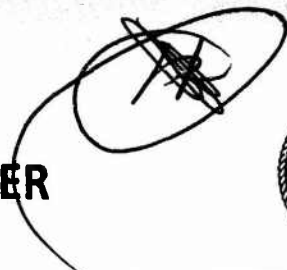


**DAHLGREN DIVISION
NAVAL SURFACE WARFARE CENTER**

Dahlgren, Virginia 22448-5100



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**USER'S GUIDE FOR AN INTERACTIVE PERSONAL
COMPUTER INTERFACE FOR THE
AEROPREDICTION CODE**

BY THOMAS C. HYMER FRANK G. MOORE
WEAPONS SYSTEMS DEPARTMENT

CORNELL DOWNS
VITRO CORPORATION (DAHLGREN)

JUNE 1994

Approved for public release; distribution is unlimited.

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Transition Process for the 1995 Version of the Aeroprediction Code (AP95)

The AP95 code has not been completed as of this time, but it is expected to be ready for transition to users by early FY95. The AP95 will consist of the AP93 extended in angle-of-attack above 30° to cover the flight envelope that most weapons fly from launch to impact. This new technology is only partially complete at present. The AP95 will also consist of the pre- and post-processor software for use on personal computers, which is documented in this report.

Transition of the AP95 to U.S. Government agencies, U.S. contractors and universities will be free (like the AP93) to continue to encourage dual-use technology between government and industry and to encourage technology transition.

To obtain a copy, please fill out the attached form and mail it to the address listed. Foreign governments can also request copies of the code by filling out the attached form and having their embassy send it to:

Mr. Dave Siegel (Code 4425)
Chief of Naval Research
Ballston Tower 1
800 N. Quincy St.
Arlington, VA 22217-5660

If the request is approved, it will be forwarded to the Foreign Military Sales (FMS) Office, where a charge of \$25,000 for the code will be made. The rationale for this charge to foreign countries is the fact that U.S. taxpayers have paid for the code development, whereas foreign governments have not. The \$25,000 is only a small fraction of the development cost of the code.

Since we are sending out a copy of the new code free of charge for most requests, we will not be able to provide the level of consulting that we would like to. However, we do request several things from the users. First, if you find an error in the code, we would appreciate you bringing it to either my attention at (703) 663-8831, to Mr. Tom Hymer at (703) 663-4164, or to Dr. Roy McInville at (703) 663-4760. Secondly, if you find areas of success or areas of weakness, we would appreciate hearing from you. We use information such as this to help guide any future modifications. Thirdly, if you find areas where additional code capability would be desirable, again, we would like to hear from you. In all cases, a written letter is preferred, but a phone call is better than no communication at all. Also, if you use the code for the purpose of comparing the results to other computations within the external literature, we would like you to use the terminology AP95. If you modify the AP95 to suit your own needs, you could refer to the code as modified AP95. Finally, we request that you not send any copies of the code to other agencies or even other activities in your company if it is at a different location. Please refer them to us so that we can keep track of copies of code. This is particularly true of foreign requests since they are now processed through the FMS Office.

DR. FRANK MOORE
Dahlgren Division
Naval Surface Warfare Center
Dahlgren, VA 22448

AP95 Transition Request

NAME: _____

COMPANY NAME: _____

ADDRESS: _____

PHONE NUMBER: _____

GOVT CONTRACT NUMBER: _____

MEANS OF TRANSITION: 3.5" Diskette

We agree to not give a copy of the AP95 to any other agency. We will refer them to NSWCCD at the address below for a copy.

Your Signature _____

Supervisor Signature _____

Please send this form completely filled out to:

Commander
Attn Dr. Frank Moore (G04)
Dahlgren Division
Naval Surface Warfare Center
Dahlgren, VA 22448

We will try to get you a copy of the AP95 along with a user's guide within a month (after the code is complete).

If the request is from a foreign country, please have your embassy send the request with an attached letter to:

Mr. Dave Siegel (Code 4425)
Chief of Naval Research
Ballston Tower 1
800 N. Quincy St.
Arlington, VA 22217-5660

FOREWORD

The work described in this report was undertaken as a result of many requests received from users of various versions of the NSWC Aeroprediction Code to make it compatible with a personal computer (PC). The user's guide describes an interactive preprocessing package for inputs to the 1993 version of the NSWC Aeroprediction Code (AP93), which allows a configuration to be much more easily set up for computations compared to the computer mainframe version of the AP93. It then gives options for post processing of data in a limited number of plots.

As noted in the authorship, Cornell Downs of Vitro was involved in the development of this effort. Due to unforeseen circumstances, the original bid by Vitro did not completely cover all the work needed to complete their contract requirements. Vitro management allocated additional in-house funding to resolve this issue. Appreciation is expressed to them for this. Also, appreciation is expressed to Mary Cummings of K department, who provided computer science consulting and expertise.

Funding for this effort was provided through the Office of Naval Technology (Mr. Dave Siegel) by the Surface Weapons Systems Technology Program managed at NSWC by Mr. Robin Staton. Appreciation is expressed to these individuals for their support.

This report has been reviewed and approved by Dr. Tom Rice of the Aeromechanics Branch and Mr. Danny Brunson of the Missile Systems Division.

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Approved by:

David Maljev

DAVIDS. MALYEVAC, Deputy Head
Weapons Systems Department

ABSTRACT

This report describes interactive, user-friendly, pre- and post-processing PC modules designed to operate with the latest version of the NSWC Aeroprediction Code (AP93). As part of the preprocessing input module, geometry inputs are now automated by giving the user many options. By using this new software, a set of aerodynamic coefficients can be obtained on most weapon configurations in less than 15 minutes from time of initial setup to computer outputs, compared to 2 to 4 hours for the AP93 computer mainframe version. While the computer cost savings are modest (the AP93 executes on a large computer in less than a second), the manpower savings and productivity enhancements can be significant.

The user's guide attempts to aid users of the AP93 by correlating AP93 PC Interface Data Inputs and the corresponding source code variable names. This cross-referencing information is given in italics in the discussion.

CONTENTS

	<u>Page</u>
1 INSTALLING THE AP93 INTERFACE	1
1.1 AP93 INTERFACE SYSTEM REQUIREMENTS	1
1.2 INSTALLATION PROCEDURES	1
1.3 STARTING THE AP93 INTERFACE	2
2 INTERFACE BASICS	3
2.1 KEYBOARD TECHNIQUES	3
2.1.1 USING MENUS WITH THE KEYBOARD	3
2.1.1.1 MENU BAR	3
2.1.1.2 MENU PADS	4
2.1.1.3 MENU POPUPS	4
2.1.1.4 MENU OPTIONS	4
2.1.2 USING DATA ENTRY SCREENS WITH THE KEYBOARD	5
2.1.2.1 DATA FIELDS	5
2.1.2.2 PUSH BUTTON	6
2.1.2.3 RADIO BUTTON	6
2.1.2.4 POPUP CONTROL	6
2.1.2.5 LIST	7
2.1.3 MOVEMENT IN DATA ENTRY SCREENS WITH THE KEYBOARD	7
2.2 MOUSE TECHNIQUES	8
2.2.1 USING MENUS WITH THE MOUSE	8
2.2.1.1 MENU BAR	8
2.2.1.2 MENU PADS	9
2.2.1.3 MENU POPUPS	9
2.2.1.4 MENU OPTIONS	9
2.2.2 USING DATA ENTRY SCREENS WITH THE MOUSE	9
2.2.2.1 DATA FIELDS	10
2.2.2.2 PUSH BUTTON	10
2.2.2.3 RADIO BUTTON	10
2.2.2.4 POPUP CONTROL	10
2.2.2.5 LIST	11
3 THE AP93 INTERFACE	13
3.1 AP93 INTERFACE MENU	14
3.1.1 AP93 INTERFACE MENU BAR	14
3.1.2 AP93 INTERFACE MENU PADS	14
3.1.2.1 CONFIGURATION	14
3.1.2.1.1 CONFIGURATION/NEW	14
3.1.2.1.2 CONFIGURATION/OPEN	15
3.1.2.1.3 CONFIGURATION/SAVE	16
3.1.2.1.4 CONFIGURATION/DELETE	16
3.1.2.2 INPUTS	16
3.1.2.2.1 INPUTS/GEOMETRY	17

CONTENTS (Continued)

	<u>Page</u>
3.1.2.2.2 INPUTS/FREE-STREAM CONDITIONS	17
3.1.2.2.3 INPUTS/OPTIONS	18
3.1.2.3 EDIT	18
3.1.2.3.1 EDIT/GEOMETRY	19
3.1.2.3.2 EDIT/FREE-STREAM CONDITIONS	19
3.1.2.3.3 EDIT/OPTIONS	19
3.1.2.4 GENERATE	19
3.1.2.4.1 GENERATE/SKETCH	19
3.1.2.4.2 GENERATE/AEROPREDICTION	20
3.1.2.5 OUTPUTS	20
3.1.2.5.1 OUTPUTS/AP93 OUTPUT FILE	21
3.1.2.5.1.1 OUTPUTS/AP93 OUTPUT FILE/OPEN	21
3.1.2.5.1.2 OUTPUTS/AP93 OUTPUT FILE/SAVE	21
3.1.2.5.1.3 OUTPUTS/AP93 OUTPUT FILE/DELETE	21
3.1.2.5.1.4 OUTPUTS/AP93 OUTPUT FILE/SCREEN	21
3.1.2.5.1.5 OUTPUTS/AP93 OUTPUT FILE/PRINTER	22
3.1.2.5.2 OUTPUTS/PLOTS	22
3.1.2.6 PRINTER	22
3.1.2.7 QUIT	22
3.2 AP93 INTERFACE DATA ENTRY SCREENS	23
3.2.1 CONFIGURATION DATA ENTRY SCREENS	23
3.2.1.1 CONFIGURATION-OPEN FILE DATA ENTRY SCREEN	23
3.2.1.2 CONFIGURATION-SAVE/DELETE FILE DATA ENTRY SCREEN	24
3.2.1.2.1 SAVING AEROPREDICTION CONFIGURATION FILES	24
3.2.1.2.2 DELETING AEROPREDICTION CONFIGURATION FILES	25
3.2.2 AEROPREDICTION GEOMETRY DATA ENTRY SCREENS	26
3.2.2.1 AEROPREDICTION-BODY-ALONE GEOMETRY DATA ENTRY SCREEN ..	26
3.2.2.2 AEROPREDICTION-WING-ALONE GEOMETRY DATA ENTRY SCREEN ..	30
3.2.2.3 AEROPREDICTION-BODY-TAIL GEOMETRY DATA ENTRY SCREEN ...	32
3.2.2.4 AEROPREDICTION-CANARD/WING-BODY-TAIL GEOMETRY DATA ENTRY SCREEN	34
3.2.2.5 NOSE GEOMETRY DATA ENTRY SCREENS	37
3.2.2.5.1 NOSE GEOMETRY-OTHER DATA ENTRY SCREEN	37
3.2.2.5.2 NOSE GEOMETRY-NOSE SEGMENT 1 DATA ENTRY SCREEN	39
3.2.2.5.3 CONE-NOSE SEGMENT 2 DATA ENTRY SCREEN	40
3.2.2.6 AFTERBODY GEOMETRY DATA ENTRY SCREENS	41
3.2.2.6.1 AFTERBODY GEOMETRY-STANDARD DATA ENTRY SCREEN	41
3.2.2.6.2 AFTERBODY GEOMETRY-OTHER DATA ENTRY SCREEN ...	41
3.2.2.6.2.1 AFTERBODY GEOMETRY-AFTERBODY SEGMENT DATA ENTRY SCREEN	43
3.2.2.6.3 AFTERBODY GEOMETRY-BOATTAIL/FLARE DATA ENTRY SCREEN	44
3.2.2.7 TAIL GEOMETRY DATA ENTRY SCREENS	45
3.2.2.7.1 TAIL GEOMETRY-DOUBLE-WEDGE AIRFOIL DATA ENTRY SCREEN	45
3.2.2.7.2 TAIL GEOMETRY-BICONVEX AIRFOIL DATA ENTRY SCREEN	47
3.2.3 FREE-STREAM CONDITIONS DATA ENTRY SCREENS	49

CONTENTS (Continued)

	<u>Page</u>
3.2.3.1 FREE-STREAM CONDITIONS-ALPHA SWEEP DATA ENTRY SCREEN . . .	49
3.2.3.2 FREE-STREAM CONDITIONS-DELTA SWEEP DATA ENTRY SCREEN . . .	52
3.2.3.3 FREE-STREAM CONDITIONS-ALTITUDE SWEEP DATA ENTRY SCREEN	53
3.2.3.4 FREE-STREAM CONDITIONS-MACH SWEEP DATA ENTRY SCREEN . . .	55
3.2.3.5 FREE-STREAM CONDITIONS-OTHER DATA ENTRY SCREEN	56
3.2.3.5.1 FREE-STREAM CONDITIONS-OTHER DATA ENTRY SCREEN (FOR CONSTANTS)	57
3.2.3.5.2 FREE-STREAM CONDITIONS-OTHER DATA ENTRY SCREEN (FOR VARIABLES)	59
3.2.4 OPTIONS DATA ENTRY SCREENS.	61
3.2.4.1 AEROPREDICTION-OPTIONS DATA ENTRY SCREEN.	61
3.2.4.1.1 AEROPREDICTION-REAL-GAS OPTION DATA DATA ENTRY SCREEN	64
3.2.4.1.2 AEROPREDICTION-POWER-ON OPTION DATA DATA ENTRY SCREEN	66
3.2.5 AEROPREDICTION-PLOT SELECTION DATA ENTRY SCREEN	67
3.2.6 AEROPREDICTION-PRINTER SELECTION DATA ENTRY SCREEN	68
4 AUTOMATED GEOMETRY AND ALIMIT COMPUTATION	71
4.1 GEOMETRY REFERENCES	71
4.2 TABLE LOOKUPS	71
4.3 AUTOMATIC ALIMIT COMPUTATION	71
4.4 EQUATIONS FOR GENERATION OF NOSE POINTS	78
4.4.1 TANGENT OGIVE NOSE	78
4.4.2 SECANT OGIVE NOSE	80
4.4.3 HAACK SERIES NOSE	82
4.4.4 VON KARMAN OGIVE	83
4.4.5 POWER SERIES NOSE	83
4.4.6 CONICAL NOSE	84
4.4.7 HEMISPHERICAL NOSE	84
5 REFERENCES	85
DISTRIBUTION	(1)

ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1	AP93 INTERFACE STARTUP SCREEN	2
2	AP93 INTERFACE MENU SYSTEM	4
3	EXAMPLE OF AP93 INTERFACE DATA ENTRY SCREEN	5
4	EXAMPLE OF AP93 INTERFACE DATA ENTRY SCREEN WITH POPUP CONTROL ACTIVATED	7
5	EXAMPLE OF AP93 INTERFACE DATA ENTRY SCREEN CONTAINING A LIST	7
6	EXAMPLE OF GEOMETRY SKETCH	20
7	EXAMPLE OF AP93 RESULTS BEING SHOWN ON SCREEN	22
8	CONFIGURATION-OPEN FILE DATA ENTRY SCREEN	23
9	CONFIGURATION-SAVE/DELETE FILE DATA ENTRY SCREEN	24
10	DELETE FILE CONFIRMATION SCREEN	26
11	AEROPREDICTION-BODY-ALONE GEOMETRY DATA ENTRY SCREEN	26
12	EXAMPLE OF NOSE GEOMETRY DATA ENTRY SCREEN	27
13	AEROPREDICTION-WING-ALONE GEOMETRY DATA ENTRY SCREEN	31
14	AEROPREDICTION-BODY-TAIL GEOMETRY DATA ENTRY SCREEN	32
15	AEROPREDICTION-CANARD/WING-BODY-TAIL GEOMETRY DATA ENTRY SCREEN	34
16	NOSE GEOMETRY-OTHER DATA ENTRY SCREEN	37
17	NOSE GEOMETRY-NOSE SEGMENT 1 DATA ENTRY SCREEN	39
18	CONE-NOSE SEGMENT 2 DATA ENTRY SCREEN	40
19	AFTERBODY GEOMETRY-STANDARD DATA ENTRY SCREEN	41
20	AFTERBODY GEOMETRY-OTHER DATA ENTRY SCREEN	42
21	AFTERBODY GEOMETRY-AFTERBODY SEGMENT 1 DATA ENTRY SCREEN	43
22	AFTERBODY GEOMETRY-BOATTAIL/FLARE DATA ENTRY SCREEN	44
23	TAIL GEOMETRY-DOUBLE-WEDGE AIRFOIL DATA ENTRY SCREEN	45
24	TAIL GEOMETRY-BICONVEX AIRFOIL DATA ENTRY SCREEN	48
25	FREE-STREAM CONDITIONS-ALPHA SWEEP DATA ENTRY SCREEN	50
26	FREE-STREAM CONDITIONS-DELTA SWEEP DATA ENTRY SCREEN	52
27	FREE-STREAM CONDITIONS-ALTITUDE SWEEP DATA ENTRY SCREEN	53
28	FREE-STREAM CONDITIONS-MACH SWEEP DATA ENTRY SCREEN	55
29	FREE-STREAM CONDITIONS-OTHER DATA ENTRY SCREEN	57
30	FREE-STREAM CONDITIONS-OTHER (FOR CONSTANTS) DATA ENTRY SCREEN	58
31	FREE-STREAM CONDITIONS-OTHER (FOR VARIABLES) DATA ENTRY SCREEN	60
32	AEROPREDICTION-OPTIONS DATA ENTRY SCREEN	62
33	AEROPREDICTION-REAL-GAS OPTION DATA DATA ENTRY SCREEN	64
34	AEROPREDICTION-POWER-ON OPTION DATA DATA ENTRY SCREEN	66
35	AEROPREDICTION-PLOT SELECTION DATA ENTRY SCREEN	67
36	AEROPREDICTION-PRINTER SELECTION DATA ENTRY SCREEN	69
37	GENERIC WING-BODY-TAIL CONFIGURATION AND NOMENCLATURE	72
38	GENERIC WING HALF SPAN AND ASSOCIATED NOMENCLATURE	73
39	GENERIC WING CROSS SECTION AND ASSOCIATED NOMENCLATURE	74
40	STANDARD AND MULTI-SECTIONED AFTERBODY NOMENCLATURE	75

ILLUSTRATIONS (Continued)

<u>Figure</u>		<u>Page</u>
41	ACCURACY OF VARIOUS METHODS FOR ESTIMATING PRESSURE DRAG OF NONSLENDER NOSES AT ZERO ANGLE OF ATTACK (TAKEN FROM REFERENCE 4)	77
42	TANGENT OGIVE NOSE NOMENCLATURE	79
43	SECANT OGIVE NOSE NOMENCLATURE	81
44	CONICAL NOSE NOMENCLATURE	84

TABLES

<u>Table</u>		<u>Page</u>
1	AMPLIFYING DATA FOR NOSE POPUP CONTROL OPTIONS	28
2	VARIATION OF FREESTREAM PRESSURE, TEMPERATURE, AND REYNOLDS NUMBER/MACH/FOOT WITH ALTITUDE	76

CHAPTER 1 INSTALLING THE AP93 INTERFACE

1.1 AP93 INTERFACE SYSTEM REQUIREMENTS

The following system environment is required to run the Aeroprediction Code (AP93) Interface program:

- Processor: 386SX or higher
- Math Coprocessor: intel 80x87
- Random Access Memory (RAM): 3 MB
- Available Hard Disk Space: 7 MB
- 3½" Floppy Disk Drive
- MS-DOS Version: 3.1 or higher
- Mouse: Recommended but not necessary
- Terminate-Stay-Resident (TSR) Routines Activated: None

1.2 INSTALLATION PROCEDURES

To install the AP93 Interface:

1. Create a directory on the hard drive to install the AP93 Interface (i.e., type `mkdir dirname` at the C:\ prompt and then hit enter).
2. Make the created directory the current directory (i.e., type `cd dirname` at the C:\ prompt and then hit enter).
3. Copy all files from the five (5) AP93 Interface floppy disks into the created directory. (i.e. insert disk 1 into Drive A (or Drive B) and type `copy a:*. *.*` at the C:*dirname* prompt. Repeat for each disk.)
4. Modify the FILES statement in the CONFIG.SYS so that the files setting is 40 or more (i.e., edit the CONFIG.SYS file, making sure that the FILES statement is set to at least 40).

1.3 STARTING THE AP93 INTERFACE

To start the AP93 Interface from the MS-DOS prompt, the current directory must be the directory that contains the AP93 Interface files. When in the correct directory, type the following and press the Enter key:

AP93

Upon entering AP93 at the MS-DOS prompt, the AP93 Interface startup screen will appear. Figure 1 contains the AP93 Interface startup screen.

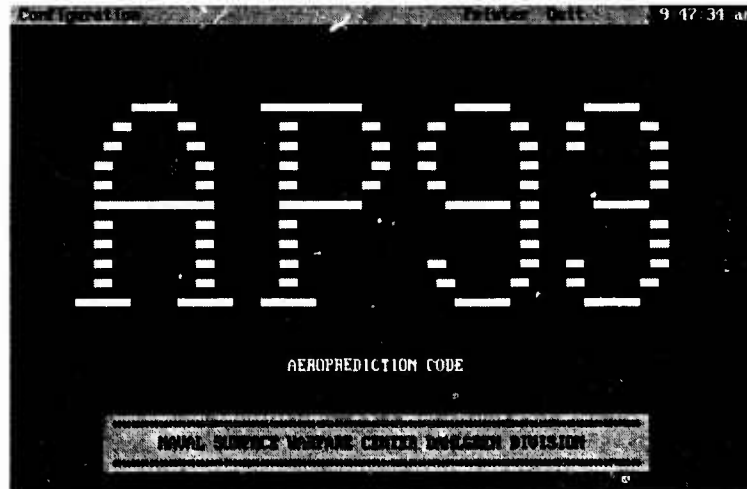


FIGURE 1. AP93 INTERFACE STARTUP SCREEN

CHAPTER 2 INTERFACE BASICS

The AP93 Interface consists of menus, data entry screens and other features that make it easy for the user to communicate with AP93.

The AP93 Interface is designed for use with a mouse or a standard keyboard. With a keyboard, you use the arrow keys and keystroke combinations to enter data or choose objects and controls in the interface. Although not required, a mouse is recommended for its ease-of-use. With the click of a button, a mouse can accomplish the equivalent of a single keystroke or many keystrokes on the keyboard.

This chapter is divided so that keyboard users can refer to the Keyboard Techniques section and mouse users can refer to the Mouse Techniques section. Mouse users who wish to use the keyboard for certain activities may also want to read the Keyboard Techniques section.

2.1 KEYBOARD TECHNIQUES

2.1.1 Using Menus with the Keyboard

The AP93 Interface menu system consists of the following parts: menu bar, menu pads, menu popups, and menu options. Each part of the menu system is displayed in Figure 2.

2.1.1.1 Menu Bar

The menu bar is located along the top of the AP93 Interface title screen. The *menu bar* displays names for menu popups. These names on the menu bar are called *menu pads*. The content of the menu bar changes as you access different parts of the interface. Different actions cause menu pads to be added to and removed from the menu bar.

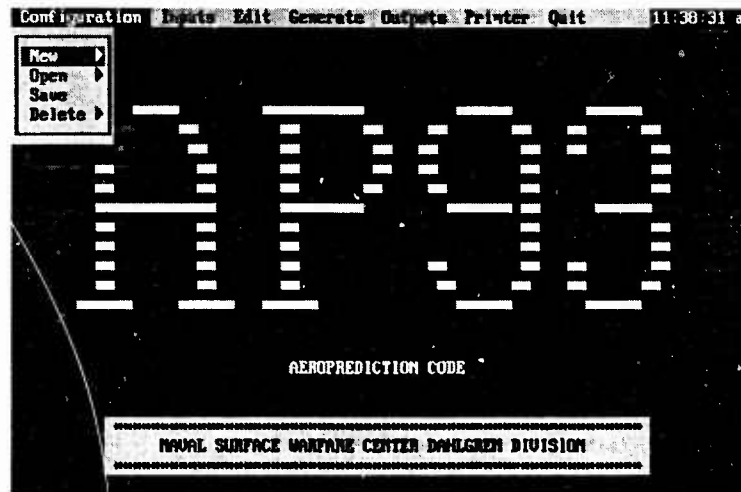


FIGURE 2. AP93 INTERFACE MENU SYSTEM

2.1.1.2 Menu Pads

Menu pads appear on the menu bar and either display the name of a menu popup, a data entry screen, or an action to be taken. The keyboard can be used to display the menu popup or data entry screen, or cause the action associated with each menu pad. Certain menu pads may be invisible and cannot be chosen. These menu pads are *disabled*.

To access the menu bar, press the Alt key. The **Configuration** menu pad appears highlighted because it is selected. Press the Right and Left Arrow keys to move from menu pad to menu pad. To choose a menu pad selection, press the Enter key. An alternate method of choosing a menu pad selection is to press the hot key in the menu pad name. The *hot key* is highlighted and is usually the first letter in the menu pad name.

2.1.1.3 Menu Popups

Some menu pads control menu popups. *Menu popups* are lists of related options. When you choose an option from a menu popup, you are telling the AP93 Interface what action to take. *Choose* means to activate a *selection* (highlighted option) by pressing the Enter key.

Once a menu popup is displayed, you will usually choose an available option, as described in the next section. If you wish to deactivate a menu popup without choosing an option, press the Alt key.

2.1.1.4 Menu Options

Menu popups contain *options*. The options on each menu popup are logically related to the controlling menu pad. On a single menu popup, options may be further grouped to indicate that they produce similar outcomes. These groups are separated by divider lines.

Certain menu options are followed by an arrow pointing to the right. When you choose this type of option, another menu popup appears with a different set of options. Sometimes a menu option will be invisible and cannot be chosen. This menu option is disabled.

Once a menu popup appears, an option can be chosen in one of the following ways:

- Press the hot key for the option.
- Use the Up and Down Arrow keys to select the desired option; then press the Enter key.

When you choose a menu option, a menu popup or data entry screen may appear, or an action may occur.

2.1.2 Using Data Entry Screens with the Keyboard

When you choose certain menu pads or menu popup options, a data entry screen will appear. Data entry screens contain fields to enter data and a variety of controls that are used to designate, confirm or cancel actions. The fields and controls are explained in the next few paragraphs. In addition, methods of moving in data entry screens will also be explained. Figure 3 is an example of an AP93 Interface data entry screen.

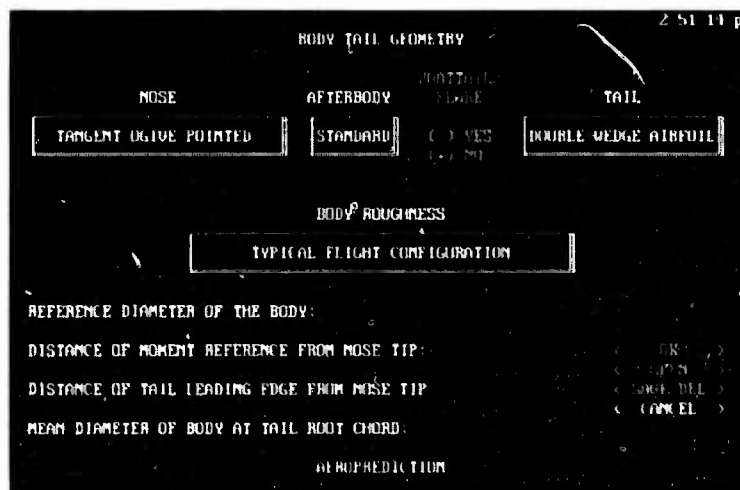


FIGURE 3. EXAMPLE OF AP93 INTERFACE DATA ENTRY SCREEN

2.1.2.1 Data Fields

In the data entry screen, data item descriptions consist of descriptive text followed by a semicolon. In most cases, the data item description is immediately followed by an associated data field. The *data field* is a rectangular area designated for the display of specific related data from the AP93 Interface or the entry of corresponding data by the user. The AP93 Interface interprets a blank numeric data field as zero, and a blank character data

field as null. To select a data field, press the Tab key until the desired data field is highlighted. To enter data, type in a response and press the Enter key. In the cases where the data field requires numeric data, a message is displayed at the bottom of the data entry screen informing the user of the required units and the data entry format.

2.1.2.2 Push Button

A *push button* is enclosed in angle brackets and contains key words that describe the action it triggers. The action associated with a push button occurs immediately. The action specified may result in the completion or cancellation of the data entry process, or it may cause another data entry screen to be displayed. To select a push button, press the Tab key until the desired push button is highlighted. To choose a selected push button, press the Enter key.

2.1.2.3 Radio Button

A *radio button* is a set of parentheses followed by text. Radio buttons are situated as groups of related items. Only one radio button in a group can be chosen at any given time. To select a radio button, press the Tab key until the desired radio button is highlighted. To choose a selected radio button, press the Enter key. When a radio button is chosen, a bullet appears in the parentheses, and any previously chosen radio button in the group becomes deselected. In the AP93 Interface data entry screens, all radio button groups have a radio button that is chosen as a default.

2.1.2.4 Popup Control

The rectangle with double lines on the right and bottom edges is a *popup control* that you can choose to display the associated popup. To select a popup control, press the Tab key until the desired popup control is highlighted. To choose a selected popup control and display the associated popup, press the Enter key. When the popup is displayed, you can use the PgDn and PgUp keys to scroll the list one full window at a time. Home and End keys move you to the first or last option on the popup. To choose a popup option, press the Up and Down Arrow keys to select the option, then press the Enter key. In some popups, the popup options are listed in alphabetical order. To move directly to an option on an alphabetized popup, type enough letters to uniquely identify the option. The letters you type don't appear on the screen. When the appropriate option is selected, press the Enter key.

The action associated with a popup option may cause another data entry screen to be displayed or may result in unseen internal data processing. In either case, the user's most recent selection will be displayed in the popup control rectangle. In the AP93 Interface data entry screens, the first popup option is chosen as a default. Figure 4 shows the AP93 Interface data entry screen depicted in Figure 2 with a popup control chosen and its associated popup options displayed.

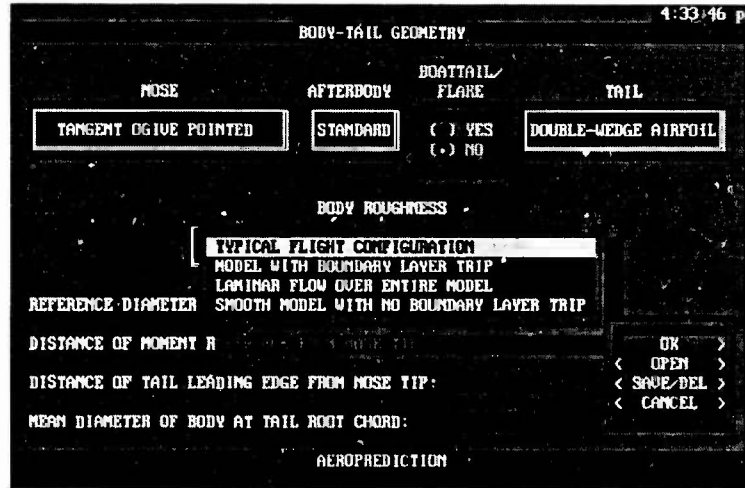


FIGURE 4. EXAMPLE OF AP93 INTERFACE DATA ENTRY SCREEN WITH POPUP CONTROL ACTIVATED

2.1.2.5 List

A *list* is simply a box containing a list of items. When using the keyboard, a list is similar to the popup options, with the exception that a list is always displayed. Figure 5 is an example of an AP93 Interface data entry screen that contains a list.

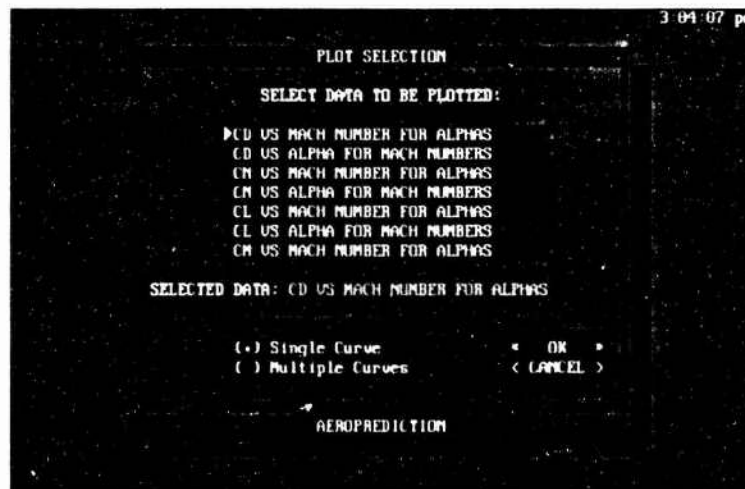


FIGURE 5. EXAMPLE OF AP93 INTERFACE DATA ENTRY SCREEN CONTAINING A LIST

2.1.3 Movement in Data Entry Screens with the Keyboard

In a data entry screen, movement flows from top to bottom, and left to right. The following keys allow you to maneuver in data entry screens with the keyboard:

Tab - Selects the next data field or data entry screen control.

Shift+Tab - Selects the previous data field or data entry screen control.

Up/Down Arrows - When in a list or popup control, the Up/Down Arrows move up and down through the list or popup options, item-by-item.

Home and End - When in a list or popup control, Home and End select the first and last item in the list or popup option.

PgUp and PgDn - When in a list or popup control, PgUp and PgDn display the previous or next window in the list or popup control.

Enter - When in a data field, push button, radio button, popup control, or list, Enter selects the next data field or data entry screen control once all associated processing for the current data field or data entry screen control has been completed.

2.2 MOUSE TECHNIQUES

It is particularly convenient to operate the AP93 Interface with a mouse. To do this, a mouse driver must be loaded and a mouse must be attached to the computer. When you complete these steps and start the AP93 Interface, a pointer appears on your screen.

The *pointer* is a solid box that contrasts with whatever it rests upon. When you roll the mouse, the pointer moves. You can position the pointer and *click* (press and release the mouse button) to anchor the pointer. The pointer marks the location where an action will occur. Note that the left button on your mouse is the only button the AP93 Interface requires.

2.2.1 Using Menus with the Mouse

The AP93 Interface menu system consists of the following parts: menu bar, menu pads, menu popups, and menu options. Each part of the menu system is displayed in Figure 2.

2.2.1.1 Menu Bar

The menu bar is located along the top of the AP93 Interface title screen. The *menu bar* displays names for menu popups. These names on the menu bar are called *menu pads*. The content of the menu bar changes as you access different parts of the interface. Different actions cause menu pads to be added to and removed from the menu bar.

2.2.1.2 Menu Pads

Menu pads appear on the menu bar and either display the name of a menu popup, a data entry screen, or an action to be taken. The mouse can be used to display the menu popup or data entry screen, or cause the action associated with each menu pad. Certain menu pads may be invisible and cannot be chosen. These menu pads are *disabled*.

To access a menu pad, point to the desired pad and click.

2.2.1.3 Menu Popups

Some menu pads control menu popups. *Menu popups* are lists of related options. A menu popup will be displayed when you choose a menu pad that controls a menu popup. *Choose* means to activate a *selection* by pointing to it and clicking.

To display a menu popup, you will have to point to a menu pad that controls a menu popup and press the mouse button. Once a menu popup is displayed, you will usually choose an available option, as described in the next section. The menu popup will remain on the screen until you choose a menu option or click anywhere off of the menu popup. By clicking anywhere off of the menu popup, you are essentially deactivating the menu popup without choosing an option.

2.2.1.4 Menu Options

Menu popups contain *options*. The options on each menu popup are logically related to the controlling menu pad. On a single menu popup, options may be further grouped to indicate that they produce similar outcomes. These groups are separated by divider lines. Certain menu options are followed by an arrow pointing to the right. When you choose this type of option, another menu popup appears with a different set of options. Sometimes a menu option will be invisible and cannot be chosen. This menu option is disabled.

Once a menu popup is displayed, an option can be chosen by pointing to the desired option and clicking. When you choose a menu option, a menu popup or data entry screen may appear, or an action may occur.

2.2.2 Using Data Entry Screens with the Mouse

When you choose certain menu pads or menu popup options, a data entry screen will appear. Data entry screens contain fields to enter data and a variety of controls that are used to designate, confirm or cancel actions. The fields and controls are explained in the next few paragraphs. Using the mouse, you can move in data entry screens by positioning the pointer, selecting and clicking the mouse button to choose. Figure 3 is an example of an AP93 Interface data entry screen.

2.2.2.1 Data Fields

In the data entry screen, data item descriptions consist of descriptive text followed by a semicolon. In most cases, the data item description is immediately followed by an associated data field. The *data field* is a rectangular area designated for the display of specific related data from the AP93 Interface or the entry of corresponding data by the user. The AP93 Interface interprets a blank numeric data field as zero, and a blank character data field as null. To select a data field, point and click on the desired field. To enter data, type in a response and press the Enter key. In the cases where the data field requires numeric data, a message is displayed at the bottom of the data entry screen informing the user of the required units and the data entry format.

2.2.2.2 Push Button

A *push button* is enclosed in angle brackets and contains key words that describe the action it triggers. The action associated with a push button occurs immediately. The action specified may result in the completion or cancellation of the data entry process, or it may cause another data entry screen to be displayed. To choose a push button, point and click on the desired push button.

2.2.2.3 Radio Button

A *radio button* is a set of parentheses followed by text. Radio buttons are situated as groups of related items. Only one radio button in a group can be chosen at any given time. To choose a radio button, point and click on the desired radio button. When a radio button is chosen, a bullet appears in the parentheses and any previously chosen radio button in the group becomes deselected. In the AP93 Interface data entry screens, all radio button groups have a radio button that is chosen as a default.

2.2.2.4 Popup Control

The rectangle with double lines on the right and bottom edges is a *popup control* that you can choose to display the associated popup. To choose a selected popup control and display the associated popup, point and click on the desired popup control without releasing the mouse button. To choose a popup option, drag the mouse (i.e. move the mouse backwards or forward while still pressing the mouse button) until the desired option is highlighted; then release the mouse button.

The action associated with a popup option may cause another data entry screen to be displayed or may result in unseen internal data processing. In either case, the user's most recent selection will be displayed in the popup control rectangle. In the AP93 Interface data entry screens, the first popup option is chosen as a default. Figure 4 shows an AP93 Interface data entry screen with a popup control chosen and its associated popup options displayed.

2.2.2.5 List

A *list* is simply a box containing a list of items. When a list is long enough that all of the items cannot be displayed, a scroll bar will appear along the right edge of the box. Click the arrows at either end of the scroll bar to move through the contents of a list a little at a time. Drag the diamond-shaped thumb to move through the list contents rapidly. The position of the thumb will indicate your position in the list. Click on the scroll bar above or below the thumb to move up one page or down one page. There are two methods that can be used to choose a desired item.

- 1) Click on the desired item to select it, and then press the Enter key.
- 2) Double-click (i.e. rapidly press the mouse button two times) on the desired item.

Figure 5 is an example of an AP93 Interface data entry screen that contains a list.

CHAPTER 3 THE AP93 INTERFACE

A new and improved version of the Naval Surface Warfare Center Dahlgren Division AP93 has been developed. The new code contains new technology that allows planar aerodynamics of axisymmetric solid rocket-type weapons to be computed with engineering accuracy over the entire Mach number range and for angles of attack to 30 degrees. New technology developed and included in the AP93 code includes:

- A new engineering method to compute aeroheating information at a high Mach number.
- Extension of the second-order shock-expansion theory to include real-gas effects, including several new pressure prediction techniques.
- An improved body-alone nonlinear normal force method.
- New methods for computing nonlinear aerodynamics of wing alone, wing body, and body wing due to angle of attack, and wing body due to control deflection.
- A new base-drag database and improved empirical base-drag estimation technique.

Comparison of the AP93 code to the former aeroprediction code (AP81) and experimental data on many configurations and test conditions showed the following:

- The AP93 code considerably reduces the normal-force and center-of-pressure errors of the AP81 code for most configurations.
- The AP93 code is more robust in terms of accuracy over a broad range of Mach numbers, angles of attack, and configuration geometries.
- The AP93 code gave slightly improved axial-force coefficients on average.
- Computational time and ease of use were about the same.

Comparison of the AP93 code to available computations of other state-of-the-art codes show the AP93 code to be as good or superior to these codes for planar aerodynamics. For a more detailed discussion of the AP93 code, see *Improved Aeroprediction Code: Part I - Summary Of New Methods And Comparisons With Experiment*, NSWCDD/TR-93/91, May 1993 and *Improved Aeroprediction Code: Part II - Computer Program User's Guide And Listing*, NSWCDD/TR-93/241, August 1993.

To improve the ease of use of the AP93 code, the AP93 Interface has been developed. The following sections provide a detailed description of the interface and the guidance necessary for its use.

3.1 AP93 INTERFACE MENU

The AP93 Interface menu is the vehicle that you must use in order to gain access to the various features of the AP93 Interface.

3.1.1 AP93 Interface Menu Bar

The AP93 Interface menu bar, with all of the menu pads enabled, is depicted in Figure 2. The AP93 Interface menu bar contains the following menu pads:



Not all of the menu pads are enabled at program startup. Different actions will cause menu pads to be added to or removed from the menu bar.

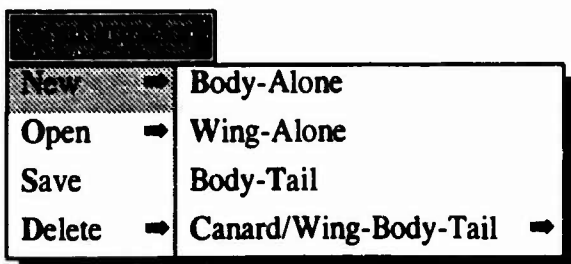
3.1.2 AP93 Interface Menu Pads

3.1.2.1 Configuration

The Configuration menu pad is enabled at program startup. It is the controlling menu pad for the Configuration menu popup. When you choose the Configuration menu pad, the Configuration menu popup is displayed. The Configuration menu popup contains the following menu options:

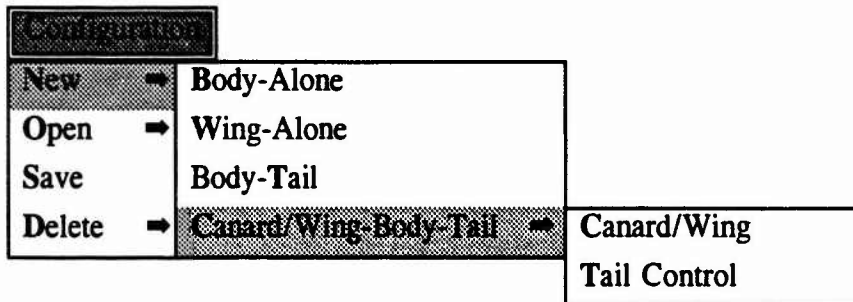


3.1.2.1.1 Configuration/New. The New menu option is always enabled. By choosing the New menu option, the user can begin the process of defining an aeroprediction configuration that can be processed by the AP93 code. Upon choosing the New menu option, a second-tier menu popup is displayed containing menu options for the following configuration types:



The choice of the Body-Alone, Wing-Alone, or Body-Tail second-tier menu options will result in the enabling of the Inputs menu pad. You will need to choose the Inputs menu pad to access the various menu options available for creating an aeroprediction configuration file that defines the configuration type that you have chosen. The Inputs menu pad is discussed in section 3.1.2.2.

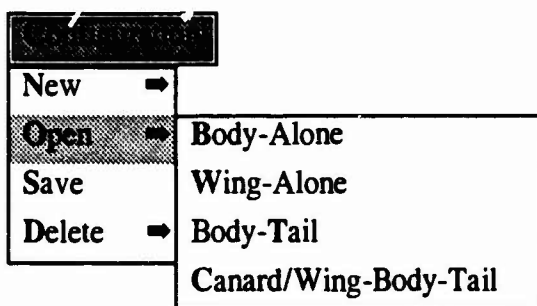
The choice of the Canard/Wing-Body-Tail second-tier menu option will cause a third-tier menu popup to be displayed. This menu popup will contain the following third-tier menu options that will allow the user to specify the lifting surface that is allowed to move:



The choice of either of the third-tier menu options will result in the enabling of the Inputs menu pad.

(This data corresponds to AP93 variable NTYPE.)

3.1.2.1.2 Configuration/Open. The Open menu option will be enabled only when there are aeroprediction configuration files that have been previously saved by the user. For a discussion on saving aeroprediction configuration files, see section 3.1.2.1.3. Upon choosing the Open menu option, a second-tier menu popup is displayed containing menu options for the following configuration types:



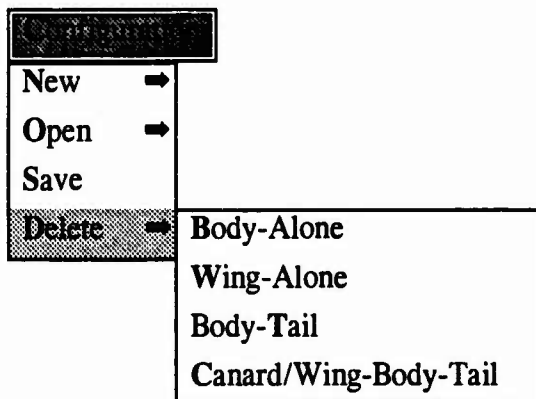
The enabling of any of these second-tier menu options will depend upon whether aeroprediction configuration files have been saved for the corresponding configuration type. If a second-tier menu option is enabled and chosen, the Configuration-Open File data entry screen will be displayed. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

(This data corresponds to AP93 variable NTYPE.)

3.1.2.1.3 Configuration/Save. The Save menu option will be enabled only when the input of aeroprediction configuration data has been completed. The input of aeroprediction configurations is discussed in section 3.1.2.2. Upon choosing the Save menu option, the Configuration-Save/Delete File data entry screen will be displayed. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

(This data corresponds to AP93 variable NTYPE.)

3.1.2.1.4 Configuration/Delete. The Delete menu option will be enabled only when there are aeroprediction configuration files that have been previously saved by the user. Upon choosing the Delete menu option, a second-tier menu popup is displayed containing menu options for the following configuration types:



The enabling of any of the second-tier menu options will depend upon whether aeroprediction configuration files have been saved for the corresponding configuration type. If a second-tier menu option is enabled and chosen, the Configuration-Save/Delete File data entry screen will be displayed. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

(This data corresponds to AP93 variable NTYPE.)

3.1.2.2 Inputs

The Inputs menu pad is not enabled at program startup. It becomes enabled after the user has either chosen the configuration type for a new aeroprediction configuration, or has opened a saved aeroprediction configuration. The Inputs menu pad is the controlling menu pad for the Inputs menu popup. The Inputs menu popup contains the menu options for creating a complete aeroprediction configuration file. When you choose the Inputs menu pad, the Inputs menu popup is displayed. The Inputs menu popup contains the following menu options:

Geometry (Feet)	
Geometry (Inches)	
Geometry (Meters)	
Geometry (Millimeters)	
Free-Stream Conditions (Feet)	→
Free-Stream Conditions (Inches)	→
Free-Stream Conditions (Meters)	→
Free-Stream Conditions (Millimeters)	→
Options (Feet)	
Options (Inches)	
Options (Meters)	
Options (Millimeters)	

The user must have completed the input of geometry data, free-stream conditions data, and options data before an aeroprediction configuration file is considered to be complete.

3.1.2.2.1 Inputs/Geometry. The Geometry menu options are always enabled. By choosing a Geometry menu option, the user can begin the process of inputting aeroprediction configuration geometry data, in the units chosen, for the chosen configuration type. Upon choosing a Geometry menu option, an Aeroprediction Geometry data entry screen, corresponding to the chosen configuration type, will be displayed. The Aeroprediction Geometry data entry screens are discussed in section 3.2.2.

3.1.2.2.2 Inputs/Free-Stream Conditions. The Free-Stream Conditions menu options are always enabled. By choosing a Free-Stream Conditions menu option, the user can begin the process of inputting aeroprediction configuration free-stream conditions data, in the units chosen. Upon choosing a Free-Stream condition menu option, a second-tier menu popup is displayed containing menu options for the following free-stream conditions:

Geometry (Feet)	
Geometry (Inches)	
Geometry (Meters)	
Geometry (Millimeters)	
	Alpha Sweep
Free-Stream Conditions (Inches) ➡	Delta Sweep
Free-Stream Conditions (Meters) ➡	Altitude Sweep
Free-Stream Conditions (Millimeters) ➡	Mach Sweep
Options (Feet)	Other
Options (Inches)	
Options (Meters)	
Options (Millimeters)	

With the exception of the Delta Sweep menu option, all second-tier menu options are always enabled. The Delta Sweep menu option is disabled for the body-alone or wing-alone configuration types. If a second-tier menu option is enabled and chosen, a corresponding Free-Stream Conditions data entry screen will be displayed. The Free-Stream Conditions data entry screens are discussed in section 3.2.3.

3.1.2.2.3 Inputs/Options. The Options menu options are enabled only when the user has completed the input of both the geometry data and the free-stream data, or when the user has opened a saved Aeroprediction configuration file. By choosing an Options menu option, the user can begin the process of inputting aeroprediction configuration options data, in the units chosen. Upon choosing an Options menu option, an Options data entry screen will be displayed. The Options data entry screens are discussed in section 3.2.4.

3.1.2.3 Edit

The Edit menu pad is not enabled at program startup. It becomes enabled after the user has completed inputting aeroprediction configuration geometry data, has completed inputting aeroprediction configuration free-stream conditions, or has opened a saved Aeroprediction configuration file. The Edit menu pad is the controlling menu pad for the Edit menu popup. The Edit menu popup contains the menu options for editing selected portions of an aeroprediction configuration. When you choose the Edit menu pad, the Edit menu popup is displayed. The Edit menu popup contains the following menu options:

Geometry
Free-Stream Conditions
Options

Using the Edit menu options to alter the data in a saved aeroprediction configuration file will not change the saved file permanently. To make the editing alterations permanent, the user must use the Configuration-Save/Delete menu option. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

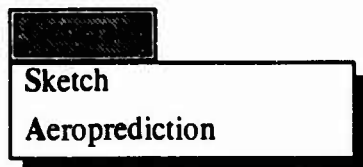
3.1.2.3.1 Edit/Geometry. The Geometry menu option is enabled after the user has either completed the input of the geometry data, or opened a saved Aeroprediction configuration file. By choosing the Geometry menu option, the user can begin the process of modifying the current aeroprediction configuration geometry data. Upon choosing the Geometry menu option, an Aeroprediction Geometry data entry screen, corresponding to the chosen configuration type, will be displayed. The Aeroprediction Geometry data entry screens are discussed in section 3.2.2.

3.1.2.3.2 Edit/Free-Stream Conditions. The Free-Stream menu option is enabled after the user has either completed the input of the free-stream data, or opened a saved aeroprediction configuration file. By choosing the Free-Stream menu option, the user can begin the process of modifying the current aeroprediction configuration free-stream data. Upon choosing the Free-Stream menu option, an Aeroprediction Free-Stream Conditions data entry screen will be displayed. The Aeroprediction Free-Stream Conditions data entry screens are discussed in section 3.2.3.

3.1.2.3.3 Edit/Options. The Options menu option is enabled after the user has either completed the input of the options data, or opened a saved Aeroprediction configuration file. By choosing the Options menu option, the user can begin the process of modifying the current aeroprediction configuration options data. Upon choosing the options menu option, an Aeroprediction Options data entry screen will be displayed. The Aeroprediction Options data entry screens are discussed in section 3.2.4.

3.1.2.4 Generate

The Generate menu pad is not enabled at program startup. It becomes enabled after the user has either completed the input of geometry data, or opened a saved aeroprediction configuration file. The Generate menu pad is the controlling menu pad for the Generate menu popup. The Generate menu popup contains the menu options for creating a sketch of the input geometry, and for generating aerodynamic coefficients. When you choose the Generate menu pad, the Generate menu popup is displayed. The Generate menu popup contains the following menu options:



3.1.2.4.1 Generate/Sketch. The Sketch menu option is always enabled. By choosing the Sketch menu option, the user can check for errors in the input geometry. Upon choosing the Sketch menu option, a sketch representing the profile of the input geometry will

be displayed. Figure 6 is an example of such a sketch. Hitting any key on the keyboard will remove the sketch and return the user to the AP93 Interface menu bar.

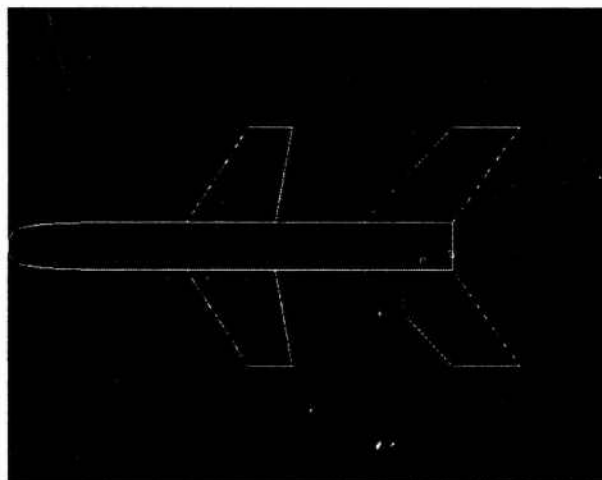


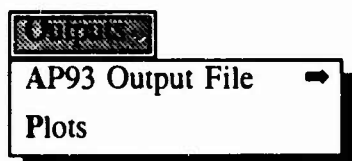
FIGURE 6. EXAMPLE OF GEOMETRY SKETCH

3.1.2.4.2 Generate/Aeroprediction. The Aeroprediction menu option is enabled when the user has completed the input of geometry data, free-stream conditions data, and options data. See section 3.1.2.2 for a discussion on inputs. The Aeroprediction menu option is also enabled if the user has opened a saved aeroprediction configuration file. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen, and see section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

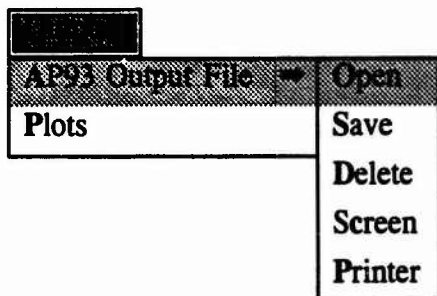
Upon choosing the Aeroprediction menu option, the following sequence of events occurs. First, an input file is generated using the current data stored in the AP93 interface. After completing of the input file generation, the Aeroprediction code itself is executed to generate aerodynamic coefficients. Finally, the user is returned to the AP93 Interface menu bar. Although this sequence of events will be invisible to the user, messages are displayed periodically so that the user can monitor the progress.

3.1.2.5 Outputs

The Outputs menu pad is enabled when the Generate/Aeroprediction option has been executed (see section 3.1.2.4.2) or when the user has previously saved an AP93 output file (see section 3.1.2.5.1). The Outputs menu pad is the controlling menu pad for the Outputs menu popup. The Outputs menu popup contains the menu options for viewing the results which have been generated by AP93. When you choose the Outputs menu pad, the Outputs menu popup is displayed. The Outputs menu popup contains the following menu options:



3.1.2.5.1 Outputs/AP93 Output File. The AP93 Output File menu option is always enabled. By choosing the AP93 Output File menu option, the user can open, save, delete, or view AP93 output results. Upon choosing the AP93 Output File menu option, a second-tier menu popup is displayed containing the following options:



3.1.2.5.1.1 Outputs/AP93 Output File/Open. The second-tier Open menu option will be enabled if a AP93 output file has been saved previously. Upon selecting the Open menu option, the AP93 Output File-Open File data entry screen will be displayed. The AP93 Output File-Open File data entry screen is operated in exactly the same way as the Configuration-Open File data entry screen (see section 3.2.1.1).

3.1.2.5.1.2 Outputs/AP93 Output File/Save. The second-tier Save menu option will be enabled if the Generate/Aeroprediction menu option has been executed (see section 3.1.2.4.2) or if the Outputs/AP93 Output File/Open menu option has been executed (see section 3.1.2.5.1.1). Upon selecting the Save menu option, the AP93 Output File-Save File data entry screen will be displayed. The AP93 Output File-Save File data entry screen is operated in exactly the same way as the Configuration-Save/Delete File data entry screen (see section 3.2.1.2).

3.1.2.5.1.3 Outputs/AP93 Output File/Delete. The second-tier Delete menu option will be enabled if a AP93 output file has been saved previously. Upon selecting the Delete menu option, the AP93 Output File-Delete File data entry screen will be displayed. The AP93 Output File-Delete File data entry screen is operated in exactly the same way as the Configuration-Save/Delete File data entry screen (see section 3.2.1.2).

3.1.2.5.1.4 Outputs/AP93 Output File/Screen. The second-tier Screen menu option will be enabled if the Generate/Aeroprediction menu option has been executed (see section 3.1.2.4.2) or if the Outputs/AP93 Output File/Open menu option has been executed (see section 3.1.2.5.1.1). Upon selecting the Screen menu option, the AP93 results will be transferred to the screen as shown in Figure 7.

The user can view the results by using the keyboard/mouse to scroll left/right or down. The "More" push button will cause the next page of output to be displayed on the screen. The "Done" push button will exit the results screen and return the user to the AP93 Interface menu bar.

```

Configuration Inputs Edit Generate Outputs Printer Quit 10:18:16 PM
CASE NO. 1
PLEASE WORK

ANGLE OF ATTACK = 1.00DEGS REFERENCE DIAMETER = 1.00FT

REFERENCE CONDITIONS
REMS. NO./MACH NO./FT. = 0.200000E+07
MOMENT REFERENCE = 5.00 CALIBERS FROM NOSE TIP
ALIGNM MACH NUMBER = 0.00 (TO BE COMPUTED AUTOMATIC)
ALTIM MACH NUMBER = 5.00

TAIL/WING GEOMETRY(BICOWEX AIRFOIL DESIGN)
D H Column: 30

```

FIGURE 7. EXAMPLE OF AP93 RESULTS BEING SHOWN ON SCREEN

3.1.2.5.1.5 Outputs/AP93 Output File/Printer. The second-tier Printer menu option will be enabled if the Generate/Aeroprediction menu option has been executed (see section 3.1.2.4.2), or if the Outputs/AP93 Output File/Open menu option has been executed (see section 3.1.2.5.1.1). Upon selecting the Printer menu option, the AP93 results will be transferred to the printer.

3.1.2.5.2 Outputs/Plots. The Plots menu option will be enabled if the Generate/Aeroprediction menu option has been executed (see section 3.1.2.4.2), or if the Outputs/AP93 Output File/Open menu option has been executed (see section 3.1.2.5.1.1). Upon selecting the Plots menu option, the Aeroprediction-Plot Selection data entry screen will be displayed. See section 3.2.5 for a discussion on the Aeroprediction-Plot Selection data entry screen.

3.1.2.6 Printer

The Printer menu pad is always enabled. By choosing the Printer menu pad, the user can define the type of printer to be used for printing output. Upon choosing the Printer menu pad, the Aeroprediction-Printer Selection data entry screen will be displayed. See section 3.2.6 for a discussion on the Aeroprediction-Printer Selection data entry screen.

3.1.2.7 Quit

The Quit menu pad is always enabled. Upon choosing the Quit menu pad, the user exits the AP93 Interface program. Any unsaved data will be lost.

3.2 AP93 INTERFACE DATA ENTRY SCREENS

The AP93 Interface data entry screens are the vehicles that are used to control the interface environment and to input aeroprediction configuration data. The following paragraphs discuss the AP93 Interface data entry screens.

3.2.1 Configuration Data Entry Screens

3.2.1.1 Configuration-Open File Data Entry Screen

The Configuration-Open File data entry screen is depicted in Figure 8.

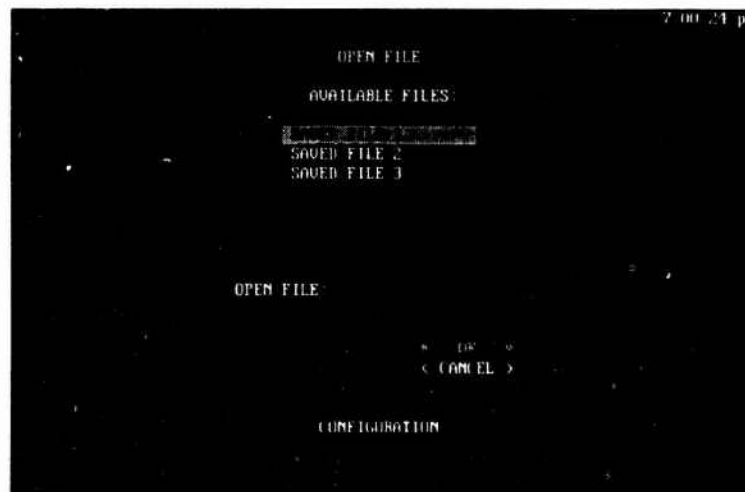


FIGURE 8. CONFIGURATION-OPEN FILE DATA ENTRY SCREEN

The Configuration-Open File data entry screen consists of a list, a data field, and two push buttons to be used as follows:

Available Files list - The user can choose the aeroprediction configuration file to be opened from the list of available files. The list will contain only the names of files that were saved for the chosen configuration type.

Open File data field - The Open File data field is not enabled (i.e. data cannot be entered into this field by the user). When a file is chosen from the Available Files List, the file name will appear in the Open File data field.

OK push button - The OK push button is not enabled until there is a file name displayed in the Open File data field. By choosing the OK push button, you are confirming that the aeroprediction configuration file that you want opened is identified by the file name displayed in the Open File data field. After choosing the OK push button, the aeroprediction configuration file will be opened.

Cancel push button - Choose the Cancel push button to leave the Configuration-Open File data entry screen without opening a file.

3.2.1.2 Configuration-Save/Delete File Data Entry Screen

The Configuration-Save/Delete File data entry screen is depicted in Figure 9. It is the vehicle that is used for saving or deleting aeroprediction configuration files. The following paragraphs discuss the use of the Configuration-Save/Delete File data entry screen when saving and deleting aeroprediction configuration files.



FIGURE 9. CONFIGURATION-SAVE/DELETE FILE DATA ENTRY SCREEN

3.2.1.2.1 Saving Aeroprediction Configuration Files. The Configuration-Save/Delete File data entry screen consists of a list, a data field, and three push buttons to be used as follows when saving aeroprediction configuration files:

Saved Files list - The Saved Files list will contain only the names of files that were saved for the configuration type of the current aeroprediction configuration inputs. The user can choose an existing aeroprediction configuration file from the list of saved files.

File Name data field - The File Name data field is always enabled. There are two methods that can be used to enter data into this field.

- 1) Choose an existing aeroprediction configuration file from the Saved Files list.
- 2) Select the File Name data field, type the desired file name, and press the Enter key.

Save push button - The Save push button is not enabled until there is a file name displayed in the File Name data field. By choosing the Save push button, you are

confirming that the aeroprediction configuration file to be saved will be identified by the file name displayed in the File Name data field. After choosing the Save push button, the aeroprediction configuration file will be generated and saved. If the file name originated from the Saved Files list, the previously saved file with that name will be overridden.

Delete push button - The Delete push button will become enabled when there is a file name displayed in the File Name data field. This push button should not be used when saving files.

Cancel push button - Choose the Cancel push button to leave the Configuration-Save/Delete File data entry screen without saving a file.

3.2.1.2.2 Deleting Aeroprediction Configuration Files. The Configuration-Save/Delete File data entry screen consists of a list, a data field, and three push buttons to be used as follows when deleting aeroprediction configuration files:

Saved Files list - The Saved Files list will contain only the names of files that were saved for the chosen configuration type. The user can choose the aeroprediction configuration file to be deleted from the list of saved files.

File Name data field - The File Name data field is always enabled. There are two methods that can be used to enter data into this field.

- 1) Choose an existing aeroprediction configuration file from the Saved Files list.
- 2) Select the File Name data field, type the desired file name, and press the Enter key.

Save push button - The Save push button will become enabled when there is a file name displayed in the File Name data field. This push button should not be used when deleting files.

Delete push button - The Delete push button will become enabled when there is a file name displayed in the File Name data field. By choosing the Delete push button, you are confirming that the aeroprediction configuration file to be deleted is identified by the file name displayed in the File Name data field. After choosing the Delete push button, the delete confirmation screen shown in Figure 10 will be displayed. When in the delete confirmation screen, choosing the "Yes" push button causes the aeroprediction configuration file to be deleted. If you choose the "No" push button, the file will not be deleted. In either case, you will leave the delete confirmation screen and return to the AP93 Interface startup screen.

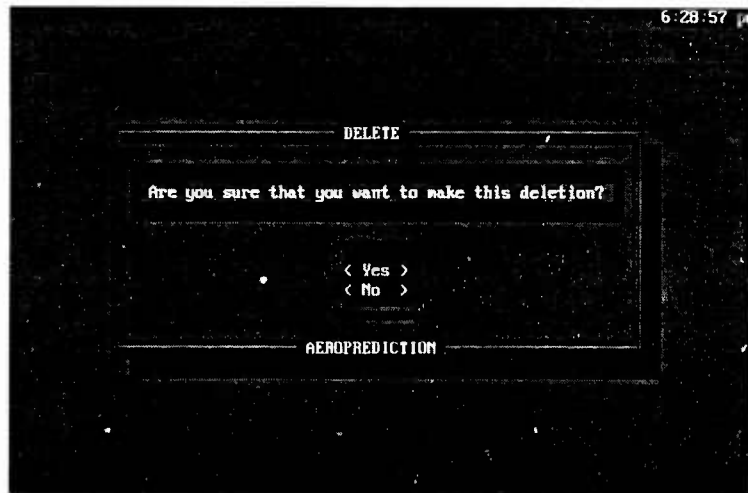


FIGURE 10. DELETE FILE CONFIRMATION SCREEN

Cancel push button - Choose the Cancel push button to leave the Configuration-Save/Delete File data entry screen without deleting a file.

3.2.2 Aeroprediction Geometry Data Entry Screens

3.2.2.1 Aeroprediction-Body-Alone Geometry Data Entry Screen

The Aeroprediction-Body-Alone Geometry data entry screen is depicted in Figure 11.

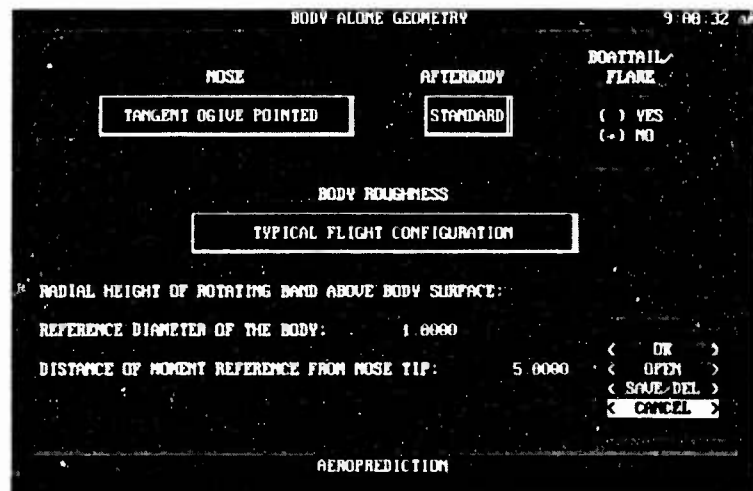


FIGURE 11. AEROPREDICTION-BODY-ALONE GEOMETRY DATA ENTRY SCREEN

The Aeroprediction-Body-Alone Geometry data entry screen consists of three popup controls, a set of radio buttons, three data fields, and four push buttons to be used as follows:

Nose popup control - The Nose popup control contains the following Nose popup options:

- Tangent Ogive Pointed
- Tangent Ogive Blunt
- Tangent Ogive Truncated
- Von Karman Ogive Blunt
- Von Karman Ogive Truncated
- Secant Ogive Pointed
- Secant Ogive Blunt
- Secant Ogive Truncated
- Haack Nose Pointed
- Haack Nose Blunt
- Haack Nose Truncated
- Cone Pointed
- Cone Blunt
- Cone Truncated
- Power Series Pointed
- Power Series Blunt
- Power Series Truncated
- Hemisphere
- Other

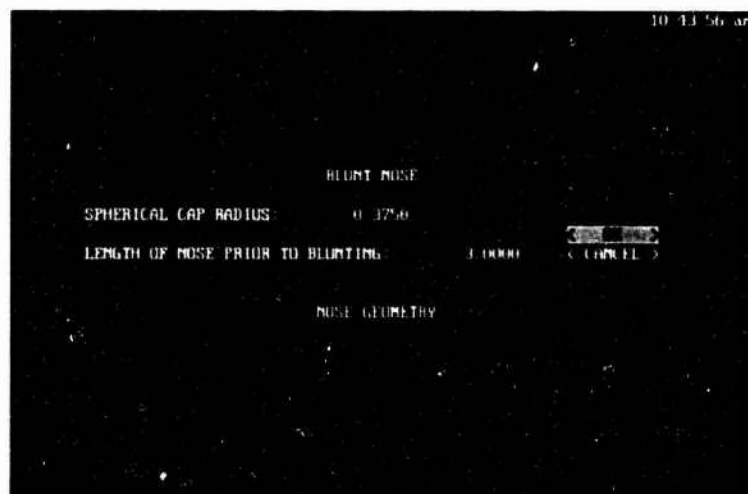


FIGURE 12. EXAMPLE OF NOSE GEOMETRY DATA ENTRY SCREEN

The choice of a Nose popup option is mandatory (i.e. until the user chooses a Nose popup option, the geometry is considered incomplete). Choosing an option other than "Hemisphere" or "Other," will result in the display of an associated Nose Geometry data entry screen, similar to the screen displayed in Figure 12, and the user will be required to enter amplifying data as listed in Table 1:

TABLE 1. AMPLIFYING DATA FOR NOSE POPUP CONTROL OPTIONS

	Length Of Nose	Spherical Cap Radius	Length Of Nose Prior To Blunting	Nose Tip Radius	Length Of Nose Prior To Truncation	Radius Of Curvature	Cone Half Angle	Power Series Exponent
Tangent Ogive Pointed	✓							
Tangent Ogive Blunt		✓	✓					
Tangent Ogive Truncated				✓	✓			
Von Karman Blunt		✓	✓					
Von Karman Truncated				✓	✓			
Secant Ogive Pointed	✓					✓		
Secant Ogive Blunt		✓	✓			✓		
Secant Ogive Truncated				✓	✓	✓		
Haack Nose Pointed	✓							
Haack Nose Blunt		✓	✓					
Haack Nose Truncated				✓	✓			
Cone Pointed	✓						✓	
Cone Blunt			✓				✓	
Cone Truncated					✓		✓	
Power Series Pointed	✓							✓
Power Series Blunt		✓	✓					✓
Power Series Truncated				✓	✓			✓

After choosing an option other than "Other" and entering required amplifying data, the AP93 Interface will automatically generate cylindrical coordinate point set pairs associated with a one section nose that corresponds to the option chosen. Choosing the "Other" popup option will result in the display of the Nose Geometry-Other data entry screen. For a discussion of the Nose Geometry-Other data entry screen, see section 3.2.2.5.1.

(This data corresponds to AP93 variable X(I), R(I).)

Afterbody popup control - The Afterbody popup control contains the following Afterbody popup options:

- Standard
- Other

The choice of an Afterbody popup option is mandatory. Choosing the "Standard" option will result in the display of the Afterbody Geometry-Standard data entry screen. For a discussion of the Afterbody Geometry-Standard data entry screen, see section 3.2.2.6.1. Choosing the "Other" option will result in the display of the Afterbody Geometry-Other data entry screen. For a discussion of the Afterbody Geometry-Other data entry screen, see section 3.2.2.6.2.

(This data corresponds to AP93 variable X(I), R(I).)

Boattail/Flare radio buttons - The Boattail/Flare radio buttons are enabled when the user chooses the "Standard" Afterbody popup option. The choice of a Boattail/Flare radio button is not mandatory. The "No" radio button is *selected* as the default. Choosing the "No" radio button will result in an afterbody geometry without a boattail/flare. Choosing the "Yes" radio button will result in the display of the Afterbody Geometry-Boattail/Flare data entry screen. For a discussion of the Afterbody Geometry-Boattail/Flare data entry screen, see section 3.2.2.6.3.

(This data corresponds to AP93 variable X(I), R(I).)

Body Roughness popup control - The Body Roughness popup control contains the following Body Roughness popup options:

- Typical Flight Configuration
- Model With Boundary Layer Trip
- Laminar Flow Over Entire Model
- Smooth Model With No Boundary Layer Trip

The choice of a Body Roughness popup option is not mandatory. The "Typical Flight Configuration" popup option is selected as the default. The location of the boundary layer transition on the body will be determined by the Body Roughness popup option that is chosen.

(This data corresponds to AP93 variable IRNCRIT.)

Radial Height Of Rotating Band Above Body Surface data field - The entry of data into the Radial Height Of Rotating Band Above Body Surface data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable HB.)

Reference Diameter Of The Body data field - The entry of data into the Reference Diameter Of The Body data field is mandatory. The Reference Diameter Of The Body must be the diameter at the end of the nose.

(This data corresponds to AP93 variable DIA.)

Distance Of Moment Reference From Nose Tip data field - The entry of data into the Distance Of Moment Reference From Nose Tip data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable XCG.)

OK push button - The OK push button is not enabled until the user completes the data entry for the Nose and Afterbody popup options. By choosing the OK push button, you are confirming that the options displayed in the popup controls are correct, and data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Open push button - The Open push button will be enabled only when there are body-alone geometry files that have been previously saved by the user. The Choice of this push button will result in the display of the Body-Alone Geometry-Open File data entry screen. The user can use the Body-Alone Geometry-Open File data entry screen for opening body-alone geometry files in exactly the same manner as the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for the Nose and Afterbody popup options.
- 2) There are body-alone geometry files that have been previously saved by the user.

The Choice of this push button will result in the display of the Body-Alone Geometry-Save/Delete File data entry screen. The user can use the Body-Alone Geometry-Save/Delete File data entry screen for saving and deleting body-alone geometry files in exactly the same manner as the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Body-Alone Geometry data entry screen without processing the body-alone geometry data.

3.2.2.2 Aeroprediction-Wing-Alone Geometry Data Entry Screen

The Aeroprediction-Wing-Alone Geometry data entry screen is depicted in Figure 13.



FIGURE 13. AEROPREDICTION-WING-ALONE GEOMETRY
DATA ENTRY SCREEN

The Aeroprediction-Wing-Alone Geometry data entry screen consists of a popup control and four push buttons to be used as follows:

Wing popup control - The Wing popup control contains the following Wing popup options:

- Double-Wedge Airfoil
- Biconvex Airfoil

The choice of a Wing popup option is mandatory. Choosing the "Double-Wedge Airfoil" popup option will result in the display of the Tail Geometry-Double-Wedge Airfoil data entry screen. For a discussion of the Tail Geometry-Double-Wedge Airfoil data entry screen, see section 3.2.2.7.1. The Choice of the "Biconvex Airfoil" popup option will result in the display of the Tail Geometry-Biconvex Airfoil data entry screen. For a discussion of the Tail Geometry-Biconvex Airfoil data entry screen, see section 3.2.2.7.2.

(This data corresponds to AP93 variables IW and IC.)

OK push button - The OK push button is not enabled until the user completes the data entry for the Wing option. By choosing the OK push button, you are confirming that the option displayed in the popup control is correct, and data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Open push button - The Open push button will be enabled only when there are Wing-Alone geometry files that have been previously saved by the user. The Choice of this push button will result in the display of the Wing-Alone Geometry-Open File data entry screen. The user can use the Wing-Alone Geometry-Open File data entry

screen for opening Wing-Alone geometry files in exactly the same manner as the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for the Wing option.
- 2) There are Wing-Alone geometry files that have been previously saved by the user.

The Choice of this push button will result in the display of the Wing-Alone Geometry-Save/Delete File data entry screen. The user can use the Wing-Alone Geometry-Save/Delete File data entry screen for saving and deleting nose geometry files in exactly the same manner as the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Wing-Alone Geometry data entry screen without processing the wing-alone geometry data.

3.2.2.3 Aeroprediction-Body-Tail Geometry Data Entry Screen

The Aeroprediction-Body-Tail Geometry data entry screen is depicted in Figure 14.

```

BODY TAIL GEOMETRY
2 51 14 PM

NOSE          AFTERBODY    BOATTAIL     TAIL
TANGENT OGIVE POINTED  STANDARD  ( ) YES      DOUBLE WEDGE AIRFOIL
( ) YES      ( ) NO

BODY ROUGHNESS
TYPICAL FLIGHT CONFIGURATION

REFERENCE DIAMETER OF THE BODY:
DISTANCE OF MOMENT REFERENCE FROM NOSE TIP: < OK >
DISTANCE OF TAIL LEADING EDGE FROM NOSE TIP: < OPEN >
MEAN DIAMETER OF BODY AT TAIL ROOT CHORD: < OK/DEL >
< CANCEL >

AEROPREDICTION
  
```

FIGURE 14. AEROPREDICTION-BODY-TAIL GEOMETRY DATA ENTRY SCREEN

The Aeroprediction-Body-Tail Geometry data entry screen consists of four popup controls, a set of radio buttons, four data fields, and four push buttons to be used as follows:

Nose popup control - See the discussion of the Nose popup control in section 3.2.2.1.

Afterbody popup control - See the discussion of the Afterbody popup control in section 3.2.2.1.

Boattail/Flare radio buttons - See the discussion of the Boattail/Flare radio buttons in section 3.2.2.1.

Tail popup control - See the discussion of the Wing popup control in section 3.2.2.2.

Body Roughness popup control - See the discussion of the Body Roughness popup control in section 3.2.2.1.

Reference Diameter Of The Body data field - The entry of data into the Reference Diameter Of The Body data field is mandatory. The Reference Diameter Of The Body must be the diameter at the end of the nose.

(This data corresponds to AP93 variable DIA.)

Distance Of Moment Reference From Nose Tip data field - The entry of data into the Distance Of Moment Reference From Nose Tip data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable XCG.)

Distance Of Tail Leading Edge From Nose Tip data field - The entry of data into the Distance Of Tail Leading Edge From Nose Tip data field is mandatory.

(This data corresponds to AP93 variable XW.)

Mean Diameter Of Body At Tail Root Chord data field - The entry of data into the Mean Diameter Of Body At Tail Root Chord data field is mandatory.

(This data corresponds to AP93 variable DW.)

OK push button - The OK push button is not enabled until the user completes the data entry for the Nose, Afterbody, and Tail menu popup options. By choosing the OK push button, you are confirming that the popup options displayed in the popup controls are correct, and data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Open push button - The Open push button will be enabled only when there are body-tail geometry files that have been previously saved by the user. The choice of this

push button will result in the display of the Body-Tail Geometry-Open File data entry screen. The user can use the Body-Tail Geometry-Open File data entry screen for opening body-tail geometry files in exactly the same manner that the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for the Nose, Afterbody, and Tail popup options.
- 2) There are body-tail geometry files that have been previously saved by the user.

The Choice of this push button will result in the display of the Body-Tail Geometry-Save/Delete File data entry screen. The user can use the Body-Tail Geometry-Save/Delete File data entry screen for saving and deleting body-tail geometry files in exactly the same manner that the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Body-Tail Geometry data entry screen without processing the body-tail geometry data.

3.2.2.4 Aeroprediction-Canard/Wing-Body-Tail Geometry Data Entry Screen

The Aeroprediction-Canard/Wing-Body-Tail Geometry data entry screen is depicted in Figure 15.

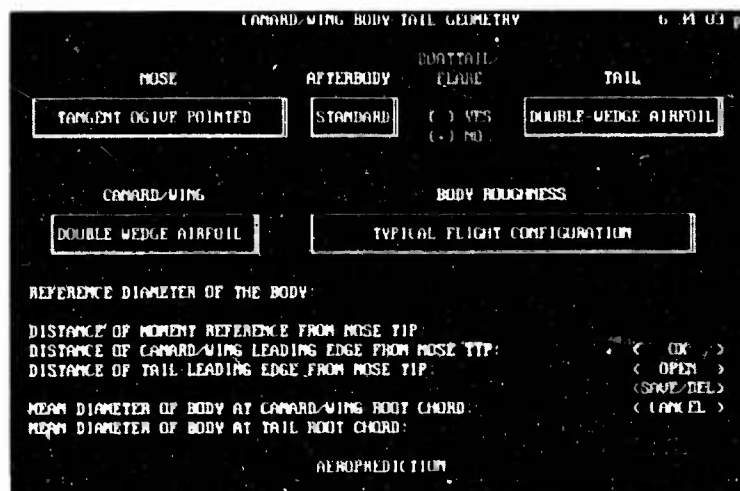


FIGURE 15. AEROPREDICTION-CANARD/WING-BODY-TAIL GEOMETRY DATA ENTRY SCREEN

The Aeroprediction Canard/Wing-Body-Tail Geometry data entry screen consists of five popup controls, a set of radio buttons, six data fields, and four push buttons to be used as follows:

Nose popup control - See the discussion of the Nose popup control in section 3.2.2.1.

Afterbody popup control - See the discussion of the Afterbody popup control in section 3.2.2.1.

Boattail/Flare radio buttons - See the discussion of the Boattail/Flare radio buttons in section 3.2.2.1.

Tail popup control - See the discussion of the Wing popup control in section 3.2.2.2.

Canard/Wing popup control - The Canard/Wing popup control contains the following Canard/Wing popup options:

- Double-Wedge Airfoil
- Biconvex Airfoil

The choice of a Canard/Wing popup option is mandatory. Choosing the "Double-Wedge Airfoil" popup option will result in the display of the Canard/Wing Geometry-Double-Wedge Airfoil data entry screen. The Canard/Wing Geometry-Double-Wedge Airfoil data entry screen is exactly like the Tail Geometry-Double-Wedge Airfoil data entry screen in format and function (see section 3.2.2.7.1). The Choice of the "Biconvex Airfoil" popup option will result in the display of the Canard/Wing Geometry-Biconvex Airfoil data entry screen. The Canard/Wing Geometry-Biconvex Airfoil data entry screen is exactly like the Tail Geometry-Biconvex Airfoil data entry screen in format and function (see section 3.2.2.7.2).

(This data corresponds to AP93 variable IC.)

Body Roughness popup control - See the discussion of the Body Roughness popup control in section 3.2.2.1.

Reference Diameter Of The Body data field - The entry of data into the Reference Diameter Of The Body data field is mandatory. The Reference Diameter Of The Body must be the diameter at the end of the nose.

(This data corresponds to AP93 variable DIA.)

Distance Of Moment Reference From Nose Tip data field - The entry of data into the Distance Of Moment Reference From Nose Tip data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable XCG.)

Distance Of Canard/Wing Leading Edge From Nose Tip data field - The entry of data into the Distance Of Canard/Wing Leading Edge From Nose Tip data field is mandatory.

(This data corresponds to AP93 variable XC.)

Distance Of Tail Leading Edge From Nose Tip data field - The entry of data into the Distance Of Tail Leading Edge From Nose Tip data field is mandatory.

(This data corresponds to AP93 variable XW.)

Mean Diameter Of Body At Canard/Wing Root Chord data field - The entry of data into the Mean Diameter Of Body At Canard/Wing Root Chord data field is mandatory.

(This data corresponds to AP93 variable DC.)

Mean Diameter Of Body At Tail Root Chord data field - The entry of data into the Mean Diameter Of Body At Tail Root Chord data field is mandatory.

(This data corresponds to AP93 variable DW.)

OK push button - The OK push button is not enabled until the user completes the data entry for the Nose, Afterbody, Tail and Canard/Wing menu popup options. By choosing the OK push button, you are confirming that the popup options displayed in the popup controls are correct, and data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Open push button - The Open push button will be enabled only when there are canard/wing-body-tail geometry files that have been previously saved by the user. The Choice of this push button will result in the display of the Canard/Wing-Body-Tail Geometry-Open File data entry screen. The user can use the Canard/Wing-Body-Tail Geometry-Open File data entry screen for opening canard/wing-body-tail geometry files in exactly the same manner that the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for the Nose, Afterbody, Tail, and Canard/Wing popup options.
- 2) There are canard/wing-body-tail geometry files that have been previously saved by the user.

The Choice of this push button will result in the display of the Canard/Wing-Body-Tail Geometry-Save/Delete File data entry screen. The user can use the Canard/Wing-Body-Tail Geometry-Save/Delete File data entry screen for saving and deleting body-tail geometry files in exactly the same manner that the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Canard/Wing-Body-Tail Geometry data entry screen without processing the canard/wing-body-tail geometry data.

3.2.2.5 Nose Geometry Data Entry Screens

3.2.2.5.1 Nose Geometry-Other Data Entry Screen. The Nose Geometry-Other data entry screen is depicted in Figure 16.

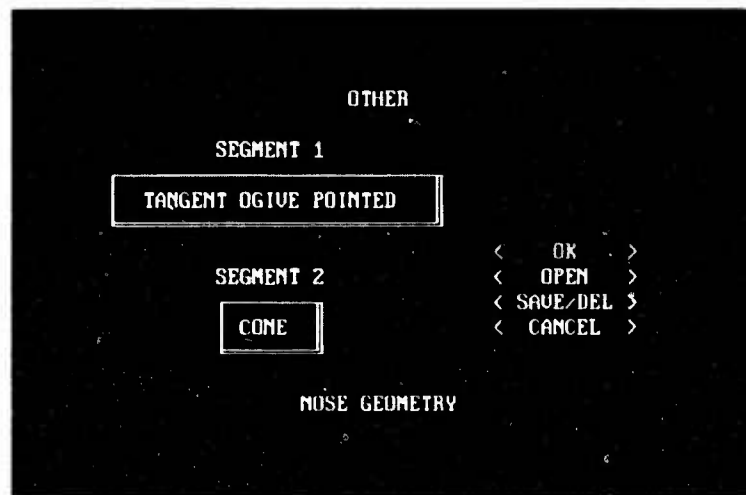


FIGURE 16. NOSE GEOMETRY-OTHER DATA ENTRY SCREEN

The Nose Geometry-Other data entry screen consists of two popup controls and four push buttons to be used as follows:

Segment 1 popup control - The Segment 1 popup control popup options are the same as those found in the Nose popup control discussed in section 3.2.2.1, with one exception. The "Other" popup option found in the Nose popup control is replaced with the following three options:

- Other Pointed
- Other Blunt
- Other Truncated

The choice of a Segment 1 popup option is mandatory. Choosing either of the "Other" popup options will result in the display of the Nose Geometry-Nose Segment 1 data entry screen. For a discussion of the Nose Geometry-Nose Segment 1 data entry screen, see section 3.2.2.5.2.

(This data corresponds to AP93 variables X(I), R(I).)

Segment 2 popup control - The Segment 2 popup control contains the following options:

- Cone
- Other

The choice of a Segment 2 popup option is mandatory. Choosing the "Cone" popup option will result in the display of the Cone-Nose Segment 2 data entry screen. For a discussion of the Cone-Nose Segment 2 data entry screen, see section 3.2.2.5.3. The Choice of the "Other" popup option will result in the display of the Nose Geometry-Nose Segment 2 data entry screen. The Nose Geometry-Nose Segment 2 data entry screen is similar to the Nose Geometry-Nose Segment 1 data entry screen in format and function (see section 3.2.2.5.2).

(This data corresponds to AP93 variables X(I), R(I).)

OK push button - The OK push button is not enabled until the user completes the data entry for a Nose Segment 1 option and a Nose Segment 2 option. By choosing the OK push button, you are confirming that the options displayed in the popup controls are correct, and data entry is complete. After choosing the OK push button, the AP93 Interface will automatically generate cylindrical coordinate point set pairs associated with a two-section nose that corresponds to the options chosen and the data entered.

Open push button - The Open push button will be enabled only when there are nose geometry files that have been previously saved by the user. The Choice of this push button will result in the display of the Nose Geometry-Open File data entry screen. The user can use the Nose Geometry-Open File data entry screen for opening nose geometry files in exactly the same manner as the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for a Nose Segment 1 option and a Nose Segment 2 option.
- 2) There are nose geometry files that have been previously saved by the user.

The Choice of this push button will result in the display of the Nose Geometry-Save/Delete File data entry screen. The user can use the Nose Geometry-Save/Delete File data entry screen for saving and deleting nose geometry files in exactly the same manner as the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Nose Geometry-Other data entry screen without processing the nose geometry data.

3.2.2.5.2 Nose Geometry-Nose Segment 1 Data Entry Screen. The Nose Geometry-Nose Segment 1 data entry screen is depicted in Figure 17.

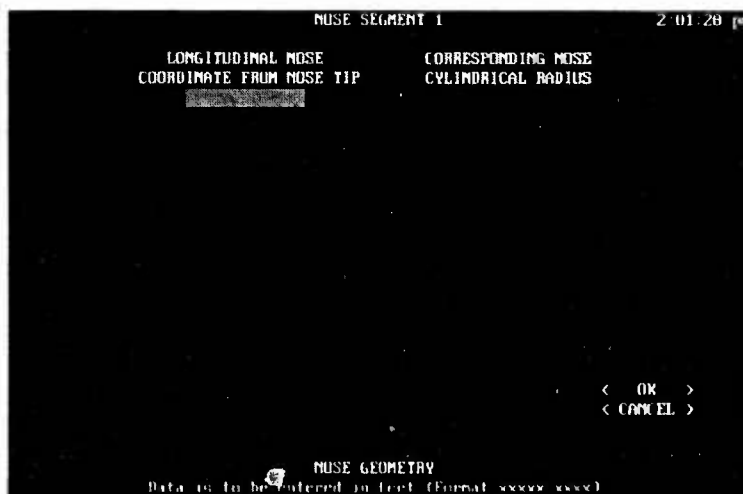


FIGURE 17. NOSE GEOMETRY-NOSE SEGMENT 1 DATA ENTRY SCREEN

The Nose Geometry-Nose Segment 1 data entry screen consists of 20 data fields and two push buttons to be used as follows:

Longitudinal Nose Coordinate From Nose Tip and Corresponding Nose Cylindrical Radius data fields - The Longitudinal Nose Coordinate From Nose Tip and Corresponding Nose Cylindrical Radius data fields allow the user to define the cylindrical coordinate point set pairs associated with the first nose section. These data fields are mandatory, and at least five point set pairs are required. If you entered this data entry screen as a result of choosing the "Other Pointed" popup option, the first point set pair will automatically be set to (0, 0) and will be disabled.

(This data corresponds to AP93 variables X(I), R(I).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push

button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Nose Geometry-Nose Segment 1 data entry screen without processing the nose geometry data.

3.2.2.5.3 Cone-Nose Segment 2 Data Entry Screen. The Cone-Nose Segment 2 data entry screen is depicted in Figure 18.



FIGURE 18. CONE-NOSE SEGMENT 2 DATA ENTRY SCREEN

The Cone-Nose Segment 2 data entry screen consists of 2 data fields and two push buttons to be used as follows:

Longitudinal Nose Coordinate From Nose Tip and Corresponding Nose Cylindrical Radius data fields - The Longitudinal Nose Coordinate From Nose Tip and Corresponding Nose Cylindrical Radius data fields allow the user to define the cylindrical coordinate point set pair necessary to define the second nose section as a conical frustrum. The entry of a point set pair is mandatory.

(This data corresponds to AP93 variables $X(I)$, $R(I)$.)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Cone-Nose Segment 2 data entry screen without processing the nose geometry data.

3.2.2.6 Afterbody Geometry Data Entry Screens

3.2.2.6.1 Afterbody Geometry-Standard Data Entry Screen. The Afterbody Geometry-Standard data entry screen is depicted in Figure 19.



FIGURE 19. AFTERBODY GEOMETRY-STANDARD DATA ENTRY SCREEN

The Afterbody Geometry-Standard data entry screen consists of two data fields and two push buttons to be used as follows:

Longitudinal Afterbody Coordinate From Nose Tip and Corresponding Afterbody Cylindrical Radius data fields - The Longitudinal Afterbody Coordinate From Nose Tip and Corresponding Afterbody Cylindrical Radius data fields allow the user to define the cylindrical coordinate point set pair necessary to define a one section afterbody. Physically, this point set pair is located near the end of the missile, not near the nose. (See Figure 37.) The entry of a point set pair is mandatory.

(This data corresponds to AP93 variables $X(I)$, $R(I)$.)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Afterbody Geometry-Standard data entry screen without processing the afterbody geometry data.

3.2.2.6.2 Afterbody Geometry-Other Data Entry Screen. The Afterbody Geometry-Other data entry screen is depicted in Figure 20.

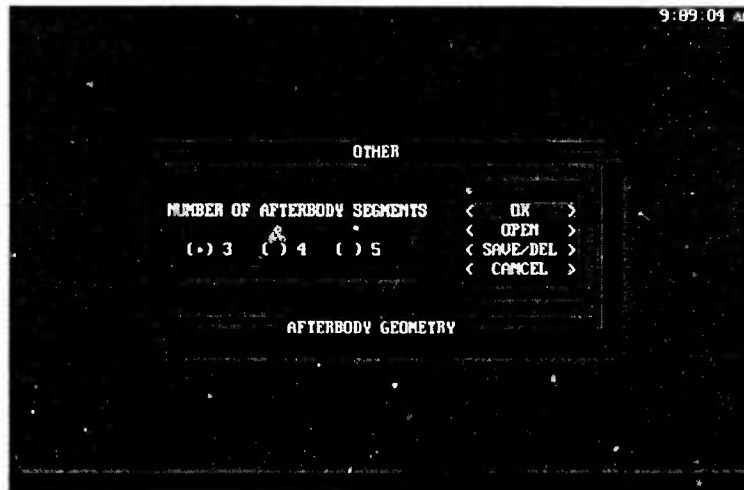


FIGURE 20. AFTERBODY GEOMETRY-OTHER DATA ENTRY SCREEN

The Afterbody Geometry-Other data entry screen consists of a set of radio buttons and four push buttons to be used as follows:

Number Of Afterbody Segments radio buttons - The Number Of Afterbody Segments radio buttons are used to designate the number of sections in the afterbody. The choice of a radio button is mandatory. Choosing a Number Of Afterbody Segments radio button will result in the display of successive Afterbody Geometry-Afterbody Segment data entry screens. The number of data entry screens that will be displayed is equal to the number of afterbody segments that you designate. Each of the Afterbody Geometry-Afterbody Segment data entry screens are similar in format and function. For a discussion of the Afterbody Geometry-Afterbody Segment 1 data entry screen, see section 3.2.2.6.2.1.

(This data corresponds to AP93 variable NH-2.)

OK push button - The OK push button is not enabled until the user has completed entering data for all of the designated afterbody segments via the Afterbody Geometry-Afterbody Segment data entry screens.

Open push button - The Open push button will be enabled only when there are afterbody geometry files that have been previously saved by the user. The Choice of this push button will result in the display of the Afterbody Geometry-Open File data entry screen. The user can use the Afterbody Geometry-Open File data entry screen for opening afterbody geometry files in exactly the same manner as the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for all of the designated afterbody segments.
- 2) There are afterbody geometry files that have been previously saved by the user.

The Choice of this push button will result in the display of the Afterbody Geometry-Save/Delete File data entry screen. The user can use the Afterbody Geometry-Save/Delete File data entry screen for saving and deleting afterbody geometry files in exactly the same manner as the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Afterbody Geometry-Other data entry screen without processing the afterbody geometry data.

3.2.2.6.2.1 Afterbody Geometry-Afterbody Segment 1 Data Entry Screen. The Afterbody Geometry-Afterbody Segment 1 data entry screen is depicted in Figure 21.

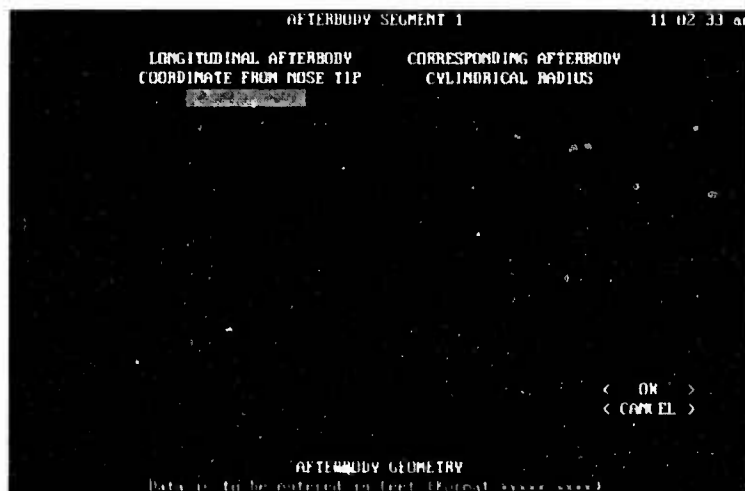


FIGURE 21. AFTERBODY GEOMETRY-AFTERBODY SEGMENT 1 DATA ENTRY SCREEN

The Afterbody Geometry-Afterbody Segment 1 data entry screen consists of 20 data fields and 2 push buttons to be used as follows:

Longitudinal Afterbody Coordinate From Nose Tip and Corresponding Afterbody Cylindrical Radius data fields - The Longitudinal Afterbody Coordinate From Nose Tip and Corresponding Afterbody Cylindrical Radius data fields allow the user to define the cylindrical coordinate point set pairs associated with the first afterbody

section. These data fields are mandatory, and at least five point set pairs are required.

(This data corresponds to AP93 variables X(I), R(I).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Afterbody Geometry-Afterbody Segment 1 data entry screen without processing the afterbody geometry data.

3.2.2.6.3 Afterbody Geometry-Boattail/Flare Data Entry Screen.

The Afterbody Geometry-Boattail/Flare data entry screen is depicted in Figure 22.



FIGURE 22. AFTERBODY GEOMETRY-BOATTAIL/FLARE DATA ENTRY SCREEN

The Afterbody Geometry-Boattail/Flare data entry screen consists of two data fields and two push buttons to be used as follows:

Longitudinal Boattail/Flare Coordinate From Nose Tip and Corresponding Boattail/Flare Cylindrical Radius data fields - The Longitudinal Boattail/Flare Coordinate From Nose Tip and Corresponding Boattail/Flare Cylindrical Radius data fields allow the user to define the cylindrical coordinate point set pair necessary to define a boattail/flare. The entry of a point set pair is mandatory.

(This data corresponds to AP93 variables X(I), R(I).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Afterbody Geometry-Boattail/Flare data entry screen without processing the boattail/flare geometry data.

3.2.2.7 Tail Geometry Data Entry Screens

3.2.2.7.1 Tail Geometry-Double-Wedge Airfoil Data Entry Screen. The Tail Geometry-Double-Wedge Airfoil data entry screen is depicted in Figure 23.

```

DOUBLE WEDGE AIRFOIL
NUMBER OF FINS      LEADING EDGE SWEEP ANGLE:      SEMISPAN:
( ) 4               ROOT CHORD:                          TIP CHORD:
( ) 2               LEADING EDGE CYLINDRICAL RADIUS AT ROOT CHORD:
                   TRAILING EDGE CYLINDRICAL RADIUS AT ROOT CHORD:
THICKNESS AT ROOT CHORD:      THICKNESS AT TIP:
DISTANCE FROM LEADING EDGE TO FIRST DISCONTINUITY
DOWNSTREAM AT THE ROOT CHORD:
DISTANCE FROM LEADING EDGE TO FIRST DISCONTINUITY
UPSTREAM AT THE ROOT CHORD:
LEADING EDGE RADIUS AT TIP:
TRAILING EDGE RADIUS AT TIP:
                   < OK >
                   < OPEN >
                   < NAME ALL >
                   < CANCEL >
TAIL GEOMETRY
  
```

FIGURE 23. TAIL GEOMETRY-DOUBLE-WEDGE AIRFOIL DATA ENTRY SCREEN

The Tail Geometry-Double-Wedge Airfoil data entry screen consists of a set of radio buttons, 12 data fields and 4 push buttons to be used as follows:

Number Of Fins radio buttons - The Number Of Fins radio buttons are used to designate the number of fins on the tail. The choice of a radio button is not mandatory. Four fins is the default.

(This data corresponds to AP93 variable NW.)

Leading Edge Sweep Angle data field - The entry of data into the Leading Edge Sweep Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable GAW(1).)

Semispan data field - The entry of data into the Semispan data field is mandatory.

(This data corresponds to AP93 variable BW/2.)

Root Chord data field - The entry of data into the Root Chord data field is mandatory.

(This data corresponds to AP93 variable CRW.)

Tip Chord data field - The entry of data into the Tip Chord data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable CTW.)

Leading Edge Cylindrical Radius At Root Chord data field - The entry of data into the Leading Edge Cylindrical Radius At Root Chord data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable RRW.)

Trailing Edge Cylindrical Radius At Root Chord data field - The entry of data into the Trailing Edge Cylindrical Radius At Root Chord data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable RTEW.)

Thickness At Root Chord data field - The entry of data into the Thickness At Root Chord data field is mandatory, and is initialized to five one-hundredths (.05) of the value entered for the Root Chord.

(This data corresponds to AP93 variable TRW.)

Thickness At Tip Chord data field - The entry of data into the Thickness At Tip Chord data field is mandatory, and is initialized to five one-hundredths (.05) of the value entered for the Tip Chord.

(This data corresponds to AP93 variable TTW.)

Distance From Leading Edge To First Discontinuity Downstream At The Root Chord data field - The entry of data into the Distance From Leading Edge To First Discontinuity Downstream At The Root Chord data field is mandatory.

(This data corresponds to AP93 variable CRIW.)

Distance From Trailing Edge To First Discontinuity Upstream At The Root Chord data field - The entry of data into the Distance From Leading Edge To First Discontinuity Upstream At The Root Chord data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable CR2W.)

Leading Edge Radius At Tip data field - The entry of data into the Leading Edge Radius At Tip data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable RTW.)

Trailing Edge Radius At Tip data field - The entry of data into the Trailing Edge Radius At Tip data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable RTEW1.)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Open push button - The Open push button will be enabled only when there are tail geometry-double-wedge airfoil files that have been previously saved by the user. The choice of this push button will result in the display of the Tail Geometry-Open File data entry screen. The user can use the Tail Geometry-Open File data entry screen for opening tail geometry-double-wedge airfoil files in exactly the same manner as the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for the mandatory data fields.
- 2) There are tail geometry-double-wedge airfoil files that have been previously saved by the user.

The Choice of this push button will result in the display of the Tail Geometry-Save/Delete File data entry screen. The user can use the Tail Geometry-Save/Delete File data entry screen for saving and deleting tail geometry-double-wedge airfoil files in exactly the same manner as the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Tail Geometry-Double-Wedge Airfoil data entry screen without processing the tail geometry-double-wedge airfoil data.

3.2.2.7.2 Tail Geometry-Biconvex Airfoil Data Entry Screen. The Tail Geometry-Biconvex Airfoil data entry screen is depicted in Figure 24.


```

6:35:13 pm
BICONVEX AIRFOIL
NUMBER OF FINS      LEADING EDGE SWEEP ANGLE:      SEMISPAN:
( ) 4
( ) 2
ROOT CHORD:
LEADING EDGE CYLINDRICAL RADIUS AT ROOT CHORD:
TRAILING EDGE CYLINDRICAL RADIUS AT ROOT CHORD:
THICKNESS AT ROOT CHORD:
<  OK  >
<  OPEN  >
< SAVE/DEL  >
<  CANCEL  >
TAIL GEOMETRY

```

FIGURE 24. TAIL GEOMETRY-BICONVEX AIRFOIL DATA ENTRY SCREEN

The Tail Geometry-Biconvex Airfoil data entry screen consists of a set of radio buttons, seven data fields and four push buttons to be used as follows:

Number Of Fins radio buttons - See the discussion of the Number Of Fins radio buttons in section 3.2.2.7.1.

Leading Edge Sweep Angle data field - See the discussion of the Leading Edge Sweep Angle data field in section 3.2.2.7.1.

Semispan data field - See the discussion of the Semispan data field in section 3.2.2.7.1.

Root Chord data field - See the discussion of the Root Chord data field in section 3.2.2.7.1.

Tip Chord data field - See the discussion of the Tip Chord data field in section 3.2.2.7.1.

Leading Edge Cylindrical Radius At Root Chord data field - See the discussion of the Leading Edge Cylindrical Radius At Root Chord data field in section 3.2.2.7.1.

Trailing Edge Cylindrical Radius At Root Chord data field - See the discussion of the Trailing Edge Cylindrical Radius At Root Chord data field in section 3.2.2.7.1.

Thickness At Root Chord data field - See the discussion of the Thickness At Root Chord data field in section 3.2.2.7.1.

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push

button, the AP93 Interface will determine if all mandatory data items have been entered.

Open push button - The Open push button will be enabled only when there are tail geometry-biconvex airfoil files that have been previously saved by the user. The Choice of this push button will result in the display of the Tail Geometry-Open File data entry screen. The user can use the Tail Geometry-Open File data entry screen for opening tail geometry-biconvex airfoil files in exactly the same manner as the Configuration-Open File data entry screen is used for opening aeroprediction configuration files. See section 3.2.1.1 for a discussion on the use of the Configuration-Open File data entry screen.

Save/Delete push button - The Save/Delete push button will be enabled only when either of the following two conditions are met:

- 1) The user has completed the data entry for the mandatory data fields.
- 2) There are tail geometry-double-wedge airfoil files that have been previously saved by the user.

The Choice of this push button will result in the display of the Tail Geometry-Save/Delete File data entry screen. The user can use the Tail Geometry-Save/Delete File data entry screen for saving and deleting tail geometry-biconvex airfoil files in exactly the same manner as the Configuration-Save/Delete File data entry screen is used for saving and deleting aeroprediction configuration files. See section 3.2.1.2 for a discussion on the use of the Configuration-Save/Delete File data entry screen.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Tail Geometry-Biconvex Airfoil data entry screen without processing the tail geometry-biconvex airfoil data.

3.2.3 Free-Stream Conditions Data Entry Screens

3.2.3.1 Free-stream Conditions-Alpha Sweep Data Entry Screen

The Free-Stream Conditions-Alpha Sweep data entry screen is depicted in Figure 25.

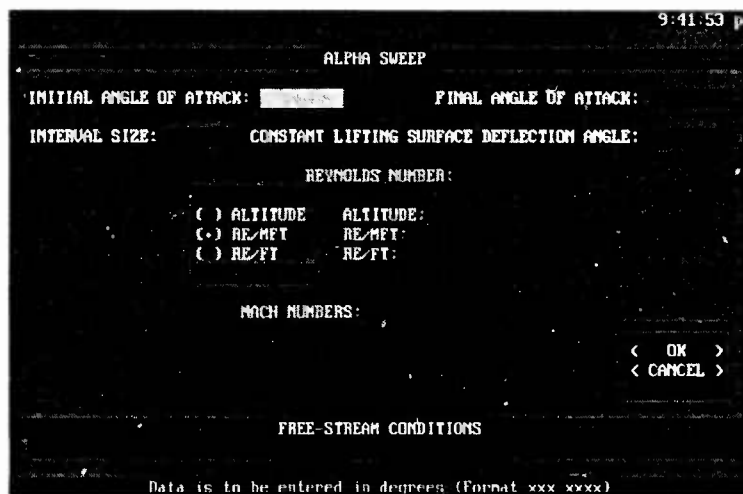


FIGURE 25. FREE-STREAM CONDITIONS-ALPHA SWEEP
DATA ENTRY SCREEN

The Free-Stream Conditions-Alpha Sweep data entry screen consists of a set of radio buttons, four data fields, and two push buttons to be used as follows:

Initial Angle Of Attack data field - The entry of data into the Initial Angle Of Attack data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable AL.)

Final Angle Of Attack data field - The entry of data into the Final Angle Of Attack data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable AL.)

Interval Size data field - The entry of data into the Interval Size data field is mandatory. The number entered into this data field represents the incremental step size between each successive angle of attack in the sweep. If the interval size is not evenly divisible into the angle of attack range (Final Angle Of Attack - Initial Angle Of Attack), then the last angle of attack is set equal to the Final Angle Of Attack. The maximum number of angles of attack that are computed automatically by the AP93 Interface based upon the Interval Size is 20.

(This data corresponds to AP93 variable AL.)

Constant Lifting Surface Deflection Angle data field - This data entry field is activated only when the chosen geometry type is a canard/wing-body-tail or a body-tail. The number entered into this data field represents a fin deflection angle relative to the missile body axis. The entry of data into the Constant Lifting Surface Deflection Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Reynolds Number radio buttons - This set of radio buttons becomes activated only after the user has completed inputting data into the Initial Angle Of Attack, Final Angle Of Attack, Interval Size, and Constant Lifting Surface Deflection Angle (if activated) data fields. The selection of a Altitude, RE/MFT, or RE/FT radio button will activate a corresponding data entry field. The RE/MFT radio button is selected as a default. The user must enter data into one of these data fields. After data is entered into one of the fields, the Mach Numbers data entry fields become activated. A brief description of each radio button type is now given.

Altitude radio button - The user can specify a constant altitude at which the desired sweep will occur. The chosen altitude must be positive and no greater than 250000 feet. A Reynolds Number/Mach/Foot is computed automatically based upon standard atmospheric data at the designated altitude.

RE/MFT radio button - The user can directly specify a value of Reynolds Number/Mach/Foot which will be held constant over the desired sweep.

RE/FT radio button - The user can specify a value of Reynolds Number/Foot. Values of Reynolds Number/Mach/Foot are computed automatically based upon values of Mach numbers which are to be entered in the Mach Numbers data fields. It should be noted that due to the limited number of cases that AP93 can process during a single run, and depending upon the number of sweep values to be run, use of the RE/FT radio button may limit the number of Mach Numbers data entry fields.

(This data corresponds to AP93 variable RMF.)

Mach Numbers data fields - These data fields become activated only after the user has selected a Reynolds Number radio button and has entered data into the corresponding Reynolds Number data field. If the user has selected the Altitude or RE/MFT radio buttons, then there will be 20 activated Mach Number data fields. If the user has selected the RE/FT radio button, then the number of activated Mach Number data fields may be limited and will be computed automatically based upon the specified sweep parameters. The entry of at least one positive value into the Mach Number data fields is mandatory. A negative value for the Mach number should not be used.

(This data corresponds to AP93 variable AM(MN).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Alpha Sweep data entry screen without processing the free-stream conditions-alpha sweep data.

3.2.3.2 Free-stream Conditions-Delta Sweep Data Entry Screen

The Free-Stream Conditions-Delta Sweep data entry screen is depicted in Figure 26.

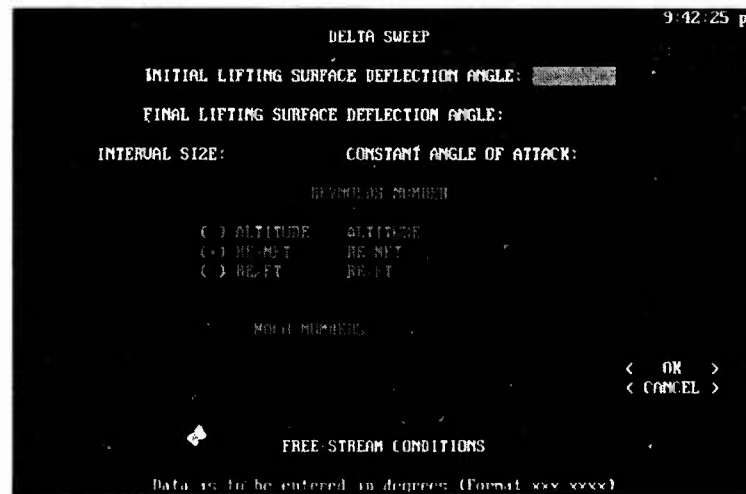


FIGURE 26. FREE-STREAM CONDITIONS-DELTA SWEEP DATA ENTRY SCREEN

The Free-Stream Conditions-Delta Sweep data entry screen consists of a set of radio buttons, four data fields, and two push buttons to be used as follows:

Initial Lifting Surface Deflection Angle data field - The entry of data into the Initial Lifting Surface Deflection Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Final Lifting Surface Deflection Angle data field - The entry of data into the Final Lifting Surface Deflection Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Interval Size data field - The entry of data into the Interval Size data field is mandatory. The number entered into this data field represents the incremental step size between each successive fin deflection angle in the sweep. If the interval size is not evenly divisible into the fin deflection range (Final Lifting Surface Deflection Angle - Initial Lifting Surface Deflection Angle), then the last fin deflection angle is set equal to the Final Lifting Surface Deflection Angle. The maximum number of fin

deflection angles that are computed automatically by the AP93 Interface based upon the Interval Size is 20.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Constant Angle Of Attack data field - The entry of data into the Constant Angle Of Attack data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable AL.)

Reynolds Number radio buttons - See the discussion of the Reynolds Number radio buttons in section 3.2.3.1.

Mach Numbers data fields - See the discussion of the Mach Numbers data fields in section 3.2.3.1.

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Delta Sweep data entry screen without processing the free-stream conditions-delta sweep data.

3.2.3.3 Free-stream Conditions-Altitude Sweep Data Entry Screen

The Free-Stream Conditions-Altitude Sweep data entry screen is depicted in Figure 27.



FIGURE 27. FREE-STREAM CONDITIONS-ALTITUDE SWEEP DATA ENTRY SCREEN

The Free-Stream Conditions-Altitude Sweep data entry screen consists of five data fields, a Mach Number data field array, and two push buttons to be used as follows:

Initial Altitude data field - The entry of data into the Initial Altitude data field is not mandatory. A value of zero is entered as the default. The value used for the Initial Altitude should be less than the value used for the Final Altitude.

(This data is related to AP93 variable RMF.)

Final Altitude data field - The entry of data into the Final Altitude data field is mandatory. The value used for the Final Altitude should be greater than the value used for the Initial Altitude.

(This data is related to AP93 variable RMF.)

Interval Size data field - The entry of data into the Interval Size data field is mandatory. The number entered into this data field represents the incremental step size between each successive altitude in the sweep. If the interval size is not evenly divisible into the altitude range (Final Altitude - Initial Altitude), then the last altitude value is set equal to the Final Altitude. The maximum number of altitudes that are computed automatically by the AP93 Interface based upon the Interval Size is 20. A positive value for the Interval Size should be used.

(This data is related to AP93 variable RMF.)

Constant Angle Of Attack data field - The entry of data into the Constant Angle Of Attack data field is not mandatory. A value of zero is entered as the default.

(This data is related to AP93 variable AL.)

Constant Lifting Surface Deflection Angle data field - This data entry field is only activated when the chosen geometry type is a canard/wing-body-tail or a body-tail. The number entered into this data field represents a fin deflection angle relative to the missile body axis. The entry of data into the Constant Lifting Surface Deflection Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Mach Numbers data fields - The entry of at least one positive value into the Mach Numbers data field is mandatory. A negative value for the Mach number should not be used.

(This data corresponds to AP93 variable AM(MN).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push

button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Delta Sweep data entry screen without processing the free-stream conditions-altitude sweep data.

3.2.3.4 Free-stream Conditions-Mach Sweep Data Entry Screen

The Free-Stream Conditions-Mach Sweep data entry screen is depicted in Figure 28.

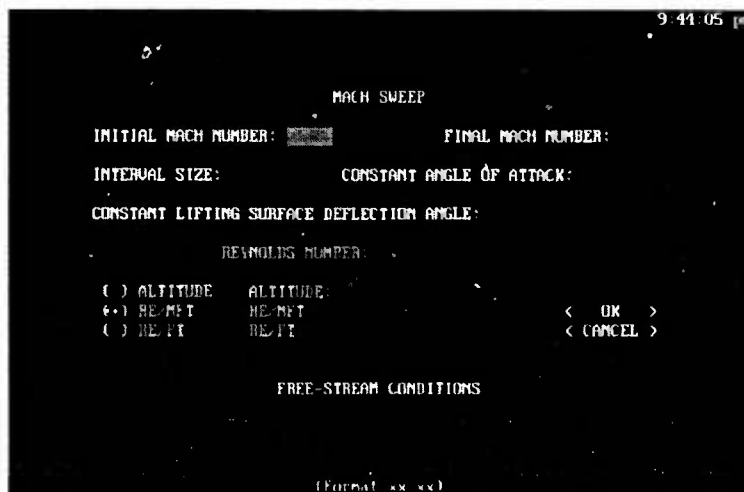


FIGURE 28. FREE-STREAM CONDITIONS-MACH SWEEP DATA ENTRY SCREEN

The Free-Stream Conditions-Mach Sweep data entry screen consists of five data fields, a set of radio buttons, and two push buttons to be used as follows:

Initial Mach Number data field - The entry of data into the Initial Mach Number data field is mandatory. The value entered into the data field should be positive and should be less than the value of the Final Mach Number.

(This data corresponds to AP93 variable AM(MN).)

Final Mach Number data field - The entry of data into the Final Mach Number data field is mandatory. The value entered into the data field should be positive and should be greater than the value of the Initial Mach Number.

(This data corresponds to AP93 variable AM(MN).)

Interval Size data field - The entry of data into the Interval Size data field is mandatory. The number entered into this data field represents the incremental step size between each successive Mach number in the sweep. If the interval size is not evenly divisible into the Mach range (Final Mach Number - Initial Mach Number),

then the last Mach number value is set equal to the Final Mach Number. The maximum number of Mach numbers that are computed automatically by the AP93 Interface based upon the Interval Size is 20. A positive value for the Interval Size should be used.

(This data corresponds to AP93 variable AM(MN).)

Constant Angle Of Attack data field - The entry of data into the Constant Angle Of Attack data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable AL.)

Constant Lifting Surface Deflection Angle data field - This data entry field is activated only when the chosen geometry type is a canard/wing-body-tail or a body-tail. The number entered into this data field represents a fin deflection angle relative to the missile body axis. The entry of data into the Constant Lifting Surface Deflection Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Reynolds Number radio buttons - See the discussion of the Reynolds Number radio buttons in section 3.2.3.1.

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Mach Sweep data entry screen without processing the free-stream conditions-Mach sweep data.

3.2.3.5 Free-stream Conditions-Other Data Entry Screen

The Free-Stream Conditions-Other data entry screen is depicted in Figure 29. It is useful to choose this free-stream condition type when the desired run matrix is nonuniform or does not lend itself to a particular type of sweep.

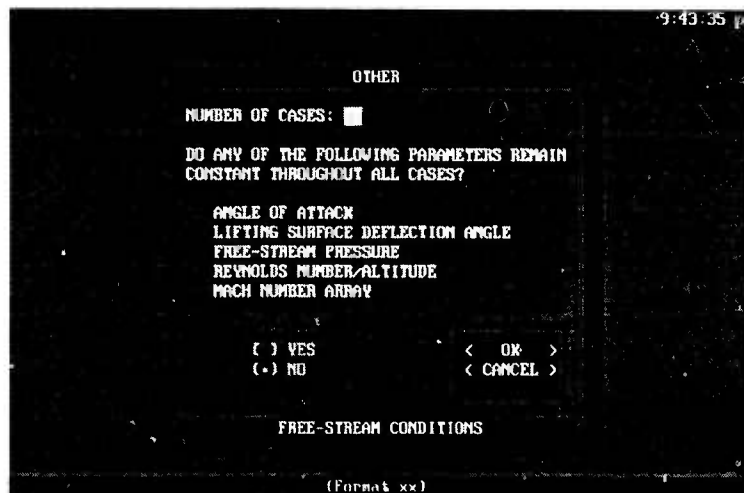


FIGURE 29. FREE-STREAM CONDITIONS-OTHER DATA ENTRY SCREEN

The Free-Stream Conditions-Other data entry screen consists of one data field, a set of radio buttons, and two push buttons to be used as follows:

Number Of Cases data field - The entry of data into the Number Of Cases data field is mandatory. The maximum number of cases is 20.

(This data corresponds to AP93 variable M.)

Specify Constant Parameters radio buttons - The Specify Constant Parameters radio buttons are enabled when the user completes data input to the Number Of Cases data field. The choice of a Specify Constant Parameters radio button is not mandatory. The "No" radio button is selected as the default. By selecting the "Yes" radio button, the user will be able to specify the values of any parameters which are constant throughout the run matrix. This allows the user to avoid the repetitive entry of data parameters which are constant.

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Other data entry screen without processing the free-stream conditions-Other data.

3.2.3.5.1 Free-Stream Conditions-Other (for constants) Data Entry Screen. The Free-Stream Conditions-Other (for constants) data entry screen is depicted in Figure 30. In order to gain access to this data entry screen, the user must select the "Yes" Specify

Constant Parameters radio button. See section 3.2.3.5 for a discussion on the Specify Constant Parameters radio buttons.

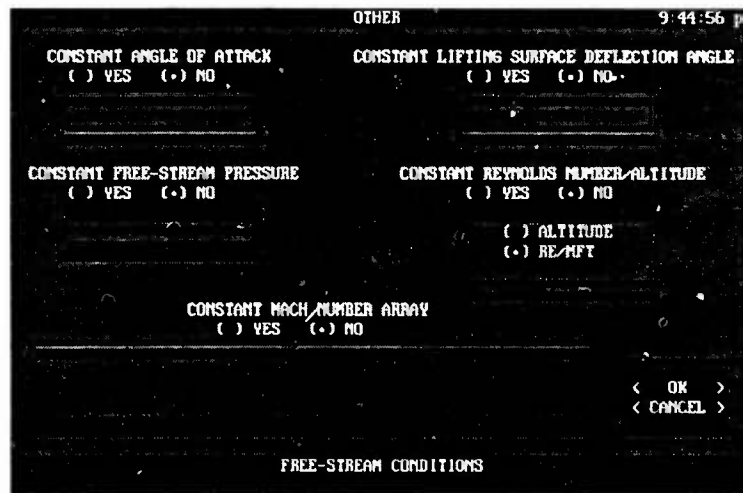


FIGURE 30. FREE-STREAM CONDITIONS-OTHER (FOR CONSTANTS) DATA ENTRY SCREEN

The Free-Stream Conditions-Other (for constants) data entry screen consists of five sets of radio buttons, and two push buttons to be used as follows:

Constant Angle Of Attack radio buttons - The choice of a Constant Angle Of Attack radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will enable a data field into which the user can enter a Constant Angle Of Attack value.

(This data corresponds to AP93 variable AL.)

Constant Lifting Surface Deflection Angle radio buttons - The Constant Lifting Surface Deflection Angle radio buttons are enabled only for canard/wing-body-tail and body-tail geometry types. The choice of a Constant Lifting Surface Deflection Angle radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will enable a data field into which the user can enter a Constant Lifting Surface Deflection Angle value.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Constant Free-Stream Pressure radio buttons - The choice of a Constant Free-Stream Pressure radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will enable a data field into which the user can enter a Constant Free-Stream Pressure value.

(This data corresponds to AP93 variable PIN.)

Constant Reynolds Number/Altitude radio buttons - The choice of a Constant Reynolds Number/Altitude radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will enable a second tier set of radio buttons and a data entry field. There are two radio buttons in this second tier:

(1) Altitude radio button - By selecting this second tier radio button, the user can specify a constant altitude to be used for all cases in the run matrix. The specified altitude must be positive and no greater than 250,000 feet. A Reynolds Number/Mach/Foot is computed automatically based upon standard atmospheric data at the designated altitude.

(2) RE/MFT radio button - By selecting this second tier radio button, the user can directly specify a value of Reynolds Number/Mach/Foot, which will be held constant for all cases in the run matrix.

Selection of a second tier radio button is not mandatory, and the RE/MFT radio button is selected as a default.

(This data corresponds to AP93 variable RMF.)

Constant Mach Number Array radio buttons - The choice of a Constant Mach Number Array radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will enable an array of data fields into which the user can enter a set of values to be used as a Constant Mach Number Array. The user must enter at least one value into the Constant Mach Number Array. A negative Mach number value should not be used.

(This data corresponds to AP93 variable AM(MN).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. If no data has been entered into the Free-Stream Conditions-Other (for constants) data screen, then no free-stream parameters will be held constant automatically.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Other (for constants) data entry screen without processing the free-stream conditions-Other (for constants) data.

3.2.3.5.2 Free-Stream Conditions-Other (for variables) Data Entry Screen. The Free-Stream Conditions-Other (for variables) Data Entry Screen is depicted in Figure 31. The user must select the "OK" push button on the Free-Stream Conditions-Other data entry screen as a prerequisite to gaining access to the Free-Stream Conditions-Other (for variables) data screen. See section 3.2.3.5 for a discussion on the Free-Stream Conditions-Other data entry screen. When the user completes the entry of data into the Free-Stream Conditions-Other (for variables) data entry screen, another empty data screen will be displayed until the free-stream data for each case has been input.

OTHER 9:45:46

CASE NUMBER: 1

ANGLE OF ATTACK: FREE-STREAM PRESSURE:

LIFTING SURFACE DEFLECTION ANGLE:

REYNOLDS NUMBER:

ALTITUDE ALTITUDE:

RE/MFT RE/MFT:

MACH NUMBERS:

FREE-STREAM CONDITIONS

< OK >

< CANCEL >

Data is to be entered in degrees (Format xxx xxx) *

FIGURE 31. AEROPREDICTION-OPTIONS DATA ENTRY SCREEN

The Free-Stream Conditions-Other (for variables) data entry screen consists of three data fields, a set of radio buttons, a Mach number data field array, and two push buttons to be used as follows:

Angle Of Attack data field - This data field is always enabled unless the user has specified a Constant Angle Of Attack in the Free-Stream Conditions-Other (for constants) data entry screen (see section 3.2.3.5.1). The entry of data into the Angle Of Attack data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable AL.)

Free-Stream Pressure data field - This data field is always enabled unless the user has specified a Constant Free-Stream Pressure in the Free-Stream Conditions-Other (for constants) data entry screen (see section 3.2.3.5.1). The entry of data into the Free-Stream Pressure data field is not mandatory. A default value will be computed based upon altitude data.

(This data corresponds to AP93 variable PIN.)

Lifting Surface Deflection Angle data field - This data field will only be enabled for canard/wing-body-tail and body-tail geometry types as long as the user has not specified a Constant Lifting Surface Deflection Angle in the Free-Stream Conditions-Other (for constants) data entry screen (see section 3.2.3.5.1). The entry of data into the Lifting Surface Deflection Angle data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable DELTAW or DELTAC.)

Reynolds Number radio buttons - This set of radio buttons is always enabled unless the user has specified a Constant Reynolds Number/Altitude in the Free-Stream Conditions-Other (for constants) data entry screen (see section 3.2.3.5.1). The choice of a Reynolds Number radio button is not mandatory. The RE/MFT Reynolds Number radio button is selected as the default. The selection of either the Altitude radio button or RE/MFT radio button will activate a corresponding data entry field. The user must enter data into one of these fields. A brief description of each radio button type is now given.

Altitude radio button - By selecting this radio button, the user can specify a desired altitude, which is to be used for the current case in the run matrix. The specified altitude must be positive and no greater than 250,000 feet. A Reynolds Number/Mach/Foot is computed automatically based upon standard atmospheric data at the designated altitude.

RE/MFT radio button - By selecting this radio button, the user can directly specify a value of Reynolds Number/Mach/Foot which is to be used for the current case in the run matrix.

(This data corresponds to AP93 variable RMF.)

Mach Numbers data fields - The Mach Numbers data fields will always be enabled unless the user has specified a Constant Mach Number Array in the Free-Stream Conditions-Other (for constants) data entry screen (see section 3.2.3.5.1). The entry of at least one positive value into the Mach Numbers data field is mandatory. A negative value for the Mach number should not be used.

(This data corresponds to AP93 variable AM(MN).)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Free-Stream Conditions-Other (for variables) data entry screen without processing the free-stream conditions-Other (for variables) data.

3.2.4 Options Data Entry Screens

3.2.4.1 Aeroprediction-Options Data Entry Screen

The Aeroprediction-Options data entry screen is depicted in Figure 32.

OPTIONS 94:17:59

DYNAMIC DERIVATIVES TRANSONIC NORMAL FORCE SPIN STABILIZED GAS COMPUTATIONS
 YES (.) NO YES (.) NO YES (.) NO REAL (.) PERFECT

PRESSURE COEFFICIENTS PRINTING

PRESSURE COEFFICIENTS, STRIP NORMAL FORCES, AEROTHERMAL INFORMATION
 NO LOADING OR AEROTHERMAL INFORMATION
 STRUCTURES OPTION

MACH NUMBER DIVIDING METHODS USED FOR LIFT ON LIFTING SURFACES: _____
 MACH NUMBER DIVIDING LOW AND HIGH SUPERSONIC COMPUTATIONS: _____

FREE-STREAM PRESSURE: _____
 DIAMETER OF NOZZLE AT EXIT PLANE (POWER ON/OFF): _____

TITLE: _____

AEROPREDICTION

Data is to be entered in lbs/sq. ft. (Format xxxxx xxx)

FIGURE 32. AEROPREDICTION-OPTIONS DATA ENTRY SCREEN

The Aeroprediction-Options data entry screen consists of five sets of radio buttons, five data fields, and two push buttons to be used as follows:

Dynamic Derivatives radio buttons - The choice of a Dynamic Derivatives radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will result in the computation of dynamic derivatives.

(This data corresponds to AP93 variable NDYM.)

Transonic Normal Force radio buttons - The choice of a Transonic Normal Force radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button will result in the computation of NEAR transonic normal force.

(This data corresponds to AP93 variable NSWTCH.)

Spin Stabilized radio buttons - The Spin Stabilized radio button is enabled only for body alone geometry types. The choice of a Spin Stabilized radio button is not mandatory. The "No" radio button is selected as the default. Selecting the "Yes" radio button indicates that the body alone geometry is spin stabilized.

(This data corresponds to AP93 variable ISPIN.)

Gas Computations radio buttons - The Gas Computations radio buttons will be enabled unless an altitude sweep has been chosen for the free-stream conditions. The choice of a Gas Computations radio button is not mandatory. The "Perfect" radio button is selected as the default. If this radio button is chosen, then computations will be performed with perfect gas assumptions. Selecting the "Real" radio button will result in the display of the Aeroprediction-Real-Gas Option Data data entry screen.

See section 3.2.4.1.1 for a discussion on the use of the Aeroprediction-Real-Gas Option Data data entry screen.

(This data corresponds to AP93 variable IGAS.)

Pressure Coefficients Printing radio buttons - The choice of a Pressure Coefficients Printing radio button is not mandatory. The "No Loading Or Aerothermal Information" radio button is selected as the default. A brief description of each radio button is as follows:

Pressure Coefficients, Strip Normal Forces, Aerothermal Information radio button - Selecting this radio button will result in the printing of pressure coefficients, strip normal forces, and aerothermal information to the output file.

No Loading Or Aerothermal Information radio button - If this radio button is selected, then no loading or aerothermal information is printed out in the output file.

Structures Option radio button - Selection of this radio button will activate the structures option. If the user has chosen an altitude sweep in the free-stream conditions, this radio button will not be enabled.

(This data corresponds to AP93 variable IPRINT.)

Mach Number Dividing Methods Used For Lift On Lifting Surfaces data field - The entry of data into this data field is not mandatory. A default value is computed automatically by adding 1.0 to the highest Mach number entered in the free-stream conditions.

(This data corresponds to AP93 variable ALIM.S.)

Mach Number Dividing Low And High Supersonic Computations data field - The entry of data into this field is not mandatory. If no value is entered, then the code will automatically compute a value based on the ALIMIT logic described in section 4.3. If a value is entered, it should not be below $M_\infty = 1.6$ or greater than 3.0. The higher value should be used only for more slender nose shapes.

(This data corresponds to AP93 variable ALIM.T.)

Free-Stream Pressure data field - The entry of data into this field is not mandatory. A default value for the free-stream pressure is found based upon altitude by using standard atmospheric data tables. If no altitude data was entered in the free-stream conditions, then standard sea level pressure is assumed.

(This data corresponds to AP93 variable PINF.)

Diameter Of Nozzle At Exit Plane (Power On/Off) data field - This data field is not enabled for wing-alone geometry types. Entry of data into this data field is not mandatory. A value of .01 is used as a default. Selecting a value greater than .1 will result in the display of the Aeroprediction-Power-On Option Data data entry screen. See section 3.2.4.1.2 for a discussion on the Aeroprediction-Power-On Option Data data screen.

(This data corresponds to AP93 variable DJ.)

Title data field - The entry of a title into this data field is mandatory.

(This data corresponds to AP93 CARD TYPE III.)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Options Data data entry screen without processing the data from the Aeroprediction-Options Data.

3.2.4.1.1 Aeroprediction-Real-Gas Option Data Data Entry Screen. The Aeroprediction-Real-Gas Option Data data entry screen is depicted in Figure 33. In order to gain access to this data screen, the user must choose the "Real" radio button in the Gas Computations radio box in the Aeroprediction-Options data screen. See section 3.2.4.1 for a discussion on the Gas Computations radio buttons.

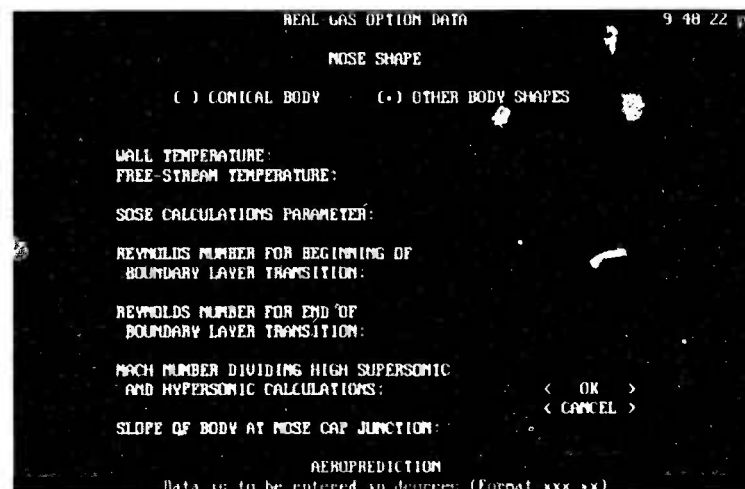


FIGURE 33. AEROPREDICTION-REAL-GAS OPTION DATA DATA ENTRY SCREEN

The Aeroprediction-Real-Gas Option Data data entry screen consists of a set of radio buttons, seven data fields, and two push buttons to be used as follows:

Nose Shape radio buttons - The choice of a Nose Shape radio button is not mandatory. The "Other Body Shapes" radio button is selected as the default.

(This data corresponds to AP93 variable INOSE.)

Wall Temperature data field - The entry of data into the Wall Temperature data field is mandatory.

(This data corresponds to AP93 variable TW.)

Free-Stream Temperature data field - The entry of data into the Free-Stream Temperature data field is not mandatory. A default value for the free-stream temperature is found based upon altitude by using standard atmospheric data tables. If no altitude data was entered in the free-stream conditions, then standard sea level temperature is assumed.

(This data corresponds to AP93 variable TINF.)

SOSE Calculations Parameter data field - The entry of data into the SOSE Calculations Parameter data field is not mandatory. A value of zero is entered as the default.

(This data corresponds to AP93 variable ETAP.)

Reynolds Number For Beginning Of Boundary Layer Transition data field - The entry of data into the Reynolds Number For Beginning Of Boundary Layer Transition data field is not mandatory. A value of 500,000 is entered as the default.

(This data corresponds to AP93 variable RNLWR.)

Reynolds Number For End Of Boundary Layer Transition data field - The entry of data into the Reynolds Number For End Of Boundary Layer Transition data field is not mandatory. A value of 1,000,000 is entered as the default.

(This data corresponds to AP93 variable RNUPR.)

Mach Number Dividing High Supersonic And Hypersonic Calculations data field - The entry of data into the Mach Number Dividing High Supersonic And Hypersonic Calculations data field is not mandatory. A value of 6.0 is entered as the default.

(This data corresponds to AP93 variable AMHIGH.)

Slope Of Body At Nose Cap Junction data field - The entry of data into the Slope Of Body At Nose Cap Junction data field is not mandatory. A value of 10 degrees is

entered as the default. Note that the value entered in this data field should be at least 6 degrees.

(This data corresponds to AP93 variable CONANG.)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Real-Gas Option Data data entry screen without processing the Aeroprediction-Real-Gas Options Data data.

3.2.4.1.2 Aeroprediction-Power-On Option Data Data Entry Screen. The Aeroprediction-Power-On Option Data data entry screen is depicted in Figure 34. In order to gain access to this data screen, the user must enter a value of greater than .1 in the Diameter Of Nozzle At Exit Plane (Power On/Off) data field in the Aeroprediction-Options data screen. See section 3.2.4.1 for a discussion on the Diameter Of Nozzle At Exit Plane (Power On/Off) data field.

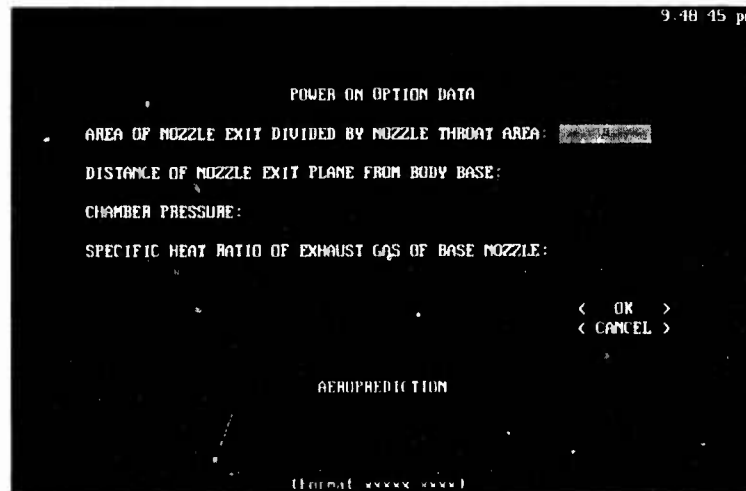


FIGURE 34. AEROPREDICTION-POWER-ON OPTION DATA DATA ENTRY SCREEN

The Aeroprediction-Power-On Option Data data entry screen consists of four data fields and two push buttons to be used as follows:

Area Of Nozzle Exit Divided By Nozzle Throat Area data field - The entry of data into the Area Of Nozzle Exit Divided By Nozzle Throat Area data field is mandatory.

(This data corresponds to AP93 variable AJ.)

Distance Of Nozzle Exit Plane From Body Base data field - The entry of data into the Distance Of Nozzle Exit Plane From Body Base data field is mandatory.

(This data corresponds to AP93 variable XJ.)

Chamber Pressure data field - The entry of data into the Chamber Pressure data field is mandatory.

*(This data corresponds to AP93 variable PC*PINF.)*

Specific Heat Ratio Of Exhaust Gas Of Base Nozzle data field - The entry of data into the Specific Heat Ratio Of Exhaust Gas Of Base Nozzle data field is mandatory.

(This data corresponds to AP93 variable GAMJ.)

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that data entry is complete. After choosing the OK push button, the AP93 Interface will determine if all mandatory data items have been entered.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Power-On Option Data data entry screen without processing the Aeroprediction-Power-On Options Data data.

3.2.5 Aeroprediction-Plot Selection Data Entry Screen

The Aeroprediction-Plot Selection data entry screen is depicted in Figure 35.



FIGURE 35. AEROPREDICTION-PLOT SELECTION DATA ENTRY SCREEN

The Aeroprediction-Plot Selection data entry screen consists of a list, a data field, a set of radio buttons, and two push buttons to be used as follows:

Select Data To Be Plotted list - The user can choose the type of plot to be generated from this list. The choices displayed in the list will depend upon the users choice of the free-stream conditions.

Selected Data data field - The Selected Data data field is not enabled (i.e., data cannot be entered into this field by the user). When a plot type is chosen from the Select Data To Be Plotted list, the plot type will appear in the Selected Data data field.

Single/Multiple Curves radio buttons - This set of radio buttons is enabled only when there is a plot type displayed in the Selected Data data field and there is more than one curve to plot. The choice of a Single/Multiple Curves radio button is not mandatory. The "Single Curve" radio button is selected as the default. A brief description of each radio button is as follows:

Single Curve radio button - By selecting this radio button, the user will be able to view a series of plots, one at a time. Each plot will contain only one curve.

Multiple Curves radio button - By selecting this radio button, up to five curves per plot are allowed. The user will be able to view up to four plots, one at a time.

OK push button - The OK push button is enabled only when there is a plot type displayed in the Selected Data data field. By choosing the OK push button, you are confirming that data entry is complete.

After choosing the OK button, the selected aerodynamic data will be plotted on the screen, one plot at a time. Press any key on the keyboard to view successive plots. After all of the data has been viewed, the user will be returned to the AP93 menu bar.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Plot-Selection Data data entry screen without processing the Aeroprediction-Plot-selection Data data.

3.2.6 Aeroprediction-Printer Selection Data Entry Screen

The Aeroprediction-Printer Selection data entry screen is depicted in Figure 36.



FIGURE 36. AEROPREDICTION-PRINTER SELECTION DATA ENTRY SCREEN

The Aeroprediction-Printer Selection data entry screen consists of a list, a data field, and two push buttons to be used as follows:

Select Printer list - From this list, the user can select the type of printer to be used to generate hard copies .

Current Printer data field - The Current Printer data field is not enabled (i.e., data cannot be entered into this field by the user). When a printer type is chosen from the Select Printer list, the printer type will appear in the Current Printer data field.

OK push button - The OK push button is always enabled. By choosing the OK push button, you are confirming that the printer type displayed in the Current Printer data field is the desired printer.

Cancel push button - The Cancel push button is always enabled. Choose the Cancel push button to leave the Aeroprediction-Printer Selection data entry screen without processing the Printer Selection data.

CHAPTER 4

AUTOMATED GEOMETRY AND ALIMIT COMPUTATION

4.1 GEOMETRY REFERENCE

This section contains figures that show the physical significance of some of the input geometry parameters. The figures also define the missile components. For each dimension shown in the figures, there is a corresponding variable name which is used in the AP93 source code. Figure 37 contains a sketch of a generic wing-body-tail geometry and its associated dimensions. The dimensions for a double wedge fin planform are shown in Figure 38, and sectional views of the fin at the root and tip chord are shown in Figure 39. Figure 40 shows the difference between a "standard" afterbody and a multisectioned "nonstandard" afterbody.

4.2 TABLE LOOKUPS

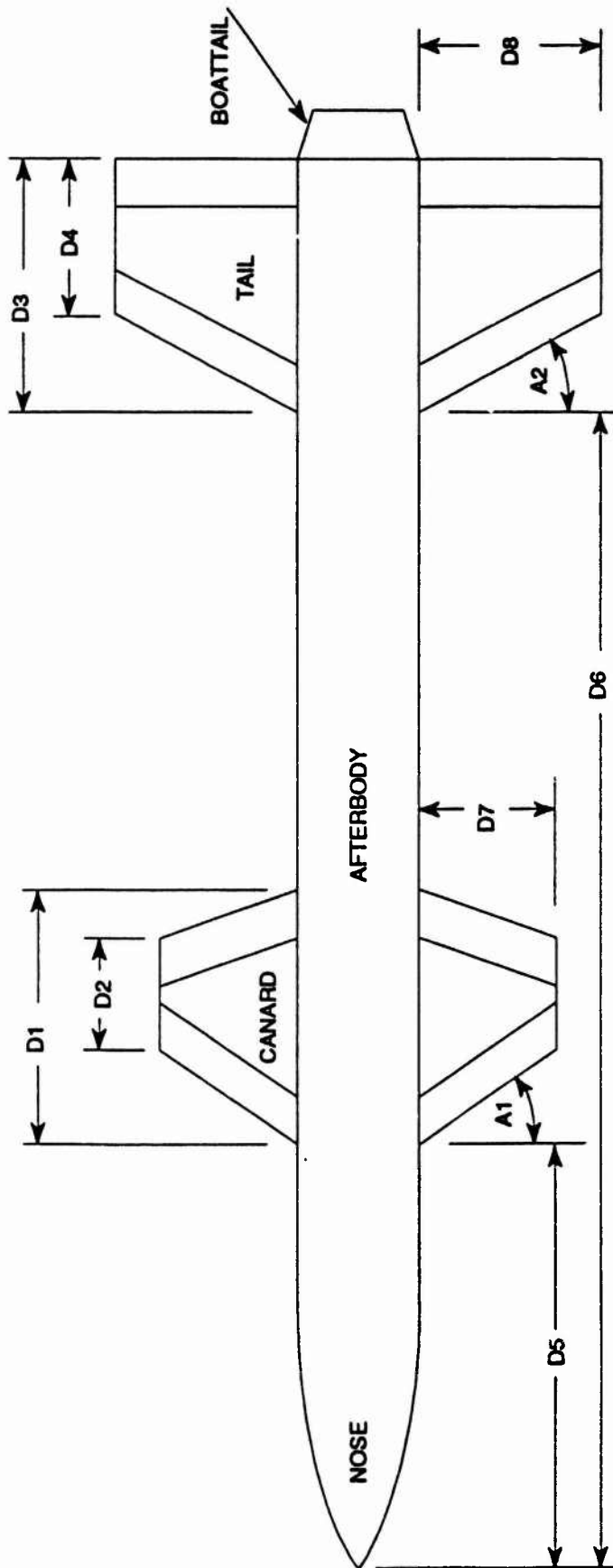
This section contains the tables which are used to look up the freestream pressure, temperature, and Reynolds Number/Mach/Foot as a function of altitude. Table 2 gives this information.

4.3 AUTOMATIC ALIMIT COMPUTATION

This section discusses a new capability which has been added to the AP93 code to compute the parameter ALIMIT automatically. ALIMIT is defined as the Mach number above which a Second Order Shock Expansion methodology is used to compute body-alone inviscid static aerodynamics.

Figure 41 shows the percent error in the drag coefficient, C_D , as a function of Similarity parameter, K , for various methodologies. In an effort to minimize the error in C_D , the Second Order Shock Expansion method is used for Similarity parameters above 1.2, and the Conical Shock Expansion method is used for Similarity parameters below 1.2. An expression for the Mach number at which the switch in these methodologies takes place in terms of the nose length, L , is given by

$$ALIMIT = 1.2L \quad (1)$$

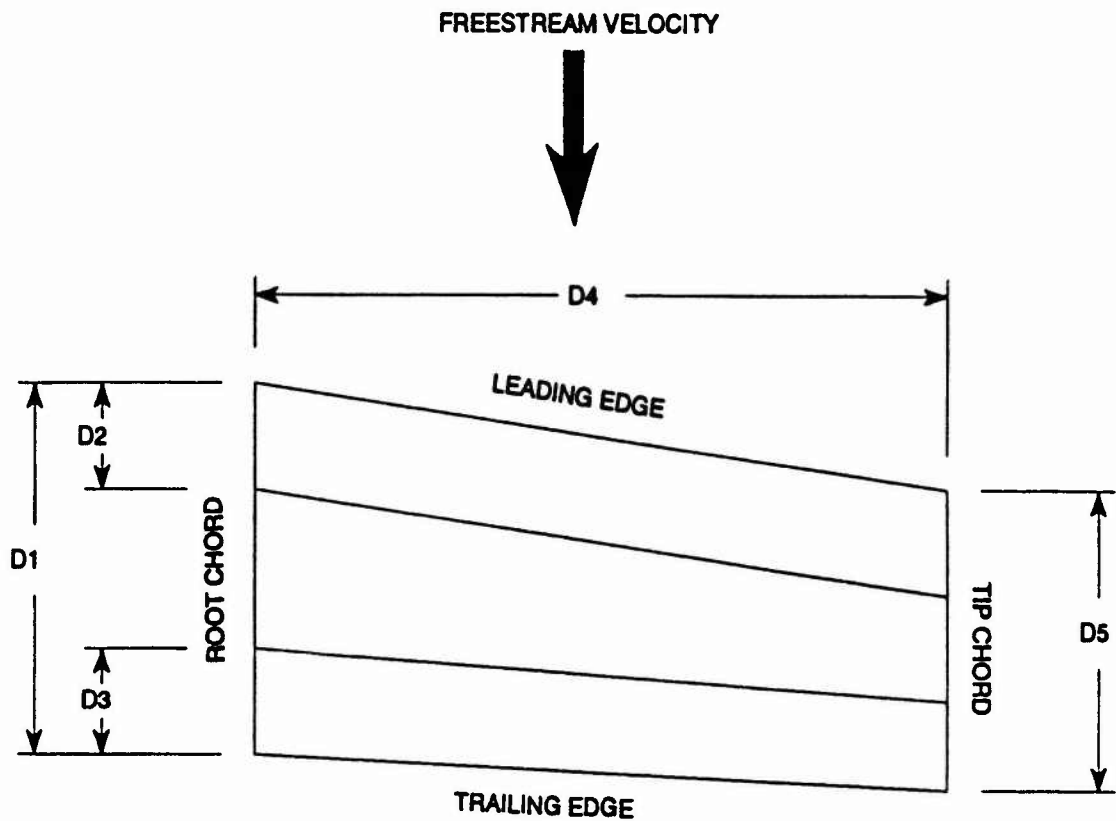


AP93 SOURCE CODE
VARIABLE NAME

DIMENSION AP93 INTERFACE DEFINITION

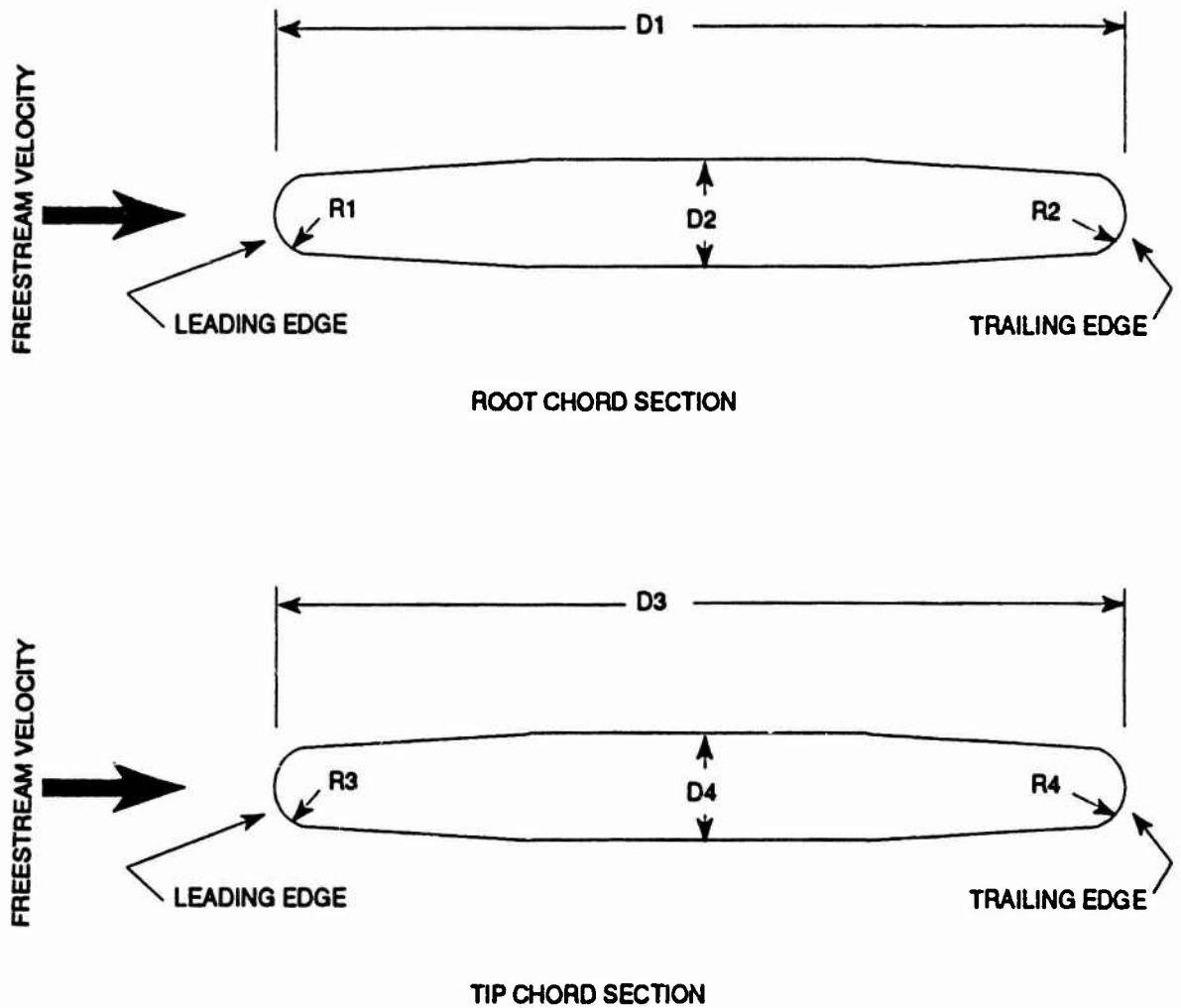
DIMENSION	AP93 INTERFACE DEFINITION	AP93 SOURCE CODE VARIABLE NAME
D1	(CANARD) ROOT CHORD	CRC
D2	(CANARD) TIP CHORD	CTC
D3	(TAIL) ROOT CHORD	CRW
D4	(TAIL) TIP CHORD	CTW
D5	DISTANCE OF CANARD LEADING EDGE FROM NOSE TIP	XC
D6	DISTANCE OF TAIL LEADING EDGE FROM NOSE TIP	XW
D7	(CANARD) SEMISPAN	BC/2
D8	(TAIL) SEMISPAN	BW/2
A1	(CANARD) LEADING EDGE SWEEP ANGLE	GAC1
A2	(TAIL) LEADING EDGE SWEEP ANGLE	GAW1

FIGURE 37. GENERIC WING-BODY-TAIL CONFIGURATION AND NOMENCLATURE



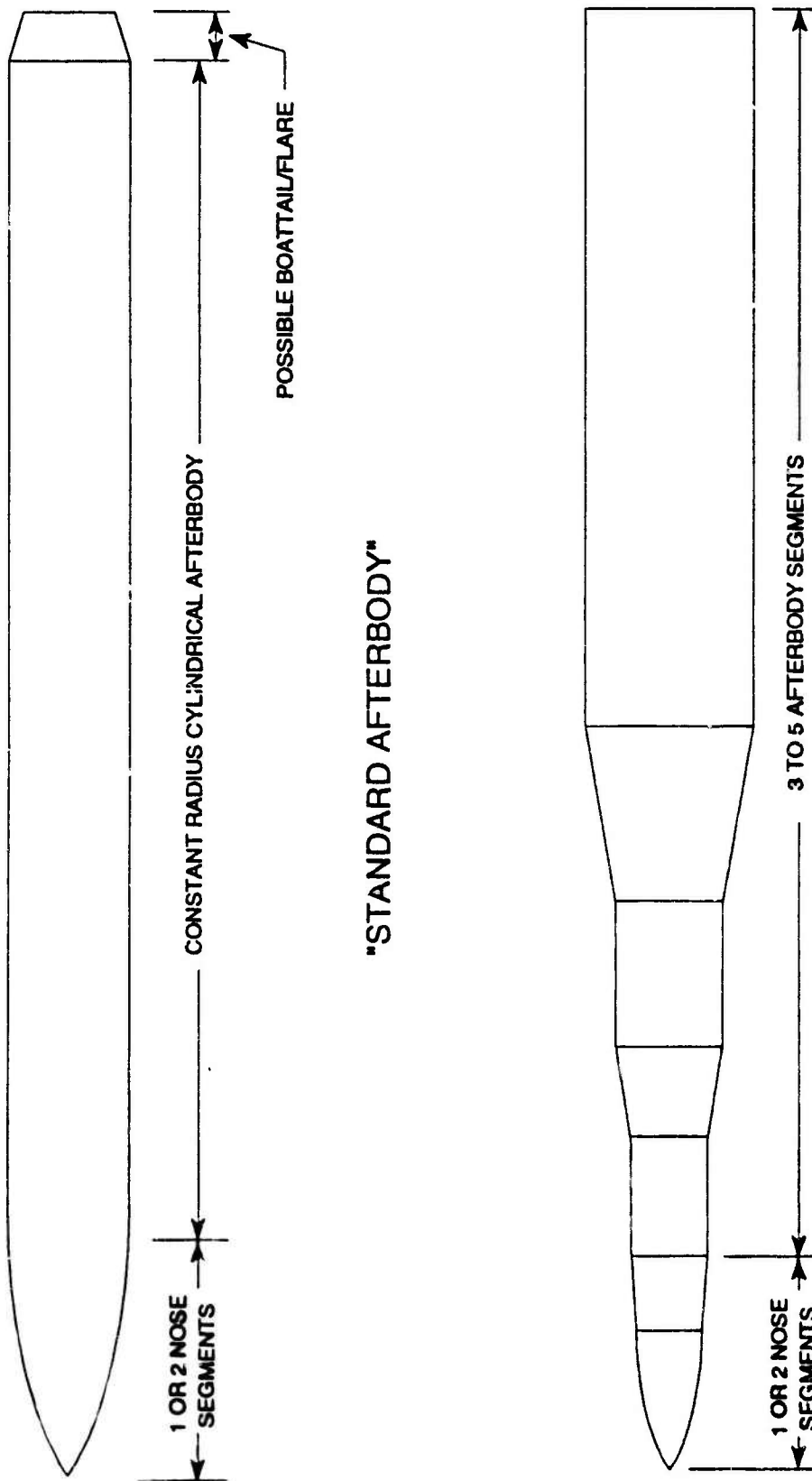
DIMENSION	AP93 INTERFACE DEFINITION	AP93 SOURCE CODE VARIABLE NAME
D1	ROOT CHORD	CRW
D2	DISTANCE FROM LEADING EDGE TO FIRST DISCONTINUITY DOWNSTREAM AT THE ROOT CHORD	CR1W
D3	DISTANCE FROM TRAILING EDGE TO FIRST DISCONTINUITY UPSTREAM AT THE ROOT CHORD	CR2W
D4	SEMISPAN	BW/2
D5	TIP CHORD	CTW

FIGURE 38. GENERIC WING HALF SPAN AND ASSOCIATED NOMENCLATURE



DIMENSION	AP93 INTERFACE DEFINITION	AP93 SOURCE CODE VARIABLE NAME
D1	ROOT CHORD	CRW
D2	THICKNESS AT ROOT CHORD	TRW
D3	TIP CHORD	CTW
D4	THICKNESS AT TIP	TTW
R1	LEADING EDGE CYLINDRICAL RADIUS AT ROOT CHORD	RRW
R2	TRAILING EDGE CYLINDRICAL RADIUS AT ROOT CHORD	RTEW
R3	LEADING EDGE RADIUS AT TIP	RTW
R4	TRAILING EDGE RADIUS AT TIP	RTEW1

FIGURE 39. GENERIC WING CROSS SECTION AND ASSOCIATED NOMENCLATURE



"NON-STANDARD AFTERBODY"

FIGURE 40. STANDARD AND MULTISECTIONED AFTERBODY NOMENCLATURE

TABLE 2. VARIATION OF FREESTREAM PRESSURE, TEMPERATURE, AND REYNOLDS NUMBER/MACH/FOOT WITH ALTITUDE

(Taken from 1966 US Standard Atmosphere Tables, Midlatitude (30-60°N), Spring/Fall)

Altitude (Kft)	PINF Pressure (lb/ft ²)	TINF Temperature (°R)	$\frac{Re}{Mft} = \frac{\rho a}{\mu}$
0	2116.22	518.69	7.1007x10 ⁶
70	1455.60	483.04	5.3854x10 ⁶
80	973.27	447.43	3.9754x10 ⁶
30	629.66	411.86	2.8696x10 ⁶
40	393.13	389.99	1.9207x10 ⁶
50	243.61	389.99	1.1878x10 ⁶
60	151.03	389.99	7.3456x10 ⁵
70	93.73	389.99	4.5549x10 ⁵
80	58.51	397.72	2.8235x10 ⁵
90	36.78	403.17	1.7544x10 ⁵
100	23.27	408.6	1.0854x10 ⁵
110	14.84	418.41	6.399x10 ⁴
120	9.60	433.61	3.9315x10 ⁴
130	6.31	448.79	2.458x10 ⁴
140	4.21	463.95	1.5633x10 ⁴
150	2.84	479.1	1.0084x10 ⁴
160	1.94	487.2	6.7367x10 ³
170	1.33	487.2	4.585x10 ³
180	1.06	478.58	3.1953x10 ³
190	.87	467.8	2.2129x10 ³
200	.71	457.03	1.5202x10 ³
210	.27	437.74	1.0623x10 ³
220	.18	416.24	7.2984x10 ²
230	.11	394.76	4.8844x10 ²
240	.07	373.3	3.1712x10 ²
250	.04	351.86	2.0205x10 ²

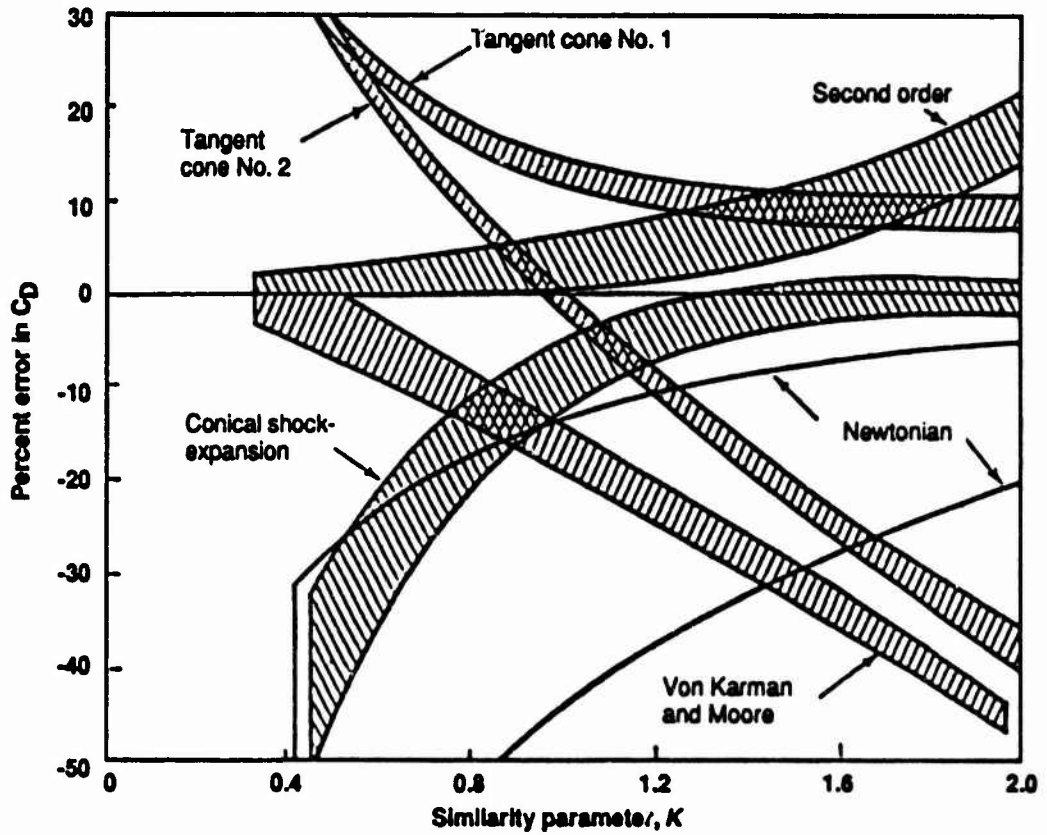


FIGURE 41. ACCURACY OF VARIOUS METHODS FOR ESTIMATING PRESSURE DRAG OF NONSLENDER NOSES AT ZERO ANGLE OF ATTACK (TAKEN FROM REFERENCE 4)

The parameter ALIMIT is bounded by the constraints:

$$1.6 < \text{ALIMIT} < 3.0 \quad (2)$$

4.4 EQUATIONS FOR GENERATION OF NOSE POINTS

This section contains the equations used for the generation of nose point coordinates. The equations for the Von Karman Ogive, Haack Series, and Power Series noses were taken from Reference 5. The equations for the Tangent Ogive, Secant Ogive, and Cone are derived.

Given the required dimensions of a particular nose shape, the AP93 Interface will use the appropriate equation to compute the nose point coordinates. To ensure adequate smoothness, a set of ten nose point coordinates are computed and used as input to AP93. For truncated and blunted noses, the coordinates of the first point is set equal to (0, cap radius). A spherical nose cap is generated automatically by AP93.

4.4.1 Tangent Ogive Nose

The shape of a Tangent Ogive nose is defined as shown in Figure 42. It consists of a circular arc whose last point is tangent to the top of the circle. The origin in Figure 42 coincides with the tip of the nose. The radius of curvature of the nose, ρ , may be found as follows:

From geometry,

$$(\rho - R)^2 + L^2 = \rho^2 \quad (3)$$

Expanding (3),

$$\rho^2 - 2\rho R + R^2 + L^2 = \rho^2 \quad (4)$$

Solving for ρ ,

$$\rho = \frac{R^2 + L^2}{2R} \quad (5)$$

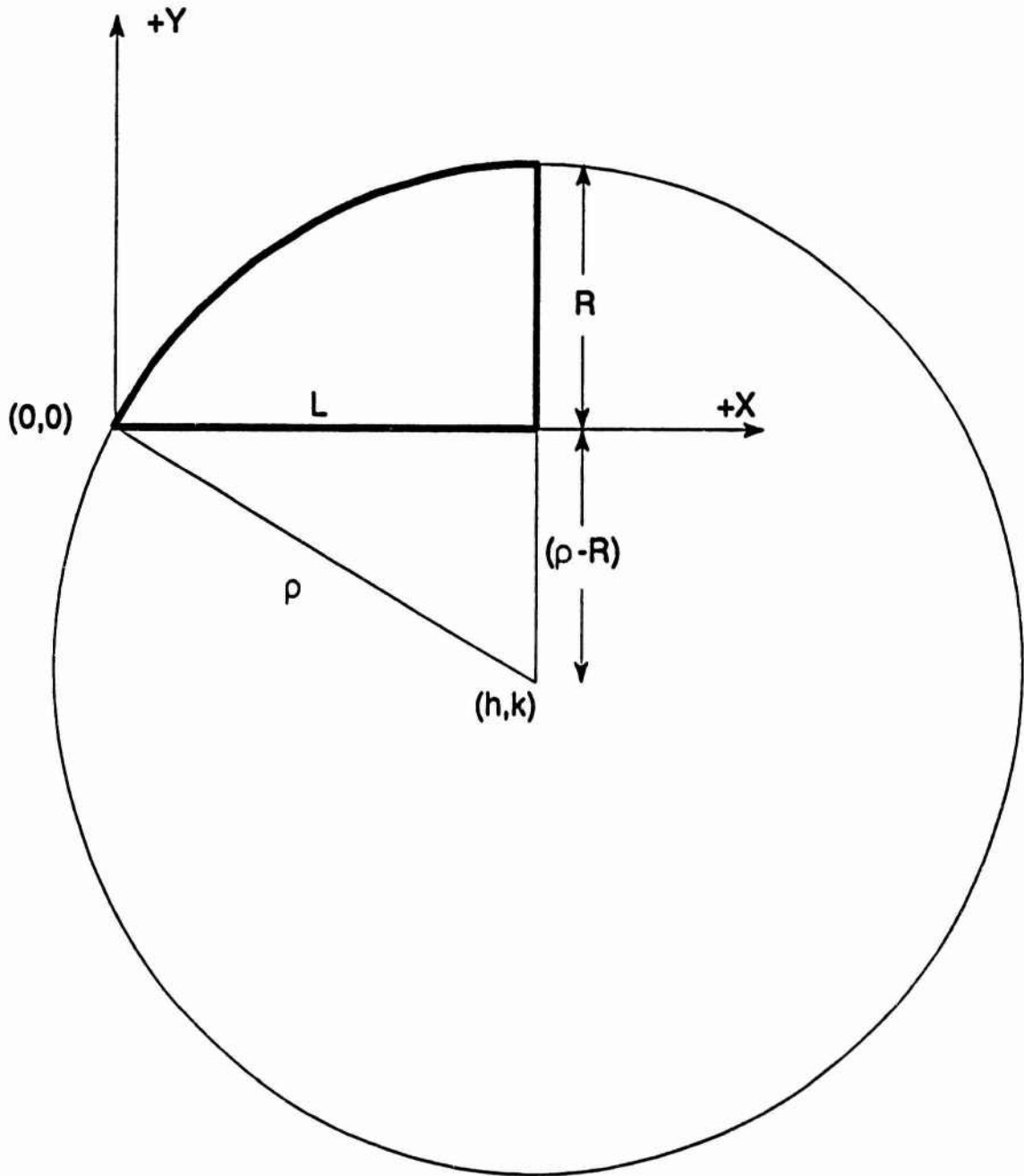


FIGURE 42. TANGENT OGIVE NOSE NOMENCLATURE

The distance y as a function of x for a circle centered at (h, k) is given by

$$\rho^2 = (x - h)^2 + (y - k)^2 \quad (6)$$

Solving (6) for y ,

$$y = \sqrt{\rho^2 - (x - h)^2} + k \quad (7)$$

Noting that $h = L$ and that $k = R - \rho$ (7) becomes

$$y = \sqrt{\rho^2 - (x - L)^2} + (R - \rho) \quad (8)$$

The length of the nose, L , and the diameter of the nose, $2R$, are supplied by the user. Given L and R , one can use (5) to solve for ρ . The nose point coordinates can then be solved for by using (8), where x is varied from 0 to L .

4.4.2 Secant Ogive Nose

The shape of a Secant Ogive nose is defined as shown in Figure 43. It is similar to the Tangent Ogive nose, with the exception that the last point does not coincide with the top of the circle. The origin in Figure 43 is located at the tip of the nose.

The length of the nose, L , the diameter of the nose, $2R$, and the radius of curvature, ρ , are supplied by the user. An equation for the nose point coordinates is derived from the equation of a circle centered at (h, k) :

$$\rho^2 = (x - h)^2 + (y - k)^2 \quad (9)$$

Solving (9) for y ,

$$y = \sqrt{\rho^2 - (x - h)^2} + k \quad (10)$$

Referring to Figure 43, the coordinates of the center of the circle are found from

$$h = \rho \cos \alpha \quad (11)$$

$$k = \rho \sin \alpha \quad (12)$$

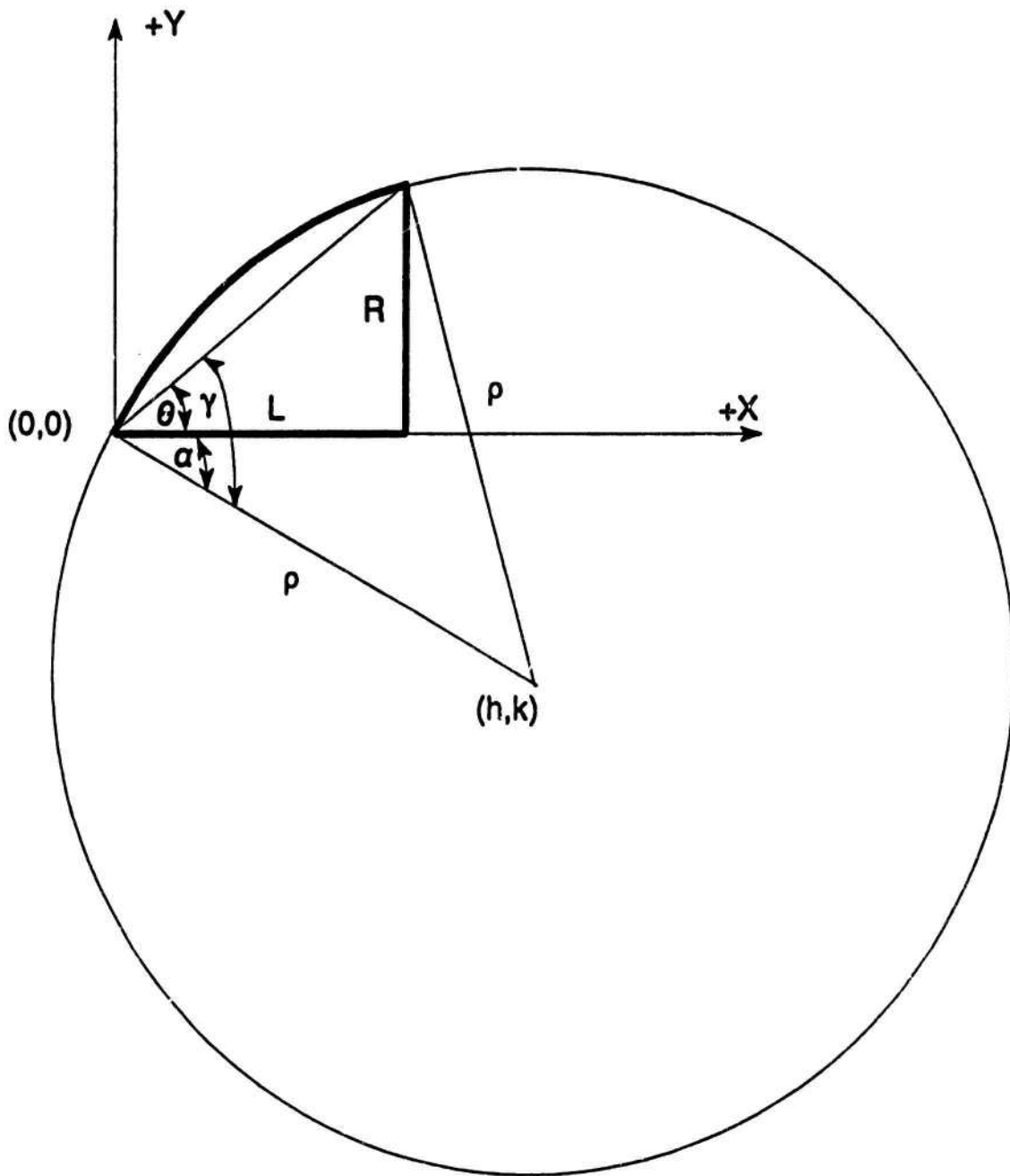


FIGURE 43. SECANT OGIVE NOSE NOMENCLATURE

where

$$\alpha = \gamma - \theta \quad (13)$$

and

$$\theta = \tan^{-1}\left(\frac{R}{L}\right) \quad (14)$$

The angle γ is found using the law of cosines:

$$\rho^2 = (L^2 + R^2) + \rho^2 - 2\rho\sqrt{L^2 + R^2}\cos\gamma \quad (15)$$

Solving for γ ,

$$\gamma = \cos^{-1}\left(\frac{\sqrt{L^2 + R^2}}{2\rho}\right) \quad (16)$$

After solving for h and k given L , R , and ρ , the nose point coordinates can be solved for using (10), where x is varied from 0 to L .

4.4.3 Haack Series Nose

The equation for a Haack Series nose is given in Reference 5 as

$$r = \frac{1}{\sqrt{\pi}} \sqrt{\phi - \frac{1}{2}\sin 2\phi + C \sin^3\phi} \quad (17)$$

where

x = distance from nose station/total nose length, and
 r = radius at any nose station/radius at base of the nose.

The quantity ϕ is given by

$$\phi = \cos^{-1}(1 - 2x) \quad (18)$$

For a Haack Series nose, the constant $C = 1/3$.

The nose point coordinates can be solved for by using (17), where x is varied from 0 to 1.0. Note that x and r have been nondimensionalized by the total nose length, L , and the radius at the base of the nose, R , respectively. The dimensions L and R are supplied by the user.

4.4.4 Von Karman Ogive Nose

The equation for a Von Karman nose is the same as the equation for the Haack Series nose with the exception that the constant C is equal to zero. Thus, equation (17) for the Haack Series nose becomes

$$r = \frac{1}{\sqrt{\pi}} \sqrt{\phi - \frac{1}{2} \sin 2\phi} \quad (19)$$

where

x = distance from nose station/total nose length, and
 r = radius at any nose station/radius at base of the nose.

The quantity ϕ is given by (18). The nose point coordinates can be solved for by using (19), where x is varied from 0 to 1.0. Note that x and r have been nondimensionalized by the total nose length, L , and the radius at the base of the nose, R , respectively. The dimensions L and R are supplied by the user.

4.4.5 Power Series Nose

The equation for a Power Series nose is given in Reference 5 as

$$r = x^n \quad (20)$$

where

x = distance from nose station/total nose length,
 r = radius at any nose station/radius at base of the nose, and
 n = an exponent between 0 and 1.

The nose point coordinates can be solved for by using (20), where x is varied from 0 to 1.0. Note that x and r have been nondimensionalized by the total nose length, L , and the radius at the base of the nose, R , respectively. The dimensions L and R , as well as the exponent, n , are supplied by the user.

4.4.6 Conical Nose

A conical nose having a half angle, θ , is shown in Figure 44. The diameter of the nose, $2R$, and either the nose half angle, θ , or the length of the nose, L , are supplied by the user. If the length of the nose, L , is given, then θ is computed from

$$\theta = \tan^{-1}\left(\frac{R}{L}\right) \quad (21)$$

The distance y as a function of x is then given by

$$y = x \tan \theta \quad (22)$$

The nose point coordinates can then be solved for by using (22), where x is varied from 0 to L .

4.4.7 Hemispherical Nose

The nose point coordinates used as input to AP93 for a hemispherical nose are always the same. They are (in calibers):

$$\begin{aligned} X(1) &= 0.00, & Y(1) &= 0.4991271 \\ X(2) &= 0.05, & Y(2) &= 0.5 \end{aligned}$$

These two points represent a short conical frustum nose section having a 0.05 caliber length and an arbitrarily selected one-degree slope.

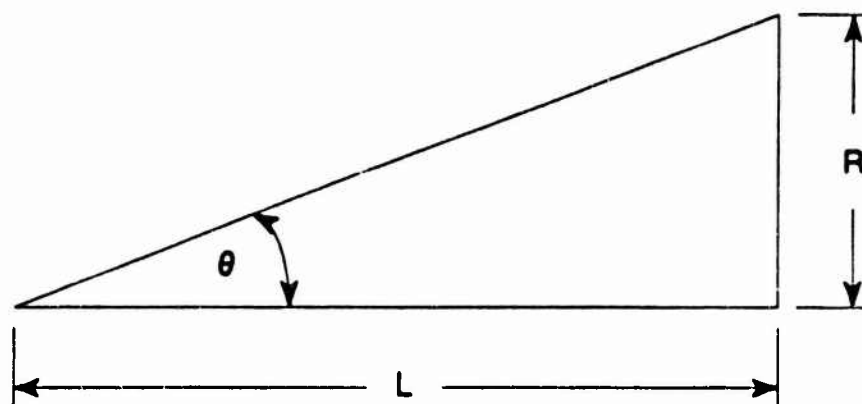


FIGURE 44. CONICAL NOSE NOMENCLATURE

**CHAPTER 5
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