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A FREE-FORMAT DATA INPUT SCHEME WRITTEN IN FORTRAN IV.

by

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A FREE-FORMAT DATA INPUT SCHEME WRITTEN IN FORTRAN IV

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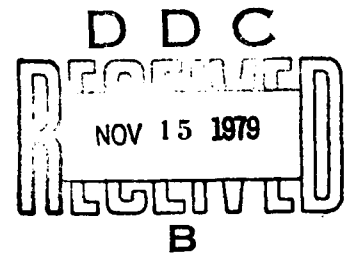
G.F. Eutler

J. Pike

SUMMARY

Data for Fortran IV programs has to be in fixed format. Some users find this constraint irksome. Presented here is a data input scheme for Fortran IV which makes the minimum of demands on the data structure. If the data is well-formed and unambiguous it will be read. Ill-formed and ambiguous data will also be read and given a reasonable interpretation, with the location of the suspect data and the value assumed being output as a (suppressible) error message. The scheme also allows input variables to retain their previous values, identical consecutive data to be input in a simplified form and alphanumeric comments to appear amongst the data. The whole data input scheme is written in standard Fortran IV so that the advantages of machine transferability of the program are retained.

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1 INTRODUCTION

Programs written in standard Fortran IV are limited to data input with fixed format. Often it is more convenient to input data separated by commas or spaces, for example, and in recognition of this various manufacturers have introduced their own 'free-format' data input routines. Unfortunately these are not standard and programs and data prepared for input in free-format on one manufacturer's machine cannot, in general, be transferred to those of another manufacturer. In this Memorandum free-format data input routines, *written in standard Fortran IV* are presented.

The scheme enables data to be read into various arrangements of variables, with each routine starting to read on a new line of data and continuing until either a specified number of numbers has been read or an end of read symbol (/ or \$) is encountered. In specifying the routines, the aim has been to give the correct interpretation of all well-formed numbers and, when ambiguous data is encountered, to give a reasonable interpretation and to issue a warning. A failure in the input routines can only occur from a system failure, for example if a number is too large for the computer to handle or an attempt is made to read beyond the end of a file.

A number of additional features have been introduced for convenience in using the routines. Alphanumeric comments can be inserted into the data by enclosing the characters between inverted commas (either single or double). An input variable can retain its previous values (that is, a 'null' datum is read) by the use of two consecutive commas, optionally enclosing blanks. If consecutive values being read are the same, then the data input can be simplified using the convention $i * V$ to denote i consecutive occurrences of value V . The character / ends the read call forthwith: any further characters beyond / on the same line are ignored.

Whilst one of the aims in the specification of the routines has been to maintain compatibility with existing formatted data for Fortran programs, this has not always been possible. For example, in order to read the two numbers 149 and 736 in Fortran 213 format, they would appear in the data as 149736. The input scheme described here would interpret this as the single number 149736. For all cases where formatted data is separated by a non-digit character, the routines will read in the numbers as intended. In addition, the routines will interpret correctly free-format data prepared in accordance with the proposed Fortran 77 standard.

Details of the data input scheme are given in section 2, while the programs themselves are described in section 3 and listed in Appendix B. A simplified users' guide to the scheme appears as Appendix C.

Since this data input scheme was developed, the authors' attention has been drawn to a similar, but less comprehensive scheme, devised by D. Lovell which has been in use as part of the data handling software of the low-speed wind-tunnels at RAE Farnborough for a number of years.

2 DETAILS OF THE DATA INPUT SCHEME

The scheme provides routines for reading from one to nine real variables, one-dimensional, two-dimensional and three-dimensional real arrays, and similar routines for integer variables and arrays. The scheme is based on a routine FFORM which reads in a line of data as individual characters and then builds up the appropriate numerical values according to the rules proposed in section 2.1. In sections 2.2 to 2.6 various enhancements to this basic scheme are described.

2.1 Number recognition

The implementation of any system for recognising numbers requires a definition of a number. Such a definition should correspond with generally accepted interpretations and be as simple as possible. Here it is defined as any consecutive sequence of digits, which may be separated by a limited set of characters (digit separators) and may also be preceded by certain other characters (digit prefixes). The digit separators are a decimal point, or a letter E followed immediately by a digit, a space, a plus sign or a minus sign. The decimal point may come before the first digit (that is, be part of the prefix), and the characters after the E are interpreted as an exponent. Any number may have a plus or minus sign as its first character. These requirements are listed more exactly below by denoting any character by enclosing it in brackets, thus $\langle \rangle$. For example the character $\langle \rangle$ is the null character (that is, no character), whereas $\langle \rangle$ would indicate a space. Then with the following definitions,

digit = $\langle 0 \rangle, \langle 1 \rangle, \langle 2 \rangle, \langle 3 \rangle, \langle 4 \rangle, \langle 5 \rangle, \langle 6 \rangle, \langle 7 \rangle, \langle 8 \rangle, \langle 9 \rangle$

d = $\langle \text{digit} \rangle, d \langle \text{digit} \rangle$ (ie d is a compact string of digits)

. = $\langle . \rangle$

\bar{E} = $\langle E \rangle, \langle E \rangle, \langle E+ \rangle, \langle E- \rangle$

\bar{S} = $\langle \rangle, \langle + \rangle, \langle - \rangle$

the numbers must be in one of the eight forms:

1. $\bar{S}d$
2. $\bar{S}.d$
3. $\bar{S}d.d$
4. $\bar{S}d.$
5. $\bar{S}d\bar{E}d$
6. $\bar{S}.d\bar{E}d$
7. $\bar{S}d.\bar{E}d$
8. $\bar{S}d.d\bar{E}d$

In the Fortran IV routines presented here, characters are read sequentially and a number is detected by the first digit found, and ended when the character list ceases to comply with one of the forms listed above.

2.2 Null data

A common requirement in inputting data is that an input variable should retain its previous value (that is, a null datum should be supplied). In the read routines described here, the occurrence of two commas optionally enclosing blanks is used to denote a null datum. Hence the character line: 123,, ,345 will give four values: 123, two null data and 345.

A comma occurring as the first non-blank character on a line implies a null datum, but a comma occurring as the last non-blank character on a line does not imply an extra null datum. Hence , 123,345, gives three values: 1 null datum, 123 and 345.

It should be noted that the new Fortran 77 free-format specification differs from the one used here, in that Fortran 77 interprets a comma occurring as the first non-blank character on a line as a null datum *only on the first line of data input* by a read statement. Hence two lines of data:

```
,123,345
,567
```

would be interpreted by the input routines described here as five values: 1 null datum, 123, 345, 1 null datum and 567, whereas Fortran 77 would interpret these characters as four values: 1 null datum, 123, 345 and 567.

2.3 Multiple data

Another common occurrence in inputting data is that several consecutive items in the data are identical. In this case, the data input can be simplified by using the convention $i*V$ to denote i consecutive occurrences of the value V . Specifically, i must be a non-negative integer. Hence $3*3.14159$ is

interpreted as three values of 3.14159 and 3*, is interpreted as three null data. When used in this way, the character * will not generate a warning (see section 2.6). Except in the case of multiple null data it is essential that the characters of i*V should be compact. For example, 3* 3.14159 will be interpreted as two values 3 and 3.14159. A similar interpretation will be made of 3.0*3.14159, or 3**3.14159 or 3 *3.14159.

If this convention is used to generate more data than is required, the input routine will end when the required amount of data has been read. For example, 100*1.5 can be used to fill a 60-element array with data. No warning is issued.

2.4 Comments

It will be appreciated that the definition of a number proposed in section 2.1 permits comments not containing digits to be included in the data. Hence for example 123,ABC,456 will be interpreted as 123 and 456.

As the facility to include alphanumeric comments in the data would seem to be of value, a convention is employed in which characters between inverted commas (either single or double) will be interpreted as a comment. Hence the characters

"AE1"

"AE2"

'AE3'

'AE4'

'AE5'

will be interpreted as comments but

AE6

will be interpreted as the value 6.

More specifically an alphanumeric comment is preceded by a (<"> or (<'> and ended by a second (<"> or (<'> or the end of a line.

2.5 End of read characters

While the user must specify the number of variables to be read by the routines (and normally the routines will continue reading until this number has been found) the character (</> will end the read call forthwith, any further characters beyond (</> on the same line, being ignored. Thus (</> can be used for the protection of further data or as a method of retaining the existing values for all further variables of the read call.

For all the routines except the two-dimensional and three-dimensional array routines, \$ has the same effect as /. For two-dimensional arrays, \$\$ is needed to end the read while \$ terminates the reading for the current row or column. Similarly with three-dimensional arrays, \$\$\$ ends the read, while \$ ends the current row or column and \$\$ ends the current row and column.

It should be noted that \$ and / have no effect if contained within an alphanumeric comment (see section 2.4).

2.6 Warnings

Under certain conditions the routines generate warning messages. These messages are output to device 50, but can be suppressed altogether by setting the input parameter IDENT to zero. It should be noted that generation of a warning will not stop the program. However, even if the warning messages are suppressed, the output parameter IERR, which is normally positive, is set negative if a warning has been generated, so that the user may take appropriate action to stop the program automatically if he wishes.

Details of the warning messages are given in section 3.2, but the conditions for which they are generated are listed below. In the input scheme described here, the standard data delimiters are assumed to be < > or < , >. Other characters can appear immediately adjacent to data, but will generate warning messages unless otherwise stated.

Specifically, if a number does not start at the beginning of a new line, is not immediately preceded by < , >, < " , or < ' or is not immediately followed by < , >, < - >, < + >, < " , < ' , < \$ >, < / > or the end of a line, a warning message locating the position of the offending character is generated. An exception is the character < * > when used to denote multiple data (see section 2.3). Similarly if an exponent contains other than < >, < + >, < - > or digits, a warning is generated.

In addition, if real data is encountered in a routine for reading integer values, the value is set to the nearest whole number and a warning is generated.

Examples of various acceptable data lines and ones which will generate warnings are given below.

- (a) 123,456,789 or 123 456 789 will not generate a warning;
- (b) 123"ABC"456 will not generate a warning, but 123ABC456 will generate two warnings;

- (c) $+3.78-2.63-1.97+2.96$ will not generate a warning;
- (d) $52*1.97$ will not generate a warning since multiple data will be assumed, but $52**1.97$ will generate two warnings;
- (e) 1,3,4.2,5, if read by an integer read routine will generate a warning and the third value will be set to 4.

3 THE PROGRAMS

The programs comprise 24 subroutines:

READ1,READ2,...,READ9	- read from one to nine real variables,
READI1,READI2,...,READI9	- read from one to nine integer variables,
READA	- read a one-dimensional real array,
READIA	- read a one-dimensional integer array,
READB	- read a two-dimensional real array,
READIB	- read a two-dimensional integer array,
READC	- read a three-dimensional real array,
READIC	- read a three-dimensional integer array.

In addition the following subroutines are used:

VAR9	- called by READ1,...,READ9. VAR9 reads nine real variables using READA,
IVAR9	- called by READI1,...,READI9. IVAR9 reads nine integer variables using READIA,
ARRAY	- called by READA, READB, READC, READIA, READIB, READIC. ARRAY reads real or integer variables into an array,
FFORM	- called by ARRAY. FFORM translates a line of characters into numerical values according to the rules proposed in section 2.

All the routines are written in standard Fortran IV. The characters $\langle \rangle$ and $\langle ' \rangle$, while not included in the standard character set are available in Fortran on most computers and have been used in the routines. Within the routines it is assumed that characters are input from unit IUNIT and that warnings are printed on unit 50. Each "READ" statement should be associated with a whole number of lines of data (that is, data for two "READ" statements should not occur on the same line).

In the remainder of this section the routines are specified in more detail. The "READ" routines, together with VAR9 and IVAR9 are fairly straightforward in terms of logic and hence these are presented with a brief specification and listing. Subroutines ARRAY and FFORM are logically more complex and flow diagrams and annotated listings are included.

3.1 Specification of subroutines

3.1.1 READ1, READ2, ..., READ9, READI1, READI2, ..., READI9

Purpose	To read from one to nine real (READ _n) or integer (READI _n) variables in free format.
Call statements	CALL READ _n (IUNIT, IDENT, IERR, X1, ... X _n) or CALL READI _n (IUNIT, IDENT, IERR, L1, ... L _n) where $1 \leq n \leq 9$.
Input parameters	IUNIT = unit identification for data input IDENT = statement identifier and warning control: If IDENT = 0, no warnings are printed; If IDENT ≥ 1 , identified warnings are printed; If IDENT ≥ 1000 , all data are printed too.
Output parameters	IERR = number of values read x sgn where sgn = 1 if there are no warnings, = -1 if there are warnings. X1, ... X _n or L1, ... L _n ($1 \leq n \leq 9$) are set to the values read in.
Subroutines called	READ _n uses VAR9, READA, ARRAY and FFORM, READI _n uses IVAR9, READIA, ARRAY and FFORM.
Exit	The routines end when either n values have been read in or a </> or a <\$> is encountered.

3.1.2 READA, READIA

Purpose	To read a one-dimensional real (READA) or integer (READIA) array.
Call statements	CALL READA(IUNIT, IDENT, IERR, A, I1, I2) or CALL READIA(IUNIT, IDENT, IERR, IA, I1, I2)
Input parameters	IUNIT and IDENT are defined in section 3.1.1; A is a one-dimensional real array of dimension $\geq I2$, IA is a one-dimensional integer array of dimension $\geq I2$, I1, I2 are the initial and final subscripts for which data is read.
Output parameters	IERR is defined in section 3.1.1. The values read in are stored in A or IA.
Subroutines called	Both routines call ARRAY and FFORM.
Exit	The routines end when either I2-I1+1 values have been read in or a </> or a <\$> is encountered.

3.1.3 READB, READIB

Purpose To read a two-dimensional real (READB) or integer (READIB) array.

Call statements CALL READB(IUNIT,IDENT,IERR,B,I1,I2,NI,J1,J2,NJ,IORD)
or
CALL READIB(IUNIT,IDENT,IERR,IB,I1,I2,NI,J1,J2,NJ,IORD)

Input parameters IUNIT and IDENT are defined in section 3.1.1,
I1, I2 are the initial and final values of I, and
J1, J2 are the initial and final values of J for which data
is required in the two-dimensional arrays B(I,J) or IB(I,J).
NI, NJ are the dimensions I and J respectively of B or IB.
IORD denotes the order in which the array is filled. If
IORD = 21, the subscript I varies while J remains fixed
(columns are read in matrix terms). Otherwise J varies
while I remains fixed (rows are read in matrix terms).

Output parameters IERR is defined in section 3.1.1.
The values read in are stored in B or IB.

Subroutines called Both routines call ARRAY and FFORM.

Exit The routines end when $(I2-I1+1)*(J2-J1+1)$ values have been
read in, or when a \langle / \rangle or two consecutive $\langle \$ \rangle$ characters
are encountered. In these routines, a single $\langle \$ \rangle$ denotes
the end of a sequence of the more rapidly varying sub-
script. It should be noted, however, that the appearance
of a \langle / \rangle or $\langle \$ \rangle$ on a line causes further data on that line
to be ignored. Hence two sequences terminated by $\langle \$ \rangle$
should not appear on the same line.

3.1.4 READC, READIC

Purpose To read a three-dimensional real (READC) or integer
(READIC) array.

Call statements CALL READC(IUNIT,IDENT,IERR,C,I1,I2,NI,J1,J2,NJ,K1,K2,NK,
IORD)
or
CALL READIC(IUNIT,IDENT,IERR,IC,I1,I2,NI,J1,J2,NJ,K1,K2,NK,
IORD)

Input parameters IUNIT and IDENT are defined in section 3.1.1,
I1, I2 are the initial and final values of I,
J1, J2 are the initial and final values of J, and
K1, K2 are the initial and final values of K for which data
is required in the three-dimensional arrays C(I,J,K) or
IC(I,J,K). NI, NJ, NK are the dimensions I, J and K
respectively of arrays C or IC.
IORD denotes the order in which the array is filled.
IORD = 132 means that J (identified with 2) varies most
rapidly, followed by K (identified with 3), followed by I
(identified with 1). Other significant values of IORD
are as follows:

IØRD = 231 implies JKI order,
 = 213 implies JIK order,
 = 312 implies KIJ order,
 = 321 implies KJI order,

For all other values of IØRD, the order is assumed to be IJK.

Output parameters IERR is defined in section 3.1.1.
 The values read in are stored in C or IC.

Subroutines called Both routines call ARRAY and FFORM.

Exit The routines end when $(I2-I1+1)*(J2-J1+1)*(K2-K1+1)$ values have been read in or a \langle / \rangle or three consecutive $\langle \$ \rangle$'s are encountered. In this routine a single $\langle \$ \rangle$ denotes the end of a sequence of the most rapidly varying subscript and two consecutive $\langle \$ \rangle$ characters denote the end of a two-dimensional sub-array with the two most rapidly varying subscripts.

3.1.5 VAR9, IVAR9 (subsidiary routines)

Purpose To read N real (VAR9) or integer (IVAR9) variables.

Call statements CALL VAR9(IUNIT,IDENT,IERR,N,X1,...,X9)
 or
 CALL IVAR9(IUNIT,IDENT,IERR,N,L1,...,L9)

Input parameters IUNIT and IDENT are defined in section 3.1.1.
 N is the number of variables required $1 \leq N \leq 9$.

Output parameters IERR is defined in section 3.1.1.
 X1,...,XN or L1,...,LN are the values found

Subroutines called VAR9 uses READA, ARRAY and FFORM,
 IVAR9 uses READIA, ARRAY and FFORM.

Exit The routines end when either N values have been read in or a \langle / \rangle or a $\langle \$ \rangle$, is encountered.

3.1.6 ARRAY (subsidiary routine)

Purpose To read data into a three-dimensional real or integer array.

Call statement CALL ARRAY(IUNIT,IDENT,IERR,C,NI,NJ,NK,IC,MI,MJ,MK,LIM,
 JØRD,IDIM,ININT)

Input parameters IUNIT, IDENT are defined in section 3.1.1
 ININT = 1 if ARRAY is called by an integer "READ" routine
 = 0 otherwise

NI, NJ, NK are the dimensions of a real array C(I,J,K)
 MI, MJ, MK are the dimensions of an integer array IC(I,J,K)

IDIM is the dimension of array in "READ" statement
 (=1 for reading variables)

LIM(6) is an array containing initial and final values of I, J, K for which data is required

JØRD indicates the order in which the array is filled (see section 3.1.4).

Output parameters IERR is defined in section 3.1.1.
The values read in are stored in IC if ININT = 1 or C otherwise.

Subroutines called FFORM

Exit The routine ends when the required number of data has been read, when </> is found or when <\$> is encountered for IDIM = 1, <\$\$> is found for IDIM = 2, <\$\$\$> is found for IDIM = 3.

An annotated listing of ARRAY appears in Appendix B and a flow diagram is given in Appendix A.

3.1.7 FFORM (subsidiary routine)

Purpose To read a line of characters and translate into numerical values.

Call statement CALL FFORM(IUNIT,IDENT,NREC,INEND,INWAR,NUM,AA,JDAT,ININT)

Input parameters IUNIT and IDENT are defined in section 3.1.1
NREC is the data record counter
INWAR is the number of warnings generated in current read routine
ININT = 1 for reading integers
= 0 otherwise

Output parameters AA(40) is an array for storage of numbers found
INEND = 0 if no end of read character has been found
1 if <\$> has occurred
2 if <\$\$> has occurred
3 if <\$\$\$> has occurred
4 if </> has occurred.
INWAR is the number of warnings generated in current read routine
JDAT(40) is an array to indicate if the corresponding value in AA is normal (JDAT = 1), null (= 0) or multiple (= 2)
NUM is the number of values found.

Subroutines called None

Exit The routine ends when the end of a line is reached.

An annotated listing of FFORM is given in Appendix B and a flow diagram appears in Appendix A.

3.2 Warning messages

The conditions for which warning messages are generated are defined in section 2.6. The warning messages are normally printed on device 50, but can be suppressed by setting the parameter IDENT to zero.

The first warning condition found in a routine gives the following heading:

**** DATA READ WARNINGS ****

Then one or more of the following warning messages will be given:

- (a) FOR IDENT = I, AFTER J LINES & K CHAR C_1C_2 message,
 where message is either STARTS NUMBER ,
 or ENDS NUMBER ,
 or IN EXPONENT .

Here I = identifier

 J = number of lines of data read in

 K = character count on current line

C_1C_2 are the two characters in positions K-1 and K .

- (b) FOR IDENT = I , V FOUND, INTEGER N ASSUMED,
 where I = identifier
 V = floating point value
 N = nearest integer value to V .

If IDENT \geq 1000 and a warning message has been given, the line of characters is printed out followed by a blank line with the character + showing the positions of the characters generating any warnings.

3.3 Implementation

The free-format data input scheme presented here has been implemented and tested on a number of computer systems. Up until now the routines have been used successfully on the following computers:

- 1) DEC KL10B at RAE Farnborough,
- 2) IBM 370/168 at UKAEA Harwell,
- 3) ICL 1906S at RAE Farnborough,
- 4) ICL 4130 at RAE Bedford,
- 5) Honeywell Mk III Time Sharing Service.

The only modification found to be necessary was on the ICL 4130, where the double quotation character (") is not allowed in Fortran programs. For use on the 4130,

therefore, all references to the variable IDQ in routine FFORM should be deleted. (The inclusion of alphanumeric comments can still be achieved, of course, by the use of single quotes ''.)

The core requirements for the data input scheme depend on how many of the 'READ' routines are called. For example, each of the individual READn routines requires approximately 40 words, but the call will also involve READA (80 words), VAR9 (200 words), ARRAY (600 words) and FFORM (1800 words). Calling all 24 'READ' routines would need approximately 4K, but, for typical usage, involving say six of the routines the storage requirement would amount to 3K.

Experience has shown that the 'READ' routines are between 10 and 15 times slower than using the normal Fortran formatted input. Typically, on the DEC KL10, 1000 numbers can be input in less than 10 seconds.

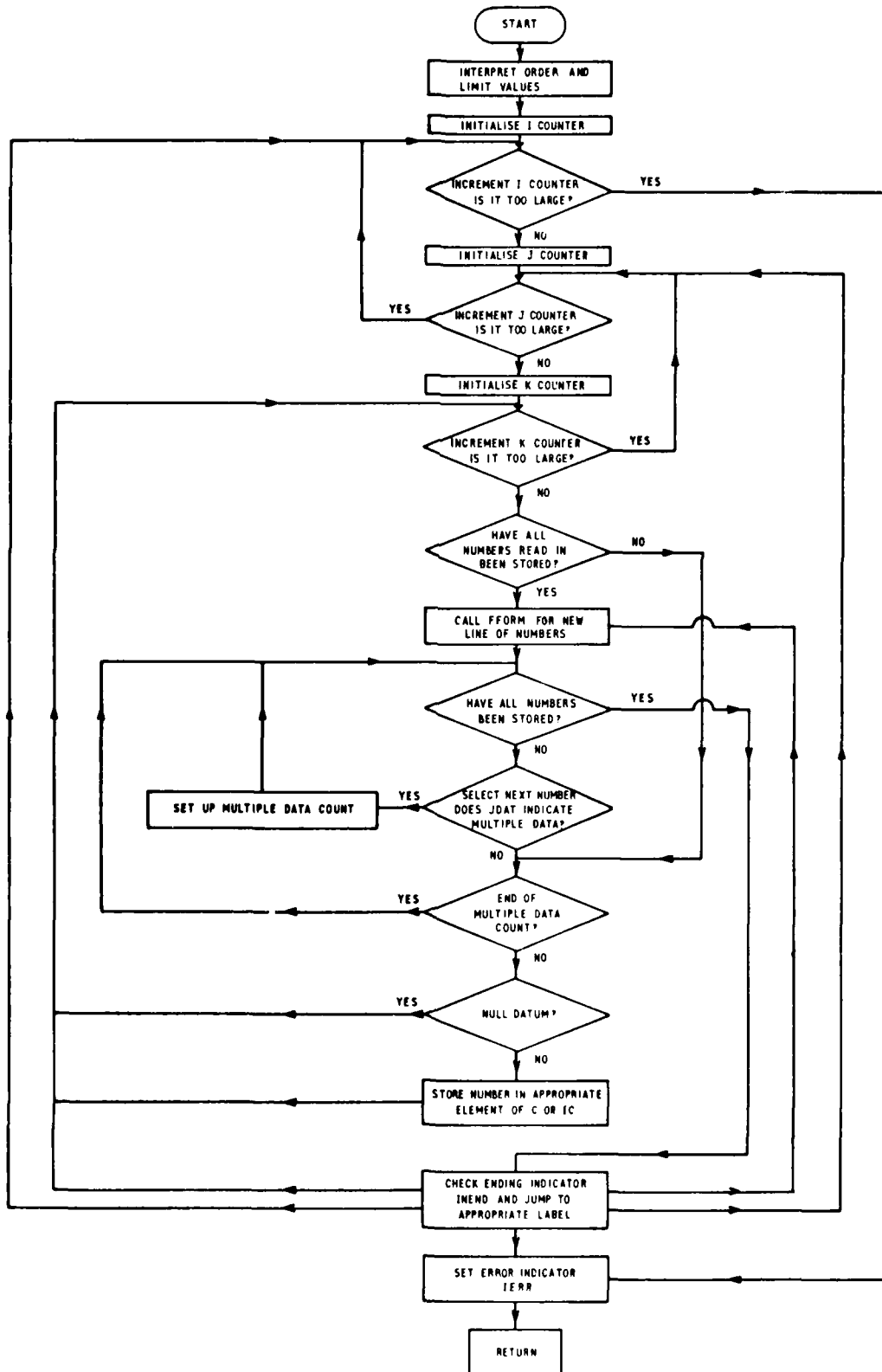
On the RAE DEC KL10B, the read system is implemented for the users' convenience in SYS: RAE LIB. A help file HELP FOREAD gives details, and a program called by RUN READEM gives a demonstration of the system. In practical use on the DEC, the read system has been found to be reliable and very accommodating. The error warnings on the DEC are arranged to appear on device 5, that is at the user's teletype or in the LOG file for batch runs.

4 CONCLUDING REMARKS

Routines, written in Fortran IV, for the input of numerical data in free-format have been described. Provided a set of simple rules are obeyed, the scheme gives the user the flexibility to format data in the most convenient way. Additional features include provision for input variables to retain their previous values (null data), for identical consecutive data to be described in a simplified form (multiple data) and for alphanumeric comments to appear amongst the data.

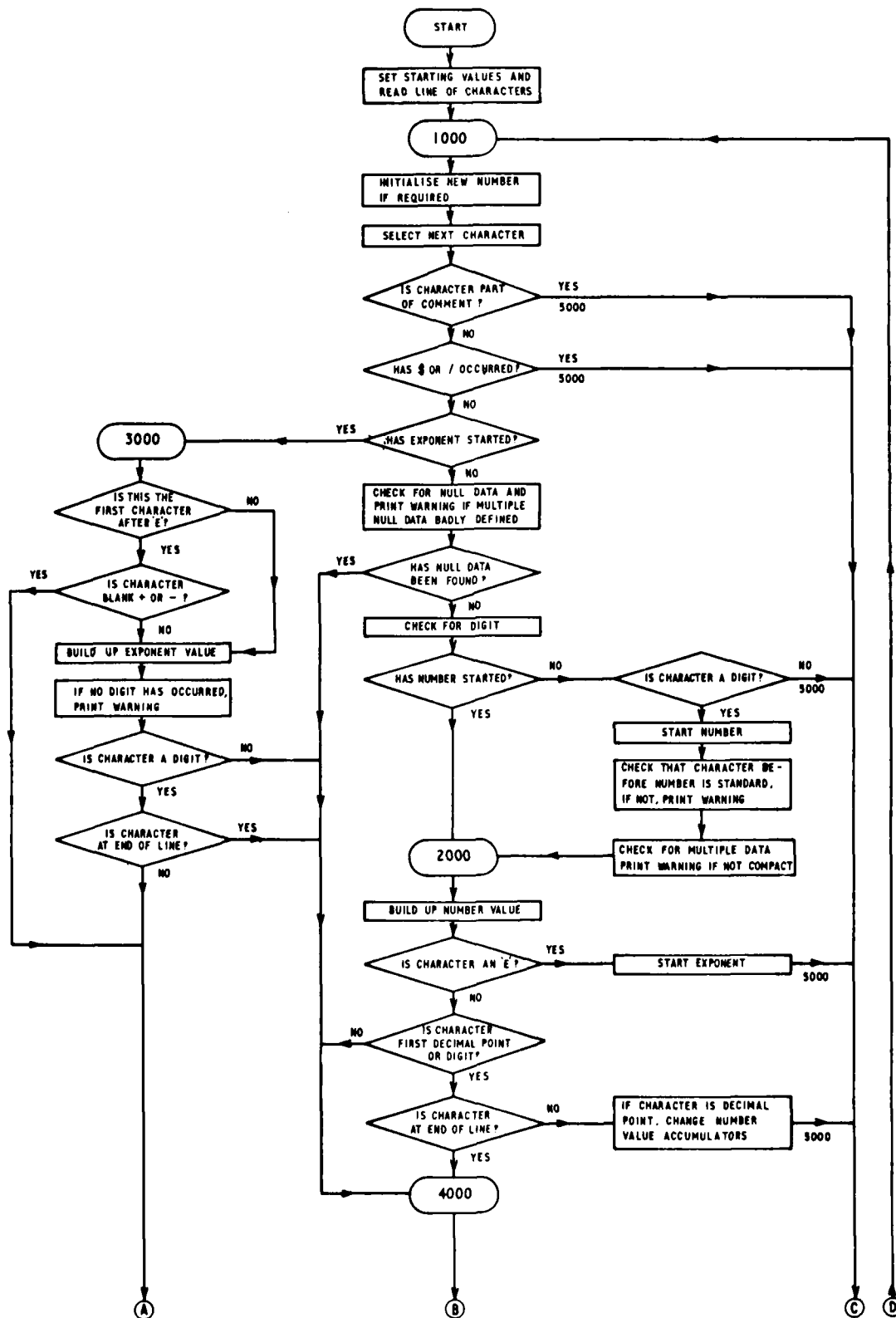
The input scheme was devised primarily to simplify the reading of data into large flow-field calculation programs which are being developed at RAE for use throughout the UK aircraft industry. For this type of program, the extra core requirements and time taken when reading in data in this way (typically less than 4K and less than 10 seconds per 1000 numbers on the DEC KL10B) are very small compared with the resources used by the program as a whole (typically 64K and 30 minutes running time). The use of standard Fortran IV throughout the routines means that programs using this input scheme can be transferred easily from one computer to another.

Appendix A
FLOW DIAGRAMS

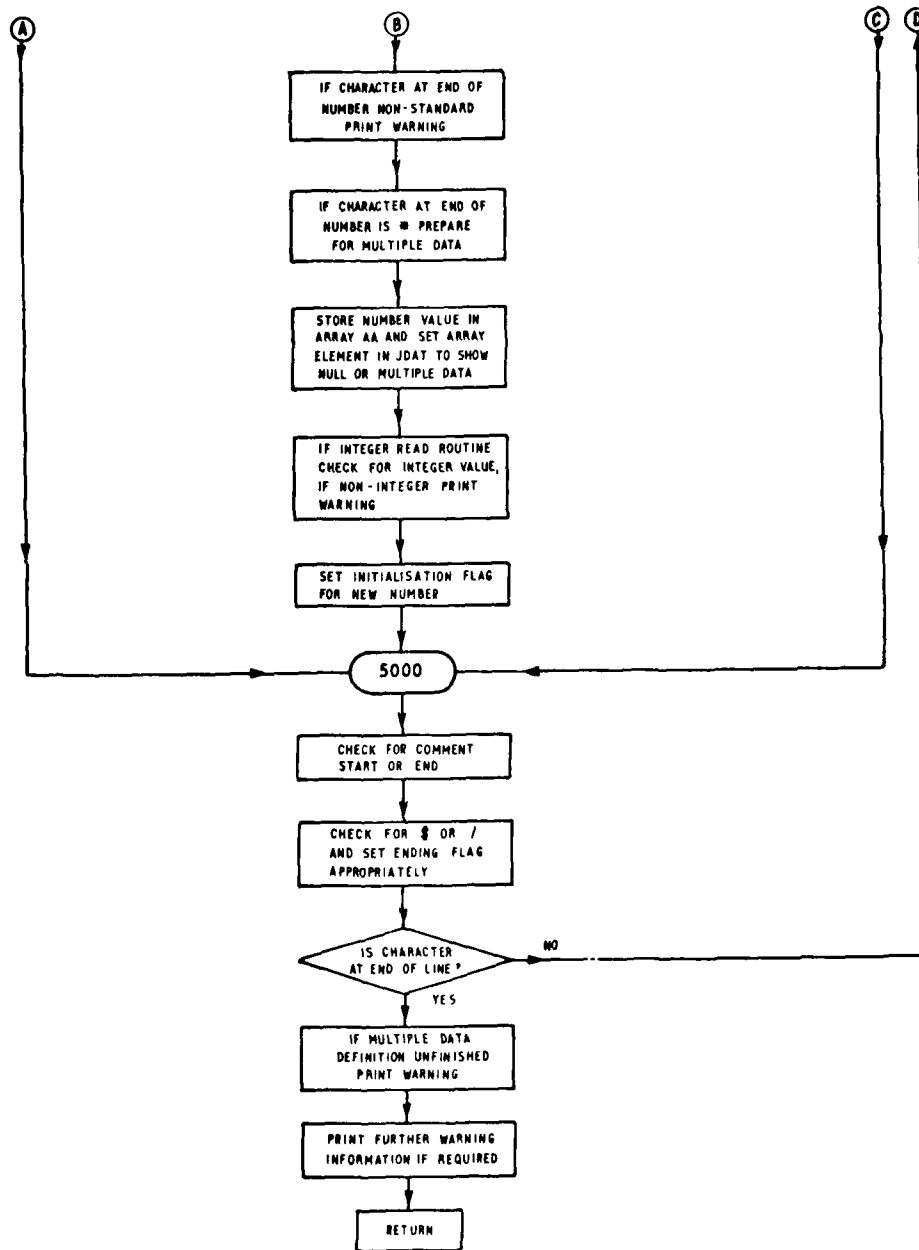


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FLOW DIAGRAM OF SUBROUTINE FFORM (1)



FLOW DIAGRAM OF SUBROUTINE FFORM (2)



Appendix BLISTINGS

```

0021 C*****
0022 C
0023 C      FORTRAN FREE-FORMAT DATA INPUT SCHEME
0024 C
0025 C      1 : READ1 TO READ9 & READ11 TO READ19
0026 C
0027 C      G BUTLER & J PIKE : MAY 73
0028 C
0029 C*****
0030 C
0031 C      THESE ROUTINES ALLOW FROM 1 TO 9 REAL OR INTEGER
0032 C      VARIABLES TO BE READ
0033 C
0034 C
0035 C      INPUT PARAMETERS
0036 C      -----
0037 C
0038 C      IDENT = IDENTIFIER AND WARNING CONTROL
0039 C              IF IDENT = 0, NO WARNINGS ARE PRINTED
0040 C              IF IDENT.GE.1, IDENTIFIED WARNINGS ARE PRINTED ON
0041 C              DEVICE 50
0042 C              IF IDENT.GE.1000, ALL DATA ARE PRINTED ON DEVICE 50
0043 C      IUNIT = DATA INPUT UNIT
0044 C
0045 C      OUTPUT PARAMETERS
0046 C      -----
0047 C
0048 C      IERR = ERROR INDICATOR
0049 C              = NUMBER OF VALUES READ MULTIPLIED BY SGN
0050 C              WHERE SGN = 1 IF NO WARNINGS HAVE OCCURRED
0051 C              SGN = -1 IF WARNINGS HAVE OCCURRED
0052 C      X1,.....,XM OR L1,.....,LM (I.E.M,LE,3) ARE SET TO THE
0053 C      VALUES FOUND
0054 C
0055 C*****
0056 C
0057 C
0058 C      SUBROUTINE READ1(IUNIT,IDENT,IERR,X1)
0059 C      CALL VAR9(IUNIT,IDENT,IERR,1,X1,X2,X3,X4,X5,X6,X7,X8,X9)
0060 C      RETURN
0061 C      END
0062 C      SUBROUTINE READ2(IUNIT,IDENT,IERR,X1,X2)
0063 C      CALL VAR9(IUNIT,IDENT,IERR,2,X1,X2,X3,X4,X5,X6,X7,X8,X9)
0064 C      RETURN
0065 C      END
0066 C      SUBROUTINE READ3(IUNIT,IDENT,IERR,X1,X2,X3)
0067 C      CALL VAR9(IUNIT,IDENT,IERR,3,X1,X2,X3,X4,X5,X6,X7,X8,X9)
0068 C      RETURN
0069 C      END
0070 C      SUBROUTINE READ4(IUNIT,IDENT,IERR,X1,X2,X3,X4)
0071 C      CALL VAR9(IUNIT,IDENT,IERR,4,X1,X2,X3,X4,X5,X6,X7,X8,X9)
0072 C      RETURN

```

```

0055     END
0056     SUBROUTINE READ5(IUNIT, IDENT, IERR, X1, X2, X3, X4, X5)
0057     CALL VAR9(IUNIT, IDENT, IERR, 5, X1, X2, X3, X4, X5, X6, X7, X8, X9)
0058     RETURN
0059     END
0060     SUBROUTINE READ6(IUNIT, IDENT, IERR, X1, X2, X3, X4, X5, X6)
0061     CALL VAR9(IUNIT, IDENT, IERR, 6, X1, X2, X3, X4, X5, X6, X7, X8, X9)
0062     RETURN
0063     END
0064     SUBROUTINE READ7(IUNIT, IDENT, IERR, X1, X2, X3, X4, X5, X6, X7)
0065     CALL VAR9(IUNIT, IDENT, IERR, 7, X1, X2, X3, X4, X5, X6, X7, X8, X9)
0066     RETURN
0067     END
0068     SUBROUTINE READ8(IUNIT, IDENT, IERR, X1, X2, X3, X4, X5, X6, X7, X8)
0069     CALL VAR9(IUNIT, IDENT, IERR, 8, X1, X2, X3, X4, X5, X6, X7, X8, X9)
0070     RETURN
0071     END
0072     SUBROUTINE READ9(IUNIT, IDENT, IERR, X1, X2, X3, X4, X5, X6, X7, X8, X9)
0073     CALL VAR9(IUNIT, IDENT, IERR, 9, X1, X2, X3, X4, X5, X6, X7, X8, X9)
0074     RETURN
0075     END
0076     C
0077     SUBROUTINE READ11(IUNIT, IDENT, IERR, L1)
0078     CALL IVAR9(IUNIT, IDENT, IERR, 1, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0079     RETURN
0080     END
0081     SUBROUTINE READ12(IUNIT, IDENT, IERR, L1, L2)
0082     CALL IVAR9(IUNIT, IDENT, IERR, 2, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0083     RETURN
0084     END
0085     SUBROUTINE READ13(IUNIT, IDENT, IERR, L1, L2, L3)
0086     CALL IVAR9(IUNIT, IDENT, IERR, 3, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0087     RETURN
0088     END
0089     SUBROUTINE READ14(IUNIT, IDENT, IERR, L1, L2, L3, L4)
0090     CALL IVAR9(IUNIT, IDENT, IERR, 4, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0091     RETURN
0092     END
0093     SUBROUTINE READ15(IUNIT, IDENT, IERR, L1, L2, L3, L4, L5)
0094     CALL IVAR9(IUNIT, IDENT, IERR, 5, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0095     RETURN
0096     END
0097     SUBROUTINE READ16(IUNIT, IDENT, IERR, L1, L2, L3, L4, L5, L6)
0098     CALL IVAR9(IUNIT, IDENT, IERR, 6, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0099     RETURN
0100     END
0101     SUBROUTINE READ17(IUNIT, IDENT, IERR, L1, L2, L3, L4, L5, L6, L7)
0102     CALL IVAR9(IUNIT, IDENT, IERR, 7, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0103     RETURN
0104     END
0105     SUBROUTINE READ18(IUNIT, IDENT, IERR, L1, L2, L3, L4, L5, L6, L7, L8)
0106     CALL IVAR9(IUNIT, IDENT, IERR, 8, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0107     RETURN
0108     END

0109     SUBROUTINE READ19(IUNIT, IDENT, IERR, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0110     CALL IVAR9(IUNIT, IDENT, IERR, 9, L1, L2, L3, L4, L5, L6, L7, L8, L9)
0111     RETURN
0112     END
*** LIST END ***

```

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0031 C*****
0032 C
0033 C      FORTRAN FREE-FORMAT DATA INPUT SCHEME
0034 C
0035 C      2 : READA, READIA, READB, READIB, READC & READIC
0036 C
0037 C      G BUTLER & J PIKE : MAY '73
0038 C
0039 C*****
0040 C
0041 C      READA READS A ONE-DIMENSIONAL REAL ARRAY
0042 C      READB READS A TWO-DIMENSIONAL REAL ARRAY
0043 C      READC READS A THREE-DIMENSIONAL REAL ARRAY
0044 C      READIA READS A ONE-DIMENSIONAL INTEGER ARRAY
0045 C      READIB READS A TWO-DIMENSIONAL INTEGER ARRAY
0046 C      READIC READS A THREE-DIMENSIONAL INTEGER ARRAY
0047 C
0048 C
0049 C      INPUT PARAMETERS
0050 C      -----
0051 C
0052 C      IDENT = IDENTIFIER AND WARNING CONTROL
0053 C      IUNIT = DATA INPUT UNIT
0054 C      A IS A ONE-DIMENSIONAL REAL ARRAY OF DIMENSION .GE. I2
0055 C      B IS A TWO-DIMENSIONAL REAL ARRAY OF DIMENSION NI,NJ
0056 C      C IS A THREE-DIMENSIONAL REAL ARRAY OF DIMENSION NI,NJ,NK
0057 C      IA IS A ONE-DIMENSIONAL INTEGER ARRAY OF DIMENSION .GE. I2
0058 C      IB IS A TWO-DIMENSIONAL INTEGER ARRAY OF DIMENSION NI,NJ
0059 C      IC IS A THREE-DIMENSIONAL INTEGER ARRAY OF DIMENSION NI,NJ,NK
0060 C      I1,I2 ARE THE INITIAL AND FINAL VALUES OF I,
0061 C      J1,J2 ARE THE INITIAL AND FINAL VALUES OF J,
0062 C      K1,K2 ARE THE INITIAL AND FINAL VALUES OF K,
0063 C           FOR WHICH DATA IS TO BE READ
0064 C      IORD DENOTES THE ORDER IN WHICH THE APPROPRIATE ARRAY IS FILLED
0065 C
0066 C
0067 C      OUTPUT PARAMETERS
0068 C      -----
0069 C
0070 C      IERR = ERROR INDICATOR
0071 C      THE VALUES ARE STORED IN THE APPROPRIATE ARRAY
0072 C
0073 C
0074 C*****
0075 C
0076 C      SUBROUTINE READA(IUNIT,IDENT,IERR,A,I1,I2)
0077 C      DIMENSION A(I2),IA(1),LIM(6)
0078 C      DO 1 K=1,6
0079 C      1 LIM(K)=1
0080 C      LIM(3)=11
0081 C      LIM(6)=12
0082 C      JORD=123
0083 C      CALL ARRAY(IUNIT,IDENT,IERR,A,1,1,I2,IA,1,1,1,LIM,JORD,1,0)
0084 C

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```

0055     RETURN
0056     END
0057   C
0058     SUBROUTINE READIA(IUNIT,IDENT,IERR,IA,I1,I2)
0059     DIMENSION IA(I2),A(1),LIM(6)
0060     DO 1 K=1,6
0061       1 LIM(K)=1
0062       LIM(3)=I1
0063       LIM(6)=I2
0064       JORD=123
0065       CALL ARRAY(IUNIT,IDENT,IERR,A,1,1,1,IA,1,1,I2,LIM,JORD,1,1)
0066       RETURN
0067     END
0068   C
0069     SUBROUTINE READB(IUNIT,IDENT,IERR,B,I1,I2,NI,J1,J2,NJ,IORD)
0070     DIMENSION B(NI,NJ),IB(1),LIM(6)
0071     LIM(1)=1
0072     LIM(2)=I1
0073     LIM(3)=J1
0074     LIM(4)=1
0075     LIM(5)=I2
0076     LIM(6)=J2
0077     JORD=123
0078     IF(IORD.EQ.21) JORD=132
0079     CALL ARRAY(IUNIT,IDENT,IERR,B,1,NI,NJ,IB,1,1,1,LIM,JORD,2,0)
0080     RETURN
0081     END
0082   C
0083     SUBROUTINE READIB(IUNIT,IDENT,IERR,IB,I1,I2,NI,J1,J2,NJ,IORD)
0084     DIMENSION IB(NI,NJ),B(1),LIM(6)
0085     LIM(1)=1
0086     LIM(2)=I1
0087     LIM(3)=J1
0088     LIM(4)=1
0089     LIM(5)=I2
0090     LIM(6)=J2
0091     JORD=123
0092     IF(IORD.EQ.21) JORD=132
0093     CALL ARRAY(IUNIT,IDENT,IERR,B,1,1,1,IB,1,NI,NJ,LIM,JORD,2,1)
0094     RETURN
0095     END
0096   C
0097     SUBROUTINE READC(IUNIT,IDENT,IERR,C,I1,I2,NI,J1,J2,NJ,
0098     1 K1,K2,NK,IORD)
0099     DIMENSION C(NI,NJ,NK),IC(1),LIM(6)
0100     LIM(1)=I1
0101     LIM(2)=J1
0102     LIM(3)=K1
0103     LIM(4)=I2
0104     LIM(5)=J2
0105     LIM(6)=K2
0106     JORD=123
0107     IF(IORD.EQ.132) JORD=132
0108     IF(IORD.EQ.231) JORD=231

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```
0109      IF(IORD.EQ.213) JORD=213
0110      IF(IORD.EQ.312) JORD=312
0111      IF(IORD.EQ.321) JORD=321
0112      CALL ARRAY(IUNIT,IDENT,IERR,C,NI,NJ,NK,IC,1,1,1,LIM,JORD,3,0)
0113      RETURN
0114      END
0115      C
0116      SUBROUTINE READIC(IUNIT,IDENT,IERR,IC,I1,I2,NI,J1,J2,NJ,
0117      I      K1,K2,NK,IORD)
0118      DIMENSION IC(NI,NJ,NK),LIM(6),C(1)
0119      LIM(1)=I1
0120      LIM(2)=J1
0121      LIM(3)=K1
0122      LIM(4)=I2
0123      LIM(5)=J2
0124      LIM(6)=K2
0125      JORD=123
0126      IF(IORD.EQ.132) JORD=132
0127      IF(IORD.EQ.231) JORD=231
0128      IF(IORD.EQ.213) JORD=213
0129      IF(IORD.EQ.312) JORD=312
0130      IF(IORD.EQ.321) JORD=321
0131      CALL ARRAY(IUNIT,IDENT,IERR,C,1,1,1,IC,NI,NJ,NK,LIM,JORD,3,1)
0132      RETURN
0133      END
**** LIST END ****
```

```

0001 C*****
0002 C
0003 C          FORTRAN FREE-FORMAT DATA INPUT SCHEME
0004 C
0005 C          3 : VAR9 & IVAR9
0006 C
0007 C          G BUTLER & J PIKE : MAY '73
0008 C
0009 C*****
0010 C
0011 C          VAR9 READS N REAL VARIABLES (1.LE.N.LE.9)
0012 C          IVAR9 READS N INTEGER VARIABLES (1.LE.N.LE.9)
0013 C
0014 C
0015 C          INPUT PARAMETERS
0016 C          -----
0017 C
0018 C          IDENT = IDENTIFIER & WARNING CONTROL
0019 C          IUNIT = DATA INPUT UNIT
0020 C          N = NUMBER OF VARIABLES REQUIRED
0021 C
0022 C
0023 C          OUTPUT PARAMETERS
0024 C          -----
0025 C
0026 C          IERR = ERROR-INDICATOR
0027 C          X1,X2,.....,XN OR L1,L2,.....,LN ARE THE VALUES FOUND
0028 C          WHERE (1.LE.N.LE.9)
0029 C
0030 C
0031 C*****
0032 C
0033 C
0034 C          SUBROUTINE VAR9(IUNIT, IDENT, IERR, N, X1, X2, X3, X4, X5, X6
0035 C          1      , X7, X8, X9)
0036 C          DIMENSION AA(9)
0037 C          AA(1)=X1
0038 C          AA(2)=X2
0039 C          AA(3)=X3
0040 C          AA(4)=X4
0041 C          AA(5)=X5
0042 C          AA(6)=X6
0043 C          AA(7)=X7
0044 C          AA(8)=X8
0045 C          AA(9)=X9
0046 C          CALL READ9(IUNIT, IDENT, IERR, AA, 1, N)
0047 C          X1=AA(1)
0048 C          X2=AA(2)
0049 C          X3=AA(3)
0050 C          X4=AA(4)
0051 C          X5=AA(5)
0052 C          X6=AA(6)
0053 C          X7=AA(7)
0054 C          X8=AA(8)

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```
0055     X9=AA(9)
0056     RETURN
0057     END
0058 C
0059     SUBROUTINE IVAR9(IUNIT, IDENT, IERR, N, L1, L2, L3, L4, L5, L6
0060     1     , L7, L8, L9)
0061     DIMENSION LA(9)
0062     LA(1)=L1
0063     LA(2)=L2
0064     LA(3)=L3
0065     LA(4)=L4
0066     LA(5)=L5
0067     LA(6)=L6
0068     LA(7)=L7
0069     LA(8)=L8
0070     LA(9)=L9
0071     CALL REDIA(IUNIT, IDENT, IERR, LA, 1, N)
0072     L1=LA(1)
0073     L2=LA(2)
0074     L3=LA(3)
0075     L4=LA(4)
0076     L5=LA(5)
0077     L6=LA(6)
0078     L7=LA(7)
0079     L8=LA(8)
0080     L9=LA(9)
0081     RETURN
0082     END
**** LIST END ****
```

```

0001 C*****
0002 C
0003 C          FORTRAN FREE-FORMAT DATA INPUT SCHEME
0004 C
0005 C          4 : ARRAY
0006 C
0007 C          G BUTLER & J PIKE : MAY '73
0008 C
0009 C*****
0010 C
0011 C          ARRAY READS DATA INTO THE THREE-DIMENSIONAL REAL ARRAY C OR
0012 C          THE THREE-DIMENSIONAL INTEGER ARRAY IC , ACCORDING TO THE
0013 C          VALUE OF THE PARAMETER ININT
0014 C
0015 C
0016 C          INPUT PARAMETERS
0017 C          -----
0018 C
0019 C          IDENT = IDENTIFIER & WARNING CONTROL
0020 C          IUNIT = DATA INPUT UNIT
0021 C          NI,NJ,NK = DIMENSIONS OF REAL ARRAY C
0022 C          MI,MJ,MK = DIMENSIONS OF INTEGER ARRAY IC
0023 C          IDIM = DIMENSION OF ARRAY IN CALLING ROUTINE
0024 C          ININT = 1 FOR READING INTEGERS , 0 OTHERWISE
0025 C          LINK6) = ARRAY CONTAINING INITIAL AND FINAL
0026 C                   VALUES OF I,J & K FOR WHICH DATA IS REQUIRED
0027 C          JORD = ORDER IN WHICH THE ARRAY IS FILLED
0028 C
0029 C
0030 C          OUTPUT PARAMETERS
0031 C          -----
0032 C
0033 C          IERR= ERROR INDICATOR
0034 C          VALUES READ IN ARE STORED IN IC IF ININT= 1,
0035 C          OR C OTHERWISE.
0036 C
0037 C
0038 C          OTHER PARAMETERS
0039 C          -----
0040 C
0041 C          AA(40) = ARRAY FOR NUMBER RETURN FROM FFORM
0042 C          INEND = ENDING INDICATOR
0043 C          INWAR = WARNING INDICATOR
0044 C          JDAT(40) = ARRAY TO INDICATE IF CORRESPONDING AA VALUE
0045 C                   IS NULL OR MULTIPLE
0046 C          KM = MULTIPLE DATA COUNTER
0047 C          KN = COUNTER FOR STORING CURRENT LINE
0048 C          MULT = MULTIPLIER FOR MULTIPLE DATA
0049 C          NCOUNT = COUNTER FOR NUMBERS FOUND
0050 C          NREC = DATA LINE COUNTER
0051 C          NUM = NUMBER OF VALUES FOUND ON CURRENT LINE
0052 C
0053 C
0054 C

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0055 C          ICOUNT, JCOUNT, KCOUNT REFER TO A " NATURAL "
0056 C          COUNTING ORDER, WITH K VARYING MORE RAPIDLY
0057 C          THAN J, WHICH IN TURN VARIES MORE RAPIDLY THAN
0058 C          I. THE ICOUNT, JCOUNT, KCOUNT VALUES FOR ANY
0059 C          DATA ITEM ARE THEN RELATED TO ITS ADDRESS IN
0060 C          ARRAY C OR D USING II, JJ, KK DERIVED FROM THE
0061 C          ORDER PARAMETER JORD.
0062 C
0063 C
0064 C *XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0065 C
0066 C
0067 C          SUBROUTINE ARRAY(IUNIT, IDENT, IERR, C, NI, NJ, NK, IC, MI, MJ, MK,
0068 C          I LIM, JORD, IDIM, ICONT)
0069 C          DIMENSION C(NI, NJ, NK), IC(MI, MJ, MK), PA(40), IDAT(40), LIM(6)
0070 C .....
0071 C          INTERPRET ORDER AND LIMIT VALUES.
0072 C          II=JORD/100
0073 C          JJ=(JORD-100*II)/10
0074 C          KK=JORD-100*II-10*JJ
0075 C          NI1=LIM(1)
0076 C          NI2=LIM(II+3)
0077 C          NJ1=LIM(3)
0078 C          NJ2=LIM(JJ+3)
0079 C          NK1=LIM(5)
0080 C          NK2=LIM(KK+3)
0081 C          NUM=0
0082 C          INVAR=0
0083 C          KN=1
0084 C          MULT=0
0085 C          KM=0
0086 C          NREC=0
0087 C          NCCOUNT=0
0088 C .....
0089 C          INITIALISE I COUNTER.
0090 C          ICOUNT=NI1-1
0091 C .....
0092 C          INCREMENT I COUNTER AND CHECK
0093 C          IF TOO LARGE?
0094 C          11 CONTINUE
0095 C          ICOUNT=ICOUNT+1
0096 C          IF(ICOUNT.GT.NI2) GO TO 21
0097 C .....
0098 C          INITIALISE J COUNTER.
0099 C          JCOUNT=NJ1-1
0100 C .....
0101 C          INCREMENT J COUNTER AND CHECK
0102 C          IF TOO LARGE ?
0103 C          12 CONTINUE
0104 C          JCOUNT=JCOUNT+1
0105 C          IF(JCOUNT.GT.NJ2) GO TO 11
0106 C .....
0107 C          INITIALISE K COUNTER.
0108 C          KCOUNT=NK1-1

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```

0129 C .....
0110 C INCREMENT K COUNTER AND CHECK
0111 C IF TOO LARGE ?
0112 13 CONTINUE
0113 KCOUNT=KCOUNT+1
0114 IF(KCOUNT.GT.NK2) GO TO 12
0115 C .....
0116 C HAVE ALL NUMBERS READ IN
0117 C BEEN STORED ?
0118 IF(KN.LE.NUM) GO TO 17
0119 C .....
0120 C CALL FFORM FOR NEW NUMBERS.
0121 14 CONTINUE
0122 NREC=NREC+1
0123 CALL FFORM(IUNIT, IDENT, NREC, INEND, INWAR, NUM, AA, JDAT, ININT)
0124 KN=0
0125 C .....
0126 C HAVE ALL NUMBERS READ IN
0127 C BEEN STORED ?
0128 15 CONTINUE
0129 MULT=1
0130 KM=0
0131 16 CONTINUE
0132 KN=KN+1
0133 IF(KN.GT.NUM) GO TO 19
0134 C .....
0135 C SELECT NEXT NUMBER AND CHECK
0136 C FOR MULTIPLE DATA.
0137 IF(JDAT(KN).NE.2) GO TO 17
0138 C .....
0139 C SET UP MULTIPLE DATA COUNT.
0140 MULT=INT(AA(KN)+0.5)
0141 GO TO 15
0142 C .....
0143 C END OF MULTIPLE DATA COUNT ?
0144 17 CONTINUE
0145 KM=KM+1
0146 IF(KM.GT.MULT) GO TO 15
0147 C .....
0148 C NULL DATUM ?
0149 NCOUNT=NCOUNT+1
0150 IF(JDAT(KN).EQ.0) GO TO 13
0151 C .....
0152 C STORE NUMBER IN APPROPRIATE
0153 C ELEMENT OF C OR IC .
0154 LIM(1)=ICOUNT
0155 LIM(2)=JCOUNT
0156 LIM(3)=KCOUNT
0157 IF(ININT.EQ.1) GO TO 18
0158 C(LIM(1),LIM(2),LIM(3))=AA(KN)
0159 GO TO 13
0160 18 CONTINUE
0161 IDUM=INT(AA(KN)+0.5)
0162 IF(AA(KN).LE.-0.5) IDUM=IDUM-1

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```
0153      IC(LIM(1),LIM(2),LIM(3))=IDUM
0154      GO TO 13
0155 C.....
0156 C      CHECK ENDING INDICATOR INEND
0157 C      AND JUMP TO APPROPRIATE LABEL.
0158      19 CONTINUE
0159      IF(INEND.GE.IDIM) GO TO 21
0170      IF(NUM.NE.0) GO TO 20
0171      IF(INEND.EQ.1) GO TO 12
0172      IF(INEND.EQ.2) GO TO 11
0173      20 CONTINUE
0174      IF(INEND.EQ.1.AND.KCOUNT.NE.NK1) GO TO 12
0175      IF(JCOUNT.EQ.NJ1.AND.KCOUNT.EQ.NK1) GO TO 14
0176      IF(INEND.EQ.2) GO TO 11
0177      GO TO 14
0178 C.....
0179 C      SET ERROR INDICATOR IERR .
0180      21 CONTINUE
0181      IERR=NCOUNT
0182      IF(INUAR.NE.0) IERR=-IERR
0183 C.....
0184 C      RETURN.
0185      RETURN
0186      END
***** LIST END *****
```



```

0051 C      IPL = PLUS
0052 C      IPT = POINT
0053 C      ISL = SLASH
0054 C      ISQ = SINGLE QUOTES
0055 C      IST = STAP
0056 C
0057 C
0058 C      OTHER PARAMETERS
0059 C      -----
0070 C
0071 C      IWP = CONTROL PARAMETER FOR WARNING RETURN
0072 C      J = CURRENT CHARACTER
0073 C      JCH(20) = CHARACTER STORAGE ARRAY
0074 C      JP = PREVIOUS CHARACTER
0075 C      JPOS(89) = WARNING POSITION STORAGE ARRAY
0076 C      JO = CHARACTER BEFORE JP
0077 C      K = COUNTER FOR CHARACTERS
0078 C      KNOL = POSITION OF * FOR MULTIPLE DATA
0079 C      KP = LAST NON-BLANK CHARACTER
0080 C      KPOS = POSITION OF LAST NON-BLANK CHARACTER
0081 C      LE = ACCUMULATOR FOR EXPONENT
0082 C      LSG = SIGN OF EXPONENT
0083 C      LY = ACCUMULATOR FOR DECIMAL PLACES
0084 C      NCH = NUMBER OF CHARACTERS PER LINE
0085 C      NUM = COUNTER FOR NUMBERS FOUND
0086 C      SG = SIGN OF NUMBER
0087 C      X = ACCUMULATOR FOR DIGITAL VALUES
0088 C
0089 C
0090 C *****
0091 C
0092 C
0093 C      SUBROUTINE FFORM(UNIT, IDENT, NREC, INEND, INVAR, NUM, AA, JDAT, ININT)
0094 C      DIMENSION JCH(20), IDI(10), JPOS(20), AA(20), JDAT(40)
0095 C      DATA IDI(1)/1H0/, IDI(2)/1H1/, IDI(3)/1H2/, IDI(4)/1H3/,
0096 C      1 IDI(5)/1H4/, IDI(6)/1H5/, IDI(7)/1H6/, IDI(8)/1H7/,
0097 C      2 IDI(9)/1H8/, IDI(10)/1H9/,
0098 C      3 1SL/1H /, 1CM/1H /, 1PT/1H ., 1MI/1H %, 1BL/1H +,
0099 C      4 1EX/1H %, 1SQ/1H ", 1DQ/1H ", 1DOL/1H $, 1ET/1H *, 1SL/1H //
0100 C
0101 C      ..... READ LINE OF CHARACTERS
0102 C      & SET STARTING VALUES.
0103 C
0104 C      TEN=10.0
0105 C      NCH=89
0106 C      DO 1 M=1,NCH
0107 C      JCH(M)=1BL
0108 C      JPOS(M)=1B.
0109 C      1 CONTINUE
0110 C      NC=M-1
0111 C      JCH(NC+1)=1BL
0112 C      READ (UNIT,500) (JCH(M),M=1,NCH)
0113 C      INEND=0
0114 C      INCOM=0
0115 C      INNL=0
0116 C      INVAR=INVAR
0117 C      SUM=0
0118 C      J=JCH
0119 C      JP=J
0120 C      KP=J
0121 C      K=0

```

```

0121          INIT=1
0122 C .....
0123 C ..... LABEL 1000 .
0124 C 1000 CONTINUE
0125 C .....
0126 C ..... INITIALISE NEW NUMBER
0127 C ..... IF REQUIRED.
0128          IF(INIT.NE.1) GO TO 2
0129          SG=1.0
0130          K=0.0
0131          LY=0
0132          LZ=0
0133          LE=0
0134          LSG=1
0135          INNUM=0
0136          INPAT=0
0137          INEXP=0
0138          INDAT=1
0139          INLT=0
0140          2 CONTINUE
0141 C .....
0142 C ..... SELECT NEXT CHARACTER.
0143          K=K+1
0144          JQ=J
0145          JF=J
0146          IF(J.NE.IBL) KP=J
0147          IF(J.NE.IBL) KPOS=K-1
0148          J=JQ
0149 C .....
0150 C ..... IS CHARACTER PART OF COMMENT ?
0151          IF(INCOM.EQ.1) GO TO 5000
0152 C .....
0153 C ..... HAS ENDING CHARACTER OCCURRED ?
0154          IF(INEND.GT.0) GO TO 5000
0155 C .....
0156 C ..... HAS EXPONENT STARTED ?
0157          IF(INEXP.GT.0) GO TO 5000
0158 C .....
0159 C ..... CHECK FOR NULL DATA AND PRINT
0160 C ..... WARNING IF MULTIPLE NULL DATA
0161 C ..... ONLY OBTAINED.
0162          II=0
0163          IF(J.EQ.ICM) II=1
0164          IF(J.EQ.IGL) II=1
0165          IF(J.EQ.IOD) II=1
0166          IF(II.EQ.0) GO TO 3
0167          IF(KP.EQ.1) INPAT=0
0168          IF(INNUM.GT.0) GO TO 3
0169          IF(INMULT.EQ.1) GO TO 3
0170          IF(INC1.EQ.KPOS) INPAT=0
0171          IF(INC1.EQ.KPOS) GO TO 3
0172          II=5
0173          STATNUM=1
0174          STAT=0
0175          IPRINT=1
0176          GO TO 010
0177          3 CONTINUE
0178 C .....
0179 C ..... HAS NULL DATA BEEN FOUND ?
0180          IF(INCOM.EQ.0) GO TO 4000

```

```

0151 C .....
0152 C CHECK FOR DIGIT.
0153 C     INDIG=0
0154 C     DO 4 M=1,10
0155 C     IF(J.EQ.IDI(M)) INDIG=1
0156 C     4 CONTINUE
0157 C .....
0158 C     HAS NUMBER STARTED ?
0159 C     IF(INNUM.GT.0) GO TO 2000
0160 C .....
0161 C     IS CHARACTER A DIGIT?
0162 C     IF(INDIG.EQ.0) GO TO 5000
0163 C .....
0164 C     START NUMBER.
0165 C     INNUM=1
0166 C .....
0167 C     CHECK WHETHER CHARACTER
0168 C     BEFORE NUMBER IS STANDARD.
0169 C     IF(JP.EQ.IPL) INNUM=2
0170 C     IF(JP.EQ.PMI) INNUM=2
0171 C     IF(JP.EQ.MI) SG=-1.0
0172 C     IF(JP.EQ.I3L) INNUM=NCH
0173 C     IF(JP.EQ.ICM) INNUM=NCH
0174 C     IF(JP.EQ.IDQ) INNUM=NCH
0175 C     IF(JP.EQ.ISQ) INNUM=NCH
0176 C     IF(JP.NE.IPT) GO TO 5
0177 C     INPT=1
0178 C     LZ=1
0179 C     LY=-1
0180 C     IF(JQ.EQ.IPL) INNUM=3
0181 C     IF(JQ.EQ.PMI) INNUM=3
0182 C     IF(JQ.EQ.MI) SG=-1.0
0183 C     IF(JQ.EQ.I3L) INNUM=NCH
0184 C     IF(JQ.EQ.ICM) INNUM=NCH
0185 C     IF(JQ.EQ.IDQ) INNUM=NCH
0186 C     IF(JQ.EQ.ISQ) INNUM=NCH
0187 C     IF(INMUL.EQ.1.AND.JQ.EQ.IST) INNUM=2
0188 C     5 CONTINUE
0189 C .....
0190 C     CHECK FOR MULTIPLE DATA.
0191 C     PRINT WARNING IF NON-COMPACT.
0192 C     IF(INMUL.NE.1) GO TO 6
0193 C     KPDS=K-INNUM
0194 C     IF(KMUL.EQ.KPDS) INNUM=2
0195 C     IF(KMUL.EQ.KPDS) GO TO 6
0196 C     IS=5
0197 C     JGT(NUM)=1
0198 C     INPL=0
0199 C     LEFT=KMUL
0200 C     GO TO 500
0201 C .....
0202 C     PRINT WARNING FOR NON-STANDARD
0203 C     CHARACTER BEFORE NUMBER.
0204 C     6 CONTINUE
0205 C     IF(INNUM.GT.1) GO TO 2000
0206 C     IS=1
0207 C     GO TO 500
0208 C .....
0209 C     LABEL 2000.
0210 C     2000 CONTINUE

```

```

0241 C .....
0242 C BUILD UP NUMBER VALUE.
0243 LY=LY+LZ
0244 X1=X*10.0
0245 DO 7 M=1,10
0246 IF(J.EQ.101(M)) X=FLOAT(M-1)+X1
0247 7 CONTINUE
0248 C .....
0249 C IS CHARACTER AN E?
0250 C IF SO START EXPONENT.
0251 IF(J.EQ.IEX) INEXP=1
0252 IF(J.EQ.IEX) GO TO 3000
0253 C .....
0254 C IS CHARACTER FIRST DECIMAL
0255 C POINT OR DIGIT ?
0256 IF(J.EQ.IPT.AND.INPNT.NE.1) INDIG=2
0257 IF(J.EQ.IPT) INPNT=1
0258 IF(INDIG.EQ.0) GO TO 4000
0259 C .....
0260 C IS CHARACTER AT END OF LINE ?
0261 IF(K.EQ.NCHP1) GO TO 4000
0262 C .....
0263 C IF CHARACTER IS DEC. POINT,
0264 C CHANGE NUMBER VALUE ACCUMULATORS.
0265 IF(J.EQ.IPT) LZ=1
0266 IF(J.EQ.IPT) LY=-1
0267 GO TO 5000
0268 C .....
0269 C LABEL 3000 : UPDATE EXPONENT.
0270 3000 CONTINUE
0271 C .....
0272 C IS THIS THE FIRST CHARACTER
0273 C AFTER E ?
0274 IF(INEXP.GT.1) GO TO 8
0275 C .....
0276 C IS CHARACTER BLANK + OR - ?
0277 IF(J.EQ.IPL) INEXP=2
0278 IF(J.EQ.IPL) INEXP=2
0279 IF(J.EQ.IHD) INEXP=2
0280 IF(J.EQ.IHD) LSG=-1
0281 IF(INEXP.GT.1) GO TO 5000
0282 C .....
0283 C BUILD UP EXPONENT VALUE.
0284 8 CONTINUE
0285 LE=LLEN-10
0286 INDIG=0
0287 DO 9 N=1,10
0288 IF(J.NE.101(M)) GO TO 9
0289 LE=(N-1+LE)
0290 INEXP=5
0291 INDIG=1
0292 9 CONTINUE
0293 C .....
0294 C IF NO DIGIT HAS OCCURRED IN
0295 C EXPONENT, PRINT WARNING.
0296 IF(INEXP.EQ.3) GO TO 10
0297 TMP=2
0298 GO TO 300
0299 10 CONTINUE
0300 C .....

```

```

0321 C          IS CHARACTER A DIGIT ?
0322 C          IF(INDIG.EQ.0) GO TO 4000
0323 C .....
0324 C          IS CHARACTER AT END OF LINE ?
0325 C          IF(K.EQ.NC4P1) GO TO 4000
0326 C          GO TO 5000
0327 C .....
0328 C          LABEL 4000.
0329 C          4000 CONTINUE
0330 C .....
0331 C          CHECK WHETHER CHARACTER AT END
0332 C          OF NUMBER IS STANDARD.
0333 C          IF(J.EQ.1BL) GO TO 12
0334 C          IF(J.EQ.1PL) GO TO 12
0335 C          IF(J.EQ.1PD) GO TO 12
0336 C          IF(J.EQ.1CD) GO TO 12
0337 C          IF(J.EQ.1DD) GO TO 12
0338 C          IF(J.EQ.1SD) GO TO 12
0339 C          IF(J.EQ.1BD) GO TO 12
0340 C          IF(J.EQ.1BL) GO TO 12
0341 C          IF(J.EQ.1PL) GO TO 12
0342 C          IF(J.EQ.1PD) GO TO 12
0343 C .....
0344 C          IF CHARACTER IS * PREPARE FOR
0345 C          MULTIPLE DATA.
0346 C          IF(INMUL.GE.1) GO TO 11
0347 C          IF(CAINT.GT.0) GO TO 11
0348 C          IF(CNEND.GT.0) GO TO 11
0349 C          IF(CGLT.0.0) GO TO 11
0350 C          IF(XULT.0.5) GO TO 11
0351 C          INMUL=2
0352 C          INDAT=2
0353 C          INBL=*
0354 C          GO TO 12
0355 C          11 CONTINUE
0356 C .....
0357 C          PRINT WARNING FOR NON-STANDARD
0358 C          CHARACTER AT END OF NUMBER.
0359 C          IF(K.EQ.NC4AND.INDIG.EQ.1) GO TO 12
0360 C          IMP=1
0361 C          NPAT=*
0362 C          GO TO 000
0363 C          12 CONTINUE
0364 C .....
0365 C          STORE NUMBER VALUE IN ARRAY AA
0366 C          AND SET ARRAY IOST TO SHOW NULL
0367 C          OR MULTIPLE DATA.
0368 C          NUM=NUM*1
0369 C          LP=L68LE-1Y
0370 C          APMUM=10**TEN**LP
0371 C          IOSTNUM=INDAT
0372 C          IOSTP=INMUL-1
0373 C .....
0374 C          IF INTEGER READ ROUTINE, CHECK
0375 C          FOR INTEGER VALUE. IF NON-INTEG-
0376 C          ER FOUND, PRINT WARNING.
0377 C          IMP=1
0378 C          IF(CAINT.NE.1) GO TO 13
0379 C          IF(CNEND.NE.0) IMP=0
0380 C          IF(CNCP.NE.0) IMP=0
0381 C          IF(CNPL.NE.0) GO TO 13

```

```

0351      II=INT(AA(NUM)+0.5)
0352      IF(AA(NUM).LE.-0.5) II=II-1
0353      IMP=3
0354      GO TO 950
0355      13 CONTINUE
0356      C.....
0357      C                                  SET INITIALISATION FLAG
0358      C                                  FOR NEW NUMBER.
0359      C      INIT=1
0360      C.....
0371      C                                  LABEL 5000 .
0372      C      5000 CONTINUE
0373      C.....
0374      C                                  CHECK FOR COMMENT START OR END.
0375      C      IF(J.EQ.IDQ) INCOM=INCOM+1
0376      C      IF(J.EQ.IDQ) INCOM=INCOM+1
0377      C      IF(INCOM.EQ.1) INCOM=0
0378      C      IF(INCOM.EQ.1) GO TO 14
0379      C.....
0390      C
0391      C
0392      C                                  CHECK FOR $ OR / AND SET
0393      C                                  ENDING INDICATOR.
0394      C      IF(J.EQ.ISL) INEND=4
0395      C      IF(INEND.EQ.4) GO TO 14
0396      C      IF(J.NE.IDDL) GO TO 14
0397      C      INEND=1
0398      C      IF(J.NE.IDDL) GO TO 14
0399      C      INEND=2
0400      C      IF(J.NE.IDDL) GO TO 14
0401      C      INEND=3
0402      C      14 CONTINUE
0403      C.....
0404      C                                  IS CHARACTER AT END OF LINE ?
0405      C
0406      C
0407      C      IF(K.NE.NDHP) GO TO 1000
0408      C.....
0409      C                                  IF MULTIPLE DATA DEFINITION
0410      C                                  UNFINISHED, PRINT WARNING.
0411      C      IF(INMUL.NE.1) GO TO 15
0412      C      IMP=1
0413      C      JDAT(NUM)=1
0414      C      KPRT=KMUL
0415      C      GO TO 999
0416      C      15 CONTINUE
0417      C.....
0418      C                                  PRINT FURTHER WARNING
0419      C                                  INFORMATION IF REQUIRED.
0420      C
0421      C
0422      C      IF(IDENT.EQ.0) GO TO 17
0423      C      IF(IDENT.EQ.999) GO TO 16
0424      C      IF(INLWR.EQ.INWAS) GO TO 17
0425      C      16 CONTINUE
0426      C      M=CHP1
0427      C      21 M=M-1
0428      C      IF(JCH(M).EQ.IDL.PNT.N.NE.1) GO TO 21
0429      C      WRITE(50,540) (JCH(K),K=1,M)
0430      C      M=CHP1
0431      C      22 M=M-1
0432      C      IF(JPOS(M).EQ.IDL.PNT.N.NE.1) GO TO 21
0433      C      IF(INLWR.NE.INWAS) WRITE(50,543) (JPOS(K),K=1,M)
0434      C      IF(IDENT.EQ.999) GO TO 17
0435      C      IF(INLWR.EQ.IDL.PNT.N.NE.1) WRITE(50,550) (AA(K),K=1,NUM)

```


Appendix CUSERS' GUIDE TO FORTRAN FREE-FORMAT INPUT SCHEME

The scheme enables free-format data to be read into various arrangements of the prescribed variables. Each routine starts on a new line of data and continues until either the specified number of numbers has been read or an end of read symbol (/ or \$) is found. The routines are designed to read anything. When ambiguous or unconventional data is encountered, the most reasonable interpretation is taken and a warning message is output. A read failure can only occur from a system failure, for example if the number is too big for the computer or an attempt is made to read beyond the end of a file.

Various calls are permitted to give maximum flexibility in the choice of input variables. The scheme is programmed in standard Fortran IV and has been tested on a wide range of computers. Data prepared in accordance with the latest FOR77 recommendations for free-format data input are compatible with the read routines.

The read routine calls

For real numbers,

n real numbers (where n represents an integer $1 \leq n \leq 9$)	READn
one-dimensional real array	READA
two-dimensional real array	READB
three-dimensional real array	READC

and for integer numbers, similarly,

n integer numbers	READIn
one-dimensional integer array	READIA
two-dimensional integer array	READIB
three-dimensional integer array	READIC .

The parameters are,

READn (IUNIT, IDENT, IERR, X1, ..., Xn)
READA (IUNIT, IDENT, IERR, A, I1, I2)
READB (IUNIT, IDENT, IERR, B, I1, I2, NI, J1, J2, NJ, IORD)
READC (IUNIT, IDENT, IERR, C, I1, I2, NI, J1, J2, NJ, K1, K2, NK, IORD)

with those for the integer reads being identical, except that the real names X1, ..., Xn, A, B, C are replaced by the integer variables I1, ..., In. IA, IB and IC. In detail the parameters have the values:

IUNIT input device number.

IDENT identification number. This is a number which appears in warning messages to identify which read call has generated the warning. It is also used to control the type of warning message output. IDENT = 0 suppresses all error output and IDENT \geq 1000 provides a complete list of the symbols read by the read routine.

IERR is a variable name which is given a value at the end of the read call. Its value is set to sign *N where N is the number of numbers found and 'sign' is +1, except when a warning connected with ambiguous or unconventional data is given when it is set to -1. It should be noted that suppressing the output with IDENT = 0 does not affect the operation of IERR. It is anticipated that the main use of IERR will be to control 'batch' running (eg to prevent programs running if ambiguities are present in the initial data input).

X1,...,Xn n real variable names.

A, I1, I2 A is a one-dimensional real array name and the numbers are read into elements A(I1) to A(I2). That is (I2 - I1 + 1) numbers are read into consecutive locations in the array.

B, I1, I2, NI, J1, J2, NJ B is a two-dimensional array of dimensions NI, NJ and the numbers are read into B(I,J) where $I1 \leq I \leq I2$ and $J1 \leq J \leq J2$ (see IORD).

C, I1, I2, NI, J1, J2, NJ, K1, K2, NK C is a three-dimensional array of dimensions NI, NJ, NK, and the numbers are read into C(I,J,K) where $I1 \leq I \leq I2$, $J1 \leq J \leq J2$ and $K1 \leq K \leq K2$ (see IORD).

IORD controls the order in which the arrays are filled. For two-dimensional arrays, if IORD = 21, the subscript I varies whilst J remains fixed (that is, columns are read in matrix terms). For all other values of IORD, J varies whilst I remains fixed (rows are read in matrix terms).

For three-dimensional arrays a similar system is used; for example IORD = 132 means that J (identified with 2) varies most rapidly, followed by K (identified with 3), followed by I (identified with 1). The other significant values of IORD are as follows:

IORD = 231 implies JKI order
 213 implies JIK order
 312 implies KIJ order
 321 implies KJI order

For all other values of IORD, the order is assumed to be IJK.

Form of free format numbers

The read routines will read numbers in any of the following forms:

$\bar{S}d$, $\bar{S}.d$, $\bar{S}d.d$, $\bar{S}d.$ $\bar{S}d\bar{E}d$, $\bar{S}.d\bar{E}d$, $\bar{S}d.d\bar{E}d$, $\bar{S}.d\bar{E}d$

where d is a single digit or a compact string of digits, \bar{S} is +, -, or no character, and \bar{E} is an E, E blank, E+ or E-. Numbers are normally separated by blank or comma (delimiters). Other forms of number or delimiter will be read and accepted, but a warning message is given so that the user can check that the interpretation taken by the read routine is that intended. Some special characters may also be used without giving warning messages as is detailed below.

The following additional features have been introduced for convenience in using the system.

(1) Non-numeric comments can be inserted in the data, but a warning will be given if there is no delimiter between comments and numbers, *eg*

1.23, ABC, 2.45 will give no warning
 but 1.23ABC2.45 will give two warnings.

(2) Alphanumeric comments may be inserted by enclosing them between inverted commas (either single or double). In this case, the inverted comma is allowed as a delimiter, *eg*

1.23"AB3"2.45 will give no warning.

(3) Null data (*ie* variables retain their previous values) are denoted by commas optionally enclosing blanks, *eg* 123,, , 345 gives four numbers: 123, two null data and 345. *Note* that comma occurring as the first non-blank character on a line implies a null datum, but that comma occurring as the last non-blank character on a line does not imply an extra null-datum, *eg* , 123, 345, gives three numbers: 1 null datum, 123 and 345.

(4) Multiple data are denoted by i^* number where i is a non-negative integer, eg

3*3.14159 means three values of 3.14159
3* , means three null data.

When $*$ is used in this way, no warning is generated.

(5) The character $/$ ends the read call forthwith, and any further characters beyond the slash on the same line are ignored. Thus $/$ can be used for the protection of further data or as a method of retaining the existing values for all further variables of the read call.

For all read calls except the two-dimensional and three-dimensional array reads, $\$$ has the same effect as $/$. For two-dimensional array reads $\$$ stops the current one-dimensional sub-array and $\$\$$ stops the read. For three-dimensional array reads $\$$ stops the current one-dimensional sub-array, $\$\$$ stops the current two-dimensional sub-array and $\$\$\$$ ends the read. *Note* that $\$$ and $/$ will have no effect if included between inverted commas.

(6) Integer locations are set to the nearest whole number when supplied with real data and a warning is given. It should be noted that integers and reals cannot be mixed in the same read. Hence a Fortran

```
READ (IUNIT, FORMAT)K, A(K), B(K), C(K)
```

would need to be replaced by

```
CALL READ4 (IUNIT, IDENT, IERR, X1, X2, X3, X4)
K = INT (X1 + 0.5)
A(K) = X2
B(K) = X3
C(K) = X4 .
```

Example:

To read three numbers into the array PTS at locations 4 and 6 from input device 5, use

```
CALL READA (5, 1, IERR, PTS, 4, 6) .
```

If the characters read from device 5 are

```
X = 3.14   Y = .3E1   Z =   2
```

then a warning is given because the number 3.14 starts with an = symbol (only space or , are permitted). The form of the warning is

***** DATA READ WARNINGS *****

FOR IDENT = 1, AFTER 1 LINE AND 3 CHAR. =3 STARTS NUMBER

X = 3.14 Y = .3E1 Z = 2
+

PTS (4) to PTS (6) are set to the values 3.14, 3 and 2 respectively.

REPORT DOCUMENTATION PAGE

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17. Abstract Data for Fortran IV programs has to be in fixed format. Some users find this constraint irksome. Presented here is a data input scheme for Fortran IV which makes the minimum of demands on the data structure. If the data is well-formed and unambiguous it will be read. Ill-formed and ambiguous data will also be read and given a reasonable interpretation, with the location of the suspect data and the value assumed being output as a (suppressible) error message. The scheme also allows input variables to retain their previous values, identical consecutive data to be input in a simplified form and alphanumeric comments to appear amongst the data. The whole data input scheme is written in standard Fortran IV so that the advantages of machine transferability of the program are retained.			

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