NBS TECHNICAL NOTE 872

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

Computer Program Package for Metric Conversion: Reference Manual

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Part of the Center for Radiation Research.
[3] Located at Boulder, Colorado 80302.
[4] Part of the Center for Building Technology.

Computer Program Package for Metric Conversion: Reference Manual

Ruth K. Anderson and
Joseph O. Harrison, Jr.

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Washington, D.C. 20234

U.S. DEPARTMENT OF COMMERCE, Rogers C. B. Morton, *Secretary*
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, *Director*

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FOREWORD

This computer program package is designed to assist manufacturing companies in converting to the metric system. The starting point of the manufacturing process is the engineering drawing, and it is at this point that metric conversion should begin. Accordingly, the package is devoted to the specialized area of converting between metric and U.S. customary units on engineering drawings.

Were it not for the rounding of converted quantities, the mathematics of conversion would be trivial. Even with rounding, the mathematics is simple. However, rounding is extremely important, since it affects the tolerances of parts produced; and the controlling of tolerances is at the heart of the manufacturing process.

The computer programs that comprise this package were developed by Caterpillar Tractor Co. and General Motors Corporation and turned over to the National Bureau of Standards for distribution for public benefit to anyone who wants them. It is hoped that by making them available to the public the processes of metric conversion in all U.S. manufacturing companies will be facilitated.

Ruth M. Davis, Ph.D.
Director, Institute for Computer
Sciences and Technology

ACKNOWLEDGEMENTS

Particular thanks are due to the companies that donated their computer programs to the National Bureau of Standards for distribution as part of the Computer Program Package for Metric Conversion--Caterpillar Tractor Co. and General Motors Corporation. Both companies, in addition to supplying their programs, assisted NBS in the testing, changed their programs as a result of the tests, and contributed material for the documentation of the package without reimbursement of any kind. Without the contributions of these companies, the package would not exist.

At Caterpillar Tractor Co. thanks are due especially to Joseph G. Langenstein, Senior Materiel and Standards Engineer. Mr. Langenstein initially conceived of the idea of distributing metric conversion programs through NBS. He is responsible for having the Caterpillar Tractor Co. Program released for this purpose, and he has worked with NBS personnel on all phases of the testing and documentation. Thanks are also due to B. Jack Prather and Karl M. Henry of the Caterpillar Tractor Co. Technical Center for their work in programming this and several prior versions of the Caterpillar program and for making further changes as a result of the NBS tests.

At General Motors Corporation thanks are due especially to Roy Trowbridge, Chief, Engineering Standards Section, General Motors Technical Center who was instrumental in getting the General Motors programs released and to Dr. Robert Davies of the General Motors Technical Center who programmed the General Motors routines.

At NBS, thanks are due to Dr. Hans J. Oser, Chief, Mathematical Analysis Section, Applied Mathematics Division, under whose direction the testing and validation were done, as well as to other members of the Applied Mathematics Division who contributed to the testing and supplied material for the documentation: William G. Hall, Frederick C. Johnson, Russell A. Kirsch, Daniel W. Lozier, and Donald J. Orser.

Other NBS persons to whom thanks are due are Margaret R. Fox, Acting Chief, Computer Information Section, Information Technology Division, Institute for Computer Sciences and Technology, for her assistance with the documentation; J. Paul Cali, Chief, and Thomas W. Mears of the Office of Standard Reference Materials, Institute for Materials Research, for their work in distributing the program package; and Louis E. Barbrow, Coordinator of Metric Activities, Engineering and Product Standards Division, Institute for Applied Technology, for serving as an advisor and reviewing the document. Thanks are also due to M. Zane Thornton, Deputy Director, Institute for Computer Sciences and Technology; Gordon B. Fields, NBS Staff Attorney; Dr. H. Thomas Yolken, Deputy Chief, Office of Standard Reference Materials; and Jeffrey V. Odom, Chief, Metric Information Office for reviewing all or part of the document.

DISCLAIMER

The National Bureau of Standards (NBS) has tested each of the programs in this package on several computers and found them to be functioning as described in the documentation that follows. Machine dependence was largely eliminated by restricting the programs to American National Standard FORTRAN. No amount of testing can anticipate, however, flaws that may not show up, except under very special circumstances, or may be caused by peculiar input conditions.* Therefore, neither NBS nor the companies whose programs are included in the package can assume responsibility for loss or damage due to (1) malfunctioning of the programs, (2) erroneous answers, or (3) errors in documentation.

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*Computer systems consist of hardware and software and seldom are two systems completely alike. NBS tested each of these three programs on several systems. For details see Section I - INTRODUCTION.

PACKAGE MAINTENANCE

It will be appreciated if reports on malfunctions and suggestions for improvement are sent to NBS in order that purchasers of the package may be notified of necessary or desirable changes in either the tape or the manual. This applies both to malfunctions resulting from the programs alone and to those due to possible mismatches between the program and the computers or operating systems upon which they are run.

Other programs for metric conversion may be added to the package in the future. Eligible programs would be ones that (a) differ significantly from those already on the tape, and (b) have been used by their parent companies enough to insure that they are practical for their intended use and free of obvious bugs. If additional programs are added, an additional charge to cover NBS costs may be necessary.

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LIST OF FIGURES

Computer Program Package for Metric Conversion: Reference Manual

Ruth K. Anderson and Joseph O. Harris, Jr.

The programs in this package are designed to convert dimensions and other quantities appearing on engineering drawings from metric to U.S. customary units and vice versa. They were developed by Caterpillar Tractor Co. and General Motors Corporation. In addition to the programs themselves, the package contains documentation explaining how to get the programs running on different computers and how to use them, and test problems to permit users to verify that the programs run correctly on their own computers. The Caterpillar program converts 31 different metric units to their U.S. customary equivalents. In contrast, the General Motors programs convert in both directions but work with millimetres and inches only. The General Motors programs also use rounding conventions differing womewhat from those employed in the Caterpillar program. Both the Caterpillar and the General Motors programs are written in American National Standard FORTRAN and are suitable for use on a wide range of computers with little or no modification. The Caterpillar program is operated in batch mode while the General Motors programs are interactive.

Key words: Caterpillar Tractor Co.; computer program; documentation; engineering drawing; General Motors Corporation; metric conversion; rounding; test problem; tolerance.

I INTRODUCTION

In order to assist engineers and manufacturers in the transition from the traditional U.S. customary system of measurement to the metric system of measurement, NBS is making available a computer program package to perform the conversion from one system to the other with carefully controlled accuracy. Control of accuracy is necessary in order to maintain required tolerances at minimum cost.

The package consists of computer programs developed by Caterpillar Tractor Co. and General Motors Corporation, documentation explaining how to get the programs running on different computers and how to use them, and test problems to permit users to verify that the programs run correctly on their own computers.

The programs' main advantage is in providing the design engineer with control over the accuracy of the conversion process and the tolerances to be maintained. In this way, errors and costs that would be unavoidable in a shop where everyone makes his own conversions are eliminated. Control at the design level also increases productivity by speeding up the manufacturing process and providing an automatic self-checking system that is essentially error-free.

The Caterpillar part of this package consists of a single program that converts 31 different metric units to their U.S. customary equivalents. There are two General Motors programs, however. One of them converts from millimetres to inches while the other converts in the reverse direction. Dimensions other than millimetres and inches are not converted. The General Motors programs use rounding conventions somewhat different from those employed in the Caterpillar program. Both the Caterpillar and the General Motors programs are written in American National Standard FORTRAN[1] and are suitable for use on a wide range of computers with little or no modification. The Caterpillar program is operated in the batch mode while the General Motors programs are interactive.

The NBS role was to assemble the documentation from material supplied by Caterpillar Tractor Co. and General Motors Corporation, to validate the programs, and to distribute the package. The NBS validation consisted of testing to determine

that the programs run correctly on different computers and that they perform in accordance with the documentation.

More specifically, the programs were tested with the Bell Telephone Laboratories' Verifier Program[2] for compliance with standard FORTRAN, and in addition, each program was compiled and executed on several different computers with test data. In particular, the Caterpillar Program was tested on an IBM 370/165 under OS and on a CDC 6400 under SCOPE 3.0. The GM Programs were tested on an IBM 370/165 under TSO, and all three programs were tested on a UNIVAC 1108 under EXEC VIII and on a PDP-10 under DECsystem-10.

II CONVERSION PACKAGE COMPONENTS

This package consists of two parts--a magnetic tape and this document.

A. TAPE

The tape is a standard 1/2 inch wide 600 foot long reel. It is recorded in FORTRAN and is available in six versions so far as numbers of tracks, code, density and parity are concerned:

No. of Tracks	Code	Density	Parity
9	ASCII	800	Odd
9	ASCII	1600	Odd
9	EBCDIC	800	Odd
9	EBCDIC	1600	Odd
7	BCD	556	Even
7	BCD	800	Even

The printed label on the tape reel identifies the version. Hexadecimal or octal representations of the FORTRAN Characters in ASCII, EBCDIC and BCD as used on the tape are given in Appendix II.

The tape contains 6 files. The first is a description of the contents and logical organization of the tape. The second contains Caterpillar's METCO program; the third contains test data for that program; the fourth gives test results based on this data. The fifth file contains the GMMETR program and the sixth GMINCH.

Each file except the last is terminated by one tape mark, while the last file is terminated by two tape marks. Programs and test data are organized in 80-character card images,blocked 9 card images per physical tape block, and test output is organized into three 132-character print line images per physical tape block.

A listing of the tape is given in appendix III.

B. DOCUMENTATION

This report constitutes the documentation portion of the conversion package. The information was, for the most part, provided by the program developers, Caterpillar Tractor Co. and General Motors Corporation. In contrast to the Caterpillar program which operates in batch mode, the General Motors programs are run in an on-line interactive mode. This difference is reflected in the varying approaches taken in developing this documentation.

The salient characteristics of each program have been summarized using the recently developed Federal Information Processing Standard Software Summary (SF185). See figures 1, 2, and 3. More detailed descriptions of each program, including some examples and program listings, will follow in the remainder of this report.

FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary date: Yr. 74 Mo. 05 Day 21

02. Summary prepared by (Name and Phone): Ruth K. Anderson, (301) 921-3551

03. Summary action: New [X] Replacement [ ] Deletion [ ]
Previous Internal Software ID:

04. Software date: Yr. 74 Mo. 05 Day 21

05. Software title: Caterpillar Tractor Co. Metric Conversion Program

06. Short title: METCO

07. Internal Software ID:

08. Software type:
- [ ] Automated Data System
- [X] Computer Program
- [ ] Subroutine/Module

09. Processing mode:
- [ ] Interactive
- [X] Batch
- [ ] Combination

10. Application area:

General:
- [ ] Computer Systems Support/Utility
- [X] Scientific/Engineering
- [ ] Bibliographic/Textual
- [ ] Management/Business
- [ ] Process Control
- [ ] Other

Specific:

11. Submitting organization and address:
Institute for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C. 20234

12. Technical contact(s) and phone:
Dr. Joseph O. Harrison, Jr.
(301) 921-3551

13. Narrative: The program converts dimensions in any of 31 different metric units to equivalent dimensions in U.S. Customary units. Input parameter cards allow the user to select rounding conventions, output format and to replace or augment the 31 built-in metric units with others more applicable to his requirements. Written in Standard FORTRAN, the program is essentially machine independent. It has been tested on the UNIVAC 1108, the PDP-10, the IBM 370 and the CDC 6400

14. Keywords:
Metric Conversion

15. Computer manuf'r and model	16. Computer operating system	17. Programing language(s)	18. Number of source program statements
See narrative	n/a	American National Standard FORTRAN X3.9-1966	approximately 1200

19. Computer memory requirements	20. Tape drives	21. Disk/Drum units	22. Terminals
12,000 words (UNIVAC 1108)	0	0	0

23. Other operational requirements:

24. Software availability:
- [X] Available
- [ ] Limited
- [ ] In-house only

25. Documentation availability:
- [X] Available
- [ ] Inadequate
- [ ] In-house only

26. FOR SUBMITTING ORGANIZATION USE:

185-101

FIGURE 1

Standard Form 185
1974 July
U.S. Dept. of Commerce—NBS
(FIPS. Pub. 30)

FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary date: Yr. 74 Mo. 05 Day 21

02. Summary prepared by (Name and Phone): Ruth K. Anderson, (301) 921-3551

03. Summary action: New [X] Replacement [ ] Deletion [ ]
Previous Internal Software ID:

04. Software date: Yr. 74 Mo. 05 Day 21

05. Software title: General Motors Corporation Millimetre to Inch Conversion Program

06. Short title: GMMETR

07. Internal Software ID:

08. Software type:
- [ ] Automated Data System
- [X] Computer Program
- [ ] Subroutine/Module

09. Processing mode:
- [X] Interactive
- [ ] Batch
- [ ] Combination

10. Application area:

General:
- [ ] Computer Systems Support/Utility
- [X] Scientific/Engineering
- [ ] Bibliographic/Textual
- [ ] Management/Business
- [ ] Process Control
- [ ] Other

Specific:

11. Submitting organization and address:
Institute for Computer Sciences and Technology
National Bureau of Standards
Washington, D.C. 20234

12. Technical contact(s) and phone:
Dr. Joseph O. Harrison, Jr.
(301) 921-3551

13. Narrative:
Program was developed by General Motors Corporation to convert millimetre dimensions to inches. The user has the option of requesting instructions from the program in entering data from the terminal. The program is written in a portable version or FORTRAN and is essentially machine-independent. It has been tested on the UNIVAC 1108 the PDP-10 and the IBM 370.

14. Keywords:
METRIC, MILLIMETRE CONVERSION

15. Computer manuf'r and model	16. Computer operating system	17. Programing language(s)	18. Number of source program statements
See narrative	n/a	American National Standard FORTRAN X3.9-1966	approximately 400
19. Computer memory requirements	**20. Tape drives**	**21. Disk/Drum units**	**22. Terminals**
12,000 words (UNIVAC 1108)	1 (or other scratch external device)	0	1

23. Other operational requirements:

24. Software availability:
Available [X] Limited [ ] In-house only [ ]

25. Documentation availability:
Available [X] Inadequate [ ] In-house only [ ]

26. FOR SUBMITTING ORGANIZATION USE

185-101

FIGURE 2

Standard Form 185
1974 July
U.S. Dept. of Commerce—NBS

FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary date	02. Summary prepared by (Name and Phone)	03. Summary action
Yr. 74 Mo. 05 Day 21	Ruth K. Anderson, (301) 921-3551	New ☒ Replacement ☐ Deletion ☐
04. Software date: Yr. 74 Mo. 05 Day 21	05. Software title: General Motors Corporation Inch to Millimetre Conversion Program	Previous Internal Software ID:
		07. Internal Software ID
06. Short title: GMINCH		

08. Software type	09. Processing mode	10. Application area — General	10. Application area — Specific
☐ Automated Data System ☒ Computer Program ☐ Subroutine/Module	☒ Interactive ☐ Batch ☐ Combination	☐ Computer Systems Support/Utility ☒ Scientific/Engineering ☐ Bibliographic/Textual ☐ Management/Business ☐ Process Control ☐ Other	

11. Submitting organization and address	12. Technical contact(s) and phone
Institute for Computer Sciences and Technology National Bureau of Standards Washington, D.C. 20234	Dr. Joseph O. Harrison, Jr. (301) 921-3551

13. Narrative

Program was developed by General Motors Corporation to convert dimensions in inches to millimetres. The user has the option of requesting instructions from the program in entering data from the terminal. The program is written in a portable version of FORTRAN and is essentially machine-independent. It has been tested on the UNIVAC 1108, the PDP-10 and the IBM 370.

14. Keywords

METRIC, INCH CONVERSION

15. Computer manuf'r and model	16. Computer operating system	17. Programing language(s)	18. Number of source program statements
See narrative	n/a	American National Standard FORTRAN X3.9-1966	Approximately 400
19. Computer memory requirements	**20. Tape drives**	**21. Disk/Drum units**	**22. Terminals**
12,000 words (UNIVAC 1108)	1 (or other scratch external devices)	0	1

23. Other operational requirements

24. Software availability			25. Documentation availability		
Available ☒	Limited ☐	In-house only ☐	Available ☒	Inadequate ☐	In-house only ☐

26. FOR SUBMITTING ORGANIZATION USE

185-101

FIGURE 3

Standard Form 185
1974 July
U.S. Dept. of Commerce—NBS

III METCO PROGRAM

A. ABSTRACT

A computer program which accepts metric units and converts them to U.S. Customary units has been developed by Caterpillar Tractor Co. The program is written in American National Standard FORTRAN and is being made available to the general public through the National Bureau of Standards. Both the input metric units and the output equivalent U.S. Customary units are printed in tabular format convenient for attaching to or copying on an engineering drawing.

The units and methods in the program are specialized to the needs of mechanical design and manufacture. Even though the designer and the man in the shop may be able to work in metric measure, others in the process flow, such as material control groups, data processing groups, purchasing groups, etc., will require a conversion chart in order to be able to conveniently intermix requirements for metric and U.S. Customary designed parts.

B. BACKGROUND INFORMATION*

This computer program was developed by Caterpillar Tractor Co. to generate metric drawing conversion charts. The Company has turned the program over to the National Bureau of Standards for distribution to the general public. While Caterpillar Tractor Co. and the National Bureau of Standards believe that the information contained herein is complete and correct, they disclaim any and all liability that may still exist or any responsibility for updating any of the information.

*This section was written by Joseph G. Langenstein of Caterpillar Tractor Co.

In industry, an engineering drawing triggers a chain of events that ends in a product that can be sold to a customer. When Caterpillar Tractor Co. management decided to change to the metric system, they reviewed the experience of their overseas plants in the United Kingdom which were making the change to the metric system. They also reviewed the experience of other companies in the United States which were dual dimensioning engineering drawings. From this review, they noted that organizations using the dual dimensioning practices described in Society of Automotive Engineers J390[3] had not achieved a change in their staff's thinking from the U.S. Customary to the metric system. The engineer making the drawing and the man in the shop making the part were no closer to thinking in metric units after years of dual dimensioning than they were prior to dual dimensioning. As a result, Caterpillar has taken a different approach to providing dual capability on engineering drawings. This approach entails completing the engineering drawing in metric units and then generating a chart to provide conversion from the metric units back to the U.S. Customary. Society of Automotive Engineers (SAE) Off Road Vehicle Council (ORVC) Report HS J1066[4] further describes metric drawing practices.

This program was written only for generating the conversion chart used on metric engineering drawings. Experience has shown that if provided with the proper tools designers can design new parts in metric measure and the man in the shop can make parts from the metric drawing. Then the question arises, "Why do we need to provide any conversion?" The following conditions justify the need for the conversion chart:

1. Many parts are procured from suppliers who are still operating in U.S. Customary units. At their option they may produce parts to the U.S. Customary units shown in the conversion chart.
2. Engineers need to know the conversion equivalents whenever a metrically defined part interfaces with a U.S. Customary defined part.
3. Tooling and gauging people need the chart for quick reference to exist-gauges and tools that may be applicable to the new metric part.
4. Data Processing systems such as those used in inventory control may not accept both units of measure and have to be fed U.S. Customary units until the systems are modified.
5. Service literature may be dual dimensioned and should continue to provide U.S. Customary units.

It was decided to use a computer to generate the conversion chart in order to obtain dual capability at minimum cost. It was also desired to be able to use personnel other than engineers to feed the information into the computer. The computer program in this package is the third one developed and used by Caterpillar Tractor Co. since January 1973. The two previous programs did not sufficiently fulfill the goal of making the program operable by clerical personnel.

One way to initiate a program of metrication is to begin designing all new or redesigned products in metric measure starting in the layout drawing stage. The term "new product" does not necessarily mean all new parts. Many existing parts are carried over from current to new products, particularly if the new product is a redesign of a current product. These parts are already in production using

tooling and gauging in the U.S. Customary units. To change or define these parts in metric units would accomplish nothing and result in an unnecessary expense with no return. Therefore, existing drawings can remain in inches until the last stages of the conversion program; when most drawings and manufacturing equipment are in metric. It may then be desirable to convert the drawings of inch designed parts that are still being manufactured.

New parts, assemblies and groups are designed and dimensioned in metric units. Ideal metric modules can be used unless the dimension defines a size or interface requirement that originated in U.S. Customary units; then direct conversions of the U.S. Customary units must be specified. The end result of this practice is a "new product" consisting of parts defined in both U.S. Customary units and metric units. However, neither the part nor the customer can tell the difference since one can manufacture and measure anything in either measurement system.

C. PROBLEM DEFINITION

1. Conversion Capability

The METCO program converts dimensions in any of 31 different metric units to equivalent dimensions in U.S. Customary units. Column 1 of Figure 4 lists the units that the program will accept. Column 2 lists the corresponding U.S. Customary units of the output. These 31 "standard" conversions are built into the system.

Several options exist for changing or adding metric units to the program. The user may:

	INPUT in Metric Units	OUTPUT in U.S. Customary Units
1.	MILLIMETRE	INCH
(1) 2.	BAR	PSI
(1) 3.	MILLIBAR	PSI
4.	MEGAPASCAL	PSI
5.	DEGREE CELSIUS	DEGREE FAHRENHEIT
6.	DEGREE C TOLERANCE	DEGREE F TOLERANCE
7.	NEWTON	POUND (FORCE)
8.	KILONEWTON	POUND (FORCE)
9.	NEWTON METRE	POUND (FORCE) FOOT
10.	GRAM METRE	OUNCE (MASS) INCH
11.	NEWTON/MILLIMETRE	POUND (FORCE)/INCH
12.	MICROMETRE	THOUSANDS OF INCH
13.	CENTIMETRE	INCH
(2) 14.	DECIMETRE	INCH
15.	METRE	FOOT
16.	KILOMETRE	MILE
17.	SQUARE MILLIMETRE	SQUARE INCH
18.	SQUARE CENTIMETRE	SQUARE INCH
19.	SQUARE METRE	SQUARE YARD
20.	CUBIC CENTIMETRE	CUBIC INCH
21.	CUBIC CENTIMETRE LIQUID	OUNCE (LIQUID)
(2) 22.	DECILITRE	OUNCE (LIQUID)
23.	LITRE	QUART
24.	CUBIC METRE	CUBIC YARD
25.	GRAM	OUNCE (MASS)
(2) 26.	HECTOGRAM	OUNCE (MASS)
27.	KILOGRAM	POUND (MASS)
28.	MEGAGRAM	POUND (MASS)
29.	KILOGRAM/SQUARE METRE	OUNCE (MASS)/ SQUARE YARD
(3) 30.	GRAM/CUBIC CENTIMETRE	GRAM/CUBIC CENTIMETRE
31.	KILOGRAM/CUBIC METRE	POUND (MASS)/ CUBIC FOOT

(1) In July 1974 Caterpillar Tractor Co. changed the units that it uses for designating pressure from bar to kilopascal and from millibar to pascal. These changes will be reflected in subsequent editions of the metric conversion package.

(2) These units have special usage at Caterpillar and are not recommended for general use.

(3) At Caterpillar this unit is used in both the metric and the U.S. Customary system of measurement. In applying the conversion program it is simpler to enter it into the computer than to make an exception of it.

FIGURE 4

BUILT-IN METCO CONVERSION CAPABILITY

a. Replace any of the 31 units listed in Figure 4 with other units that may be more applicable to his requirements.

b. Augment the list of metric units by an additional 18 to a total of 49 units. This may be done in two ways. One is to add the additional units on a permanent basis by changing the program. The other is to use special identifier cards and add additional units for an individual run as explained in Section D, in the paragraph entitled Special Identifier Card.

The program is specialized to the conversion of millimetres, the most commonly used unit of measure on engineering drawings. It assumes that any input dimension not accompanied by an identifier is in millimetres (default condition), and it also applies a special rounding convention to all millimetre conversions.

2. Input Identifier

Except for millimetres, each dimension to be converted by METCO is entered into the program with a label identifying its metric unit of measure. As noted earlier, the absence of a label indicates to the program that the dimension is in millimetres. This label is called an "Input Identifier" and is used by the program to select the conversion factor to operate on the dimension, to determine the rounding convention to be applied and to control the labelling of the output. Shown in Figure 5 is a list of the 31 metric units the program will handle, along with their input identifiers, conversion factors, U.S. Customary units and the rounding method used by the program. The input identifier must be entered exactly as shown in the figure observing the presence or absence of blanks. Incorrect identifiers will be printed at the beginning of the output as errors.

(3)	Metric Unit	Input Identifier	Conversion Factor	U.S. Customary Unit	Rounding Method Used
	1. MILLIMETRE	(1)	1/25.4	INCH	(2)
(4)	2. BAR	BAR	14.504	PSI	3
(4)	3. MILLIBAR	MBAR	.014504	PSI	1
	4. MEGAPASCAL	MPA	145.04	PSI	3
	5. DEGREE CELSIUS	DEG C	1.8 + 32	DEGREE FAHRENHEIT	3
	6. DEGREE C TOLERANCE	DEG TOL	1.8	DEGREE F TOLERANCE	3
	7. NEWTON	N	.22481	POUND (FORCE)	1
	8. KILONEWTON	KN	224.81	POUND (FORCE)	1
	9. NEWTON METRE	NM	.73756	POUND (FORCE) FOOT	1
	10. GRAM METRE	GM	1.3887	OUNCE (MASS) INCH	2
	11. NEWTON/MILLIMETRE	N/MM	5.7101	POUND (FORCE)/INCH	1
	12. MICROMETRE	UM	.039370	THOUSANDS OF INCH	2
	13. CENTIMETRE	CM	.39370	INCH	1
(4)	14. DECIMETRE	DM	3.9370	INCH	1
	15. METRE	M	3.2808	FOOT	1
	16. KILOMETRE	KM	.62137	MILE	2
	17. SQUARE MILLIMETRE	MM2	.0015500	SQUARE INCH	1
	18. SQUARE CENTIMETRE	CM2	.15500	SQUARE INCH	1
	19. SQUARE METRE	M2	1.1960	SQUARE YARD	2
	20. CUBIC CENTIMETRE	CM3	.061024	CUBIC INCH	1
	21. CUBIC CENTIMETRE LIQUID	CM3 LIQ	.03381	OUNCE (LIQUID)	1
(4)	22. DECILITRE	DL	3.3810	OUNCE (LIQUID)	2
	23. LITRE	LITRE	1.0567	QUART	2
	24. CUBIC METRE	M3	1.3080	CUBIC YARD	1
	25. GRAM	G	.035274	OUNCE (MASS)	1
(4)	26. HECTOGRAM	HG	3.5274	OUNCE (MASS)	2
	27. KILOGRAM	KG	2.2046	POUND (MASS)	2
	28. MEGAGRAM	MG	2204.6	POUND (MASS)	1
	29. KILOGRAM/SQUARE METRE	KG/M2	29.494	OUNCE (MASS)/ SQUARE YARD	3
(4)	30. GRAM/CUBIC CENTIMETRE	G/CM3	1.0000	GRAM/CUBIC CENTIMETRE	3
	31. KILOGRAM/CUBIC METRE	KG/M3	.062428	POUND (MASS)/ CUBIC FOOT	1

(1) No input identifier is necessary for millimetres.

(2) Rounding method for millimetre conversions is explained in Section IIIC3.

(3) These identifiers do not necessarily represent approved symbols for the units to which they refer. Recommended representations in upper case letters for most of these units are given in ISO/DIS 2955[6].

(4) See notes to figure 4.

FIGURE 5. METCO SUMMARY TABLE

3. Rounding Conventions

The METCO program uses four different rounding conventions for built-in conversions. These are summarized below. It should be pointed out that the user may modify these rounding conventions by making simple changes to the program.

a. Millimetres

Conversions of millimetre dimensions to inches are rounded to one decimal place more than indicated in the input but to no less than three decimal places. The minimum number of decimal places in the output can be increased or decreased by program modification.

Example: Input in Millimetres	Output in Inches
.020	.0008
.5	.020
50.0	1.969

b. Other Units

Rounding Method 1 (Code -1)

Converted dimensions are rounded to three significant figures.

Example: Computed Value	Rounded Value
.0034864	.00349
.34864	.349
3.4864	3.49
34864.	34900.

Rounding Method 2 (Code 1)

Converted dimensions are rounded to one decimal place but retain a maximum of three significant digits. Zeros are used as required.

Example: Computed Value	Rounded Value
.0034864	.0
.34864	.3
3.4864	3.5
34864.	34900.

Rounding Method 3 (Code 0)

Converted dimensions are rounded to whole numbers but retain a maximum of three significant digits. Zeros are used as required.

Example: Computed Value	Rounded Value
.0034864	0.
.34864	0.
3.4864	3.
34864.	34900.

In the program itself, these three methods are referred to by the codes -1, 1, 0 respectively.

D. APPLICATION INFORMATION

1. Input

Data is entered in units of data sets consisting of 500 or less dimensions each. Normally a data set will consist of all the dimensions on a single drawing.

Punched cards are used as input and there are three different card types for each data set:

Header Card

Special Identifier Card (optional)

Data Card

If the user is entering dimensions in any of the 31 metric units ordinarily accepted by the program, he will use one header card followed by one or more data cards. If he is inputting dimensions in metric units not included in the list of 31, he must complete a special identifier card for each unit. A typical deck set-up for a single data set would appear as in figure 6.

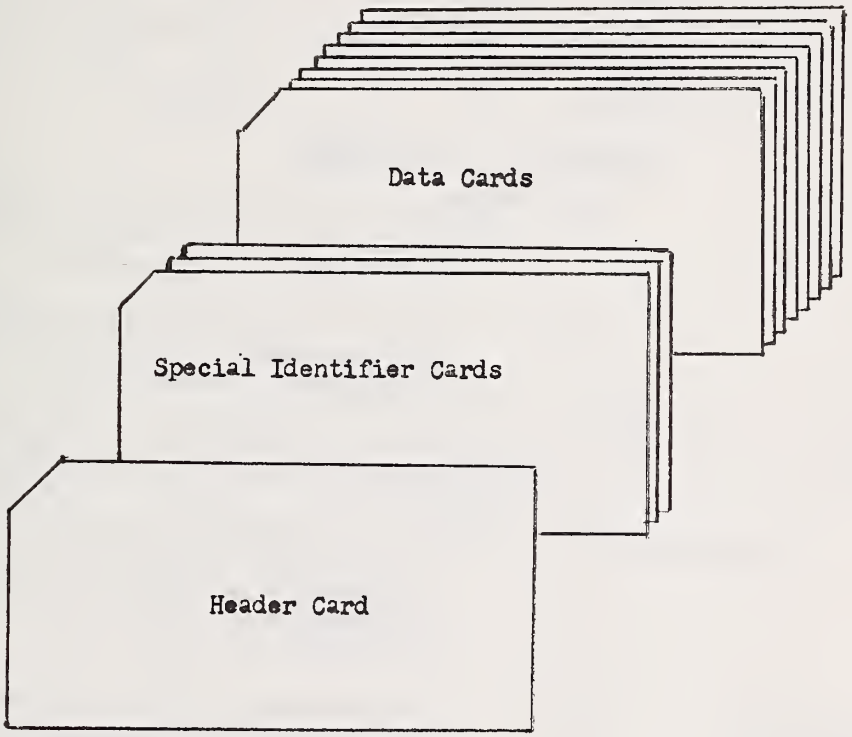


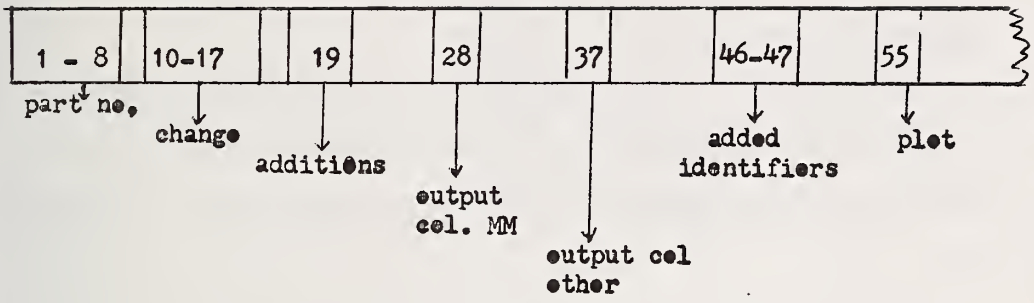
FIGURE 6. INPUT CARDS

a. Header Card

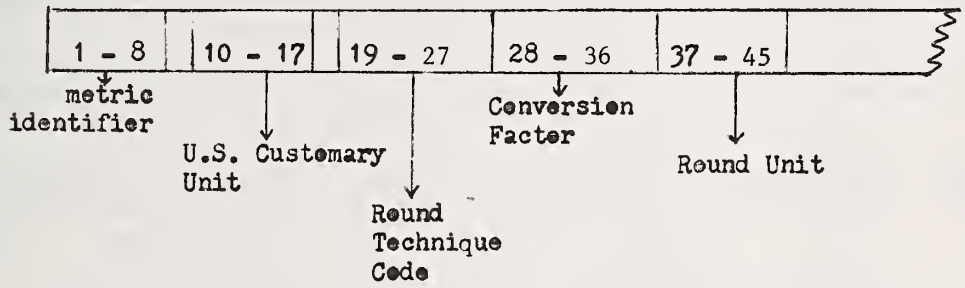
The first card of each set of data must be a header card. It contains identification information and format specifications and indicates to the program the number of special identifiers being used. The contents of the header card (with appropriate substitution of default values) is stored by the program and printed with each data set being processed. The information items on a header card are described below and the card format is illustrated in figure 7.

Item	Column No.	Description
Part Number	1-8	Used for data set identification only. Not processed by program. May vary from blank to 8 characters.
Change	10-17	Used for data set identification only. Not processed by program. May vary from blank to 8 characters.
Additions	19	Enter "1" if data are to be added to an existing chart. Otherwise leave blank.
Output Columns MM	28	Output format for millimetre conversion may be printed in 1, 2, 3 or 4 pairs of columns. Enter number of pairs desired. If left blank, output will be printed in 1 pair of columns.
Output Columns Other	37	Non-millimetre conversions can be printed in 1 or 2 parallel sets of 4 columns each. Enter number of sets desired. If left blank, output will be printed in 1 set of 4 columns.
Added Identifiers	46-47	Enter the number of special identifiers being added for the set. METCO can accommodate 18 special identifiers for a total of 49.

a. Header Card



b. Special Identifier Card



c. Data Card

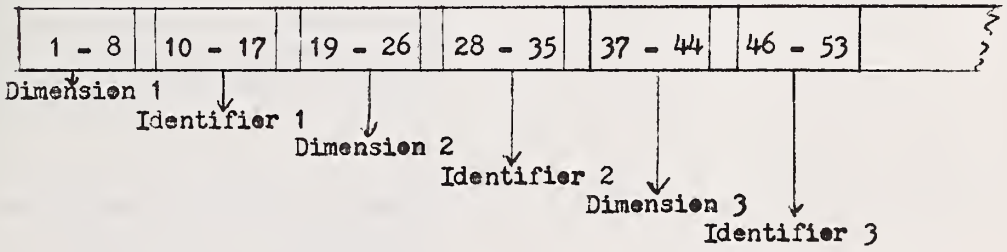


FIGURE 7

CARD FORMATS

Item	Column No.	Description
Plot	55	A special option can be added to the program to provide output through a plotter. This option is not included in this version of the program.
Remarks	56-72	Enter any remarks to appear on output.

b. Special Identifier Card

If additional metric units are being added for an individual run, a special identifier card must be furnished for each unit. The information items to be on a special identifier card are described below, and the card format is illustrated in figure 7b.

Item	Column No.	Description
Metric Identifier	1-8	Input identifier (metric). Maximum of 8 characters.
U.S. Customary Unit	10-17	Output identifier (U.S. Customary). Maximum of 8 characters.
Round Technique Code	19-27	Code / Rounding Technique: -1 — 3 significant digits 0 — whole numbers 1 — 1 decimal place 2 — 2 decimal places 3 — 3 decimal places 4 — 4 decimal places 5 — 5 decimal places With codes 0-5 a maximum of 3 significant digits is retained. Examples of the use of codes -1, 0, 1 are given in section IIIC3b.
Conversion Factor	28-36	Enter the constant (in fixed decimal format) by which the metric unit is multiplied to convert it to a U.S. Customary Unit. See figure 5, column headed Conversion Factor (items 2 through 31) for format examples.

Item	Column No.	Description
Rounding unit	37-45	Indicate the smallest increment that the program should recognize in the rounded dimension. This will normally be one unit in the last place retained, but not necessarily so. It could, for example, be 5 units in the last place retained which would permit rounding to 1/2 of the next larget unit; or 25 units in the last place retained which would permit rounding to 1/4 of the next after the next larger unit. The rounding must be an integral multiple of one unit in the least significant decimal place retained. It should be left blank with round technique code -1 but always used with round technique codes 0-5.

Duplicate metric identifiers are not recognized by the program. Duplicates are accepted as input and each occupies a storage position in the identifier table. Only the first definition of an identifier is ever accessed by the conversion portion of the program.

The number of special identifier cards should be as specified in the added identifier field of the header card. If it is not, the following anomalies will occur.

If the number of special identifier cards in the input deck is less than that specified by the added identifier field, the data cards which follow are interpreted as special identifier cards until the special identifier count agrees with its specification. The program then executes normally. The dimensions on the data cards which have been interpreted as special identifier cards will not appear on the output. This situation can be recognized by noting the appearance of garbage in the last temporary entry (or entries) of the table of conversion factors.

If the number of special identifier cards in the input deck exceeds the number specified, the cards in excess of the specification are interpreted as data cards. The misinterpreted special identifier cards will each result in an illegal

identifier printout. Furthermore, each dimension which requires an unaccepted special identifier card will cause an illegal identifier printout.

If the number of special identifiers to be added plus the number of identifiers resident (thirty one plus those added in previous problems of the same run) exceeds forty nine, the fiftieth and each succeeding special identifier card are printed with an appropriate error message. Each dimension which requires an unaccepted special identifier card will cause an illegal identifier print.

c. Data Card

The data card contains the dimensions to be converted and their associated identifiers. Up to three pairs of dimensions and identifiers may be entered per card. If a dimension is in millimetres, the identifier must be left blank. The information items for a data card are described below, and the card format is illustrated in figure 7c.

Item	Column No.	Description
Dimension 1	1-8	Enter dimension to be converted. Acceptable characters are 0 through 9, ., +, -. Leading or trailing blanks have no meaning but blanks must not appear imbedded within the characters of the dimensions field. Significant zeros must be entered because round-off is based on the number of digits to the right of the decimal. The dimensions may be placed anywhere within the field. The number of characters including decimal point and sign cannot exceed 8 characters.

Item	Column No.	Description
Identifier 1	10-17	This item must be chosen from the list of acceptable identifiers and entered exactly as shown on the list in figure 5 or in the identifier field of the Special Identifier Card. The first character of the identifier must be in the first character position of the field.
Dimension 2	19-26	Same as Dimension 1
Identifier 2	28-35	Same as Identifier 1
Dimension 3	37-44	Same as Dimension 1
Identifier 3	46-53	Same as Identifier 1

Any number of data sets, each containing as many as 500 dimensions, may be processed as a single run. Data sets must be separated by STOP in an identifier position. The run is terminated when $EOP is detected in card columns 1 through 4. No more data will be accepted.

If, by mistake, there are more than five hundred dimensions in a set, the five hundred and first and all subsequent dimensions are printed with appropriate error messages. The program executes normally with the five hundred accepted dimensions.

The output of this program can be used in one of several ways depending on the system selected by the user. (1) Used as a separate document or Page 2 of a drawing. (2) The information could be copied by a desk copier onto an adhesive

backed plastic sheet and then put on the engineering drawing. (3) The output could be typed directly onto the adhesive backed plastic sheet and then put on the drawing. The option depends on the equipment and the required distribution of the conversion chart.

A special option can be added to the program to provide output through a plotter. This option, however, is not included in the program being furnished. Such hookups vary too greatly to provide this option.

2. Output

Output from the METCO program consists of:

(1) metric to U.S. Customary conversion tables (Tables showing U.S. Customary units and their corresponding metric values for specific drawings.)

(2) identification, error messages and (under certain conditions) a table of conversion factors employed.

These two items are addressed in the order given in this document for expository reasons. They appear on the computer printout in reverse order. All of this material is referred to collectively on the computer printout as "Metric--U.S.

Customary Conversion Table". The pagination of the output is oriented to these two types of information and they appear on separate output pages. A brief description of the components of each type of output appears below.

a. Metric to U.S. Customary Conversion Tables

This is the output to be attached to or associated with an engineering drawing. If a data set contains both millimetres and other metric units, two tables will be printed - each on a separate page and each properly identified with "part number" and "change". A blank line appears after each 5 lines of output in the table. A string of asterisks (********) in the U.S. Customary units field means that the converted dimension overflows the 8 characters permitted by its output format.

Millimetres to Inches - The table is printed in a 2 column array (input millimetres and output inches respectively), and sorted in ascending order by input millimetre dimension. As many as four 2-column arrays may be printed across the page depending on the value specified for "output columns MM" on the header card.

Other Units - Table is printed in a 4 column array consisting of (1) input dimenseion, (2) input metric unit, (3) output dimension, and (4) output U.S. Customary unit. Data is sorted first by input dimension and then by input metric unit. A maximum of two 4-column arrays may be printed across the page.

b. Identification, Error Messages and Table of Conversion Factors

The program prints "METRIC - U.S. CUSTOMARY CONVERSION TABLE" followed by the fields of the input header card with appropriate column headings. Default values are substituted for blank fields on the header card.

Error Messages - This information appears only if there has been an illegal entry in one or more of the input data items. Error messages are of two types: "illegal identifier" and "illegal character in dimensions".

Table of Conversion Factors - This table is printed only if special identifiers have been added for the data set. It is preceded by a count of the number of units that it currently contains. The count covers 30 of the 31 built-in conversions (millimetres to inches are not counted) and any special identifiers in either the current data set or previous data sets for the run.

The table is comprised of the current version of the conversion table with headings. Special identifiers are labeled as temporary entries.

3. Sample Computations

Eleven sample computations are given in files 3 and 4 of the conversion package tape. The first three of the samples are reproduced and briefly commented on here.

Sample 1	Comments
Input	Non-millimetre dimensions only. One set of data per data card. No added identifiers.
Output	Identification and Errors Illegal identifier "GRAM" was used. Should have been "G". See figure 5.
Output	Conversion Table One 4-column array called for. Dimensions associated with the illegal identifier were not converted.

```
959721    13.                                                SAMPLE 1    121700
.85       GRAM                                                           121800
8.5       LITRE                                                          121900
14.       LITRE                                                          122000
17.       LITRE                                                          122100
22.5      LITRE                                                          122200
-31.5     DEG C                                                          122300
2.0       DEG TOL                                                        122400
-40.0     DEG C                                                          122500
29.5      LITRE                                                          122600
34.       LITRE                                                          122700
170.      LITRE                                                          122800
65.5      LITRE                                                          122900
68.       LITRE                                                          123000
75.       LITRE                                                          123100
75.5      LITRE                                                          123200
3060.     GRAM                                                           123300
106.      LITRE                                                          123400
148.      LITRE                                                          123500
519.      LITRE                                                          123600
          STOP                                                           123700
```

Sample 1

OUTPUT - IDENTIFICATION AND ERRORS

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
9S9721	13.	0	1	1	0		SAMPLE 1

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
.85	GRAM	ILLEGAL IDENTIFIER
3060.	GRAM	ILLEGAL IDENTIFIER

OUTPUT - CONVERSION TABLE.

PART 9S9721 CHANGE 13.

DIM	UNITS	DIM	UNITS
-40.0	DEG C	-40.	DEG F
-31.5	DEG C	-25.	DEG F
2.0	DEG TOL	4.	DEG TOL
8.5	LITRE	9.0	QT
14.	LITRE	14.8	QT
17.	LITRE	18.0	QT
22.5	LITRE	23.8	QT
29.5	LITRE	31.2	QT
34.	LITRE	35.9	QT
65.5	LITRE	69.2	QT
68.	LITRE	71.9	QT
75.	LITRE	79.3	QT
75.5	LITRE	79.8	QT
106.	LITRE	112.	QT
148.	LITRE	156.	QT
170.	LITRE	180.	QT
519.	LITRE	548.	QT

Sample 1 (Continued)

Sample 2	Comments
Input	A combination of millimetre and non-millimetre dimensions. The number of sets of data per card data varies from one to three. No added identifiers
Output	Identification and Errors Output calls for 4 sets of output data for millimetres and 2 sets of output data for other units. Errors in both identifier and dimension fields are flagged.
Output	Converted Data in 2 tables. Millimetres to inches and "Other".

```
3F1341    15         1.0        4.0        2.0                                SAMPLE 2   123800
1000.     MPA        100.       0.                                                       123900
100.      DEG C      3.                                                                  124000
19.35     N/MM       .35                                                                 124100
.0025                .621                  47.33                                       124200
77.0                 85.0                  154.0                                       124300
2.        BAR        .4                                                                124400
4.        LITRE      .1                                                                124500
2.        KM         .1                                                                124600
20.       DEG C      2.                                                                124700
10.       N M        2.                                                                124800
5.6                                                                                    124900
35.       ML                                                                           125000
30.860               0.013                                                            125100
5.6                                                                                    125200
14.25                .5                                                               125300
1.5                                                                                    125400
11.00                                                                                  125500
75.0      REF                                                                          125600
5.        DEG TOL    7.0        DEG TOL    20.00      DEG TOL                         125700
2.0       ML         1.5        ML                                                    125800
3.0       ML                                                                          125900
5.0       ML                                                                          126000
-31.5     DEG C                                                                       126100
-40.0     DEG C                                                                       126200
2.0       DEG TOL                                                                     126300
P-.0      DEG TOL                                                                     126400
4.0       DEG TOL                                                                     126500
8.0       ML                                                                          126600
12.0      ML                                                                          126700
2.0       KM                                                                          126800
3.0       KM                                                                          126900
8.0       KM                                                                          127000
11.25     KM                                                                          127100
22.55     KM                                                                          127200
22.0                                                                                  127300
17.50                                                                                 127400
50.       KG                                                                          127500
10.       N                                                                           127600
57.0                                                                                  127700
2.40      A                                                                           127800
128.0                                                                                 127900
38.10                                                                                 128000
32.0                                                                                  128100
447.22    DEEP       12.25      -12.00+                                             128200
25.17                                                                                 128300
21.8                                                                                  128400
20.83                                                                                 128500
19.8                                                                                  128600
16.0                                                                                  128700
6.35                                                                                  128800
1.5                                                                                   128900
.76                                                                                   129000
50.0                                                                                  129100
17.0                 0.5                                                              129200
18.0                 0.05                                                             129300
19.0                 0.051                                                            129400
19.0                 0.0505                                                           129500
          STOP                                                                        129600
```

Sample 2

OUTPUT - IDENTIFICATION AND ERRORS

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
3F1341	15	1.0	4.0	2.0	0		SAMPLE 2

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
100.	0.	ILLEGAL IDENTIFIER
10.	N M	ILLEGAL IDENTIFIER
35.	ML	ILLEGAL IDENTIFIER
75.0	REF	ILLEGAL IDENTIFIER
2.0	ML	ILLEGAL IDENTIFIER
1.5	ML	ILLEGAL IDENTIFIER
3.0	ML	ILLEGAL IDENTIFIER
5.0	ML	ILLEGAL IDENTIFIER
P-.0	DEG TOL	ILLEGAL CHARACTER IN DIMENSION
8.0	ML	ILLEGAL IDENTIFIER
12.0	ML	ILLEGAL IDENTIFIER
2.40	A	ILLEGAL IDENTIFIER
447.22	DEEP	ILLEGAL IDENTIFIER
12.25	-12.00+	ILLEGAL IDENTIFIER

OUTPUT - CONVERSION TABLES

PART 3F1341 CHANGE 15

MM	INCH	MM	INCH	MM	INCH	MM	INCH
.0025	.00010	.76	.030	17.50	.689	38.10	1.500
.013	.0005	1.5	.059	18.0	.709	47.33	1.863
.05	.002	2.	.079	19.0	.748	50.0	1.969
.0505	.00199	3.	.118	19.8	.780	57.0	2.244
.051	.0020	5.6	.220	20.83	.820	77.0	3.031
.1	.004	6.35	.250	21.8	.858	85.0	3.346
.35	.014	11.00	.433	22.0	.866	128.0	5.039
.4	.016	14.25	.561	25.17	.991	154.0	6.063
.5	.020	16.0	.630	30.860	1.2150		
.621	.0244	17.0	.669	32.0	1.260		

PART 3F1341 CHANGE 15

DIM	UNITS	DIM	UNITS	DIM	UNITS	DIM	UNITS
2.	BAR	29.	PSI	10.	N	2.25	LBF
1000.	MPA	145000.	PSI	19.35	N/MM	110.	LB/INCH
-40.0	DEG C	-40.	DEG F	2.0	KM	1.2	MILE
-31.5	DEG C	-25.	DEG F	2.	KM	1.2	MILE
20.	DEG C	68.	DEG F	3.0	KM	1.9	MILE
100.	DEG C	212.	DEG F	8.0	KM	5.0	MILE
2.0	DEG TOL	4.	DEG TOL	11.25	KM	7.0	MILE
4.0	DEG TOL	7.	DEG TOL	22.55	KM	14.0	MILE
5.	DEG TOL	9.	DEG TOL	4.	LITRE	4.2	QT
7.0	DEG TOL	13.	DEG TOL	50.	KG	110.	LB
20.00	DEG TOL	36.	DEG TOL				

Sample 2 (Continued)

Sample 3

Comments

Input

This sample contains mixed millimetre and non-millimetre dimensions and various numbers of sets of data per data card as does sample 2. In addition, it contains two special identifier cards -- the second and third on the input list. These cards provide the capability for converting from metres to inches and from dekametres to inches respectively. The sample also contains data cards employing each of these added conversions.

Care must be exercised in reading the special identifier cards. Specifically, the 1's in the quantities 139.37 and 1393.7 are in card column 27 and are therefore not part of their respective identifiers since they are not in the conversion factor field. They represent round technique codes instead. The last two lines of the output table of conversion factors clarifies this.

Output

The added identifier cards trigger the printout of the table of conversion factors.

INPUT

```
953184   01        1.0       3.0       2.0       2.0       1.0       SAMPLE 3  129700
METER    INCH                139.37     0.1                                   129800
DECA M   INCH                1393.7    0.1                                    129900
57.0                                                                          130000
5.6                                                                           130100
19.35    N/MM                                                                 130200
30.360             0.013                                                      130300
5.6                                                                           130400
200.0    DM                                                                   130500
300.0    CM                                                                   130600
400.0    HG                                                                   130700
500.0    DL                                                                   130800
135.44   N/MM                                                                 130900
14.25              .5                                                         131000
7.0      DECA M    7.6       METER                                           131100
1.5                                                                           131200
11.00                                                                         131300
12.35    GAGE                                                                 131400
75.0     REF        1000.00             1100.0                                131500
20.0     DEG C                                                                131600
10.0     G                                                                    131700
0.01     MPA                                                                  131800
12                                                                            131900
12.                                                                           132000
012                                                                           132100
00123                                                                         132200
2.25               4.68                8.9                                    132300
13.1               15.22               23.35                                  132400
27.691             29.9                31.0                                   132500
36.0               40.15               44.44                                  132600
52.2               54.755              69.75                                  132700
81.15              85.65               405.0                                  132800
0123.5                                                                        132900
1200.              1300.               1400.                                  133000
1600.              1700.               1800.                                  133100
22.0                                                                          133200
17.50                                                                         133300
50.      KG                                                                   133400
10.      N                                                                    133500
35.      ML                                                                   133600
4.       LITRE                                                                133700
-100.22+                                                                      133800
2.       BAR                                                                  133900
10.      N M                                                                  134000
2.       KM                                                                   134100
50.0                                                                          134200
128.0                                                                         134300
38.10                                                                         134400
32.0                                                                          134500
25.17                                                                         134600
21.8                                                                          134700
20.83                                                                         134800
19.8                                                                          134900
16.0                                                                          135000
6.35                                                                          135100
1.5                                                                           135200
.76                                                                           135300
17.0               0.5                                                        135400
18.0               0.05                                                       135500
19.0               0.051                                                      135600
19.0               0.0505                                                     135700
         STOP                                                                 135800
```

Sample 3

OUTPUT - IDENTIFICATION,TABLE OF CONVERSION FACTORS AND ERRORS

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
953184	01	1.0	3.0	2.0	2.0	1.0	SAMPLE 3

NUMBER OF ENTRIES IN CONVERSION TABLE = 32

IDENTIFIER IN	IDENTIFIER OUT	ROUND TECHNIQUE	CONVERSION FACTOR	ROUNDING UNIT	
BAR	PSI	0	14.50400	1.00000	
MBAR	PSI	-1	.01450	.00000	
MPA	PSI	0	145.04000	1.00000	
DEG C	DEG F	0	-1.80000	1.00000	
DEG TOL	DEG TOL	0	1.80000	1.00000	
N	LBF	-1	.22481	.00000	
KN	LBF	-1	224.81000	.00000	
NM	LB FT	-1	.73756	.00000	
GM	OZ INCH	1	1.38870	.10000	
N/MM	LB/INCH	-1	5.71010	.00000	
UM	MILS	1	.03937	.10000	
CM	INCH	-1	.39370	.00000	
DM	INCH	-1	3.93700	.00000	
M	FT	-1	3.28080	.00000	
KM	MILE	1	.62137	.10000	
MM2	IN2	-1	.00155	.00000	
CM2	IN2	-1	.15500	.00000	
M2	YD2	1	1.19600	.10000	
CM3	IN3	-1	.06102	.00000	
CM3 LIQ	OZ LIQ	-1	.03381	.00000	
DL	OZ LIQ	1	3.38100	.10000	
LITRE	QT	1	1.05670	.10000	
M3	YD3	-1	1.30800	.00000	
G	OZ	-1	.03527	.00000	
HG	OZ	1	3.52740	.10000	
KG	LB	1	2.20460	.10000	
MG	LB	-1	2204.60001	.00000	
KG/M2	OZ/YD2	0	29.49400	1.00000	
G/CM3	G/CM3	0	1.00000	1.00000	
KG/M3	LB/FT3	-1	.06243	.00000	
METER	INCH	1	39.37000	.10000	**** THIS IS A TEMPORARY ENTRY ****
DECA M	INCH	1	393.70000	.10000	**** THIS IS A TEMPORARY ENTRY ****

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
12.35	GAGE	ILLEGAL IDENTIFIER
75.0	REF	ILLEGAL IDENTIFIER
35.	ML	ILLEGAL IDENTIFIER
-100.22+		ILLEGAL CHARACTER IN DIMENSION
10.	N M	ILLEGAL IDENTIFIER

Sample 3 (Continued)

OUTPUT - CONVERSION TABLES

PART 9S3184 CHANGE 01

MM	INCH	MM	INCH	MM	INCH
.013	.0005	17.50	.689	52.2	2.055
.05	.002	18.0	.709	54.755	2.1557
.0505	.00199	19.0	.748	57.0	2.244
.051	.0020	19.8	.780	69.75	2.746
.5	.020	20.83	.820	81.15	3.195
.76	.030	21.8	.858	85.65	3.372
1.5	.059	22.0	.866	123.	4.843
2.25	.089	23.35	.919	123.5	4.862
4.68	.184	25.17	.991	128.0	5.039
5.6	.220	27.691	1.0902	405.0	15.945
6.35	.250	29.9	1.177	1000.00	39.370
8.9	.350	30.860	1.2150	1100.0	43.307
11.00	.433	31.0	1.220	1200.	47.244
12.	.472	32.0	1.260	1300.	51.181
13.1	.516	36.0	1.417	1400.	55.118
14.25	.561	38.10	1.500	1600.	62.992
15.22	.599	40.15	1.581	1700.	66.929
16.0	.630	44.44	1.750	1800.	70.866
17.0	.669	50.0	1.969		

PART 9S3184 CHANGE 01

DIM	UNITS	DIM	UNITS	DIM	UNITS	DIM	UNITS
2.	BAR	29.	PSI	2.	KM	1.2	MILE
.01	MPA	1.	PSI	500.0	DL	1690.	OZ LIQ
20.0	DEG C	68.	DEG F	4.	LITRE	4.2	QT
10.	N	2.25	LBF	10.0	G	.353	OZ
19.35	N/MM	110.	LB/INCH	400.0	HG	1410.	OZ
135.44	N/MM	773.	LB/INCH	50.	KG	110.	LB
300.0	CM	118.	INCH	7.6	METER	299.	INCH
200.0	DM	787.	INCH	7.0	DECA M	2760.	INCH

Sample 3 (Continued)

E. PROGRAMMING INFORMATION

1. General

The program is comprised of a main program, six subroutines called ENCODE, DECODE, DASORT, SETUP, SIGNIF and READER; a function subprogram DROUND; and a BLOCK DATA subprogram. The main routine and subroutines are liberally interspersed with comments.

Modifications in the dimensions converted and their conversion factors may be accomplished by changing the appropriate values in BLOCK.

The program is written in American National Standard FORTRAN[1] and is essentially machine independent.

The source program consists of about 1200 FORTRAN statements. When tested on the UNIVAC 1108 it required approximately 12,000 words of memory.

2. Accuracy and Size of Numbers

The program uses double precision arithmetic so as to minimize the limitations of computer word length. Of the computers upon which the program was tested the smallest mantissa in the double precision floating point number representation was 54 bits for the PDP-10 under DECsystem 10 with KA10 "long mode" number representation.

Word length should not be a limitation on any computer with equivalent double precision floating point representation. This includes virtually all large scale computers and some minicomputers.

The rounding technique employed in millimetre to inch conversions is essentially the same as that recommended in American National Standard Z25.1-1940 reaffirmed 1961[7]. Specifically:

(a) Remainders less than 1/2 are rounded downward,

(b) Remainders greater than 1/2 are rounded upward,

(c) Remainders exactly equal to 1/2 are rounded to the nearest even digit. In this program, exactly 1/2 is defined to be any number within the range .5 + .0001 to .5 - .0001 inclusive.

If the quantity 1/2 used in the nearest even digit routine were defined exactly, this procedure would result in a maximum rounding error of 1/2 unit in the least significant place retained. Actually, however, the maximum error is .5001 in the least significant place retained. This difference is of no practical importance and will be neglected in the subsequent discussion.

Non-millimetre conversions, both those that are built in and those that are introduced by means of added identifier cards, are rounded according to one, two or three procedures applied serially in order as follows:

(a) The special rounding unit, if any, is applied. The quantity 0.5 is added to the quotient of the unrounded converted dimension divided by the special rounding unit. The result is truncated to its integral part and multiplied back by the special rounding unit to give the rounded dimension to the nearest allowable increment.

(b) The result of operation (a) is rounded to three significant figures using the same procedure that is used for rounding from millimetres to inches.

(c) If the number of decimal places is specified (round technique codes 1-5), the result of operation (b) is rounded again. The same procedure that is used for rounding from millimetres to inches is again employed.

Undesireable interaction among the several serial rounding operations may be avoided by applying the restrictions specified under the rounding unit item in the table in section III D1b. The subsequent discussion assumes that they have been applied.

a. Millimetres to Inches

Although the input card format for millimetre dimensions permits eight characters, the largest unsigned number that can be processed is controlled by the print format of the inch equivalent output - decimal point and a maximum of seven numeric characters, at least three of which must lie to the right of the decimal point. The largest unsigned dimension that can be handled, therefore, is 9999.999 inches or, conservatively, 250 000 millimetres. For all input values no larger than 250 000 millimetres, the inch equivalent will be printed with an error no larger than one half unit in the last place retained. Since at least three decimal places are retained in all circumstances, the error is always less than or equal to 5 ten-thousandths of an inch.

The program also accepts signed millimetre dimensions. The purpose of this is to permit the entering of positive and negative tolerances. The output print format for a signed dimension is sign, decimal point and six digits, at least three of which must lie to the right of the decimal point. The largest signed dimension that can be handled is therefore +999.999 inches or, conservatively, 25,000 millimetres. The maximum error is the same as in the unsigned case.

b. Other Built-in Conversions

Conversions of units other than millimetres (figure 5) use the same input card format and output print format as do millimetre conversions - eight characters in each case. The maximum unsigned dimension that can be processed is limited by either the input or the output format depending upon the magnitude of the conversion factor. Dimensions with conversion factors equal to or less than one-tenth

are limited by the output format. The dividing point is one-tenth rather than unity since a decimal point is mandatory in the output format but not in the inpu format. The magnitude of the dimension that can be processed depends also on the rounding rule employed since this dictates the number of places to the right of the decimal point.

It will be noted from figure 5 that most built-in conversion factors have been rounded to five significant digits. This does not affect the accuracy of the computed results, however, since converted dimensions are rounded to at most three significant digits.

Other built-in conversions handle signed numbers in a manner similar to the way that millimetre conversions do. In all cases, the magnitude of a signed number must be decreased by a factor of ten, but the error is unaffected.

C. Numerical Values

Based upon these considerations the maximum permissible magnitudes of the input dimensions and the maximum errors produced have been calculated and verified and are presented in figure 8 for both millimetre and built-in non-millimetre dimensions. In the table the maximum dimensions are conservative approximations - i.e., rounded downward from their true values.

Figure 8

MAXIMUM PERMISSIBLE DIMENSIONS AND MAXIMUM ERRORS

	CONVERSION	MAXIMUM PERMISSIBLE DIMENSION (1)	MAXIMUM ERROR (2)
1	MILLIMETRE TO INCH	250 000 MM	.0005 INCHES
(3) 2.	BAR TO PSI	700 000 BAR	MAX (.5 PSI, 5 PARTS IN 1 000)
(3) 3.	MBAR TO PSI	90 000 000 MBAR	5 PARTS IN 1 000
4.	MEGAPASCAL TO PSI	60 000 MPA	MAX (.5 PSI, 5 PARTS IN 1 000)
5.	DEGREES C TO DEGREES F	5 000 000 DEG C	MAX (.5 DEG F, 5 PARTS IN 1 000)
6.	DEGREES C TOL TO DEGREES F TOL	5 000 000 DEG C	MAX (.5 DEG F, 5 PARTS IN 1 000)
7.	NEWTON TO POUND	40 000 000 N	5 PARTS IN 1 000
8.	KILONEWTON TO POUND	40 000 N	5 PARTS IN 1 000
9.	NEWTON METRE TO POUND FOOT	10 000 000 NM	5 PARTS IN 1 000
10.	GRAM METRE TO OUNCE INCH	700 000 GM	MAX (.05 OZ INCH, 5 PARTS IN 1 000)
11.	NEWTON/MM TO POUND/INCH	1 000 000 N/MM	5 PARTS IN 1 000
12.	MICROMETRE TO INCH/1000	9 000 000 UM	MAX (.05 INCH/1000, 5 PARTS IN 1 000)
13.	CENTIMETRE TO INCH	20 000 000 CM	5 PARTS IN 1 000
(3) 14.	DECIMETRE TO INCH	2 000 000 DM	5 PARTS IN 1 000
15.	METRE TO FOOT	30 000 000 M	5 PARTS IN 1 000
16.	KILOMETRE TO MILE	1 000 000 KM	MAX (.05 MILE, 5 PARTS IN 1 000)
17.	MM2 TO INCH2	90 000 000 MM2	5 PARTS IN 1 000
18.	CM2 TO INCH2	60 000 000 CM2	5 PARTS IN 1 000
19.	M2 TO YARD2	8 000 000 M2	MAX (.05 YARD2, 5 PARTS IN 1 000)
20.	CM3 TO INCH3	90 000 000 CM3	5 PARTS IN 1 000
21.	CM3 LIQ TO OZ LIQ	90 000 000 CM3	5 PARTS IN 1 000
(3) 22.	DECILITRE TO OZ LIQ	200 000 DL	MAX (.05 OZ, 5 PARTS IN 1 000)
23.	LITRE TO QUART	900 000 LITRE	MAX (.05 QT, 5 PARTS IN 1 000)
24.	M3 TO YARD3	7 000 000 M3	5 PARTS IN 1 000
25.	GRAM TO OUNCE	90 000 000 G	5 PARTS IN 1 000

Figure 8 (Continued)

	CONVERSION	MAXIMUM PERMISSIBLE DIMENSION (1)	MAXIMUM ERROR (2)
(3)	26. HG TO OUNCE	200 000 OZ	MAX (.05 OZ, 5 PARTS IN 1 000)
	27. KG TO LB	400 000 KG	MAX (.05 LB, 5 PARTS IN 1 000)
	28. MG TO LB	4 000 MG	5 PARTS IN 1 000
	29. KG/M2 TO OZ/YARD2	300 000 KG/M2	MAX (.5 OZ/YD2, 5 PARTS IN 1 000)
	30. G/CM3 to G/CM3	9 000 000 G/CM3	MAX (.5 G/CM3, 5 PARTS IN 1 000)
	31. KG/M3 TO LB/FT3	90 000 000 KG/M3	5 PARTS IN 1 000

(1) Dimensions exceeding the exact numbers from which these figures are rounded will cause input or output overflow.

(2) Maximum error for the computers on which the program was tested. See text.

(3) See notes to figure 4 for use of these units.

IV GMMETR AND GMINCH PROGRAMS

A. ABSTRACT

GMMETR and GMINCH are metric conversion programs developed by the General Motors Corporation. GMMETR converts input dimensions in millimetres to equivalent output dimensions in inches while GMINCH performs the reverse conversion. The programs operate in an on-line, interactive mode. They give the user the option of selecting prompting assistance from the program while entering information at the terminal.

B. BACKGROUND INFORMATION

This pair of programs was developed by the General Motors Corporation for computing a conversion table going from millimetres to inches to attach to a metric drawing and a table going from inches to millimetres to attach a customary drawing. The programs have been made available to General Motors Corporation design engineers through 400 remote terminals.

C. PROBLEM DEFINITION

The General Motors Corporation conversion programs GMMETR and GMINCH are essentially identical in structure and in logic even though they convert in opposite directions. The remainder of this documentation will address both programs collectively or GMMETR specifically. GMINCH will be referred to only when it differs from GMMETR.

The programs are capable of converting an unlimited number of tables, however each table may contain no more than 1000 measurements. For each table processed, the user enters drawing identification, format specifications, and the measurements to be converted. Output consists of a pair of values for each input measurement, i.e., the original input measurement and the equivalent converted output measurement. The number of pairs of values printed on a line are optional (up to a maximum of 6) and are indicated to the program in the format specifications.

GMMETR is capable of converting input dimensions between 25,000 and 0.001 millimetres while GMINCH is capable of converting input dimensions between 1000 and 0.0001 inches. GMMETR output in inches contains one more decimal place than the input millimetre measurement while GMINCH output in millimetres contains one less decimal place than the input inch measurement. For either program a measurement may not exceed 8,000,000 times its tolerance. In this context tolerance means one unit in the least significant decimal place retained. Because of word length differences among various computers, the user must exercise caution when exceeding the above limitations.

GMMETR and GMINCH have been tested on the UNIVAC 1108, PDP 10 and IBM 360. For machines with smaller word lengths the above statements regarding acceptable ranges of input numbers and accuracies of output results may not apply.

Output is sorted in increasing order of magnitude and duplicates are eliminated. The programs edit the input and print out various diagnostic messages. All of

the above characteristics of the General Motors programs will be addressed specifically in the following section.

D. APPLICATION INFORMATION

This section describes program characteristics from the user's point of view.

1. Annotated Illustration of Program Application

A sample problem for GMMETR is illustrated in figure 9 and is described below. The lower case letters in parentheses queued onto the figure identify those portions of the sheet printed by the computer and those by the user. The sections of the write-up are cross referenced to the figure.

A1 Having logged in and called the program, the user has the option of requesting "more information" by entering a plus sign*.

A2 The user has exercised this option.

B1 The program asks for drawing identification and maximum width of the input conversion table in millimetres. These two items must be separated by a comma and may not exceed 80 characters collectively.

Drawing identification - This entry will be used as the title of the drawing. Any alphanumeric characters may be used.

Maximum width - Program output is comprised of a pair of columns or values for each input measurement, i.e., the input measurement and the equivalent converted output measurement. The program can accommodate six pairs of

*On most interactive terminal systems every entry is followed by a carriage return which signals to the computer that the input line is completed.

GMMETR ON UNIVAC
SAMPLE PROBLEM - MILLIMETERS TO INCHES (user)

```
 ENTER A SINGLE PLUS SIGN,  +,
 FOR MORE INFORMATION. ELSE, HIT CARRIAGE RETURN.  (A1) (computer)

+  (A2) (user)
 ENTER THE DRAWING IDENTIFICATION AND THE MAXIMUM WIDTH ON THE DRAWING
 FOR THE MILLIMETRE-INCH CONVERSION TABLE (IN MILLIMETRES).  PUT A COMMA
 BETWEEN THE TWO ENTRIES.  A PAIR OF COLUMNS IS 53.34 MILLIMETRES WIDE.
                                                          (computer) (B1)
TEST DATA FOR GMMETR,200  (B2) (user)


 ENTER THE MILLIMETRE DIMENSIONS ON A LINE WITH COMMAS IN BETWEEN.
 THE COMPUTER WILL KEEP ASKING FOR ANOTHER LINE OF INPUT UNTIL YOU
 INDICATE THAT YOU HAVE NO MORE INPUT BY ENTERING 0. (ZERO) AS THE
 LAST NUMBER.
 SHOW THE DECIMAL POINT EVEN WITH INTEGERS.
 BE CAREFUL IF YOU ENTER A DIMENSION LARGER THAN  25 000  MILLIMETRES
 DO NOT ENTER A TOLERANCE SMALLER THAN  0.001  MILLIMETRE
 A DIMENSION CANNOT EXCEED  8 000 000  TIMES ITS TOLERANCE.  (C1) (computer)

.001,.010,.100,.254,2,54,.254,2.540,25.4,25.40,254.,2540.,
254.0,254.00,254.000,254.01,2540.0,25400.,25400.0,25400.00,
.1,.2,.3,.4,.5,.6,.7,.8,.9,1.0,0.                  (C2) (user)

 DUPLICATE MEASUREMENT(S) REMOVED.  (D) (computer)

 TEST DATA FOR GMMETR

       MM      (INCH)          MM      (INCH)          MM      (INCH)

       .001     .000 0         .010     .000 4         .1       .00
       .100     .003 9         .2       .01            .254     .010 0
       .3       .01            .4       .02            .5       .02
       .6       .02            .7       .03            .8       .03
       .9       .04           1.0       .04           2.        .1      (E)
      2.540     .100 0       25.4       1.00         25.40     1.000
     54.        2.1         254.       10.0          254.0     10.00     (computer)
    254.00     10.000       254.000    10.000 0      254.01    10.000
  2 540.      100.         2 540.0    100.00      25 400.    1000.0
 25 400.0    1000.00


 ENTER THE IDENTIFICATION (COMMA) AND WIDTH FOR ANOTHER TABLE.
 TO END PROGRAM, ENTER ANY ALPHABETICAL CHARACTER.  (computer)  (F)


S  (G) (user)
```

Figure 9

values across the page. A pair of values is 53.34 millimetres wide. For simplification, the user may round this value and enter integers. A recommended convention is the following:

1 pair of columns = 60

2 pairs of columns = 120

"

"

6 pairs of columns = 360

Care must be exercised in specifying a number compatible with the width of the paper that the table is being printed on and the space available on the drawing to which it will be attached.

B2 User types in both items separated by a comma.

C1 The user is asked to enter the measurements to be converted. These are entered on a line with commas in between. Every measurement must have a decimal point. A final zero followed by a decimal point indicates that no more measurements will be entered for this table. Legal characters are the decimal point, comma, and numerics. Range of permissible values is as follows:

GMMETR: between 25,000 and 0.001 millimetres

GMINCH between 1,000 and 0.0001 inches

C2 Data is entered. Note (1) decimal point with each dimension, (2) separating commas, (3) final zero followed by period. (Some systems accept integers without decimal points and several numbers were so entered in the example in figure 9 without error.)

D Program removes duplicate measurements, if they exist, and prints a line to indicate that it has done so.

E Drawing identification is printed followed by conversion table. Table has been formatted with 3 pair of columns as specified in B2. Duplicates have been removed. Program sorts on the output data and prints the entries of the table in increasing order of magnitude in rows rather than columns. The millimetre values always appear first. This is true in both programs, GMMETR and GMINCH. One more decimal place always appears in the inch measurement than in the millimetre measurement.

F The user may process another table by entering a new drawing identification and table width or alternatively he may terminate the run by entering any alphabetic character.

G The character S was entered to terminate the run.

A similar example for GMINCH is given in figure 10.

2. Program Limitations

a. Accuracy of GMMETR

On the computers tested, the program is valid for input measurements between 0 and 25,000 mm. Measurements less than or equal to 8000 mm should be entered with 3 or less decimal places while those greater than 8000 mm should be restricted to at most 2 decimal places. Under these conditions the error in the converted measurement is not more than one-half unit in the last place retained.

```
                    GMINCH ON UNIVAC
              SAMPLE PROBLEM - INCHES TO MILLIMETERS


ENTER A SINGLE PLUS SIGN, + ,
FOR MORE INFORMATION. ELSE, HIT CARRIAGE RETURN.

+

ENTER THE DRAWING IDENTIFICATION AND THE MAXIMUM WIDTH ON THE DRAWING
FOR THE MILLIMETRE-INCH CONVERSION TABLE (IN MILLIMETRES).  PUT A COMMA
BETWEEN THE TWO ENTRIES.  A PAIR OF COLUMNS IS 53.34 MILLIMETRES WIDE.

TEST DATA FOR GMINCH,200


ENTER THE INCH DIMENSIONS ON A LINE WITH COMMAS IN BETWEEN.
THE COMPUTER WILL KEEP ASKING FOR ANOTHER LINE OF INPUT UNTIL YOU
INDICATE THAT YOU HAVE NO MORE INPUT BY ENTERING 0. (ZERO) AS THE
LAST NUMBER.
SHOW THE DECIMAL POINT EVEN WITH INTEGERS.
BE CAREFUL IF YOU ENTER A DIMENSION LARGER THAN 1000 INCHES
DO NOT ENTER A TOLERANCE  SMALLER THAN  0.000 1  INCH
A DIMENSION CANNOT EXCEED  8 000 000  TIMES ITS TOLERANCE ,

1000.,100.,100.0,100.00,100.000,10.,10.0,10.00,10.000,10.0000,
1.,1.0,1.00,1.000,1.0000,1.,10.,100.,1000.0,.01,.001,.0001,
1.01,1.001,2.002,2.0002,3.003,3.0003,4.4,4.04,4.004,4.0004,0.

DUPLICATE MEASUREMENT(S) REMOVED.

TEST DATA FOR GMINCH

      MM      (INCH)          MM      (INCH)          MM      (INCH)

      .003     .000 1          .03      .001           .3       .01
    25.        1.             25.       1.0          25.4      1.00
    25.40      1.000          25.400    1.000 0      25.43     1.001
    25.7       1.01           50.805    2.000 2      50.85     2.002
    76.208     3.000 3        76.28     3.003       101.610    4.000 4
   101.70      4.004         102.6      4.04        112.       4.4
   254.       10.            254.      10.0         254.0     10.00
   254.00     10.000         254.000   10.000 0   2 540.     100.
 2 540.      100.0         2 540.0    100.00      2 540.00  100.000
25 400.     1000.         25 400.     1000.0

ENTER THE IDENTIFICATION (COMMA) AND WIDTH FOR ANOTHER TABLE.
TO END PROGRAM, ENTER ANY ALPHABETICAL CHARACTER.

S
```

Figure 10

In other words, for input entered with the maximum number of decimal places, measurements less than or equal to 8000 mm will be converted to within 5 hundred-thousandths of an inch and those between 8000 and 25000 mm to within 5 ten-thousandths of an inch. Input measurements with fewer decimal places will be converted with correspondingly less accuracy but still to within one-half unit in the last decimal place retained in the output.

b. Accuracy of GMINCH

On the computers tested, the program is valid for input measurements between 0 and 1000 inches. Measurements less than or equal to 800 inches should be entered with 4 or less decimal places while those greater than 800 inches should be restricted to at most 3 decimal places. Under these conditions the error in the converted measurement is not more than one-half unit in the last place retained.

In other words, for input entered with the maximum number of decimal places, measurements less than or equal to 800 inches will be converted to within 5 ten-thousandths of a millimetre and those between 800 and 1000 inches to within 5 thousandths of a millimetre. Input measurements with fewer decimal places will be converted with correspondingly less accuracy but still to within one-half unit in the last decimal place retained in the output.

c. Computers with short word lengths

The computers upon which these programs have been tested included one with a 32-word length and a single precision floating point mantissa of 24 bits. The

above described accuracy should be obtained on any computer with equivalent or greater fixed and floating point word length. The programs are not intended to be run on computers with lesser capability.

3. Rounding Conventions

GMMETR output in inches contains one more decimal place than the input millimetre measurement.

GMINCH output in millimetres contains one less decimal place than the input inch measurement.

4. Error and Other Special Conditions

Diagnostics are printed immediately following an incorrect line of input. If multiple errors occur on the same line, only the first will be recognized and flagged. The program stops examining the input after the first diagnostic and requests the user to reenter the line.

Each of the following conditions generates a diagnostic message and a request to reenter data.

1. Illegal character in input dimension
   a. alpha character
   b.[1] two consecutive commas
2.[2] Two consecutive decimal points not separated by a comma.

(1) Two consecutive commas at the end of a line are not detected.

(2) Some computers automatically append decimal points to integers.

3. Error in entering maximum table width.

4. Number of dimensions entered exceed maximum 1000 allowed.

Various other conditions are recognized and compensated for without requiring that the data be reentered.

1. Duplicate input measurements are eliminated, a message to this effect is printed, and the program proceeds automatically.

2. Imbedded blanks are detected and the program proceeds without a diagnostic message.

3. Blanks appear when input values that are too small are processed.

4. Asterisks are printed on the output table in lieu of quantities which are too large for the print format specification.

A sample run exercising many of these conditions is illustrated in figure 11. As in figure 9 lower case letters in parentheses queued onto the figure identify those parts of the sheet printed by the computer and those by the users.

E. PROGRAMMING INFORMATION

Shown in Appendix 3 are program listings for GMMETR and GMINCH. They are essentially the same with the exception of the key subroutine at the end of each program, the subroutine CONVMM in GMMETR and the subroutine CONVIN in GMINCH. Detailed comments are generously dispersed throughout the programs and are identified by the letter "C" as the left most character in the line explaining the operation of the program.

The programs are written in American National Standard FORTRAN and are essentially machine independent.

Each source program consists of about 400 FORTRAN statements, when tested on the UNIVAC 1108. Computer memory requirements were approximately 12,000 words.

GMMETR ON UNIVAC
ILLUSTRATION OF PROGRAMMED DIAGNOSTICS (user)

ENTER A SINGLE PLUS SIGN, +,
FOR MORE INFORMATION. ELSE, HIT CARRIAGE RETURN. (computer)

\+ (user)
ENTER THE DRAWING IDENTIFICATION AND THE MAXIMUM WIDTH ON THE DRAWING
FOR THE MILLIMETRE-INCH CONVERSION TABLE (IN MILLIMETRES). PUT A COMMA
BETWEEN THE TWO ENTRIES. A PAIR OF COLUMNS IS 53.34 MILLIMETRES WIDE.
(computer)

DIAGNOSTICS FOR GMMETR,200 (user)

ENTER THE MILLIMETRE DIMENSIONS ON A LINE WITH COMMAS IN BETWEEN.
THE COMPUTER WILL KEEP ASKING FOR ANOTHER LINE OF INPUT UNTIL YOU
INDICATE THAT YOU HAVE NO MORE INPUT BY ENTERING 0. (ZERO) AS THE
LAST NUMBER.
SHOW THE DECIMAL POINT EVEN WITH INTEGERS.
BE CAREFUL IF YOU ENTER A DIMENSION LARGER THAN 25 000 MILLIMETRES
DO NOT ENTER A TOLERANCE SMALLER THAN 0.001 MILLIMETRE (computer)
A DIMENSION CANNOT EXCEED 8 000 000 TIMES ITS TOLERANCE.

A.A,B.B,I.I,1.0,1.0,7..,9 9. 9,2 5 . 4,9.,,25000000.,0. (user)
THERE IS AN ILLEGAL CHARACTER IN THE INPUT LINE. (computer)
ONLY POINTS, SINGLE COMMAS, AND THE TEN DIGITS MAY BE USED.
PLEASE REENTER THE LINE.

1.1,1.1,1.1,1.0 1.0,7..,9 9. 9,2 5 . 4,9.,,25000000.,0. (user)
THE LINE HAS TWO DECIMAL POINTS WITHOUT A COMMA IN BETWEEN. (computer)
PLEASE REENTER THE LINE.

1.1,1.1,1.1,1.0,1.0,7. ,9 9. 9,2 5 4,9.,,25000000.,0. (user)
THERE IS AN ILLEGAL CHARACTER IN THE INPUT LINE. (computer)
ONLY POINTS, SINGLE COMMAS, AND THE TEN DIGITS MAY BE USED.
PLEASE REENTER THE LINE.

1.1,1.1,1.1,1.0,1.0,7. ,9 9. 9,2 5 4,9.,25000000.000,0. (user)
(computer)
DUPLICATE MEASUREMENT(S) REMOVED.

DIAGNOSTICS FOR GMMETR

MM	(INCH)	MM	(INCH)	MM	(INCH)	
1.0	.04	1.1	.04	7.	.3	(computer)
9.	.4	99.9	3.93	254.	10.0	

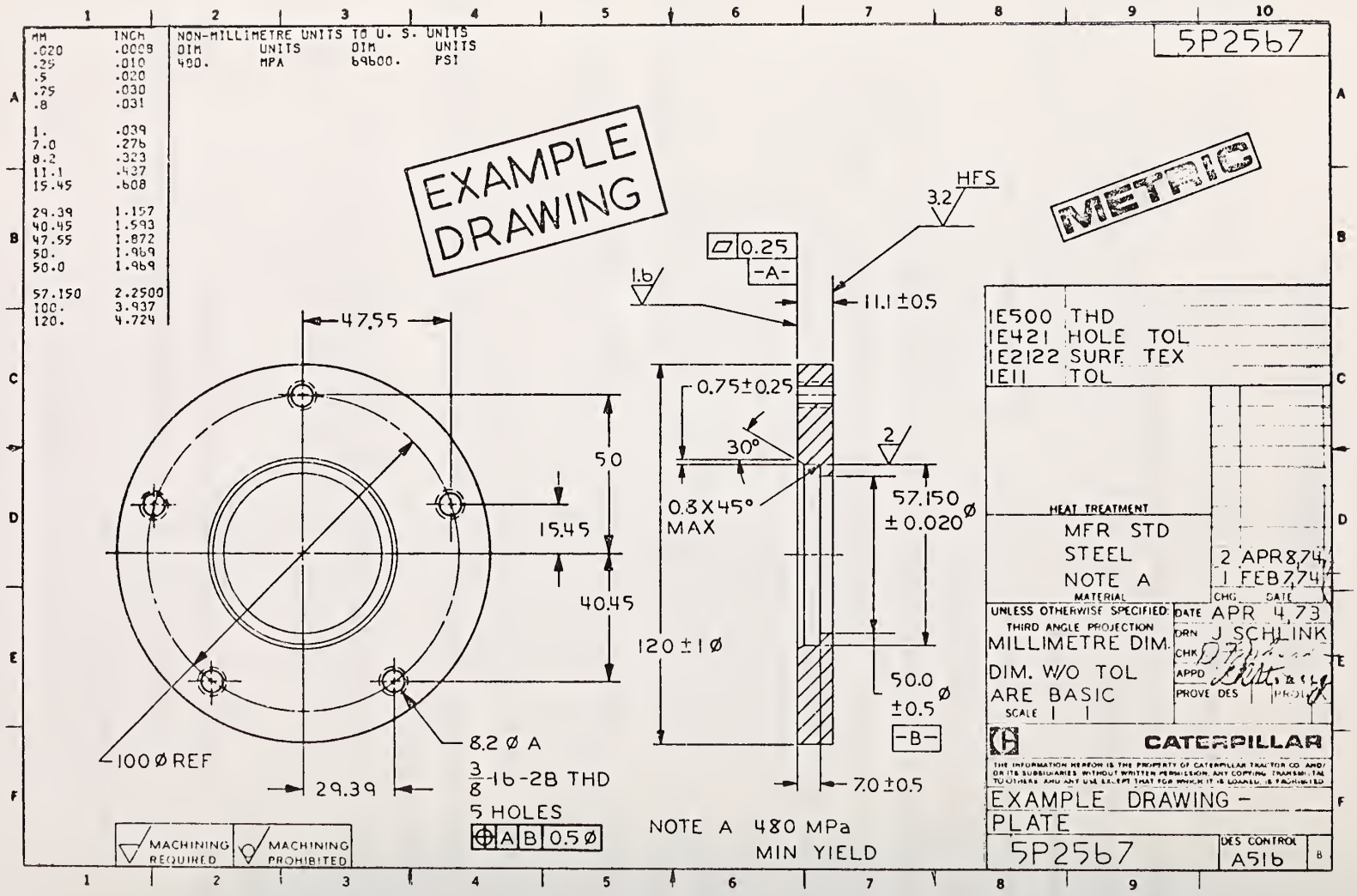
** ********** *

ENTER THE IDENTIFICATION (COMMA) AND WIDTH FOR ANOTHER TABLE.
TO END PROGRAM, ENTER ANY ALPHABETICAL CHARACTER.
(computer)

Figure 11

REFERENCES

1. American Standard FORTRAN, X3.9-1966 American Standards Association, Available from American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.
2. B. G. Ryder, "The FORTRAN Verifier: Users' Guide". The Bell Laboratories, Computing Science Technical Report #12. Bell Telephone Laboratories, Inc., Murray Hill, New Jersey 07974.
3. SAE Standard, Dual Dimensioning - SAE J390, July 1970. The Society of Automotive Engineers, 2 Pennsylvania Plaza, New York, N.Y. 10001; after September 1974, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.
4. SAE Handbook Supplement HS J1066, Recommended Guidelines for Company Metrication Programs in the Metal Working Industry, July 1974. The Society of Automotive Engineers, 2 Pennsylvania Plaza, New York, N.Y. 10001; after September 1974, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.
5. American Society for Testing and Materials - Metric Practice Guide E 380-72E. Also designated as American National Standard Z210.1-1973. American Society for Testing and Materials, 1916 Race St., Philadelphia, Pennsylvania 19103.
6. Draft International Standard ISO/DIS2955 submitted 11 January 1973, Representations for SI and Other Units to be Used in Systems with Limited Character Sets.
7. American National Standard Z25.1-1940 reaffirmed 1961, "Rules for Rounding off Numerical Values." Available from American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.


5P2567
EXAMPLE DRAWING
METRIC
NON-MILLIMETRE UNITS TO U. S. UNITS
DIM UNITS DIM UNITS
480. MPA 69600. PSI
MM INCH
.020 .0008
.25 .010
.5 .020
.75 .030
.8 .031
1. .039
7.0 .276
8.2 .323
11.1 .437
15.45 .608
29.39 1.157
40.45 1.593
47.55 1.872
50. 1.969
50.0 1.969
57.150 2.2500
100. 3.937
120. 4.724
47.55
50
15.45
40.45
120 ±1 Ø
100 Ø REF
29.39
8.2 Ø A
3/8-16-2B THD
5 HOLES
⊕ A B 0.5 Ø
0.25 -A-
1.6
3.2 HFS
11.1 ±0.5
0.75±0.25
30°
0.8X45° MAX
2
57.150 Ø ±0.020
50.0 Ø ±0.5
-B-
7.0±0.5
NOTE A 480 MPa MIN YIELD
MACHINING REQUIRED
MACHINING PROHIBITED
1E500 THD
1E421 HOLE TOL
1E2122 SURF TEX
1E11 TOL
HEAT TREATMENT
MFR STD
STEEL
NOTE A
MATERIAL
2 APR 8,74
1 FEB 7,74
CHG DATE
UNLESS OTHERWISE SPECIFIED:
THIRD ANGLE PROJECTION
MILLIMETRE DIM
DIM. W/O TOL
ARE BASIC
SCALE 1 1
DATE APR 4,73
DRN J SCHLINK
CHK
APPD
PROVE DES
CATERPILLAR
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5P2567
DES CONTROL A516
B

APPENDIX II

REPRESENTATION OF FORTRAN CHARACTERS IN ASCII, EBCDIC AND BCD

Character	ASCII (Mixed*)	EBCDIC (Hexadecimal)	BCD (Octal)
A	41	C1	61
B	42	C2	62
C	43	C3	63
D	44	C4	64
E	45	C5	65
F	46	C6	66
G	47	C7	67
H	48	C8	70
I	49	C9	71
J	4A	D1	41
K	4B	D2	42
L	4C	D3	43
M	4D	D4	44
N	4E	D5	45
O	4F	D6	46
P	50	D7	47
Q	51	D8	50
R	52	D9	51
S	53	E2	22
T	54	E3	23
U	55	E4	24
V	56	E5	25
W	57	E6	26
X	58	E7	27
Y	59	E8	30
Z	5A	E9	31
0	30	F0	12
1	31	F1	01
2	32	F2	02
3	33	F3	03
4	34	F4	04
5	35	F5	05
6	37	F6	06
7	37	F7	07
8	38	F8	10

Character	ASCII (Mixed*)	EBCDIC (Hexadecimal)	BCD (Octal)
9	39	F9	11
Blank	20	40	20
=	3D	7E	13
+	2B	4E	60
-	2D	60	40
*	2A	5C	54
/	2F	61	21
(	28	4D	34
)	29	5D	74
,	2C	6B	33
.	2E	4B	73
$	24	5B	53

*Left digit is OCTAL, right is HEXADECIMAL.

APPENDIX III

LISTING

CONTENTS OF TAPE

THIS IS FILE 1 OF A MAGNETIC TAPE CONTAINING PROGRAMS FOR CONVERSION BETWEEN METRIC AND U.S. CUSTOMARY UNITS, PLUS TEST DATA AND TEST OUTPUT FOR ONE OF THEM. THE PROGRAMS, TEST DATA AND TEST OUTPUT EXIST AS SEPARATE FILES ON THE TAPE. EACH FILE IS TERMINATED BY A TAPE MARK (END-OF-FILE MARK), EXCEPT THE LAST FILE IS TERMINATED BY TWO TAPE MARKS. PROGRAMS AND TEST DATA ARE REPRESENTED BY 80-CHARACTER CARD IMAGES, 9 CARD IMAGES PER PHYSICAL TAPE BLOCK. TEST OUTPUT IS REPRESENTED BY 132-CHARACTER PRINT LINE IMAGES, 3 PRINT LINE IMAGES PER PHYSICAL TAPE BLOCK. THE CONTENTS OF THE FILES ON THIS TAPE ARE...

FILE 2. PROGRAM...METCO, METRIC TO U.S. CUSTOMARY CONVERSION.
SOURCE...CATERPILLAR TRACTOR COMPANY.
LANGUAGE...AMERICAN NATIONAL STANDARD FORTRAN.

FILE 3. TEST DATA FOR FILE 2.

FILE 4. TEST OUTPUT FOR FILE 2.

FILE 5. PROGRAM...GMMETR, MILLIMETRE TO INCH CONVERSION.
SOURCE...GENERAL MOTORS CORPORATION.
LANGUAGE...AMERICAN NATIONAL STANDARD FORTRAN.
FEATURES...DESIGNED FOR DEMAND TERMINAL USAGE.

FILE 6. PROGRAM...GMINCH, INCH TO MILLIMETRE CONVERSION.
SOURCE...GENERAL MOTORS CORPORATION.
LANGUAGE...AMERICAN NATIONAL STANDARD FORTRAN.
FEATURES...DESIGNED FOR DEMAND TERMINAL USAGE.

```
C
C
C
C     CATERPILLAR TRACTOR COMPANY                                              500
C        100 NORTHEAST ADAMS STREET                                            600
C           PEORIA, ILLINOIS  61602                                            700
C                                                                              800
C     PROGRAM BY-  B. J. PRATHER                                               900
C                                                                             1000
C   TITLE-  METRICATION-METRIC TO U. S. CUSTOMARY  06121-545  3  10/19/73     1100
C     PROGRAM  0545                                                           1200
C                                                                             1300
C     IMPLICIT  INTEGER  (  I  -  N  )                                        1400
C                                                                             1500
      COMMON  DIN(2, 500),  TDIN(2)                                           1600
C                                                                             1700
      COMMON  INOUT(16),  INCARD(30),  INDEXR,  NC,  NP,  NCHEK,  ID(4),      1800
     1        IDCARD(72),  LISTER(64),  IDOUT(8),  KINDX(500),  NLIST,        1900
     2        IDIN(500)                                                       2000
C                                                                             2100
      DOUBLE PRECISION  DIN,  TDIN,  ADDCHG,  VALUE,  PLOT,  TYPE,  CON,      2200
     1                  DIM,  RDUNIT,  RCONST,  DROUND                        2300
C                                                                             2400
C     DIN(2, 500)                                                             2500
C        STORAGE FOR TDIN  -  UP TO 500 UNIQUE DIMENSIONS                     2600
C                                                                             2700
C     TDIN(2)  REAL  TEMPORARY  STORAGE                                       2800
C        WORD  1  TYPE OF CONVERSION  (INDEX OF LABEL)                        2900
C        WORD  2  DIMENSION VALUE                                             3000
C                                                                             3100
C     INOUT(16)  16A1                                                         3200
C        WORDS   1- 8  INPUT DIMENSION                                        3300
C        WORDS   9-16  OUTPUT DIMENSION  (CONVERTED)                          3400
C                                                                             3500
C     INCARD(30)  2A4, 8A1, 2A4, 8A1, 2A4, 8A1                                3600
C        WORDS  1 - 2  INPUT IDENTIFIER                                       3700
C        WORDS  3 - 10  INPUT DIMENSION                                       3800
C        WORDS  11 - 20  TAKE THE SAME PATTERN AS WORDS  1 - 10               3900
C                                                                             4000
C     INDEXR  -  INDEX OF THE 3 PAIRS OF INPUT DIMENSION FOR READER           4100
C                SUBROUTINE                                                   4200
C                                                                             4300
C     NC  -  UNIT NUMBER FOR THE CARD READER                                  4400
C                                                                             4500
C     NP  -  UNIT NUMBER FOR THE LINE PRINTER                                 4600
C                                                                             4700
C     NCHEK  -  CHECK VARIABLE FOR THE PRINTING OF ERROR HEADING              4800
C                                                                             4900
C     ID(4)  4A4                                                              5000
C        WORDS  1-2  INPUT IDENTIFIER                                         5100
C        WORDS  3-4  OUTPUT IDENTIFIER                                        5200
C                                                                             5300
C     ITDIN     INTEGER TEMPORARY STORAGE                                     5400
C                 NUMBER OF DIGITS TO THE RIGHT OF THE DECIMAL POINT          5500
```

```
C                  IN THE DIMENSION                                      5600
C                                                                        5700
C     IDCARD(72)  72A1                                                   5800
C        WORDS   1- 9  PART NUMBER                                       5900
C        WORDS  10-18  CHANGE NUMBER                                     6000
C        WORDS  19-36  TITLE BLOCK TOLERANCES                            6100
C        WORDS  37-45  CONVERSION TO METRIC OR U.S. CUSTOMARY            6200
C        WORDS  46-72  IDENTIFICATION                                    6300
C                                                                        6400
C     IDIN(500)                                                          6500
C        STORAGE FOR ITDIN - UP TO 500 UNIQUE DIMENSIONS                 6600
C                                                                        6700
C     KINDX(500)                                                         6800
C        ARRAY GIVING THE LOCATION OF THE SORTED DIN ARRAY               6900
C                                                                        7000
C     LISTER(64)  -  OUTPUT ARRAY FOR NUMERIC DATA                       7100
C                                                                        7200
C     IDOUT(8)  -  OUTPUT ARRAY FOR IDENTIFIERS                          7300
C                                                                        7400
C     NLIST  -  NUMBER OF UNIQUE DIMENSIONS                              7500
C                                                                        7600
      COMMON  /  DATA  /  KTBL(42),  MESAG(40),  LABEL(5, 50),         7700
     1  TABLE(2, 50),  NLSAVE,  NUMLAB,  ISTOP(4),  IBLANK              7800
C                                                                        7900
C     ZERO OUT ALL OF COMMON                                             8000
C                                                                        8100
   50 CONTINUE                                                           8200
C                                                                        8300
      INDEXR  =  0                                                       8400
      NC  =  0                                                           8500
      NP  =  0                                                           8600
      NCHEK  =  0                                                        8700
      NLIST  =  0                                                        8800
      TDIN(1)  =  0.0D0                                                  8900
      TDIN(2)  =  0.0D0                                                  9000
      DO  60  I  =  1,  500                                              9100
      IDIN(I)  =  0                                                      9200
      KINDX(I)  =  0                                                     9300
   60 CONTINUE                                                           9400
      DO  70  I  =  1,  16                                               9500
      INOUT(I)  =  IBLANK                                                9600
   70 CONTINUE                                                           9700
      DO  80  I  =  1,  4                                                9800
      ID(I)  =  IBLANK                                                   9900
   80 CONTINUE                                                          10000
      DO  90  I  =  1,  72                                              10100
      IDCARD(I)  =  IBLANK                                              10200
   90 CONTINUE                                                          10300
      DO  100  I  =  1,  30                                             10400
      INCARD(I)  =  IBLANK                                              10500
  100 CONTINUE                                                          10600
      DO  110  I  =  1,  64                                             10700
      LISTER(I)  =  IBLANK                                              10800
  110 CONTINUE                                                          10900
```

```
      DO  120  I  =  1,  8                                                  11000
      IDOUT(I)  =  IBLANK                                                   11100
  120 CONTINUE                                                              11200
      DO  130  I  =  1,  500                                                11300
      DIN(1, I)  =  0.0D0                                                   11400
      DIN(2, I)  =  0.0D0                                                   11500
  130 CONTINUE                                                              11600
C                                                                           11700
C     NC  =  CARD READER UNIT NUMBER                                        11800
C     NP  =  PRINTER UNIT NUMBER                                            11900
C                                                                           12000
      NC=5                                                                  12100
      NP=6                                                                  12200
C                                                                           12300
  150 CONTINUE                                                              12400
C                                                                           12500
C     READ PART NUMBER, CHG NUMBER, AND COMMENTS                            12600
C                                                                           12700
      READ  (  NC,  200  )  IDCARD                                          12800
  200 FORMAT  (  72A1  )                                                    12900
      IF  (  IDCARD(1)  .EQ.  ISTOP(1)                                      13000
     1  .AND.  IDCARD(2)  .EQ.  ISTOP(2)                                     13100
     2  .AND.  IDCARD(3)  .EQ.  ISTOP(3)                                     13200
     3  .AND.  IDCARD(4)  .EQ.  ISTOP(4)  )  GO TO 16000                C   13300
C                                                                           13400
      NX=0                                                              A   13450
      DO  300  I  =  1,  8                                                  13500
      INOUT(I)  =  IDCARD(I + 18)                                           13600
      IF  ( INOUT(I).EQ. KTBL(14))   NX = NX + 1                        A   13650
  300 CONTINUE                                                              13700
      IF ( NX . EQ . 8)  IDCARD (23) = KTBL(1)                          A   13750
      CALL  DECODE  (  1,  8,  ADDCHG,  J  )                                13800
      NX=0                                                              A   13850
      DO  400  I  =  1,  8                                                  13900
      INOUT(I)  =  IDCARD(I + 27)                                           14000
      IF  ( INOUT(I).EQ. KTBL(14))   NX = NX + 1                        A   14050
  400 CONTINUE                                                              14100
      IF ( NX . EQ . 8)  IDCARD (29) = KTBL(2)                          A   14150
      CALL  DECODE  (  1,  8,  VALUE,  J  )                                 14200
      NCOLS1  =  IDINT  (  VALUE  )                                         14300
      IF  (  NCOLS1  .LE.  0  )  NCOLS1  =  1                               14400
      IF  (  NCOLS1  .GT.  4  )  NCOLS1  =  4                               14500
      Nx=0                                                              A   14550
      DO  500  I  =  1,  8                                                  14600
      INOUT(I)  =  IDCARD(I + 36)                                           14700
      IF  ( INOUT(I).EQ. KTBL(14))   NX = NX + 1                        A   14750
  500 CONTINUE                                                              14800
      IF ( NX . EQ . 8)  IDCARD (39) = KTBL(2)                          A   14850
      CALL  DECODE  (  1,  8,  VALUE,  J  )                                 14900
      NCOLS2  =  IDINT  (  VALUE  )                                         15000
      IF  (  NCOLS2  .LE.  0  )  NCOLS2  =  1                               15100
      IF  (  NCOLS2  .GT.  2  )  NCOLS2  =  2                               15200
      NX=0                                                              A   15250
      DO  600  I  =  1,  8                                                  15300
```

```
      INOUT(I)  =  IDCARD(I + 45)                                          15400
      IF  ( INOUT(I).EQ. KTBL(14))   NX = NX + 1                        A  15450
  600 CONTINUE                                                             15500
      IF ( NX . EQ . 8)  IDCARD (50) = KTBL(1)                          A  15550
      CALL  DECODE  (  1,  8,  VALUE,  J  )                                15600
      NUMID  =  IDINT  (  VALUE  )                                         15700
      DO  700  I  =  1,  8                                                 15800
      INOUT(I)  =  IDCARD(I + 54)                                          15900
  700 CONTINUE                                                             16000
      CALL  DECODE  (  1,  8,  PLOT,  J  )                                 16100
C                                                                          16200
C     PRINT OUT PART NUMBER CARD                                           16300
C                                                                          16400
      WRITE  (  NP,  900  )  IDCARD                                        16500
  900 FORMAT  (  1H1,                                                      16600
     1  45H METRIC - U.S. CUSTOMARY CONVERSION TABLE        /   /         16700
     2  53H                                              NUMBER OF     ,  16800
     3   52H              NUMBER OF                                   /    16900
     4  53H PART                                         OUTPUT COLUM  ,  17000
     5   52HNS            ADDED                                       /    17100
     6  53H NUMBER        CHANGE        ADDITIONS     MM              ,    17200
     7   52HOTHER         IDENTIFIERS   PLOT          REMARKS         /    17300
     8  1H ,  8  (  9A1,  4X  )  /  )                                        17400
C                                                                          17500
C     READ IN ADDITIONAL IDENTIFIERS AND CONVERSION FACTORS                17600
C                                                                          17700
      IF  (  NUMID  .EQ.  0  )  GO  TO  2100                               17800
      ITEMP1  =  LABEL(1, NUMLAB)                                          17900
      ITEMP2  =  LABEL(2, NUMLAB)                                          18000
      ITEMP3  =  LABEL(3, NUMLAB)                                          18100
      ITEMP4  =  LABEL(4, NUMLAB)                                          18200
      ITEMP5  =  LABEL(5, NUMLAB)                                          18300
      ATEMP1  =  TABLE(1, NUMLAB)                                          18400
      ATEMP2  =  TABLE(2, NUMLAB)                                          18500
      DO  1300  J  =  1,  NUMID                                            18600
      IF (NUMLAB.LE.49)  GO TO 1000                                     A  18610
      READ (NC,1200)  (LISTER(I),I=1,20)                                A  18620
      WRITE (NP,1210) (LISTER(I),I=1,20)                                A  18630
 1200 FORMAT (20A4)                                                     A  18640
 1210 FORMAT (20H EXCESS IDENTIFIER  ,20A4)                             A  18650
      GO TO 1300                                                        A  18660
 1000 READ  (  NC,  1100  )  (  LABEL(I, NUMLAB),  I  =  1,  5  ),      C  18700
     1  TABLE(1, NUMLAB),  TABLE(2, NUMLAB)                                18800
 1100 FORMAT  (  2A4,  1X,  2A4,  1X,  T9,  2F2.0  )                       18900
      NUMLAB  =  NUMLAB  +  1                                              19000
 1300 CONTINUE                                                             19100
      LABEL(1, NUMLAB)  =  ITEMP1                                          19200
      LABEL(2, NUMLAB)  =  ITEMP2                                          19300
      LABEL(3, NUMLAB)  =  ITEMP3                                          19400
      LABEL(4, NUMLAB)  =  ITEMP4                                          19500
      LABEL(5, NUMLAB)  =  ITEMP5                                          19600
      TABLE(1, NUMLAB)  =  ATEMP1                                          19700
      TABLE(2, NUMLAB)  =  ATEMP2                                          19800
      NX = NUMLAB- 2                                                    A  19810
```

```
      NMX = NX + 1                                                      A  19820
      WRITE  (  NP,  1500  )  NX                                        C  19900
 1500 FORMAT  (  40H0NUMBER OF ENTRIES IN CONVERSION TABLE =  ,            20000
     1  I5  /  /  /                                                     20100
     2  73H IDENTIFIER  IDENTIFIER       ROUND  CONVERSION    ROUNDING  20200
     3                /                                                20300
     4  73H IN           OUT          TECHNIQUE      FACTOR        UNIT  20400
     5                /  )                                             20500
C                                                                       20600
      DO  1900  J  =  2,  NMX                                           C  20700
      WRITE  (  NP,  1700  )  (  LABEL(I, J),  I  =  1,  5  ),          20800
     1  TABLE(1, J),  TABLE(2, J)                                       20900
 1700 FORMAT  (  1H ,  2A4,  4X,  2A4,  4X,  I10,  2E12.5  )            21000
      IF  (  J  .GE.  NLSAVE  .AND.  J  .LT.  NUMLAB  )                 21100
     1  WRITE  (  NP,  1800  )                                          21200
 1800 FORMAT  (  1H+,  60X,  35H**** THIS IS A TEMPORARY ENTRY ****  )  21300
 1900 CONTINUE                                                          21400
      WRITE  (  NP,  12300  )                                           21500
 2100 CONTINUE                                                          21600
C                                                                       21700
      N  =  1                                                           21800
 3700 CONTINUE                                                          21900
C                                                                       22000
C     CLEAR ALL  TEMPORARY STORAGE BEFORE READING IN DIMENSION DATA     22100
C                                                                       22200
      DO  3800  I  =  1,  16                                            22300
      INOUT(I)  =  KTRL(14)                                             22400
 3800 CONTINUE                                                          22500
      TDIN(1)  =  0.0D0                                                 22600
      TDIN(2)  =  0.0D0                                                 22700
      ITDIN  =  0                                                       22800
      ID(1)  =  IBLANK                                                  22900
      ID(2)  =  IBLANK                                                  23000
      ID(3)  =  IBLANK                                                  23100
      ID(4)  =  IBLANK                                                  23200
C                                                                       23300
C     READ DIMENSION AND IDENTIFIER  ( 3 PAIRS AT A TIME )              23400
C                                                                       23500
      CALL  READER                                                      23600
C                                                                       23700
C     SEARCH LABEL ARRAY FOR PROPER IDENTIFIER                          23800
C                                                                       23900
      DO  4400  I  =  1,  NUMLAB                                        24000
      DO  4300  J  =  1,  2                                             24100
      IF  (  ID(J)  .NE.  LABEL(J, I)  )  GO  TO  4400                  24200
 4300 CONTINUE                                                          24300
      GO  TO  5100                                                      24400
 4400 CONTINUE                                                          24500
      INDEX  =  1                                                       24600
 4600 CONTINUE                                                          24700
      IF  (  NCHEK  )  4900,  4700,  4900                               24800
 4700 CONTINUE                                                          24900
C                                                                       25000
C     PRINT THIS HEADING IF A LEAST ONE ERROR IS FOUND                  25100
```

```
C                                                                       25200
      WRITE  (  NP,  4800  )                                            25300
 4800 FORMAT  (  70H0LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME T 25400
     1YPE OF ERROR(S).     /  61H0DIMENSION   IDENTIFIER    ERROR TYPE   25500
     2                       /  )                                       25600
      NCHEK  =  NCHEK  +  1                                             25700
 4900 CONTINUE                                                          25800
C                                                                       25900
C     PRINT BAD CARD AND IDENTIFY ERROR                                 26000
C                                                                       26100
      INDEX  =  (  INDEX  -  1  )  *  8                                 26200
      I1=INDEX+1                                                    A   26210
      I8=INDEX+8                                                    A   26220
      WRITE  (  NP,  5000  )  (  INOUT(I),  I  =  1,  8  ),             26300
     1  ID(1),  ID(2),  (  MESAG(  I  ),  I  =  I1,  I8  )          C   26400
 5000 FORMAT  (  1H ,  8A1,  4X,  2A4,  6X,  8A4  )                     26500
      GO  TO  3700                                                      26600
 5100 CONTINUE                                                          26700
C                                                                       26800
C     DETERMINE TYPE OF IDENTIFIER                                      26900
C                                                                       27000
      IF  (  I  .EQ.  NUMLAB  )  GO  TO  9500                           27100
      TDIN(1)  =  I                                                     27200
C                                                                       27300
C     DECODE DIMENSION INTO TDIN AND ITDIN                              27400
C                                                                       27500
      CALL  DECODE  (  1,  8,  VALUE,  ITDIN  )                         27600
      TDIN(2)  =  VALUE                                                 27700
C                                                                       27800
C     CHECK FOR ILLEGAL CHARACTERS IN DIMENSION                         27900
C                                                                       28000
      IF  (  ITDIN  +  1  )  6100,  3700,  6200                         28100
 6100 CONTINUE                                                          28200
      INDEX  =  2                                                       28300
      GO  TO  4600                                                      28400
 6200 CONTINUE                                                          28500
C                                                                       28600
C     WRITE DIAGNOSTIC IF MORE THAN 500 UNIQUE INPUT CARDS ARE GIVEN    28700
C                                                                       28800
      IF  (  N  -  500  )  8600,  8600,  8500                           28900
 8500 CONTINUE                                                          29000
      INDEX  =  3                                                       29100
      GO  TO  4600                                                      29200
 8600 CONTINUE                                                          29300
      IF  (  N  -  1  )  8700,  8700,  8900                             29400
 8700 CONTINUE                                                          29500
C                                                                       29600
C     TRANSFER ALL TEMPORARY STORAGE TO PERMANENT STORAGE AND THEN GO    29700
C     BACK AND READ ANOTHER CARD    STOP MUST BE LAST IDENTIFIER        29800
C                                                                       29900
      DIN(1, N)  =  TDIN(1)                                             30000
      DIN(2, N)  =  TDIN(2)                                             30100
      IDIN(N)  =  ITDIN                                                 30200
      N  =  N  +  1                                                     30300
```

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      GO  TO  3700                                                      30400
C                                                                       30500
C     BEGIN EDIT OF DATA                                                30600
C     THROW OUT DATA WHEN SAME PREVIOUS DATA HAS ALREADY BEEN           30700
C     ENCOUNTERED                                                       30800
C                                                                       30900
 8900 CONTINUE                                                          31000
      L  =  N  -  1                                                     31100
      DO  9200  I  =  1,  L                                             31200
      DO  9000  J  =  1,  2                                             31300
      IF  (  TDIN(J)  -  DIN(J, I)  )  9200,  9000,  9200              31400
 9000 CONTINUE                                                          31500
      IF  (  ITDIN  -  IDIN(I)  )  9200,  9100,  9200                   31600
 9100 CONTINUE                                                          31700
      GO  TO  3700                                                      31800
 9200 CONTINUE                                                          31900
      GO  TO  8700                                                      32000
C                                                                       32100
C     BEGIN SORT OF DATA                                                32200
C     NUMBER KINDX ARRAY FROM 1 TO 500                                  32300
C                                                                       32400
 9500 CONTINUE                                                          32500
      NLIST  =  N  -  1                                                 32600
C                                                                       32700
C     NLIST  =  THE NUMBER OF OUTPUT ITEMS                              32800
C                                                                       32900
      IF  (  NLIST  .LE.  0  )  GO  TO  50                              33000
      DO  9600  I  =  1,  500                                           33100
      KINDX(I)  =  I                                                    33200
 9600 CONTINUE                                                          33300
      CALL  DASORT                                                      33400
      DO  9700  K  =  1,  NLIST                                         33500
      I  =  KINDX(K)                                                    33600
      TYPE  =  DIN(1, I)                                                33700
      IF  (  TYPE  .GT.  1.0D0  )  GO  TO  9800                         33800
 9700 CONTINUE                                                          33900
      NTYPE1  =  NLIST                                                  34000
      NTYPE2  =  0                                                      34100
      GO  TO  9900                                                      34200
 9800 CONTINUE                                                          34300
      NTYPE1  =  K  -  1                                                34400
      NTYPE2  =  NLIST  -  NTYPE1                                       34500
 9900 CONTINUE                                                          34600
C                                                                       34700
C     BEGIN PRINT OUT OF INPUT DATA AND ANSWERS                         34800
C                                                                       34900
C     BEGIN TYPE 1 PRINT OUTS  (MILLIMETRE TO INCH CONVERSION)          35000
C                                                                       35100
C     CONVERT FROM METRIC TO ENGLISH UNITS                              35200
C                                                                       35300
      CON  =  1.0D0  /  25.4D0                                          35400
      IF  (  NTYPE1  .LE.  0  )  GO  TO  12600                          35500
      NLINES  =  (  NTYPE1  +  NCOLS1  -  1  )  /  NCOLS1               35600
      KOUNT  =  0                                                       35700
```

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      DO  12500  NLINE  =  1,  NLINES                                    35800
      KOUNT  =  KOUNT  +  1                                              35900
      IF  (  NLINE  -  1  )  10500,  10000,  10500                       36000
10000 CONTINUE                                                           36100
C                                                                        36200
C     SKIP PAGE AND PRINT HEADING FOR MM TO IN CONVERSIONS               36300
C                                                                        36400
      WRITE (NP,10010)  (IDCARD(L), L=1,12)                          A   36450
10010 FORMAT ( 6H1PART ,8A1,10H   CHANGE ,4A1)                       A   36460
      GO  TO  (  10020,  10060,  10120,  10160  ),  NCOLS1               36500
10020 CONTINUE                                                           36600
      WRITE (NP,10040)                                               C   36700
10040 FORMAT ( 1H0, 1 (2HMM,8X,4HINCH,10X))                          C   36800
      GO  TO  10190                                                      37100
10060 CONTINUE                                                           37200
      WRITE (NP,10080)                                               C   37300
10080 FORMAT ( 1H0, 2 (2HMM,8X,4HINCH,10X))                          C   37400
      GO  TO  10190                                                      37700
10120 CONTINUE                                                           37800
      WRITE (NP,10140)                                               C   37900
10140 FORMAT ( 1H0, 3 (2HMM,8X,4HINCH,10X))                          C   38000
      GO  TO  10190                                                      38300
10160 CONTINUE                                                           38400
      WRITE (NP,10180)                                               C   38500
10180 FORMAT ( 1H0, 4 (2HMM,8X,4HINCH,10X))                          C   38600
10190 CONTINUE                                                           38900
10400 CONTINUE                                                           39400
10500 CONTINUE                                                           39500
      DO  10600  I  =  1,  64                                            39600
      LISTER(I)  =  IBLANK                                               39700
10600 CONTINUE                                                           39800
      DO  12100  NCOL  =  1,  NCOLS1                                     39900
      K  =  (  NCOL  -  1  )  *  NLINES  +  NLINE                        40000
      IF  (  K  .GT.  NTYPE1  )  GO  TO  12100                           40100
      I  =  KINDX(K)                                                     40200
C                                                                        40300
C     CLEAR ALL TEMPORARY ARRAYS BEFORE LOADING WITH CHARACTERS FOR      40400
C     PRINTING                                                           40500
C                                                                        40600
      DO  10700  J  =  1,  16                                            40700
      INOUT(J)  =  KTBL(14)                                              40800
10700 CONTINUE                                                           40900
      TDIN(1)  =  0.0D0                                                  41000
      TDIN(2)  =  0.0D0                                                  41100
      ITDIN  =  0                                                        41200
      TDIN(1)  =  DIN(1, I)                                              41300
      TDIN(2)  =  DIN(2, I)                                              41400
      ITDIN  =  IDIN(I)                                                  41500
C                                                                        41600
C     INPUT DIMENSION PREPARATION                                        41700
C                                                                        41800
      VALUE  =  TDIN(2)                                                  41900
      CALL  ENCODE  (  1,  8,  VALUE,  ITDIN  )                          42000
C                                                                        42100
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C     ROUND TO 1 MORE PLACE TO THE RIGHT OF THE DECIMAL POINT THAN          42200
C     GIVEN IN THE DIMENSION VALUE WITH A MINIMUM OF 3                      42300
C                                                                           42400
      IPLACE  =  ITDIN  +  1                                                42500
      IF  (  IPLACE  -  3  )  11900,  12000,  12000                         42600
11900 CONTINUE                                                              42700
C                                                                           42800
C     MINIMUM OF 3 PLACES ROUND OFF                                         42900
C                                                                           43000
      IPLACE  =  3                                                          43100
12000 CONTINUE                                                              43200
C                                                                           43300
C     CONVERT DIMENSION, ROUND TO PROPER NUMBER OF PLACES AND PLACE IN      43400
C     ARRAY READY FOR PRINTING                                              43500
C                                                                           43600
      DIM  =  TDIN(2)  *  CON                                               43700
      DIM  =  DABS  (  DIM  )                                               43800
      DIM  =  DROUND  (  DIM,  IPLACE  )                                    43900
      CALL  ENCODE  (  9,  16,  DIM,  IPLACE  )                             44000
      MYLINE  =  (  NCOL  -  1  )  *  16                                    44100
      DO  12050  J  =  1,  16                                               44200
      JJ=MYLINE+J                                                       A   44250
      LISTER(    JJ    )  =  INOUT(J)                                   C   44300
12050 CONTINUE                                                              44400
12100 CONTINUE                                                              44500
C                                                                           44600
C     PRINT ORIGINAL INPUT DATA AND CONVERTED DATA                          44700
      IF  (  KOUNT  .EQ.  1  )  WRITE  (  NP,  12300  )                 A   44750
C                                                                           44800
      WRITE  (  NP,  12200  )  (  LISTER(J),  J  =  1,  64  )               44900
12200 FORMAT  (  1H ,  8A1,  2X,  8A1,  6X,  8A1,  2X,  8A1,  6X,  8A1, C   45000
     1  2X,  8A1,  6X,  8A1,  2X,  8A1  )                                 C   45100
      IF  (  MOD  (  KOUNT,  5  )  .EQ.  0  )  WRITE  (  NP,  12300  )      45200
12300 FORMAT  (  1H  )                                                      45300
12500 CONTINUE                                                              45400
12600 CONTINUE                                                              45500
C                                                                           45600
C     GREATER THAN TYPE 1 CONVERSION DATA  (  OTHER THAN MM TO IN  )        45700
C                                                                           45800
      IF  (  NTYPE2  .LE.  0  )  GO  TO  15000                              45900
      KOUNT  =  0                                                           46000
      NLINES  =  (  NLIST  -  NTYPE1  +  NCOLS2  -  1  )  /  NCOLS2         46100
      DO  14000  NLINE  =  1,  NLINES                                       46200
      KOUNT  =  KOUNT  +  1                                                 46300
      IF  (  NLINE  -  1  )  13000,  12800,  13000                          46400
12800 CONTINUE                                                              46500
C                                                                           46600
C     SKIP 2 LINES AND PRINT HEADING FOR OTHER THAN MM TO IN CONVERSIONS     46700
C                                                                           46800
      WRITE (NP,10010)  (IDCARD(L), L=1,12)                             A   46850
      IF  (  NCOLS2  .EQ.  1  )                                             46900
     1  WRITE  (  NP,  12850  )                                          C   47000
12850 FORMAT  (  1H0,                                                   C   47100
     2  2  (  3HDIM,  7X,  5HUNITS,  6X  )  )                              47300
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      IF  (  NCOLS2  .EQ.  2  )                                          47400
     1  WRITE  (  NP,  12900  )                                        C  47500
12900 FORMAT  (  1H0,                                                 C  47600
     2 2(3HDIM,7X,5HUNITS,6X,3HDIM,7X,5HUNITS,9X))                    C  47800
12975 CONTINUE                                                           48300
13000 CONTINUE                                                           48400
      DO  13025  I  =  1,  32                                            48500
      LISTER(I)  =  IBLANK                                               48600
13025 CONTINUE                                                           48700
      DO  13050  I  =  1,  8                                             48800
      IDOUT(I)  =  IBLANK                                                48900
13050 CONTINUE                                                           49000
      DO  13800  NCOL  =  1,  NCOLS2                                     49100
      K  =  (  NCOL  -  1  )  *  NLINES  +  NLINE  +  NTYPE1             49200
      IF  (  K  .GT.  NLIST  )  GO  TO  13800                            49300
      I  =  KINDX(K)                                                     49400
C                                                                        49500
C     CLEAR ALL TEMPORARY ARRAYS BEFORE LOADING WITH CHARACTERS FOR      49600
C     PRINTING                                                           49700
C                                                                        49800
      DO  13100  J  =  1,  16                                            49900
      INOUT(J)  =  KTBL(14)                                              50000
13100 CONTINUE                                                           50100
      DO  13200  J  =  1,  4                                             50200
      ID(J)  =  IBLANK                                                   50300
13200 CONTINUE                                                           50400
      TDIN(1)  =  0.0D0                                                  50500
      TDIN(2)  =  0.0D0                                                  50600
      ITDIN  =  0                                                        50700
      TDIN(1)  =  DIN(1, I)                                              50800
      TDIN(2)  =  DIN(2, I)                                              50900
      ITDIN  =  IDIN(I)                                                  51000
C                                                                        51100
C     INPUT DIMENSION PREPARATION                                        51200
C                                                                        51300
      VALUE  =  TDIN(2)                                                  51400
      CALL  ENCODE  (  1,  8,  VALUE,  ITDIN  )                          51500
C                                                                        51600
C     SETUP INPUT AND OUTPUT IDENTIFIERS                                 51700
C     CALCULATE CONVERSION CONSTANT                                      51800
C     SETUP TYPE OF PRINT OUT                                            51900
C                                                                        52000
      N  =  TDIN(1)                                                      52100
      ID(1)  =  LABEL(1, N)                                              52200
      ID(2)  =  LABEL(2, N)                                              52300
      ID(3)  =  LABEL(3, N)                                              52400
      ID(4)  =  LABEL(4, N)                                              52500
      IPLACE  =  LABEL(5, N)                                             52600
      CON  =  TABLE(1, N)                                                52700
      RDUNIT  =  TABLE(2, N)                                             52800
C                                                                        52900
C     CONVERT DIMENSION AND CHECK SPECIAL CASE FOR DEGREE C TO DEGREE F  53000
C                                                                        53100
      DIM  =  TDIN(2)  *  DABS  (  CON  )                                53200
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      IF  (  CON  .LT.  0.000  )  DIM  =  DIM  +  32.000                    53300
      IF  (  RDUNIT  )  13400,  13400,  13300                               53400
13300 CONTINUE                                                              53500
      RCONST  =  0.500                                                      53600
      IF  (  DIM  .LT.  0.000)  RCONST  =  -0.500                           53700
      IDIM  =  DIM  /  RDUNIT  +  RCONST                                    53800
      DIM  =  IDIM                                                          53900
      DIM  =  DIM  *  RDUNIT                                                54000
13400 CONTINUE                                                              54100
      CALL  SETUP  (  DIM,  IPLACE  )                                       54200
      MYLINE  =  (  NCOL  -  1  )  *  16                                    54300
      DO  13500  J  =  1,  16                                               54400
      JJ=MYLINE+J                                                       A   54450
      LISTER(    JJ    )  =  INOUT(J)                                   C   54500
13500 CONTINUE                                                              54600
      MYLINE  =  (  NCOL  -  1  )  *  4                                     54700
      DO  13600  J  =  1,  4                                                54800
      JJ=MYLINE+J                                                       A   54850
      IDOUT(    JJ    )  =  ID(J)                                       C   54900
13600 CONTINUE                                                              55000
13300 CONTINUE                                                              55100
C                                                                           55200
C     PRINT OUT ALL INPUT DATA AND ALL CONVERTED VALUES WITH APPROPRIATE    55300
C     IDENTIFIERS                                                           55400
      IF ( KOUNT . EQ . 1 )  WRITE ( NP, 12300 )                        A   55450
C                                                                           55500
      WRITE  (  NP,  13900  )  (  LISTER(J),  J  =  1,  8  ),               55600
     1  IDOUT(1),  IDOUT(2),  (  LISTER(J),  J  =  9,  16  ),               55700
     2  IDOUT(3),  IDOUT(4),  (  LISTER(J),  J  =  17,  24  ),              55800
     3  IDOUT(5),  IDOUT(6),  (  LISTER(J),  J  =  25,  32  ),              55900
     4  IDOUT(7),  IDOUT(8)                                                 56000
13900 FORMAT  (  1H ,  8A1,  2X,  2A4,  3X,  8A1,  2X,  2A4,            C   56100
     1           6X ,  8A1,  2X,  2A4,  3X,  8A1,  2X,  2A4  )          C   56200
      IF  (  MOD  (  KOUNT,  5  )  .EQ.  0  )  WRITE  (  NP,  12300  )      56300
14000 CONTINUE                                                              56400
15000 CONTINUE                                                              56500
      GO  TO  50                                                            56600
16000 WRITE ( NP, 16001 )                                               A   56610
16001 FORMAT ( 10H1          )                                          A   56620
      STOP                                                              A   56630
      END                                                                   56700
      SUBROUTINE  ENCODE  (  I,  J,  R,  NDR  )                             57100
C                                                                           57200
C                                                                           57300
C     THIS SUBROUTINE TAKES A REAL NUMERIC WORD AND EXAMINES EACH           57400
C     CHARACTER.  IT THEN TAKES THE REAL WORD AND BUILDS UP AN              57500
C     ALPHABETIC CHARACTER ARRAY  (A1)                                      57600
C                                                                           57700
C     INOUT  -  ALPHABETIC CHARACTER ARRAY                                  57800
C     I      -  BEGINNING WORD IN INOUT ARRAY                               57900
C     J      -  LAST WORD IN INOUT ARRAY                                    58000
C     R      -  REAL NUMBER                                                 58100
C     NDR    -  NUMBER OF PLACES TO THE RIGHT OF THE DECIMAL POINT          58200
C                                                                           58300
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C     I, J, R, AND NDR MUST BE GIVEN                                    58400
C     INOUT IS OUTPUT                                                   58500
C                                                                       58600
C                                                                       58700
C     IMPLICIT  INTEGER  (  I  -  N  )                                  58800
C                                                                       58900
      COMMON  DIN(2, 500),  TDIN(2)                                     59000
C                                                                       59100
      COMMON  INOUT(16)                                                 59200
C                                                                       59300
      DOUBLE PRECISION  DIN,  TDIN,  R,  AR                             59400
C                                                                       59500
      COMMON  /  DATA  /  KTBL(42),  MESAG(40),  LABEL(5, 50),       C  59600
     1  TABLE(2, 50),  NLSAVE,  NUMLAB,  ISTOP(4),  IBLANK           A  59650
C                                                                       59700
      DO  100  N  =  I,  J                                              59800
      INOUT(N)  =  KTBL(14)                                             59900
  100 CONTINUE                                                          60000
      IF  (  NDR  )  200,  300,  300                                    60100
  200 CONTINUE                                                          60200
      RETURN                                                            60300
C                                                                       60400
  300 CONTINUE                                                          60500
      IF  (  R  )  500,  400,  500                                      60600
  400 CONTINUE                                                          60700
      INOUT(I)  =  KTBL(1)                                              60800
      RETURN                                                            60900
  500 CONTINUE                                                          61000
      NTC  =  0                                                         61100
      NDL  =  0                                                         61200
      IDCML  =  1                                                       61300
      N  =  I                                                           61400
      AR  =  R                                                          61500
      IF  (  R  )  600,  700,  700                                      61600
  600 CONTINUE                                                          61700
      AR  =  -R                                                         61800
      NTC  =  1                                                         61900
      N  =  N  +  1                                                     62000
      INOUT(I)  =  KTBL(12)                                             62100
  700 CONTINUE                                                          62200
      IR  =  AR                                                         62300
  800 CONTINUE                                                          62400
      IF  (  IR  -  IDCML  )  1000,  900,  900                          62500
  900 CONTINUE                                                          62600
      NDL  =  NDL  +  1                                                 62700
      IDCML  =  IDCML  *  10                                            62800
      GO  TO  800                                                       62900
 1000 CONTINUE                                                          63000
      NTC  =  NTC  +  NDL  +  NDR  +  1                                 63100
      IF  (  NTC  -  (  J  -  I  +  1  )  )  1200,  1200,  1100        63200
 1100 CONTINUE                                                          63300
      RETURN                                                            63400
C                                                                       63500
 1200 CONTINUE                                                          63600
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      IDCP  =  NTC  -  NDR  +  I  -  1                                  63700
      INOUT(IDCP)  =  KTBL(13)                                          63800
      IR  =  AR  *  10.0D0  **  NDR  +  0.100                           63900
      IDCML  =  10  **  (  NDL  +  NDR  -  1  )                         64000
 1300 CONTINUE                                                          64100
      IN  =  IR  /  IDCML                                               64200
      IR  =  IR  -  IN  *  IDCML                                        64300
      IF  (  N  -  IDCP  )  1500,  1400,  1500                          64400
 1400 CONTINUE                                                          64500
      N  =  N  +  1                                                     64600
 1500 CONTINUE                                                          64700
      INOUT(N)  =  KTBL(IN  +  1)                                       64800
      N  =  N  +  1                                                     64900
      IDCML  =  IDCML  /  10                                            65000
      IF  (  IDCML  )  1300,  1600,  1300                               65100
 1600 CONTINUE                                                          65200
      RETURN                                                            65300
      END                                                               65400
      SUBROUTINE  DECODE  (  I,  J,  R,  NDR  )                        65500
C                                                                       65600
C                                                                       66000
C     THIS SUBROUTINE TAKES AN ALPHABETIC ARRAY IN (A1) AND EXAMINES    66100
C     EACH CHARACTER TO DEVELOP A REAL WORD                             66200
C                                                                       66300
C     INOUT  -  ALPHABETIC ARRAY                                        66400
C     I      -  BEGINNING WORD IN INOUT ARRAY                           66500
C     J      -  LAST WORD IN INOUT ARRAY                                66600
C     R      -  REAL WORD                                               66700
C     NDR    -  NUMBER OF DECIMAL PLACES TO THE RIGHT OF THE DECIMAL    66800
C               POINT                                                   66900
C                                                                       67000
C     INOUT, I AND J ARE INPUT DATA                                     67100
C     R AND NDR ARE OUTPUT DATA                                         67200
C                                                                       67300
C                                                                       67400
C     IMPLICIT  INTEGER  (  I  -  N  )                                  67500
C                                                                       67600
      COMMON  DIN(2, 500),  TDIN(2)                                     67700
C                                                                       67800
      COMMON  INOUT(16)                                                 67900
C                                                                       68000
      DOUBLE PRECISION  DIN,  TDIN,  R,  SEYEGN,  DCML                  C  68100
C                                                                       68200
      COMMON  /  DATA  /  KTBL(42),  MESAG(40),  LABEL(5, 50),          C  68300
     1  TABLE(2, 50),  NLSAVE,  NUMLAB,  ISTOP(4),  IBLANK              A  68350
C                                                                       68400
      IR  =  0                                                          68500
      NDR  =  0                                                         68600
      K  =  0                                                           68700
      IDCML  =  1                                                       68800
      NSW  =  0                                                         68900
      SEYEGN  =  1.0D0                                                  69000
      KTBL11  =  0                                                      69100
      KTBL12  =  0                                                      69200
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      KTBL13  =  0                                                          69300
      DO  1000  N  =  I,  J                                                 69400
      NC  =  INOUT(N)                                                       69500
      IF  (  NC  .EQ.  KTBL(14)  )  GO  TO  1000                            69600
      IF  (  NC  .EQ.  KTBL(13)  )  GO  TO  900                             69700
      IF  (  NC  .NE.  KTBL(12)  )  GO  TO  400                             69800
      SEYEGN  =  -1.0D0                                                     69900
      IF  (  KTBL11  )  550,  350,  550                                     70000
  350 CONTINUE                                                              70100
      KTBL12  =  KTBL12  +  1                                               70200
      IF  (  KTBL12  -  1  )  550,  1000,  550                              70300
  400 CONTINUE                                                              70400
      DO  500  K  =  1,  11                                                 70500
      IF  (  NC  .EQ.  KTBL(K)  )  GO  TO  600                              70600
  500 CONTINUE                                                              70700
  550 CONTINUE                                                              70800
      NDR  =  -2                                                            70900
      R  =  0.0D0                                                           71000
      RETURN                                                                71100
C                                                                           71200
  600 CONTINUE                                                              71300
      IF  (  K  -  10  )  700,  700,  950                                   71400
  700 CONTINUE                                                              71500
      IR  =  IR  *  10  +  K  -  1                                          71600
      IF  (  NSW  ) 800,  1000,  800                                        71700
  800 CONTINUE                                                              71800
      IDCML  =  IDCML  *  10                                                71900
      NDR  =  NDR  +  1                                                     72000
      GO  TO  1000                                                          72100
  900 CONTINUE                                                              72200
      NSW  =  1                                                             72300
      KTBL13  =  KTBL13  +  1                                               72400
      IF  (  KTBL13  -  1  )  550,  1000,  550                              72500
  950 CONTINUE                                                              72600
      IF  (  KTPL12  )  550,  975,  550                                     72700
  975 CONTINUE                                                              72800
      KTBL11  =  KTBL11  +  1                                               72900
      IF  (  KTBL11  -  1  )  550,  1000,  550                              73000
 1000 CONTINUE                                                              73100
      DCML  =  IDCML                                                        73200
      R  =  IR                                                              73300
      R  =  R  /  DCML  *  SEYEGN                                           73400
      IF  (  K  )  1200,  1100,  1200                                       73500
 1100 CONTINUE                                                              73600
      NDR  =  -1                                                            73700
 1200 CONTINUE                                                              73800
      RETURN                                                                73900
      END                                                                   74000
      SUBROUTINE  DASORT                                                    74100
C                                                                           74500
C                                                                           74600
C     THIS SUBROUTINE SORTS THE LARGE ARRAY OF INPUT DIMENSIONS INTO        74700
C     ASCENDING ORDER                                                       74800
C                                                                           74900
```

```
C      DIN    -  ARRAY OF INPUT DATA                                          75000
C      KINDX  -  ARRAY SHOWING THE SORTED ORDER OF DIN                        75100
C                                                                             75200
C      IMPLICIT  INTEGER  (  I  -  N  )                                       75300
C                                                                             75400
       COMMON  DIN(2, 500),  TDIN(2)                                          75500
C                                                                             75600
       COMMON  INOUT(16),  INCARD(30),  INDEXR,  NC,  NP,  NCHEK,  ID(4),     75700
      1        IDCARD(72),  LISTER(64),  IDOUT(3),  KINDX(500),  NLIST,      75800
      2        IDIN(500)                                                      75900
C                                                                             76000
       DOUBLE PRECISION  DIN,  TDIN                                           76100
C                                                                             76200
       MMM  =  NLIST                                                          76300
  100  CONTINUE                                                               76400
       MMM  =  MMM  /  2                                                      76500
       IF  (  MMM  -  1  )  200,  300,  300                                   76600
  200  CONTINUE                                                               76700
       RETURN                                                                 76800
C                                                                             76900
  300  CONTINUE                                                               77000
       M  =  MMM  +  1                                                        77100
       DO 1000  I= M , NLIST                                                  77200
       J  =  I  -  MMM                                                        77300
       KI  =  KINDX(I)                                                        77400
       KJ  =  KINDX(J)                                                        77500
       DO  400  NN = 1, 2                                                     77600
       IF  (  DIN(NN, KI)  -  DIN(NN, KJ)  )  500,  400,  1000               77700
  400  CONTINUE                                                               77800
       GO  TO  1000                                                           77900
  500  CONTINUE                                                               78000
       L  =  I                                                                78100
  600  CONTINUE                                                               78200
       KINDX(L)  =  KJ                                                        78300
       L  =  J                                                                78400
       J  =  J  -  MMM                                                        78500
       IF  (  J  -  1  )  900,  700,  700                                     78600
  700  CONTINUE                                                               78700
       KJ  =  KINDX(J)                                                        78800
       DO  800  NN = 1, 2                                                     78900
       IF  (  DIN(NN, KI)  -  DIN(NN, KJ)  )  600,  800,  900                79000
  800  CONTINUE                                                               79100
  900  CONTINUE                                                               79200
       KINDX(L)  =  KI                                                        79300
 1000  CONTINUE                                                               79400
       GO  TO  100                                                            79500
       END                                                                    79600
       SUBROUTINE  SETUP  (  DIM,  IPLACE  )                                  80000
C                                                                             80100
C                                                                             80200
C      THIS SUBROUTINE EXAMINES THE CONVERTED VALUES OF DIMENSION             80300
C                AND ALONG WITH THE PRINT OPTION (IPLACE) DECIDES HOW         80400
C      MANY PLACES TO THE RIGHT OF THE DECIMAL POINT TO PRINT OUT             80500
C                                                                             80600
```

```
C     NO MORE THAN 3 SIGNIFICANT DIGITS ARE PRINTED OUT                      80700
C                                                                            80800
C     DIM     -  CONVERTED DIMENSION                                         80900
C     IPLACE  -  PRINT OPTION                                                81000
C                                                                            81100
C     IMPLICIT  INTEGER  (  I  -  N  )                                       81200
C                                                                            81300
      COMMON  DIN(2, 500),  IDIN(2)                                          81400
C                                                                            81500
      COMMON  INOUT(16)                                                      81600
C                                                                            81700
      DOUBLE PRECISION  DIN,  IDIN,  DIM,  DROUND                            81800
C                                                                            81900
      COMMON  /  DATA  /  KTBL(42),  MESAG(40),  LABEL(5, 50),           C   82000
     1  TABLE(2, 50),  NLSAVE,  NUMLAB,  ISTOP(4),  IBLANK               A   82050
C                                                                            82100
      IF  (  DIM  .EQ.  0.0D0)  GO  TO  1000                                 82200
      CALL  SIGNIF  (  DIM,  LARGE,  NPLACE  )                               82300
      IF  (  LARGE  )  300,  300,  100                                       82400
  100 CONTINUE                                                               82500
      DO  200  J  =  9,  16                                                  82600
      INOUT(J)  =  KTBL(41)                                                  82700
  200 CONTINUE                                                               82800
      RETURN                                                                 82900
C                                                                            83000
  300 CONTINUE                                                               83100
      IF  (  NPLACE  )  400,  500,  500                                      83200
  400 CONTINUE                                                               83300
      IVAL  =  0                                                             83400
      GO  TO  600                                                            83500
  500 CONTINUE                                                               83600
      IVAL  =  NPLACE                                                        83700
  600 CONTINUE                                                               83800
      NDR  =  IVAL                                                           83900
      IF  (  IPLACE  )  700,  900,  900                                      84000
  700 CONTINUE                                                               84100
      DIM  =  DROUND  (  DIM,  IVAL  )                                       84200
  800 CONTINUE                                                               84300
      CALL  ENCODE  (  9,  16,  DIM,  NDR  )                                 84400
      RETURN                                                                 84500
C                                                                            84600
  900 CONTINUE                                                               84700
      NDR  =  MINO  (  NDR,  IPLACE  )                                       84800
      IVAL  =  NDR                                                           84900
      GO  TO  700                                                            85000
 1000 CONTINUE                                                               85100
      NDR  =  0                                                              85200
      GO  TO  800                                                            85300
      END                                                                    85400
      SUBROUTINE  SIGNIF  (  VALUE,  LARGE,  IPLACE  )                       85500
C                                                                            85600
C                                                                            86000
C     THIS SUBROUTINE DETERMINES THE NUMBER OF SIGNIFICANT DIGITS            86100
C     GIVEN A DIMENSION VALUE                                                86200
```

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C                                                                       86300
C     VALUE   -  CONVERTED DIMENSION                                    86400
C     LARGE   -  CHECK FOR TOO LARGE A NUMBER TO PRINT OUT              86500
C     IPLACE  -  NUMBER OF PLACES FOR ROUND OFF SUBROUTINE              86600
C                                                                       86700
C                                                                       86800
      IMPLICIT  INTEGER  (  I  -  N  )                                  86900
C                                                                       87000
      DOUBLE  PRECISION  VALUE,  VAL,  FACTOR,  DROUND                  87100
C                                                                       87200
      IPLACE  =  0                                                      87300
      LARGE  =  0                                                       87400
      VAL  = DABS  (  VALUE  )                                          87500
      NL  =  8                                                          87600
      FACTOR  =  10000000.0D0                                           87700
  100 CONTINUE                                                          87800
      IF  (  VAL  -  FACTOR  )  200,  200,  300                         87900
  200 CONTINUE                                                          88000
      FACTOR  =  FACTOR  /  10.0D0                                      88100
      NL  =  NL  -  1                                                   88200
      GO  TO  100                                                       88300
  300 CONTINUE                                                          88400
      IF  (  VALUE  )  400,  900,  700                                  88500
  400 CONTINUE                                                          88600
      IF  (  NL  -  6  )  600,  900,  500                               88700
  500 CONTINUE                                                          88800
      LARGE  =  1                                                       88900
      RETURN                                                            89000
C                                                                       89100
  600 CONTINUE                                                          89200
      IF  (  NL  +  5  )  500,  900,  900                               89300
  700 CONTINUE                                                          89400
      IF  (  NL  -  7  )  800,  900,  500                               89500
  800 CONTINUE                                                          89600
      IF  (  NL  +  6  )  500,  900,  900                               89700
  900 CONTINUE                                                          89800
      IPLACE  =  -1  *  (  NL  -  3  )                                  89900
      VALUE  = DROUND  (  VALUE,  IPLACE  )                             90000
      RETURN                                                            90100
      END                                                               90200
      SUBROUTINE  READER                                                90600
C                                                                       90700
C     IMPLICIT  INTEGER  (  I  -  N  )                                  90800
C                                                                       90900
      COMMON  DIN(2, 500),  TDIN(2)                                     91000
C                                                                       91100
      COMMON  INOUT(16),  INCARD(30),  INDEXR,  NC,  NP,  NCHEK,  ID(4),  91200
     1        IDCARD(72),  LISTER(64),  IDOUT(8),  KINDX(500),  NLIST,   91300
     2        IDIN(500)                                                  91400
C                                                                       91500
      DOUBLE PRECISION  DIN,  TDIN                                      91600
C                                                                       91700
      INDEXR  =  INDEXR  +  1                                           91800
      GO  TO  (  1000,  4000,  6000  ),  INDEXR                         91900
```

```
 1000 CONTINUE                                                          92000
      READ  (  NC,  2000  )  INCARD                                     92100
 2000 FORMAT  (  3  (  8A1,  1X,  2A4,  1X  )  )                       92200
      DO  3000  I  =  1,  8                                             92300
      INOUT(I)  =  INCARD(I)                                            92400
 3000 CONTINUE                                                          92500
      ID(1)  =  INCARD(9)                                               92600
      ID(2)  =  INCARD(10)                                              92700
      RETURN                                                            92800
C                                                                       92900
 4000 CONTINUE                                                          93000
      DO  5000  I  =  1,  8                                             93100
      INOUT(I)  =  INCARD(I + 10)                                       93200
 5000 CONTINUE                                                          93300
      ID(1)  =  INCARD(19)                                              93400
      ID(2)  =  INCARD(20)                                              93500
      RETURN                                                            93600
C                                                                       93700
 6000 CONTINUE                                                          93800
      DO  7000  I  =  1,  8                                             93900
      INOUT(I)  =  INCARD(I + 20)                                       94000
 7000 CONTINUE                                                          94100
      ID(1)  =  INCARD(29)                                              94200
      ID(2)  =  INCARD(30)                                              94300
      INDEXR  =  0                                                      94400
      RETURN                                                            94500
      END                                                               94600
      DOUBLE PRECISION FUNCTION  DROUND)  (  VALUE,  IPLACE  )      C   95000
C                                                                       95100
C     IMPLICIT  INTEGER  (  I  -  N  )                                  95200
C                                                                       95300
      DOUBLE  PRECISION  VALUE,  FACTOR,  UTAH,  ALASKA,  HAWAII,       95400
     1                   TEXAS                                      C   95500
C                                                                       95600
C     VALUE  =  NUMBER TO BE ROUNDED BY CATERPILLAR STANDARDS  (+ OR -) 95700
C     DROUND  =  ROUNDED NUMBER  ( + OR - )                             95800
C     IPLACE  =  NUMBER OF PLACES TO THE RIGHT OF THE DECIMAL POINT IF  95900
C                  POSITIVE, OR NUMBER OF ZEROS TO THE LEFT OF THE      96000
C                  DECIMAL POINT IF NEGATIVE                            96100
C                                                                       96200
      FACTOR  =  DSIGN  (  10.0D0  **  IPLACE,  VALUE  )                96300
      UTAH  =  VALUE  *  FACTOR                                         96400
      IDAHO  =  IDINT  (  UTAH  )                                       96500
      ALASKA  =  IDAHO                                                  96600
      HAWAII  =  UTAH  +  0.5D0                                         96700
      IOWA  =  IDINT  (  HAWAII  )                                      96800
      TEXAS  =  IOWA                                                    96900
      IF  (  DABS ( UTAH - ALASKA - 0.5D0 )  -  0.0001D0  )  1,  1,  2  97000
    1 DROUND  =  (  ALASKA  +  DMOD  (  ALASKA,  2.0D0  )  )  /  FACTOR 97100
      RETURN                                                            97200
C                                                                       97300
    2 DROUND =  TEXAS  /  FACTOR                                        97400
      RETURN                                                            97500
      END                                                               97600
```

```
      BLOCK  DATA                                                       98000
C                                                                       98100
C     IMPLICIT  INTEGER  (  I  -  N  )                                  98200
C                                                                       98300
C     COMMON  /  DATA  /  KTBL(42),  MESAG(40),  LABEL(5, 50),          98400
C    1  TABLE(2, 50),  NLSAVE,  NUMLAB,  ISTOP(4),  IBLANK             98500
C                                                                       98600
      COMMON  /  DATA  /  KTBL(42),  MESAG(40)                          98700
      COMMON  /  DATA  /  LAB01(25),  LAB02(25),  LAB03(25),  LAB04(25),  98800
     1                    LAB05(25),  LAB06(25),  LAB07(25),  LAB08(25),  98900
     2                    LAB09(25),  LAB10(25)                          99000
      COMMON  /  DATA  /  TBL1(25),  TBL2(25),  TBL3(25),  TBL4(25)     99100
      COMMON  /  DATA  /  NLSAVE,  NUMLAB,  ISTOP(4),  IBLANK           99200
C                                                                       99300
C     KTBL(42)  A1                                                      99400
C        CHARACTER TABLE USED IN DECODE AND ENCODE SUBROUTINES AS WELL  99500
C        AS INITIALIZATION OF ARRAYS                                    99600
C                                                                       99700
      DATA  KTBL(01),  KTBL(02),  KTBL(03),  KTBL(04),  KTBL(05),       99800
     1      KTBL(06),  KTBL(07),  KTBL(08),  KTBL(09),  KTBL(10),       99900
     2      KTBL(11),  KTBL(12),  KTBL(13),  KTBL(14),  KTBL(15),      100000
     3      KTBL(16),  KTBL(17),  KTBL(18),  KTBL(19),  KTBL(20),      100100
     4      KTBL(21)  /                                                100200
     5                  1H0,  1H1,  1H2,  1H3,  1H4,  1H5,  1H6,       100300
     6                  1H7,  1H8,  1H9,  1H+,  1H-,  1H.,  1H ,       100400
     7                  1HA,  1HB,  1HC,  1HD,  1HE,  1HF,  1HG  /     100500
C                                                                      100600
      DATA  KTBL(22),  KTBL(23),  KTBL(24),  KTBL(25),  KTBL(26),      100700
     1      KTBL(27),  KTBL(28),  KTBL(29),  KTBL(30),  KTBL(31),      100800
     2      KTBL(32),  KTBL(33),  KTBL(34),  KTBL(35),  KTBL(36),      100900
     3      KTBL(37),  KTBL(38),  KTBL(39),  KTBL(40),  KTBL(41),      101000
     4      KTBL(42)  /                                                101100
     5                  1HH,  1HI,  1HJ,  1HK,  1HL,  1HM,  1HN,       101200
     6                  1HO,  1HP,  1HQ,  1HR,  1HS,  1HT,  1HU,       101300
     7                  1HV,  1HW,  1HX,  1HY,  1HZ,  1H*,  1H)  /     101400
C                                                                      101500
C     MESAG(40)                                                        101600
C        ERROR MESSAGES TO BE PRINTED OUT WITH BAD INPUT CARDS         101700
C                                                                      101800
      DATA  MESAG(01),  MESAG(02),  MESAG(03),  MESAG(04),  MESAG(05),  101900
     1      MESAG(06),  MESAG(07),  MESAG(08),  MESAG(09),  MESAG(10),  102000
     2      MESAG(11),  MESAG(12),  MESAG(13),  MESAG(14),  MESAG(15),  102100
     3      MESAG(16),  MESAG(17),  MESAG(18),  MESAG(19),  MESAG(20)  /  102200
     4  4HILLE, 4HGAL , 4HIDEN, 4HTIFI, 4HER  , 4H    , 4H    , 4H    ,  102300
     5  4HILLE, 4HGAL , 4HCHAR, 4HACTE, 4HR IN, 4H DIM, 4HENSI, 4HON  ,  102400
     6  4HMORE, 4H THA, 4HN 50, 4H0 UN  /                               102500
C                                                                      102600
      DATA  MESAG(21),  MESAG(22),  MESAG(23),  MESAG(24),  MESAG(25),  102700
     1      MESAG(26),  MESAG(27),  MESAG(28),  MESAG(29),  MESAG(30),  102800
     2      MESAG(31),  MESAG(32),  MESAG(33),  MESAG(34),  MESAG(35),  102900
     3      MESAG(36),  MESAG(37),  MESAG(38),  MESAG(39),  MESAG(40)  /  103000
     4                                  4HIQUE, 4H DAT, 4HA CA, 4HDDS ,  103100
     5  4H    , 4H    , 4H    , 4H    , 4H    , 4H    , 4H    , 4H    ,  103200
     6  4H    , 4H    , 4H    , 4H    , 4H    , 4H    , 4H    , 4H    /  103300
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C                                                                       103400
C     LABEL(5, 100)  4A4,  T10                                          103500
C     THIS ARRAY STORES THE FOLLOWING-                                  103600
C        LABEL(1)  INPUT IDENTIFIER  (FIRST 4 CHARACTERS)               103700
C        LABEL(2)  INPUT IDENTIFIER   (LAST 4 CHARACTERS)               103800
C        LABEL(3)  OUTPUT IDENTIFIER  (FIRST 4 CHARACTERS)              103900
C        LABEL(4)  OUTPUT IDENTIFIER   (LAST 4 CHARACTERS)              104000
C        LABEL(5)  ROUND TECHNIQUE CODE                                 104100
C            -1  3 SIGNIFICANT DIGITS ONLY                              104200
C             0  ROUND TO NEAREST WHOLE NUMBER                          104300
C         1 TO 5  ROUND TO NEAREST 0.1, 0.01, ETC.                      104400
C                                                                       104500
      DATA  LAB01(01),  LAB01(02),  LAB01(03),  LAB01(04),  LAB01(05),  104600
     1      LAB01(06),  LAB01(07),  LAB01(08),  LAB01(09),  LAB01(10),  104700
     2      LAB01(11),  LAB01(12),  LAB01(13),  LAB01(14),  LAB01(15),  104800
     3      LAB01(16),  LAB01(17),  LAB01(18),  LAB01(19),  LAB01(20),  104900
     4      LAB01(21),  LAB01(22),  LAB01(23),  LAB01(24),  LAB01(25)  /105000
     5  4H    , 4H    , 4HBLAN, 4HK   ,   0,                           105100
     6  4HBAR , 4H    , 4HPSI , 4H    ,   0,                           105200
     7  4HMBAR, 4H    , 4HPSI , 4H    ,  -1,                           105300
     8  4HMPA , 4H    , 4HPSI , 4H    ,   0,                           105400
     9  4HDEG , 4HC   , 4HDEG , 4HF   ,   0  /                         105500
C                                                                       105600
      DATA  LAB02(01),  LAB02(02),  LAB02(03),  LAB02(04),  LAB02(05),  105700
     1      LAB02(06),  LAB02(07),  LAB02(08),  LAB02(09),  LAB02(10),  105800
     2      LAB02(11),  LAB02(12),  LAB02(13),  LAB02(14),  LAB02(15),  105900
     3      LAB02(16),  LAB02(17),  LAB02(18),  LAB02(19),  LAB02(20),  106000
     4      LAB02(21),  LAB02(22),  LAB02(23),  LAB02(24),  LAB02(25)  /106100
     5  4HDEG , 4HTOL , 4HDEG , 4HTOL ,   0,                           106200
     6  4HN   , 4H    , 4HLBF , 4H    ,  -1,                           106300
     7  4HKN  , 4H    , 4HLBF , 4H    ,  -1,                           106400
     8  4HNM  , 4H    , 4HLB F, 4HT   ,  -1,                           106500
     9  4HGM  , 4H    , 4HOZ I, 4HNCH ,   1  /                         106600
C                                                                       106700
      DATA  LAB03(01),  LAB03(02),  LAB03(03),  LAB03(04),  LAB03(05),  106800
     1      LAB03(06),  LAB03(07),  LAB03(08),  LAB03(09),  LAB03(10),  106900
     2      LAB03(11),  LAB03(12),  LAB03(13),  LAB03(14),  LAB03(15),  107000
     3      LAB03(16),  LAB03(17),  LAB03(18),  LAB03(19),  LAB03(20),  107100
     4      LAB03(21),  LAB03(22),  LAB03(23),  LAB03(24),  LAB03(25)  /107200
     5  4HN/MM, 4H    , 4HLB/I, 4HNCH ,  -1,                           107300
     6  4HUM  , 4H    , 4HMILS, 4H    ,   1,                           107400
     7  4HCM  , 4H    , 4HINCH, 4H    ,  -1,                           107500
     8  4HDM  , 4H    , 4HINCH, 4H    ,  -1,                           107600
     9  4HM   , 4H    , 4HFT  , 4H    ,  -1  /                         107700
C                                                                       107800
      DATA  LAB04(01),  LAB04(02),  LAB04(03),  LAB04(04),  LAB04(05),  107900
     1      LAB04(06),  LAB04(07),  LAB04(08),  LAB04(09),  LAB04(10),  108000
     2      LAB04(11),  LAB04(12),  LAB04(13),  LAB04(14),  LAB04(15),  108100
     3      LAB04(16),  LAB04(17),  LAB04(18),  LAB04(19),  LAB04(20),  108200
     4      LAB04(21),  LAB04(22),  LAB04(23),  LAB04(24),  LAB04(25)  /108300
     5  4HKM  , 4H    , 4HMILE, 4H    ,   1,                           108400
     6  4HMM2 , 4H    , 4HIN2 , 4H    ,  -1,                           108500
     7  4HCM2 , 4H    , 4HIN2 , 4H    ,  -1,                           108600
     8  4HM2  , 4H    , 4HYD2 , 4H    ,   1,                           108700
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     9  4HCM3 ,  4H    ,  4HIM3 ,  4H    ,  -1  /                                  108800
C                                                                                  108900
      DATA  LAB05(01),  LAB05(02),  LAB05(03),  LAB05(04),  LAB05(05),             109000
     1      LAB05(06),  LAB05(07),  LAB05(08),  LAB05(09),  LAB05(10),             109100
     2      LAB05(11),  LAB05(12),  LAB05(13),  LAB05(14),  LAB05(15),             109200
     3      LAB05(16),  LAB05(17),  LAB05(18),  LAB05(19),  LAB05(20),             109300
     4      LAB05(21),  LAB05(22),  LAB05(23),  LAB05(24),  LAB05(25)   /          109400
     5  4HCM3 ,  4HLIQ ,  4H0Z L,  4HTQ  ,  -1,                                    109500
     6  4HDL  ,  4H    ,  4H0Z L,  4HIQ  ,   1,                                    109600
     7  4HLITR,  4HE   ,  4H0T  ,  4H    ,   1,                                    109700
     8  4HM3  ,  4H    ,  4HY03 ,  4H    ,  -1,                                    109800
     9  4HG   ,  4H    ,  4H0Z  ,  4H    ,  -1  /                                  109900
C                                                                                  110000
      DATA  LAB06(01),  LAB06(02),  LAB06(03),  LAB06(04),  LAB06(05),             110100
     1      LAB06(06),  LAB06(07),  LAB06(08),  LAB06(09),  LAB06(10),             110200
     2      LAB06(11),  LAB06(12),  LAB06(13),  LAB06(14),  LAB06(15),             110300
     3      LAB06(16),  LAB06(17),  LAB06(18),  LAB06(19),  LAB06(20),             110400
     4      LAB06(21),  LAB06(22),  LAB06(23),  LAB06(24),  LAB06(25)   /          110500
     5  4HHG  ,  4H    ,  4H0Z  ,  4H    ,   1,                                    110600
     6  4HKG  ,  4H    ,  4HLB  ,  4H    ,   1,                                    110700
     7  4HMG  ,  4H    ,  4HLB  ,  4H    ,  -1,                                    110800
     8  4HKG/M,  4H2   ,  4H0Z/Y,  4HD2  ,   0,                                    110900
     9  4HG/CM,  4H3   ,  4HG/CM,  4H3   ,   0  /                                 111000
C                                                                                  111100
      DATA  LAB07(01),  LAB07(02),  LAB07(03),  LAB07(04),  LAB07(05),             111200
     1      LAB07(06),  LAB07(07),  LAB07(08),  LAB07(09),  LAB07(10),             111300
     2      LAB07(11),  LAB07(12),  LAB07(13),  LAB07(14),  LAB07(15),             111400
     3      LAB07(16),  LAB07(17),  LAB07(18),  LAB07(19),  LAB07(20),             111500
     4      LAB07(21),  LAB07(22),  LAB07(23),  LAB07(24),  LAB07(25)   /          111600
     5  4HKG/M,  4H3   ,  4HLB/F,  4HT3  ,  -1,                                    111700
     6  4HSTOP,  4H    ,  4H    ,  4H    ,   0,                                    111800
     7  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    111900
     8  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    112000
     9  4H    ,  4H    ,  4H    ,  4H    ,   0  /                                  112100
C                                                                                  112200
      DATA  LAB08(01),  LAB08(02),  LAB08(03),  LAB08(04),  LAB08(05),             112300
     1      LAB08(06),  LAB08(07),  LAB08(08),  LAB08(09),  LAB08(10),             112400
     2      LAB08(11),  LAB08(12),  LAB08(13),  LAB08(14),  LAB08(15),             112500
     3      LAB08(16),  LAB08(17),  LAB08(18),  LAB08(19),  LAB08(20),             112600
     4      LAB08(21),  LAB08(22),  LAB08(23),  LAB08(24),  LAB08(25)   /          112700
     5  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    112800
     6  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    112900
     7  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    113000
     8  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    113100
     9  4H    ,  4H    ,  4H    ,  4H    ,   0  /                                  113200
C                                                                                  113300
      DATA  LAB09(01),  LAB09(02),  LAB09(03),  LAB09(04),  LAB09(05),             113400
     1      LAB09(06),  LAB09(07),  LAB09(08),  LAB09(09),  LAB09(10),             113500
     2      LAB09(11),  LAB09(12),  LAB09(13),  LAB09(14),  LAB09(15),             113600
     3      LAB09(16),  LAB09(17),  LAB09(18),  LAB09(19),  LAB09(20),             113700
     4      LAB09(21),  LAB09(22),  LAB09(23),  LAB09(24),  LAB09(25)   /          113800
     5  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    113900
     6  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    114000
     7  4H    ,  4H    ,  4H    ,  4H    ,   0,                                    114100
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     8  4H    , 4H    , 4H    , 4H    ,  0,                                  114200
     9  4H    , 4H    , 4H    , 4H    ,  0  /                                114300
C                                                                             114400
      DATA  LAB10(01),  LAB10(02),  LAB10(03),  LAB10(04),  LAB10(05),        114500
     1      LAB10(06),  LAB10(07),  LAB10(08),  LAB10(09),  LAB10(10),        114600
     2      LAB10(11),  LAB10(12),  LAB10(13),  LAB10(14),  LAB10(15),        114700
     3      LAB10(16),  LAB10(17),  LAB10(18),  LAB10(19),  LAB10(20),        114800
     4      LAB10(21),  LAB10(22),  LAB10(23),  LAB10(24),  LAB10(25)  /      114900
     5  4H    , 4H    , 4H    , 4H    ,  0,                                  115000
     6  4H    , 4H    , 4H    , 4H    ,  0,                                  115100
     7  4H    , 4H    , 4H    , 4H    ,  0,                                  115200
     8  4H    , 4H    , 4H    , 4H    ,  0,                                  115300
     9  4H    , 4H    , 4H    , 4H    ,  0  /                                115400
C                                                                             115500
C     TABLE(2, 50)  -  ARRAY FOR CONVERSION FACTORS AND ROUNDING UNITS        115600
C        WORD 1  -  CONVERSION FACTOR  ( 5 SIGNIFICANT FIGURES )              115700
C        WORD 2  -  ROUNDING UNIT  ( 5 SIGNIFICANT FIGURES )                  115800
C                                                                             115900
      DATA  TBL1(01),  TBL1(02),  TBL1(03),  TBL1(04),  TBL1(05),             116000
     1      TBL1(06),  TBL1(07),  TBL1(08),  TBL1(09),  TBL1(10),             116100
     2      TBL1(11),  TBL1(12),  TBL1(13),  TBL1(14),  TBL1(15),             116200
     3      TBL1(16),  TBL1(17),  TBL1(18),  TBL1(19),  TBL1(20),             116300
     4      TBL1(21),  TBL1(22),  TBL1(23),  TBL1(24),  TBL1(25)  /           116400
     5   0.0,      0.0,      14.504,   1.0,      0.014504,                    116500
     6   0.0,      145.04,   1.0,      -1.8,     1.0,                         116600
     7   1.8,      1.0,      0.22481,  0.0,      224.81,                      116700
     8   0.0,      0.73756,  0.0,      1.3887,   0.1,                         116800
     9   5.7101,   0.0,      0.03937,  0.1,      0.3937  /                    116900
C                                                                             117000
      DATA  TBL2(01),  TBL2(02),  TBL2(03),  TBL2(04),  TBL2(05),             117100
     1      TBL2(06),  TBL2(07),  TBL2(08),  TBL2(09),  TBL2(10),             117200
     2      TBL2(11),  TBL2(12),  TBL2(13),  TBL2(14),  TBL2(15),             117300
     3      TBL2(16),  TBL2(17),  TBL2(18),  TBL2(19),  TBL2(20),             117400
     4      TBL2(21),  TBL2(22),  TBL2(23),  TBL2(24),  TBL2(25)  /           117500
     5   0.0,      3.937,    0.0,      3.2808,   0.0,                         117600
     6   0.62137,  0.1,      0.00155,  0.0,      0.155,                       117700
     7   0.0,      1.1960,   0.1,      0.061024, 0.0,                         117800
     8   0.03381,  0.0,      3.381,    0.1,      1.0567,                      117900
     9   0.1,      1.3080,   0.0,      0.035274, 0.0  /                       118000
C                                                                             118100
      DATA  TBL3(01),  TBL3(02),  TBL3(03),  TBL3(04),  TBL3(05),             118200
     1      TBL3(06),  TBL3(07),  TBL3(08),  TBL3(09),  TBL3(10),             118300
     2      TBL3(11),  TBL3(12),  TBL3(13),  TBL3(14),  TBL3(15),             118400
     3      TBL4(16),  TBL4(17),  TBL4(18),  TBL4(19),  TBL4(20),             118500
     4      TBL3(21),  TBL3(22),  TBL3(23),  TBL3(24),  TBL3(25)  /           118600
     5   3.5274,   0.1,      2.2046,   0.1,      2204.6,                      118700
     6   0.0,      28.494,   1.0,      1.0,      1.0,                         118800
     7   0.062428, 0.0,      0.0,      0.0,      0.0,                         118900
     8   0.0,      0.0,      0.0,      0.0,      0.0,                         119000
     9   0.0,      0.0,      0.0,      0.0,      0.0  /                       119100
C                                                                             119200
      DATA  TBL4(01),  TBL4(02),  TBL4(03),  TBL4(04),  TBL4(05),             119300
     1      TBL4(06),  TBL4(07),  TBL4(08),  TBL4(09),  TBL4(10),             119400
     2      TBL4(11),  TBL4(12),  TBL4(13),  TBL4(14),  TBL4(15),             119500
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     3       TBL3(16),  TBL3(17),  TBL3(18),  TBL3(19),  TBL3(20),          119600
     4       TBL4(21),  TBL4(22),  TBL4(23),  TBL4(24),  TBL4(25)  /        119700
     5   0.0,       0.0,       0.0,       0.0,       0.0,                   119800
     6   0.0,       0.0,       0.0,       0.0,       0.0,                   119900
     7   0.0,       0.0,       0.0,       0.0,       0.0,                   120000
     8   0.0,       0.0,       0.0,       0.0,       0.0,                   120100
     9   0.0,       0.0,       0.0,       0.0,       0.0  /                 120200
C                                                                           120300
      DATA  NLSAVE  /  32  /                                                120400
C                                                                           120500
      DATA  NUMLAB  /  32  /                                                120600
C                                                                           120700
      DATA  ISTOP(1),  ISTOP(2),  ISTOP(3),  ISTOP(4)  /                    120800
     1      1H$,  1HE,  1HO,  1HP  /                                        120900
C                                                                           121000
      DATA  IBLANK  /  4H      /                                            121100
C                                                                           121200
      END                                                                   121300
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9S9721   13.                                                  SAMPLE 1   121700
.85      GRAM                                                            121800
8.5      LITRE                                                           121900
14.      LITRE                                                           122000
17.      LITRE                                                           122100
22.5     LITRE                                                           122200
-31.5    DEG C                                                           122300
2.0      DEG TOL                                                         122400
-40.0    DEG C                                                           122500
29.5     LITRE                                                           122600
34.      LITRE                                                           122700
170.     LITRE                                                           122800
65.5     LITRE                                                           122900
68.      LITRE                                                           123000
75.      LITRE                                                           123100
75.5     LITRE                                                           123200
3060.    GRAM                                                            123300
106.     LITRE                                                           123400
148.     LITRE                                                           123500
519.     LITRE                                                           123600
         STOP                                                            123700
3F1341   15          1.0       4.0       2.0                SAMPLE 2   123800
1000.    MPA         100.      0.                                       123900
100.     DEG C       3.                                                 124000
19.35    N/MM        .35                                                124100
.0025                 .621                47.33                        124200
77.0                  85.0                154.0                        124300
2.       BAR         .4                                                 124400
4.       LITRE       .1                                                 124500
2.       KM          .1                                                 124600
20.      DEG C       2.                                                 124700
10.      N M         2.                                                 124800
5.6                                                                     124900
35.      ML                                                             125000
30.860               0.013                                              125100
5.6                                                                     125200
14.25                .5                                                 125300
1.5                                                                     125400
11.00                                                                   125500
75.0     REF                                                            125600
5.       DEG TOL     7.0       DEG TOL   20.00      DEG TOL            125700
2.0      ML          1.5       ML                                       125800
3.0      ML                                                             125900
5.0      ML                                                             126000
-31.5    DEG C                                                          126100
-40.0    DEG C                                                          126200
2.0      DEG TOL                                                        126300
P-.0     DEG TOL                                                        126400
4.0      DEG TOL                                                        126500
8.0      ML                                                             126600
12.0     ML                                                             126700
2.0      KM                                                             126800
3.0      KM                                                             126900
8.0      KM                                                             127000
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11.25     KM                                                                  127100
22.55     KM                                                                  127200
22.0                                                                          127300
17.50                                                                         127400
50.       KG                                                                  127500
10.       N                                                                   127600
57.0                                                                          127700
2.40      A                                                                   127800
128.0                                                                         127900
38.10                                                                         128000
32.0                                                                          128100
447.22    DEEP      12.25     -12.00+                                         128200
25.17                                                                         128300
21.8                                                                          128400
20.83                                                                         128500
19.8                                                                          128600
16.0                                                                          128700
6.35                                                                          128800
1.5                                                                           128900
.76                                                                           129000
50.0                                                                          129100
17.0              0.5                                                         129200
18.0              0.05                                                        129300
19.0              0.051                                                       129400
19.0              0.0505                                                      129500
          STOP                                                                129600
9S3184    01        1.0       3.0       2.0       2.0       1.0       SAMPLE 3  129700
METER     INCH                139.37      0.1                                 129800
DECA M    INCH                1393.7    0.1                                   129900
57.0                                                                          130000
5.6                                                                           130100
19.35     N/MM                                                                130200
30.860            0.013                                                       130300
5.6                                                                           130400
200.0     DM                                                                  130500
300.0     CM                                                                  130600
400.0     HG                                                                  130700
500.0     DL                                                                  130800
135.44    N/MM                                                                130900
14.25             .5                                                          131000
7.0       DECA M  7.6       METER                                             131100
1.5                                                                           131200
11.00                                                                         131300
12.35     GAGE                                                                131400
75.0      REF        1000.00            1100.0                                131500
20.0      DEG C                                                               131600
10.0      G                                                                   131700
0.01      MPA                                                                 131800
12                                                                            131900
12.                                                                           132000
012                                                                           132100
00123                                                                         132200
2.25              4.68              8.9                                       132300
13.1              15.22             23.35                                     132400
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27.691              29.9                31.0                                    132500
36.6                40.15               44.44                                   132600
52.2                54.755              69.75                                   132700
81.15               85.65               405.0                                   132800
0123.5                                                                          132900
1200.               1300.               1400.                                   133000
1600.               1700.               1800.                                   133100
22.0                                                                            133200
17.50                                                                           133300
50.       KG                                                                    133400
10.       N                                                                     133500
35.       ML                                                                    133600
4.        LITRE                                                                 133700
-100.22+                                                                        133800
2.        BAR                                                                   133900
10.       N.Y                                                                   134000
2.        KM                                                                    134100
50.0                                                                            134200
123.0                                                                           134300
38.10                                                                           134400
32.0                                                                            134500
25.17                                                                           134600
21.8                                                                            134700
20.83                                                                           134800
19.8                                                                            134900
16.0                                                                            135000
6.35                                                                            135100
1.5                                                                             135200
.76                                                                             135300
17.0                0.5                                                         135400
18.0                0.05                                                        135500
19.0                0.051                                                       135600
19.0                0.0505                                                      135700
          STOP                                                                  135800
6Se878    0                   2.0         1.0         2.0         SAMPLE 4      135900
MJ/KWH    BTU/HPHR        -1706.79        1.0                                   136000
KG/H      POUND/HR        -12.2046        0.25                                  136100
9.52      REF                                                                   136200
9.40                0.05                                                        136300
12.5                1.5                                                         136400
70.0                                                                            136500
28.0                                                                            136600
325.0                                                                           136700
265.0                                                                           136800
220.0                                                                           136900
160.0                                                                           137000
66.0                                                                            137100
47.0                                                                            137200
18.0                                                                            137300
34.0                                                                            137400
90.0                                                                            137500
140.0                                                                           137600
.0001               .0002               .0003                                   137700
.0004               .0005               .0006                                   137800
```

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.0007                .0008                .0009                                  137900
.0010                .001                 .002                                   138000
.003                 .004                 .005                                   138100
.006                 .007                 .008                                   138200
.009                 .010                 .01                                    138300
.02                  .03                  .04                                    138400
.05                  .06                  .07                                    138500
.08                  .09                  .10                                    138600
.1                   .2                   .3                                     138700
.4                   .5                   .6                                     138800
.7                   .8                   .9                                     138900
1.0                  .5        KG/H       1.0       KG/H                         139000
25        KG/H       17        KG/H       75        MJ/KWH                       139100
17.5      MK/KWH                                                                 139200
17.5      MJ/KWH                                                                 139300
850.001              850.002              850.003                                139400
850.004              850.005              850.006                                139500
850.007              850.008              850.009                                139600
165.0                                                                           139700
19.0                                                                            139800
701.0                                                                           139900
42.5                                                                            140000
81.0                                                                            140100
23.6                                                                            140200
259.0                                                                           140300
37.7                                                                            140400
41.2                                                                            140500
56.7                                                                            140600
725.      REF                                                                   140700
10.5      BAR                                                                   140800
.125      MPA        0.0     DEG C     5.0       DEG TOL                        140900
100.0     N          100.0   N M       200.0     G M                            141000
55.55     N/MM       1000.00 UM        10.50     C                              141100
10.00     DM         100.0   KM        10000.    M2                             141200
100.0     CM2        120.    M2        100.0     CM3                            141300
545.0     CM3 LTO    25.     DL                                                  141400
100.      LITRE      100     M3        100       G                              141500
10.05     HG         10.005  KG        10.       KG/M2                          141600
5.0       G/CM3      1000.0  KG/M3                                              141700
A12.358                                                                         141800
          STOP                                                                  141900
9M7107    35.                                                 SAMPLE 5          142000
85.       GRAM                                                                  142100
4.5       LITRE                                                                 142200
          ADD                                                                   142300
5.5       LITRE                                                                 142400
8.5       LITRE                                                                 142500
14.       LITRE                                                                 142600
17.       LITRE                                                                 142700
22.5      LITRE                                                                 142800
98.5      LITRE                                                                 142900
24.5      LITRE                                                                 143000
29.5      LITRE                                                                 143100
48.5      LITRE                                                                 143200
```

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51.       LITRE                                                                  143300
53.       LITRE                                                                  143400
81.5      LITRE                                                                  143500
2780.     GRAM                                                                   143600
322.      LITRE                                                                  143700
368.      LITRE                                                                  143800
          STOP                                                                   143900
9A3099    0.                  1.0       1.0                 1.0       SAMPLE 6   144000
0.5                                                                              144100
100.0                                                                            144200
47.55                                                                            144300
50.00                                                                            144400
16.45                                                                            144500
40.45                                                                            144600
29.39                                                                            144700
8.20                                                                             144800
0.25                                                                             144900
7.0                                                                              145000
120.0                                                                            145100
0.8                                                                              145200
11.1                                                                             145300
50.0                                                                             145400
57.15                                                                            145500
0.02                                                                             145600
480.      MPA                                                                    145700
          STOP                                                                   145800
9S3144    1                   4.0       2.0       1.0       SAMPLE 7           145900
METRE     INCH              139.37       0.1                                   146000
57.0                                                                             146100
5.6                                                                              146200
19.35     N/MM                                                                   146300
30.860              0.013                                                        146400
5.6                                                                              146500
200.0     DM                                                                     146600
300.0     CM                                                                     146700
400.0     HG                                                                     146800
500.0     DL                                                                     146900
1000.0    MPA       10.0      MPA       5.0       DEKA M                       147000
10.0                 0.1                                                         147100
1.00                 1.0                 2.55                                    147200
135.44    N/MM                                                                   147300
14.25                .5                                                          147400
1.5                                                                              147500
11.00                                                                            147600
75.0      REF        1000.00              1100.0                                 147700
1.00                 1200.0               1300.0                                 147800
10.0                 0.1                                                         147900
20.0      DEG C                                                                  148000
10.0      G                                                                      148100
0.01      MPA                                                                    148200
12                                                                               148300
12.                                                                              148400
012                                                                              148500
00123                                                                            148600
```

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0123.5                                                                  148700
18.95     MAX                                                           148800
.05       MIN                                                           148900
1.65      1E526                                                         149000
22.0                                                                    149100
17.50                                                                   149200
10.       N                                                             149300
50.       KG                                                            149400
35.       ML                                                            149500
4.        LITRE                                                         149600
-100.22+                                                                149700
2.        BAR                                                           149800
2.        KM                                                            149900
50.0                                                                    150000
128.0                                                                   150100
38.10                                                                   150200
32.0                                                                    150300
25.17                                                                   150400
21.8                                                                    150500
20.83                                                                   150600
19.8                                                                    150700
16.0                                                                    150800
6.35                                                                    150900
5.0       DECA M                                                        151000
0.5       KG/H      1.0       KG/H      10.0      MJ/KWH                151100
1.5                                                                     151200
.76                                                                     151300
37.00     BSC                                                           151400
17.0                0.5                                                 151500
18.0                0.05                                                151600
19.0                0.051                                               151700
19.0                0.0505                                              151800
17.00               0.08                0.03                            151900
19.0                0.049                                               152000
19.0                0.05                                                152100
10.       NM        17.88     NM        25.55     NM                    152200
12.5      M3        55.55     M3        101.      M3                    152300
5.        CM3       10.00     CM3       15.55     CM3                   152400
100000.   MPA       100.                50.                             152500
1100.     MPA       15.                 3.0                             152600
0.001               0.00001             0.00002                         152700
100.0     DEGREF C   5.0                                                152800
10.0      GM        20.0      GM        100.0     GM                    152900
100.0     ML        1.1       MM2                                       153000
100.0     DEG C     5.0       DEG TOL                                   153100
15.88                                                                   153200
11.25                                                                   153300
6.625                                                                   153400
3.75                                                                    153500
3.623                                                                   153600
.12                                                                     153700
7.50                                                                    153800
1.00                                                                    153900
1.56                                                                    154000
```

3.50	154100
1.00	154200
.812	154300
1.38	154400
7.75	154500
5.75	154600
3.875	154700
1.81	154800
2.06	154900
.56	155000
9.25	155100
20.125	155200
2.00	155300
.88	155400
.75	155500
3.62	155600
5.88	155700
.50	155800
6.00	155900
.62	156000
.19	156100
18.50	156200
2.12	156300
1.25	156400
.010	156500
.15	156600
.06	156700
.25	156800
4.75	156900
1.875	157000
.81	157100
1.12	157200
.718	157300
.7417	157400
.0008	157500
.88	157600
9.25	157700
4.00	157800
2.69	157900
1.75	158000
15.50	158100
20.125	158200
27.500	158300
74.250	158400
3.75	158500
1.88	158600
1.16	158700
.38	158800
1.56	158900
5.00	159000
17.00	159100
8.00	159200
5.62	159300
.040	159400

```
1.575                                                                   159500
.812                                                                    159600
.781                                                                    159700
.31                                                                     159800
13.40                                                                   159900
12.50                                                                   160000
7.365                                                                   160100
2.50                                                                    160200
2.88                                                                    160300
2.12                                                                    160400
1.85                                                                    160500
1.25                                                                    160600
1.19                                                                    160700
2.50                                                                    160800
.020                                                                    160900
3.38                                                                    161000
1.62                                                                    161100
3.06                                                                    161200
.44                                                                     161300
.22                                                                     161400
4.50                                                                    161500
2.75                                                                    161600
2.62                                                                    161700
1.06                                                                    161800
.06                                                                     161900
5.12                                                                    162000
.82                                                                     162100
4.88                                                                    162200
5.69                                                                    162300
7.00                                                                    162400
.25                                                                     162500
.21                                                                     162600
.44                                                                     162700
63.5                    1.3                                             162800
1020.0                  13.0                                            162900
1025.0                  13.0                                            163000
559.0                                                                   163100
762.0                                                                   163200
1270.0                                                                  163300
915.0                                                                   163400
1829.0                                                                  163500
5335.0                                                                  163600
5080.0                                                                  163700
54.0        DM                                                          163800
51.0        DM                                                          163900
1473.0                                                                  164000
1524.0                                                                  164100
1535.0                                                                  164200
16.0        DM                                                          164300
15.         DM                                                          164400
60.8                                                                    164500
40.0                                                                    164600
6.9                                                                     164700
14.0                                                                    164800
```

```
3.0                                                                  164900
4.0                                                                  165000
46.0                                                                 165100
2.0                                                                  165200
20.0                                                                 165300
26.0                                                                 165400
16.0                                                                 165500
7.0                                                                  165600
3.05              0.25                                               165700
6.4                                                                  165800
3.05              0.25                                               165900
14.0                                                                 166000
20.0                                                                 166100
8.0                                                                  166200
4.0                                                                  166300
15.0                                                                 166400
12.0                                                                 166500
20.0                                                                 166600
41.0                                                                 166700
580.0             7.0                                                166800
2.46                                                                 166900
2.57                                                                 167000
3.02                                                                 167100
3.07                                                                 167200
2.74                                                                 167300
54.23                                                                167400
2.77                                                                 167500
2.82                                                                 167600
2.74                                                                 167700
53.82                                                                167800
41.0                                                                 167900
38.0                                                                 168000
9.5                                                                  168100
73.0                                                                 168200
67.0                                                                 168300
40.0                                                                 168400
32.0                                                                 168500
25.0                                                                 168600
6.0                                                                  168700
3.0                                                                  168800
19.0                                                                 168900
14.0                                                                 169000
57.0                                                                 169100
45.0                                                                 169200
.79               .15                                                169300
5.0                                                                  169400
        STOP                                                         169500
6J3135  NBS                                          SAMPLE 8        169600
198.431           19843.1     1984.33                                169700
198.432           19843.2     19843.8                                169800
198.433           19843.3     764.3     MPA                          169900
198.434           19843.4     764.4     DEG C                        170000
198.435           19843.5     764.5     DEG TOT                      170100
198.436           19843.6     764.6     N                            170200
```

```
198.437          19843.7          764.7    KN                          170300
198.438          19843.8          764.8    MN                          170400
198.439          19843.9          764.9    GN                          170500
198.440          19844.0          765.0    N/MM                        170600
1984.31          764.21   UM      76.1     KG                          170700
1984.32          764.22   CM      76.2     MG                          170800
1984.33          764.23   DM      76.3     KG/M2                       170900
1984.34          764.24   M       76.4     G/CM3                       171000
1984.35          764.25   KM      76.5     KG/M3                       171100
1984.36          764.26   MM2     764.1    BAR                         171200
1984.37          764.27   CM2     764.2    MBAR                        171300
1984.38          764.28   M2      764.5    DEG TOT                     171400
1984.39          764.29   CM3                                          171500
1984.40          764.30   CM3 LIQ                                      171600
76.1     DL      764.3    MPA     35.0     DEGC                        171700
76.2     LITRE   764.4    DEGC                                         171800
76.3     M3                                                            171900
76.4     G                         7.61     BAR                         172000
76.5     HG                                                            172100
         STOP                                                          172200
1X1111   0                                                SAMPLE 9     172400
.002             .025              .254                                172500
2.540            25.40             254.                                172600
25.400           25.4              254.0                               172700
2540.            25400.            2541.                               172800
         STOP                                                          172900
2X2222   0                                                SAMPLE 10    173000
25.4             27.94             25.65                               173100
25.43            25.003            25.0003                             173200
25.43            25.403            25.4003                             173300
         STOP                                                          173400
3X3333   0                                                SAMPLE 11    173500
25.4             26.84             27.33                               173600
27.40            27.411            27.4122                             173700
27.41233                                                               173800
         STOP                                                          173900
4X4444   0                                                SAMPLE 12    174000
25.4             27.94             28.45                               174100
28.52            28.534            28.5356                             174200
28.53578                                                               174300
         STOP                                                          174400
$EOP                                                                   174500
```

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
9S9721	13.	0	1	1	0		SAMPLE 1

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
.85	GRAM	ILLEGAL IDENTIFIER
3060.	GRAM	ILLEGAL IDENTIFIER

PART 9S9721 CHANGE 13.

DIM	UNITS	DIM	UNITS
-40.0	DEG C	-40.	DEG F
-31.5	DEG C	-25.	DEG F
2.0	DEG TOL	4.	DEG TOL
8.5	LITRE	9.0	QT
14.	LITRE	14.8	QT
17.	LITRE	18.0	QT
22.5	LITRE	23.8	QT
29.5	LITRE	31.2	QT
34.	LITRE	35.9	QT
65.5	LITRE	69.2	QT
68.	LITRE	71.9	QT
75.	LITRE	79.3	QT
75.5	LITRE	79.8	QT
106.	LITRE	112.	QT
148.	LITRE	156.	QT
170.	LITRE	180.	QT
519.	LITRE	548.	QT

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
3F1341	15	1.0	4.0	2.0	0		SAMPLE 2

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
100.	0.	ILLEGAL IDENTIFIER
10.	N M	ILLEGAL IDENTIFIER
35.	ML	ILLEGAL IDENTIFIER
75.0	REF	ILLEGAL IDENTIFIER
2.0	ML	ILLEGAL IDENTIFIER
1.5	ML	ILLEGAL IDENTIFIER
3.0	ML	ILLEGAL IDENTIFIER
5.0	ML	ILLEGAL IDENTIFIER
P-.0	DEG TOL	ILLEGAL CHARACTER IN DIMENSION
8.0	ML	ILLEGAL IDENTIFIER
12.0	ML	ILLEGAL IDENTIFIER
2.40	A	ILLEGAL IDENTIFIER
447.22	DEEP	ILLEGAL IDENTIFIER
12.25	-12.00+	ILLEGAL IDENTIFIER

PART 3F1341 CHANGE 15

MM	INCH	MM	INCH	MM	INCH	MM	INCH
.0025	.00010	.76	.030	17.50	.689	38.10	1.500
.013	.0005	1.5	.059	18.0	.709	47.33	1.863
.05	.002	2.	.079	19.0	.748	50.0	1.969
.0505	.00199	3.	.118	19.8	.780	57.0	2.244
.051	.0020	5.6	.220	20.83	.820	77.0	3.031
.1	.004	6.35	.250	21.8	.858	85.0	3.346
.35	.014	11.00	.433	22.0	.866	128.0	5.039
.4	.016	14.25	.561	25.17	.991	154.0	6.063
.5	.020	16.0	.630	30.860	1.2150		
.621	.0244	17.0	.669	32.0	1.260		

PART 3F1341 CHANGE 15

DIM	UNITS	DIM	UNITS	DIM	UNITS	DIM	UNITS
2.	BAR	29.	PSI	10.	N	2.25	LBF
1000.	MPA	145000.	PSI	19.35	N/MM	110.	LB/INCH
-40.0	DEG C	-40.	DEG F	2.0	KM	1.2	MILE
-31.5	DEG C	-25.	DEG F	2.	KM	1.2	MILE
20.	DEG C	68.	DEG F	3.0	KM	1.9	MILE
100.	DEG C	212.	DEG F	8.0	KM	5.0	MILE
2.0	DEG TOL	4.	DEG TOL	11.25	KM	7.0	MILE
4.0	DEG TOL	7.	DEG TOL	22.55	KM	14.0	MILE
5.	DEG TOL	9.	DEG TOL	4.	LITRE	4.2	QT
7.0	DEG TOL	13.	DEG TOL	50.	KG	110.	LB
20.00	DEG TOL	36.	DEG TOL				

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
9S3184	01	1.0	3.0	2.0	2.0	1.0	SAMPLE 7

NUMBER OF ENTRIES IN CONVERSION TABLE = 32

IDENTIFIER IN	IDENTIFIER OUT	ROUND TECHNIQUE	CONVERSION FACTOR	ROUNDING UNIT	
BAR	PSI	0	14.50400	1.00000	
MBAR	PSI	-1	.01450	.00000	
MPA	PSI	0	145.04000	1.00000	
DEG C	DEG F	0	-1.80000	1.00000	
DEG TOL	DEG TOL	0	1.80000	1.00000	
N	LBF	-1	.22481	.00000	
KN	LBF	-1	224.81000	.00000	
NM	LB FT	-1	.73756	.00000	
GM	OZ INCH	1	1.38870	.10000	
N/MM	LB/INCH	-1	5.71010	.00000	
UM	MILS	1	.03937	.10000	
CM	INCH	-1	.33370	.00000	
DM	INCH	-1	3.93700	.00000	
M	FT	-1	3.28080	.00000	
KM	MILE	1	.62137	.10000	
MM2	IN2	-1	.00155	.00000	
CM2	IN2	-1	.15500	.00000	
M2	YD2	1	1.19600	.10000	
CM3	IN3	-1	.06102	.00000	
CM3 LIQ	OZ LIQ	-1	.03381	.00000	
DL	OZ LIQ	1	3.38100	.10000	
LITRE	QT	1	1.05670	.10000	
M3	YD3	-1	1.30800	.00000	
G	OZ	-1	.03527	.00000	
HG	OZ	1	3.52740	.10000	
KG	LB	1	2.20460	.10000	
MG	LB	-1	2204.60201	.00000	
KG/M2	OZ/YD2	0	29.49400	1.00000	
G/CM3	G/CM3	0	1.00000	1.00000	
KG/M3	LB/FT3	-1	.06243	.00000	
METER	INCH	1	39.37000	.10000	**** THIS IS A TEMPORARY ENTRY ****
DECA M	INCH	1	393.70000	.10000	**** THIS IS A TEMPORARY ENTRY ****

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
12.35	GAGE	ILLEGAL IDENTIFIER
75.0	REF	ILLEGAL IDENTIFIER
35.	ML	ILLEGAL IDENTIFIER
-100.22+		ILLEGAL CHARACTER IN DIMENSION
10.	N M	ILLEGAL IDENTIFIER

PART 9S3184 CHANGE 01

MM	INCH	MM	INCH	MM	INCH
.013	.0005	17.50	.689	52.2	2.055
.05	.002	18.0	.709	54.755	2.1557
.0505	.00199	19.0	.748	57.0	2.244
.051	.0020	19.8	.780	69.75	2.746
.5	.020	20.83	.820	81.15	3.195
.76	.030	21.8	.858	85.65	3.372
1.5	.059	22.0	.866	123.	4.843
2.25	.089	23.35	.919	123.5	4.862
4.68	.184	25.17	.991	128.0	5.039
5.6	.220	27.691	1.0902	405.0	15.945
6.35	.250	29.9	1.177	1000.00	39.370
8.9	.350	30.860	1.2150	1100.0	43.307
11.00	.433	31.0	1.220	1200.	47.244
12.	.472	32.0	1.260	1300.	51.181
13.1	.516	36.0	1.417	1400.	55.118
14.25	.561	38.10	1.500	1600.	62.992
15.22	.599	40.15	1.581	1700.	66.929
16.0	.630	44.44	1.750	1800.	70.866
17.0	.669	50.0	1.969		

PART 9S3184 CHANGE 01

DIM	UNITS	DIM	UNITS	DIM	UNITS	DIM	UNITS
2.	BAR	29.	PSI	2.	KM	1.2	MILE
.01	MPA	1.	PSI	500.0	DL	1600.	OZ LIQ
20.0	DEG C	68.	DEG F	4.	LITRE	4.2	QT
10.	N	2.25	LBF	10.0	G	.353	OZ
19.35	N/MM	110.	LB/INCH	400.0	HG	1410.	OZ
135.44	N/MM	773.	LB/INCH	50.	KG	110.	LB
300.0	CM	118.	INCH	7.6	METER	299.	INCH
200.0	DM	787.	INCH	7.0	DECA M	2760.	INCH

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
656878	0	0	2.0	1.0	2.0		SAMPLE 4

NUMBER OF ENTRIES IN CONVERSION TABLE = 34

IDENTIFIER IN	IDENTIFIER OUT	ROUND TECHNIQUE	CONVERSION FACTOR	ROUNDING UNIT	
BAR	PSI	0	14.50400	1.00000	
MBAR	PSI	-1	.01450	.00000	
MPA	PSI	0	145.04000	1.00000	
DEG C	DEG F	0	-1.80000	1.00000	
DEG TOL	DEG TOL	0	1.80000	1.00000	
N	LBF	-1	.22481	.00000	
KN	LBF	-1	224.81000	.00000	
NM	LB FT	-1	.73756	.00000	
GM	OZ INCH	1	1.38870	.10000	
N/MM	LB/INCH	-1	5.71010	.00000	
UM	MILS	1	.03937	.10000	
CM	INCH	-1	.39370	.00000	
DM	INCH	-1	3.93700	.00000	
M	FT	-1	3.28090	.00000	
KM	MILE	1	.62137	.10000	
MM2	IN2	-1	.00155	.00000	
CM2	IN2	-1	.15500	.00000	
M2	YD2	1	1.19600	.10000	
CM3	IN3	-1	.06102	.00000	
CM3 LIQ	OZ LIQ	-1	.03381	.00000	
DL	OZ LIQ	1	3.38100	.10000	
LITRE	QT	1	1.05670	.10000	
M3	YD3	-1	1.30800	.00000	
G	OZ	-1	.03527	.00000	
HG	OZ	1	3.52740	.10000	
KG	LB	1	2.20460	.10000	
MG	LB	-1	2204.60001	.00000	
KG/M2	OZ/YD2	0	29.49400	1.00000	
G/CM3	G/CM3	0	1.00000	1.00000	
KG/M3	LB/FT3	-1	.06243	.00000	
METER	INCH	1	39.37000	.10000	**** THIS IS A TEMPORARY ENTRY ****
DECA M	INCH	1	393.70000	.10000	**** THIS IS A TEMPORARY ENTRY ****
MJ/KWH	BTU/HPHR	-1	706.73000	1.00000	**** THIS IS A TEMPORARY ENTRY ****
KG/H	POUND/HR	-1	2.20462	.25000	**** THIS IS A TEMPORARY ENTRY ****

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
9.52	REF	ILLEGAL IDENTIFIER
17.5	MK/KWH	ILLEGAL IDENTIFIER
725.	REF	ILLEGAL IDENTIFIER
100.0	N M	ILLEGAL IDENTIFIER

200.0	G M	ILLEGAL IDENTIFIER
A12.35B		ILLEGAL CHARACTER IN DIMENSION

PART 656878 CHANGE 0

MM	INCH	MM	INCH
.0001	0	.8	.031
.0002	.00001	.9	.035
.0003	.00001	1.0	.039
.0004	.00002	1.5	.059
.0005	.00002	9.40	.370
.0006	.00002	12.5	.492
.0007	.00003	18.0	.709
.0008	.00003	19.0	.748
.0009	.00004	23.6	.929
.001	0	28.0	1.102
.0010	.00004	34.0	1.339
.002	.0001	37.7	1.484
.003	.0001	41.2	1.622
.004	.0002	42.5	1.673
.005	.0002	47.0	1.850
.006	.0002	56.7	2.232
.007	.0003	66.0	2.598
.008	.0003	70.0	2.756
.009	.0004	81.0	3.189
.010	.0004	90.0	3.543
.01	0	140.0	5.512
.02	.001	160.0	6.299
.03	.001	165.0	6.496
.04	.002	220.0	8.661
.05	.002	259.0	10.197
.06	.002	265.0	10.433
.07	.003	325.0	12.795
.08	.003	701.0	27.598
.09	.004	850.001	33.4646
.10	.004	850.002	33.4646
.1	.004	850.003	33.4647
.2	.008	850.004	33.4647
.3	.012	850.005	33.4648
.4	.016	850.006	33.4648
.5	.020	850.007	33.4648
.6	.024	850.008	33.4649
.7	.028	850.009	33.4649

PART 6S6878 CHANGE 0

DIM	UNITS	DIM	UNITS
10.5	BAR	152.	PSI
.125	MPA	18.	PSI
0	DEG C	32.	DEG F
5.0	DEG TOL	9.	DEG TOL
100.0	N	22.5	LBF
55.55	N/MM	317.	LB/INCH
1000.00	UM	39.4	MILS
10.50	CM	4.13	INCH
10.00	DM	39.4	INCH
100.0	KM	62.1	MILE
10000.	MM2	15.5	IN2
100.0	CM2	15.5	IN2
120.	M2	144.	YD2
100.0	CM3	6.10	IN3
545.0	CM3 LIQ	18.4	OZ LIQ
25.	DL	84.5	OZ LIQ
100.	LITRE	106.	QT
100.	M3	131.	YD3
100.	G	3.53	OZ
10.05	HG	35.5	OZ
10.005	KG	22.1	LB
10.	KG/M2	295.	OZ/YD2
5.0	G/CM3	5.	G/CM3
1000.0	KG/M3	62.4	LB/FT3
17.5	MJ/KWH	12400.	BTU/HPHR
75.	MJ/KWH	53000.	BTU/HPHR
.5	KG/H	1.000	POUND/HR
1.0	KG/H	2.25	POUND/HR
17.	KG/H	37.5	POUND/HR
25.	KG/H	55.0	POUND/HR

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
9M7107	35.	0	1	1	0		SAMPLE 5

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
85.	GRAM	ILLEGAL IDENTIFIER
	ADD	ILLEGAL IDENTIFIER
2780.	GRAM	ILLEGAL IDENTIFIER

PART 9M7107 CHANGE 35.

DIM	UNITS	DIM	UNITS
4.5	LITRE	4.8	QT
5.5	LITRE	5.8	QT
8.5	LITRE	9.0	QT
14.	LITRE	14.8	QT
17.	LITRE	18.0	QT
22.5	LITRE	23.8	QT
24.5	LITRE	25.9	QT
29.5	LITRE	31.2	QT
48.5	LITRE	51.2	QT
51.	LITRE	53.9	QT
53.	LITRE	56.0	QT
81.5	LITRE	86.1	QT
98.5	LITRE	104.	QT
322.	LITRE	340.	QT
368.	LITRE	389.	QT

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
9A3099	0	0	1.0	1.0	0	1.0	SAMPLE 6

PART 9A3099 CHANGE 0

MM	INCH
.02	.001
.25	.010
.5	.020
.8	.031
7.0	.276
8.20	.323
11.1	.437
16.45	.648
29.39	1.157
40.45	1.593
47.55	1.872
50.0	1.969
50.00	1.969
57.15	2.250
100.0	3.937
120.0	4.724

PART 9A3099 CHANGE 0

DIM	UNITS	DIM	UNITS
480.	MPA	69600.	PSI

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
953144	1	0	4.0	2.0	1.0		SAMPLE 7

NUMBER OF ENTRIES IN CONVERSION TABLE = 35

IDENTIFIER IN	IDENTIFIER OUT	ROUND TECHNIQUE	CONVERSION FACTOR	ROUNDING UNIT	
BAR	PSI	0	14.50400	1.00000	
MBAR	PSI	-1	.01450	.00000	
MPA	PSI	0	145.04000	1.00000	
DEG C	DEG F	0	-1.80000	1.00000	
DEG TOL	DEG TOL	0	1.80000	1.00000	
N	LBF	-1	.22481	.00000	
KN	LBF	-1	224.81000	.00000	
NM	LB FT	-1	.73756	.00000	
GM	OZ INCH	1	1.38870	.10000	
N/MM	LB/INCH	-1	5.71010	.00000	
UM	MILS	1	.03937	.10000	
CM	INCH	-1	.39370	.00000	
DM	INCH	-1	3.93700	.00000	
M	FT	-1	3.28080	.00000	
KM	MILE	1	.62137	.10000	
MM2	IN2	-1	.00155	.00000	
CM2	IN2	-1	.15500	.00000	
M2	YD2	1	1.19600	.10000	
CM3	IN3	-1	.06102	.00000	
CM3 LIQ	OZ LIQ	-1	.03381	.00000	
DL	OZ LIQ	1	3.38100	.10000	
LITRE	QT	1	1.05670	.10000	
M3	YD3	-1	1.30800	.00000	
G	OZ	-1	.03527	.00000	
HG	OZ	1	3.52740	.10000	
KG	LB	1	2.20460	.10000	
MG	LB	-1	2204.60001	.00000	
KG/M2	OZ/YD2	0	29.49400	1.00000	
G/CM3	G/CM3	0	1.00000	1.00000	
KG/M3	LB/FT3	-1	.06243	.00000	
METER	INCH	1	39.37000	.10000	**** THIS IS A TEMPORARY ENTRY ****
DECA M	INCH	1	393.70000	.10000	**** THIS IS A TEMPORARY ENTRY ****
MJ/KWH	BTU/HPHR	-1	706.79000	1.00000	**** THIS IS A TEMPORARY ENTRY ****
KG/H	POUND/HR	-1	2.20460	.25000	**** THIS IS A TEMPORARY ENTRY ****
METRE	INCH	1	39.37000	.10000	**** THIS IS A TEMPORARY ENTRY ****

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
5.0	DEKA M	ILLEGAL IDENTIFIER
75.0	REF	ILLEGAL IDENTIFIER
18.95	MAX	ILLEGAL IDENTIFIER

.05	MIN	ILLEGAL IDENTIFIER
1.65	1E526	ILLEGAL IDENTIFIER
35.	ML	ILLEGAL IDENTIFIER
-100.22+		ILLEGAL CHARACTER IN DIMENSION
37.00	BSC	ILLEGAL IDENTIFIER
100.0	DEGREE C	ILLEGAL IDENTIFIER
100.0	ML	ILLEGAL IDENTIFIER

PART 9S3144 CHANGE 1

MM	INCH	MM	INCH	MM	INCH	MM	INCH
.00001	0	1.3	.051	5.6	.220	21.8	.858
.00002	.000001	1.375	.0541	5.62	.221	22.0	.866
.0008	.00003	1.38	.054	5.69	.224	25.0	.984
.001	0	1.5	.059	5.75	.226	25.17	.991
.010	.0004	1.56	.061	5.88	.231	26.0	1.024
.013	.0005	1.62	.064	6.00	.236	27.500	1.082
.020	.0008	1.75	.069	6.0	.236	30.860	1.215
.03	.001	1.81	.071	6.35	.250	32.0	1.260
.040	.0016	1.86	.073	6.4	.252	38.0	1.496
.049	.0019	1.875	.0738	6.625	.2608	38.10	1.500
.05	.002	1.88	.074	6.9	.272	40.0	1.575
.0505	.00199	2.00	.079	7.00	.276	41.0	1.614
.051	.0020	2.0	.079	7.0	.276	45.0	1.772
.06	.002	2.06	.081	7.365	.2900	46.0	1.811
.08	.003	2.12	.083	7.50	.295	50.0	1.969
.1	.004	2.46	.097	7.75	.305	50.	1.969
.12	.005	2.50	.098	8.0	.315	53.82	2.119
.15	.006	2.55	.100	8.00	.315	54.23	2.135
.19	.007	2.57	.101	9.25	.364	57.0	2.244
.21	.008	2.62	.103	9.5	.374	60.8	2.394
.22	.009	2.69	.106	10.0	.394	63.5	2.500
.25	.010	2.74	.108	11.00	.433	67.0	2.638
.31	.012	2.75	.108	11.25	.443	73.0	2.874
.38	.015	2.77	.109	12.0	.472	74.250	2.923
.44	.017	2.82	.111	12.	.472	100.	3.937
.5	.020	2.88	.113	12.50	.492	123.	4.843
.50	.020	3.0	.118	13.0	.512	123.5	4.862
.56	.022	3.02	.119	13.40	.528	128.0	5.039
.62	.024	3.05	.120	14.0	.551	558.0	21.969
.718	.0283	3.06	.120	14.25	.561	580.0	22.834
.7417	.02920	3.07	.121	15.0	.591	762.0	30.000
.75	.030	3.50	.138	15.	.591	915.0	36.020
.76	.030	3.62	.143	15.50	.610	1000.00	39.370
.781	.0307	3.623	.1426	15.88	.625	1020.0	40.157
.79	.031	3.75	.148	16.0	.630	1025.0	40.354
.81	.032	3.875	.1526	17.0	.669	1100.0	43.307
.812	.0320	3.88	.153	17.00	.669	1200.0	47.244
.88	.035	4.00	.157	17.50	.689	1270.0	50.000
1.0	.039	4.0	.157	18.0	.709	1300.0	51.181
1.00	.039	4.50	.177	18.50	.728	1473.0	57.992
1.06	.042	4.75	.187	19.0	.748	1524.0	60.000
1.12	.044	4.88	.192	19.8	.780	1535.0	60.433
1.16	.046	5.0	.197	20.0	.787	1829.0	72.000
1.19	.047	5.00	.197	20.125	.7923	5080.0	200.00
1.25	.049	5.12	.202	20.83	.820	5335.0	210.03

PART 9S3144 CHANGE 1

DIM	UNITS	DIM	UNITS	DIM	UNITS	DIM	UNITS
2.	BAR	29.	PSI	51.0	DM	201.	INCH
.01	MPA	1.	PSI	54.0	DM	213.	INCH
10.0	MPA	1450.	PSI	200.0	DM	787.	INCH
1000.0	MPA	145000.	PSI	2.	KM	1.2	MILE
1100.	MPA	160000.	PSI	1.1	MM2	.00170	IN2
100000.	MPA	********	PSI	5.	CM3	.305	IN3
20.0	DEG C	68.	DEG F	10.00	CM3	.610	IN3
100.0	DEG C	212.	DEG F	15.55	CM3	.949	IN3
5.0	DEG TOL	9.	DEG TOL	500.0	DL	1690.	OZ LIQ
10.	N	2.25	LBF	4.	LITRE	4.2	QT
10.	NM	7.38	LB FT	12.5	M3	16.4	YD3
17.88	NM	13.2	LB FT	55.55	M3	72.7	YD3
25.55	NM	18.8	LB FT	101.	M3	132.	YD3
10.0	GM	13.9	OZ INCH	10.0	G	.353	OZ
20.0	GM	27.8	OZ INCH	400.0	UG	1410.	OZ
100.0	GM	139.	OZ INCH	50.	KG	110.	LB
19.35	N/MM	110.	LB/INCH	5.0	DECA N	1970.	INCH
135.44	N/MM	773.	LB/INCH	10.0	MJ/KWH	7070.	BTU/HPHR
300.0	CM	118.	INCH	.5	KG/H	1.000	POUND/HR
15.	DM	59.1	INCH	1.0	KG/H	2.25	POUND/HR
16.0	DM	63.0	INCH				

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
6J3135	NBS	0	1	1	0		SAMPLE 9

LISTED BELOW ARE THE INPUT DATA CARD(S) WITH SOME TYPE OF ERROR(S).

DIMENSION	IDENTIFIER	ERROR TYPE
35.0	DEGC	ILLEGAL IDENTIFIER
764.4	DEGC	ILLEGAL IDENTIFIER

PART 6J3135 CHANGE NBS

MM	INCH
198.431	7.8122
198.432	7.8123
198.433	7.8123
198.434	7.8124
198.435	7.8124
198.436	7.8124
198.437	7.8125
198.438	7.8125
198.439	7.8126
198.440	7.8126
1984.31	78.122
1984.32	78.123
1984.33	78.123
1984.34	78.124
1984.35	78.124
1984.36	78.124
1984.37	78.125
1984.38	78.125
1984.39	78.126
1984.40	78.126
19843.1	781.224
19843.2	781.228
19843.3	781.232
19843.4	781.236
19843.5	781.240
19843.6	781.244
19843.7	781.248
19843.8	781.252
19843.9	781.256
19844.0	781.260

PART 6J3135 CHANGE NBS

DIM	UNITS	DIM	UNITS
7.61	BAR	110.	PSI
764.1	BAR	11100.	PSI
764.2	MBAR	11.1	PSI
764.3	MPA	111000.	PSI
764.4	DEG C	1410.	DEG F
764.5	DEG TOL	1380.	DEG TOL
764.6	N	172.	LBF
764.7	KN	172000.	LBF
764.8	NM	564.	LB FT
764.9	GM	1060.	OZ INCH
765.0	N/MM	4370.	LB/INCH
764.21	UM	30.1	MILS
764.22	CM	301.	INCH
764.23	DM	3010.	INCH
764.24	M	2510.	FT
764.25	KM	475.	MILE
764.26	MM2	1.18	IN2
764.27	CM2	118.	IN2
764.28	M2	914.	YD2
764.29	CM3	46.6	IN3
764.30	CM3 LIQ	25.8	OZ LIQ
76.1	DL	257.	OZ LIQ
76.2	LITRE	80.5	QT
76.3	M3	99.8	YD3
76.4	G	2.69	OZ
76.5	HG	270.	OZ
76.1	KG	168.	LB
76.2	MG	168000.	LB
76.3	KG/M2	2250.	OZ/YD2
76.4	G/CM3	76.	G/CM3
76.5	KG/M3	4.78	LB/FT3

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
1x1111	0	0	1	1	0		SAMPLE 9

PART 1X1111 CHANGE 0

MM	INCH
.002	.0001
.025	.0010
.254	.0100
2.540	.1000
25.40	1.000
25.400	1.0000
25.4	1.000
254.	10.000
254.0	10.000
2540.	100.000
2541.	100.039
25400.	1000.000

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
2X2222	0	0	1	1	0		SAMPLE 10

PART 2X2222 CHANGE 0

MM	INCH
25.0003	.98426
25.003	.9844
25.4	1.000
25.4003	1.00001
25.403	1.0001
25.43	1.001
25.65	1.010
27.94	1.100

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
3X3333	0	0	1	1	0		SAMPLE 11

PART 3X3333 CHANGE 0

MM	INCH
25.4	1.000
26.84	1.057
27.33	1.076
27.40	1.079
27.411	1.0792
27.4122	1.07922
27.41233	1.079226

METRIC - U.S. CUSTOMARY CONVERSION TABLE

PART NUMBER	CHANGE	ADDITIONS	NUMBER OF OUTPUT COLUMNS MM	OTHER	NUMBER OF ADDED IDENTIFIERS	PLOT	REMARKS
4X4444	0	0	1	1	0		SAMPLE 12

PART 4X4444 CHANGE 0

MM	INCH
25.4	1.000
27.94	1.100
28.45	1.120
28.52	1.123
28.534	1.1234
28.5356	1.12345
28.53578	1.123456

```
C
C
C
C
C PROGRAM GMMETR CONVERTS FROM MILLIMETRES TO INCHES - JUNE 1974
C ROBERT DAVIES
C ROOM 1-14 R.A.B.
C EXTENSION 5-2745
C GM RESEARCH LABORATORIES
C GM TECHNICAL CENTER
C WARREN, MICHIGAN 48090
C
      DIMENSION AM(1000),L(130),L1(80),LL(114),ND(1000),USC(1000)
      DIMENSION IBUF(20)
C THE TWO PREVIOUS LINES CONTAIN ALL REFERENCES TO ARRAY SIZES
C EXCEPT FOR SOME FORMAT STATEMENTS AFTER STATEMENT 36.
C
C AM = THE METRIC MEASUREMENT IN MILLIMETRES
C L  = THE INPUT DATA, HOLLERITH
C LL = THE OUTPUT DATA, HOLLERITH
C ND = THE NUMBER OF DIGITS TO THE RIGHT OF THE DECIMAL POINT
C      IN THE US CUSTOMARY OUTPUT
C USC= THE US CUSTOMARY MEASUREMENT IN INCHES
C
      DATA LM,NH,NM/72,19,1000/
      DATA  IBUF(1), IBUF(2), IBUF(3), IBUF(4), IBUF(5),
     1      IBUF(6), IBUF(7), IBUF(8), IBUF(9), IBUF(10),
     1      IBUF(11),IBUF(12),IBUF(13),IBUF(14),IBUF(15),
     1      IBUF(16),IBUF(17),IBUF(18),IBUF(19),IBUF(20)
     1      /1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,
     1       1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H /
      DATA IBLANK,IPLUS,ICOMMA,IPOINT,IZERO,ININE/
     11H ,1H+,1H,,1H.,1H0,1H9/
      DATA IREAD,IWRITE,IUNIT/5,5,1/
C
C   THE ABOVE DATA STATEMENT SETS THE INPUT UNIT NUMBER, THE OUTPUT
C UNIT NUMBER AND THE SCRATCH UNIT NUMBER.
C
      LM1=LM+1
      ISW1=1
C ISW1 IS A SWITCH THAT IS USED TO SUPPRESS PRINTING OUT CERTAIN
C INSTRUCTIONS UNLESS ASKED FOR THE FIRST TIME THROUGH.
C
      WRITE(IWRITE,97)
   97 FORMAT(30H ENTER A SINGLE PLUS SIGN, + ,/2H FOR MORE,
     140H INFORMATION. ELSE, HIT CARRIAGE RETURN./)
      READ(IREAD,3)I
      IF(I.EQ.IPLUS)ISW1=0
      IF(ISW1.EQ.0)WRITE(IWRITE,1)
    1 FORMAT(49H ENTER THE DRAWING IDENTIFICATION AND THE MAXIMUM,
     121H WIDTH ON THE DRAWING/24H FOR THE MILLIMETRE-INCH,
     148H CONVERSION TABLE (IN MILLIMETRES).  PUT A COMMA/8H BETWEEN,
     157H THE TWO ENTRIES.  A PAIR OF COLUMNS IS 53.34 MILLIMETRES,
     16H WIDE./)
```

```
  100 IF(ISW1.EQ.1)WRITE(IWRITE,52)
C
    2 CONTINUE
C RETURN TO STATEMENT 2 IF THERE IS TO BE MORE THAN ONE TABLE
C CALCULATED.
C
C THE VECTOR  L1  IS TO CONTAIN THE DRAWING IDENTIFICATION AND
C MAXIMUM TABLE WIDTH WITH A COMMA IN BETWEEN.  IN ORDER TO
C SEPARATE THE TWO, THE COMMA IS LOCATED (BY  L11)  AFTER THE
C TRAILING BLANKS ARE DROPPED OFF.
      READ(IREAD,3)(L1(I),I=1,LM)
    3 FORMAT(136A1)
      DO 4 I=1,LM
      J=LM1-I
      IF(L1(J).NE.IBLANK)GOTO 5
    4 CONTINUE
    5 CONTINUE
      DO 6 L11=1,J
      IF(L1(L11).EQ.ICOMMA)GOTO 7
    6 CONTINUE
      STOP
    7 CONTINUE
      L11=L11+1
C CHECK FOR NONNUMERIC CHARACTERS AFTER COMMA
      DO 70 I=L11,J
      IF(L1(I).GT.ININE) GO TO 54
      IF(L1(I).LT.IZERO) GO TO 54
   70 CONTINUE
C THE MAXIMUM WIDTH OF THE PRINTOUT IN MILLIMETRES IS IN THE VECTOR
C L1  FROM  L11  TO  J  AS HOLLERITH CHARACTERS.  TO RECOVER IT
C AS A FLOATING POINT NUMBER, IT IS WRITTEN INTO CHANNEL IUNIT AND
C READ BACK OUT.  EVENTUALLY IT IS CONVERTED INTO  IW,  THE
C NUMBER OF COLUMN PAIRS.  EACH COLUMN PAIR REQUIRES 21 SPACES OR
C 53.34 MILLIMETRES, AND THERE CAN BE NO MORE THAN 6 PAIRS.
      IS=20-J
      DO 71 II=L11,J
      IJ=IS+II
   71 IBUF(IJ)=L1(II)
      WRITE (IUNIT,72) IBUF
   72 FORMAT(20A1)
      DO 73 II=L11,J
      IJ=IS+II
   73 IBUF(IJ)=IBLANK
      REWIND IUNIT
      READ(IUNIT,76)W
   76 FORMAT(F20.0)
      REWIND IUNIT
      L11=L11-2
      IW=INT(W/53.34)
      IW=MAX0(1,IW)
      IW=MIN0(6,IW)
      IF(ISW1.EQ.0)WRITE(IWRITE,8)
    8 FORMAT(54H ENTER THE MILLIMETRE DIMENSIONS ON A LINE WITH COMMAS,
     112H IN BETWEEN./42H THE COMPUTER WILL KEEP ASKING FOR ANOTHER,
```

```
     124H LINE OF INPUT UNTIL YOU/31H INDICATE THAT YOU HAVE NO MORE,
     135H INPUT BY ENTERING 0. (ZERO) AS THE/13H LAST NUMBER./
     143H SHOW THE DECIMAL POINT EVEN WITH INTEGERS./
     157H BE CAREFUL IF YOU ENTER A DIMENSION LARGER THAN  25 000 ,
     112H MILLIMETRES/
     158H DO NOT ENTER A TOLERANCE SMALLER THAN  0.001  MILLIMETRE /
     159H A DIMENSION CANNOT EXCEED  8 000 000  TIMES ITS TOLERANCE./)
      IF(ISW1.EQ.1)WRITE(IWRITE,9)
    9 FORMAT(53H ENTER THE MILLIMETRE DIMENSIONS, INDICATING LAST ONE,
     114H BY 0. (ZERO)./)
      N1=1
C
   10 CONTINUE
C RETURN TO STATEMENT 10 IF MORE THAN ONE LINE IS NEEDED FOR THE
C INPUT DATA FOR ONE TABLE.
      READ(IREAD,3)(L(I),I=1,LM)
C READ THE INPUT DATA AS HOLLERITH CHARACTERS AND THEN REJECT
C TRAILING BLANKS.
  121 DO 11 I=1,LM
      J=LM1-I
      IF(L(J).NE.IBLANK)GOTO 12
   11 CONTINUE
   12 CONTINUE
C
C REJECT A TERMINAL COMMA.
      M=0
      IF(L(J).NE.ICOMMA)GOTO 13
      L(J)=IBLANK
      J=J-1
      IF(J.GT.1) GO TO 121
C ELIMINATE LEADING COMMAS
C INSPECT THE INPUT FOR ILLEGAL CHARACTERS, IMBEDDED BLANKS (REJECT
C THEM), CONSECUTIVE DECIMAL POINTS WITHOUT A COMMA BETWEEN,
C AND CONSECUTIVE COMMAS WITHOUT NUMERICAL CHARACTERS BETWEEN.
C FINALLY, COUNT THE NUMBER OF DIGITS AFTER THE DECIMAL POINT.
   13 CONTINUE
      M=M+1
      IF(M.GT.J)GOTO 15
      IF(L(M).NE.IBLANK.AND.L(1).NE.ICOMMA)GOTO 13
      J=J-1
      DO 14 K=M,J
      L(K)=L(K+1)
   14 CONTINUE
      M=M-1
      GOTO 13
   15 CONTINUE
      ISWC=1
      ISWP=0
      N=N1-1
      DO 22 I=1,J
      IF(L(I).EQ.IPOINT)GOTO 16
      IF(L(I).EQ.ICOMMA)GOTO 19
      IF(L(I).LT.IZERO)GOTO 20
      IF(L(I).GT.ININE)GOTO 20
```

```
      ISWC=0
      GOTO 22
   16 CONTINUE
      IF(ISWP.EQ.1)GOTO 17
      NP=I
      ISWP=1
      ISWC=0
      GOTO 22
   17 CONTINUE
      WRITE(IWRITE,18)
   18 FORMAT(51H THE LINE HAS TWO DECIMAL POINTS WITHOUT A COMMA IN,
     19H BETWEEN./25H PLEASE REENTER THE LINE./)
      GOTO 10
   19 CONTINUE
      IF(ISWC.EQ.1) GO TO 20
      N=N+1
      ND(N)=I-NP
      IF(ISWP.EQ.0)ND(N)=1
      ISWC=1
      ISWP=0
      GOTO 22
   20 CONTINUE
      WRITE(IWRITE,21)
   21 FORMAT(49H THERE IS AN ILLEGAL CHARACTER IN THE INPUT LINE./
     161H ONLY POINTS, SINGLE  COMMAS, AND THE TEN DIGITS MAY BE USED./
     125H PLEASE REENTER THE LINE./)
      GOTO 10
   22 CONTINUE
      N2=N+1
      ND(N2)=J-NP+1
      IF(ISWP.EQ.0)ND(N2)=1
      IF(N2.GT.NM+1)WRITE(IWRITE,23)NM,NM
   23 FORMAT(5H ONLY,I5,24H NUMBERS CAN BE ENTERED./
     115H ONLY THE FIRST,I5,22H ARE BEING PROCESSSED.)
      N2=MIN0(N2,NM)
C
C WRITE THE DATA AS HOLLERITH CHARACTERS ON CHANNEL IUNIT AND READ IT
C BACK FREE-FIELD FORMAT (AS NON-INTEGER NUMBERS).
      K1=1
      JP1=J+1
      REWIND IUNIT
      DO 245 K=1,JP1
      IF (K.LT.JP1 .AND. L(K).NE.ICOMMA) GO TO 245
      K2=K-1
      I5=21-K
      DO 241 II=K1,K2
      IJ=IS+II
  241 IBUF(IJ)=L(II)
      WRITE(IUNIT,3)IBUF
      DO 243 II=K1,K2
      IJ=IS+II
  243 IBUF(IJ)=IBLANK
      K1=K2+2
  245 CONTINUE
```

```
      REWIND IUNIT
      DO 247 I=N1,N2
      READ (IUNIT,246) AM(I)
  246 FORMAT(F20.0)
  247 CONTINUE
      IF(AM(N2).EQ.0.)GOTO 25
      IF(N2.EQ.NM)GOTO 26
      N1=N2+1
C GO BACK TO GET ANOTHER LINE OF DATA.
      GOTO 10
C
   25 CONTINUE
C THE LAST NUMBER WAS ZERO SO ALL THE DATA IS IN AND REJECT THE
C ZERO, OR
      N2=N2-1
   26 CONTINUE
C NM NUMBERS WERE FED IN, THE MAXIMUM.
      N1=N2+1
C
C PUT THE NUMBERS IN ORDER, FIRST BY NUMBER OF DIGITS TO THE RIGHT
C OF THE DECIMAL POINT, ND.
      DO 28 I=1,N1
      J1=N1-I
      IF(J1.LT.2) GO TO 28
      DO 27 J=2,J1
      K=J-1
      IF(ND(K).LE.ND(J))GOTO 27
      A=AM(K)
      AM(K)=AM(J)
      AM(J)=A
      M=ND(K)
      ND(K)=ND(J)
      ND(J)=M
   27 CONTINUE
   28 CONTINUE
C
C THEN PUT THEM IN ORDER BY SIZE OF THE MEASUREMENT SO THAT ANY
C DUPLICATE MEASUREMENTS WILL BE TOGETHER.
      DO 30 I=1,N1
      J1=N1-I
      IF(J1.LT.2) GO TO 30
      DO 29 J=2,J1
      K=J-1
      IF(AM(K).LE.AM(J))GOTO 29
      A=AM(K)
      AM(K)=AM(J)
      AM(J)=A
      M=ND(K)
      ND(K)=ND(J)
      ND(J)=M
   29 CONTINUE
   30 CONTINUE
C
C REJECT ANY DUPLICATE MEASUREMENTS.  ISWP IS THE SWITCH THAT TELLS
```

```
C WHETHER THAT HAS BEEN DONE.  FOR REJECTION, BOTH AM, THE SIZE,
C AND ND, THE TOLERANCE, MUST BE THE SAME.
      ISWP=0
      I=0
      J=1
   31 CONTINUE
      I=I+1
      J=J+1
   32 CONTINUE
      IF(J.GT.N2)GOTO 34
      IF(AM(I).NE.AM(J))GOTO 31
      IF(ND(I).NE.ND(J))GOTO 31
      N2=N2-1
      ISWP=1
      DO 33 K=J,N2
      K1=K+1
      AM(K)=AM(K1)
      ND(K)=ND(K1)
   33 CONTINUE
      GOTO 32
   34 CONTINUE
      IF(ISWP.EQ.1)WRITE(IWRITE,35)
   35 FORMAT(/34H DUPLICATE MEASUREMENT(S) REMOVED./)
C
C THE PAUSE IS NEEDED TO PUT IN THE SPECIAL TRANSPARENT PRINTOUT
C PAPER. THE C IN COL. 1 SHOULD BE REMOVED IF THIS OPTION IS WANTED
C      PAUSE
      REWIND IUNIT
      WRITE(IWRITE,3)IBLANK,(L1(I),I=1,L11)
      WRITE(IUNIT,36)
   36 FORMAT(6(7X,2HMM,5X,6H(INCH),1X))
      REWIND IUNIT
      NC=21*IW
      READ(IUNIT,3)(L(I),I=1,NC)
      WRITE(IWRITE,37)
   37 FORMAT(1H )
      WRITE(IWRITE,3)(L(I),I=1,NC)
      WRITE(IWRITE,37)
      REWIND IUNIT
      N1=(N2+IW-1)/IW
C
C THE NEXT  DO  LOOP PRINTS THE OUTPUT.
      I=0
      DO 51 I1=1,N1
      K1=1
      K2=NH
C
C THE NEXT  DO  LOOP PREPARES ONE LINE OF THE TABLE.  EACH TIME
C THROUGH ONE PAIR OF COLUMNS IS PREPARED.
      DO 47 I2=1,IW
      I=I+1
      IF(I.GT.N2)GOTO 44
      CALL CONVMM(AM(I),ND(I),USC(I))
      IF(ND(I).LT.1)WRITE(IUNIT,38)AM(I),USC(I)
```

```
   38 FORMAT(F7.0,F8.0,4X)
      IF(ND(I).EQ.1)WRITE(IUNIT,39)AM(I),USC(I)
   39 FORMAT(F7.0,F9.1,3X)
      IF(ND(I).EQ.2)WRITE(IUNIT,40)AM(I),USC(I)
   40 FORMAT(F8.1,F9.2,2X)
      IF(ND(I).EQ.3)WRITE(IUNIT,41)AM(I),USC(I)
   41 FORMAT(F9.2,F9.3,1X)
      IF(ND(I).EQ.4)WRITE(IUNIT,42)AM(I),USC(I)
   42 FORMAT(F10.3,F9.4)
      IF(ND(I).GT.4)WRITE(IUNIT,43)
   43 FORMAT(19(1H ))
      GOTO 45
   44 CONTINUE
      WRITE(IUNIT,43)
   45 CONTINUE
      REWIND IUNIT
      READ(IUNIT,46)(LL(K),K=K1,K2)
      REWIND IUNIT
   46 FORMAT(19A1)
      K1=K1+NH
      K2=K2+NH
   47 CONTINUE
      K2=K2-NH
      K3=K2+1
      DO 48 J=1,K2
      K=K3-J
      IF(LL(K).NE.IBLANK)GOTO 49
   48 CONTINUE
   49 CONTINUE
      WRITE(IWRITE,50)(LL(J),J=1,K)
   50 FORMAT(6(3A1,1X,15A1,1X,A1))
   51 CONTINUE
C
C  THE TABLE HAS BEEN COMPLETED SO ASK IF THERE IS ANOTHER ONE.
      WRITE(IWRITE,52)
   52 FORMAT(//37H ENTER THE IDENTIFICATION (COMMA) AND,
     125H WIDTH FOR ANOTHER TABLE./
     150H TO END PROGRAM, ENTER ANY ALPHABETICAL CHARACTER./)
   53 ISW1=1
      REWIND IUNIT
      GOTO 2
   54 CONTINUE
      WRITE(IWRITE,55)
   55 FORMAT(48H THERE HAS BEEN AN ERROR IN ENTERING THE MAXIMUM,
     113H TABLE WIDTH./42H PLEASE REENTER THE IDENTIFICATION AND THE,
     113H TABLE WIDTH./)
      REWIND IUNIT
      GOTO 2
      END
C
      SUBROUTINE CONVMM(A,N,B)
C SUBROUTINE CONVMM CONVERTS MILLIMETRES, A, INTO INCHES, B.
C N  IS THE NUMBER OF (SIGNIFICANT) DIGITS THERE SHOULD BE TO THE
C RIGHT OF THE DECIMAL POINT IN  B.  FIRST  A  IS CONVERTED TO
```

```
C INCHES MULTIPLIED BY THE PROPER POWER OF 10 SO THAT AS AN
C INTEGER IT WILL HAVE THE CORRECT NUMBER OF DIGITS.  ROUNDING IS
C THEN CARRIED OUT.
      R=10.**N
      S=R*A/25.4
      K=INT(S)
      T=FLOAT(K)
      D=S-T
      IF(D.EQ..5)GOTO 1
      IF(D.GT..5)T=T+1.
      GOTO 2
    1 CONTINUE
      K=MOD(K,2)
      IF(K.EQ.1)T=T+1.
    2 CONTINUE
      B=T/R
      RETURN
      END
```

```
C
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C
C PROGRAM GMINCH  CONVERTS FROM INCHES TO MILLIMETRES - JUNE 1974
C ROBERT DAVIES
C ROOM 1-141 R.A.B.
C EXTENSION 5-2745
C GM RESEARCH LABORATORIES
C GM TECHNICAL CENTER
C WARREN, MICHIGAN 48090
C
      DIMENSION AM(1000),L(130),L1(80),LL(114),ND(1000),USC(1000)
      DIMENSION IBUF(20)
C THE TWO PREVIOUS LINES CONTAIN ALL REFERENCES TO ARRAY SIZES
C EXCEPT FOR SOME FORMAT STATEMENTS AFTER STATEMENT 36.
C
C AM = THE US CUSTOMARY MEASUREMENT IN INCHES
C L  = THE INPUT DATA, HOLLERITH
C LL = THE OUTPUT DATA, HOLLERITH
C ND = THE NUMBER OF DIGITS TO THE RIGHT OF THE DECIMAL POINT
C       IN THE US CUSTOMARY INPUT
C USC= THE METRIC MEASUREMENT IN MILLIMETRES
C
      DATA LM,NH,NM/72,19,1000/
      DATA  IBUF(1), IBUF(2), IBUF(3) ,IBUF(4), IBUF(5),
     1       IBUF(6), IBUF(7), IBUF(8), IBUF(9), IBUF(10),
     1       IBUF(11),IBUF(12),IBUF(13),IBUF(14),IBUF(15),
     1       IBUF(16),IBUF(17),IBUF(18),IBUF(19),IBUF(20)
     1       /1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,
     1        1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H ,1H /
      DATA IBLANK,IPLUS,ICOMMA,IPOINT,IZERO,ININE/
     11H ,1H+,1H,,1H.,1H0,1H9/
      DATA IREAD,IWRITE,IUNIT/5,5,1/
C
C   THE ABOVE DATA STATEMENT SETS THE INPUT UNIT NUMBER, THE OUTPUT
C UNIT NUMBER AND THE SCRATCH UNIT NUMBER.
C
      LM1=LM+1
      ISW1=1
C ISW1 IS A SWITCH THAT IS USED TO SUPPRESS PRINTING OUT CERTAIN
C INSTRUCTIONS UNLESS ASKED FOR THE FIRST TIME THROUGH.
C
      WRITE(IWRITE,97)
   97 FORMAT(30H ENTER A SINGLE PLUS SIGN, + ,/9H FOR MORE,
     140H INFORMATION. ELSE, HIT CARRIAGE RETURN./)
      READ(IREAD,3)I
      IF(I.EQ.IPLUS)ISW1=0
      IF(ISW1.EQ.0)WRITE(IWRITE,1)
    1 FORMAT(49H ENTER THE DRAWING IDENTIFICATION AND THE MAXIMUM,
     121H WIDTH ON THE DRAWING/24H FOR THE MILLIMETRE-INCH,
```

```
     148H CONVERSION TABLE (IN MILLIMETRES).  PUT A COMMA/8U BETWEEN,
     157H THE TWO ENTRIES.  A PAIR OF COLUMNS IS 53.34 MILLIMETRES,
     16H WIDE./)
  100 IF(ISW1.EQ.1)WRITE(IWRITE,52)
C.
    2 CONTINUE
C RETURN TO STATEMENT 2 IF THERE IS TO BE MORE THAN ONE TABLE
C CALCULATED.
C
C THE VECTOR  L1  IS TO CONTAIN THE DRAWING IDENTIFICATION AND
C MAXIMUM TABLE WIDTH WITH A COMMA IN BETWEEN.  IN ORDER TO
C SEPARATE THE TWO, THE COMMA IS LOCATED (BY  L11)  AFTER THE
C TRAILING BLANKS ARE DROPPED OFF.
      READ(IREAD,3)(L1(I),I=1,LM)
    3 FORMAT(136A1)
      DO 4 I=1,LM
      J=LM1-I
      IF(L1(J).NE.IBLANK)GOTO 5
    4 CONTINUE
    5 CONTINUE
      DO 6 L11=1,J
      IF(L1(L11).EQ.ICOMMA)GOTO 7
    6 CONTINUE
      STOP
    7 CONTINUE
      L11=L11+1
C CHECK FOR NONNUMERIC CHARACTERS AFTER COMMA
      DO 70 I=L11,J
      IF(L1(I).GT.ININE) GO TO 54
      IF(L1(I).LT.IZERO) GO TO 54
   70 CONTINUE
C THE MAXIMUM WIDTH OF THE PRINTOUT IN MILLIMETRES IS IN THE VECTOR
C L1  FROM  L11  TO  J  AS HOLLERITH CHARACTERS.  TO RECOVER IT
C AS A FLOATING POINT NUMBER, IT IS WRITTEN INTO CHANNEL IUNIT AND
C READ BACK OUT.  EVENTUALLY IT IS CONVERTED INTO  IW,  THE
C NUMBER OF COLUMN PAIRS.  EACH COLUMN PAIR REQUIRES 21 SPACES OR
C 53.34 MILLIMETRES, AND THERE CAN BE NO MORE THAN 6 PAIRS.
      IS=20-J
      DO 71 II=L11,J
      IJ=IS+II
   71 IBUF(IJ)=L1(II)
      WRITE (IUNIT,72) IBUF
   72 FORMAT(20A1)
      DO 73 II=L11,J
      IJ=IS+II
   73 IBUF(IJ)=IBLANK
      REWIND IUNIT
      READ(IUNIT,76)W
   76 FORMAT(F20.0)
      REWIND IUNIT
      L11=L11-2
      IW=INT(W/53.34)
      IW=MAX0(1,IW)
      IW=MIN0(6,IW)
```

```
      IF(ISW1.EQ.0)WRITE(IWRITE,8)
    8 FORMAT(48H ENTER THE INCH DIMENSIONS ON A LINE WITH COMMAS,
     112H IN BETWEEN./42H THE COMPUTER WILL KEEP ASKING FOR ANOTHER,
     124H LINE OF INPUT UNTIL YOU/31H INDICATE THAT YOU HAVE NO MORE,
     135H INPUT BY ENTERING 0. (ZERO) AS THE/13H LAST NUMBER./
     143H SHOW THE DECIMAL POINT EVEN WITH INTEGERS./
     161H BE CAREFUL IF YOU ENTER A DIMENSION LARGER THAN 1000 INCHES,/
     155H DO NOT ENTER A TOLERANCE SMALLER THAN  0.000 1  INCH  /
     160H A DIMENSION CANNOT EXCEED  8 000 000  TIMES ITS TOLERANCE  /)
      IF(ISW1.EQ.1)WRITE(IWRITE,9)
    9 FORMAT(51H ENTER THE INCH DIMENSIONS, INDICATING THE LAST ONE,
     114H BY 0. (ZERO)./)
      N1=1
C
   10 CONTINUE
C RETURN TO STATEMENT 10 IF MORE THAN ONE LINE IS NEEDED FOR THE
C INPUT DATA FOR ONE TABLE.
      READ(IREAD,3)(L(I),I=1,LM)
C READ THE INPUT DATA AS HOLLERITH CHARACTERS AND THEN REJECT
C TRAILING BLANKS.
  121 DO 11 I=1,LM
      J=LM1-I
      IF(L(J).NE.IBLANK)GOTO 12
   11 CONTINUE
   12 CONTINUE
C
C REJECT A TERMINAL COMMA.
      M=0
      IF(L(J).NE.ICOMMA)GOTO 13
      L(J)=IBLANK
      J=J-1
      IF(J.GT.1) GO TO 121
C ELIMINATE LEADING COMMAS
C INSPECT THE INPUT FOR ILLEGAL CHARACTERS, IMBEDDED BLANKS (REJECT
C THEM), CONSECUTIVE DECIMAL POINTS WITHOUT A COMMA BETWEEN,
C AND CONSECUTIVE COMMAS WITHOUT NUMERICAL CHARACTERS BETWEEN.
C FINALLY, COUNT THE NUMBER OF DIGITS AFTER THE DECIMAL POINT.
   13 CONTINUE
      M=M+1
      IF(M.GT.J)GOTO 15
      IF(L(M).NE.IBLANK.AND.L(1).NE.ICOMMA)GOTO 13
      J=J-1
      DO 14 K=M,J
      L(K)=L(K+1)
   14 CONTINUE
      M=M-1
      GOTO 13
   15 CONTINUE
      ISWC=1
      ISWP=0
      N=N1-1
      DO 22 I=1,J
      IF(L(I).EQ.IPOINT)GOTO 16
      IF(L(I).EQ.ICOMMA)GOTO 19
```

```
      IF(L(I).LT.IZERO)GOTO 20
      IF(L(I).GT.ININE)GOTO 20
      ISWC=0
      GOTO 22
   16 CONTINUE
      IF(ISWP.EQ.1)GOTO 17
      NP=I
      ISWP=1
      ISWC=0
      GOTO 22
   17 CONTINUE
      WRITE(IWRITE,18)
   18 FORMAT(51H THE LINE HAS TWO DECIMAL POINTS WITHOUT A COMMA IN,
     19H BETWEEN./25H PLEASE REENTER THE LINE./)
      GOTO 10
   19 CONTINUE
      IF(ISWC.EQ.1) GO TO 20
      N=N+1
      ND(N)=I-NP-1
      IF(ISWP.EQ.0)ND(N)=0
      ISWC=1
      ISWP=0
      GOTO 22
   20 CONTINUE
      WRITE(IWRITE,21)
   21 FORMAT(49H THERE IS AN ILLEGAL CHARACTER IN THE INPUT LINE./
     161H ONLY POINTS, SINGLE  COMMAS, AND THE TEN DIGITS MAY BE USED./
     125H PLEASE REENTER THE LINE./)
      GOTO 10
   22 CONTINUE
      N2=N+1
      ND(N2)=J-NP
      IF(ISWP.EQ.0)ND(N2)=0
      IF(N2.GT.NM+1)WRITE(IWRITE,23)NM,NM
   23 FORMAT(5H ONLY,I5,24H NUMBERS CAN BE ENTERED./
     115H ONLY THE FIRST,I5,22H ARE BEING PROCESSSED.)
      N2=MINO(N2,NM)
C
C WRITE THE DATA AS HOLLERITH CHARACTERS ON CHANNEL IUNIT AND READ IT
C BACK FREE-FIELD FORMAT (AS NON-INTEGER NUMBERS).
      K1=1
      JP1=J+1
      REWIND IUNIT
      DO 245 K=1,JP1
      IF (K.LT.JP1 .AND. L(K).NE.ICOMMA) GO TO 245
      K2=K-1
      IS=21-K
      DO 241 II=K1,K2
      IJ=IS+II
  241 IBUF(IJ)=L(II)
      WRITE(IUNIT,3)IBUF
      DO 243 II=K1,K2
      IJ=IS+II
  243 IBUF(IJ)=IBLANK
```

```
      K1=K2+2
  245 CONTINUE
      REWIND IUNIT
      DO 247 I=N1,N2
      READ (IUNIT,246) AM(I)
  246 FORMAT(F20.0)
  247 CONTINUE
      IF(AM(N2).EQ.0.)GOTO 25
      IF(N2.EQ.NM)GOTO 26
      N1=N2+1
C GO BACK TO GET ANOTHER LINE OF DATA.
      GOTO 10
C
   25 CONTINUE
C THE LAST NUMBER WAS ZERO SO ALL THE DATA IS IN AND REJECT THE
C ZERO, OR
      N2=N2-1
   26 CONTINUE
C NM NUMBERS WERE FED IN, THE MAXIMUM.
      N1=N2+1
C
C PUT THE NUMBERS IN ORDER, FIRST BY NUMBER OF DIGITS TO THE RIGHT
C OF THE DECIMAL POINT, ND.
      DO 28 I=1,N1
      J1=N1-I
      IF(J1.LT.2) GO TO 28
      DO 27 J=2,J1
      K=J-1
      IF(ND(K).LE.ND(J))GOTO 27
      A=AM(K)
      AM(K)=AM(J)
      AM(J)=A
      M=ND(K)
      ND(K)=ND(J)
      ND(J)=M
   27 CONTINUE
   28 CONTINUE
C
C THEN PUT THEM IN ORDER BY SIZE OF THE MEASUREMENT SO THAT ANY
C DUPLICATE MEASUREMENTS WILL BE TOGETHER.
      DO 30 I=1,N1
      J1=N1-I
      IF(J1.LT.2) GO TO 30
      DO 29 J=2,J1
      K=J-1
      IF(AM(K).LE.AM(J))GOTO 29
      A=AM(K)
      AM(K)=AM(J)
      AM(J)=A
      M=ND(K)
      ND(K)=ND(J)
      ND(J)=M
   29 CONTINUE
   30 CONTINUE
```

```
C
C REJECT ANY DUPLICATE MEASUREMENTS.  ISWP IS THE SWITCH THAT TELLS
C WHETHER THAT HAS BEEN DONE.  FOR REJECTION, BOTH AM, THE SIZE,
C AND ND, THE TOLERANCE, MUST BE THE SAME.
      ISWP=0
      I=0
      J=1
   31 CONTINUE
      I=I+1
      J=J+1
   32 CONTINUE
      IF(J.GT.N2)GOTO 34
      IF(AM(I).NE.AM(J))GOTO 31
      IF(ND(I).NE.ND(J))GOTO 31
      N2=N2-1
      ISWP=1
      DO 33 K=J,N2
      K1=K+1
      AM(K)=AM(K1)
      ND(K)=ND(K1)
   33 CONTINUE
      GOTO 32
   34 CONTINUE
      IF(ISWP.EQ.1)WRITE(IWRITE,35)
   35 FORMAT(/34H DUPLICATE MEASUREMENT(S) REMOVED./)
C
C THE PAUSE IS NEEDED TO PUT IN THE SPECIAL TRANSPARENT PRINTOUT
C PAPER. THE C IN COL. 1 SHOULD BE REMOVED IF THIS OPTION IS WANTED
C      PAUSE
      REWIND IUNIT
      WRITE(IWRITE,3)ISLANK,(L1(I),I=1,L11)
      WRITE(IUNIT,36)
   36 FORMAT(6(7X,2HMM,5X,6H(INCH),1X))
      REWIND IUNIT
      NC=21*IW
      READ(IUNIT,3)(L(I),I=1,NC)
      WRITE(IWRITE,37)
   37 FORMAT(1H )
      WRITE(IWRITE,3)(L(I),I=1,NC)
      WRITE(IWRITE,37)
      REWIND IUNIT
      N1=(N2+IW-1)/IW
C
C THE NEXT  DO  LOOP PRINTS THE OUTPUT.
      I=0
      DO 51 I1=1,N1
      K1=1
      K2=NH
C
C THE NEXT  DO  LOOP PREPARES ONE LINE OF THE TABLE.  EACH TIME
C THROUGH ONE PAIR OF COLUMNS IS PREPARED.
      DO 47 I2=1,IW
      I=I+1
      IF(I.GT.N2)GOTO 44
```

```
      CALL CONVIN(AM(I),ND(I),USC(I))
      IF(ND(I).LT.1)WRITE(IUNIT,38)USC(I),AM(I)
   38 FORMAT(F7.0,F8.0,4X)
      IF(ND(I).EQ.1)WRITE(IUNIT,39)USC(I),AM(I)
   39 FORMAT(F7.0,F9.1,3X)
      IF(ND(I).EQ.2)WRITE(IUNIT,40)USC(I),AM(I)
   40 FORMAT(F8.1,F9.2,2X)
      IF(ND(I).EQ.3)WRITE(IUNIT,41)USC(I),AM(I)
   41 FORMAT(F9.2,F9.3,1X)
      IF(ND(I).EQ.4)WRITE(IUNIT,42)USC(I),AM(I)
   42 FORMAT(F10.3,F9.4)
      IF(ND(I).GT.4)WRITE(IUNIT,43)
   43 FORMAT(19(1H ))
      GOTO 45
   44 CONTINUE
      WRITE(IUNIT,43)
   45 CONTINUE
      REWIND IUNIT
      READ(IUNIT,46)(LL(K),K=K1,K2)
      REWIND IUNIT
   46 FORMAT(19A1)
      K1=K1+NH
      K2=K2+NH
   47 CONTINUE
      K2=K2-NH
      K3=K2+1
      DO 48 J=1,K2
      K=K3-J
      IF(LL(K).NE.IBLANK)GOTO 49
   48 CONTINUE
   49 CONTINUE
      WRITE(IWRITE,50)(LL(J),J=1,K)
   50 FORMAT(6(3A1,1X,15A1,1X,A1))
   51 CONTINUE
C
C THE TABLE HAS BEEN COMPLETED SO ASK IF THERE IS ANOTHER ONE.
      WRITE(IWRITE,52)
   52 FORMAT(//37H ENTER THE IDENTIFICATION (COMMA) AND,
     125H WIDTH FOR ANOTHER TABLE./
     150H TO END PROGRAM, ENTER ANY ALPHABETICAL CHARACTER./)
   53 ISW1=1
      REWIND IUNIT
      GOTO 2
   54 CONTINUE
      WRITE(IWRITE,55)
   55 FORMAT(48H THERE HAS BEEN AN ERROR IN ENTERING THE MAXIMUM,
     113H TABLE WIDTH./42H PLEASE REENTER THE IDENTIFICATION AND THE,
     113H TABLE WIDTH./)
      REWIND IUNIT
      GOTO 2
      END
C
      SUBROUTINE CONVIN(A,N,B)
C SUBROUTINE CONVIN CONVERTS INCHES, A, INTO MILLIMETRES, B.
```

```
C N  IS THE NUMBER OF (SIGNIFICANT) DIGITS TO THE RIGHT OF THE
C DECIMAL POINT IN  A.  A  IS CONVERTED TO AN INTEGER  K  WHICH
C CONTAINS EXACTLY THE SIGNIFICANT DIGITS OF  A,  NO MORE AND NO
C LESS.  K  IS TO BE MULTIPLIED BY 254, BUT, BECAUSE THE HONEYWELL
C COMPUTER CANNOT HANDLE DIRECTLY AN INTEGER LARGER THAN  8 388 607,
C K,  BEFORE BEING MULTIPLIED BY 254, COULD BE  10 LARGER THAN
C 33 026.  THEREFORE  K  IS BROKEN INTO  K1, THE RIGHT FOUR DIGITS,
C AND K2, THE REST OF  K.
      M=MAX0(N,1)
      K=INT(A*10.**M+.5)
      K1=MOD(K,10000)
      K2=(K-K1)/10000
      L1=254*K1
      L2=254*K2
      L3=MOD(L1,100)
      L1=L1/100
      IF(L3.EQ.50)GOTO 1
      IF(L3.GT.50)L1=L1+1
      GOTO 2
    1 CONTINUE
      L3=MOD(L1,2)
      IF(L3.EQ.1)L1=L1+1
    2 CONTINUE
      B=FLOAT(L2)/10.**(M-3)
      B=B+FLOAT(L1)/10.**(M-1)
      RETURN
      END
```

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)* The programs in this package are designed to convert dimensions and other quantities appearing on engineering drawings from metric to U. S. customary units and vice versa. They were developed by Caterpillar Tractor Co. and General Motors Corporation. In addition to the programs themselves, the package contains documentation explaining how to get the programs running on different computers and how to use them, and test problems to permit users to verify that the programs run correctly on their own computers. The Caterpillar program converts 31 different metric units to their U. S. customary equivalents. In contrast, the General Motors programs convert in both directions but work with millimetres and inches only. The General Motors programs also use rounding conventions differing somewhat from those employed in the Caterpillar program. Both the Caterpillar and the General Motors programs are written in American National Standard FORTRAN and are suitable for use on a wide range of computers with little or no modification. The Caterpillar program is operated in batch mode while the General Motors programs are interactive.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)* Caterpillar Tractor Co.; computer program; documentation; engineering drawing; General Motors Corporation; metric conversion; rounding; test problem; tolerance

18. AVAILABILITY

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