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STORAGE AND RETRIEVAL OF INFORMATION ON SYSTEMS OF PARTIAL DIFF--ETC(U)
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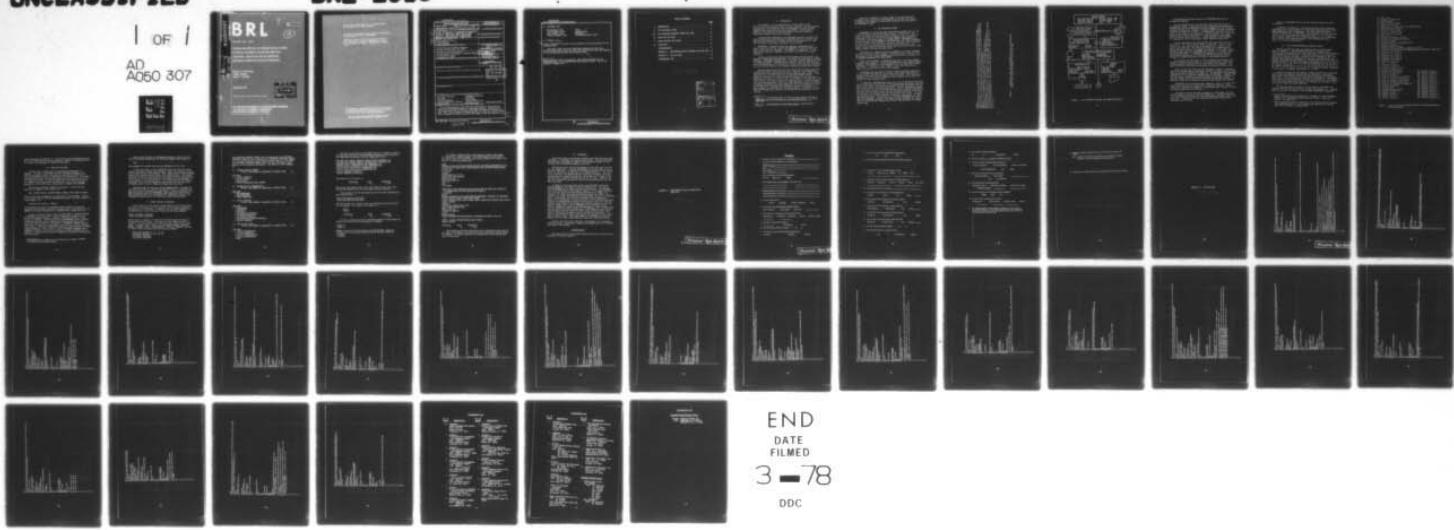
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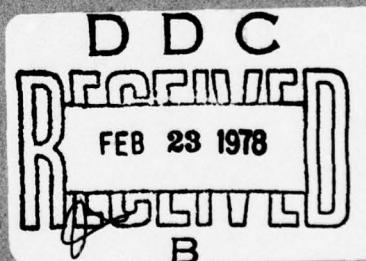
REPORT NO. 2015

STORAGE AND RETRIEVAL OF INFORMATION ON SYSTEMS
OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR
SOLUTIONS: CREATABASE AND THE CONTINUUM
MECHANICS CENTER DATA BASE OF HYDROCODES

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Joseph Lacetera
James A. Schmitt

September 1977

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER <i>(6)</i> BRL REPORT NO. 2015	2. GOVT ACCESSION NO. <i>(14) BRL-2015</i>	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) <i>(10)</i> STORAGE AND RETRIEVAL OF INFORMATION ON SYSTEMS OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR SOLUTIONS: CREATABASE AND THE CONTINUUM MECHANICS CENTER DATA BASE OF HYDROCODES.	5. TYPE OF REPORT & PERIOD COVERED	
5. AUTHOR(s) Morton A. Hirschberg, Joseph Lacetera James A. Schmitt	6. PERFORMING ORG. REPORT NUMBER	
6. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Ballistic Research Laboratory Aberdeen Proving Ground, MD 21005	7. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS <i>(16)</i> 11161102AH43	
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Materiel Development & Readiness Command 5001 Eisenhower Avenue Alexandria, VA 22333	12. REPORT DATE <i>(10)</i> SEP 1977	13. NUMBER OF PAGES <i>(10)</i> 49
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.	18a. DECLASSIFICATION/DOWNGRADING SCHEDULE <i>(16)</i> FEB 23 1978	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)	DDC REF ID: A6461 B	
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Relational Data Base Information Retrieval Data Base CREATABASE Continuum Mechanics Data Storage Partial Differential Equations Storage and Retrieval Data Retrieval Data Base Query (See reverse side)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) ams A Continuum Mechanics Center has been established for the purposes of evaluating and developing models of interacting continua. Because of the large and growing body of literature concerning such models and related computer codes, the vast number of assumptions made in their use, and the varying types of numerical methods utilized in these codes, a data base analysis →		

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19. KEY WORDS, Cont.

Fluid Dynamic Codes
Solid Mechanics Codes
Heat Transfer Codes
Neutron Transport Codes

Codes
Computer Codes
Hydrocodes
Continuum Mechanics Center

20. ABSTRACT, Cont.

system, CREATABASE,¹ was used to store information and characteristics of the different codes.

This paper briefly describes CREATABASE, delineates the data base, describes queries made on the data base, and outlines future uses and expansion of the data base and the data base analysis system.

¹Daniel Analytical Services Corporation, "User Reference Manual for the CREATABASE Module of an Integrated Data Base Analysis System: Level U-4A," Houston, TX, August 1976.

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I. INTRODUCTION

The formation of a Continuum Mechanics Center (CMC) at the Ballistic Research Laboratory (BRL) to study, evaluate, and develop large hydrodynamics, solid mechanics, particle transport, and heat transfer computer codes presented an excellent opportunity to simultaneously generate a data base containing information on systems of partial differential equations and their solutions.

A questionnaire (Appendix I) was developed and sent to a number of BRL scientists soliciting information regarding codes of interest. The response furnished data on 20 codes and led to the formation of a data base from which significant information can be derived.

CREATABASE, a commercial data base analysis system marketed by Daniel Analytical Services Corporation (**DANALYT**) of Houston, Texas, was used to store data for retrieval. CREATABASE is a relational ^{2,3} data base system, written in FORTRAN, which runs on the UNIVAC 1100 series computers.

Queries are made using English-like statements and may be made in a batch or interactive processing mode. The output for each mode is slightly different. CREATABASE affords little in the way of report generation; that is, formatted output. CREATABASE does, however, offer the user the capability of outputting all or any part of the data on an auxiliary file which the user can then process in any fashion desired, including report formats.

Sixty-two descriptors form the total domain of the current data base. It offers the user an accessible and easily used tool for ascertaining characteristics and capabilities of certain computer codes at BRL. Information such as the code's applications, numerical method, spatial geometry, equation(s) of state and reports dealing with the code and its performance, as well as 32 other items, are included in the data base. However, specific data about solutions of equations such as subroutine names in which various processes occur, the actual equations solved, or anomalies of systems of equations in a particular code do not now constitute a part of the data base. Although this information should be available in a user's manual, a more accessible information source is desirable. As the data base develops such items will be considered as possibilities for inclusion.

² Codd, E.F., "A Relational Model of Data for Large Shared Data Banks," Communications of the Association for Computing Machinery, 13, No. 6, June 1970.

³ Date, C.J., An Introduction to Data Base Systems, Addison-Wesley, NY, 1976.

Adding new information on codes already in the data base and cataloging other codes are a continuing part of the CMC's activities. In addition, new commands to allow easier querying are being added to the CREATABASE system.

II. THE CREATABASE SYSTEM

CREATABASE is a relational data base analysis system; that is, all of the data which forms the data base exists in tabular form. The columns are formally called descriptors (domains or sets in relational terms) and contain all of the states which comprise that descriptor. For example, a descriptor might be MAXIMUM SPATIAL DIMENSIONALITY and contain as states ONE DIMENSIONAL, TWO DIMENSIONAL, AND THREE DIMENSIONAL. Rows are formally called records (n-tuples or relations) and are formed by selecting one of the possible states from each descriptor. See Figure 1 as an example of an input record (note that two successive commas indicate there is no data for that entry).

CREATABASE is a compiler, written in FORTRAN, that takes statements written in an English-like language, interprets them and executes them. The program is very compact requiring only 21,000 words of storage, yet is modular consisting of 42 subroutines.

There are 56 commands in CREATABASE which fall into seven command categories (see Figure 2). Since an explanation for each command appears elsewhere (see Reference 1) the commands will not be discussed in great detail here. It should be noted, however, that a data base can be created and queried with as few as four commands.

CREATABASE does not have an extensive report generation capability. It does indicate how many hits or matches have occurred and what percentage of the data base the number of hits represent. This statistical information can be used for designing further queries and to check the validity of the data base itself.

In addition, CREATABASE does allow any or all of the data in the data base to be output onto a file for further processing during that execution or at a later time. This selective retrieval of data for future use is a most useful tool for scientific processing. Several independent programs exist to assist the user in reformatting data for his special applications. The user then has great control over the subsequent handling of his data in addition to the capabilities provided by the system itself. The user may interface his data with graphics, simulation, statistical, or reports generation packages. The user may also interface CREATABASE with other data base management packages, for example, using CREATABASE for the purpose of collecting and refining data and the other packages for elegant output forms.

BLAST.
UNSTEADY/2D/EULERIAN/SINGLE MATERIAL/FINITE DIFFERENCE/COMPRESSIBLE FLUID.
CALCULATION OF MUZZLE BLAST FLOW FIELDS/TR-4155 PICATINNY ARSENAL /AD881523/DEC
1970.T D TAYLOR,1.BRLESCE,1.MUZZLE BLAST CALCULATIONS,JET FLOW CALCULATIONS,1.1,
GODUNOV,1.2,2,1,CONSERVATION OF MASS/MOMENTUM/ENERGY,
DENSITY/DENSITY TIMES VELOCITIES/DENSITY TIMES TOTAL ENERGY,2,0,,
REFLECTIVE/FREE-SLIP,70 BY 70,4,1,2,3,1,2,1,1,3,NOT APPLICABLE,3,3,2,,
C K ZOLTANI,1,EVALUATION OF THE COMPUTER CODE BLAST DURF HELP AND HEMP FOR SUITA
BILITY OF UNDEREXPANDED JET FLOW CALCULATION BRL1659,C K ZOLTANI,.....,

Figure 1. An Example of One Input CREATABASE Record for the Hydrocode
BLAST in the Continuum Mechanics Center Data Base

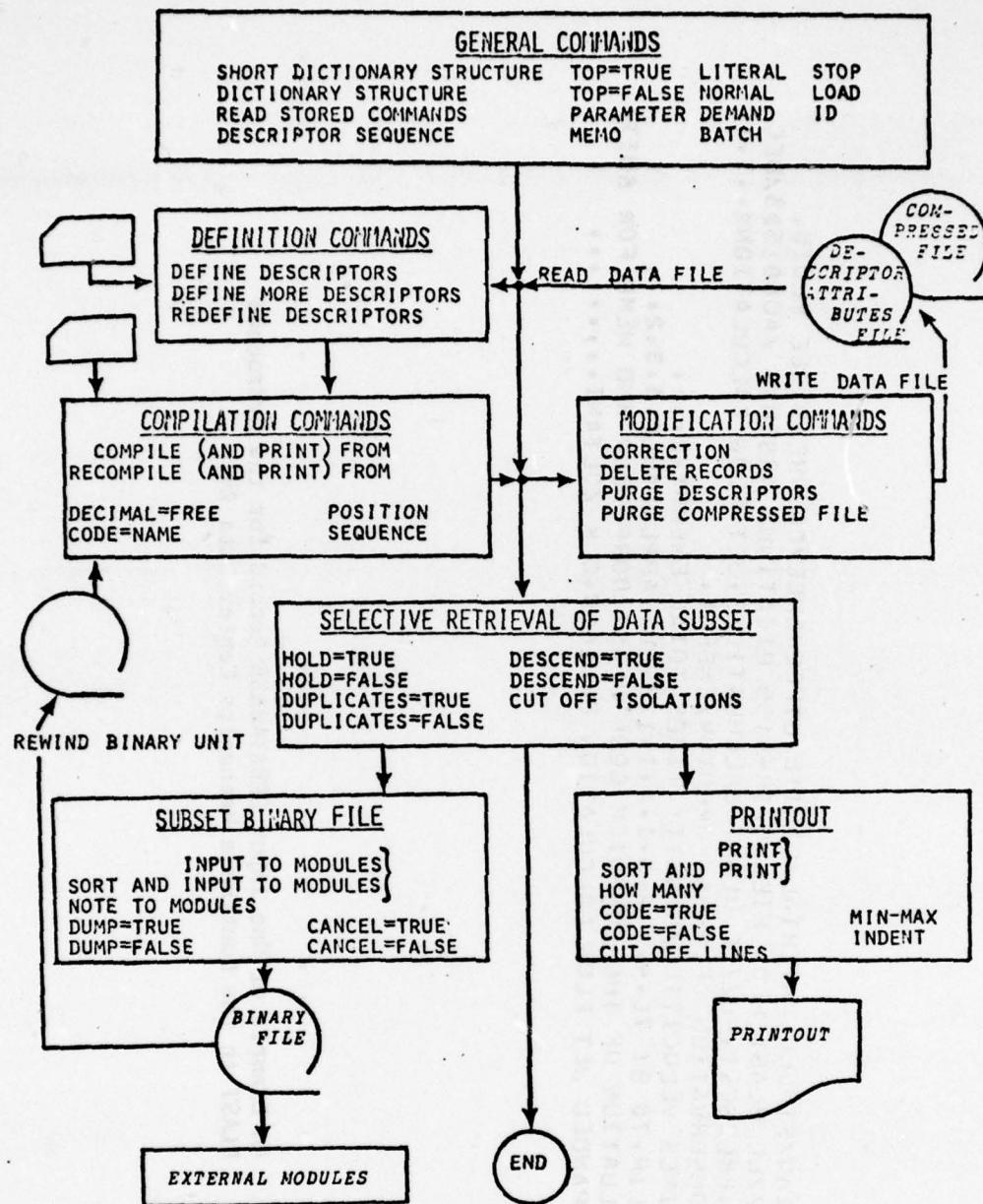


Figure 2. The CREATABASE Commands and Command Categories

The following describes briefly how a CREATABASE data base is assembled and queried.

The user determines his own descriptor names which may be up to 126 characters long. Descriptors are used to represent both numeric and alphanumeric data but a descriptor may only represent one type of data. A numeric descriptor may represent a range of numbers and carry additional identifying information (a label). An alphanumeric descriptor may be in either of two forms; it may represent a series of states all of which are predetermined (coded descriptors), or it may represent an open ended series of states (name descriptors). Coded descriptors are preferable for alphanumeric data as they require fewer computer storage cells.

Once the descriptors have been defined, data are input using one of three forms. The first and most common is card input. Input in this fashion is in free format and may be accomplished in a batch or interactive processing mode. The second input mode uses a formatted file whereby the user indicates the number of characters in the input string. The third input mode uses a CREATABASE file which is in a highly coded, densely packed format. A CREATABASE file generally is used when the user wishes to operate on a subfile which he has previously created (output) on another execution, or earlier in the current execution.

Once the data has been input it may be examined using general and printout commands shown in Figure 2. If there are errors, these may be corrected using the modification or subset binary file commands. One might correct the data base by reentering the entire data base as well.

After the data are corrected, the data base is ready to be queried. Queries are accomplished using general, selective retrieval, subset binary file, and printout commands (see Figure 2). At the heart of the querying commands are the two printout commands PRINT and HOW MANY. Commands from the other query categories allow manipulations of the data so that the specific queries may be answered by the PRINT and HOW MANY commands. In addition, output may be generated using the subset binary file commands.

CREATABASE has full Boolean logic capability ("and", "or" and "not") which can be used with the modification, selective retrieval, subset binary file, and printout commands. Using Boolean logic one may retrieve any datum contained in the data base.

The general form of the output commands is a descriptor list (the desired output) followed by a Boolean expression. A Boolean expression is a concatenation of quantifiers using the Boolean operators "and", "or" and "not". A quantifier has the form descriptor name, followed by a descriptor value (state).

Samples of CREATABASE queries and the resulting output are shown in Section V.

In addition to Reference 1, an annotated guide⁴ and two samples of CREATABASE runs⁵ are most helpful for using and understanding the CREATABASE commands and their interactions. The cited references, while forming a complete set of CREATABASE system documents, are terse and make the use of the system seem more complicated than it is. Of course, quite complex interactions can be obtained through the use of CREATABASE and the UNIVAC EXEC 8 operating system. Such interactions, while noted, will not be discussed here.

III. THE CONTINUUM MECHANICS CENTER DATA BASE

Data for the CMC data base was gathered using the questionnaire shown in Appendix I. Questionnaires were sent to a number of BRL scientists who supplied data which were then used to define the descriptors (state names) for the data base. Sixty-two descriptors (see Figure 3) were used to describe the data. The data base was designed so that each record of data provided information for one code. The descriptors are divided into several broad categories: those dealing with (i) the type of problems treated by the code; for example, descriptors 8, 9, 10, 15, 16, 17, 18, 24, 28, 29, 31, 32, 34, 36, 37, (ii) the characteristics of the code; for example, descriptors 1, 2, 5, 6, 7, 11, 12, 13, 14, 19, 20, 21, 22, 23, 25, 26, 27, 30, 33, 35, 38, 39, 40, and (iii) people and reports connected with the code; for example, descriptors, 3, 4, 41-62.

Queries are often initially made on certain descriptors to determine which code(s) can perform a desired type of calculation. Subsequent queries can then be made to obtain more detailed information concerning these codes. (For an example set of queries, see Section V). Furthermore, other data bases can be generated from the current data base; for example, if the data base becomes very large, one consisting only of reports dealing with the codes may become desirable.

The data base which is stored in 35,000 words on the UNIVAC 1108 computer currently contains data for 20 codes (see Appendix II). Although there are now only 20 records in the data base significant information

⁴ Daniel Analytical Services Corporation, ""Primer" for "The CREATABASE Module" of An Integrated Data Base Analysis System: Level U-4A," Houston, TX, August 1976.

⁵ Daniel Analytical Services Corporation, "An Illustrative Check Deck for "The CREATABASE Module" of An Integrated Data Base Analysis System: Level U-4A," Houston, TX, August 1976.

1. CODE NAME
2. GENERAL DESCRIPTION
3. USERS MANUAL
4. USERS MANUAL AUTHOR
5. COMPUTER LANGUAGE
6. COMPUTERS ON WHICH CODE IS OPERATIONAL
7. DEVELOPMENTAL STATUS
8. PRIMARY APPLICATION
9. SECONDARY APPLICATION
10. TERTIARY APPLICATION
11. MESH TYPE
12. GENERAL NUMERICAL METHOD
13. PARTICULAR NUMERICAL METHOD
14. ORDER OF SCHEME
15. MAXIMUM SPATIAL DIMENSIONALITY
16. SPATIAL GEOMETRY
17. UNSTEADY CALCULATION
18. CONSERVATION/TRANSPORT EQUATIONS SOLVED
19. VARIABLES COMPUTED FROM CONSERVATION/TRANSPORT EQUATIONS
20. EQUATION OF STATE 1
21. EQUATION OF STATE 2
22. EQUATION OF STATE 3
23. EQUATION OF STATE 4
24. BOUNDARY CONDITIONS
25. MAXIMUM GRID SIZE
26. TYPE OF REZONING
27. EXPANDING GRID
28. MATERIAL RESPONSE
29. ELASTIC PLASTIC SOLID
30. NUMBER OF MATERIALS
31. INTERFACE CAPABILITY
32. TYPE OF FLUID FLOW
33. SHOCK TREATMENT
34. TYPE OF RADIATION TRANSPORT
35. TYPE OF ENERGY DEPOSITION
36. TYPE OF CHEMICAL REACTIONS
37. TYPE OF ATOMIC REACTIONS
38. EXTENT OF GRAPHICS CAPABILITY
39. SPECIAL FEATURES
40. LIMITATIONS
41. KNOWLEDGEABLE USERS
42. NUMBER OF REPORTS
43. REPORT TITLE 1
44. REPORT AUTHORS 1
45. REPORT TITLE 2
46. REPORT AUTHORS 2
47. REPORT TITLE 3
48. REPORT AUTHORS 3
49. REPORT TITLE 4
50. REPORT AUTHORS 4
51. REPORT TITLE 5
52. REPORT AUTHORS 5
53. REPORT TITLE 6
54. REPORT AUTHORS 6
55. REPORT TITLE 7
56. REPORT AUTHORS 7
57. REPORT TITLE 8
58. REPORT AUTHORS 8
59. REPORT TITLE 9
60. REPORT AUTHORS 9
61. REPORT TITLE 10
62. REPORT AUTHORS 10

Figure 3. The Sixty-Two Descriptors Used for the Continuum Mechanics Center Data Base

can be extracted (see Section V). Future plans include expanding the data base to include more codes and more reports. However, this data base will not become a bibliography for different hydrocodes.

IV. USING THE DATA BASE

The data base is operational on the UNIVAC 1108 computer at Edgewood. As such, it runs under the EXEC 8 operating system. This section will provide the user the means to sign onto the computer, invoke the CREATABASE system, and gain access to the data base. It is highly recommended that users copy the data base files onto their own files before using the system. If this is impractical, the user must not invoke any commands which would modify the data base; that is, the user must not use any of the definition, modification, or compilation commands.

The following describes BATCH mode operation. To sign onto the computer the command in card column 1 is:

```
@RUN IDENTIFICATION, ACCOUNT NUMBER, CMCLIB, TIME, PAGES OF OUTPUT.
```

The user must make arrangements for obtaining an account number. CMCLIB is the project name for the CMC CREATABASE data base. The next instruction (card column 1) is:

```
@MISD*CAB.CAB CMDIC1.D, CMCMPl.C . *
```

The MISD*CAB.CAB invokes the CREATABASE system; CMDIC1.D is the file containing the descriptor attributes (logical unit 9; see Reference 1) and CMCMPl.C is the file containing the compressed data (logical unit 12).

At this time control passes from the UNIVAC EXEC 8 operating system to CREATABASE. You are ready to query the data base using any of the permissible command categories: general, selective retrieval, subset binary, or printout. A familiarity with the CREATABASE system is helpful to minimize the time spent in designing queries and auxiliary output (using the subset binary file operations). CREATABASE commands are free form; that is, there are no card column restrictions as to where commands can be placed. The normal CREATABASE separator is the comma and the normal command terminator is the asterisk. Not all CREATABASE commands need a terminator; however, the user is unburdened by using a terminator on all commands. The user has the option of changing the separator and terminator if he so desires.

* If files CMDIC1 or CMCMPl are not available do an @ASG,A filename for either or both missing files.

When one has finished his CREATABASE operations, control is given back to the UNIVAC system with the following command (card column 1):

@FIN

This command will provide time and cost information to the user.

If the user wishes to query CREATABASE using the interactive mode, several additional commands are necessary. First, the user must dial up and be given access to the computer. Next, before using the RUN statement, the user must identify himself using a site identification. Site identifications are easily obtained and are well marked on hard wired terminals. After the site ID has been entered and the computer has acknowledged it, the procedure is as described above. At the conclusion of the terminal execution, after the @FIN command has been issued, the user must issue an @@TERM and wait for the terminal or modem light to go out.

Additional aids for the user are the commands CNTRL Z to erase the last character typed if a mistake was made and @@X TIO to interrupt output when a query is producing too much output. Greater knowledge of the EXEC 8 operating system and CREATABASE only enhances the skill of the user and enables him to do more complicated operations. However, the information presented here is sufficient to query the data base.

V. SAMPLE QUERIES AND OUTPUTS

This section will show several typical queries and the instructions used prior to the queries so that the user has the proper information for querying at his disposal. A complete list of the 62 descriptors in the CMC data base can be obtained by using the following command:

```
>SHORT DICTIONARY STRUCTURE*
    SHORT DICTIONARY STRUCTURE*
```

Notice that the command is echoed back to the user which accounts for the repeated line of output. The output of this command is given in Figure 3. The individual states of any descriptor can easily be determined; for example, the states of the descriptors GENERAL NUMERICAL METHOD, MAXIMUM SPATIAL DIMENSIONALITY, SPATIAL GEOMETRY and TYPE OF FLUID FLOW, are obtained by the following command:

```
> DESCRIPTOR SEQUENCE 12, 15, 16, 32*
    DESCRIPTOR SEQUENCE 12, 15, 16, 32*
> DICTIONARY STRUCTURE*
    DICTIONARY STRUCTURE*
```

The DESCRIPTOR SEQUENCE command used in conjunction with DICTIONARY STRUCTURE command restricts output of the DICTIONARY STRUCTURE command to just those descriptors whose sequence numbers appear in the former. The DICTIONARY STRUCTURE COMMAND prints the name and complete specification of the requested descriptors. The output of these commands is:

12. GENERAL NUMERICAL METHOD
OPTION CODE NUMBER OF CHARACTERS IN LONGEST STATE 32

CODE NAME

- 1 FINITE DIFFERENCE
- 2 FINITE ELEMENT
- 3 MONTE CARLO
- 4 FINITE DIFFERENCE/FINITE ELEMENT

15. MAXIMUM SPATIAL DIMENSIONALITY
OPTION CODE NUMBER OF CHARACTERS IN LONGEST STATE 17

CODE NAME

- 1 ONE DIMENSIONAL
- 2 TWO DIMENSIONAL
- 3 THREE DIMENSIONAL

16. SPATIAL GEOMETRY
OPTION CODE NUMBER OF CHARACTERS IN LONGEST STATE 33

CODE NAME

- 1 RECTANGULAR
- 2 CYLINDRICAL
- 3 SPHERICAL
- 4 RECTANGULAR/CYLINDRICAL
- 5 RECTANGULAR/SPHERICAL
- 6 CYLINDRICAL/SPHERICAL
- 7 RECTANGULAR/CYLINDRICAL/SPHERICAL
- 8 SPECIAL TREATMENT

32. TYPE OF FLUID FLOW
OPTION CODE NUMBER OF CHARACTERS IN LONGEST STATE 23

CODE NAME

- 1 INVISCID COMPRESSIBLE
- 2 VISCID COMPRESSIBLE
- 3 INVISCID INCOMPRESSIBLE
- 4 VISCID INCOMPRESSIBLE
- 5 NONE

The user can now make an intelligent query as to number of codes in the data base which use a finite difference method and which calculate two dimensional cylindrical inviscid compressible flows.

>HOW MANY HAVE GENERAL NUMERICAL METHOD,FINITE DIFFERENCE AND
HOW MANY HAVE GENERAL NUMERICAL METHOD,FINITE DIFFERENCE AND
>MAXIMUM SPATIAL DIMENSIONALITY,TWO DIMENSIONAL AND
MAXIMUM SPATIAL DIMENSIONALITY,TWO DIMENSIONAL AND
>TYPE OF FLUID FLOW,INVISCID COMPRESSIBLE AND
TYPE OF FLUID FLOW,INVISCID COMPRESSIBLE AND
>SPATIAL GEOMETRY,CYLINDRICAL*
SPATIAL GEOMETRY,CYLINDRICAL*

The response for this query is:

ISOLATIONS	TOTAL	PERCENTAGE
2	20	10.00

Notice that the number of hits, the total number of data base items and the percentage of hits to total items is always displayed.

Now wishing to see the code names for the two codes satisfying the above query we ask:

>PRINT CODE NAME FOR WITH HOLD*
PRINT CODE NAME FOR WITH HOLD*

The HOLD instruction is used so that the long Boolean expression need not be repeated. The result of this query is:

BLAST
LASXPT

ISOLATIONS	TOTAL	PERCENTAGE
2	20	10.00

Finally, wishing to see more information about the codes BLAST and LASXPT, we issue the following sequence of commands:

>INDENT 0*
INDENT 0*

>PRINT 1,2,3,4,5,7,8,20,24,25,34,41,42,43,44 FOR WITH 1,BLAST OR
PRINT 1,2,3,4,5,7,8,20,24,25,34,41,42,43,44 FOR WITH 1,BLAST OR
>1,LASXPT*
1,LASXPT*

The INDENT 0 command instructs the system to indent zero spaces (no indentation) between outputs. The PRINT command illustrates that the numeric value of a descriptor may be used in place of its name. The results of these instructions are:

BLAST

UNSTEADY/2D/EULERIAN/SINGLE MATERIAL/FINITE DIFFERENCE/COMPRESSIBLE FLUID CALCULATION OF MUZZLE BLAST FLOW FIELDS/TP-4155 PICATINNY ARSENAL/AD881
523/DEC 1970

T D TAYLOR

FORTRAN

OPERATIONAL/EASY TO RUN
MUZZLE BLAST CALCULATIONS
PERFECT GAS LAW
REFLECTIVE/FREE-SLIP

70 by 70

NONE

C K ZOLTANI

1

EVALUATION OF THE COMPUTER CODE BLAST DORF HELP AND HEMP FOR SUITABILITY
OF UNDEREXPANDED JET FLOW CALCULATION BRL1659

C K ZOLTANI

LASXPT

NONEQUILIBRIUM/RADIATION-HYDRODYNAMICS/ATMOSPHERIC TRANSPORT AND RESPONSE/
PLASMA CHEMISTRY/LASER PLASMA/LASER TARGET
THE BRL NONEQUILIBRIUM LASER PLASMA-TARGET INTERACTION CODE/BRL DRAFT REPORT
JOSEPH LACETERA

FORTRAN

OPERATIONAL/COMPLICATED TO RUN

LASER PLASMA INTERACTIONS

PERFECT GAS LAW

TRANSMITTIVE/MOVING

50 BY 5

NONEQUILIBRIUM

JOSEPH LACETERA/CONTINUUM MECHANICS CENTER/BRL/APG MD/301 278 4353

2

LASXPT 1 PLASMA INTERACTIONS/BRL DRAFT REPORT

JOSEPH LACETERA

ISOLATIONS	TOTAL	PERCENTAGE
2	20	10.00

These examples have been constructed as an illustrative group and are not meant to be complete or portray all of the capabilities of the system. For example, the reverse numerical and alphabetical sorting capabilities have not been shown.

VI. DISCUSSION

This report deals with the CMC's computer code data base which uses CREATABASE, a relational data base analysis system. Besides describing the data base, the manner in which it is accessed and queried is also explained and corresponding examples are given.

CMC personnel are not only the designers of the data base but also are its primary users. Care and maintenance of the data base is one of the CMC's functions. In addition to ensuring correctness of the current data, the center will add new data as it becomes available. Such data is not limited to that defined by the current 62 descriptors since new descriptors will be added as required. No attempt will be made to make the data base a complete reference system for all codes. However, the CMC will consider and catalog not only the most promising, but also the most used codes.

In addition to the data base itself, the CREATABASE system must undergo change and not remain a static inflexible tool. One area in which CREATABASE can be improved is that of subtabling. The amalgamation of like descriptors (for example, authors) into a single descriptor will allow for easier querying and new relations to be formed. For instance, the output of a query involving an author may produce his co-authors for a single reference or all his co-authors for all his published works. Furthermore, short queries involving a single amalgamated descriptor are preferable to long descriptor lists or Boolean expressions. Finally, the amalgamated descriptor will alleviate some of the need for handling subset binary files through the fortuitous production of information. Another area in which CREATABASE can be improved involves limited alphanumeric searching for name descriptors. Such a change would not only extend the textual capabilities of CREATABASE but free the user from entering artificial data for several types of applications and/or exactly specifying a descriptor state in the Boolean expression. The form for this extension should also provide for a range of values rather than a specific state. Other improvements of CREATABASE are possible; however, the two items listed above will make this system even better.

Finally, the use of this data base is encouraged as an information retrieval system. Furthermore, comments and suggestions on its structure and contents are welcome.

ACKNOWLEDGEMENT

The authors wish to thank Daniel Analytical Services Corporation for permission to publish Figure 2.

APPENDIX I. QUESTIONNAIRE USED TO GATHER DATA
BASE DATA

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QUESTIONNAIRE

1. The name of the code (acronym plus its meaning) is _____.
2. List the following information on the user's manual:
Author(s) _____
Address of Authors _____
Title _____
Report Number _____
Date of Publication _____.
3. Code is operational on the following computers:
CDC 7600 UNIVAC 1108 BRLESC _____.
4. The following people are knowledgeable in the code's use:

5. Primary application of the code is _____.
Second application of the code is _____.
Tertiary application of the code is _____.

6. The type of mesh used is
Eulerian Lagrangian Eulerian & Lagrangian unknown.

7. The code uses the following general numerical method:
finite difference finite element Monte Carlo _____.

8. The code uses the following particular numerical method:
characteristics Lax-Wendroff random walk Galerkin multipass integral

9. The order of the numerical scheme is
_____ not applicable unknown.

10. The code performs unsteady calculation: yes no.

11. The code can treat the following spatial geometry(ies):
rectangular cylindrical spherical.

12. The code can treat the following spatial dimensionality:

one two three.

13. List the variables computed directly from the transport equations.

14. The code can use the following equations of state:

Tillotson perfect gas law BRLGRAY JWL CHARTD PUFF

15. The code can apply the following types of boundary conditions:

reflective transmittive non-slip free-slip moving free surface

16. The maximum grid size for the code is _____ by _____.

17. The code has the following type of rezoning capability:

automatic manual none unknown

18. The code does the following type of radiation transport

equilibrium non-equilibrium none unknown

19. The code does the following type of energy deposition:

time-independent time-dependent none unknown

20. The code does the following type of chemical reactions:

equilibrium non-equilibrium none unknown

21. The code does the following type of atomic reactions:

equilibrium non-equilibrium none unknown

22. The code calculates material response: yes no.

23. The code treats solids as an elastic plastic:

yes no not applicable unknown .

24. The code has an interface capability:

yes no not applicable unknown.

25. The code can handle _____ (number of) different materials.

26. The code treats the following types of fluid flow:

inviscid compressible viscous compressible inviscid incompressible
viscous incompressible none unknown.

27. The code treats shocks by the following method:

artificial viscosity shock fitting _____
none not applicable.

28. The code solves the following equations:

conservation of mass conservation of momentum conservation of energy
Boltzmann's equation _____

29. The code is written in the following computer language(s):

FORTRAN ALGOL APL

30. The code has the following special features:

strength option tracer particles combustion option sliplines

31. The following reports contain information relating to the code itself or the code's performance. For such reports give author(s), report number(s), and title(s) or key words. The total description per report should be less than 120 characters including blanks.

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.

32. Describe the salient features of the code in less than 120 characters; for example,

HELP: unsteady, 2D, Eulerian, multi-material, finite difference, integral formulation, solid and compressible fluid applications.

33. Please list any pertinent computer code properties omitted and any other comments.

APPENDIX II. THE DATA BASE

2ELHUS J.
FINITE DIFFERENCE/LARGE ELASTIC-PLASTIC TRANSIENT DEFORMATIONS OF MULTILAYER VARIABLE-THICKNESS KIRCHOFF SHELLS
PETROS 3.5 NEW DEVELOPMENTS AND PROGRAM MANUAL FOR ... /BRL-CR-211/FEB 75
S O PIROTIN/B A BERG/E A WITMER
FORTRAN
BRLSC

OPERATIONAL/EASY TO RUN
TRANSIENT DEFORMATION OF SHELLS

AUGUSTIAN
FINITE DIFFERENCE

EXPLICIT

SECOND

THREE DIMENSIONAL

SPECIAL TREATMENT

YES
CONSERVATION OF MASS/MOMENTUM/ENERGY
ENERGY/DISPLACEMENT/STRAIN

23 BY 37

VONE

YES

4

YES

VONE

NOT APPLICABLE

VONE

3

VONE

EXTENSIVE

MECHANICAL LOADS/

TEMPERATURE DEPENDENT/MULTIMATERIAL SHELLS/INITIAL VELOCITY DISTRIBUTIONS

4 L WISNIEWSKI/J M SANTIAGO/J D MORTAN/N J HUFFINGTON JR

5 COUPLING OF XRAY DEPOSITION TO STRUCTURAL RESPONSE/BRL-TR-474/FEB 76

4 L WISNIEWSKI

MICROSCOPIC FAILURE CRITERIA FOR ABM SUBSTRUCTURE OF BERYLLIUM/BRL-MR-2596/FEB 76

C T CANLAND

CONTAINMENT STRUCTURES VS SUPPRESSIVE STRUCTURES/BRL-MR-2597/FEB 76

V J HUFFINGTON JR/S H ROBERTSON

SURVIVABILITY ANALYSIS FOR UNSYMMETRICAL ABM CONFIGURATION/BRL-MR-2461/MAR 75

V J HUFFINGTON JR/J M SANTIAGO/J L WISNIEWSKI

COMPARISON OF FINITE DEFORMATION SHELL CODES REPSIL AND PETROS 3/BRL-MR-2391/JUN 74

S R ROBERTSON

FINITE DIFFERENCE ANALYSIS FOR PREDICTING LARGE ELASTIC-PLASTIC TRANSIENT DEFORMATIONS OF VARIABLE THICKNESS KIRCHOFF *****

S O PIROTIN/MORINO/WITMER/LEECH

FL MAIN
A FINITE ELEMENT METHOD APPLIED TO SYSTEMS OF FIRST ORDER HYPERBOLIC EOS USING LEAST SQUARES FORMULATION INVIScid FLOWS
J A SCHMITT
FORTRAN
SHMESC
ZULOT
UNSTEADY INVISCID GAS FLOWS

EULERIAN
FINITE ELEMENT
ELEMENTWISE LEAST SQUARES MINIMIZATION OF RESIDUAL ERROR
FIRST
TWO DIMENSIONAL
RECTANGULAR/CYLINDRICAL
YES
CONSERVATION OF MASS/MOMENTUM/ENERGY
PRESSURE/VELOCITIES/INTERNAL ENERGY
NOBLE-AREL
PERFECT GAS LAW

2000 NODES
40VC
Y0
Y0
Y0

1
NOT APPLICABLE
INVISCID COMPRESSIBLE
NONE
NONE
NOT APPLICABLE
NONE
NONE
NONE

LIMITED GRAPHICS PACKAGE AVAILABLE/TREATS HYPERBOLIC EOS DIRECTLY BY FINITE ELEMENTS
OSCILLATIONS AT SHOCK FRONTS/NO BOUNDARY CONDITIONS EXPLICITLY TREATED
J A SCHMITT

ASRPT I
VONEQUILIBRIUM/HADRONIC/HYDRODYNAMICS/ATMOSPHERIC TRANSPORT AND RESPONSE/PLASMA CHEMISTRY/LASER PLASMA/LASER TARGET
THE BRL NON-EQUILIBRIUM LASER PLASMA-TARGET INTERACTION CODE/BRL DRAFT REPORT

JOSEPH LACETERA

FORTRAN

BDC 7600 HUNTSVILLE

OPERATIONAL/COMPLICATED TO RUN

-LASER PLASMA INTERACTIONS

LASER TARGET INTERACTIONS

K-RAY LASER TRANSPORT

EULERIAN

FINITE DIFFERENCE

VARIATION OF PIC

FIRST

TWO DIMENSIONAL

CYLINDRICAL

YES

CONSERVATION OF MASS/MOMENTUM/ENERGY/PARTICLES

JENNERITIES/ALLOCITIES/GAS ENERGY/RADIATION ENERGY

PERFECT GAS 'LAW'

3KG/GRAY

TRANSMITTIVE/MOVING

50 BY 5

40 VE

YES

YES

NOT APPLICABLE

2

YES

INVISCID COMPRESSIBLE

SPECIAL TREATMENT

NO EQUILIBRIUM

TIME-DEPENDENT PHOTON ENERGY DEPOSITION

NO EQUILIBRIUM

NO EQUILIBRIUM

ROUTINELY RUN

141TED

VONEQUILIBRIUM IONIZATION/NON-LTE

NO EQUILIBRIUM

NO EQUILIBRIUM

2

LASRPT I PLASMA INTERACTIONS/BRL DRAFT REPORT

JOSEPH LACETERA

LASRPT II TARGET INTERACTIONS/BRL DRAFT REPORT

JOSEPH LACETERA

ON SCREEN

REVIEWED
SOLAR SYSTEM
BY THE AUTHOR

BC/INHOMOGENEOUS BC
3D HEAT TRANSFER/HEAT DIFFUSION/MONTE CARLO/GREENS FUNCTIONS/HOMOGENEUS
SOLUTION OF THE TIME-DEPENDENT HEAT CONDUCTION EQUATION IN COMPLEX GEOMETRY BY THE MONTE
CARLO METHOD
TROUBIJKOVÁ KALOŠA/STEINBERG/BRUNČ-385/DEC 1976

**CUC 7600 HUNTSVILLE
OPERATIONAL/EASY TO RUN
MEAT TRANSFER**

EULERIAN
MONTE CARLO
RANDOM WALK

THREE DIMENSIONAL
RECTANGULAR/CYLINDRICAL/SPHERICAL
YES
HEAT CONDUCTION
TEMPERATURE

11

30

REFLECTIVE/TRANSITIVE/FREE SURFACE

SPECIAL
"NO. 100" SCARF

NO

200

WESI
M04R

VOT APPPLICABLE

LINE-DEPENDENT

HOME

FRAMES ATTACHMENT TO BREVET TIME ARRAYS

三

卷之三

三

ALCHI
UNSTEADY/1D/FEULENTIAN/COMPRESSIBLE VISCOUS TUBE FLOW/METHOD OF CHARACTERISTICS/NOISE/THRUST/HEAT LOSS/INTERIOR BALLISTIC
RECRIF USERS MANUAL BRL MR 2693 OCTOBER 1976

4 CELMINS

FORTRAN

BRLESC

OPERATIONAL/EASY TO RUN
INTERIOR BALLISTICS OF RECOILLESS WEAPONS

INTERIOR BALLISTICS OF CLOSED BREACH WEAPONS

EULERIAN

FINITE DIFFERENCE

CHARACTERISTICS

ERST

ONE DIMENSIONAL

SPECIAL TREATMENT

YES

CONSERVATION OF MASS/MOMENTUM/ENERGY
IN BARREL-VELOCITY/PRESSURE/DENSITY//IN COMBUSTION CHAMBER-INTERNAL ENERGY/MASS/VOLUME

PERFECT GAS LAW

MOVING/TUBE EXIT FLOW

4500 NODES/200 CHARACTERISTICS

SPCIAL

VO

NOT APPLICABLE

BLAST
JNSTFADY2D/EULERIAN/SINGLE MATERIAL/FINITE DIFFERENCE/COMPRESSIBLE FLUID
CALCULATION OF MUZZLE BLAST FLOW FIELDS/TR-4155 PICATINNY ARSENAL /ADAB1523/OCC 1970

F J TAYLOR

FORTRAN

3MLESC

JET FLOW

MATERIAL/EASY TO RUN

MUZZLE BLAST CALCULATIONS

JET FLOW CALCULATIONS

EULERIAN

FINITE DIFFERENCE

GODUNOV

FIRST

TWO-DIMENSIONAL

CYLINDRICAL

YES

CONSERVATION OF MASS/MOMENTUM/ENERGY

DENSITY/TIMES VELOCITIES/DENSITY TIMES TOTAL ENERGY

PERFECT GAS LAW

REFLECTIVE/FREE-SLIP

70 BY 70

NO

YES

NO

NOT APPLICABLE

1

NO

INVISCID COMPRESSIBLE

ARTIFICIAL VISCOSITY

NO

NOT APPLICABLE

NO

LIMITED

VASIKAI
STRUCTURES/WHITE ELEMENT/NORMAL MODE/FREQUENCIES/TRANSIENT-ELASTIC/STATIC-PIECEWISE LINEAR/HEAT FLOW
THE NASTRAN USERS MANUAL/LEVEL 15/SCIENTIFIC AND TECHNICAL OFFICE/NASA/HASH DC

THURM MULL,
 NONEQUILIBRIUM/RADIATION-HYDRODYNAMICS/ATMOSPHERIC TRANSPORT AND RESPONSE/ATOMIC IONIZATION/FIREBALL CHEMISTRY/
 THE BRL NONEQUILIBRIUM NUCLEAR FIREBALL CODE/BRL DRAFT REPORT/
 JOSEPH LACETERA ET AL./CONTINUUM MECHANICS CENTER/BRL/APG MD/301 278 4353

FORTRAN :DC 7600 HUNTSVILLE

OPERATIONAL/COMPLICATED TO RUN

FIREBALL PHENOMENOLOGY

X-RAY TRANSPORT

SPHERICAL BLAST

EULERIAN

FINITE DIFFERENCE

VARIATION OF PIC

FIRST

ONE DIMENSIONAL

SPHERICAL

YES
CONSERVATION OF MASS/MOMENTUM/ENERGY/PARTICLES
DENSITIES/VELOCITIES/GAS ENERGY/RADIATION ENERGY
PERFECT GAS LAW

...
...
...

TRANSMITTING/MOVING

SO BY 1

MANUAL/AUTOMATIC

NO

YES

NOT APPLICABLE

1
NOT APPLICABLE

INVISCID COMPRESSIBLE

SPECIAL TREATMENT

NONEQUILIBRIUM

TIME-DEPENDENT PHOTON ENERGY DEPOSITION

NONEQUILIBRIUM

NONEQUILIBRIUM

VOKE

NONEQUILIBRIUM IONIZATION/NON-LTE

NOT ROUTINELY RUN

JOSEPH LACETERA

1
EFFECTS OF NONEQUILIBRIUM PHENOMENA ON RADAR TRANSMISSION/BRL DRAFT REPORT

JOSEPH LACETERA/G DAUM

...
...
...

SAMS
INSTADY/2U/EULERIAN/ONE MATERIAL/FINITE DIFFERENCE/COMPRESSIBLE FLUID/MOVING BOUNDARY OF ARBITRARY GEOMETRY
A USERS MANUAL FOR SAMS ARL CONTRACT REPORT NO162 A0782 179 / JUNE1974
J L FARRAC W TRACI/SAI 101 CONTINENTAL BLDG SUITE310 EL SEGUNDO CA 90245

FORTNAN

FORLES

OPERATIONAL/EASY TO RUN

NUZZLE BLAST CALCULATIONS

PROPANE TORCH CALCULATIONS

JET FLOW CALCULATIONS

EULERIAN

FINITE DIFFERENCE

VARIATION OF PIC

FIRST

FOO DIMENSIONAL

RECTANGULAR/CYLINDRICAL

YES

CONSERVATION OF MASS/MOMENTUM/ENERGY

2DENSITY/VELOCITIES/TOTAL ENERGY

PERFECT GAS LAW

NOSELE-ARBL

REFLECTIVE/TRANSMITTIVE/FREE-SLIP/MOVING

SO BY 150

VOKE

YES

VOKE

NOT APPLICABLE

1

VO

ENVISCID COMPRESSIBLE

ARTIFICIAL VISCOSITY

VOKE

NOT APPLICABLE

VOKE

VOKE

FRACER PARTICLES/EXTENSIVE GRAPHICS PACKAGE AVAILABLE

STATIC INSTABILITIES AT LATE TIMES

2 K ZOLTANI/COLEMAN

3 W TRACI/J L FARRAC Y LIU

4 NUMERICAL METHOD FOR THE SIMULATION OF MUZZLE GAS FLOWS WITH FIXED AND MOVING BOUNDARIES ARL CONTRACT REPORT 161

5 THE INTERMEDIATE BALLISTIC ENVIRONMENT OF THE M-16 RIFLE ARL REPORT 1860 FEB 1976

6 K ZULTANI

CALCULATION OF THE MUZZLE FLOW FIELD OF THE 155MM HOWITZER M-109 ARL REPORT 1901 AUG 1976

7 K ZOLTANI

8 K ZOLTANI

9 K ZOLTANI

10 K ZOLTANI

11 K ZOLTANI

12 K ZOLTANI

13 K ZOLTANI

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33 K ZOLTANI

34 K ZOLTANI

EPIC-5

TO BE PUBLISHED AS URL CONTRACT REPORT ON OR ABOUT MAY 1977

S R JOHNSON/DEFENSE SYSTEMS DIV/HONEYWELL INC/MINNEAPOLIS MN
FORT HAN

JHIVAC 1108 ENGEWOOD

PILOT

KINETIC ENERGY PENETRATION

SHAPED CHARGE STUDIES

IMPACT AND WAVE PROPAGATION

LAGRANGIAN

FINITE ELEMENT

NOT APPLICABLE

THREE DIMENSIONAL

RECTANGULAR/CTL IMORICAL/SPHERICAL

YES

NIE-GRUNE ISBN

REFLECTIVE/TRANSMITTIVE/NON-SLIP/FREE-SLIP/MOVING/FREE SURFACE
USES SUBSTRUCTURE METHOD---GRID LIMITED ONLY BY TIME-COST CONSIDERATIONS

None

No

Yes

REMARKS: THE PROGRAM IS A GENERAL PURPOSE FINITE ELEMENT ANALYSIS CODE FOR THE DYNAMIC ANALYSIS OF STRUCTURES. IT IS CAPABLE OF HANDLING A VARIETY OF ELEMENT TYPES, MATERIALS, AND GEOMETRIES. THE CODE IS DESIGNED TO BE USED IN THE ANALYSIS OF MECHANICAL SYSTEMS, INCLUDING AUTOMOTIVE, AIRCRAFT, AND INDUSTRIAL EQUIPMENT.

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INSTITUTE FOR COMPUTATIONAL MATERIALS/FINITE DIFFERENCE/INTERNAL FORMULATION/PIC TYPE/SOLID AND FLUID APPLICATIONS
HELP A MULTI-MATERIAL EULERIAN.../MULIPES 1-2/SSR-75-2654 MAY75/BRLCR39 JUL75
J. J. HAGEMAN D. F. WILKINS ET AL./SYSTEMS SCIENCE AND SOFTWARE LAJOLLA CA 92038

FORTRAN
ERLESAC/CUC 7600 MINTSVILLE/UNIVAC 1108 EDGEWOOD

OPERATIONAL/EASY TO RUN

SHAPED CHARGE STUDIES

KINETIC ENERGY PENETRATION

FRAGMENTATION MUNITIONS

EULERIAN

FINITE DIFFERENCE

VARIATION OF PIC

FIRST

TWO-DIMENSIONAL

RECTANGULAR/CYLINDRICAL

YES

CONSERVATION OF MASS/MOMENTUM/ENERGY

YES/VELOCITIES/TOTAL ENERGY

TILLOTSON

JNL-JONES/WILKINS/LEE

PERFECT GAS LAW

REFLECTIVE/TRANSMITITIVE

JRC/COC 7600 60 BY 200/ON UNIVAC 1108 34 BY 66

MANUAL

NO

YES

23

YES

INVISCID COMPRESSIBLE

ARTIFICIAL VISCOSITY

NONE

TIME-DEPENDENT EXPLOSIVE DETONATION

NONE

NONE

LIMITED

STRENGTH OPTION/TRACER PARTICLES/SPLINES

OVER THERMALIZATION

JONUS/J MISF/M CHANL/JANET LACETERA/JOE HARRISON/J SCHMITT

4

BRLSC AN ADVANCED EULERIAN CODE FOR PREDICTING SHAPED CHARGES VOLUME 2

SYSTEMS SCIENCE AND SOFTWARE LAJOLLA CA 92038

NUMERICAL ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF PENETRATION BY KINETIC PROJECTILES AFATL-TR-72-98

SYSTEMS SCIENCE AND SOFTWARE LAJOLLA CA 92038

EFFECTS OF HIGH EXPLOSIVE PARAMETERS AND DEGREE OF CONFINEMENT ON JETS FROM LINED SHAPED CHARGES BRL CR 205

SYSTEMS SCIENCE AND SOFTWARE LAJOLLA CA 92038

RESEARCH STUDY AND ANALYSIS FOR IMPROVEMENT OF SHAPED CHARGE CODE BRLCR40

SYSTEMS SCIENCE AND SOFTWARE LAJOLLA CA 92038

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4-ERIC
INSTITUTE FOR EULERIAN/MULTI-MATERIAL/FINITE DIFFERENCE/INTEGRAL FORMULATION/SOLID AND COMPRESSIBLE FLUID APPLICATIONS
DEVELOPMENT OF ORUNANCE, VELOCITY MULTIMATERIAL 3D PERFORATING CODE FOR FINITE PLATES SSS R 76-2861(DRAFT) FEB 76
J HAGEMANNE P LEE SYSTEMS SCIENCE AND SOFTWARE LAJOLLA CA 92098
FORTRAN
INVAC 1108 EDGEWOOD

GENETIC ENERGY PENETRATION

EULERIAN
ELIMITE DIFFERENCE

— E R S T —
THREE DIMENSIONAL
SCENES WITH A

VISUALISATION OF MASS/MOMENTUM/ENERGY

MILROTH AND COOPER

11

REFLECTIVE/TRANSMITTIVE
14 BY 27 AT 13

MORE

RESUME OF THE REPORT

INVISCIU INCOMPRESSIBILE

ARTIFICIAL VISC
HOME

NOT APPLICABLE

ВОНЕ
СЕ

STRENGTH OPTION

CODE IS UNTRIED

—

11

11

SH111
SMITE-A SECOND ORDER EULERIAN CODE FOR HYDRODYNAMIC AND ELASTIC-PLASTIC PROBLEMS BRL CR REPORT 255 AUG 75
S 2 HURSTEIN/H SCHECHTER/TURKEL/MAGI INC ELMHFORD NY
FORTRAN
JNTVAC 1108 EGGEMOOD
SILOT
KINETIC ENERGY PENETRATION
SHAPE CHARGE STUDIES

EULERIAN
FINITE DIFFERENCE
-AKHENDOFF
SECOND
TWO DIMENSIONAL
RECTANGULAR/CLINORICAL

YES
CONSERVATION OF MASS/MOMENTUM/ENERGY
FILLOTSON
WIEGRUNEISEN

REFLECTIVE/MOVING/FREE SURFACE
109 BY 30
DONE
NO
YES
YES
5
YES
INVISCID COMPRESSIBLE
ARTIFICIAL VISCOSITY
NONE
NOT APPLICABLE
NONE
NONE
STRENGTH OPTION

J A ZUKAS

3

BRL CONTRACT REPORT NO 294
BRL CONTRACT REPORT NO 295
BRL CONTRACT REPORT NO 175

REPSIL
A LARGE TRANSIENT RESPONSE/ELASTOPLASTIC/STRAIN HARDENING/STRAIN RATE DEPENDENT/KIRCHOFF SHELLS/DYNAMIC LOADING
A USERS MANUAL FOR THE REPSIL CODE/BRL R 1749/OCT 74
J M SANTIAGO/H L MISNIEWSKI/N J HUFFINGTON JR/BALLISTIC RES LAB
FORTRAN
SRLESC

OPERATIONAL/EASY TO RUN
TRANSIENT DEFORMATION OF SHELLS

...

AGRANGIAN
FINITE DIFFERENCE
EXPLICIT TIME DIFFERENCE

SECOND

THREE DIMENSIONAL

SPECIAL TREATMENT

YES
CONSERVATION OF MASS/MOMENTUM
ENERGY

...

:LAMPLID/HINCU/SYMMETRY
3D BY 50
134E
UD
NO
YES
FES
1
NOT APPLICABLE

...

NOT APPLICABLE
NO/NE
NO/NE
NO/NE
NO/NE

...

NOT APPLICABLE

...

EXTENSIVE
STRENGTH OPTION/TRACEON PARTICLES/GENERAL SHELL/2D SHELL/3D SPACE
REPSIL IS NOT A HYUNDO CODE
J M SANTIAGO/H L MISNIEWSKI/N J HUFFINGTON JR/J D WORTMAN

...

THEORY LARGE DEFLECTION ELASTOPLASTIC STRAIN HARDENING SHELL RESPONSE/BRL R 1571
J M SANTIAGO

-ARGE DEFLECTION ELASTOPLASTIC RESPONSE OF SHELL STRUCTURES/BRL R 1515
N J HUFFINGTON JR
ANALYTICAL STUDY OF EXPLOSIVE LOADING SIMULATION OF IMPULSIVE LOADING/
V J HUFFINGTON JR/J D WORTMAN
2D ANETRIC INFLUENCES ON RESPONSE OF STRUCTURAL SHELLS/BRL R 1689

...

4111P
UNSTEADY 2D/EULERIAN/DNE MATERIAL/FINITE DIFFERENCE/INVISCID COMPRESSIVE FLOW
A-2D UNSTEADY EULERIAN HYDRODYNAMIC CODE-USERS MANUAL BRL REPORT 1632 FEB 78
C. A. NELSON
FORTRAN
BRL/SEC/UNIVAC 1108 EDGEWOOD
OPERATIONAL/EASY TO RUN
BLAST WAVES

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1	Commander US Army Materiel Development and Readiness Command ATTN: DRCMS-I, Dr. R.P. Uhlig 5001 Eisenhower Avenue Alexandria, VA 22333	1	Commander US Army Mobility Equipment Research & Development Command ATTN: DRSME-RZT Tech Docu Cen, Bldg 315 Fort Belvoir, VA 22060
1	Commander US Army Materiel Development and Readiness Command ATTN: DRCMS-T Mr. J. Cianflone 5001 Eisenhower Avenue Alexandria, VA 22333	1	Commander US Army Armament Materiel Readiness Command Rock Island, IL 61202
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1	Director US Army Air Mobility Research and Development Laboratory Ames Research Center Moffett Field, CA 94035	2	Commander US Army White Sands Missile Range ATTN: STEWS- Dr. Fields Dr. Graves White Sands Missile Range, NM 88002
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5	Director US Army TRADOC Systems Analysis Activity ATTN: ATAA-SA Mr. Goode, Mr. Peters Mr. Salizar Mr. De Saint Germaine White Sands Missile Range, NM 88002	1	Operating Systems Inc. ATTN: Dr. C. Montgomery 21031 Ventura Boulevard Woodland Hills, CA 91364
3	Director US Army Concepts Analysis Agency ATTN: Mr. Bayse, Mr. Hurd Ms. Tenney 8120 Woodmont Avenue Bethesda, MD 20014	1	Performance Development Corp. ATTN: Mr. L. J. Cohen 32 Scotch Road Trenton, NJ 08628
1	Commander Naval Weapons Center ATTN: Mr. R.D. Hawkins Systems Dev Dept China Lake, CA 93555	1	Pritsker and Associates, Inc. ATTN: Dr. A. Pritsker 1710 South Street Lafayette, IN 47904
1	Office of Technology Assessment US Congress ATTN: Mr. Coates Washington, DC 20510		<u>Aberdeen Proving Ground</u>
2	Daniel Analytical Services, Inc. ATTN: Mr. Miller Mr. Graham 16821 Buccaneer Lane, Suite 202 Clear Lake City Houston, TX 77058		Marine Corps Ln Ofc Dir, USAMSA ATTN: Dr. Sperrazza Dr. Streilen Dr. Atzinger Mrs. Taylor Mr. Itten Mr. Bain Mr. Bannon Mr. Maki Cdr, USATECOM ATTN: Mr. Goldstine Mr. Barnhart

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**Cdr/Dir, Chemical Systems Lab
ATTN: DRDAR-MSE, Mr. Goldberg
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