is in a state of statistical control. The module DRIVER and the eleven subprograms needed for this step are as follows: BLKDAT, OBSCS2, PRTOB2, SORTLN, RDNIN2, VARRD, CONID, DATCON, FCDF, NORCDF and CHSCDF.

The input data consists of two data files and measurement data via the runstream. The first data file expected to be available on logical unit 7 is the data file containing the laboratory standards information. The second data file expected to be available on logical unit 9 is the data file containing the process control parameters. The data needed via the runstream is as follows:

Record 1 - observer's name (6 characters unless the parameter NPOSID is modified), date (month, day, and year), and indicator
indicator = 0 if this is first time for collecting control data
indicator = 1 if control data file is to be augmented

Record 2 - nominal length, identification of S_1 block, identification of S_2 block, identification of test block, test block observation, S_1 block observation, S_2 block observation, and test block observation.

Values within a record are separated by spaces or commas. Repeat record 2 for each measurement. Terminate all data with the flag 99999 beginning in position 7 unless the parameter values of NPOSID and NPOS have been modified. The value 7 corresponds to the current value of NPOS. See Section 1.6.02.

The output consists of two parts: printed pages of the analysis using a format similar to the worksheet in NBS Monograph 163 [5] and a data file, on logical unit 10, of the collected control values which are declared to be in statistical control via the t-test and F-test as defined in reference [5].

2.7 Step 6 - Update Process Control Parameters

To perform this step it is assumed that an adequate amount of control data has been collected as a result of the use of the control blocks in routine calibrations. This amount depends on the user's workload but should be done initially after 5 or 10 values per nominal length have been collected and then at convenient intervals, perhaps every six months or every year. Three data files are used as input in this procedure; the first being the data file of collected control data, the second being the data file containing the current process control parameters, and the third being the initial data file of control data sorted and flagged. From this procedure an updated process control parameter file and an augmented control data file will be created.

The first step is to sort the collected control data and generate a new data file of sorted and merged control data.

The DRIVER module and six subprograms needed for this procedure are: RAWFL2, VARRD, CONDAT, SORTLN, BLKDAT, and DATCON.

The input expected on logical unit 10 is the data file of collected control data generated by step 5.

The output expected on logical unit 8 is the input data recorded in a sorted and flagged order.

The next step is to update the process control parameters data file and the control data file. For this step the module DRIVER and the following eight subprograms are needed: VARRD, BLKDAT, DATCON, MRGPP2, FCDF, NORCDF, CHSCDF, and PPUPD2.

The input data files needed here are the sorted and flagged collected control data on logical unit 8 as defined above, the process control parameter data file on logical unit 9 and the data file containing the initial control data on logical unit 7. Note that logical unit 7 in this step is being used for something other than for the standards information as in step 1.

The output consists of two components; a printed report of the updated process parameters using a format similar to that in reference [5] and two updated data files. The data file on logical unit 9 contains the updated process control parameters. The data file on logical unit 10 contains current control data. This is to say, the new control values used to update the process control parameters are merged with the values used to produce the inital process control parameters. At this point flags of 0 are inserted into the control data file if a t-test fails. See reference [5].

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APPENDIX A - LISTING OF SAMPLE RUNS

Sample runstreams and outputs are listed for each step described in sections 2.1 through 2.7.

A.1 STEP 1--CREATE A DATA FILE OF LAB STANDARDS INFORMATION

A.1.1 SAMPLE RUNSTREAM FOR STEP 1

```
@HDG,X STEP 1--CREATE A DATA FILE OF LAB STANDARDS INFORMATION
@USE 7.,LABSTDFL. LABSTDFL IS THE OUTPUT FILE WITH LAB STANDARDS INFO
@ASG,UP 7.
@USE B.,LNGTHMAPPRG2.
@ASG,A B.
@XQT B.ABSNEW
STEP 1
18
D241     .111000  -1.0  2.0  11.5
C288     .112000  -2.5  2.0  11.5
C289     .113000  -1.4  2.0  11.5
D457     .114000  -2.5  2.0  11.5
C422     .115000  -0.8  2.0  11.5
E392     .100000   0.4  2.0  11.5
C254     .100025  -0.3  2.0  11.5
I271     .100050   1.6  2.0  11.5
D142     .130000  -1.2  2.0  11.5
C377     .131000  -1.1  2.0  11.5
C318     .132000   0.1  2.0  11.5
C377     .133000  -0.5  2.0  11.5
C662     .250000   1.2  2.0  11.5
E196     .300000   0.7  2.0  11.5
C448     .350000   1.1  2.0  11.5
E550     .950000  -1.5  2.0  11.5
E409    1.000000  -3.6  2.0  11.5
C1153   2.000000   6.4  2.0  11.5
18
E424     .100000  -0.1  2.0  11.5
J245     .100025   1.0  2.0  11.5
E266     .100050  -2.0  2.0  11.5
D313     .111000   0.8  2.0  11.5
E300     .112000  -1.1  2.0  11.5
E307     .113000  -0.5  2.0  11.5
E214     .114000  -0.8  2.0  11.5
E342     .115000  -0.3  2.0  11.5
D180     .250000  -1.3  2.0  11.5
E676     .300000  -1.5  2.0  11.5
D331     .350000   0.0  2.0  11.5
E543     .950000  -1.0  2.0  11.5
E1012   1.000000  -3.3  2.0  11.5
E695    2.000000  -0.1  2.0  11.5
C524     .130000  -0.4  2.0  11.5
C363     .131000  -1.6  2.0  11.5
E576     .132000  -0.8  2.0  11.5
E482     .133000  -2.5  2.0  11.5
```

A.1.2 SAMPLE PRINTOUT FOR STEP 1

```
@XQT B.ABSNEW
ENTER THE WORD STEP AND THE STEP NUMBER REQUIRED.


STEP 1
A DATA FILE CONTAINING LABORATORY STANDARDS INFORMATION IS CREATED.
THIS DATA FILE WILL BE RECORDED ON LOGICAL UNIT 7.
INPUT IS EXPECTED FROM THE RUNSTREAM.

INPUT THE NUMBER OF UNIQUE LENGTHS IN STANDARDS 1 FILE.

INPUT THE FOLLOWING VALUES (ALL ON ONE INPUT RECORD) FOR EACH LENGTH:
BLOCK IDENTIFICATION, LENGTH, ASSIGNED CORRECTION,
UNCERTAINITY AND COEFFICIENT OF EXPANSION.

INPUT THE NUMBER OF UNIQUE LENGTHS IN STANDARDS 2 FILE.

INPUT THE FOLLOWING VALUES (ALL ON ONE INPUT RECORD) FOR EACH LENGTH:
BLOCK IDENTIFICATION, LENGTH, ASSIGNED CORRECTION,
UNCERTAINITY AND COEFFICIENT OF EXPANSION.
THE DATA FILE OF LABORATORY STANDARDS CONTAINS
    THE FOLLOWING ACCEPTED VALUES
```

ID	LENGTH	ACCEPTED CORRECTION	UNCERTAINTY	COEF OF EXP
S1 E392	.100000	.40	2.00	11.50
S2 E424	.100000	-.10	2.00	11.50
S1 C254	.100025	-.30	2.00	11.50
S2 J245	.100025	1.00	2.00	11.50
S1 I271	.100050	1.60	2.00	11.50
S2 E266	.100050	-2.00	2.00	11.50
S1 D241	.111000	-1.00	2.00	11.50
S2 D313	.111000	.80	2.00	11.50
S1 C288	.112000	-2.50	2.00	11.50
S2 E300	.112000	-1.10	2.00	11.50
S1 C289	.113000	-1.40	2.00	11.50
S2 E307	.113000	-.50	2.00	11.50
S1 D457	.114000	-2.50	2.00	11.50
S2 E214	.114000	-.80	2.00	11.50
S1 C422	.115000	-.80	2.00	11.50
S2 E342	.115000	-.30	2.00	11.50
S1 D142	.130000	-1.20	2.00	11.50
S2 C524	.130000	-.40	2.00	11.50
S1 C377	.131000	-1.10	2.00	11.50
S2 C363	.131000	-1.60	2.00	11.50
S1 C318	.132000	.10	2.00	11.50
S2 E576	.132000	-.80	2.00	11.50
S1 C377	.133000	-.50	2.00	11.50
S2 E482	.133000	-2.50	2.00	11.50

S1 C662	.250000	1.20	2.00	11.50
S2 D180	.250000	-1.30	2.00	11.50
S1 E196	.300000	.70	2.00	11.50
S2 E676	.300000	-1.50	2.00	11.50
S1 C448	.350000	1.10	2.00	11.50
S2 D331	.350000	.00	2.00	11.50
S1 E550	.950000	-1.50	2.00	11.50
S2 E543	.950000	-1.00	2.00	11.50
S1 E409	1.000000	-3.60	2.00	11.50
S2 E1012	1.000000	-3.30	2.00	11.50
S1 C1153	2.000000	6.40	2.00	11.50
S2 E695	2.000000	-.10	2.00	11.50

A.1.3 SAMPLE LABORATORY STANDARDS DATA FILE(IFA) AS DEFINED BY STEP 1

18

14392	.100000	.40	2.00	11.50	E392
14424	.100000	-.10	2.00	11.50	E424
12254	.100025	-.30	2.00	11.50	C254
19245	.100025	1.00	2.00	11.50	J245
18271	.100050	1.60	2.00	11.50	I271
14266	.100050	-2.00	2.00	11.50	E266
13241	.111000	-1.00	2.00	11.50	D241
13313	.111000	.80	2.00	11.50	D313
12288	.112000	-2.50	2.00	11.50	C288
14300	.112000	-1.10	2.00	11.50	E300
12289	.113000	-1.40	2.00	11.50	C289
14307	.113000	-.50	2.00	11.50	E307
13457	.114000	-2.50	2.00	11.50	D457
14214	.114000	-.80	2.00	11.50	E214
12422	.115000	-.80	2.00	11.50	C422
14342	.115000	-.30	2.00	11.50	E342
13142	.130000	-1.20	2.00	11.50	D142
12524	.130000	-.40	2.00	11.50	C524
12377	.131000	-1.10	2.00	11.50	C377
12363	.131000	-1.60	2.00	11.50	C363
12318	.132000	.10	2.00	11.50	C318
14576	.132000	-.80	2.00	11.50	E576
12377	.133000	-.50	2.00	11.50	C377
14482	.133000	-2.50	2.00	11.50	E482
12662	.250000	1.20	2.00	11.50	C662
13180	.250000	-1.30	2.00	11.50	D180
14196	.300000	.70	2.00	11.50	E196
14676	.300000	-1.50	2.00	11.50	E676
12448	.350000	1.10	2.00	11.50	C448
13331	.350000	.00	2.00	11.50	D331
14550	.950000	-1.50	2.00	11.50	E550
14543	.950000	-1.00	2.00	11.50	E543
14409	1.000000	-3.60	2.00	11.50	E409
141012	1.000000	-3.30	2.00	11.50	E1012
121153	2.000000	6.40	2.00	11.50	C1153
14695	2.000000	-.10	2.00	11.50	E695

A.2 STEP 2--CREATE A RAW DATA FILE OF CONTROL VALUES (S1-S2)

A.2.1 SAMPLE RUNSTREAM FOR STEP 2

```
@HDG,X STEP 2--CREATE A RAW DATA FILE OF CONTROL VALUES (S1-S2)
@USE 10.,RAWCNTL   RAWCNTL IS THE OUTPUT FILE CONTAINING THE CONTROL DATA
@ASG,UP 10.
@USE B.,LNGTHMAPPRG2.
@ASG,A B.
@XQT B.ABSNEW
STEP 2
   .100000  3.6  3.0  2.3  3.9 07 03 80
   .100025 19.4 16.1 17.4 19.1 07 03 80
   .100050 19.9 21.9 17.2 19.9 07 03 80
   .130000 22.7 32.8 33.7 22.4 07 03 80
   .131000 20.0 14.3 12.9 19.9 07 03 80
   .132000 19.1 22.7 21.6 17.8 07 03 80
   .133000 17.6 19.0 16.7 17.0 07 03 80
   .250000 19.1 19.3 19.4 19.9 07 03 80
   .300000 12.1 32.8 30.0 12.9 07 03 80
   .350000 18.2 23.9 23.8 18.5 07 03 80
   .111000 19.7 21.2 22.8 19.0 07 03 80
   .112000 19.4 31.0 31.3 19.6 07 03 80
   .113000 19.2 27.3 27.2 19.6 07 03 80
   .114000 20.1 23.9 25.2 20.9 07 03 80
   .115000 20.0 31.0 30.8 20.3 07 03 80
   .950000 20.1 38.2 39.5 20.9 07 03 80
  1.000000 21.0 14.0 14.5 20.6 07 03 80
  2.000000 11.1 59.8 54.7 10.8 07 03 80
   .100000 13.5 12.2 14.1 14.0 07 08 80
   .100025 14.8 14.0 15.2 15.0 07 08 80
   .100050 17.9 32.7 28.4 18.2 07 08 80
   .111000  9.1 29.7 31.1  8.0 07 08 80
   .112000 17.2 32.1 33.0 17.8 07 08 80
   .113000  3.9 11.9 12.2  3.3 07 08 80
   .114000  8.5 14.5 15.8  8.5 07 08 80
   .115000  7.7 22.6 22.0  8.0 07 08 80
   .130000  3.0 35.7 36.1  3.0 07 08 80
   .131000  5.6 21.0 19.9  5.9 07 08 80
   .132000  3.0 21.1 19.2  2.9 07 08 80
   .133000  8.1 16.0 14.2  7.0 07 08 80
   .250000 14.8 16.4 15.9 15.0 07 08 80
   .300000  0.3 39.7 37.1  0.2 07 08 80
   .350000 -1.0 38.0 37.4  1.1 07 08 80
   .950000  4.3 29.3 30.0  4.1 07 08 80
  1.000000 11.8  9.0  9.9 11.4 07 08 80
  2.000000 16.0 21.0 18.8 16.2 07 08 80
   .950000 20.0 22.8 21.0 19.7 07 10 80
  1.000000 20.4 13.9 14.7 20.8 07 10 80
  2.000000 19.9 27.9 26.2 21.1 07 10 80
   .100000 20.7 20.3 19.8 20.1 07 10 80
   .100025 20.0 18.9 19.6 19.2 07 10 80
   .100050 21.0 17.0 12.8 20.4 07 10 80
   .111000 20.0 19.9 21.0 20.1 07 10 80
```

.112000	20.2	17.1	18.0	20.7	07	10	80
.113000	19.7	14.1	13.9	19.8	07	10	80
.114000	19.2	25.2	27.2	18.6	07	10	80
.115000	19.9	14.9	14.3	19.6	07	10	80
.130000	19.2	16.2	16.9	19.3	07	10	80
.131000	19.9	19.9	18.0	19.6	07	10	80
.132000	20.2	15.4	14.1	20.0	07	10	80
.133000	18.0	14.2	12.1	17.7	07	10	80
.250000	18.1	21.4	20.7	18.4	07	10	80
.300000	21.1	20.8	18.0	21.1	07	10	80
.350000	19.9	20.4	19.9	19.9	07	10	80
.100000	13.0	11.1	10.3	11.5	07	15	80
.100025	9.9	10.0	10.3	9.2	07	15	80
.100050	6.3	9.8	3.7	6.0	07	15	80
.111000	20.1	21.0	22.5	20.4	07	15	80
.112000	11.2	10.7	11.2	9.9	07	15	80
.113000	6.5	7.4	7.5	6.6	07	15	80
.114000	11.4	18.3	20.9	13.4	07	15	80
.115000	10.7	19.2	19.1	11.3	07	15	80
.130000	2.0	20.5	20.4	2.2	07	15	80
.131000	6.3	4.6	3.0	6.3	07	15	80
.132000	9.1	21.1	19.7	8.6	07	15	80
.133000	9.5	20.1	18.0	9.2	07	15	80
.250000	3.5	27.7	27.1	2.6	07	15	80
.300000	8.5	7.7	5.8	7.0	07	15	80
.350000	5.4	23.1	22.7	4.6	07	15	80
.950000	5.0	17.4	18.6	4.7	07	15	80
1.000000	14.8	14.0	14.9	14.6	07	15	80
2.000000	4.7	30.5	28.4	3.4	07	15	80
.100000	8.0	29.1	28.2	7.9	07	18	80
.100025	19.7	13.4	14.1	19.5	07	18	80
.100050	20.0	20.0	15.9	19.9	07	18	80
.111000	19.6	19.8	20.8	19.8	07	18	80
.112000	20.0	13.6	14.2	19.9	07	18	80
.113000	19.1	14.3	14.1	19.0	07	18	80
.114000	20.0	14.9	16.8	20.0	07	18	80
.115000	19.3	17.1	16.7	19.0	07	18	80
.250000	19.9	23.3	22.8	19.4	07	18	80
.300000	20.0	19.7	17.1	20.0	07	18	80
.350000	19.0	25.1	24.4	19.0	07	18	80
.950000	21.0	28.5	28.8	21.0	07	18	80
1.000000	20.0	18.1	17.3	20.2	07	18	80
2.000000	1.0	29.2	33.0	0.9	07	18	80
.130000	19.8	18.0	18.4	19.7	07	18	80
.131000	20.0	16.0	14.0	19.8	07	18	80
.132000	20.0	18.0	16.5	19.9	07	18	80
.133000	20.0	17.1	14.2	19.8	07	18	80
.100000	8.9	13.3	12.8	8.8	07	22	80
.100025	11.4	11.5	12.7	11.6	07	22	80
.100050	11.2	12.6	8.8	11.5	07	22	80
.111000	10.5	6.3	7.1	10.7	07	22	80
.112000	12.9	9.8	10.2	14.0	07	22	80
.113000	14.2	9.1	9.1	14.4	07	22	80

```
    .114000  9.4  2.8  4.9  9.1 07 22 80
    .115000 11.6 13.3 13.1 11.7 07 22 80
    .130000 13.7 18.1 20.3 13.3 07 22 80
    .131000 17.1 14.1 12.9 17.8 07 22 80
    .132000 15.1 12.1  9.8 15.6 07 22 80
    .133000 12.3  8.5  6.8 12.9 07 22 80
    .250000 13.8 17.0 16.6 13.5 07 22 80
    .300000 14.4 13.7 12.3 15.1 07 22 80
    .350000 16.2 13.1 13.1 15.8 07 22 80
    .950000 16.9 14.4 14.5 17.0 07 22 80
   1.000000 14.6 12.4 13.2 13.8 07 22 80
   2.000000 15.3 25.6 23.1 15.0 07 22 80
99999
```

A.2.2 SAMPLE PRINTOUT FOR STEP 2

```
@XQT B.ABSNEW
ENTER THE WORD STEP AND THE STEP NUMBER REQUIRED.


STEP 2
A DATA FILE CONTAINING OBSERVED CONTROL VALUES S1-S2 IS CREATED.
INPUT IS EXPECTED FROM THE RUNSTREAM AND IS TERMINATED BY THE VALUE 99999.
OUTPUT IS THE RAW CONTROL DATA FILE ON LOGICAL UNIT 10.

ON ONE INPUT RECORD PROVIDE THE FOLLOWING:
LENGTH,TEST READING,S1 READING,S2 READING,TEST READING, MONTH,DAY AND YEAR.
     THE DATA FILE OF INITIAL CHECK STANDARDS
          CONTAINS THE FOLLOWING VALUES
```

LENGTH	TEST	S1	S2	TEST	DATE			S1-S2
.100000	3.6	3.0	2.3	3.9	7	3	80	1.0
.100025	19.4	16.1	17.4	19.1	7	3	80	-1.6
.100050	19.9	21.9	17.2	19.9	7	3	80	4.7
.130000	22.7	32.8	33.7	22.4	7	3	80	-1.2
.131000	20.0	14.3	12.9	19.9	7	3	80	1.3
.132000	19.1	22.7	21.6	17.8	7	3	80	-.2
.133000	17.6	19.0	16.7	17.0	7	3	80	1.7
.250000	19.1	19.3	19.4	19.9	7	3	80	.7
.300000	12.1	32.8	30.0	12.9	7	3	80	3.6
.350000	18.2	23.9	23.8	18.5	7	3	80	.4
.111000	19.7	21.2	22.8	19.0	7	3	80	-2.3
.112000	19.4	31.0	31.3	19.6	7	3	80	-.1
.113000	19.2	27.3	27.2	19.6	7	3	80	.5
.114000	20.1	23.9	25.2	20.9	7	3	80	-.5
.115000	20.0	31.0	30.8	20.3	7	3	80	.5
.950000	20.1	38.2	39.5	20.9	7	3	80	-.5
1.000000	21.0	14.0	14.5	20.6	7	3	80	-.9
2.000000	11.1	59.8	54.7	10.8	7	3	80	4.8
.100000	13.5	12.2	14.1	14.0	7	8	80	-1.4
.100025	14.8	14.0	15.2	15.0	7	8	80	-1.0
.100050	17.9	32.7	28.4	18.2	7	8	80	4.6
.111000	9.1	29.7	31.1	8.0	7	8	80	-2.5

.112000	17.2	32.1	33.0	17.8	7	8	80	-.3
.113000	3.9	11.9	12.2	3.3	7	8	80	-.9
.114000	8.5	14.5	15.8	8.5	7	8	80	-1.3
.115000	7.7	22.6	22.0	8.0	7	8	80	.9
.130000	3.0	35.7	36.1	3.0	7	8	80	-.4
.131000	5.6	21.0	19.9	5.9	7	8	80	1.4
.132000	3.0	21.1	19.2	2.9	7	8	80	1.8
.133000	8.1	16.0	14.2	7.0	7	8	80	.7
.250000	14.8	16.4	15.9	15.0	7	8	80	.7
.300000	.3	39.7	37.1	.2	7	8	80	2.5
.350000	1.0	38.0	37.4	1.1	7	8	80	.7
.950000	4.3	29.3	30.0	4.1	7	8	80	-.9
1.000000	11.8	9.0	9.9	11.4	7	8	80	-1.3
2.000000	16.0	21.0	18.8	16.2	7	8	80	2.4
.950000	20.0	22.8	21.0	19.7	7	10	80	1.5
1.000000	20.4	13.9	14.7	20.8	7	10	80	-.4
2.000000	19.9	27.9	26.2	21.1	7	10	80	2.9
.100000	20.7	20.3	19.8	20.1	7	10	80	-.1
.100025	20.0	18.9	19.6	19.2	7	10	80	-1.5
.100050	21.0	17.0	12.8	20.4	7	10	80	3.6
.111000	20.0	19.9	21.0	20.1	7	10	80	-1.0
.112000	20.2	17.1	18.0	20.7	7	10	80	-.4
.113000	19.7	14.1	13.9	19.8	7	10	80	.3
.114000	19.2	25.2	27.2	18.6	7	10	80	-2.6
.115000	19.9	14.9	14.3	19.6	7	10	80	.3
.130000	19.2	16.2	16.9	19.3	7	10	80	-.6
.131000	19.9	19.9	18.0	19.6	7	10	80	1.6
.132000	20.2	15.4	14.1	20.0	7	10	80	1.1
.133000	18.0	14.2	12.1	17.7	7	10	80	1.8
.250000	18.1	21.4	20.7	18.4	7	10	80	1.0
.300000	21.1	20.8	18.0	21.1	7	10	80	2.8
.350000	19.9	20.4	19.9	19.9	7	10	80	.5
.100000	13.0	11.1	10.3	11.5	7	15	80	-.7
.100025	9.9	10.0	10.3	9.2	7	15	80	-1.0
.100050	6.3	9.8	3.7	6.0	7	15	80	5.8
.111000	20.1	21.0	22.5	20.4	7	15	80	-1.2
.112000	11.2	10.7	11.2	9.9	7	15	80	-1.8
.113000	6.5	7.4	7.5	6.6	7	15	80	.0
.114000	11.4	18.3	20.9	13.4	7	15	80	-.6
.115000	10.7	19.2	19.1	11.3	7	15	80	.7
.130000	2.0	20.5	20.4	2.2	7	15	80	.3
.131000	6.3	4.6	3.0	6.3	7	15	80	1.6
.132000	9.1	21.1	19.7	8.6	7	15	80	.9
.133000	9.5	20.1	18.0	9.2	7	15	80	1.8
.250000	3.5	27.7	27.1	2.6	7	15	80	-.3
.300000	8.5	7.7	5.8	7.0	7	15	80	.4
.350000	5.4	23.1	22.7	4.6	7	15	80	-.4
.950000	5.0	17.4	18.6	4.7	7	15	80	-1.5
1.000000	14.8	14.0	14.9	14.6	7	15	80	-1.1
2.000000	4.7	30.5	28.4	3.4	7	15	80	.8
.100000	8.0	29.1	28.2	7.9	7	18	80	.8
.100025	19.7	13.4	14.1	19.5	7	18	80	-.9
.100050	20.0	20.0	15.9	19.9	7	18	80	4.0

.111000	19.6	19.8	20.8	19.8	7	18	80	-.8
.112000	20.0	13.6	14.2	19.9	7	18	80	-.7
.113000	19.1	14.3	14.1	19.0	7	18	80	.1
.114000	20.0	14.9	16.8	20.0	7	18	80	-1.9
.115000	19.3	17.1	16.7	19.0	7	18	80	.1
.250000	19.9	23.3	22.8	19.4	7	18	80	.0
.300000	20.0	19.7	17.1	20.0	7	18	80	2.6
.350000	19.0	25.1	24.4	19.0	7	18	80	.7
.950000	21.0	28.5	28.8	21.0	7	18	80	-.3
1.000000	20.0	18.1	17.3	20.2	7	18	80	1.0
2.000000	1.0	29.2	33.0	.9	7	18	80	-3.9
.130000	19.8	18.0	18.4	19.7	7	18	80	-.5
.131000	20.0	16.0	14.0	19.8	7	18	80	1.8
.132000	20.0	18.0	16.5	19.9	7	18	80	1.4
.133000	20.0	17.1	14.2	19.8	7	18	80	2.7
.100000	8.9	13.3	12.8	8.8	7	22	80	.4
.100025	11.4	11.5	12.7	11.6	7	22	80	-1.0
.100050	11.2	12.6	8.8	11.5	7	22	80	4.1
.111000	10.5	6.3	7.1	10.7	7	22	80	-.6
.112000	12.9	9.8	10.2	14.0	7	22	80	.7
.113000	14.2	9.1	9.1	14.4	7	22	80	.2
.114000	9.4	2.8	4.9	9.1	7	22	80	-2.4
.115000	11.6	13.3	13.1	11.7	7	22	80	.3
.130000	13.7	18.1	20.3	13.3	7	22	80	-2.6
.131000	17.1	14.1	12.9	17.8	7	22	80	1.9
.132000	15.1	12.1	9.8	15.6	7	22	80	2.8
.133000	12.3	8.5	6.8	12.9	7	22	80	2.3
.250000	13.8	17.0	16.6	13.5	7	22	80	.1
.300000	14.4	13.7	12.3	15.1	7	22	80	2.1
.350000	16.2	13.1	13.1	15.8	7	22	80	-.4
.950000	16.9	14.4	14.5	17.0	7	22	80	.0
1.000000	14.6	12.4	13.2	13.8	7	22	80	-1.6
2.000000	15.3	25.6	23.1	15.0	7	22	80	2.2

A.2.3 SAMPLE OF RAW CONTROL DATA FILE (IFD) AS DEFINED BY STEP 2

.100000	1.0	7	3	80
.100025	-1.6	7	3	80
.100050	4.7	7	3	80
.130000	-1.2	7	3	80
.131000	1.3	7	3	80
.132000	-.2	7	3	80
.133000	1.7	7	3	80
.250000	.7	7	3	80
.300000	3.6	7	3	80
.350000	.4	7	3	80
.111000	-2.3	7	3	80
.112000	-.1	7	3	80
.113000	.5	7	3	80
.114000	-.5	7	3	80
.115000	.5	7	3	80
.950000	-.5	7	3	80
1.000000	-.9	7	3	80
2.000000	4.8	7	3	80

.100000	-1.4	7	8	80
.100025	-1.0	7	8	80
.100050	4.6	7	8	80
.111000	-2.5	7	8	80
.112000	-.3	7	8	80
.113000	-.9	7	8	80
.114000	-1.3	7	8	80
.115000	.9	7	8	80
.130000	-.4	7	8	80
.131000	1.4	7	8	80
.132000	1.8	7	8	80
.133000	.7	7	8	80
.250000	.7	7	8	80
.300000	2.5	7	8	80
.350000	.7	7	8	80
.950000	-.9	7	8	80
1.000000	-1.3	7	8	80
2.000000	2.4	7	8	80
.950000	1.5	7	10	80
1.000000	-.4	7	10	80
2.000000	2.9	7	10	80
.100000	-.1	7	10	80
.100025	-1.5	7	10	80
.100050	3.6	7	10	80
.111000	-1.0	7	10	80
.112000	-.4	7	10	80
.113000	.3	7	10	80
.114000	-2.6	7	10	80
.115000	.3	7	10	80
.130000	-.6	7	10	80
.131000	1.6	7	10	80
.132000	1.1	7	10	80
.133000	1.8	7	10	80
.250000	1.0	7	10	80
.300000	2.8	7	10	80
.350000	.5	7	10	80
.100000	-.7	7	15	80
.100025	-1.0	7	15	80
.100050	5.8	7	15	80
.111000	-1.2	7	15	80
.112000	-1.8	7	15	80
.113000	.0	7	15	80
.114000	-.6	7	15	80
.115000	.7	7	15	80
.130000	.3	7	15	80
.131000	1.6	7	15	80
.132000	.9	7	15	80
.133000	1.8	7	15	80
.250000	-.3	7	15	80
.300000	.4	7	15	80
.350000	-.4	7	15	80
.950000	-1.5	7	15	80
1.000000	-1.1	7	15	80

```
  2.000000    .8  7 15 80
   .100000    .8  7 18 80
   .100025   -.9  7 18 80
   .100050   4.0  7 18 80
   .111000   -.8  7 18 80
   .112000   -.7  7 18 80
   .113000    .1  7 18 80
   .114000  -1.9  7 18 80
   .115000    .1  7 18 80
   .250000    .0  7 18 80
   .300000   2.6  7 18 80
   .350000    .7  7 18 80
   .950000   -.3  7 18 80
  1.000000   1.0  7 18 80
  2.000000  -3.9  7 18 80
   .130000   -.5  7 18 80
   .131000   1.8  7 18 80
   .132000   1.4  7 18 80
   .133000   2.7  7 18 80
   .100000    .4  7 22 80
   .100025  -1.0  7 22 80
   .100050   4.1  7 22 80
   .111000   -.6  7 22 80
   .112000    .7  7 22 80
   .113000    .2  7 22 80
   .114000  -2.4  7 22 80
   .115000    .3  7 22 80
   .130000  -2.6  7 22 80
   .131000   1.9  7 22 80
   .132000   2.8  7 22 80
   .133000   2.3  7 22 80
   .250000    .1  7 22 80
   .300000   2.1  7 22 80
   .350000   -.4  7 22 80
   .950000    .0  7 22 80
  1.000000  -1.6  7 22 80
  2.000000   2.2  7 22 80
99999
```

A.3 STEP 3--CREATE A PROCESS CONTROL DATA FILE

A.3.1 SAMPLE RUNSTREAM FOR STEP 3

```
@HDG,X STEP 3--CREATE A PROCESS CONTROL DATA FILE
@USE 8.,CNTLDATA.  CNTLDATA IS FILE OF THE CONTROL VALUES SORTED AND WEIGHTED
@ASG,UP 8.
@USE 9.,PROCPARFL. PROCPARFL IS THE FILE CONTAINING THE PROCESS PARAMETERS
@ASG,UP 9.
@USE 10.,RAWCNTL   RAWCNTL IS THE FILE CONTAINING THE CONTROL DATA (INPUT)
@ASG,A 10.
@USE B.,LNGTHMAPPRG2.
@ASG,A B.
@XQT B.ABSNEW
STEP 3
```

A.3.2 SAMPLE PRINTOUT FOR STEP 3

```
@XQT B.ABSNEW
ENTER THE WORD STEP AND THE STEP NUMBER REQUIRED.


STEP 3
CREATE A SORTED CONTROL DATA FILE ON LOGICAL UNIT  8.
INPUT IS THE RAW CONTROL DATA FILE ON LOGICAL UNIT 10
WHICH WAS CREATED IN STEP 2.
COMPUTE PROCESS CONTROL PARAMETERS.
RECORD PROCESS CONTROL PARAMETERS ON A DATA FILE-LOGICAL UNIT  9.

ON ONE INPUT RECORD PROVIDE THE FOLLOWING:
LENGTH, ACCEPTED VALUE, MONTH, DAY, YEAR

                         ***PROCESS PARAMETERS***
                       ACCEPTED VALUE OF THE CONTROL
               GROUP STANDARD DEVIATION AND DEGREES OF FREEDOM

                   VALUES IN MICROINCHES AT 20 DEGREES C
```

GROUP	NOMINAL SIZE	CONTROL AVERAGE VALUE	NUMBER OF REPETITIONS	OBSERVED S.D. OF CONTROL	GROUP S.D.	DEGREES OF FREEDOM
2	.100000	.00	6	.923		
2	.100025	-1.17	6	.301		
2	.100050	4.47	6	.769		
	COMBINED				.715	15
3	.111000	-1.40	6	.802		
3	.112000	-.43	6	.819		
3	.113000	.03	6	.489		
3	.114000	-1.55	6	.896		
3	.115000	.47	6	.294		
	COMBINED				.699	25
4	.130000	-.83	6	.989		
4	.131000	1.60	6	.228		
4	.132000	1.30	6	.996		
4	.133000	1.83	6	.674		
	COMBINED				.787	20
5	.250000	.37	6	.505		
5	.300000	2.33	6	1.069		
5	.350000	.25	6	.517		
	COMBINED				.745	15

6	.950000	-.28	6	1.017		
6	1.000000	-.72	6	.933		
6	2.000000	1.53	6	2.960		
	COMBINED				1.885	15

A.3.3 SAMPLE OF OUTPUT CONTROL DATA FILE (IFB) (SORTED AND WEIGHTED) FROM STEP 3

Because this data file is similar to the one listed in A.2.3 only the first 10 and the last 10 records are listed.

.100000	1.00	7	3	80	1
.100000	-1.40	7	8	80	1
.100000	-.10	7	10	80	1
.100000	-.70	7	15	80	1
.100000	.80	7	18	80	1
.100000	.40	7	22	80	1
.100025	-1.60	7	3	80	1
.100025	-1.00	7	8	80	1
.100025	-1.50	7	10	80	1
.100025	-1.00	7	15	80	1
(data not listed)					
1.000000	-1.10	7	15	80	1
1.000000	1.00	7	18	80	1
1.000000	-1.60	7	22	80	1
2.000000	4.80	7	3	80	1
2.000000	2.40	7	8	80	1
2.000000	2.90	7	10	80	1
2.000000	.80	7	15	80	1
2.000000	-3.90	7	18	80	1
2.000000	2.20	7	22	80	1
99999					

A.3.4 SAMPLE OF PROCESS CONTROL DATA FILE (IFC) AS CREATED BY STEP 3

.100000	.00	6	.923	.715	15
.100025	-1.17	6	.301	.715	15
.100050	4.47	6	.769	.715	15
.111000	-1.40	6	.802	.699	25
.112000	-.43	6	.819	.699	25
.113000	.03	6	.489	.699	25
.114000	-1.55	6	.896	.699	25
.115000	.47	6	.294	.699	25
.130000	-.83	6	.989	.787	20
.131000	1.60	6	.228	.787	20
.132000	1.30	6	.996	.787	20
.133000	1.83	6	.674	.787	20
.250000	.37	6	.505	.745	15
.300000	2.33	6	1.069	.745	15
.350000	.25	6	.517	.745	15
.950000	-.28	6	1.017	1.885	15
1.000000	-.72	6	.933	1.885	15
2.000000	1.53	6	2.960	1.885	15
99999					

A.4 STEP 4--PLOT CONTROL DATA FILE

A.4.1 SAMPLE RUNSTREAM FOR STEP 4

```
@HDG,X STEP 4--PLOT CONTROL DATA BY GROUP
@USE 8.,CNTLDATA.   CNTLDATA IS THE FILE CONTAINING CONTROL DATA
@ASG,A 8.
@USE B.,LNGTHMAPPRG2.
@ASG,A B.
@XQT B.ABSNEW
STEP 4
99999
```

A.4.2 SAMPLE PRINTOUT FROM STEP 4

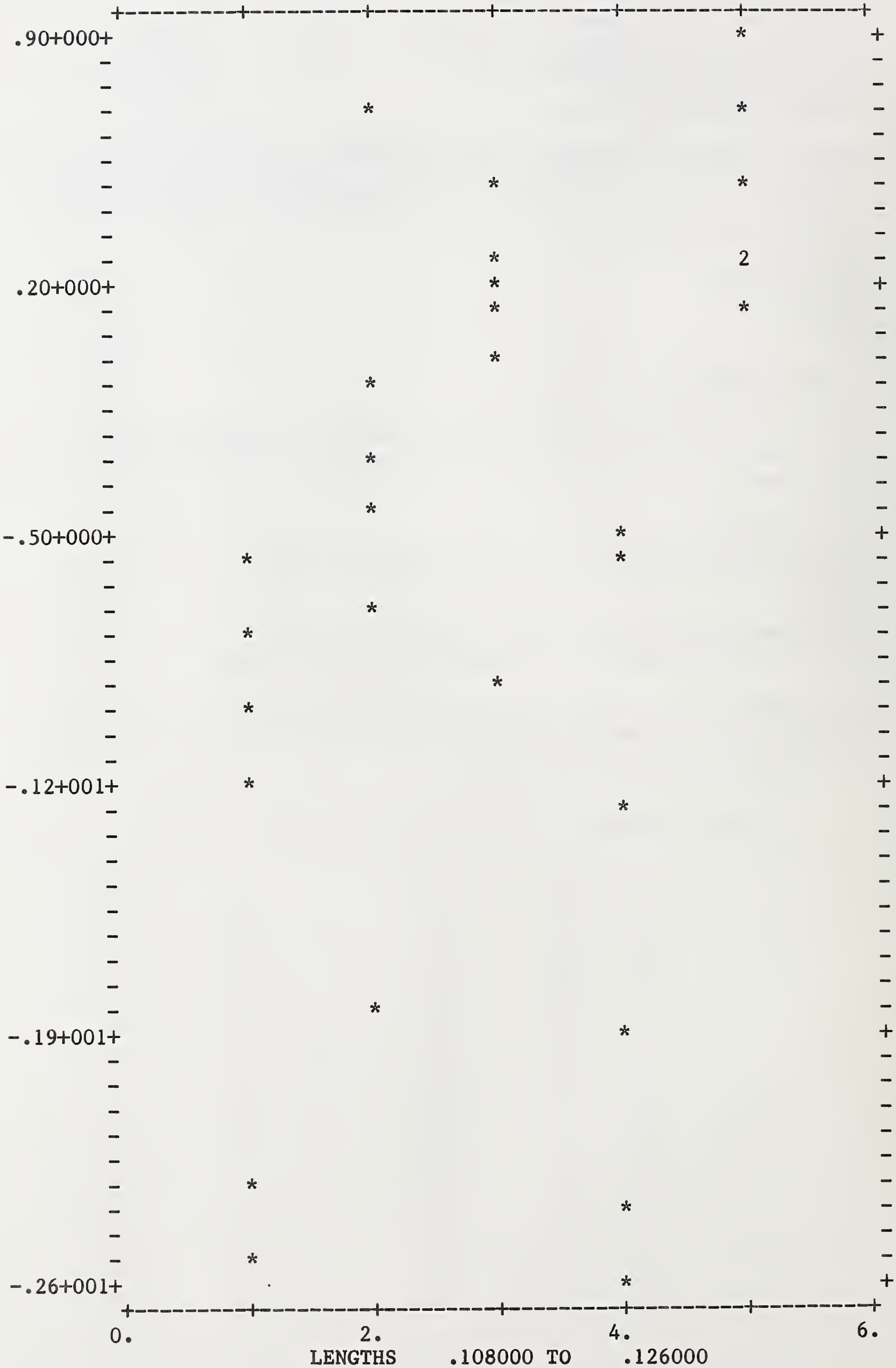
There are five plots, one for each group, generated for this step. Only one plot example is given. The remaining plots are similar to the one shown.

```
@XQT B.ABSNEW
ENTER THE WORD STEP AND THE STEP NUMBER REQUIRED.

STEP 4
PLOT CONTROL DATA FILE FOUND ON LOGICAL UNIT 8.
ADDITIONAL INFORMATION IS EXPECTED VIA THE RUNSTREAM.

INPUT 99999 IF ALL GROUPS ARE TO BE PLOTTED.
IF ONE PLOT PER LENGTH IS REQUIRED INPUT EACH LENGTH TO BE PLOTTED.
TERMINATE DATA INPUT WITH 99999.
```

PLOT FOR GROUP 3



A.5 STEP 5--MAINTAINING MEASUREMENT PROCESS CONTROL

A.5.1 SAMPLE RUNSTREAM FOR STEP 5

```
@HDG,X ANALYZE OBSERVED DATA
@USE 7.,LABSTDFL. LABSTDFL IS THE FILE CONTAINING LAB STANDARDS INFO
@ASG,A 7.
@USE 9.,PROCPARFL. PROCPARFL IS THE FILE CONTAINING THE PROCESS PARAMETERS
@ASG,A 9.
@USE 10.,CNTLNEW. CNTLNEW CONTAINS CHECK STANDARDS DATA FOR NEXT UPDATE
@ASG,UP 10.
@USE B.,LNGTHMAPPRG2.
@ASG,A B.
@XQT B.ABSNEW
STEP 5
COMPA  10  29  80  0
    .100000  E392  E424  7044  19.5  16.1  16.9  19.1
    .100025  C254  J245  3573  19.0  17.4  18.2  18.8
    .100050  I271  E266  4677  21.1  21.9  17.2  20.8
    .111000  D241  D313  2784  19.8  18.0  18.9  19.8
    .112000  C288  E300  3205  19.0  17.0  18.1  19.0
    .113000  C289  E307  3167  20.0  17.9  17.9  20.3
    .114000  D457  E214  3240  20.0  13.7  15.4  20.5
    .115000  C422  E342  2928  20.7  16.9  16.3  20.2
    .130000  D142  C524  4444  20.0  13.2  14.0  20.1
    .131000  C377  C363  3130  20.0  17.0  15.0  20.2
    .132000  C318  E576  2703  21.0  18.8  17.0  21.0
    .133000  C377  E482  2792  20.9  18.8  15.8  21.0
    .250000  C662  D180  6885  20.3  17.8  17.7  20.7
    .300000  E196  E676  6444  20.1  19.5  24.1  20.4
    .350000  C448  D331  4089  21.2  20.1  19.9  21.2
    .950000  E550  E543  3811  21.3  19.8  22.0  22.0
  1.000000  E409 E1012  1707  18.9  11.1  10.2  18.9
  2.000000 C1153  E695  7654  20.7  18.1  15.0  21.3
        99999
@XQT B.ABSNEW
STEP 5
COMPA  11  06  80  1
    .100000  E392  E424  7044  20.1  17.3  16.2  19.8
    .100025  C254  J245  3573  23.0  22.2  22.0  22.9
    .100050  I271  E266  4677  22.0  22.6  18.7  22.1
    .111000  D241  D313  2784  21.0  18.0  20.6  21.7
    .112000  C288  E300  3205  22.6  21.9  22.3  22.2
    .113000  C289  E307  3167  21.5  19.2  19.7  21.7
    .114000  D457  E214  3240  21.1  15.5  17.3  21.1
    .115000  C422  E342  2928  23.0  19.7  19.7  22.9
    .130000  D142  C524  4444  22.6  16.8  17.7  22.9
    .131000  C377  C363  3130  20.7  18.9  16.4  21.1
    .132000  C318  E576  2703  22.0  20.3  18.1  22.0
    .133000  C377  E482  2792  22.9  20.2  18.0  22.9
```

```
   .250000  C662  D180  6885  22.1  19.8  19.0  21.8
   .300000  E196  E676  6444  21.9  22.2  17.6  21.6
   .350000  C448  D331  4089  22.1  20.3  21.7  21.5
   .950000  E550  E543  3811  23.4  23.5  23.4  23.3
  1.000000  E409 E1012  1707  22.4  13.3  14.0  22.0
  2.000000 C1153  E695  7654  23.0  21.0  16.7  22.4
       99999
@XQT B.ABSNEW
STEP 5
COMPA  10  30  80  1
   .100000  E392  E424  7002  21.2  19.0  19.1  21.6
   .100025  C254  J245  3530  20.4  19.9  20.2  21.0
   .100050  I271  E266  4629  21.2  20.0  15.4  21.1
   .111000  D241  D313  2771  18.9  16.0  18.0  19.6
   .112000  C288  E300  3222  19.9  19.0  20.0  20.0
   .113000  C289  E307  3158  20.3  17.6  18.0  20.5
   .114000  D457  E214  3257  19.4  13.0  15.0  19.1
   .115000  C422  E342  2988  20.4  16.9  16.5  20.9
   .130000  D142  C524  4430  20.9  14.7  15.1  21.1
   .131000  C377  C363  3122  20.0  16.9  15.2  20.2
   .132000  C318  E576  2740  20.1  18.2  16.4  20.2
   .133000  C377  E482  2739  25.9  18.9  15.7  20.3
   .250000  C662  D180  6839  20.9  20.9  20.8  21.0
   .300000  E196  E676  6461  20.3  19.9  15.2  20.0
   .350000  C448  D331  4024  21.0  19.8  20.0  21.0
   .950000  E550  E543  3814  20.1  19.2  20.1  20.8
  1.000000  E409 E1012  1792  21.3  14.0  14.0  22.1
  2.000000 C1153  E695  7646  20.7  18.5  16.4  21.1
       99999
@XQT B.ABSNEW
STEP 5
COMPA  11  10  80  1
   .100000  E392  E424  7002  19.0  16.2  15.4  18.3
   .100025  C254  J245  3530  22.7  21.4  22.1  23.0
   .100050  I271  E266  4629  20.4  19.3  15.5  21.0
   .111000  D241  D313  2771  23.0  19.2  20.9  23.2
   .112000  C288  E300  3222  22.8  21.9  22.7  23.3
   .113000  C289  E307  3158  21.5  19.1  19.4  22.4
   .114000  D457  E214  3257  21.1  15.4  17.0  21.0
   .115000  C422  E342  2988  14.9  11.0  11.1  15.3
   .130000  D142  C524  4430  21.0  15.9  16.6  21.1
   .131000  C377  C363  3122  21.0  18.0  16.2  21.6
   .132000  C318  E576  2740  20.9  19.4  17.5  21.1
   .133000  C377  E482  2739  26.2  20.3  17.6  22.2
   .250000  C662  D180  6839  21.7  22.1  21.7  21.7
   .300000  E196  E676  6461  22.9  23.2  19.2  23.0
   .350000  C448  D331  4024  24.1  23.0  23.0  23.9
   .950000  E550  E543  3814  20.8  20.2  20.3  20.9
  1.000000  E409 E1012  1792  22.1  13.9  14.9  22.9
  2.000000 C1153  E695  7646  20.4  17.7  14.7  20.6
       99999
```

A.5.2 <u>SAMPLE PRINTOUT FOR STEP 5</u>

There are four sets of data given above. This printout is the printout of only the first set of data.

```
@XQT B.ABSNEW
ENTER THE WORD STEP AND THE STEP NUMBER REQUIRED.


STEP 5
CHECK PROCESS CONTROL BY CALIBRATION.

INPUT IS THE LABORATORY STANDARDS INFORMATION ON LOGICAL UNIT  7
WHICH WAS CREATED IN STEP 1,
THE PROCESS CONTROL PARAMETERS ON LOGICAL UNIT  9
WHICH WAS CREATED IN STEP 3,
AND THE OBSERVATIONS VIA THE RUNSTREAM TERMINATED BY THE VALUE 99999.
LOGICAL UNIT 10 IS THE OUTPUT FILE WHICH COLLECTS CONTROL VALUES.

INPUT OPERATOR IN POSITIONS 1 TO  6 ,DATE AND FLAG WHERE
  FLAG EQUALS 0 IF THIS IS THE BEGINNING OF COLLECTION OF CONTROL DATA
  AND FLAG EQUALS 1 IF CONTROL DATA IS TO BE ADDED TO AN EXISTING FILE.

INPUT OBSERVATIONS AND IDENTIFICATION FOR EACH LENGTH.
  EACH INPUT RECORD CONTAINS LENGTH, STANDARD 1 ID, STANDARD 2 ID,
  TEST ID AND THE FOUR CORRESPONDING READINGS.
  THE VALUE 99999 IS ENTERED TO DENOTE THE END OF DATA.

            OBSERVED VALUES OF CONTROL AND STANDARD DEVIATIONS
                   COMPARED TO ACCEPTED VALUES OF CONTROL
              VALUES ARE IN MICROINCHES AT 20 DEGREES CELSIUS

                      GROUP 2  OBSERVER COMPA   DATE 10/29/  80
```

NOMINAL SIZE (INCHES)	TEST ID	TEST OBS	STD 1 ID	STD 1 OBS	STD 2 ID	STD 2 OBS	TEST ID	TEST OBS
.100000	7044	19.50	E392	16.10	E424	16.90	7044	19.10
.100025	3573	19.00	C254	17.40	J245	18.20	3573	18.80
.100050	4677	21.10	I271	21.90	E266	17.20	4677	20.80

STATISTICAL ANALYSIS FOR GROUP 2

NOMINAL SIZE (INCHES)	CONTROL OBS VALUE	CONTROL ACC VALUE	CONTROL MINUS ACC	GROUP S.D. OBS	GROUP S.D. ACC	GROUP S.D. ACC D.F.	T TEST	F TEST
.100000	-1.20	.00	-1.20				1.67	
.100025	-1.00	-1.17	.17				.24	
.100050	4.40	4.47	-.07				.10	
COMBINED				.70	.72	15		.95

VALUES FOR TEST BLOCKS FOR GROUP 2

SIZE (INCHES)	TEST ID	OBS VALUE	STANDARD UNCERTAINTY	ERROR LIMIT	UNCERTAINTY FOR TEST
.100000	7044	2.95	2.00	1.08	3.08
.100025	3573	1.45	2.00	1.08	3.08
.100050	4677	1.20	2.00	1.08	3.08

OBSERVED VALUES OF CONTROL AND STANDARD DEVIATIONS
COMPARED TO ACCEPTED VALUES OF CONTROL
VALUES ARE IN MICROINCHES AT 20 DEGREES CELSIUS

GROUP 3 OBSERVER COMPA DATE 10/29/ 80

NOMINAL SIZE (INCHES)	TEST ID	TEST OBS	STD 1 ID	STD 1 OBS	STD 2 ID	STD 2 OBS	TEST ID	TEST OBS
.111000	2784	19.80	D241	18.00	D313	18.90	2784	19.80
.112000	3205	19.00	C288	17.00	E300	18.10	3205	19.00
.113000	3167	20.00	C289	17.90	E307	17.90	3167	20.30
.114000	3240	20.00	D457	13.70	E214	15.40	3240	20.50
.115000	2928	20.70	C422	16.90	E342	16.30	2928	20.20

STATISTICAL ANALYSIS FOR GROUP 3

NOMINAL SIZE (INCHES)	CONTROL OBS VALUE	CONTROL ACC VALUE	CONTROL MINUS ACC	GROUP S.D. OBS	GROUP S.D. ACC	GROUP S.D. ACC D.F.	T TEST	F TEST
.111000	-.90	-1.40	.50				.71	
.112000	-1.10	-.43	-.67				.96	
.113000	.30	.03	.27				.39	
.114000	-1.20	-1.55	.35				.50	
.115000	.10	.47	-.37				.53	
COMBINED				.45	.70	25		.41

VALUES FOR TEST BLOCKS FOR GROUP 3

SIZE (INCHES)	TEST ID	OBS VALUE	STANDARD UNCERTAINTY	ERROR LIMIT	UNCERTAINTY FOR TEST
.111000	2784	1.25	2.00	1.05	3.05
.112000	3205	-.35	2.00	1.05	3.05
.113000	3167	1.30	2.00	1.05	3.05
.114000	3240	4.05	2.00	1.05	3.05
.115000	2928	3.30	2.00	1.05	3.05

OBSERVED VALUES OF CONTROL AND STANDARD DEVIATIONS
COMPARED TO ACCEPTED VALUES OF CONTROL
VALUES ARE IN MICROINCHES AT 20 DEGREES CELSIUS

GROUP 4 OBSERVER COMPA DATE 10/29/ 80

NOMINAL SIZE (INCHES)	TEST ID	TEST OBS	STD 1 ID	STD 1 OBS	STD 2 ID	STD 2 OBS	TEST ID	TEST OBS
.130000	4444	20.00	D142	13.20	C524	14.00	4444	20.10
.131000	3130	20.00	C377	17.00	C363	15.00	3130	20.20
.132000	2703	21.00	C318	18.80	E576	17.00	2703	21.00
.133000	2792	20.90	C377	18.80	E482	15.80	2792	21.00

STATISTICAL ANALYSIS FOR GROUP 4

NOMINAL SIZE (INCHES)	CONTROL OBS VALUE	CONTROL ACC VALUE	CONTROL MINUS ACC	GROUP S.D. OBS	GROUP S.D. ACC	GROUP S.D. ACC D.F.	T TEST	F TEST
.130000	-.70	-.83	.13				.16	
.131000	2.20	1.60	.60				.76	
.132000	1.80	1.30	.50				.63	
.133000	3.10	1.83	1.27				1.61	
COMBINED				.75	.79	20		.90

VALUES FOR TEST BLOCKS FOR GROUP 4

SIZE (INCHES)	TEST ID	OBS VALUE	STANDARD UNCERTAINTY	ERROR LIMIT	UNCERTAINTY FOR TEST
.130000	4444	5.65	2.00	1.18	3.18
.131000	3130	2.75	2.00	1.18	3.18
.132000	2703	2.75	2.00	1.18	3.18
.133000	2792	2.15	2.00	1.18	3.18

OBSERVED VALUES OF CONTROL AND STANDARD DEVIATIONS
COMPARED TO ACCEPTED VALUES OF CONTROL
VALUES ARE IN MICROINCHES AT 20 DEGREES CELSIUS

GROUP 5 OBSERVER COMPA DATE 10/29/ 80

NOMINAL SIZE (INCHES)	TEST ID	TEST OBS	STD 1 ID	STD 1 OBS	STD 2 ID	STD 2 OBS	TEST ID	TEST OBS
.250000	6885	20.30	C662	17.80	D180	17.70	6885	20.70
.300000	6444	20.10	E196	19.50	E676	24.10	6444	20.40
.350000	4089	21.20	C448	20.10	D331	19.90	4089	21.20

STATISTICAL ANALYSIS FOR GROUP 5

NOMINAL SIZE (INCHES)	CONTROL OBS VALUE	CONTROL ACC VALUE	CONTROL MINUS ACC	GROUP S.D. OBS	GROUP S.D. ACC	GROUP S.D. ACC D.F.	T TEST	F TEST
.250000	.50	.37	.13				.18	
.300000	-4.30	2.33	-6.63				8.96*	
.350000	.20	.25	-.05				.07	
COMBINED				.10	.74	15		.02

* T-TEST IS GREATER THAN 3. REMEASURE BLOCK AND TEST AGAIN. THIS THIS DATA IS NOT INCLUDED IN THE COMPUTATION OF THE GROUP STANDARD DEVIATION NOR ON THE FILE OF COLLECTED CONTROL DATA.

VALUES FOR TEST BLOCKS FOR GROUP 5

SIZE (INCHES)	TEST ID	OBS VALUE	STANDARD UNCERTAINTY	ERROR LIMIT	UNCERTAINTY FOR TEST
.250000	6885	2.70	2.00	1.11	3.11
.300000	6444	-1.95	2.00	1.11	3.11
.350000	4089	1.75	2.00	1.11	3.11

OBSERVED VALUES OF CONTROL AND STANDARD DEVIATIONS
COMPARED TO ACCEPTED VALUES OF CONTROL
VALUES ARE IN MICROINCHES AT 20 DEGREES CELSIUS

GROUP 6 OBSERVER COMPA DATE 10/29/ 80

NOMINAL SIZE (INCHES)	TEST ID	TEST OBS	STD 1 ID	STD 1 OBS	STD 2 ID	STD 2 OBS	TEST ID	TEST OBS
.950000	3811	21.30	E550	19.80	E543	22.00	3811	22.00
1.000000	1707	18.90	E409	11.10	E1012	10.20	1707	18.90
2.000000	7654	20.70	C1153	18.10	E695	15.00	7654	21.30

STATISTICAL ANALYSIS FOR GROUP 6

NOMINAL SIZE (INCHES)	CONTROL OBS VALUE	CONTROL ACC VALUE	CONTROL MINUS ACC	GROUP S.D. OBS	GROUP S.D. ACC	GROUP S.D. ACC D.F.	T TEST	F TEST
.950000	-1.50	-.28	-1.22				.65	
1.000000	.90	-.72	1.62				.86	
2.000000	3.70	1.53	2.17				1.15	
COMBINED				1.71	1.89	15		.82

VALUES FOR TEST BLOCKS FOR GROUP 6

SIZE (INCHES)	TEST ID	OBS VALUE	STANDARD UNCERTAINTY	ERROR LIMIT	UNCERTAINTY FOR TEST
.950000	3811	-.50	2.00	2.83	4.83
1.000000	1707	4.80	2.00	2.83	4.83
2.000000	7654	7.60	2.00	2.83	4.83

A.5.3 SAMPLE OUTPUT FILE (IFD)

This data file contains the data from all four sets of data as given in A.5.1.

```
 .100000 -1.20 10 29 80
 .100025 -1.00 10 29 80
 .100050  4.40 10 29 80
 .111000  -.90 10 29 80
 .112000 -1.10 10 29 80
 .113000   .30 10 29 80
 .114000 -1.20 10 29 80
 .115000   .10 10 29 80
 .130000  -.70 10 29 80
 .131000  2.20 10 29 80
 .132000  1.80 10 29 80
 .133000  3.10 10 29 80
 .250000   .50 10 29 80
 .350000   .20 10 29 80
 .950000 -1.50 10 29 80
1.000000   .90 10 29 80
2.000000  3.70 10 29 80
 .100000   .80 11  6 80
 .100025   .10 11  6 80
 .100050  4.00 11  6 80
 .111000 -1.90 11  6 80
 .112000  -.80 11  6 80
 .113000  -.30 11  6 80
 .114000 -1.80 11  6 80
 .115000  -.10 11  6 80
 .130000  -.60 11  6 80
 .131000  2.90 11  6 80
 .132000  2.20 11  6 80
 .133000  2.20 11  6 80
 .250000   .50 11  6 80
 .300000  4.30 11  6 80
 .950000   .00 11  6 80
1.000000 -1.10 11  6 80
2.000000  3.70 11  6 80
 .100000   .30 10 30 80
 .100025   .30 10 30 80
 .100050  4.50 10 30 80
 .111000 -1.30 10 30 80
```

```
 .112000  -.90 10 30 80
 .113000  -.20 10 30 80
 .114000 -2.30 10 30 80
 .115000   .90 10 30 80
 .130000  -.20 10 30 80
 .131000  1.90 10 30 80
 .132000  1.90 10 30 80
 .250000   .20 10 30 80
 .300000  4.40 10 30 80
 .350000  -.20 10 30 80
 .950000  -.20 10 30 80
1.000000   .80 10 30 80
2.000000  2.50 10 30 80
 .100000   .10 11 10 80
 .100025  -.40 11 10 80
 .100050  4.40 11 10 80
 .111000 -1.50 11 10 80
 .112000  -.30 11 10 80
 .113000   .60 11 10 80
 .114000 -1.70 11 10 80
 .115000   .30 11 10 80
 .130000  -.60 11 10 80
 .131000  2.40 11 10 80
 .132000  2.10 11 10 80
 .250000   .40 11 10 80
 .300000  4.10 11 10 80
 .350000  -.20 11 10 80
 .950000   .00 11 10 80
1.000000  -.20 11 10 80
2.000000  3.20 11 10 80
   99999
```

A.6 STEP 6--UPDATE PROCESS PARAMETERS

A.6.1 SAMPLE RUNSTREAM FOR STEP 6

```
@HDG,X STEP 6--UPDATE PROCESS CONTROL DATA FILE
@USE 10.,CNTLNEW.
@ASG,A 10.
@USE 8.,CNTLNEWS CNTLNEWS IS THE NEW CONTROL FILE SORTED
@ASG,UP 8.
@USE 9.,PROCPARFL. PROCPARFL IS THE FILE CONTAINING PROCESS PARAMETERS
@ASG,A 9.
@USE 7.,CNTLDATA. CNTLDATA IS THE FILE CONTAINING OLD CONTROL SORTED VALUES
@ASG,A 7.
@XQT B.ABSNEW
STEP 6
```

A.6.2 <u>SAMPLE OF PRINTOUT FROM STEP 6</u>

@XQT B.ABSNEW
ENTER THE WORD STEP AND THE STEP NUMBER REQUIRED.

STEP 6
SORT COLLECTED CONTROL DATA FILE ON LOGICAL UNIT 10.
WHICH WAS CREATED IN STEP 5.
THE SORTED COLLECTED CONTROL DATA IS RECORDED ON LOGICAL UNIT 8.
UPDATE PROCESS CONTROL DATA FILE AND MERGE OLD AND NEW CONTROL DATA.
INPUT IS THE PROCESS CONTROL DATA FILE ON LOGICAL UNIT 9.
THE NEW SORTED COLLECTED CONTROL DATA ON LOGICAL UNIT 8.
THE OLD SORTED COLLECTED CONTROL DATA ON LOGICAL UNIT 7.
OUTPUT IS THE UPDATED PROCESS CONTROL DATA FILE ON LOGICAL UNIT 9 AND

THE OLD MERGED WITH NEW CONTROL DATA FILE ON LOGICAL UNIT 10.

NEW VALUES OF PROCESS PARAMETERS COMPARED TO ACCEPTED VALUES
VALUES IN MICROINCHES AT 20 DEGREES CELSIUS

GROUP	NOMINAL SIZE (INCHES)	OLD VALUES CONTROL	OLD VALUES GROUP S.D.	N1	NEW VALUES CONTROL	NEW VALUES GROUP S.D.	N2	T TEST	CONTROL UPDATE VALUE
2	.100000	.00	.715	6	.00	.609	4	.00	.00
2	.100025	-1.17	.715	6	-.25	.609	4	1.99	-.80
2	.100050	4.47	.715	6	4.32	.609	4	.33	4.41

F-TEST1= .73 F-TEST2= 1.38 NEW GROUP S.D.= .677 DEGREES OF FREEDOM= 24

GROUP	NOMINAL SIZE (INCHES)	OLD VALUES CONTROL	OLD VALUES GROUP S.D.	N1	NEW VALUES CONTROL	NEW VALUES GROUP S.D.	N2	T TEST	CONTROL UPDATE VALUE
3	.111000	-1.40	.699	6	-1.40	.415	4	.00	-1.40
3	.112000	-.43	.699	6	-.77	.415	4	.75	-.57
3	.113000	.03	.699	6	.10	.415	4	.16	.06
3	.114000	-1.55	.699	6	-1.75	.415	4	.44	-1.63
3	.115000	.47	.699	6	.30	.415	4	.38	.40

F-TEST1= .35 F-TEST2= 2.84 NEW GROUP S.D.= .608 DEGREES OF FREEDOM= 40

GROUP	NOMINAL SIZE (INCHES)	OLD VALUES CONTROL	OLD VALUES GROUP S.D.	N1	NEW VALUES CONTROL	NEW VALUES GROUP S.D.	N2	T TEST	CONTROL UPDATE VALUE
4	.130000	-.83	.787	6	-.52	.344	4	.61	-.71
4	.131000	1.60	.787	6	2.35	.344	4	1.48	1.90
4	.132000	1.30	.787	6	2.00	.344	4	1.38	1.58
4	.133000	1.83	.787	6	2.65	.344	2	1.28	2.03

F-TEST1= .19 F-TEST2= 5.23*** NEW GROUP S.D.= .344 DEGREES OF FREEDOM= 10

GROUP	NOMINAL SIZE (INCHES)	OLD VALUES CONTROL	OLD VALUES GROUP S.D.	N1	NEW VALUES CONTROL	NEW VALUES GROUP S.D.	N2	T TEST	CONTROL UPDATE VALUE
5	.250000	.37	.745	6	.40	1.755	4	.06	.38
5	.300000	2.33	.745	6	4.27	.175	3	3.68*	4.27
5	.350000	.25	.745	6	-.07	1.755	3	.61	.14

F-TEST1= .06** F-TEST2= 18.12*** NEW GROUP S.D.= .175 DEGREES OF FREEDOM= 7

GROUP	NOMINAL SIZE (INCHES)	OLD VALUES CONTROL	OLD VALUES GROUP S.D.	N1	NEW VALUES CONTROL	NEW VALUES GROUP S.D.	N2	T TEST	CONTROL UPDATE VALUE
6	.950000	-.28	1.885	6	-.42	.760	4	.12	-.34
6	1.000000	-.72	1.885	6	.10	.760	4	.67	-.39
6	2.000000	1.53	1.885	6	3.27	.760	4	1.43	2.23

F-TEST1= .16 F-TEST2= 6.15*** NEW GROUP S.D.= .760 DEGREES OF FREEDOM= 9

*T-TEST GREATER THAN OR EQUAL TO 3.0. USE NEW VALUE
***F-TEST IS GREATER THAN CRITICAL VALUE.
USE NEW VALUE FOR GROUP STANDARD DEVIATION.

A.6.3 SAMPLE OF OUTPUT FILE (IFC) FROM STEP 6

.100000	.00	10	.852	.677	24
.100025	-.80	10	.580	.677	24
.100050	4.41	10	.222	.677	24
.111000	-1.40	10	.416	.608	40
.112000	-.57	10	.340	.608	40
.113000	.06	10	.424	.608	40
.114000	-1.63	10	.451	.608	40
.115000	.40	10	.432	.608	40
.130000	-.71	10	.222	.344	10
.131000	1.90	10	.420	.344	10
.132000	1.58	10	.183	.344	10
.133000	2.03	8	.636	.344	10
.250000	.38	10	.141	.175	7
.300000	4.27	3	.153	.175	7
.350000	.14	9	.231	.175	7
.950000	-.34	10	.723	.760	9
1.000000	-.39	10	.942	.760	9
2.000000	2.23	10	.568	.760	9
99999					

A.6.4 SAMPLE OF OUTPUT FILE (IFD) FROM STEP 6

.100000	1.00	7	3	80	1
.100000	-1.40	7	8	80	1
.100000	-.10	7	10	80	1
.100000	-.70	7	15	80	1
.100000	.80	7	18	80	1
.100000	.40	7	22	80	1
.100000	.80	11	6	80	1
.100000	.10	11	10	80	1
.100000	-1.20	10	29	80	1
.100000	.30	10	30	80	1
.100025	-1.60	7	3	80	1
.100025	-1.00	7	8	80	1
.100025	-1.50	7	10	80	1
.100025	-1.00	7	15	80	1
.100025	-.90	7	18	80	1
.100025	-1.00	7	22	80	1
.100025	.10	11	6	80	1
.100025	-.40	11	10	80	1
.100025	-1.00	10	29	80	1
.100025	.30	10	30	80	1
.100050	4.70	7	3	80	1
.100050	4.60	7	8	80	1
.100050	3.60	7	10	80	1
.100050	5.80	7	15	80	1

.100050	4.00	7	18	80	1
.100050	4.10	7	22	80	1
.100050	4.00	11	6	80	1
.100050	4.40	11	10	80	1
.100050	4.40	10	29	80	1
.100050	4.50	10	30	80	1
.111000	-2.30	7	3	80	1
.111000	-2.50	7	8	80	1
.111000	-1.00	7	10	80	1
.111000	-1.20	7	15	80	1
.111000	-.80	7	18	80	1
.111000	-.60	7	22	80	1
.111000	-1.90	11	6	80	1
.111000	-1.50	11	10	80	1
.111000	-.90	10	29	80	1
.111000	-1.30	10	30	80	1
.112000	-.10	7	3	80	1
.112000	-.30	7	8	80	1
.112000	-.40	7	10	80	1
.112000	-1.80	7	15	80	1
.112000	-.70	7	18	80	1
.112000	.70	7	22	80	1
.112000	-.80	11	6	80	1
.112000	-.30	11	10	80	1
.112000	-1.10	10	29	80	1
.112000	-.90	10	30	80	1
.113000	.50	7	3	80	1
.113000	-.90	7	8	80	1
.113000	.30	7	10	80	1
.113000	.00	7	15	80	1
.113000	.10	7	18	80	1
.113000	.20	7	22	80	1
.113000	-.30	11	6	80	1
.113000	.60	11	10	80	1
.113000	.30	10	29	80	1
.113000	-.20	10	30	80	1
.114000	-.50	7	3	80	1
.114000	-1.30	7	8	80	1
.114000	-2.60	7	10	80	1
.114000	-.60	7	15	80	1
.114000	-1.90	7	18	80	1
.114000	-2.40	7	22	80	1
.114000	-1.80	11	6	80	1
.114000	-1.70	11	10	80	1
.114000	-1.20	10	29	80	1
.114000	-2.30	10	30	80	1
.115000	.50	7	3	80	1
.115000	.90	7	8	80	1
.115000	.30	7	10	80	1
.115000	.70	7	15	80	1
.115000	.10	7	18	80	1
.115000	.30	7	22	80	1
.115000	-.10	11	6	80	1
.115000	.30	11	10	80	1

.115000	.10	10	29	80 1
.115000	.90	10	30	80 1
.130000	-1.20	7	3	80 1
.130000	-.40	7	8	80 1
.130000	-.60	7	10	80 1
.130000	.30	7	15	80 1
.130000	-.50	7	18	80 1
.130000	-2.60	7	22	80 1
.130000	-.60	11	6	80 1
.130000	-.60	11	10	80 1
.130000	-.70	10	29	80 1
.130000	-.20	10	30	80 1
.131000	1.30	7	3	80 1
.131000	1.40	7	8	80 1
.131000	1.60	7	10	80 1
.131000	1.60	7	15	80 1
.131000	1.80	7	18	80 1
.131000	1.90	7	22	80 1
.131000	2.90	11	6	80 1
.131000	2.40	11	10	80 1
.131000	2.20	10	29	80 1
.131000	1.90	10	30	80 1
.132000	-.20	7	3	80 1
.132000	1.80	7	8	80 1
.132000	1.10	7	10	80 1
.132000	.90	7	15	80 1
.132000	1.40	7	18	80 1
.132000	2.80	7	22	80 1
.132000	2.20	11	6	80 1
.132000	2.10	11	10	80 1
.132000	1.80	10	29	80 1
.132000	1.90	10	30	80 1
.133000	1.70	7	3	80 1
.133000	.70	7	8	80 1
.133000	1.80	7	10	80 1
.133000	1.80	7	15	80 1
.133000	2.70	7	18	80 1
.133000	2.30	7	22	80 1
.133000	2.20	11	6	80 1
.133000	3.10	10	29	80 1
.250000	.70	7	3	80 1
.250000	.70	7	8	80 1
.250000	1.00	7	10	80 1
.250000	-.30	7	15	80 1
.250000	.00	7	18	80 1
.250000	.10	7	22	80 1
.250000	.50	11	6	80 1
.250000	.40	11	10	80 1
.250000	.50	10	29	80 1
.250000	.20	10	30	80 1
.300000	3.60	7	3	80 0
.300000	2.50	7	8	80 0
.300000	2.80	7	10	80 0
.300000	.40	7	15	80 0

.300000	2.60	7	18	80	0
.300000	2.10	7	22	80	0
.300000	4.30	11	6	80	1
.300000	4.10	11	10	80	1
.300000	4.40	10	30	80	1
.350000	.40	7	3	80	1
.350000	.70	7	8	80	1
.350000	.50	7	10	80	1
.350000	-.40	7	15	80	1
.350000	.70	7	18	80	1
.350000	-.40	7	22	80	1
.350000	-.20	11	10	80	1
.350000	.20	10	29	80	1
.350000	-.20	10	30	80	1
.950000	-.50	7	3	80	1
.950000	-.90	7	8	80	1
.950000	1.50	7	10	80	1
.950000	-1.50	7	15	80	1
.950000	-.30	7	18	80	1
.950000	.00	7	22	80	1
.950000	.00	11	6	80	1
.950000	.00	11	10	80	1
.950000	-1.50	10	29	80	1
.950000	-.20	10	30	80	1
1.000000	-.90	7	3	80	1
1.000000	-1.30	7	8	80	1
1.000000	-.40	7	10	80	1
1.000000	-1.10	7	15	80	1
1.000000	1.00	7	18	80	1
1.000000	-1.60	7	22	80	1
1.000000	-1.10	11	6	80	1
1.000000	-.20	11	10	80	1
1.000000	.90	10	29	80	1
1.000000	.80	10	30	80	1
2.000000	4.80	7	3	80	1
2.000000	2.40	7	8	80	1
2.000000	2.90	7	10	80	1
2.000000	.80	7	15	80	1
2.000000	-3.90	7	18	80	1
2.000000	2.20	7	22	80	1
2.000000	3.70	11	6	80	1
2.000000	3.20	11	10	80	1
2.000000	3.70	10	29	80	1
2.000000	2.50	10	30	80	1
99999					

Appendix B Availability of the Computer Software

The computer software consists of approximately 4050 lines of FORTRAN language code. Because of the size of the software a listing is not included in this document. Either a hardcopy listing of the software or a recording of the software on magnetic tape is available upon request. A listing of the runstreams for each of the 6 steps described in this document are also provided. The following table gives a list of the subprograms and the number of lines of FORTRAN code for each subprogram:

	Subprogram	Lines of code
1.	DRIVER	209
2.	BLKDAT	89
3.	VARRD	163
4.	DATCON	29
5.	CONID	45
6.	SORTLN	39
7.	STNDR2	236
8.	S1MS22	90
9.	RAWFL2	146
10.	CONDAT	22
11.	PPFIL2	211
12.	PLOTCK	271
13.	PLOT	127
14.	OBSCS2	338
15.	RDN1N2	167
16.	PRTOB2	184
17.	FCDF	344
18.	NORCDF	50
19.	CHSCDF	226
20.	PPUPD2	380
21.	MRGPP2	62

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U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO.	2. Performing Organ. Report No.	3. Publication Date
	NBS TN 1168		October 1982

4. TITLE AND SUBTITLE

Computer Software for Measurement Assurance of Gage Blocks

5. AUTHOR(S)

Ruth N. Varner

6. PERFORMING ORGANIZATION *(If joint or other than NBS, see instructions)*

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

Final

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

Same as Item 6.

10. SUPPLEMENTARY NOTES

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

11. 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 document is intended for those who are interested in computer software needed to provide, on a continual basis, a measurement assurance procedure for calibrating gage blocks where a test set of gage blocks is measured against two standard sets with control being on the difference of the two standards. A thorough discussion is given of the software including its implementation and usage. A hard copy or a magnetic tape of the software is available on request.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

computer software; FORTRAN; gage blocks; measurement assurance; statistical control; statistical tests.

13. AVAILABILITY

☒ Unlimited
☐ For Official Distribution. Do Not Release to NTIS
☒ Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
☐ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

58

15. Price

$4.75

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