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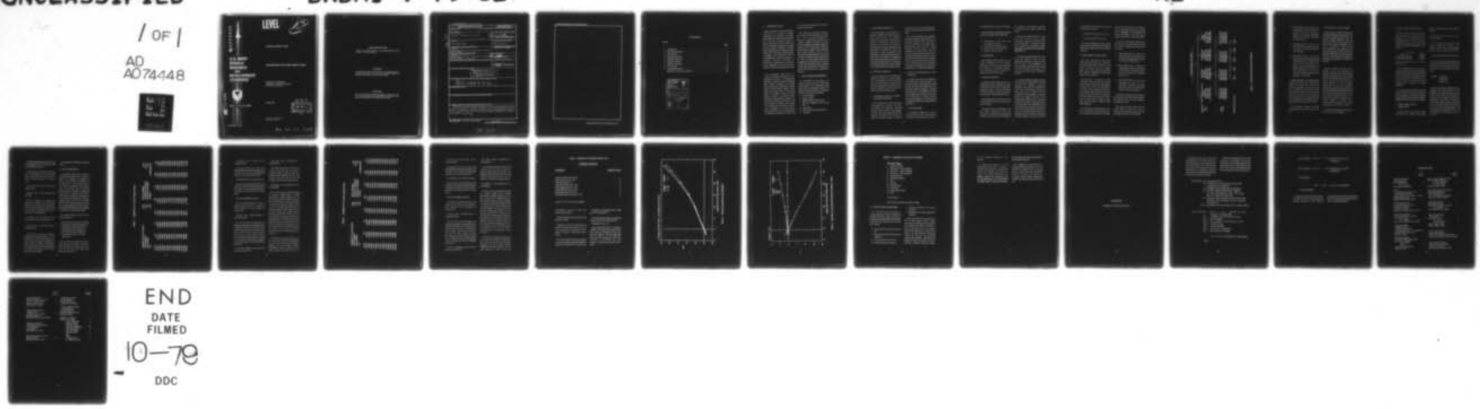

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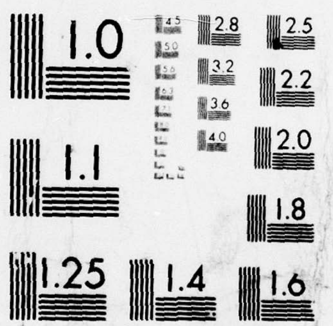

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U.S. ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND

TECHNICAL REPORT T-79-62

AERODYNAMIC DATA BASE USER'S GUIDE

George M. Landingham
Systems Simulation Directorate,
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5 June 1979

Redstone Arsenal, Alabama 35809

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A data base system has been developed for storage and interactive analysis of data. This report is intended as a description of the system and as a user's guide. The equipment on which the data base system is implemented is detailed. A description of the data base structure and detailed instructions for using the system are included.

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1. INTRODUCTION

What is a data base? In the simplest sense, a data base is a collection of related information. This information may reside on punched cards, magnetic tape, magnetic discs or only as a computer listing in a report. If a data base is to be of value, it must have the information organized in a manner such that specific information contained within the data base can be readily extracted by the user. If a data base is implemented on a computer, the extraction of data is accomplished by computer programs, i.e., software. Efficient extraction of information is dependent on the software, on the organization of the data and on the medium in which the information is stored.

The Aerodynamic Data Base is a collection of information related to various aerodynamic projects. The Aerodynamic Data Base is really many smaller data bases which contain information on specific projects such as the "High Angle of Attack" research, "Rocket Plume" studies or "Bluff Body" wind tunnel study. To the extent which it is feasible, the data from every project is stored in a common format. Similarly, the information in a specific data base may come from many sources such as tests conducted in different wind tunnels. The information from different sources is made compatible in the data base by organizing the data into a common format, by making the nomenclature consistent and by referencing of coefficients to consistent dimensional constants.

Some software is available to data base users to help in organizing data into the data base. Also, two general applications programs, to tabulate and to plot data, are available. Detailed procedures for using these two applications programs are given in Sections 7 and 8 of this report. Additional general purpose software will be developed and made available. Some of the applications being considered are discussed in Section 9. Special purpose programs can be written to satisfy special needs. These programs do not become a part of the total Aerodynamic Data Base, but are associated instead with a specific user. This concept of private and universal files is explained in Section 3.

2. DATA BASE EQUIPMENT

To understand the data base, it is necessary to have at least a rudimentary understanding of the equipment which makes up the Aerodynamic Analyzer on which the data base resides. This equipment basically consists of the following:

- A mini-computer
- System console
- Magnetic discs and disc drives
- Half inch magnetic tapes and tape drives
- Card reader
- Various hard-copy output devices
- Terminals

A. THE MINI-COMPUTER

The mini-computer is an Interdata 8/32 presently configured with 500 kilo-bytes of central core memory. The computer controls all input/output operations and performs all calculations. The type of computer is not essential to the overall data base concept, but certain dependencies are introduced in making the data base operational. These dependencies are actually due to the operating system and to peculiarities of the higher level language in which the data base software is written. The most obvious dependency is in naming the disc files that comprise a data base. Sections 3 and 4 illustrate the file naming concept.

B. SYSTEM CONSOLE

The system console is a Lear-Seigler LSI ADM-3A terminal. The system console allows communication with the operating system. Certain necessary operations can only be performed from the system console. However, usually the data base user is not concerned with the system console.

C. MAGNETIC DISC PLATTERS AND DISC DRIVES.

One Interdata disc and two CDC drives are connected to the system. The drives accomodate 67.5 mega-byte removable platters which are used to store programs and data. The various data bases reside on different disc platters. The user must be certain the necessary platter is mounted. Each platter has a unique identification, called the volume name, which the user must know.

Just as each disc platter has a unique ID, each disc drive has a unique identifer. These disc IDs are DSCO:, DSC1: and DSC2:. The colon indicates to the system that a physical device and not a file is being identified. One disc platter is always designated the "systems disc". This disc contains all the operating system programs and data base programs. The systems disc is the default disc for any operation. Usually, this disc is mounted on disc drive DSCO:. Caution should be taken in mounting and removing the disc platters to insure that the systems disc is not removed accidentally.

D. HALF INCH MAGNETIC TAPE DRIVES

Two Pertec tape drives are available, a seven-track and a nine-track drive. The seven-track drive operates at 556 bpi or 800 bpi and will read or write BCD code. The nine-track operates at 800 bpi or 1600 bpi and will read or write EBCDIC or ASCII codes. Magnetic tapes are used to input data to the system and to " 'backup" 'the data stored on the disc platters. A utility program is available to facilitate backing up data base information.

E. CARD READER

A Documation M300 card reader is available. This card reader reads 026 punch and operates at about 600 cards/minute.

F. HARD-COPY OUTPUT DEVICES

Various devices for obtaining permanent copies are available. These devices are:

- Dataproducts model 2230, 300 line/minute line printer.
- Varian Statos 42 Printer/Plotter.
- Tektronix 4632 video hard copy.
- Tektronix 4631 hard copy.

G. TERMINALS

Approximately eight terminals are now active, including five with graphics capability. The Tektronix hard copy units are connected to the graphics terminals. Also, automatic dial-up capability is available, allowing off-site usage.

3. FILES CONCEPT

The primary mass-storage device is a 67.5 megabyte disc platter. Information is stored on the platter in files, which contain either programs or data. To access information stored on the platter, the user must know the "file descriptor" which identifies the file.

The file descriptor consists of four fields: volume name, file name, extension and file account number.

The volume name is the identifier of the disc platter containing the file. This identifier is a string of four alphanumeric characters, the first character of which must be alphabetic. Typical platter identifiers now being used are MT32, TDK1, and TDK2.

The file name is assigned by the user. This name may consist of one to eight alphanumeric characters, the first of which must be alphabetic. For example, all data base programs are assigned file names beginning with DBASE such as DBASE01, DBASE02, etc.

The extension is assigned by the user. This name may consist of zero to three alphanumeric characters, the first of which does not have to be alphabetic. The extension allows related files to be assigned the same file name. The utility of the extension to the data base is explained in Section 4.

The account number may apply to private files, group files or system files. Private file accounts are assigned to specific individuals, and only that individual has access to the information in these files. Group files may be used by all the individuals who are assigned to a specific group. For example, all users in the Aerodynamics Branch share a common group account number. Group files cannot be directly altered once established. All the data base data are stored in group files. Systems files are files which are available to any user, but like group files they are not changeable from a terminal. All operating systems programs are stored in the system files, and certain data base files must also be stored in the system files.

A complete file descriptor is given by:

VOLN:FILENAME.EXT/ACT

For more explanation of files and file descriptors see Interdata manual *Dynamic OS-32 MT Program Reference Manual,* Chapter 4.

4. DATABASE STRUCTURE

The total Aerodynamics Data Base includes many projects, each of which is a data base within itself. In general, "data base" in this report refers to a specific project, not to the full Aerodynamics Data Base. *Figure 1* illustrates the hierarchical structure of the data base.

The data base is structured to take advantage of the Interdata file naming system. Usually, information is gathered on a project over several years and perhaps from many sources. A data base consists of one or more groups of data associated with a specific project. The data base is assigned a six letter identifier and each group of data within the data base is assigned a single letter. A group of data is usually the data froma single test.

The organization of the "Bluff Body" data base is an example. This data base consists of aerodynamic data gathered from eight separate wind tunnel tests of a variety of blunt, hence bluff, missile noses. The data base is identified by the alphanumeric string, "BLUFBD". The first test is identified by the letter "A" plus "BLUFBD".

Three files are associated with the total data base. For the Bluff Body data base these files are assigned the following file descriptors:

- ABLUFBD.COF-An ASCII file containing *titles for all variables* in the data base. Examples: Angle of Attack, Normal Force Coefficient, etc.
- BBLUFBD.COF-An ASCII file containing *short titles for all variables* in the data base in the same order as the file described above. Examples: Alph, CN, etc.
- ABLUFBD.PRM-An ASCII file containing the *names of all independent parameters* associated with the data base. Examples: Mach Number, Reynolds Number, etc.

Note that the initial letters A and B for these three files is arbitrary and should not be confused with the group identifier discussed previously.

Three files are associated with each data group within the data base. The file descriptors for the first group of data in the Bluff Body data base are an example.

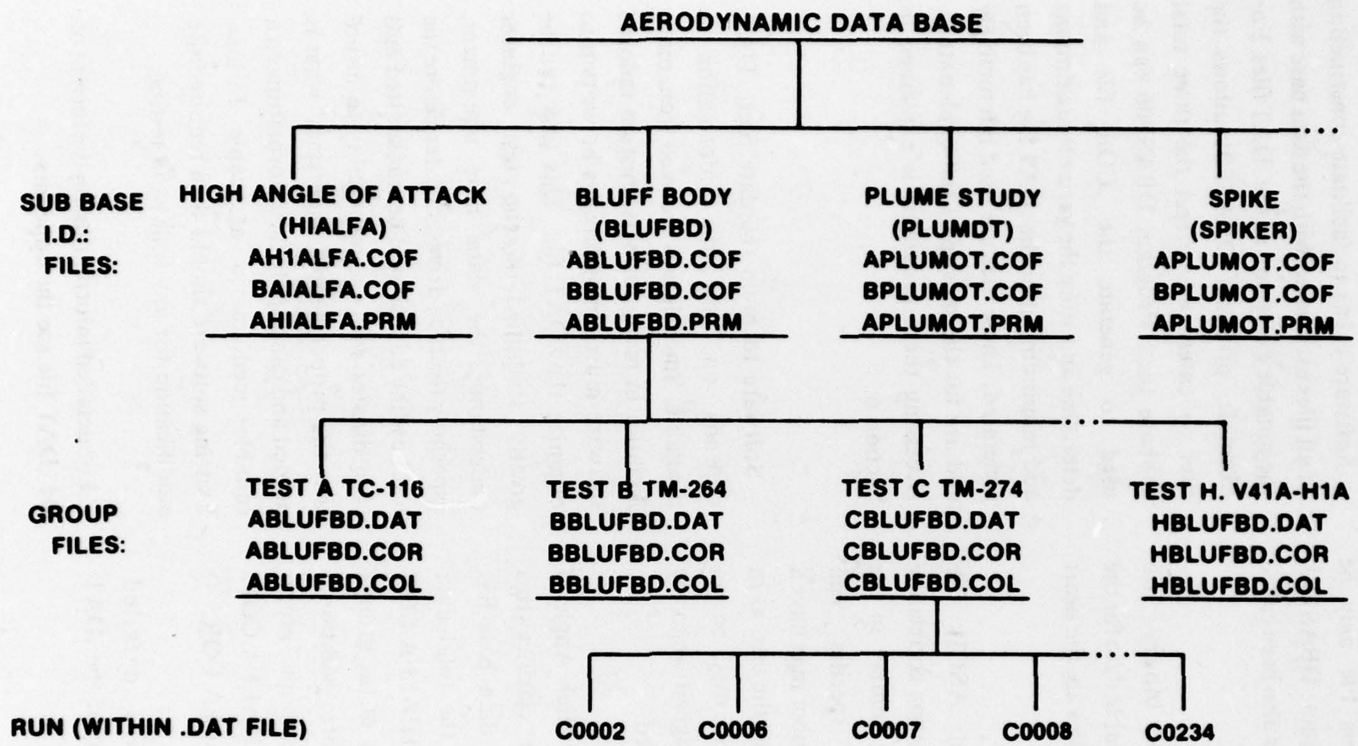

Figure 1. Data base hierarchy and file structure.

- ABLUFBD.COL-An ASCII file containing test summary information. A hard copy of this file may be obtained with program DBASE03. This test summary has also been called the "collation sheet".

- ABLUFBD.DAT-A binary file containing all the variable data for the first test. The .DAT files are the heart of the data base.

- ABLUFBD.COR-An ASCII file which contains information correlating the beginning record number in the .DAT file with a specific "run number". The run number may have a definate relationship to the test, as in wind tunnel data, or may be an artificial identifier assigned when the data base is constructed.

Another data base, the " High Angle of Attack" data base further clarifies this modular file concept. This data base has three files associated with the total data base: AHIALFA.COF, BHIALFA.COF and AHIALFA.PRM. Each of the groups within this data base has three additional files associated with it. For example, group three is contained in files, CHIALFA.COL, CHIALFA.DAT and CHIALFA.COR.

The appendix contains detailed information on the structure of the .DAT file.

5. BUILDING A DATA BASE

Software exists to facilitate construction of all files associated with the data base with the notable exception of the .DAT files. For example, program DBASE01 allows the user to enter and correct the three total subbase files. Program DBASE06 can be used to generate the .COR file and determine and store the variable maximums and minimums after the .DAT file has been generated. These files are used interactively and are for the most part self-explanatory. Accessing these programs is explained in Section 6.

Software to build the data files, .DAT, depends on how the information is available. Since data is received from many facilities in many formats, custom tailored software must almost always be written to organize the .DAT file. This task can be greatly simplified if the test engineer understands the data base equipment, especially the tape drives; decides before the test how the data should be transmitted and co-ordinates with the test facility to insure that the proper people understand what is needed and can supply the information on a suitable medium in a usable format. Existing software should then require little modification for any follow-on testing.

For detailed information on the format of the .DAT file see the appendix.

6. USING THE DATA BASE

All the data base programs are interactive programs. A user at a terminal activates a program and is then guided by prompts from the program itself. After signing on at a terminal, the user may enter the word "DBASE", and the following appears on the terminal:

INFORMATION TOPIC	KEYWORD
(1) AVAILABLE PROGRAMS	DBPROG
(2) AVAILABLE DATA BASES	DBBASE
(3) DATA BASE STRUCTURE	DBSTRUC

TO ACCESS INFORMATION ON A TOPIC: TYPE IN THE KEYWORD.

Entering DBPROG gives the user a list of programs available and information on how to activate the program. Entering DBBASE identifies all data bases available and gives their six letter identifier. Information on the structure and format of the files constituting a data base is obtained by entering DBSTRUC.

As the user gains familiarity with the system, he will be able to directly access the desired program or information. Detailed instructions on using the plot and tabulation programs are given in the next two sections.

7. THE TABULATION PROGRAM

This program is activated by entering TAB at any terminal. The program then proceeds interactively in the following manner:

ENTER DATA BASE ID--6 CHARACTERS

The user then enters the data base identifier discussed in Section 4. For example, to have access to the Bluff Body data base, the user would enter BLUFBD.

ENTER DISC ID--4 CHARACTERS

The user enters the platter identifier, also called the volume name, which identifies the disc platter on which the data base resides. See Section 3 for a discussion of the volume name.

ENTER 1 CONSOLE
2 PRINTER
3 PLOTTER

The user responds by entering the number indicating the output device for the tabulation. The console refers to the user's terminal. The printer is the line printer, a "spooled" device. Spooled means that the information is first written to a temporary file and must await its turn in a queue with other users before being printed. Plotter refers to the Varian electrostatic plotter. The Varian plotter is not spooled; therefore, if it is requested but is already in use, an error will occur.

ENTER NUMBER OF RUNS TO LIST--I2 FORMAT OR ENTER 99 FOR ENTER TEST LISTING

The user enters the number of runs up to 20 to be tabulated. Note the I2 format means if less than 10 runs are desired the value is entered preceeded by a space or zero.

If the user enters 99 at this time, the next display will be

ENTER TEST IDENTIFIER--ONE LETTER

The user responds by entering the identifier for a specific group of data. See Section 4 for a discussion of this identifier. At this time the entire group of data is listed to the previously specified output device whereupon the program ends.

If, instead, the user chooses to enter selected runs, the next message will be

ENTER RUN IDENTIFIER--5 CHARACTERS

The user enters an identifier created by appending the group identifier to a run number. If the third run of the fourth test is desired, the entry would be D0003. The above prompt is repeated until identifiers for the total number of runs specified earlier are entered. The program then proceeds with the listing and ends.

An example of a tabulated run is given in *Table 1.*

8. PLOT PROGRAM

The general purpose plot program is activated by entering PLOT at any terminal. The program is designed to interact with the user by leading the user through a series of questions and answers. User inputs are accepted in either floating point or fixed point form. Two special purpose keys are provided to modify the normal flow of questions and answers. These keys are % and &. The user may enter either of these keys whenever the program is expecting input from the user. Entering SPACE% will cause the program to re-cycle to the absolute beginning of the program. Entering SPACE & will cause the program to re-cycle to the immediate question.

The program begins a session with the following question

ENTER OUTPUT DEVICE NUMBER
1 HP2648A GRAPHICS TERMINAL
2 TEKTRONIX 4006 TERMINAL
2 TEKTRONIX 4051 TERMINAL
3 TEKTRONIX 4014 TERMINAL
4 TEKTRONIX 4662 FLAT BED PLOTTER

The user enters the number of the device where the plot will be made. The output device may or may not be the user's console. After the user enters this number the program responds with

TABLE 1. EXAMPLE OF A RUN TABULATION.

NUMBER OF DATA POINTS	13.00	MACH NUMBER	0.80
RUN NUMBER	10.00	DYNAMIC PRESSURE	884.08
DATA MODE	1.00	REYNOLDS NUMBER	5.30
PHI	0.00	CONFIG.	N002M005A003

ALPH	CN	CY	CAT	CM	CLN	CAF	CLL
-2.0070	-0.2417	-0.0240	1.4120	1.1261	0.0069	1.4070	0.0012
-1.0040	-0.0243	-0.0243	1.4005	0.5847	0.0173	1.3980	0.0007
-0.0004	0.0033	-0.0324	1.3972	-0.0255	0.0162	1.3950	0.0008
0.9941	0.1406	-0.0336	1.4014	-0.6573	0.0066	1.3990	0.0005
2.0090	0.2663	-0.0302	1.4124	-1.2162	0.0144	1.4130	0.0003
3.0040	0.3801	-0.0361	1.4284	-1.7085	0.0204	1.4270	-0.0009
4.0310	0.4953	-0.0297	1.4436	-2.1780	0.0282	1.4430	-0.0031
6.0280	0.7431	-0.0355	1.4570	-3.1328	0.0200	1.4590	0.0020
8.0580	1.0320	-0.0399	1.4664	-4.2310	0.0321	1.4710	-0.0017
10.0800	1.3460	-0.0246	1.4778	-5.4350	0.0189	1.4828	-0.0021
15.1600	2.1990	-0.0342	1.4909	-8.5485	0.0244	1.5020	-0.0029
20.2400	3.0880	0.0308	1.5061	-11.3510	-0.0251	1.5530	-0.0127
25.3400	3.9640	-0.1355	1.5437	-13.7290	0.1149	1.6320	0.0146

ENTER DATA BASE ID--6 CHARACTERS

The user then enters the six letter data base identifier as discussed in Section 4. For example, to have access to the Bluff Body data base, the user enters BLUFBD.

ENTER DISC ID--4 CHARACTERS

The user enters the platter identifier, also called the volume name, which identifies the disc platter on which the data base resides. See Section 3 for a discussion of the volume name.

ENTER NUMBER OF RUNS

The user enters the number of runs to be plotted on the same plot. The number of runs is limited to 20. The program will respond with

ENTER RUN IDENTIFIER (5 CHARACTERS) 1

The user enters the five character run identifier consisting of a group letter and a four digit run number. For example, the run identifier for run number 15 in the third data group is C0015. This continues until all of the runs have been entered. Entering SPACE& at any time the program is asking for a run identifier will cause the program to return to the prompt "ENTER NUMBER OF RUNS".

If the user specifies only one run, the program responds with

DO YOU WANT MULTIPLE Y-VARIABLES?

This option allows the user to plot several variables from the same run against a common variable. For the moment, let us assume the user responds with NO or has requested more than one run, then the program will print the following prompt

**ENTER X, Y OR O FOR LIST OF VARIABLES

The user may enter a number specifying the abscissa variable and a number specifying the ordinate variable, or if the user is unsure of the variable numbers he may enter O and get a list of the variables. An example of such a list is shown in *Table 2*. If several runs have been requested, only variables common to those runs are given. For this reason, some numbers may be missing in the INPUT VALUE list. After printing the list, the program cycles back to the message above. The user then enters the numbers of the two variables selected. At this time the program executes the plot. If the output device is the HP 2648A terminal the terminal will go into a Tektronix emulation mode. An example plot is given in *Figure 2*.

To continue after the plot is drawn, the user presses the "ENTER" or "RETURN" key on the user console. If the HP 2648A terminal is the user console, "RESET TERMINAL" should be pressed twice in rapid succession in order to exit the

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NUMBER OF DATA POINTS	13.00	MACH NUMBER	0.80
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PHI	0.00	CONFIG.	N002M005A003

ALPH	CN	CY	CAT	CM	CLN	CAF	CLL
-2.0070	-0.2417	-0.0240	1.4120	1.1261	0.0069	1.4070	0.0012
-1.0040	-0.0243	-0.0243	1.4005	0.5847	0.0173	1.3980	0.0007
-0.0004	0.0033	-0.0324	1.3972	-0.0255	0.0162	1.3950	0.0008
0.9941	0.1406	-0.0336	1.4014	-0.6573	0.0066	1.3990	0.0005
2.0090	0.2663	-0.0302	1.4124	-1.2162	0.0144	1.4130	0.0003
3.0040	0.3801	-0.0361	1.4284	-1.7085	0.0204	1.4270	-0.0009
4.0310	0.4953	-0.0297	1.4436	-2.1780	0.0282	1.4430	-0.0031
6.0280	0.7431	-0.0355	1.4570	-3.1328	0.0200	1.4590	0.0020
8.0580	1.0320	-0.0399	1.4664	-4.2310	0.0321	1.4710	-0.0017
10.0800	1.3460	-0.0246	1.4778	-5.4350	0.0189	1.4828	-0.0021
15.1600	2.1990	-0.0342	1.4909	-8.5485	0.0244	1.5020	-0.0029
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If the user specifies only one run, the program responds with

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This option allows the user to plot several variables from the same run against a common variable. For the moment, let us assume the user responds with NO or has requested more than one run, then the program will print the following prompt

**ENTER X, Y OR O FOR LIST OF VARIABLES

The user may enter a number specifying the abscissa variable and a number specifying the ordinate variable, or if the user is unsure of the variable numbers he may enter O and get a list of the variables. An example of such a list is shown in *Table 2*. If several runs have been requested, only variables common to those runs are given. For this reason, some numbers may be missing in the INPUT VALUE list. After printing the list, the program cycles back to the message above. The user then enters the numbers of the two variables selected. At this time the program executes the plot. If the output device is the HP 2648A terminal the terminal will go into a Tektronix emulation mode. An example plot is given in *Figure 2*..

To continue after the plot is drawn, the user presses the "ENTER" or "RETURN" key on the user console. If the HP 2648A terminal is the user console, "RESET TERMINAL" should be pressed twice in rapid succession in order to exit the

TABLE 2 EXAMPLE OF VARIABLE INPUT LIST

COMMON VARIABLES

VARIABLE	INPUT VALUE
Angle of Attack, Alpha, Deg	1
Normal Force Coef., CN	2
Side Force Coef., CY	3
Total Axial Force Coef., CAT	4
Pitching Moment Coef., CM	5
Yawing Moment Coef., CLN	6
Rolling Moment Coef., CLL	7
Forebody Axial Force Coef., CAF	8

**Enter X, Y or 0 for List of Variables

TEXTRONIX emulation mode. The program then displays

ENTER OPTION OR ENTER O FOR OPTION TABLE

Entering O at this time will cause the program to display a list of options. *Table 3* is the current list of options. This list is subject to change as users suggest needed options.

Now let us assume the user has requested one run only and has requested multiple y-variables. The program will respond with

**ENTER X VARIABLE OR O FOR LIST OF VARIABLES

The user enters the number of the abscissa variable, and the next prompt will be

**ENTER Y1, Y2, Y3...

The user may enter from 1 to 10 ordinate variables. The program will then execute the plot as before. A sample plot of this type is shown in *Figure 3*. The user again may access the option section by pressing the "ENTER" or "RETURN" key. The program is exited by selecting the "STOP" option.

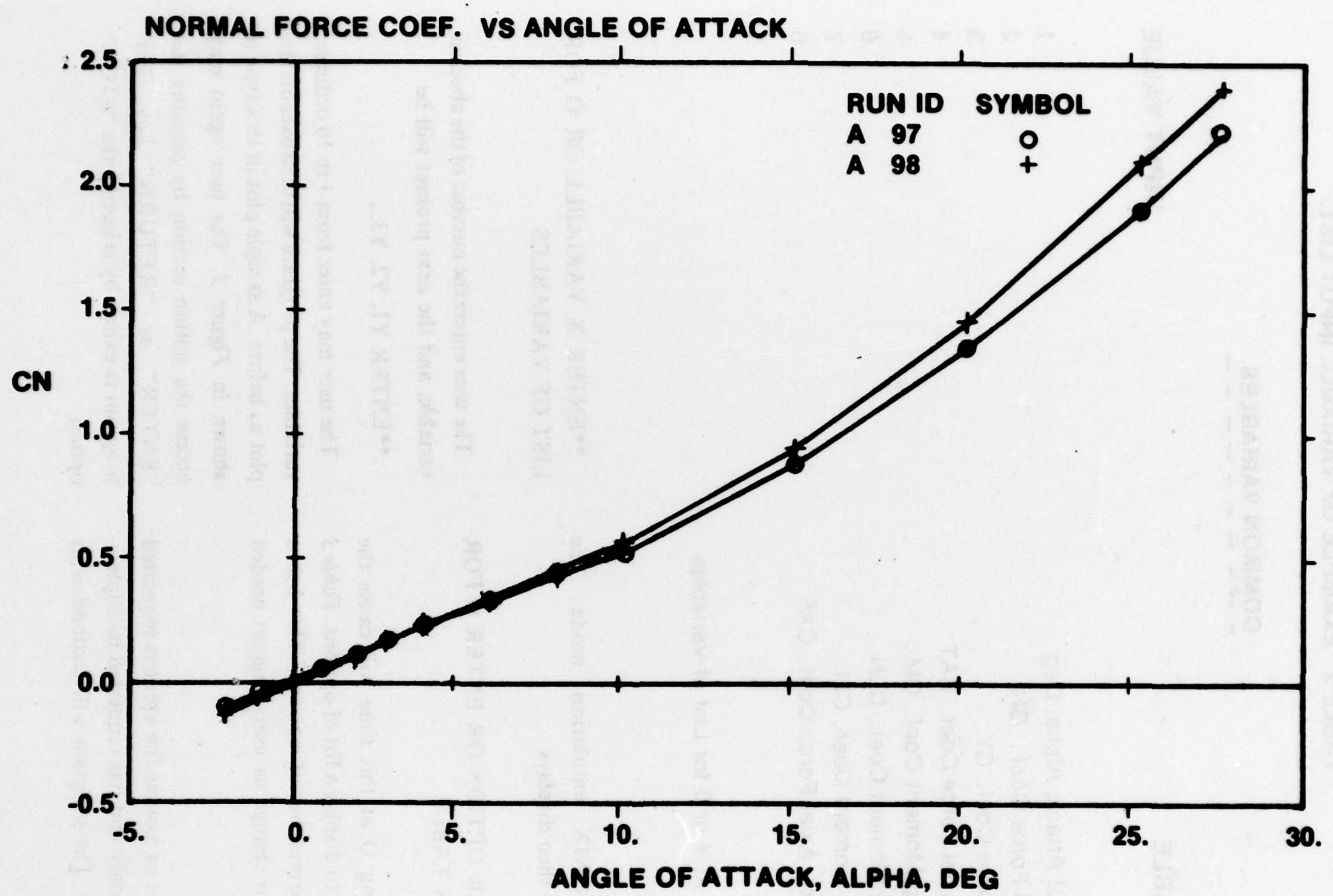

Figure 2. Typical plot generated using DBASE09.

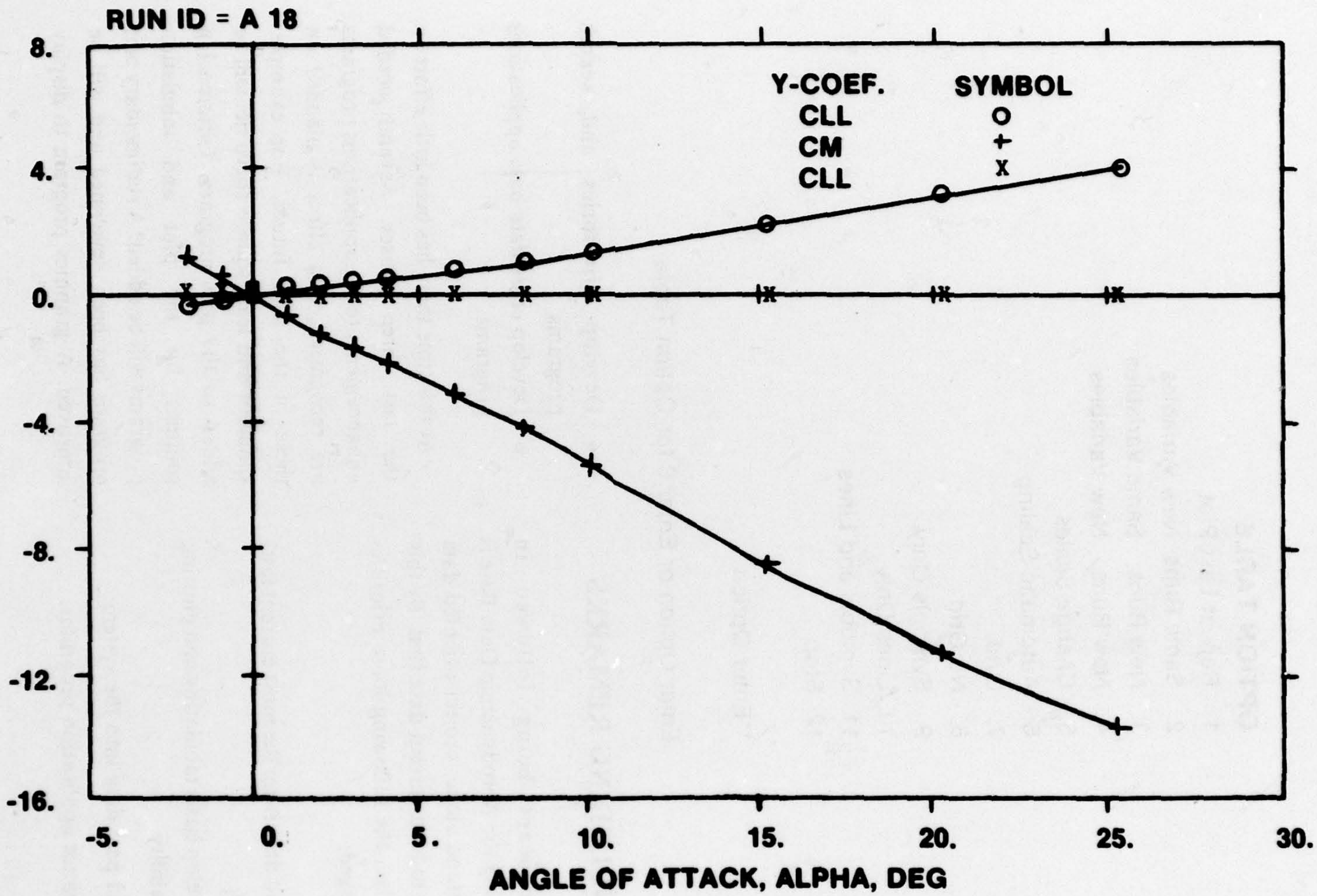

Figure 3. Example of a plot generated using the multiple y option.

TABLE 3. CURRENT LIST OF PLOT OPTIONS.

```
OPTION TABLE
1.  Repeat Last Plot
2.  Same Runs  New Variables
3.  New Runs   Same Variables
4.  New Runs   New Variables
5.  Change Scales
6.  Automatic Scaling
7.  Grid
8.  No Grid
9.  Symbols Only
10. Lines Only
11. Symbols and Lines
12. Stop

**Enter Option

Enter Option or Enter 0 for Option Table
```

9. CONCLUDING REMARKS

The concept being followed in constructing the Aerodynamic Data Base is to build stand alone, project oriented data bases and to load current data first. By this concept then the following loose priorities have emerged:

- Load data from the most current tests first.
- Develop basic tabulating and plotting capability.
- Load past data into the system.
- Enhance application programs.
- Develop directories and search programs.
- Develop cross data base applications programs.

At this time there has been little effort on the last three phases. Several needed enhancements to the applications programs are recognized, and effort is planned on these in the near future. For example. spline-fit and least-square curve fits will be added to the plot program. Differencing routines for the plot and tabulation programs will be added. A rudimentary edit program has been developed and will be improved. A graphics program to display the test summary information is also planned.

To make the concept of a total Aerodynamics Data Base a reality, a directory of information is planned from which search programs may extract the location of related information from different projects. This information may then be pulled together into mini-data bases for special studies. At present, this effort is still conceptual, but some work is planned in this area within the year.

User's suggestions for improvements to existing applications programs or for new applications programs that are general enough to apply to all users are solicited. However, at present, the burden for developing special purpose applications programs for specific projects rests with the user.

APPENDIX

FORMAT OF THE DATA FILE

The data file, .DAT file, is a binary file containing all of the variable data for one group. This group is usually one specific test of several conducted on a specific project. The format was developed for wind tunnel data. However, it is applicable to any data which contain one independent variable and any number of dependent variables.

The data are grouped within the .DAT file according to run number. For each run number there are four heading records and *n* data records where *n* is the number of data points in the run. The following illustration gives the expected values for each record.

1ST RECORD - N2, N3, IC(2), IP, ACON

- N2 - NUMBER OF VARIABLES INCLUDING THE INDEPENDENT VARIABLE.
- N3 - NUMBER OF PARAMETERS IN HEADING.
- IC - PACKED WORDS INDICATING WHICH OF THE VARIABLES IN THE -.COF FILES ARE AVAILABLE TO THIS RUN.
- IP - PACKED WORD INDICATING WHICH OF THE HEADING PARAMETERS ARE AVAILABLE TO THIS RUN.
- ACON - CONFIGURATION (LIMITED TO 12 CHARACTERS).

2ND RECORD - (H(I),I = 1,N3) VALUES OF THE HEADING PARAMETERS

- H(1) - NUMBER OF DATA POINTS IN RUN.
- H(2) - RUN NUMBER.
- H(3) - DATA MODE 1- PITCH, 2-ROLL, 3-YAW.
- H(4) - ALPHA OR PHI.
- H(5) - MACH NUMBER.
- H(6) - DYNAMIC PRESSURE.
- H(7) - REYNOLDS NUMBER.

:

: DATA BASE DEPENDENT PARAMETERS.

:

H(N3)

3RD RECORD - (C(1,I), I = 1, N2) MINIMUM VALUES OF VARIABLES.

4TH RECORD - (C(2,I), I = 1, N2) MAXIMUM VALUES OF VARIABLES.

5TH RECORD

:

: Y(J), J = 1, N2 VALUES OF VARIABLES.

:

5 + H(1) RECORD

The runs are written one after the other in the .DAT file. Access to a particular run is provided through use of the .COR file discussed in Section 4. The only changes for data, other than wind tunnel data, are in the choice of heading parameters.

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