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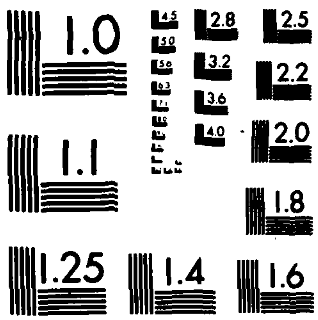

MICROCOPY RESOLUTION TEST CHART
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DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

MATERIALS RESEARCH LABORATORIES

MELBOURNE, VICTORIA

REPORT

MRL-R-877

USERSIN - AN INTERACTIVE USER-INTERFACE FOR FORTRAN SIN

E. Northeast

Approved for Public Release

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ABSTRACT

This report describes a program Usersin, written to give a quick and ready access to the necessary input data, and to provide a more convenient interactive mode for setting up a problem while the "number-crunching" remains a batch-oriented process. It is designed to be as machine independent as possible, to permit transition between computers as may be required.

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C O N T E N T S

USERSIN - AN INTERACTIVE USER-INTERFACE FOR FORTRAN SIN

1. INTRODUCTION

An increasing requirement for hydrodynamic calculations to predict explosive behaviour and weapon performance has arisen from the complexity and expense of detailed experimentation in these fields. Many explosive and weapon systems can be simulated by relatively simple one-dimensional computer codes. Phenomena such as explosive-metal interactions, fragmentation and shock studies are ideally suited to this approach.

For some years, MRL has had access to SIN[1], a Lagrangian one-dimensional hydrodynamic program, used extensively overseas for problems including chemical reactions, material failure and phase transitions. Fortran SIN was developed at the Los Alamos Scientific Laboratories in 1964 for a CDC6600 computer and has been modified to run on the CSIRO computer network which is based on a Cyber 7600.

Running the SIN code[1] directly on the Cyber 76 clearly demonstrated the inherent difficulties in compiling the input data for a batch run. This Report then describes USERSIN (Fig. 1), a program developed to create interactively the input data deck for SIN.

2. SIN:

The SIN code requires a large amount of input data defining material properties, the number of cells over which the calculations are to be made, as well as the time increment to be considered. Further input data include the parameters for elastic-plastic calculations on the solids and those parameters defining the equation of state of the detonation products, the latter constants being evaluated by the BKW code[3]. (Appendix 1 lists the input data required for SIN).

As it is necessary to collect and format correctly all the data before SIN can be run, such a procedure is both a time-consuming and error-prone operation.

3. USERSIN:

The user interface usersin written in extended Fortran 4 IV. Usersin takes advantage of the computer's connected input/output subsystem (CIO) to create interactively the data deck for subsequent use by SIN.

The program is menu driven. This means that it displays a table of options, to which a user is able to select any option by entering the corresponding key. The user moves from one menu to the next being promoted with a suitable message to enter the required data. These data are then validated and written into the data deck. The program also assumes default values which may be changed by the user.

The equation of state parameters and other physical material constants are stored in a data base file. This file is a sequential file with the name of the material its key (i.e. TNT). The file is automatically searched after the components name is entered. If the component is on file, the appropriate parameters are retrived and placed into the data deck, otherwise the user is solicited for these parameters.

Users of this program are requested to store the components they use into this data base file when prompted, thus increasing the usefulness of this data base to future users.

The Usersin package is simple to master, making SIN a more reliable and efficient research tool.

A typical run of Usersin for an expanding steel casing is shown in Appendix 3.

4. MAINTENANCE

For ease of maintaining USERSIN the program has been fully commented, each subroutine having one particular function which is explained in detail at the routines beginning. The program was written to be as machine independent as possible and a comment appears where it was not possible. The input/output variable names have been kept the same as those used in SIN so the maintenance programmer can easily swap from one to the other.

The data base file is under the format of

(1HZ, 2A6, 2X 15,/, 2(1X, E18.11), /, 9(4(1X, E18.11)/)

KEY:-	NAME	2A6
	EXPLOSIVE OR SOLID (1 OR 0)	15
	DENSITY	E18.11
	MASS FRACTION	E18.11
	C,S C1, S1, CV SPALLP, USP, SPA, F, G, H, I, J, Mo, 2/3 YO, γ, MINV, VSW, PLAP, A, B, C, D, E, K, L, M, N, CV1, Q, R, S, T, U, ZO, VFACT, EO, Z	E18.11

5. CONCLUSION

Development of USERSIN has been completely justified by its ease of operation, its data-storage capability and its use.

6. REFERENCES

1. Mader, C.L. and Gage, W.R. (1967). "FORTRAN SIN", Los Alamos Scientific Laboratory Report LA-3720.

2. Mader, C.L. (1967) "FORTRAN BKW" Los Alamos Scientific Laboratory Report LA-3704

3. Mader, C.L. (1979). Numerical Modelling of Detonations, University of California Press.

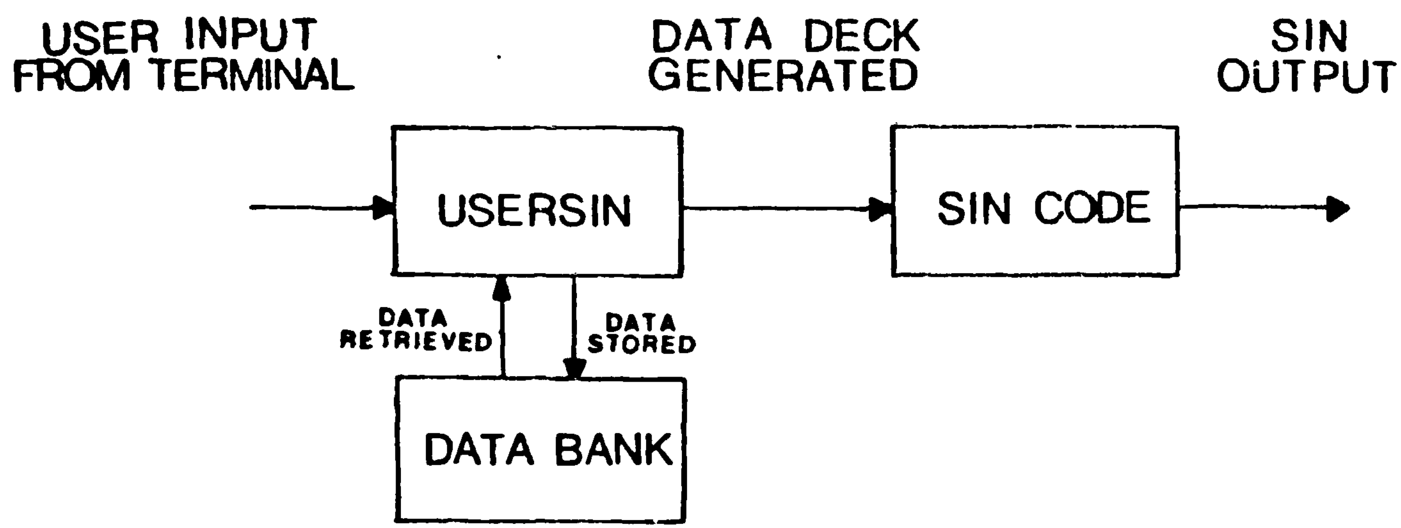

FIG. (1): USE OF SIN.

<u>APPENDIX 1</u>

<u>DATA REQUIRED FOR SIN</u>

Variable name	Default value	Units	Definitions
TITL	Time - date	-	A suitable title for the run (0-80 char)
IHC	No	-	Is a heat calculation required [Y/N]
ALPHA	SLAB		The geometry of the system SLAB - slab geometry CYL - cylindrical geometry SPHER - spherical geometry
IPINC	400	-	Every IPINC cycles are printed
IGINC	200	-	Every IGINC cycles are graphed
ILB	CON	-	Left hand boundary conditions CON - Continuum FRE - free space INIT - initial-final piston A+BT - A + BT piston STDY - steady state reaction zone piston
IRB	CON	-	Right hand boundary conditions CON - continuum FRE - free space INIT - initial-final piston A+BT - A + BT piston
Only required if ILB, IRB is equal to INIT "initial-final piston"			
ALB,LRB	-	cm/μs	initial piston velocity
BLB, BRB	-	cm/μs	final piston velocity

Variable name	Default value	Units	Definitions
	Only required if ILB, IRB is equal to A+BT "A + BT piston"		
ALB, ARB	-	-	A
BLB, BRB	-	-	B
	Only required if ILB, IRB is equal to INIT, A+BT or STDY		
NLI, NRI	-	-	The number of cells initially in the calculation from the left, right if Ø all cells are taken.
NLINC, NRINC	-	-	Every NLINC, NRINC cycles a cell is added on from the left, right
	The following data is required for all components		
NAM	- X	-	Name of the component (0-12 char)
NINC	- X	-	Number of space increments for this component
DX	-	cm	Size of these cells
DTIME	0.2 of DX	μs	Size of the time increments
IEXP	- X	-	Is the component a gas or explosive [Y/N]?
IVIS	PIC	-	PIC - Pic viscosity LAND - Landshoff form REAL - Real form
VFACT	2	-	Viscosity factor
PO	1×10^{-6}	MBAR	Initial pressure
TO	300	°K	Initial temperature
EO	0	MBar-cc/g	Initial internal energy

Variable name	Default value	Units	Definitions
U0	0	cm/μs	Initial velocity
RHO0	0<RHO0<50X	g/cm^3	Initial density
W0	0<W0<1 X		Initial mass fraction
VSW	0.01	-	-
		Solid parameters	
C,S	- X	-	Co-efficients to a linear set of Us and Up used from the initial pressure to the switch pressure.
C1,S1	- X	-	Second set of co-efficients to the linear fit of Us and Up used from the switch pressure to the max. pressure
CV[+]	X	Cal/g/Degree	Heat of capacity of the component
V0	1/DENS	cm^3/g	Initial volume of the condensed component
ALPH	- X	-	Linear co-efficient of thermal expansion
F,G,H,J,I,	- X	-	Constants used in the Hom condensed components equation
GAMMA	- X	-	γ-law gas constant
	Not requested if the component is a gas or an explosive		
SPALLP	- X	MBar	Interface spalling pressure
USP	- X	MBar	Ultimate spalling pressure
SPA	- X	-	Spalling constant to relate pressure and tension rate
SHEAR	- X	MBar	Shear modulus
Y0	- X	MBar	Yield strength

Only requested if the component is a gas or explosive

Variable name	Default value	Units	Definitions
Z	1E15 X		Frequency factor for an Arrhenius burn
E	4.5E4 X	cal/mole	Activation energy for an Arrhenius burn
VCJ	X	cm^3/g or cm/μs	Volume of the component for a C-J burn or the C-J detonation velocity for a Gamma-Law Taylor wave.
A,B,C,D,E K,L,M,N,O Q,R,S,T,U	- X - X - X	- - -	Parameters defining the equation of state of the detonation products. Parameters obtained from the BKW code[2]
Z1	- X	-	A constant used to change the standard state to be consistant with the solid explosive standard state usually ≃ 0.1
IBRN	ARR X	-	ARR - Arrhenius burn C-J - C-J volume burn GAMMA - Gamma-Law Taylor wave burn FOREST - Forest Fire burn (when available)

All variables with an "X" marked in the default value column are storex on the data base file.

APPENDIX 2

USE OF THE SIN COMPUTER CODE ON THE CYBER 7600

cussed elsewhere in this report a user interface has been
e the data deck for the SIN code.

iled binary version of USERSIN are stored on the library
only necessary to execute this file to run USERSIN. This must
, an interactive subsystem of the Cyber, once logged on.

	quit edit subsystem
O	gain entry to CIO
MIT (USERSIN)	excute USERSIN

and a brief description of the program should then be

questions asked and at the end of the session the data
cards will have been created and will only require

	quit CIO subsystem
	gain entry to EDIT
/	copy the data deck into work space
	excute SIN

in is a menu driven program, for example the
ng initial menu. The user simply enters the

NU	DEFAULT
ter title	Date and Time
ations	Not included
the system	SLAB
undary conditions	CONTINUUM
undary conditions	CONTINUUM

option at least the first three characters
urrent value of the option is given on the

ntered the following options are offered.

LLOWING:

GEOMETRY
RICAL GEOMETRY
CAL GEOMETRY

The program will validate the reply and return to the initial menu changing the default value as requested.

		INITIAL MENU	DEFAULT
TITL	-	80 char title	Date and Time
HEAT	-	Heat calculation	Not included
GEOM	-	Geometry of the system	CYLINDRICAL
LHB	-	Left hand boundary conditions	CONTINUUM
RHB	-	Right hand boundary conditions	CONTINUUM
CONT	-	to continue	

To move to the next menu CON (continue) must be entered. The user works his way through the menu's specifying each parameter, Usersin reads and validates his reply before creating the data deck.

APPENDIX 3

```
System ?
: cio
Cio version 15/10/82
:submit,usersin
Enterins 7000 mode...wait

THIS IS THE FRONT END PACKAGE FOR SIN.
A ONE-DIMENSIONAL HYDRODYNAMIC CODE FOR PROBLEMS
WHICH INCLUDE CHEMICAL REACTIONS, ELASTIC-PLASTIC FLOW
,SPALLING, AND PHASE TRANSITIONS.

IT IS A QUESTION ANSWER TYPE PROGRAM, CONTROL 'H' WORKS AS BACKSPACE
IF THE WRONG DATA IS ENTERED EITHER AN ERROR MESSAGE WILL APPEAR OR YOU CAN
EDIT THE ENTERED DATA AT THE END OF EACH SECTION


ENTER ONE OF THE FOLLOWING                                  DEFAULT

          TITLE - FOR THE TITLE OF THIS RUN (0-80 CHAR)    CURRENTLY
                     04/03/83             16.58.48.
          HEAT  - IF HEAT CALCULATIONS ARE REQUIRED        NOT INCLUDED
          GEOM  - FOR THE GEOMETRY                         SLAB GEOMETRY
          LHB   - LEFT HAND BOUNDARY CONDITIONS            A CONTINUUM
          RHB   - RIGHT HAND BOUNDARY CONDITIONS           A CONTINUUM
          CONT  - TO CONTINUE


:tit


ENTER A TITLE FOR THIS RUN :
:cylinder test  comp b  steel 4.225, 5.225 cm dimensions


ENTER ONE OF THE FOLLOWING
                                                            DEFAULT

          TITLE - FOR THE TITLE OF THIS RUN (0-80 CHAR)    CURRENTLY
CYLINDER TEST  COMP B  STEEL 4.225, 5.225 CM DIMENSIONS
          HEAT  - IF HEAT CALCULATIONS ARE REQUIRED        NOT INCLUDED
          GEOM  - FOR THE GEOMETRY                         SLAB GEOMETRY
          LHB   - LEFT HAND BOUNDARY CONDITIONS            A CONTINUUM
          RHB   - RIGHT HAND BOUNDARY CONDITIONS           A CONTINUUM
          CONT  - TO CONTINUE


:geo
```

```
ENTER GEOMETRY

          SLAB   - FOR SLAB GEOMETRY
          CYLIND - FOR CYLINDRICAL GEOMETRY
          SPHER  - FOR SPHERICAL GEOMETRY
:cyl


ENTER ONE OF THE FOLLOWING
                                                              DEFAULT

          TITLE - FOR THE TITLE OF THIS RUN (0-80 CHAR)  CURRENTLY
CYLINDER TEST  COMP B  STEEL 4.225, 5.225 CM DIMENSIONS
          HEAT  - IF HEAT CALCULATIONS ARE REQUIRED      NOT INCLUDED
          GEOM  - FOR THE GEOMETRY                       CYLINDRICAL GEOMETRY
          LHB   - LEFT HAND BOUNDARY CONDITIONS          A CONTINUUM
          RHB   - RIGHT HAND BOUNDARY CONDITIONS         A CONTINUUM
          CONT  - TO CONTINUE




:cont

                              OUTPUT MENU


ENTER ONE OF THE FOLLOWING

                                                              DEFAULT

          PRINT - CYCLES PRINTED                           400
          GRAPH - CYCLES GRAPHED                          .400E+03
          DUMP  - CYCLES DUMPED                           .200E+07
          IPR - FOR A PLOT OF PRESS VS RADIUS
          ITR - FOR A PLOT OF TEMP VS RADIUS
          IWR - FOR A PLOT OF MASS FRAC VS RADIUS
          IIR - FOR A PLOT OF VOLUME VS RADIUS
          IUR - FOR A PLOT OF PART VEL VS RADIUS
                                             NO GRAPHICAL OUTPUT REQUESTED
          CONT  - TO CONTINUE
:print

ENTER N, WHERE EVERY N CYCLES ARE PRINTED
:100


                              OUTPUT MENU


ENTER ONE OF THE FOLLOWING
```

```
                                                            DEFAULT

        PRINT - CYCLES PRINTED                               100
        GRAPH - CYCLES GRAPHED                              .400E+03
        DUMP  - CYCLES DUMPED                               .200E+07
        IPR - FOR A PLOT OF PRESS VS RADIUS
        ITR - FOR A PLOT OF TEMP VS RADIUS
        IWR - FOR A PLOT OF MASS FRAC VS RADIUS
        IIR - FOR A PLOT OF VOLUME VS RADIUS
        IUR - FOR A PLOT OF PART VEL VS RADIUS
                                           NO GRAPHICAL OUTPUT REQUESTED
        CONT  - TO CONTINUE
:iur

                          OUTPUT MENU

ENTER ONE OF THE FOLLOWING

                                                            DEFAULT

        PRINT - CYCLES PRINTED                               100
        GRAPH - CYCLES GRAPHED                              .400E+03
        DUMP  - CYCLES DUMPED                               .200E+07
        IPR - FOR A PLOT OF PRESS VS RADIUS
        ITR - FOR A PLOT OF TEMP VS RADIUS
        IWR - FOR A PLOT OF MASS FRAC VS RADIUS
        IIR - FOR A PLOT OF VOLUME VS RADIUS
        IUR - FOR A PLOT OF PART VEL VS RADIUS
                                           A GRAPH OF PART VEL VS RADIUS
                                   WILL BE PLOTTED EVERY  .400E+03 CYCLES
        CONT  - TO CONTINUE
:cont

ENTER THE NAME OF COMPONENT     1, OR A QUESTION MARK '?' FOR A LIST
OF THE COMPONENTS ON FILE
:?

THE COMPONENTS ON FILE ARE :-

        COMPONENTS ON FILE                  COMMENT

          STEEL                             PETERS PROBLEM RDX FILLED
          RDX                               PETERS PROBLEM RDX FILLED
          TNT                               INITIATION OF TNT (WATER ONLY)
          H6                                MARK 82 H6 FULL SIZE
          COMP B                            4.5 INCH SHELL/BARREL/JACKET
          AIR
          PETN                              DAVID'S PROB
          POLYETHYLENE                      DAV'S
          WATER                             DAV'S
          PETN(RHO=1.4                      DAV'S
          PENTOLITE                         DAV'S
```

```
THERE ARE    11 COMPONENTS ON THE COMPONENTS FILE

ENTER THE NAME OF COMPONENT     1
:comp b


COMP B       HAS BEEN FOUND ON THE COMPONENTS FILE


ENTER THE NUMBER OF SPACE INCREMENTS FOR COMP B
:50


ENTER THE SPACE INCREMENT SIZE FOR  COMP B        [CM]
:0.0845

A GOOD APPROXIMATION OF THE TIME INCREMENT IS 0.2 OF THE CELL WIDTH
WHICH IN THIS CASE IS       .1690000E-01 IS THIS APPROXIMATION
VALID [Y/N]
:y



PLEASE ENTER ONE OF THE FOLLOWING

                                                          DEFAULT

          VISC - FOR THE VISCOSITY FACTOR                 2.00
          BURN - FOR TYPE OF BURN                         ARRHENIUS BURN
          FORM - FOR TYPE OF VISCOSITY                    PIC VISCOSITY
          PRES - INITIAL PRESSURE                           .100E-05 MBAR
          TEMP - INITIAL TEMPERATURE                        .300E+03 K
          ENGY - INITIAL INTERNAL ENERGY                   0.          MBAR-CC/G
          VELC - INITIAL VELOCITY                          0.          CM/MICROSEC
          FREQ - FREQUENCY FACTOR                           .100E+16
          ACTV - ACTIVATION ENERGY                          .450E+05
          NUMB - NUMBER OF CELLS                          50
          SIZE - SIZE OF THE CELLS                          .845E-01 CM
          TIME - TIME INCREMENTS                            .169E-01 MICROSEC
          MASS - MASS FRACTION                             0.          G
          DENS - DENSITY                                    .165E+01 G/CC
          PAR  - PARAMETERS RELATING TO THE EQU OF STATE
          CONT - TO CONTINUE
:cont


ARE THERE ANY MORE COMPONENTS ? [Y/N]
:y


ENTER THE NAME OF COMPONENT   2, OR A QUESTION MARK '?' FOR A LIST
OF THE COMPONENTS ON FILE
:steel


STEEL        HAS BEEN FOUND ON THE COMPONENTS FILE
```

```
ENTER THE NUMBER OF SPACE INCREMENTS FOR STEEL
:40


ENTER THE SPACE INCREMENT SIZE FOR STEEL        [CM]
:0.025

A GOOD APPROXIMATION OF THE TIME INCREMENT IS 0.2 OF THE CELL WIDTH
WHICH IN THIS CASE IS       .5000000E-02 IS THIS APPROXIMATION
VALID [Y/N]
:y


PLEASE ENTER ONE OF THE FOLLOWING

                                                         DEFAULT

          VISC - FOR THE VISCOSITY FACTOR               2.00
          FORM - FOR TYPE OF VISCOSITY                  PIC VISCOSITY
          PRES - INITIAL PRESSURE                        .100E-05 MBAR
          TEMP - INITIAL TEMPERATURE                     .300E+03 K
          ENGY - INITIAL INTERNAL ENERGY                 0.        MBAR-CC/G
          VELC - INITIAL VELOCITY                        0.        CM/MICROSEC
          NUMB - NUMBER OF CELLS                        40
          SIZE - SIZE OF THE CELLS                       .250E-01 CM
          TIME - TIME INCREMENTS                         .500E-02 MICROSEC
          MASS - MASS FRACTION                           .100E+01 G
          DENS - DENSITY                                 .792E+01 G/CC
          PAR  - PARAMETERS RELATING TO THE EQU OF STATE
          CONT - TO CONTINUE
:cont


ARE THERE ANY MORE COMPONENTS ? [Y/N]
:y


ENTER THE NAME OF COMPONENT    3, OR A QUESTION MARK '?' FOR A LIST
OF THE COMPONENTS ON FILE
:air


AIR          HAS BEEN FOUND ON THE COMPONENTS FILE


ENTER THE NUMBER OF SPACE INCREMENTS FOR AIR
:10


ENTER THE SPACE INCREMENT SIZE FOR  AIR          [CM]
:1.0

A GOOD APPROXIMATION OF THE TIME INCREMENT IS 0.2 OF THE CELL WIDTH
WHICH IN THIS CASE IS       .2000000E+00 IS THIS APPROXIMATION
VALID [Y/N]
:y
```

```
PLEASE ENTER ONE OF THE FOLLOWING

                                                                  DEFAULT

         VISC - FOR THE VISCOSITY FACTOR                          2.00
         BURN - FOR TYPE OF BURN                                  ARRHENIUS BURN
         FORM - FOR TYPE OF VISCOSITY                             PIC VISCOSITY
         PRES - INITIAL PRESSURE                                    .100E-05 MBAR
         TEMP - INITIAL TEMPERATURE                                 .300E+03 K
         ENGY - INITIAL INTERNAL ENERGY                            0.          MBAR-CC/G
         VELC - INITIAL VELOCITY                                   0.          CM/MICROSEC
         FREQ - FREQUENCY FACTOR                                   0.
         ACTV - ACTIVATION ENERGY                                  0.
         NUMB - NUMBER OF CELLS                                   10
         SIZE - SIZE OF THE CELLS                                   .100E+01 CM
         TIME - TIME INCREMENTS                                     .200E+00 MICROSEC
         MASS - MASS FRACTION                                       .100E+01 G
         DENS - DENSITY                                             .129E-02 G/CC
         PAR  - PARAMETERS RELATING TO THE EQU OF STATE
         CONT - TO CONTINUE
:cont


ARE THERE ANY MORE COMPONENTS ? [Y/N]
:n

DO YOU WISH TO PLACE ANY OF THE COMPONENTS ON THE FILE [Y/N]
:
## REPLY SHOULD BE 'Y' OR 'N' ##  TRY AGAIN:
:n



THERE ARE 3 COMPONENTS INCLUDED IN RUN
CYLINDER TEST  COMP B  STEEL 4.255, 5.225 CM DIMENSIONS
AND THEY COMPRISE OF :

         COMPONENTS

           COMP B
           STEEL
           AIR


ENTER ONE OF THE FOLLOWING

         CREAT - TO CREATE THE DATE FILE FOR 'SIN'
         DEL   - TO DELETE A COMPONENT FROM THE ABOVE
         CONT  - TO CONTINUE IE. ADD MORE COMPONENTS
         ALT   - TO ALTER ANY OF THE ABOVE COMPONENTS
         START - TO START FROM SCRATCH AGAIN
         EXIT  - TO EXIT THE PROGRAM
:creat
```

```
THE DATA FILE 'SINDATA' HAS BEEN CREATED




ENTER ONE OF THE FOLLOWING

          CREAT - TO CREATE THE DATE FILE FOR 'SIN'
          DEL   - TO DELETE A COMPONENT FROM THE ABOVE
          CONT  - TO CONTINUE IE. ADD MORE COMPONENTS
          ALT   - TO ALTER ANY OF THE ABOVE COMPONENTS
          START - TO START FROM SCRATCH AGAIN
          EXIT  - TO EXIT THE PROGRAM
:exit


THE DATA FOR 'SIN' HAS BEEN PRODUCED AND IS IN YOUR DEFAULT ED LIB
'SINDATA'
7000 job existing
CIO active mode
:q,ed
ED version 15/10/82
```

```
SIN(T400)
GETSET(DFC4522)
PURGE(SINRUN,SN=DFC4522,ID=DFCEDN)
EXIT(U)
REQUEST(TAPE2,*PF,SN-DFC4522
ATTACH(SINBIN,SINBIN,SN=DFC4522,ID=DFCEDN)
SINBIN.
EXIT(U)
REWIND(TAPE2)
CATALOG(TAPE2,SINRUN,SN=DFC4522,ID=DFCEDIN)
*EOS
    3  100    0    0    0    0    0    1    0    0    0    0
CYLINDER TEST  COMP B  STEEL 4.225, 5.225 CM DIMENSIONS
  .20000000000E+01  .10000000000E+03  .40000000000E+03  .20000000000E+07
COMP B
   50    1    0    0
  .84500000000E-01  .16900000000E-01  .20000000000E+01  .16500000000E+01
  .10000000000E-05  .30000000000E+03 0.                 0.
  .23100000000E+00  .18300000000E+01  .10000000000E-01 0.
 0.                -.86482267660E+01 -.76497948971E+02 -.14330798590E+03
 -.12260697623E+03 -.34139045850E+02  .26600000000E+01  .25300000000E+00
  .60606060606E+00  .50000000000E-04 0.                 0.
  .30000000000E+03  .10000000000E-05 0.                 0.
 0.                0.                0.
 0.                 .10000000000E+16  .45000000000E+05 0.
 -.35222141110E+01 -.24959474720E+01  .25411585450E+00  .25589619270E-01
 -.10990541300E-01 -.15437672010E+01  .51978884760E+00  .79918603550E-01
  .65029983420E-02  .21499074120E-03  .75567098200E+01 -.45930275520E+00
  .66679850240E-01  .18767838090E-01 -.13302603210E-02  .50000000000E+00
  .10000000000E+00
STEEL
   40    0    0    0
  .25000000000E-01  .50000000000E-02  .20000000000E+01  .79170000000E+01
  .10000000000E-05  .30000000000E+03 0.                 0.
  .45800000000E+00  .15100000000E+01  .10000000000E-01 0.
 0.                -.38238258745E+04 -.70321195402E+04 -.48367021389E+04
 -.14667840212E+-4 -.16639161598E+03  .20000000000E+01  .10780000000E+00
  .12631047114E+00  .11700000000E-04  .70000000000E-01  .15000000000E+00
  .30000000000E+03  .10000000000E-05  .50000000000E-02  .97800000000E+00
  .50000000000E-01  .10000000000E-05 0.
  .10000000000E+01 0.                0.                0.
AIR
   10    1    0    0
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