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COMPUTER PROGRAM FOR THE PREDICTION OF
AIRCRAFT RESPONSE TO RUNWAY ROUGHNESS.
VOLUME II. USER'S MANUAL

Anthony G. Gerardi, et al

Air Force Flight Dynamics Laboratory

Prepared for:

Air Force Weapons Laboratory

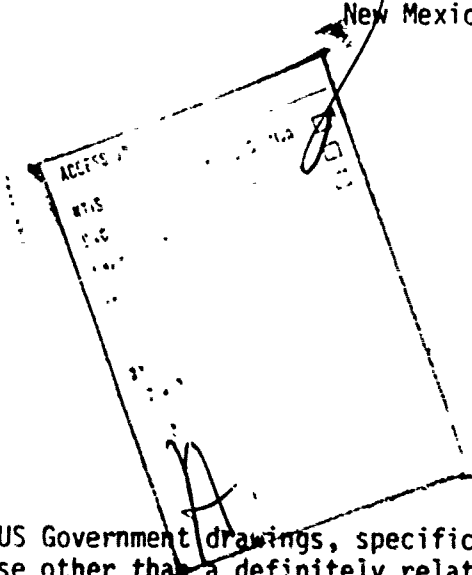
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COMPUTER PROGRAM FOR THE PREDICTION OF
AIRCRAFT RESPONSE TO RUNWAY ROUGHNESS

Volume II

User's Manual

Anthony G. Gerardi
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Air Force Flight Dynamics Laboratory
Wright-Patterson Air Force Base, OH 45433

Final Report for Period October 1971 through April 1973

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FOREWORD

This report was prepared by the Air Force Flight Dynamics Laboratory under AFWL Project Order 72-025. The research was performed under Program Element 63723F, Project 683M, Task 04.

The inclusive dates of research were October 1971 through April 1973. The report was submitted 11 February 1974 by the Air Force Weapons Laboratory Project Engineer, Mr. L. M. Womack (DEZ).

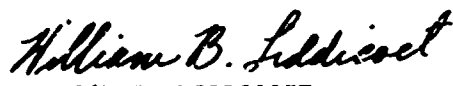
This report is composed of two volumes. Volume I, Program Development, contains a complete description of the mathematical model used to represent any aircraft during taxi or takeoff. Volume II, User's Manual, consists of a description of the usage and form of the computer program TAXI which simulates the aircraft.

Acknowledgement is due to F. J. Milfeit who contributed significantly to the collecting and cataloging of airplane data, to J. J. Guckian for assistance in flow charting the computer program, and J. J. Olsen, B. M. Crenshaw, Major H. L. Russell and R. F. Cook for technical and administrative assistance.

This technical report has been reviewed and is approved.


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ABSTRACT

(Distribution Limitation Statement A)

A computer program has been developed for use in determining the dynamic response of an aircraft to runway roughness during takeoff and constant speed taxi. The mathematical model has been programmed in Fortran for a CDC 6600 digital computer. A typical takeoff simulation requires less than 200 seconds of computer time and less than 77,000 octal storage locations. The output from the program is in two formats, a digital listing and a Calcomp-plotted time history. The plotted output is very useful in evaluating results.

TABLE OF CONTENTS

<u>SECTION</u>		<u>PAGE</u>
I	INTRODUCTION	1
II	PROGRAM OPERATION PROCEDURES	3
	General Procedures	3
	Aircraft Input Data	4
	Runway Profile Magnetic Tapes	11
	Deck Set-Up	14
III	PROGRAM DESCRIPTION	19
	Program Flow Charts	19
	TAXI	21
	Subroutine TAYLOR	31
	Subroutine IC	36
	Subroutine COEFF	39
	Subroutine TLOOK	41
IV	PROGRAM OUTPUT	43
	APPENDIX I Program Listings	47
	APPENDIX II Fortran Symbol Definitions	82
	DISTRIBUTION	94

ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1	Source Deck Setup for Conventional Aircraft	15
2	Source Deck Setup for F-4 Aircraft	16
3	Source Deck Setup for F-111 Aircraft	17
4	Source Deck Setup for C-5A Aircraft	18
5	Flow Chart Symbols	20
6	Program Output Listing	44
7	Typical Calcomp Plot	45

TABLES

<u>Table</u>		<u>Page</u>
I	Conventional Aircraft Input Data Format	6
II	Input Data Changes for the F-4	9
III	Input Data Changes for the F-111	10
IV	Input Data Changes for the C-5	11
V	Format for Runway Profile Magnetic Tape	12
VI	Sample Aircraft Data Deck, KC-135 Aircraft	13

SECTION I

INTRODUCTION

This volume contains a detailed presentation of the form and use of the program "TAXI", which will compute the dynamic response of an aircraft to a runway profile. This program consists of one main program and four subroutines. Input to the program consists of airplane data on punched cards and a runway profile on magnetic tape. Its output includes a listing of ten aircraft parameters at given time intervals and a time history Calcomp plot of center of gravity and pilot station vertical accelerations and the runway profile traversed by the nose gear of the aircraft.

This program will enable the user to simulate any aircraft traversing a runway profile with a minimum of modification to the computer code. The phrase "conventional landing gear aircraft" refers to aircraft with one set of main landing gear which are nonarticulated and of the single-acting type such as the C-141, KC-135 and B-52. Several nonconventional landing gear aircraft include the F-4, F-111 and C-5A. All conventional landing gear aircraft can be simulated with only a change in the aircraft input data. In contrast, the F-4, which is not a conventional landing gear aircraft, requires a change in aircraft data and the substitution of two subroutines in the basic computer program with those designated for use for the F-4. Simulation of the F-111 also requires a change in aircraft data and substitution of two subroutines in the basic computer program with those designated for the F-111. Due to the complexities of modifying the basic program by substitution of subroutines for the C-5A aircraft, which has two

sets of main gear that are double-acting, a completely separate deck is used.

In order to facilitate the use of the program TAXI, this volume also contains a detailed description of the program in its basic form and the modifications of the basic source deck required for the F-4, F-111 and C-5A simulations. First, the form of the aircraft input data cards and runway profile tape are described along with the general setup of the program source deck. Next, program flow charts are shown. Finally, the output listing and plot are discussed. A complete listing of the program and Fortran symbols are contained in appendices 1 and 2.

SECTION II

PROGRAM OPERATION PROCEDURES

General Procedures

Before the program TAXI can be used for a runway roughness analysis, the following procedures must be followed.

First, adequate computer core memory space must be specified. For all simulations a core memory of 77000 octal words is required.

Second, sufficient computer time must also be specified. Central processor (CP) time is a function of the integration step size, number of flexible modes included in the analysis, and the type of simulation, either a taxi or takeoff. In order to estimate this CP time, the following examples can be used. Using the recommended integration step size of 0.001 sec., a takeoff with 10 modes of vibration included requires CP time of 2.5 sec. for every second of actual simulation time. For a taxi with 10 modes included, CP time is 2.0 sec. for every second of actual simulation time. Including fewer vibration modes and a larger step size, the result will be less CP time required while more modes and a smaller integration step size will require more time. These estimates are for a CDC 6600 computer. Other machines may require more or less time.

Third, a set of data cards for the aircraft being simulated must be punched and a magnetic tape on which the runway profile is stored must be obtained. The formats for the aircraft data cards and magnetic tape are contained in Section II of this Volume.

Fourth, the modifications of the basic source deck must be made if an F-4, or F-111 simulation is to be run. If a C-5A aircraft is to be simulated, the source deck designated for this particular aircraft must be used. Instructions for the modification of the basic source deck for an F-4 or F-111 simulation are contained in Section II of this volume.

Finally, the entire deck including control cards, source deck and aircraft data cards must be assembled as shown in this section.

Aircraft Input Data

The following tables contain the form of the aircraft input data required for an aircraft/airfield simulation. The data cards are sequenced as they must appear in the aircraft data deck. For each data card variable names, definitions, units, card columns and format field specifications are given.

Table I contains the form of the aircraft data deck for all conventional landing gear aircraft such as the C-141, KC-135 and B-52. These aircraft all have a single set of main landing gear which are single-acting and are nonarticulated.

Table II shows the modifications of certain cards in Table I which are necessary for an F-4 simulation. All other cards remain the same.

Table III contains the changes to various cards in Table I for an F-111 simulation. All other data cards remain the same.

Similarly, Table IV contains the changes to certain data cards in Table I required for a C-5A simulation. Again, all other data cards remain unchanged.

The aircraft input data for the C-141, KC-135, B-52, F-111, F-4 and C-5A aircraft are contained in Volume I of this report. A sample aircraft input data deck for the KC-135 aircraft is shown in Table VI.

TABLE I

AIRCRAFT DATA FOR CONVENTIONAL AIRCRAFT

Section 1 (cards 1-5) - General Airplane Data

Card Column	Format	Variable Name	Definition
<u>Card 1</u>			
1-80	8A10	PLANE	Airplane Being Simulated and Gross Weight
<u>Card 2</u>			
1-10	F10.1	W	Vehicle Weight (lbs)
11-20	F10.1	A	Distance Main Gear to CG (in)
21-30	F10.1	B	Distance Nose Gear to CG (in)
31-42	F12.0	MMI	Mass Moment of Inertia (lb in sec ²)
<u>Card 3</u>			
1-10	F10.2	PSARM	Distance of Pilot Station to CG (in)
11-20	F10.2	TAILRM	Distance of Tail Station to CG (in)
<u>Card 4</u>			
1-10	F10.2	SPEED	Initial Velocity of Airplane (ft/sec)
11-20	F10.2	THRUST	Total Airplane Thrust (lbs)
21-30	F10.2	TAKOFF	Airplane Rotation Speed (ft/sec)
<u>Card 5</u>			
1-10	F10.4	CL	Lift Coefficient
11-20	F10.4	AREA	Wing Area (ft ²)
21-30	F10.4	CD	Drag Coefficient

Section 2 (cards 6-11) - Main and Nose Gear

<u>Card 6</u>			
1-10	F10.2	WM	Unsprung Weight of Each Main Gear (lbs)
11-20	F10.2	WN	Unsprung Weight of Nose Gear (lbs)
21-30	F10.2	SXM	Number of Main Gear Struts
31-40	F10.2	SXN	Number of Nose Gear Struts

TABLE I (Con't)

Card Column	Format	Variable Name	Definition
<u>Card 7</u>			
1-10	F10.5	AHN	Hydraulic Piston Area Nose (in ²)
11-20	F10.5	AAN	Pneumatic Piston Area Nose (in ²)
21-30	F10.5	AHM	Hydraulic Piston Area Main (in ²)
31-40	F10.5	AAM	Pneumatic Piston Area Main (in ²)
<u>Card 8</u>			
1-10	F10.5	PAON	Nose Strut Preload Pressure (lbs/in ²)
11-20	F10.5	PAOM	Main Strut Preload Pressure (lbs/in ²)
21-30	F10.5	VON	Fully Extended Nose Strut Air Volume (in ³)
31-40	F10.5	VOM	Fully Extended Main Strut Air Volume (in ³)
41-50	F10.5	OAM	Orifice Area Main (in ²)
51-60	F10.5	OAN	Orifice Area Nose (in ²)
<u>Card 9</u>			
1-10	F10.3	SLM	Distance from Axle to CG Waterline Main Gear Strut Unloaded (in)
11-20	F10.3	SLN	Distance from Axle to CG Waterline Nose Gear Strut Unloaded (in)
<u>Card 10</u>			
1-10	F10.1	TSMI	Main Tire Spring Constant Per Strut (lbs/in)
11-20	F10.1	TSNI	Nose Tire Spring Constant Per Strut (lbs/in)
<u>Card 11</u>			
1-10	F10.5	DX	Integration Step Size
<u>Card 12</u>			
1-5	I5	IFPLOT	0 Plot 1 No Plot
<u>Section 3 (cards 13-16)-Metering Pin Description</u>			
<u>Card 13</u>			
1-5	I5	NSCN	Number of Slope Changes Nose Gear

TABLE 1 (Con't)

Card Column	Format	Variable Name	Definition
<u>*Card 14A, 14B,....</u>			
1-10	F10.3	STROKN	Stroke Corresponding to Metering Pin Diameter, Nose Gear
11-20	F10.3	PINDN	Metering Pin Diameter, Nose Gear (in)
<u>Card 15</u>			
1-5	I5	NSCM	Number of Slope Changes Main Gear
<u>*Card 16A, 16B,....</u>			
1-10	F10.3	STROKM	Stroke Corresponding to Metering Pin Diameter, Nose Gear
11-20	F10.3	PINDM	Metering Pin Diameter, Main Gear (in)
<u>Section 4 (cards 17-19)-Flexibility Data</u>			
<u>Card 17</u>			
1-5	I5	NFM	Number of Flexible Modes
<u>**Card 18A, 18B,.....</u>			
1-10	F10.3	SIMAIN	Mode Shape Deflection Main Gear
11-20	F10.3	SINOSE	Mode Shape Deflection Nose Gear
21-30	F10.3	SICG	Mode Shape Deflection CG
31-40	F10.3	SITAIL	Mode Shape Deflection Tail Station
41-50	F10.3	SIPS	Mode Shape Deflection Pilot Station
<u>**Card 19A, 19B,....</u>			
1-15	F15.2	GM	Generalized Mass (lbs sec ² /in)
16-25	F10.3	OMEGA	Modal Frequency (rad/sec)

*One card is required for each stroke-metering pin combination read into the program.

**One card is required for each flexible mode.

TABLE II
INPUT DATA CHANGES FOR THE F-4

Card Column	Format	Variable Name	Definition
<u>Card 13</u>			
1-5	I5	NSCN	Number of area changes in nose gear metering tube
<u>*Card 14A, 14B,....</u>			
1-10	F10.3	STROKN	Stroke corresponding to orifice area, nose gear
11-20	F10.3	PINDN	Net orifice area at STROKN, nose gear (in ²)
<u>*Card 15</u>			
1-5	I5	NSCM	Number of area changes in main gear metering tube
<u>*Card 16A, 16B,....</u>			
1-10	F10.3	STROKM	Stroke corresponding to orifice area, main gear
11-20	F10.3	PINDM	Net orifice area at STROKM, main gear (in ²)

*One card is required for each stroke-metering pin combination read into the program

TABLE III
INPUT DATA CHANGES FOR THE F-111

Card Column	Format	Variable Name	Definition
<u>Card 13</u>			
1-5	15	NSCN	Number of area changes in nose gear fluted metering pin
<u>*Card 14A, 14B,....</u>			
1-10	F10.3	STROKN	Stroke corresponding to orifice area, nose gear
11-20	F10.3	PINDN	Net orifice area at STROKN, Nose Gear (in ²)
<u>Card 15</u>			
1-5	15	MSCM	Number of area changes in main gear fluted metering pin
<u>*Card 16A, 16B,....</u>			
1-10	F10.3	STROKM	Stroke corresponding to orifice area, main gear
11-20	F10.3	PINDM	Net orifice area at STROKM, main gear (in ²)

* One card is required for each stroke - metering pin combination read into the program.

TABLE IV
INPUT DATA CHANGES FOR THE C-5

Card Column	Format	Variable Name	Definition
<u>Card 2</u>			
1-10	F10.1	W	Vehicle Weight (lbs)
11-20	F10.1	A	Distance from Rear Main to CG (in)
21-30	F10.1	B	Distance from Nose Gear to CG (in)
31-40	F10.1	C	Distance from Front Main to CG (in)
41-52	F12.0	MMI	Mass Moment of Inertia (lb-in-sec ²)
<u>Card 13</u>			
1-5	I5	NSCN	Number of Area Changes in Nose Gear Metering Tube
<u>*Card 14A, 14B,....</u>			
1-10	F10.3	STROKN	Stroke Corresponding to Orifice Area, Nose Gear
11-20	F10.3	PINDN	Net Orifice Area at STROKN, Nose Gear (in ²)
<u>Card 15</u>			
1-5	I5	NSCM	Number of Area Changes in Main Gear Metering Tube
<u>*Card 16A, 16B,....</u>			
1-10	F10.3	STROKM	Stroke Corresponding to Orifice Area, Main Gear
11-20	F10.3	PINDM	Net Orifice Area at STROKM, Main Gear (in ²)
<u>**Card 18A, 18B,....</u>			
1-10	F10.3	SIMAIN1	Mode Shape Deflection Rear Main Gear
11-20	F10.3	SIMAIN2	Mode Shape Deflection Front Main Gear
21-30	F10.3	SINOSE	Mode Shape Deflection Nose
31-40	F10.3	SICG	Mode Shape Deflection CG
41-50	F10.3	SITAIL	Mode Shape Deflection Tail Station
51-60	F10.3	SIPS	Mode Shape Deflection Pilot Station

* One card is required for each stroke-metering pin combination read into the program

** One card is required for each flexible mode.

Runway Profile Magnetic Tape

The runway profile is read into the program from a magnetic tape. The format for this tape is shown in Table V.

TABLE V
RUNWAY PROFILE MAGNETIC TAPE

Card Column	Format	Variable Name	Definition
<u>Card 1</u>			
1-80	8A10	SITE	Runway Profile and Direction
<u>Card 2</u>			
1-6	I6	NPTSS	Number of Runway Elevation Points
<u>*Card 3, 4, ...N+2</u>			
1-70	10F7.3	ELEV	Runway Profile Data

* One card required for every ten runway profile elevation points.

TABLE VI

Sample Aircraft Data Deck, KC-135

KC-135 273000 POUNDS					
273000.	46.0	502.0	57772000.		
581.0	500.0				
1.00	55000.	278.88			
0.603	2433.0	0.06			
2634.0	343.0	2.0	1.0		
1317.0	24.51	64.77	82.3		
150.0	222.0	392.2	1810.0	3.149	1.227
92.0	92.0				
42352.0	11957.0				
0.01					
0					
5					
0.001	1.064				
6.41	1.129				
9.86	1.129				
13.88	1.160				
16.58	1.240				
3 3					
0.10	1.483				
12.13	1.483				
22.00	1.980				
8					
4.5	7.0	4.5	10.0	8.0	
0.0	1.5	0.0	1.0	1.0	
0.0	4.0	0.0	2.5	4.0	
-3.0	-3.0	-3.0	2.5	-3.0	
24.2	-68.0	23.0	-410	-88.0	
7.0	-5.5	7.0	0.0	-10.0	
-1.0	-16.0	-1.0	-21.8	-24.0	
-5.0	15.0	-6.0	3.5	30.0	
81903.4	10.62				
946.62	14.51				
7128.17	15.58				
34028.44	18.47				
724890.1	20.80				
48741.8	23.69				
121052.2	29.47				
63481.19	36.88				

Deck Setup

Figures 1, 2, 3, and 4 contain schematic diagrams of the source deck setup for conventional, F-4, F-111, and C-5A aircraft simulations.

For conventional aircraft, no modifications of the basic deck are required. Only the correct aircraft input data must be used. This basic source deck setup is shown in Figure 1.

In order to simulate the F-4, however, changes must be made to the basic program. This change is a result of the main landing gear having a double-acting strut, which is described in Volume I of this report. The F-4 source deck is formed by removing the subroutines Taylor and IC from the basic source deck and replacing them with the Taylor and IC subroutines designated for use with the F-4. This is shown in Figure 2. The modifications of the aircraft data cards described in this volume must also be made.

Changes to the basic source deck for an F-111 simulation are shown in Figure 3. The use of an articulated main landing gear and a fluted metering pin on this aircraft necessitates this change. The F-111 source deck is formed by removing the Taylor and IC subroutines from the basic source deck and replacing them with the Taylor and IC subroutines designated for the F-111 aircraft. The aircraft input data changes shown in this volume must also be made.

Due to the complexities of adding an extra set of main landing gear to the basic computer code by substitution of subroutines, a completely new deck is provided for the C-5A and other multiple strut aircraft. The source deck setup for the C-5A aircraft is shown in Figure 4. The modification of the aircraft data input for the C-5A is shown in this volume.

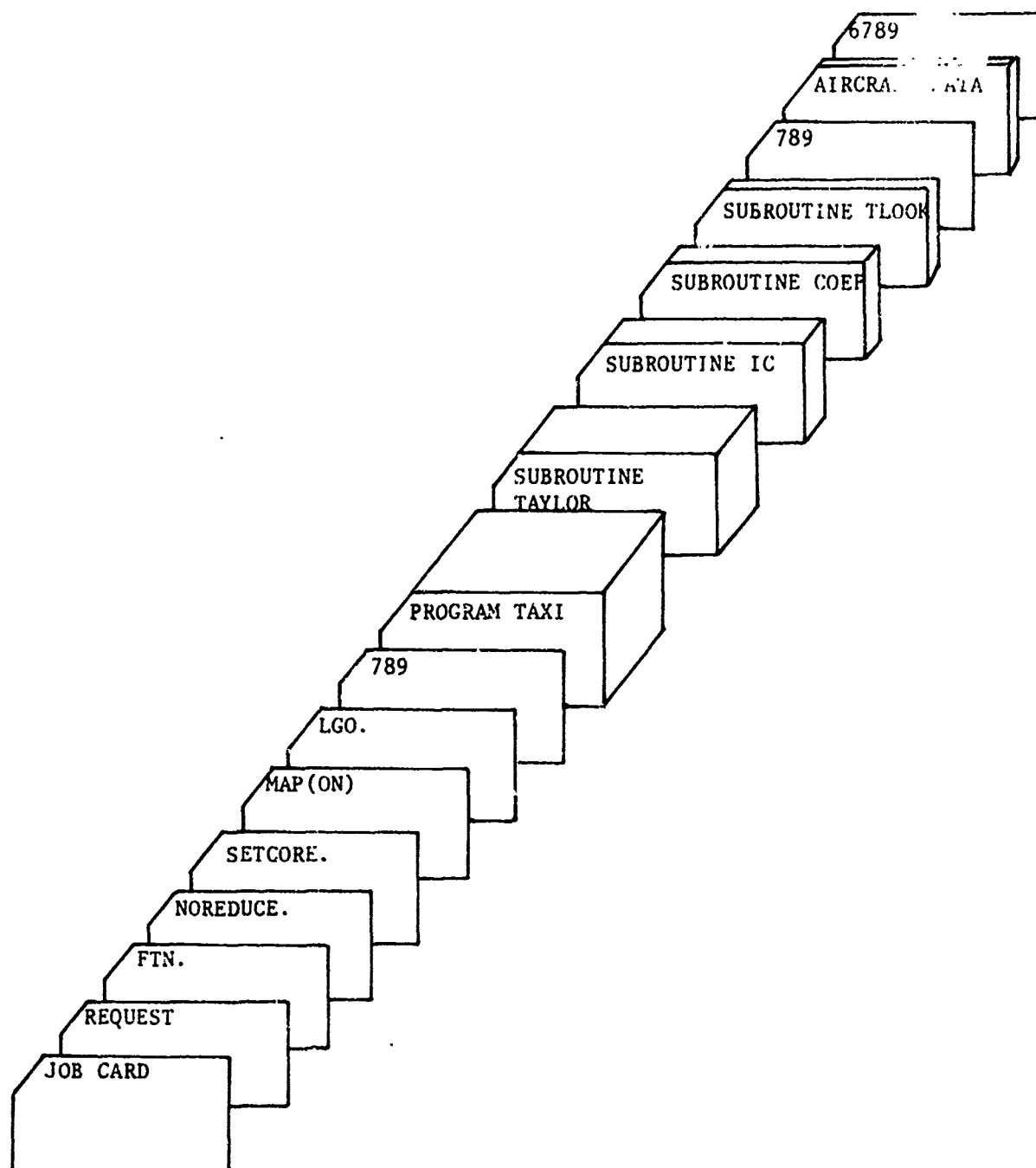


FIGURE 1. Source Deck Setup For Conventional Aircraft

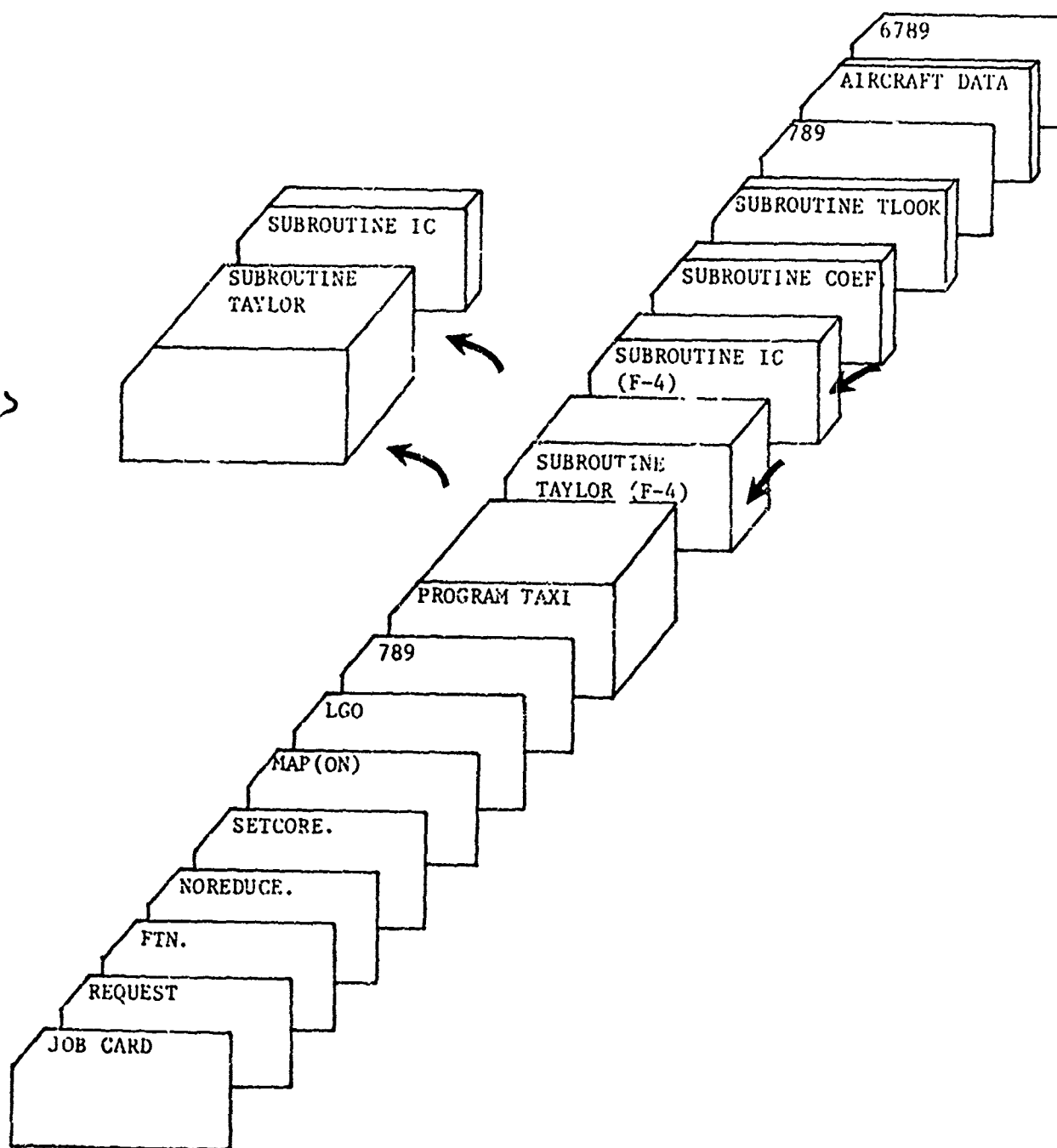


FIGURE 2. Source Deck Setup For F-4 Aircraft

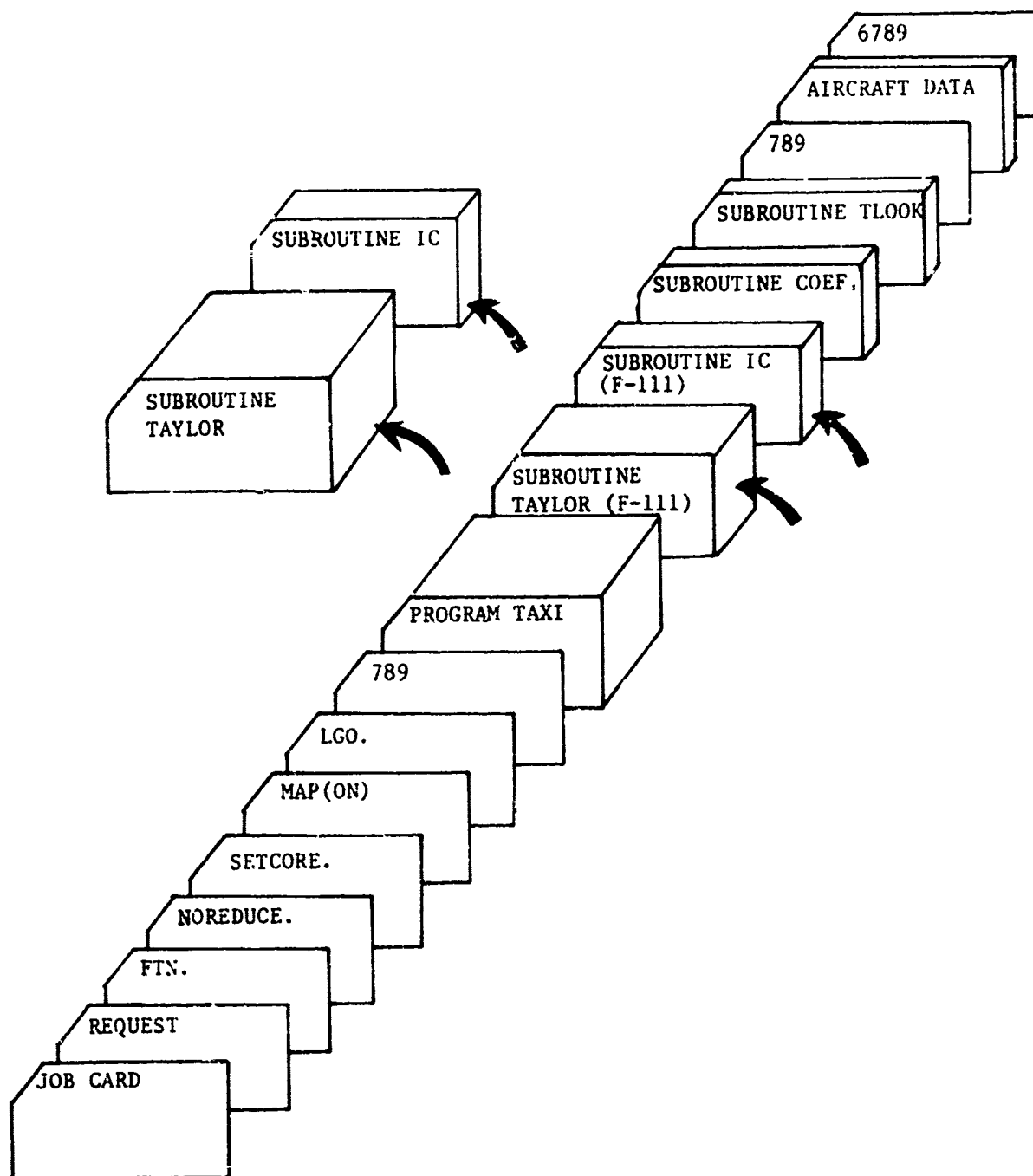


FIGURE 3 Source Deck Setup For F-111 Aircraft

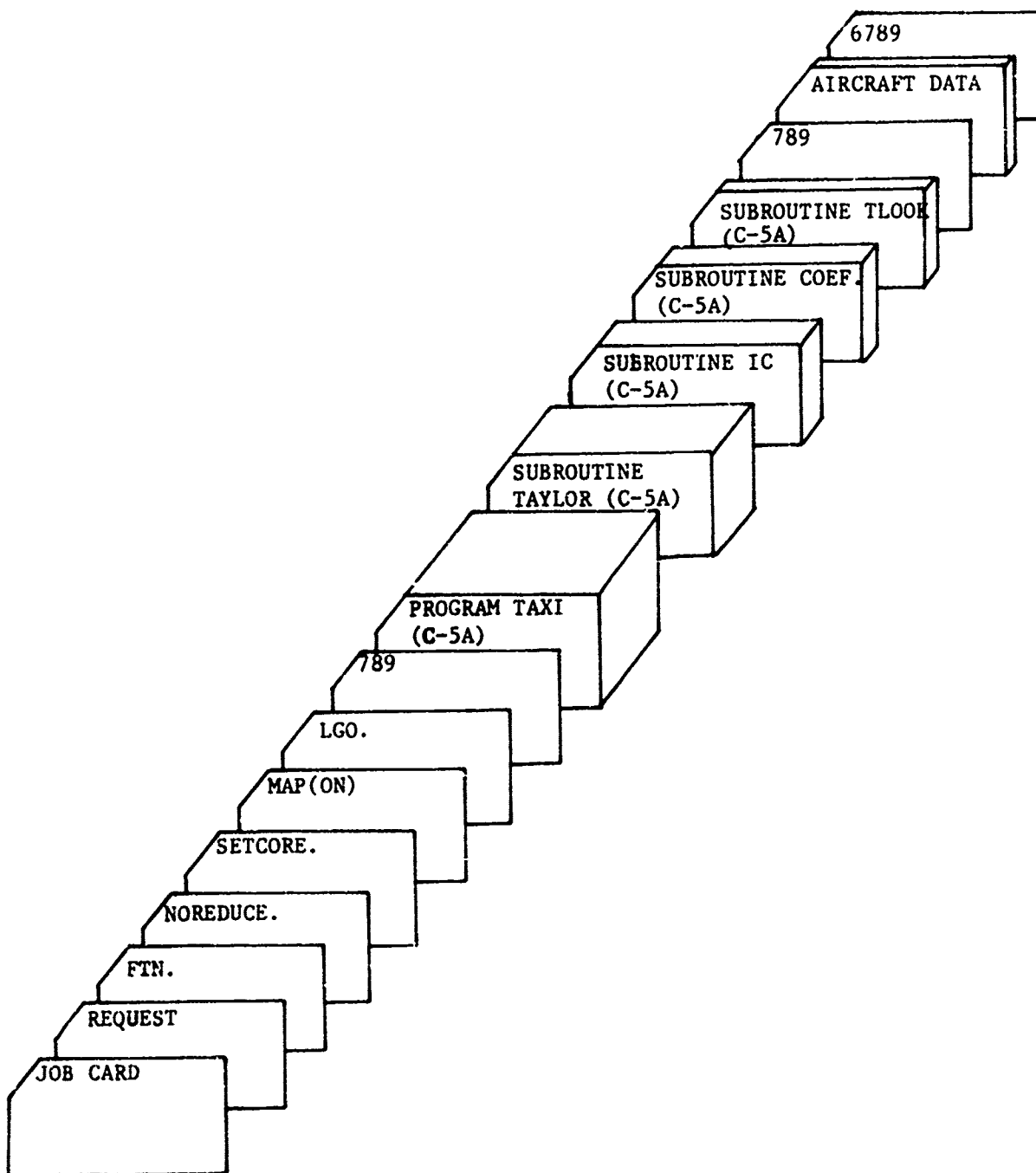


FIGURE 4. Source Deck Setup For C-5 Aircraft

SECTION III

PROGRAM DESCRIPTION

Program Flow Charts

The following pages contain flow charts of the program TAXI. The basic computer program is flow charted entirely. The program is broken down into its individual routines and each routine is flow charted separately. The flow charting symbols and their definitions are shown in Figure 5. The conventional direction of flow, from top to bottom of the page is used.

PROGRAM FLOW CHART SYMBOLS

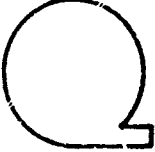
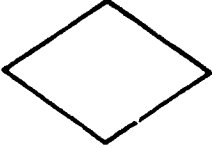
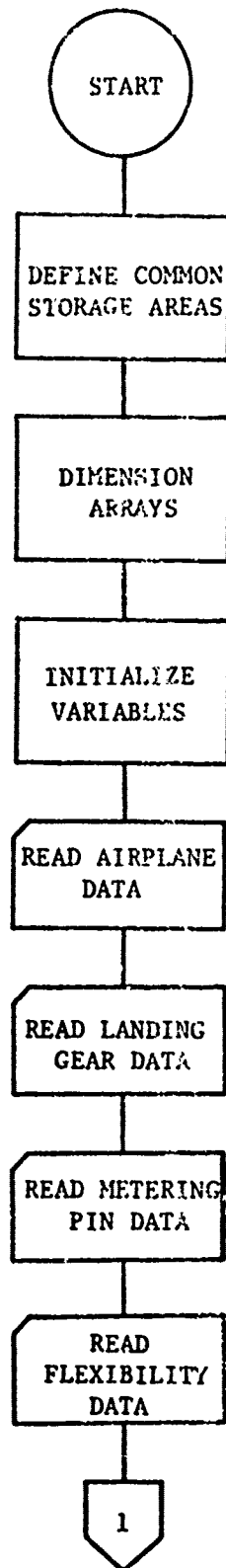
<u>SYMBOL</u>	<u>DEFINITION</u>
	Operation Box
	Card Input
	Tape Input
	Printed Output
	Decision
	Subprogram Execution
	Program Statement Number
	Page Connector
	Termination

FIGURE 5. Flow Chart Symbols

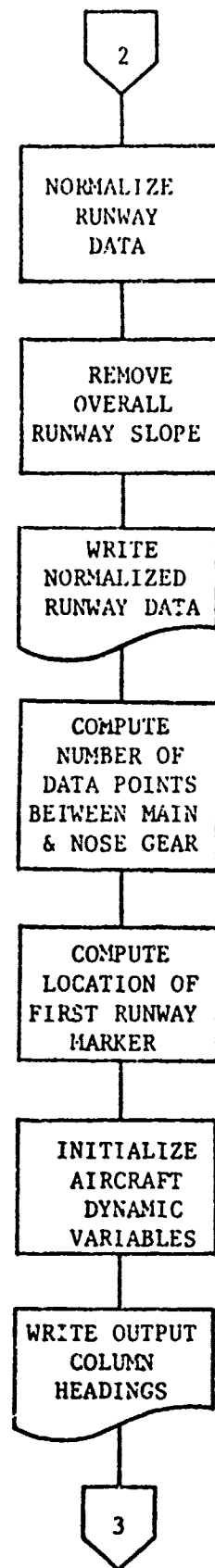
TAXI

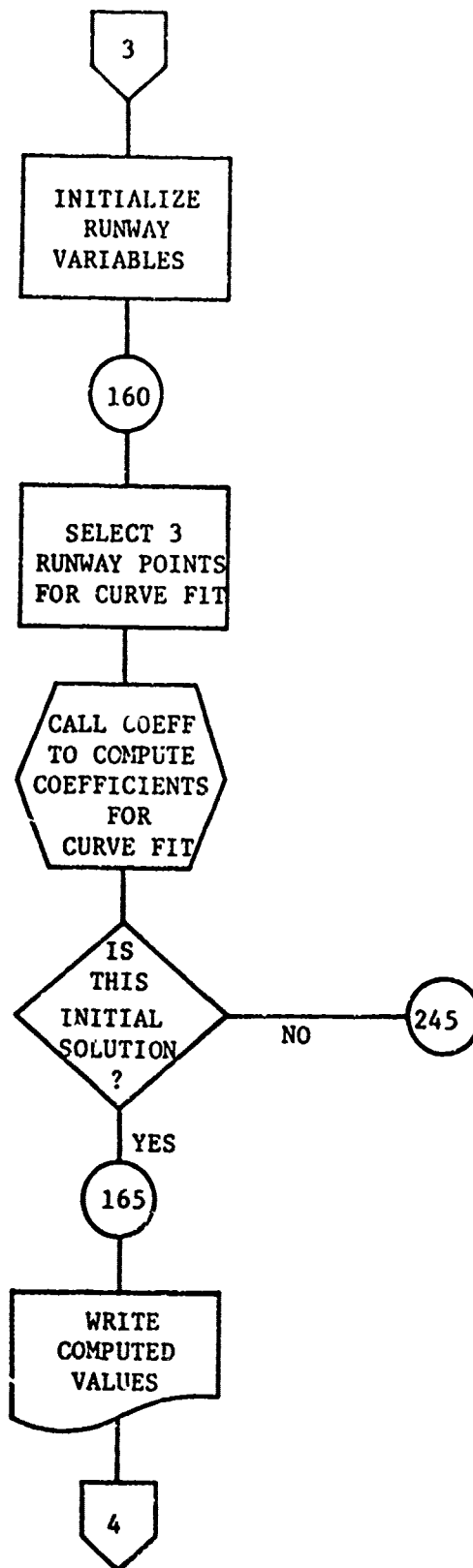
TAXI is the main routine which directs the entire program in the sequence of operations and the calculations to be made. It reads aircraft data from cards and the runway profile from a magnetic tape and outputs this data. The runway profile is both normalized to the first elevation point and detrended in TAXI. TAXI calls the subroutines IC, COEFF, and TAYLOR. IC returns aircraft initial conditions which are used to initialize aircraft dynamic variables. COEFF returns the coefficients of the polynomial fits to the runway profile segments. Taylor returns the solution to the differential equations of motion. TAXI then determines if this data is to be printed and/or stored for use in the Calcomp plot. TAXI also directs the Calcomp plotting.

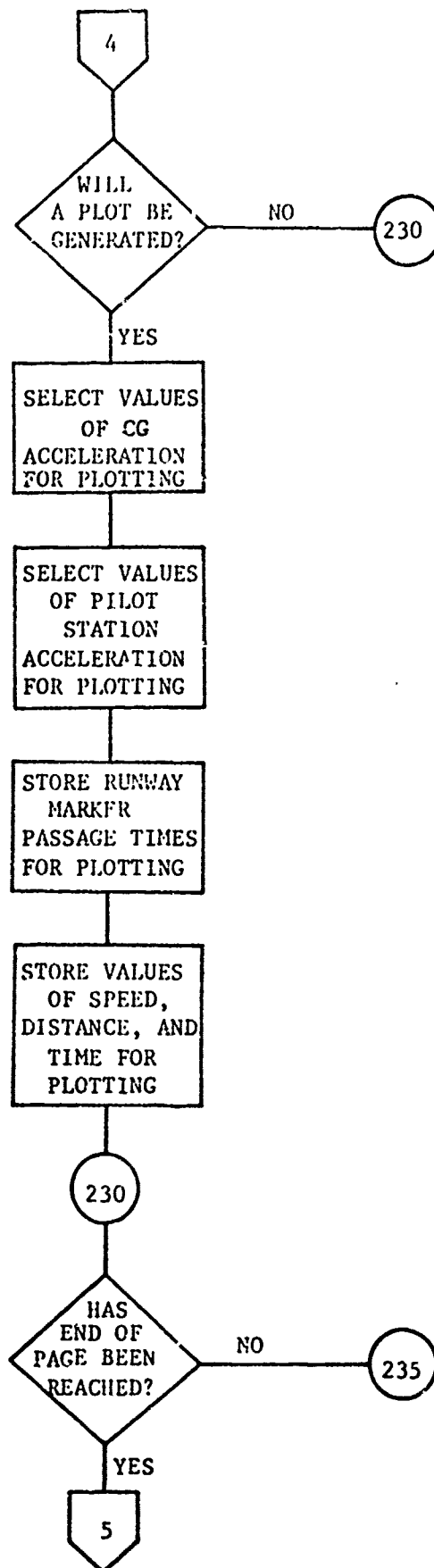
PROGRAM TAXI

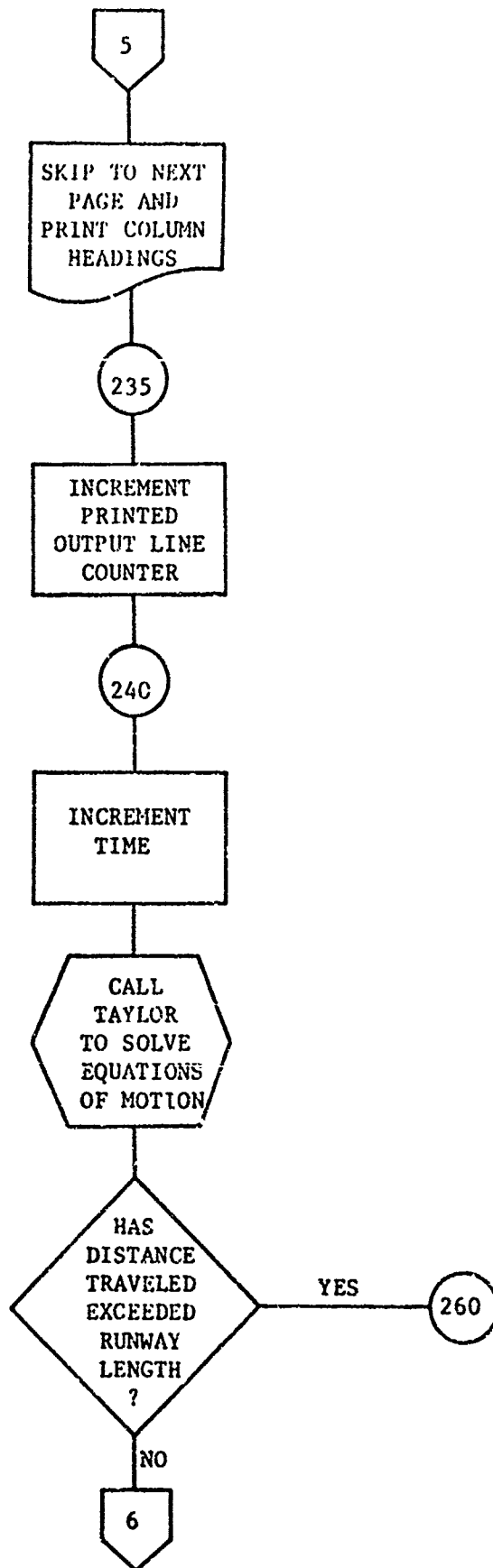


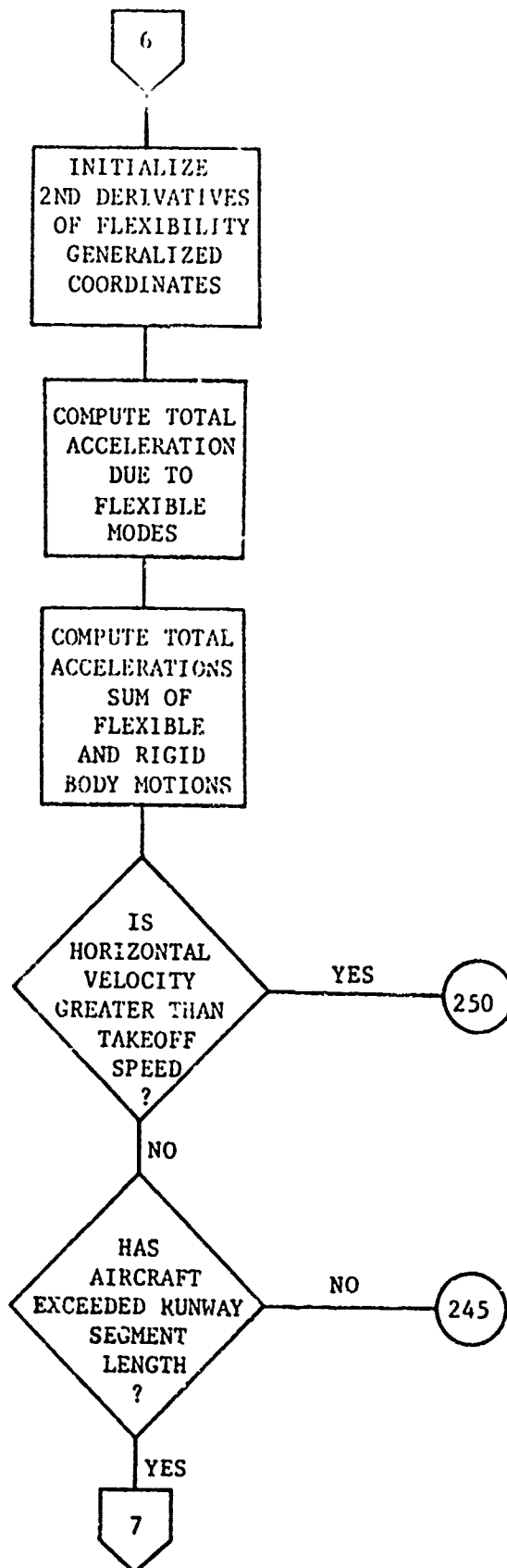


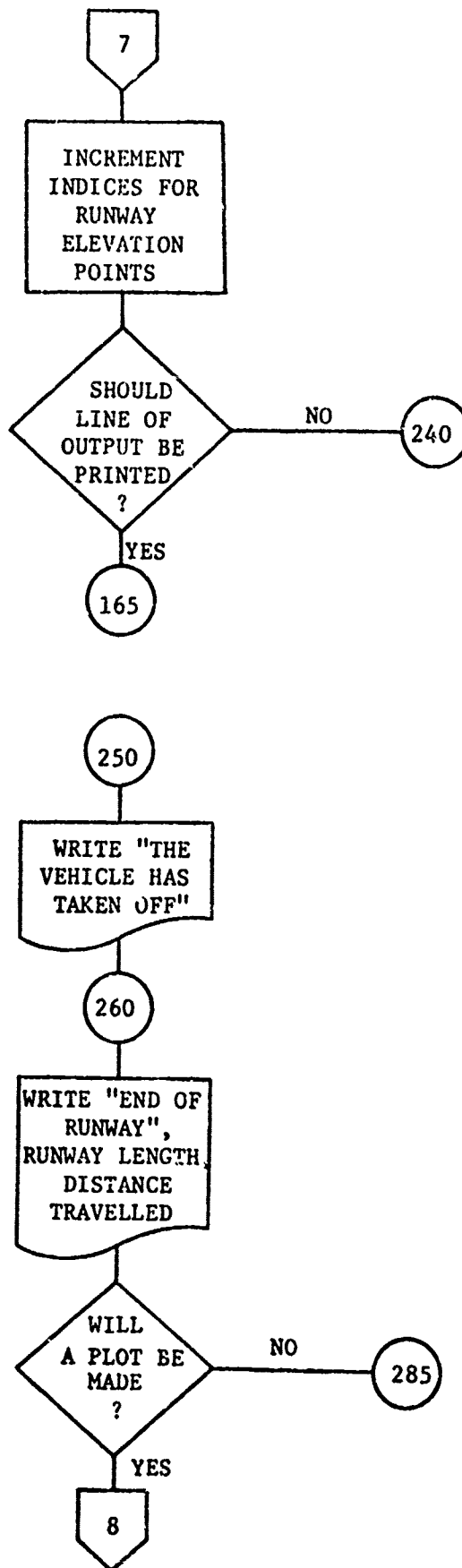


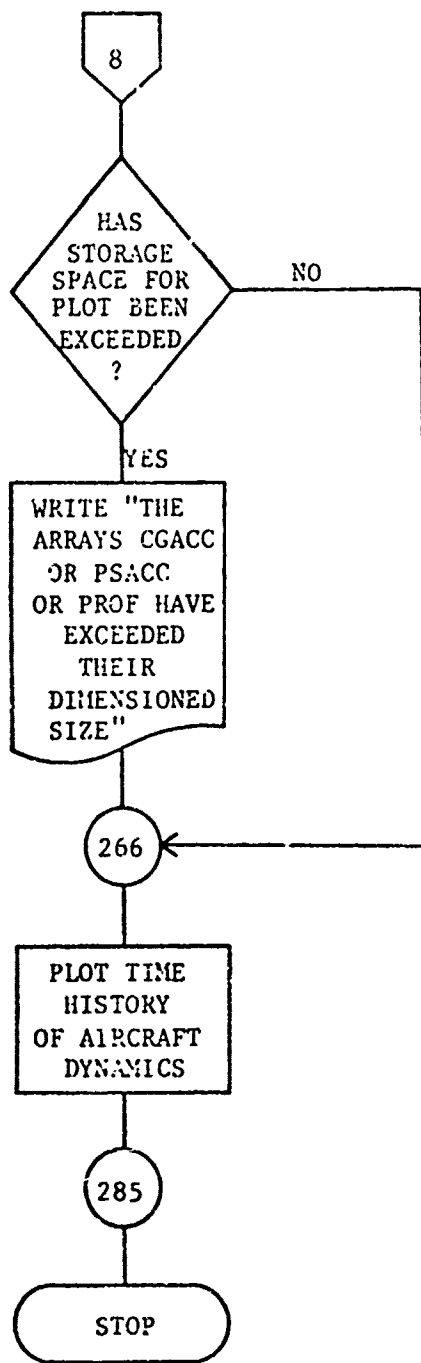








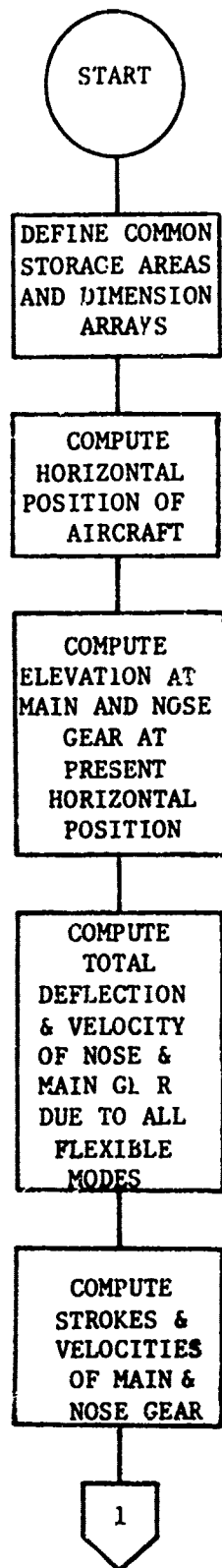


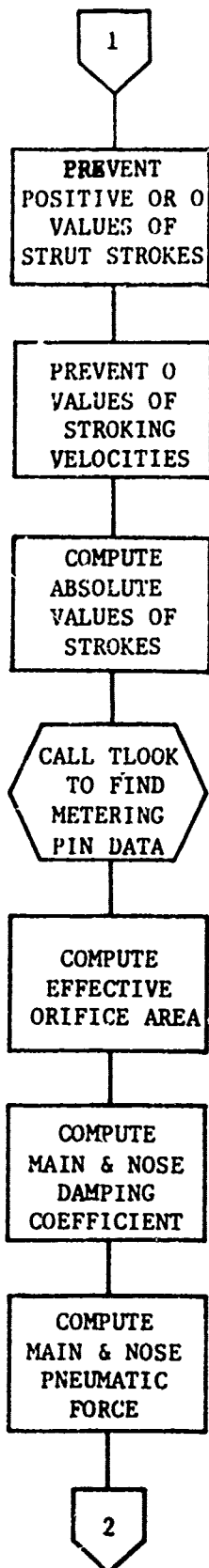


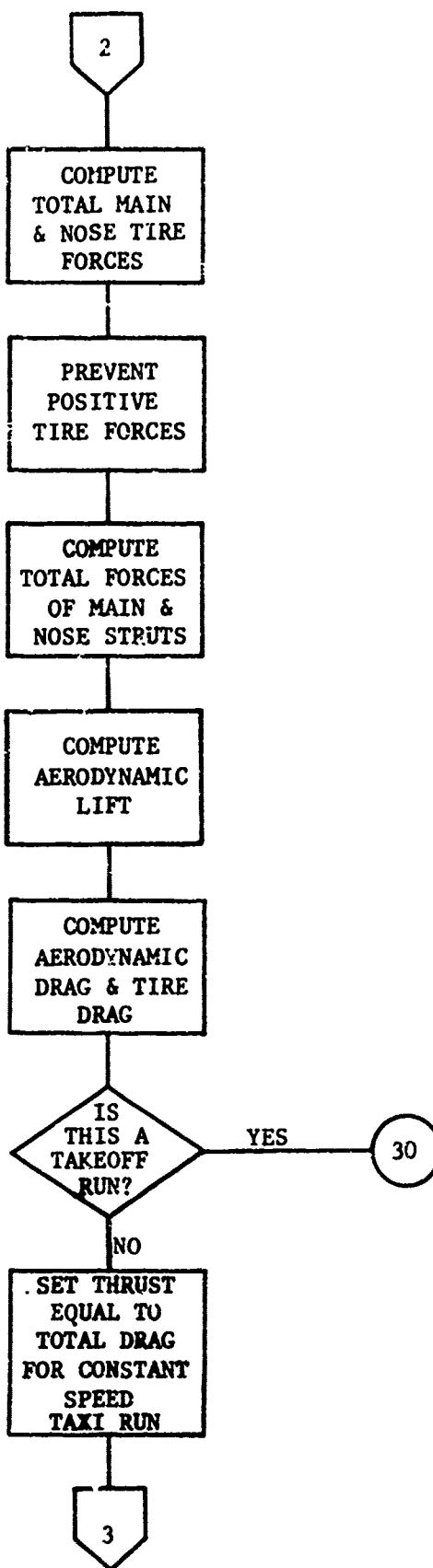
Subroutine Taylor

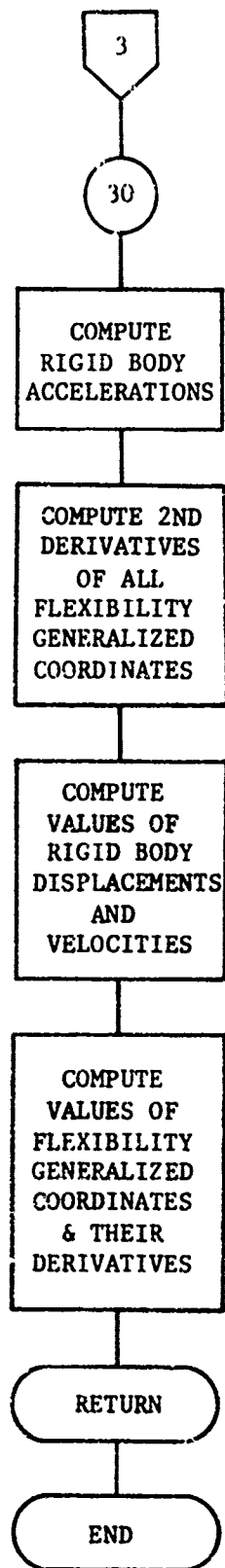
Taylor is the subroutine which computes the dynamic motion of the aircraft. Using runway profile information and aircraft data from TAXI and net orifice areas by calling subroutine TLOOK it calculates forces in the landing gear and tires. Subsequently, the aerodynamic and mechanical forces and moments acting on the aircraft fuselage are found. Taylor then sets up the differential equations of motion and integrates them using a three term Taylor series method. The dynamic variables are returned to TAXI for printing and storage.

SUBROUTINE TAYLOR





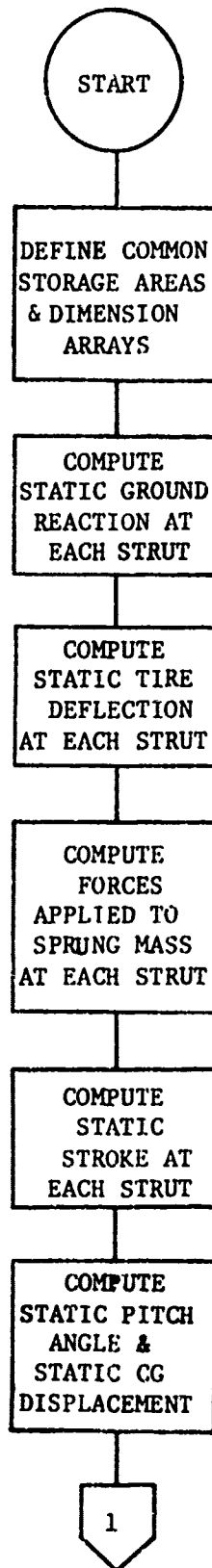


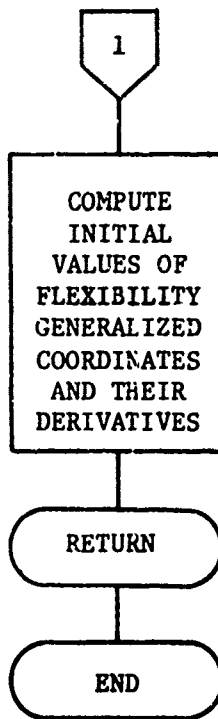


Subroutine IC

This subroutine calculates the static conditions of the aircraft needed to initiate an aircraft simulation. From statics, the reaction force at the main and nose gears are calculated by summing moments and forces. Tire deflections and main and nose gear strut stroke are computed from these reactions. Using these values, the initial aircraft pitch angle and the initial vertical position of the CG are found. These values are returned to the main routine TAXI.

SUBROUTINE IC

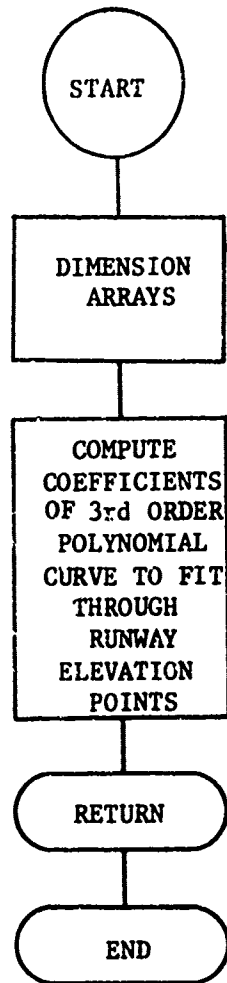




Subroutine COEFF

COEFF calculates a third order polynomial fit to a four foot runway profile segment. Given three runway elevation points and the slope from the end of the previous runway segment, a set of four simultaneous equations is solved. This solution yields the four constant coefficients of the runway segment polynomial. This subroutine calculates a runway profile segment fit for each set of landing gear after each four foot traversal of the runway. The coefficients are returned to TAXI and used in Taylor for computing the runway profile elevations at each time step during a simulation.

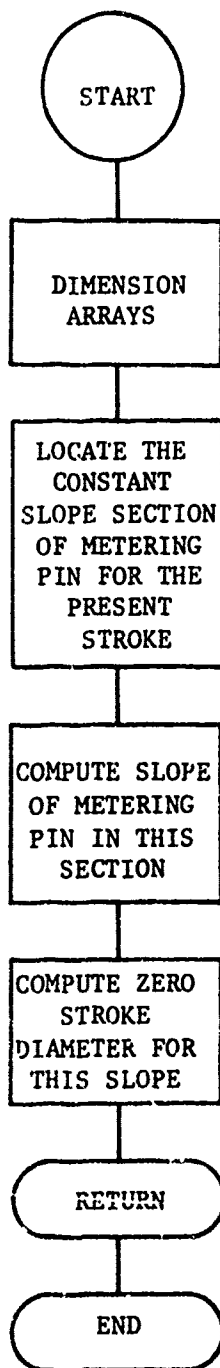
SUBROUTINE COEFF



Subroutine TLOOK

TLOOK performs a linear interpolation of the values in the table of metering pin diameter vs. stroke. For an aircraft with a metering tube or fluted metering pin, this table becomes net orifice area vs. stroke. In either case TLOOK is called by Taylor and furnished with a landing gear strut stroke. It does a table look-up and fits a straight line between the two points which straddle the given strut stroke. The slope and y-intercept of this line are returned to Taylor where a net orifice area is computed. TLOOK is called at each time step during a simulation for each set of landing gear of the aircraft.

SUBROUTINE TLOOK



SECTION IV

PROGRAM OUTPUT

The results of the program are presented in two forms. These are a listing of ten dynamic aircraft parameters and a Calcomp plot.

The listing of the dynamic aircraft parameters occurs at specified time intervals during an aircraft simulation which are larger than the integration step size. For a take-off simulation printing occurs at .01 second intervals. If a constant speed taxi simulation is made, printing occurs every .02 seconds. These intervals are model simulation times not real time. Thus, using an integration step size of .001 seconds, ten or twenty solution integrations are made between every line of printing. The ten aircraft parameters selected for printing are main gear stroke, nose gear stroke, main gear force, nose gear force, speed of the aircraft, distance down the runway, tail acceleration, CG acceleration, pilot station acceleration, and simulation time. Other variables may be printed out by modifying the WRITE statement in the main routine TAXI and putting the variable in COMMON between TAXI and the routine in which it is defined. A sample page of printed output is shown in Figure 6.

The other form of output is the Calcomp plot. On this plot, CG acceleration and pilot station acceleration time histories are displayed along with the runway profile time history as seen by the nose gear of the aircraft. Aircraft speed and distance and runway markers are also plotted at specified intervals. A more complete description of the Calcomp plot is contained in Volume I of this report. A photographic reduction of a typical Calcomp plot is shown in Figure 7.

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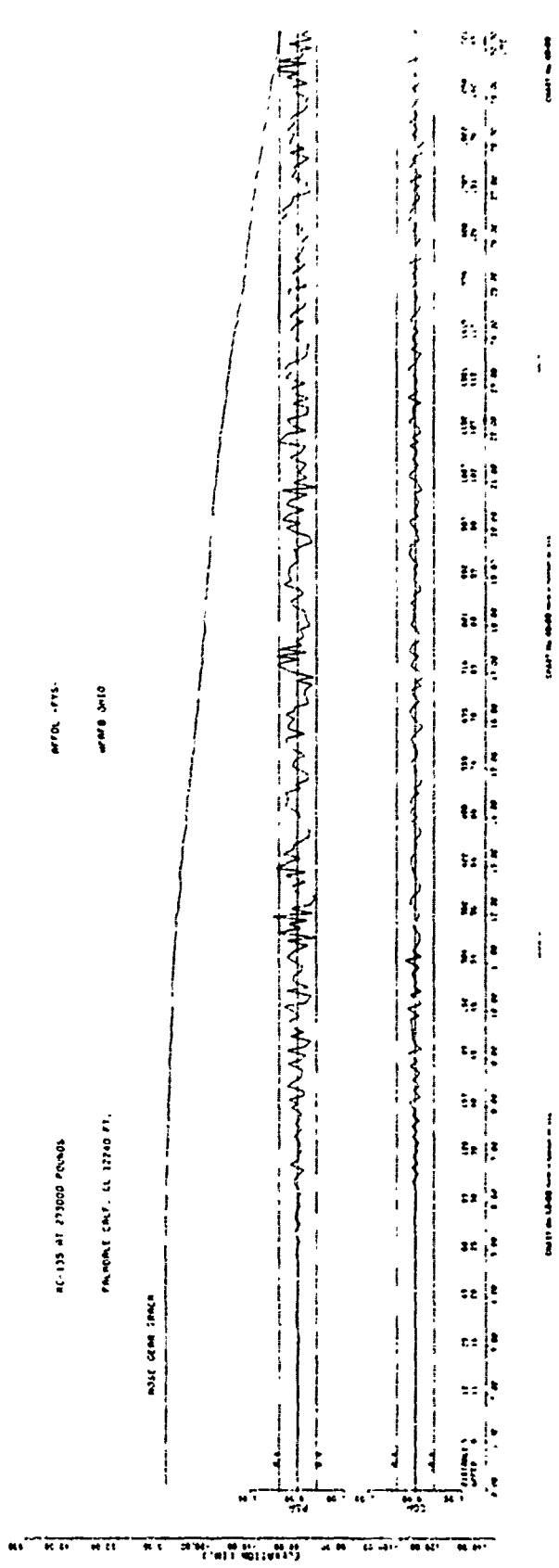
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FIGURE 6. Program Output Listing



45/46

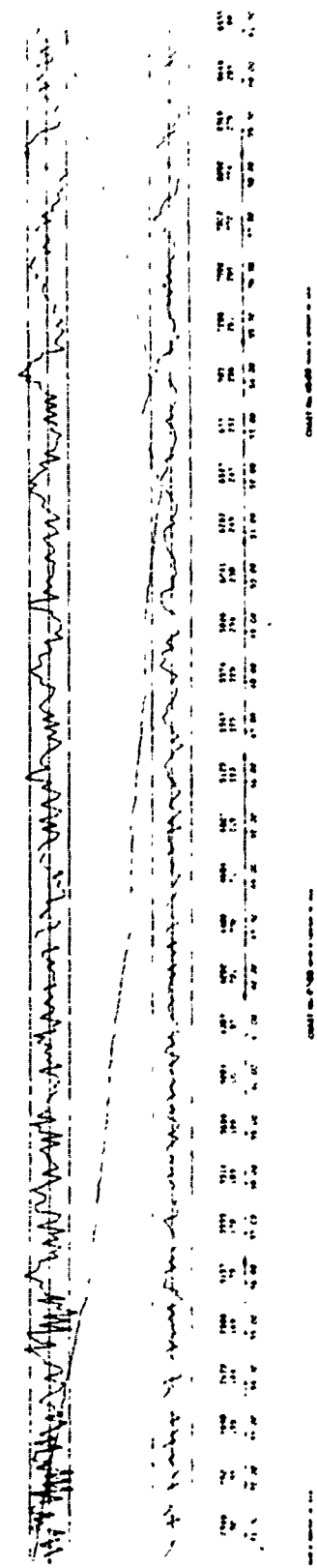


FIGURE 7. Typical Calcomp Plot

APPENDIX I

PROGRAM LISTINGS

A complete listing of the program source deck for conventional landing gear aircraft and the C-5A aircraft is given below. Listing of the TAYLOR and IC subroutines for the F-4 and F-111 simulation are also included. The programs are separated into individual routines for clarity.

```

PROGRAM TAXI(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE3,TAPE2,
1TAPE7)
*****
*****
*****
C THIS PROGRAM WILL PERFORM A SYMMETRIC
C DYNAMIC TAXI ANALYSIS ON A FLEXIBLE
C VEHICLE TRAVERSING A GIVEN RIGID RUNWAY
C PROFILE.
*****
*****
*****
COMMON/FLEX1/SIMAIN(15),SINOS(15),SICG(15),SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GH(15),CHEGA(15)
COMMON/FLEX3/Q(15),QD(15),QDD(15)
COMMON/X1/W,MH,MN,MCG,MH,MN,A,B,MHI
COMMON/X2/PACH,VCH,AAM,APH,OAM
COMMON/X3/PAGN,VON,AAN,AHN,OAN
COMMON/X4/SXP,SN,SLM,SLN,TSM,TSN
COMMON/X5/CL,CD,AREA,THRUST
COMMON/X6/Z,REACTH,REACTN,CX,NTRUN,SPEED
COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
COMMON/X8/STROKM(20),PINGM(20),STROKN(20),PINDN(20),NSCM,NSCN
COMMON/X9/FSF,FSN,FTP,FTA,XMAIN,XNOSE,VELM,VELN
COMMON/X10/ZPM,ZPN
DIMENSION PLANE(8),SITE(8)
DIMENSION T(12),TD(12),TDD(12)
DIMENSION ELEV(7000)
DIMENSION YP(4),YPN(4)
DIMENSION CGACC(1600),TIME(1600),PSACC(1600),TIME1(1600)
DIMENSION PRCF(1600),RMARK(20)
DIMENSION SSPLIT(300),STIME(300),DOPLIT(300)
REAL MCG,MH,MN,PHI
CALL PLOTS(100,0UM,3)
PSA=0.0
CGOUT=0.0
RDR=0.
X=0.
LLL = 1
LL = 0
STORE1 = 0.
STORE2 = 0.
STORE3 = 0.
STORE4 = 0.
NN = 0
II = 0
FP = 1.0
P = 1
ITT = 0
*****
C READ AND PRINT INPUT DATA
*****
C W=VEHICLE WEIGHT AT CG (POUNDS)
C A=DISTANCE MAIN GEAR TO CG (INCHES)
C B=DISTANCE NOSE GEAR TO CG (INCHES)
C PHI=MASS MOMENT OF INERTIA (LB IN SEC SQ)
C PLANE= AIRPLANE BEING SIMULATED AND GROSS WEIGHT
C PSARM = DISTANCE OF PILOT STATION TO CG

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C TAILRM = DISTANCE OF TAIL STATION TO CG
 C TAKOFF= TAKE-OFF SPEED (FEET/SEC)
 C SPEED = INITIAL VEL OF AIRPLANE
 C THRUST= TOTAL AIRPLANE THRUST
 C CL=LIFT COEFF.
 C AREA=WING AREA
 C CD=DRAG COEFF.
 C WM=WEIGHT OF MAIN GEAR (EACH)
 C WN=WEIGHT OF NOSE GEAR
 C SXM= NUMBER OF MAIN GEAR STRUTS
 C SXN= NUMBER OF NOSE GEAR STRUTS
 C AHM HYDRAULIC PISTON AREA NOSE SQ INCHES
 C AAN PNEUMATIC PISTON AREA NOSE SQ INCHES
 C AHM HYDRAULIC PISTON AREA MAIN SQ INCHES
 C AAM PNEUMATIC PISTON AREA MAIN SQ INCHES
 C PAON NOSE STRUT PRELCAO PRESSURE PSI
 C PAOM MAIN STRUT PRELCAO PRESSURE PSI
 C VON NOSE STRUT INITIAL VOLUME CU. IN.
 C VOM MAIN STRUT INITIAL VOLUME CU. IN.
 C OAM ORIFACE AREA MAIN
 C OAN ORIFACE AREA NOSE
 C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES
 C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES
 C TSM MAIN TIRE SPRING CONSTANT PER STRUT
 C TSN NOSE TIRE SPRING CONSTANT PER STRUT
 C DX=TIME STEP SIZE
 C READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE
 C NSCN=3 OF METERING PIN CHANGES NOSE GEAR
 C NSCM=3 OF METERING PIN CHANGES MAIN GEAR
 C NFM = NUMBER OF FLEXIBLE MODES
 C SIXXXX(I) = MODE SHAPE DEFLECTION (NOM DIM.)
 C GM(I) = GENERALIZED MASS (PCUNDS-SEC SQ/IN)
 C OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)
 READ (5,1) PLANE
 1 FORMAT(8A10)
 READ(5,5) W,A,B,MHI
 5 FORMAT(3F10.1,F12.6)
 READ(5,10) PSARM,TAILRM
 10 FORMAT(2F10.2)
 READ(5,15) SPEED,THRUST,TAKOFF
 15 FORMAT(3F10.3)
 READ(5,20) CL,AREA,CD
 20 FORMAT(3F10.4)
 READ(5,25) WM,WN,SXM,SXN
 25 FORMAT(4F10.2)
 READ(5,30) AHM,AAN,AHM,AAM
 30 FORMAT(4F10.5)
 READ(5,35) PAON,PAOM,VON,VOM,OAM,OAN
 35 FORMAT(6F10.5)
 READ(5,40) SLM,SLN
 40 FORMAT(2F10.3)
 READ(5,45) TSM,TSN
 45 FORMAT(2F10.1)
 READ(5,50) DX
 READ(5,51) IFFLOT
 50 FORMAT(F10.3)

```

      READ(5,51) NSCN
51  FORMAT(I5)
      READ(5,52) (STROKN(I),PINON(I),I=1,NSCN)
52  FORMAT(2(F10.3))
      READ(5,51) NSCM
      READ(5,52) (STROKN(I),PINOP(I),I=1,NSCM)
      READ(5,51) NFM
      READ(5,53) (SIMAIN(I),SINOSE(I),SICG(I),SITAIL(I),SIPS(I)
1, I=1,NFM)
53  FORMAT(5F10.3)
      READ(5,54) (GM(I),CMEGA(I),I=1,NFM)
54  FORMAT(F15.2,F10.3)
      PM=WM/386.
      PN=WN/386.
      PCG=W/386.
      TYPRUN = .01
      NTRUN = 1
      IF(SPEED .GT. 5.) 56,57
56  TYPRUN = .01
      NTRUN = 2
57  WRITE(6,55)
55  FORMAT(1F1,4EX,***** )
      WRITE(6,60)
60  FORMAT(4EX,46H***** INPUT DATA ***** )
      WRITE(6,61)
61  FORMAT(///1X,41H***** GENERAL AIRCRAFT DATA ***** )
      WRITE(6,62) PLANE
62  FORMAT(//,1X,8A19)
      WRITE(6,65) W,WM,MN,A,B,PHI
65  FORMAT(///,5X,*W=*,F10.1,5X,*WM=*,F10.2,5X,*MN=*,F10.2,5X,
1*A=*,F10.3,5X,*B=*,F10.3,5X,*MMI=*,F12.0)
      WRITE(6,66) SXH,SXH,SLH,SLH,PSARM,TAILRM
66  FORMAT(//,5X,*SXH=*,F8.1,5X,*SXH=*,F9.1,5X,*SLH=*,F9.1,5X,
1*SLH=*,F8.1,5X,*PSARM=*,F7.1,4X,*TAILRM=*,F7.1)
      WRITE(6,70) AAM,AHM,PAOH,VOM,OAM,TSM
70  FORMAT(//,5X,*AAM=*,F8.2,5X,*AHM=*,F8.2,6X,*PAOH=*,F9.2,4X,
1*VOM=*,F8.2,5X,*OAM=*,F8.2,5X,*TSM=*,F10.2)
      WRITE(6,74) AAN,AHN,PAON,VON,OAN,TSN
74  FORMAT(//,5X,*AAN=*,F8.2,5X,*AHN=*,F8.2,6X,*PAON=*,F9.2,4X,
1*VON=*,F8.2,5X,*OAN=*,F8.2,5X,*TSN=*,F10.2)
      WRITE(6,75) CL,CO,AREA,SPEED,THRUST,TAKOFF
75  FORMAT(//,5X,*CL=*,F9.3,5X,*CO=*,F9.3,6X,*AREA=*,F8.2,5X,
1*SPEED=*,F7.1,4X,*THRUST=*,F7.0,3X,*TAKOFF=*,F10.2)
      WRITE(6,76) (STROKN(I),PINON(I),I=1,NSCN)
76  FORMAT(//,3X,*STROKE NOSE  PIN DIAMETER  *//,2(3X,F10.3))
      WRITE(6,77) (STROKN(I),PINOP(I),I=1,NSCM)
77  FORMAT(//,3X,*STROKE MAIN  PIN DIAMETER  *//,2(3X,F10.3))
      WRITE(6,80)
80  FORMAT(1F1,1X,*MCDE SIPS  SINOSE*,4X,* SICG  SIMAIN SITAIL
1OMEGA GEN. PASS*)
      CO 85 I=1,NFM
85  WRITE(6,90) (I,SIPS(I),SINOSE(I),SICG(I),SIMAIN(I),SITAIL(I),
1CMEGA(I),GM(I))
90  FORMAT(//, 2X,I2,6(F7.2,2X),F10.1)
C ZMI =INITIAL MAIN GEAR POSITION INCHES
      WRITE(6,95)
95  FORMAT(///,4EX,40H***** INTIAL CONDITIONS ***** ,
C ZNI =INITIAL NOSE GEAR POSITION INCHES

```

```

C ZCGI=INITIAL C.G. POSITION INCHES
C THETAI=INITIAL PITCH ANGLE DEGREES
C THE ABOVE PARAMETERS ARE CALCULATED IN SUBROUTINE IC
  CALL IC( ZCGI,ZNI,ZNI,THETAI)
  WRITE(6,105) ZNI,ZNI,THETAI,ZCGI
105  FORMAT(/,5X,4HZNI=,F10.3,5X,4HZNI=,F10.3,5X,7HTHETAI=,F10.6,
      15X,5HZCGI=,F10.3)
      REACTN=(ZNI*TSN)*SXN
      REACTH=(ZNI*TSH)*SXH
      WRITE(6,106) XMAIN,XNOSE,REACTN,REACTH
106  FORMAT(/,3X,*XMAIN=*,F8.3,3X,*XNOSE=*,F8.3,3X,*REACTN=*,F10.0,
      13X,*REACTH=*,F10.0)
*****
C READ RUNWAY PROFILE DATA (ELEV)
C SITE= RUNWAY PROFILE AND DIRECTION
C NPTSS= # OF RUNWAY ELEVATION DATA POINTS
  WRITE (6,111)
111  FORMAT(*T*)
  DO 112 I=1,50
112  ELEV(I)=0.0
      READ(2,1) SITE
      READ(2,116) NPTSS
      NPTSS=NPTSS+50
116  FORMAT(I5)
      LD=51
117  LSD = LD + 9
      READ(2,118) (ELEV(I),I=LD,LSD)
118  FORMAT(10F7.3)
      N10=LD
      IF(LSD.GE.NPTSS) GO TO 120
      LD=LD+10
      GO TO 117
120  ELEV1=ELEV(51)
      DO 125 I=51,N10
125  ELEV(I) = ELEV(I) -ELEV1
      CALL RETURNS(2)
      DISTAN=0.
      LSD=LSD-90
      SLP=(LSD-50)*2
      SLP=ELEV(LSD)/SLP
      DO 126 I=51 ,N10
      ELEV(I)=ELEV(I)-SLP*DISTAN
126  DISTAN=DISTAN+2.
      IVAL=(A+B)/24.
      WRITE(6,130)
130  FORMAT(1H1,5X,* RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)*
      150X,*FEET DOWN THE RUNWAY*)
      WRITE(6,1) SITE
      LD1=1
135  LSD1 = LD1 + 9
      LPRIN = LSD1 * 2
      WRITE(6,140) (ELEV(I),I=LD1,LSD1),LPRIN
140  FORMAT(3X,10F10.9,10X,I0)
      LD1=LD1+10
      IF(LD1.GE.N10) GO TO 145
      GO TO 135
145  WRITE(6,150) LD1
150  FORMAT(42H***** END RUNWAY DATA ***** LD1=,I5)

```

```

WRITE(7,1) SITE
ENDRUN = NPTSS*2
PRN=(ENDRUN-100.)/1000.
RM=((ENDRUN-100.)-FLOAT(MRN*1000))/2.)+1100.
ENDRUN=ENDRUN-90.
T(2) = ZCGI
TD(2) = 0.
T(4) = ZPI
TD(4) = 0.
T(6) = ZNI
TD(6) = 0.
T(8) = THETA1
TD(8) = 0.
T(10) = 0.
TD(10) = SPEED
WRITE(6,155)
155  FORMAT(1H1,7X,*      XMAIN      XNOSE      FSM      FSN
1  TAILAC      SPEED      DIST.      CGACC      PSA      TIM
2E*)
CZ=0.
ZPM=0.
ZPN=0.
ZDOT=0.
ZNDOT=0.
J=1
160  YP(1) = ZDOT
YP(2)=ELEV(J)
YP(3)=ELEV(J+1)
YP(4)=ELEV(J+2)
YPN(1)=ZNDOT
YPN(2)=ELEV(IVAL)
YPN(3)=ELEV(IVAL+1)
YPN(4)=ELEV(IVAL+2)
Z=0Z
CALL COEFF (YPN,AN,BN,CN,ON)
CALL COEFF (YP,AM,BM,CM,CM)
ZDOT=BM
ZNDOT=BN
IF(M.GT.1) GC TO 245
M = M + 1
165  WRITE(6,170) XMAIN,XNOSE,FSM,FSN,TAILAC,TD(10),T(20),
1CGOUT,PSA,X
WRITE(7,900) TAILAC,CGOUT,PSA
900  FORMAT(3X,F10.3)
TIMEX = C.
170  FORMAT(3X,2(3X,F10.3),2(3X,F10.0),5(3X,F10.3),2X,F6.2)
*****
IF(IFPLOT.EQ.1) GO TO 230
IF(ABS(CGOUT).LE.ABS(STORE2).AND.ABS(STORE2).GE.ABS(STORE1))
1GO TO 1A0
175  STORE1 = STORE2
STORE2 = CGOUT
GO TO 190
180  IF(X-TIME(NN).GT..08) GO TO 185
IF(ABS(STORE2).GT..300CG) GO TO 185
GO TO 175
185  NN = NN + 1
CGACC(NN) = STORE2

```

```

      PROF(NN) = ZPN
      TIME(NN) = X - 10. * DX
      IF (TIME(NN).LT.0.) TIME(NN) = .01
      STORE1 = STORE2
      STORE2 = CGOUT
190   IF (ABS(PSA).LE.ABS(STORE4).AND.ABS(STORE4).GE.ABS(STORE3))
      GO TO 205
200   STORE3 = STORE4
      STORE4 = PSA
      GO TO 215
205   IF (X-TIME1(LL).GT..08) GC TO 210
      IF (ABS(STORE4).GT..32) GC TO 210
      GO TO 200
210   LL = LL + 1
      PSACC(LL) = STORE4
      TIME1(LL) = X - 10*DX
      IF (TIME1(LL).LE.0.) TIME1(LL) = .001
      STORE3 = STORE4
      STORE4 = PSA
215   IF (ABS(T(10)-RM).LT.5.0) GC TO 220
      GO TO 225
220   II = II + 1
      RMARK(II) = X
      RM = RM + 1000.
      ITT = II
225   IF (ABS(X-PP) .GT. .005) GO TO 230
      SSPLT(LLL) = T(10)
      STIME(LLL) = X
      COPLT(LLL) = T(10)
      LLL = LLL + 1
      PP = PP + 1.0
*****
230   IF (HQR.LE.80.) GO TO 235
      HQR=0.
      WRITE(6,155)
235   HQR = HQR + 1.
240   X = X + CX
      CALL TAYLOR(T,TO,T00)
      IF (T(10).GE.ENDRUN) GO TO 260
      IF (X.GE.300.) GO TO 263
      TIMEX=TIMEX+CX
      QDDCG=0.
      QDOPS=0.
      QDOTAL=0.
      DO 241 I=1,NFM
        QDOTAL=QDOTAL+QDD(I)*SITAIL(I)
        QDDCG=QDDCG+QDD(I)*SICG(I)
241   QDOPS=QDOPS+QDD(I)*SIPS(I)
      TAILAC=(T00(2)+TAILRP*T00(8))/386. +QDOTAL/386.
      PSA=(T00(2)-PSARP*T00(8))/386. +QDOPS/386.
      CGOUT=T00(2)/386. +QDDCG/386.
      IF (T(10).GE.TAKOFF) GO TO 250
      IF (Z.LT.4.) GO TO 245
      CZ=Z-4.
      J=J+2
      IVAL=IVAL+2
      GO TO 160
245   IF (TIMEX.LT.TYPRUN) GO TO 240

```

```

      GO TO 165
250  WRITE(6,255)
255  FORMAT(5X,* THE VEHICLE HAS TAKEN OFF*)
260  WRITE(6,262) ENDRUN,T(10)
262  FORMAT(3X,* END OF RUNWAY*,2F10.3)
C*****
      TOTAL = X/TYPRUN
      WRITE(6,300) TOTAL
300  FORMAT( * TOTAL NUMBER OF POINTS ON TAPE IS* F12.0)
263  MGH = X
      IF(IFPLOT.EQ.1) GO TO 285
      XLONG = FLOAT(MGH)
      WRITE(6,265) NN,LL
265  FORMAT(2I20)
      IF(NN.LE.1800.OR.LL.LE.1800) GO TO 266
      WRITE(6,267)
267  FORMAT(3X,*THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED
1  THEIR DIMENSIONED SIZE*)
266  CONTINUE
C266  CALL PLOTS(DATA,438)
C      CALL FACTOR (2.0)
C      CALL PLOT(3.0,-11.0,-3)
C      CALL PLOT(3.,.7,-3)
      TIME(NN+1) = 0.0
      TIME(NN+2) = 1.0
      TIME1(LL+1) = 0.0
      TIME1(LL+2) = 1.0
      CGACC(NN+1) = -1.0
      CGACC(NN+2) = 1.0
      PSACC(LL+1) = -1.0
      PSACC(LL+2) = 1.0
      CALL SCALE(PROF,10.,NN,1)
      PROF10 = PROF(NN+2) *10.
      IF(PROF10.GT.10.5) GO TO 270
      PRCF(NN+2) = 6.0
      IF(NPTSS.GE.1000) GO TO 270
      DO 269 I=1,NN
269  PROF(I)=PROF(I)+36.
270  CALL AXIS(0.,0.,11*TIME (SEC.),-11,XLONG,0.0,TIME(NN+1),
1  TIME(NN+2),0)
      IXLONG = XLONG
      CALL PLOT (XLONG,1.1,3)
      CALL PLOT (.,.1.1,2)
      CALL SYMBOL (.1,.4,.105,8*DISTANCE,0.,8)
      CALL SYMBOL (.1,.2,.105,5*SPEED,0.,5)
      DO 275 I=1,IXLONG
      CALL NUHEER(STIME(I),.2,.105,SSPLOT(I),0.0,4*HF4.0)
275  CALL NUHEER(STIME(I),.4,.105,DDPLOT(I),0.0,4*HF5.0)
      CALL PLOT (XLONG,1.5,3)
      CALL PLOT (0.,1.5,2)
      DO 280 I=1,ITT
280  CALL SYMBOL(RMARK(I),-.1,.245,70,0.0,-1)
      CALL PLOT (XLONG,1.9,3)
      CALL PLOT (0.,1.9,2)
      CALL SYMBOL(4.,9.,.14,PLANE,0.,40)
      CALL SYMBOL(4.,8.,.14,SITE,0.,40)
      XLONG2=XLONG/2.
C      CALL SYMEOL(XLONG2,9.,.14,11*AFFDL -FYS-,0.,11)

```

```

C      CALL SYMBOL(XLONG2,3.,.14,10HWPAGE OHIO,0.,10)
      CALL PLOT(0.,1.5,-3)
      CALL AXIS(0.,-1.0,3HCGA,3,2.0,90.,CGACC(NN+1),CGACC(NN+2),-1)
      CALL NUMBER(0.4,-.4,.105,-.4,00.0,4HF4.1)
      CALL NUMBER(0.5,.4,.105,+.4,00.0,4HF4.1)
      CALL PLOT(0.,-1.0,-3)
      CALL LINE(TIME,CGACC,NN,1,0,0)
      CALL PLOT (XLONG,3.1,3)
      CALL PLOT (0.,3.1,2)
      CALL PLOT(0.,3.5,-3)
      CALL AXIS(0.,-1.0,3HPSA,3,2.0,90.,PSACC(LL+1),PSACC(LL+2),-1)
      CALL PLOT(0.,0.,3)
      CALL PLOT(XLCNG,0.,2)
      CALL PLOT (XLONG,.4,3)
      CALL PLOT (-.1,.4,2)
      CALL NUMBER(0.5,.4,.105,+.4,00.0,4HF4.1)
      CALL NUMBER(0.4,-.5,.105,-.4,00.0,4HF4.1)
      CALL PLOT(0.,-1.0,-3)
      CALL LINE(TIME1,PSACC,LL,1,0,0)
      CALL PLOT(0.,-3.0,-3)
      CALL AXIS(-1.5,0.,15ELEVATION (IN.),15,10.0,90.0,PROF(NN+1),
1 PROF(NN+2),-1)
      CALL PLOT(0.,0.,-3)
      XPROF=.25+ABS(PROF(NN+1))/PROF(NN+2)
      CALL SYMEOL (2.,XPROF,.14,15HNOSE GEAR TRACK,0.,15)
      CALL LINE(TIME,PROF,NN,1,0,0)
      XSTOP=XLCNG+5.
      CALL PLOT (XSTOP,0.,-3)
      WRITE(6,290)
      CALL PLOT(0.,0.,40)
C      CALL PLOTE
285  STOP
299  FORMAT(*S*)
      END

```

```

SUBROUTINE TAYLOR(T,TD,TDD)
COMMON/FLEX1/SIMAIN(15),SINSE(15),SICG(15),SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GM(15),OMEGA(15)
COMMON/FLEX3/Q(15),QD(15),QDD(15)
COMMON/X1/W,MN,MN,MCG,MH,MN,A,B,MPI
COMMON/X2/PACH,VOM,AAM,A+H,OAM
COMMON/X3/PACH,VON,AAN,A+H,OAN
COMMON/X4/SXP,SYN,SLM,SLN,TSM,TSN
COMMON/X5/CL,CD,AREA,THRUST
COMMON/X6/Z,REACTH,REACTN,DX,NTRUN,SPEED
COMMON/X7/AH,BH,CH,DH,AN,BN,CN,DA
COMMON/X8/STROKH(20),PINCH(20),STROKN(20),PINDN(20),NSCH,NSCH
COMMON/X9/FSF,FSN,FTF,FTN,XMAIN,XNOSE,VELH,VELN
COMMON/X10/ZFH,ZPN
DIMENSION T(12),TD(12),TDD(12)
REAL MCG,MH,MN,MPI
1 Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
120 ZPH=AH+BH*Z+CH*Z**2+DH*Z**3
ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
QTN=0.
QTH=0.
QTON=0.
QTOM=0.
DO 130 I=1,NFM
QTN=QTN+Q(I)*SINSE(I)
QTH=QTH+Q(I)*SIMAIN(I)
QTOM=QTOM+Q(I)*SIMAIN(I)
130 QTON=QTON+QD(I)*SINSE(I)
XNOSE = (T(2) - B * T(8) - T(6)) +QTN
XMAIN = (T(2) + A * T(8) - T(4)) +QTH
VELH = TC(2) + A * TD(8) - TD(4) +QTOM
VELN = TC(2) - B * TD(8) - TD(6) +QTON
IF(XMAIN.GE.0.) XMAIN=-.1
IF(XNOSE.GE.0.) XNOSE=-.1
IF(VELH.EQ.0.) VELH=-.1
IF(VELN.EQ.0.) VELN=-.1
XHLK=ABS(XMAIN)
XNLK=ABS(XNOSE)
C NOSE AND MAIN DAMPING COEFF
CALL TLOCK(XHLK,SLOPH,YCEPH,STROKH,PINDN,NSCH)
CALL TLOCK(XNLK,SLOPN,YCEFN,STROKN,PINDN,NSCH)
AOM = OAM - ((SLOPEP*XHLK+YCEPH)**2)*.7/59
AON = OAN - ((SLOPFN*XNLK+YCEFN)**2)*.78539
CON= (.00008*(AOM**3.))/(2.*(.9*AOM)**2)
CON= (.00008*(AON**3.))/(2.*(.9*AON)**2)
C NOSE AND MAIN STRUT PNEUMATIC FORCES
SSM=(PAOP*VOP)/(((VOM/AAM)-XHLK))
SSN=(PAON*VON)/(((VON/AAN)-XNLK))
FTH = SXM * TSM * (T(4) - ZPH)
FTN = SYN * TSN * (T(6) - ZPN)
IF(FTH.GT.0.)FTH=0.
IF(FTN.GT.0.)FTN=0.
FSH=SXM*(-SSM+CON*VELH*ABS(VELH))
FSN=SYN*(-SSN+CON*VELN*ABS(VELN))
VLIFT = .001189*CL*AREA*(TD(10)*TC(10))
DRAGA=VLIFT*CD/CL
DRAGT =ABS(.025*FTH+.025*FTN)
IF(NTRUN.EQ.1) GO TO 125

```

```

IF(TD(10) .LT. SPEED) GO TO 125
THRUST=DRAGA+DRAGT
125 TOD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG
TOD(4)=(FSF-FTM-386.*SXM*MN)/(MN*SXM)
TOD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)
TOD(8) = -(FSF*A -FSN*B -DRAGT *(SLM+XMAIN))/MMI
TOD(10) = (THRUST-DRAGA-DRAGT)/(MCG*12.)
DO 200 I=1,NFM
200 QDD(I)=- (SIPAIN(I)*(FSM-REACTN)+SINOSI(I)*(FSN-REACTN)
1+.10*OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)
CO 1001 I = 2,10,2
T(I) = T(I) + TD(I)*DX + (TOD(I)*DX**2)/2.
1001 TD(I) = TD(I) + TOD(I)*DX
DO 1002 I=1,NFM
Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
1002 QD(I)=QD(I)+QDD(I)*DX
RETURN
END

```

```

SUBROUTINE IC( ZCGI,ZHI,ZNI,THETAI)
COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GM(15),OMEGA(15)
COMMON/FLEX3/Q(15),QD(15),QDD(15)
COMMON/X1/W,WM,WN,MCG,MH,MN,A,B,PMI
COMMON/X2/PAOM,VOM,AAM,AHM,CAM
COMMON/X3/PACN,VON,AAN,AHN,OAN
COMMON/X4/SXP,SYN,SLH,SLN,TSM,TSN
COMMON/X5/FSP,FSH,FTP,FTN,XMAIN,XNOSE,VELM,VELN
*****
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR TAXI
C FOR SXH MAIN AND SYN NOSE GEAR
C ZHI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C ZCGI= CG DEFLECTION
C THETAI= PITCH ANGLE
C XMAIN= MAIN LANDING GEAR STATIC STROKE
C XNOSE= NOSE GEAR STATIC STROKE
*****
      RM=W/(1.+A/B)
      RN=W-RM
      RM=RM/SXM
      RN=RN/SLN
      ZHI=-RM/TSM
      ZNI=-RN/TSN
      RSM=RM-WM
      RSN=RN-WN
      XNOSE=+PAON*VON/RSN-VON/AAN
      XMAIN=+PAOM*VOM/RSM-VOM/AAM
      THETAI=-(XNOSE+ZNI-(XMAIN+ZHI))/(B+A)
      ZCGI=XMAIN-A*THETAI+ZHI
      DO 10 I=1,NFM
      QD(I)=0.
10  G(I)=0.
      RETURN
      END

```

```

SUBROUTINE CCEFF (Y, A,B,C,D)
DIMENSION Y(4)
A=Y(2)
B=Y(1)
C=(96.*Y(1)+56.*Y(2)-64.*Y(3)+8.*Y(4))/(-128.)
D=(-16.*Y(1)-12.*Y(2)+16.*Y(3)-4.*Y(4))/(-128.)
RETURN
END

```

```

SUBROUTINE TLOOK (X,SLOPE,YCEPT,S,P,N)
DIMENSION S(30),P(30)
C
C   THIS IS A 2 DIMENSIONAL TABLE LOOK UP ROUTINE
C   WITH LINEAR INTERPCLATION
C
C   X IS THE CURRENT VALUE OF STROKE
C   SLOPE AND YCEPT ARE CALCULATED AND RETURNED
C   S AND P MAKE UP THE TABLE
C   N IS THE NUMBER OF VALUES IN THE TABLE
DO 1 I=1,N
  IF (X.GE.S(I).AND.X.LT.S(I+1))GO TO 2
1  CONTINUE
2  SLOPE=(P(I+1)-P(I))/(S(I+1)-S(I)+.01)
  YCEPT=P(I)-SLOPE*S(I)
  RETURN
END

```

```

      PROGRAM TAXI (INPUT, OUTPUT, TAPE5=INPUT, TAPE6=OUTPUT, TAPE3, TAPE2,
      1 TAPE7)
*****
C   THIS IS THE TAXI MAIN ROUTINE FOR A C-5A AIRCRAFT SIMULATION
*****
*****
*****
C   ****THIS DECK IS FOR THE C-5A AIRCRAFT ONLY****
C   THIS PROGRAM WILL PERFORM A SYMMETRIC
C   DYNAMIC TAXI ANALYSIS ON A FLEXIBLE
C   VEHICLE TRAVERSING A GIVEN RIGID RUNWAY
C   PROFILE.
*****
*****
      COMMON/FLEX*/SIMAIN1(15),SIMAIN2(15),SINOSE(15),SICG(15)
      1,SITAIL(15),SIPS(15)
      COMMON/FLEX2/WM,GM(15),CMEGA(15)
      COMMON/FLEX3/Q(15),QG(15),QDD(15)
      COMMON/X1/W,M,MN,MCG,MH,MN,A,B,C,MNI
      COMMON/X2/PACH,VON,AAN,AHN,OAH
      COMMON/X3/PACH,VON,AAN,AHN,OAH
      COMMON/X4/SXP,SN,SLP,SLN,TSM,TSN
      COMMON/X5/CL,CD,AREA,THRLST
      COMMON/X6/Z,REACTH1,REACTN,REACTP2,DX,NTRUN,SPEED
      COMMON/X7/AM,BH,CH,DM,AN,BN,CN,DA,MA,BMA,CHA,DMA
      COMMON/X8/STROKP(20),PINCH(20),STROKN(20),PINON(20),NSCH,NSCN
      COMMON/X9/FSF1,FSH2,FSN,FTH1,FTM2,FTN,XMAIN1,XMAIN2,XNOSE,
      1VELM1,VELM2,VELN
      COMMON/X10/ZPM,ZPHA,ZPN
      DIMENSION PLANE(8),SITE(8)
      DIMENSION T(18),TD(18),TDD(18)
      DIMENSION YP(4),YPN(4),DATA(438),YPA(4)
      DIMENSION ELEV(7500)
      DIMENSION CGACC(1800),TIME(1800),PSACC(1800),TIME1(1500)
      DIMENSION PRCF(1800),RMARK(20)
      DIMENSION SSPLT(300),STIME(300),DDPLOT(300)
      REAL MCG,MH,MN,MPI
      CALL PLOTS(160.,DUM,3)
      PSA=0.0
      CGOUT=0.0
      VDR=0.
      X=0.
      LLL = 1
      LL = 0
      STORE1 = 0.
      STORE2 = 0.
      STORE3 = 0.
      STORE4 = 0.
      NN = 0
      II = 0
      FP = 1.0
      P = 1
      ITT = 0
*****
C   READ AND PRINT INPUT DATA
*****

```

C W=VEHICLE WEIGHT AT CG (POUNDS)
 C A=DISTANCE MAIN GEAR TO CG (INCHES)
 C R=DISTANCE NOSE GEAR TO CG (INCHES)
 C C = DISTANCE FROM FRONT MAIN GEAR TO CG
 C 1 CORRESPONDS TO REAR MAIN GEAR
 C 2 CORRESPONDS TO FRONT MAIN GEAR
 C PHI=MASS MOMENT OF INERTIA (LB IN SEC SQ)
 C PLANE= AIRPLANE BEING SIMULATED AND GROSS WEIGHT
 C PSARM = DISTANCE OF PILOT STATION TO CG
 C TAILRM = DISTANCE OF TAIL STATION TO CG
 C TAKOFF= TAKE-OFF SPEED (FEET/SEC)
 C SPEED=INITIAL VEL OF AIRPLANE
 C THRUST= TOTAL AIRPLANE THRUST
 C CL=LIFT COEFF.
 C AREA=WING AREA
 C CD=DRAG COEFF.
 C WM=WEIGHT OF MAIN GEAR (EACH)
 C WN=WEIGHT OF NOSE GEAR
 C SXM= NUMBER OF MAIN GEAR STRUTS
 C SXN= NUMBER OF NOSE GEAR STRUTS
 C AMN HYDRAULIC PISTON AREA NOSE SQ INCHES
 C AAN PNEUMATIC PISTON AREA NOSE SQ INCHES
 C AMH HYDRAULIC PISTON AREA MAIN SQ INCHES
 C AAH PNEUMATIC PISTON AREA MAIN SQ INCHES
 C PAON NOSE STRUT PRELOAD PRESSURE PSI
 C PAOM MAIN STRUT PRELOAD PRESSURE PSI
 C VON NOSE STRUT INITIAL VOLUME CU. IN.
 C VOM MAIN STRUT INITIAL VOLUME CU. IN.
 C CAM ORIFACE AREA MAIN
 C CAN ORIFACE AREA NOSE
 C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES
 C DISTANCE FROM CL OF AXLE TO CG LINE
 C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES
 C DISTANCE FROM CL OF AXLE TO CG LINE
 C TSM MAIN TIRE SPRING CONSTANT PER STRUT
 C TSN NOSE TIRE SPRING CONSTANT PER STRUT
 C DX=TIME STEP SIZE
 C READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE
 C NSCN== OF METERING PIN CHANGES NOSE GEAR
 C NSCM== OF METERING PIN CHANGES MAIN GEAR
 C NFM = NUMBER OF FLEXIBLE MODES
 C SIXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)
 C GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)
 C OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)
 READ (5,1) PLANE
 1 FORMAT(8A10)
 READ(5,5) W, A, R, C, PHI
 5 FORMAT(4F10.1,F12.0)
 READ(5,10) PSARM, TAILRM
 10 FORMAT(2F10.2)
 READ(5,15) SPEED, THRUST, TAKOFF
 15 FORMAT(3F10.3)
 READ(5,20) CL, AREA, CD
 20 FORMAT(3F10.4)
 READ(5,25) WM, WN, SXM, SXN
 25 FORMAT(4F10.2)
 READ(5,30) AMN, AAN, AMH, AAH
 30 FORMAT(4F10.5)

```

35 READ(5,35) PACN,PAON,VON,VOM,OAH,OAN
   FORMAT(6F10.5)
   READ(5,40) SLM,SLN
40   FORMAT(2F10.3)
   READ(5,45) TSM,TSN
45   FORMAT(2F10.1)
   READ(5,50) OX
   READ(5,51) IFPLOT
50   FORMAT(F10.3)
   READ(5,51) NSCN
51   FORMAT(I5)
   READ(5,52) (STROKN(I),PINON(I),I=1,NSCN)
52   FORMAT(2(F10.3))
   READ(5,51) NSCN
   READ(5,52) (STROKN(I),PINON(I),I=1,NSCN)
   READ(5,51) NFM
   READ(5,53) (SIMAIN1(I),SIMAIN2(I),SINOS(I),SICG(I),SITAIL(I),
1SIPS(I),I=1,NFM)
53   FORMAT(6F10.3)
   READ(5,54) (CM(I),OMEGA(I),I=1,NFM)
54   FORMAT(F15.2,F10.3)
   MM=MM/386.
   PN=PN/386.
   MCG=M/386.
   TYPRUN = .01
   NTRUN= 1
   IF(SPEED .GT. 5.) 56,57
56   TYPRUN = .01
   NTRUN = 2
57   WRITE(6,55)
55   FORMAT(11F1,4EX,*****
   WRITE(6,60)
60   FORMAT(4EX,4EH,***** INPUT DATA *****)
   WRITE(6,61)
61   FORMAT(///1X,41H***** GENERAL AIRCRAFT DATA *****)
   WRITE(6,62) PLANE
62   FORMAT(///1X,8A10)
   WRITE(6,65) h,MM,MN,A,B,C,PMI
65   FORMAT(///,5X,*h=*,F10.1,5X,*MM=*,F10.2,5X,*MN=*,F10.2,5X,
1*A=*,F10.3,5X,*B=*,F10.3,5X,*C=*,F10.3,5X,*PMI=*,F12.0)
   WRITE(6,66) SXH,SXH,SLH,SLH,PSARH,TAILRH
66   FORMAT(///,5X,*SXH=*,F8.1,5X,*SXN=*,F9.1,5X,*SLH=*,F9.1,5X,
1*SLN=*,F8.1,5X,*PSARH=*,F7.1,4X,*TAILRH=*,F7.1)
   WRITE(6,70) AAH,AHH,PAOH,VOM,OAH,TSM
70   FORMAT(///,5X,*AAH=*,F8.2,5X,*AHH=*,F8.2,6X,*PAOH=*,F9.2,4X,
1*VOM=*,F8.2,5X,*OAH=*,F8.2,5X,*TSM=*,F10.2)
   WRITE(6,74) AAN,AHN,PAON,VON,OAN,TSN
74   FORMAT(///,5X,*AAN=*,F8.2,5X,*AHN=*,F8.2,6X,*PAON=*,F9.2,4X,
1*VON=*,F8.2,5X,*OAN=*,F8.2,5X,*TSN=*,F10.2)
   WRITE(6,75) CL,CD,AREA,SPEED,THRUST,TAKOFF
75   FORMAT(///,5X,*CL=*,F9.3,5X,*CD=*,F9.3,6X,*AREA=*,F8.2,5X,
1*SPEED=*,F7.1,4X,*THRUST=*,F7.0,3X,*TAKOFF=*,F10.2)
   WRITE(6,76) (STROKN(I),PINON(I),I=1,NSCN)
76   FORMAT(///,3X,*STROKE NOSE PIN DIAMETER *///,2(3X,F10.3))
   WRITE(6,77) (STROKN(I),PINON(I),I=1,NSCN)
77   FORMAT(///,3X,*STROKE MAIN PIN DIAMETER *///,2(3X,F10.3))
   WRITE(6,80)
80   FORMAT(11F1,1X,*MODE SIPS SINOS SICG SIMAIN1 SIMAIN2

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15ITAIL (MEGA GEN. MASS*)
DO 85 I=1,NFM
85 WRITE(6,90) (I,SIPS(I),SINCSE(I),SICG(I),SIHAIN1(I),SIHAIN2(I),
15ITAIL(I),OMEGA(I),GM(I))
90 FORMAT(//, 2X,I2,7(F7.2,2X),F10.1)
C ZMI =INITIAL MAIN GEAR POSITION INCHES
WRITE(6,95)
95 FORMAT(//,46X,40H***** INITIAL CONDITIONS *****
C ZNI =INITIAL NOSE GEAR POSITION INCHES
C ZCGI=INITIAL C.G. POSITION INCHES
C THETA1=INITIAL PITCH ANGLE DEGREES
C THE ABOVE PARAMETERS ARE CALCULATED IN SUBROUTINE IC
CALL IC(ZCGI,ZMI1,ZMI2,ZNI,THETA1)
WRITE(6,105)ZMI1,ZMI2,ZNI,THETA1,ZCGI
105 FORMAT(/,5X,*ZMI1=*,F7.3,5X,*ZMI2=*,F7.3,6X,*ZNI=*,F7.3,7X,
1*THETA1=*,F7.3,6X,*ZCGI=*,F10.3)
REACTN=(ZNI*TSN)*SXN
REACTM1=(ZMI1*TSN)*SXM/2.
REACTM2=(ZMI2*TSN)*SXM/2.
WRITE(6,106)XMAIN1,XMAIN2,XNOSE,REACTM1,REACTM2,REACTN
106 FORMAT(/5X,*XMAIN1=*,F7.2,3X,*XMAIN2=*,F7.2,4X,*XNOSE=*,F7.2,5X,
1*REACTM1=*,F10.0,2X,*REACTM2=*,F10.0,2X,*REACTN=*,F10.0)
*****
C READ RUNWAY PROFILE DATA (ELEV)
C SITE= RUNWAY PROFILE ANGLE DIRECTION
C NPTSS= # OF RUNWAY ELEVATION DATA POINTS
WRITE(6,111)
111 FORMAT(*T*)
DO 112 I=1,50
112 ELEV(I)=0.0
READ(2,1) SITE
READ(2,116) NPTSS
NPTSS=NPTSS+50
116 FORMAT(I5)
LD=51
117 LSD = LD + 9
READ(2,116) (ELEV(I),I=LC,LSD)
118 FORMAT(10F7.3)
N10=LD
IF(LSD.GE.NPTSS) GO TO 120
LD=LD+10
GO TO 117
120 ELEV1=ELEV(51)
DO 125 I=51,N10
125 ELEV(I) = ELEV(I)-ELEV1
CALL RETURNS(2)
DISTAN=0.
LSD=LSD-50
SLP=(LSD-50)*2
SLP=ELEV(LSD)/SLP
DO 126 I=51,N10
ELEV(I)=ELEV(I)-SLP*DISTAN
126 DISTAN=DISTAN+2.
IVAL=(A+E)/24.
VALA=(A+C)/24.
IVALA=VALA
WRITE(6,130)
130 FORMAT(1+1,5X,* RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)*

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```

150X,*FEET DOWN THE RUNWAY*)
WRITE(6,1) SITE
LD1=1
135 LSD1 = LD1 + 9
LPRIN = LSD1 * 2
WRITE(6,140) (ELEV(I),I=LD1,LSD1),LPRIN
140 FORMAT(3X,10F10.5,10X,I8)
LD1=LD1+10
IF(LD1.GE.N10) GO TO 145
GO TO 135
145 WRITE(6,150) LD1
150 FORMAT(42H***** END RUNWAY DATA ***** LD1=,I5)
WRITE(7,1) SITE
ENDRUN = NPTSS*2
PRM=(ENDRUN-100.)/1.00.
RM=((ENDRUN-100.)-FLOAT(MFM*1000))/2.)+1100.
ENDRUN=ENDRUN-90.
T(2) = ZCGI
TD(2) = 0.
T(4) = ZPI1
TD(4) = 0.
T(6) = ZAI
TD(6) = 0.
T(8) = THETA1
TD(8) = 0.
T(10) = 0.
TD(10)=SPEED
T(12) = ZMI2
TD(12) = 0.0
T(14)= TD(14) =TDD(14) = 0.0
T(16)= TD(16) =TDD(16) = 0.0
T(18)= TD(18) =TDD(18) = 0.0
WRITE(6,155)
155 FORMAT(1H1,7X,* XMAIN1 XNOSE FSM1
1 TAILAC SPEED DIST. CGACC PSA FSN TIM
2E*)
CZ=0.
ZFM=0.
ZPN=0.
ZOOT=0.
ZNDOT=0.
ZPHA = 0.0
ZADOT=0.
J=1
160 YP(1) = ZOOT
YP(2)=ELEV(J)
YP(3)=ELEV(J+1)
YP(4)=ELEV(J+2)
YPN(1)=ZNDOT
YPN(2)=ELEV(IVAL)
YPN(3)=ELEV(IVAL+1)
YPN(4)=ELEV(IVAL+2)
YPA(1)=ZADOT
YPA(2) = ELEV(IVALA)
YPA(3) = ELEV(IVALA+1)
YPA(4) = ELEV(IVALA+2)
Z=0Z
CALL COEFF (YPN,AN,BN,CN DN)

```

```

CALL COEFF (YP,AM,BM,CM,DM)
CALL COEFF(YPA,AMA,BMA,CMA,DMA)
ZDOT=BM
ZNDOT=BM
ZA00T=BPA
IF(M.GT.1) GO TO 245
M = M + 1
165 WRITE(6,170) XMAIN1,XNCSE,FSH1,FSN,TAILAC,TD(10),T(10),
1CGOUT,PSA,X
WRITE(7,900) TAILAC,CGOUT,PSA
900 FORMAT(1X,F10.3)
TIMEX=..
170 FORMAT(3X,2(3X,F10.3),2(3X,F10.0),5(3X,F10.3),2X,F6.2)
*****
IF(IFPLOT,EQ.1) GO TO 230
IF(ABS(CGOUT).LE.ABS(STORE2).AND.ABS(STORE2).GE.ABS(STORE1))
GO TO 180
175 STORE1 = STORE2
STORE2 = CGOUT
GO TO 190
180 IF(X-TIME(NN).GT..C8) GO TO 185
IF(ABS(STORE2).GT..30000) GO TO 195
GO TO 175
185 AN = NN + 1
CGACC(NN) = STORE2
PROF(NN) = ZPN
TIME(NN) = X - 10. * DX
IF(TIME(NN).LT.0.) TIME(NN) = .01
STORE1 = STORE2
STORE2 = CGOUT
190 IF(ABS(PSA).LE.ABS(STORE4).AND.ABS(STORE4).GE.ABS(STORE3))
GO TO 205
200 STORE3 = STORE4
STORE4 = PSA
GO TO 215
205 IF(X-TIME1(LL).GT..38) GO TO 210
IF(ABS(STORE4).GT..32) GO TO 210
GO TO 200
210 LL = LL + 1
PSACC(LL) = STORE4
TIME1(LL)=X - 10*DX
IF(TIME1(LL).LE.0.) TIME1(LL) = .001
STORE3 = STORE4
STORE4 = PSA
215 IF(ABS(T(10)-RM).LT.5.0) GO TO 220
GO TO 225
220 II = II + 1
RMARK(II) = X
RM = RM + 1000.
ITT = II
225 IF(ABS(X-PP).GT..005) GO TO 230
SSPLOT(LLL) = T(10)
STIME(LLL) = X
COPILOT(LLL) = T(10)
LLL = LLL + 1
PP = PP + 1.0
*****
230 IF(MDR.LE.60.) GO TO 235

```

```

      MOR=0.
      WRITE(6,155)
235  MOR = MOR + 1.
240  X = X + CX
      CALL TAYLOR(T,TO,TDD)
      IF(T(10).GE.ENDRUN) GO TO 260
      IF(X.GE.300.) GO TO 263
      TIMEX=TIMEX+DX
      QDDCG=0.
      QDOOPS=0.
      QDOTAL=0.
      DO 241 I=1,NFM
        QDOTAL=QDOTAL+QDD(I)*SITAIL(I)
        QDDCG=QDDCG+QDD(I)*SICG(I)
241  QDOOPS=QDOOPS+QDD(I)*SIPS(I)
      TAILAC=(TDD(2)+TAILRM*TDD(8))/386. +QDOTAL/386.
      PSA=(TDD(2)-PSARM*TDD(8))/386. +QDOOPS/386.
      CGOUT=TDD(2)/386. +QDDCG/386.
      IF(TD(10).GE.TAKOFF) GO TO 250
      IF(Z.LT.4.) GO TO 245
      CZ=Z-4.
      J=J+2
      IVAL=IVAL+2
      IVALA = IVALA + 2
      GO TO 160
245  IF(TIMEX.LT.TYPRUN) GO TO 240
      GO TO 165
250  WRITE(6,255)
255  FORMAT(5X,* THE VEHICLE HAS TAKEN OFF*)
260  WRITE(6,262) ENDRUN,T(10)
262  FORMAT(3X,* END OF RUNWAY*,2F10.3)
*****
      TOTAL = X/.01
      WRITE(6,300) TOTAL
300  FORMAT(* TOTAL NUMBER OF PCINTS ON TAPE IS*F12.0)
263  MGN = X
      IF(IFPLOT.EQ.1) GO TO 285
      XLCNG = FLOAT(MGN)
      WRITE(6,265) NN,LL
265  FORMAT(2I20)
      IF(NN.LE.1800.OR.LL.LE.1800) GO TO 266
      WRITE(6,267)
267  FORMAT(3X,*THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED
1 THEIR DIMENSIONED SIZE*)
266  CONTINUE
C266  CALL PLOTS(DATA,438)
C      CALL FACTOR (2.0)
C      CALL PLOT(0.0,-11.(-3)
C      CALL PLOT(3.,.7,-3)
      TIME(NN+1) = 0.0
      TIME(NN+2) = 1.0
      TIME1(LL+1) = 0.0
      TIME1(LL+2) = 1.0
      CGACC(NN+1) = -1.0
      CGACC(NN+2) = 1.0
      PSACC(LL+1) = -1.0
      PSACC(LL+2) = 1.0
      CALL SCALE(PROF,10.,NN,1)

```

```

PROF10 = PROF(NN+2) *10.
IF(PROF10.GT.10.5) GO TO 270
PROF(NN+2) = 6.0
IF(NPTSS.GE.1000) GO TO 270
DO 269 I=1,NN
269 PROF(I)=PROF(I)+36.
270 CALL AXIS(0.,0.,11*TIME (SEC.),-11,XLONG,0.0,TIME(MN+1),
1TIME(NN+2),3)
IXLONG = XLONG
CALL PLCT (XLONG,1.1,1)
CALL PLOT (0.,1.1,2)
CALL SYMBOL (1.,4.,105,8*DISTANCE,0.,8)
CALL SYMBOL (1.,2.,105,5*SPD,0.,5)
DO 275 I=1,IXLONG
CALL NUMBER(STIME(I),.2.,105,SSPLOT(I),0.0,4*HF4.0)
275 CALL NUMBER(STIME(I),.4.,105,DDPLOT(I),0.0,4*HF5.0)
CALL PLOT (XLONG,1.5,3)
CALL PLOT (0.,1.5,2)
DO 280 I=1,ITT
280 CALL SYMBOL(RMARK(I),-.1.,245,70,0.0,-1)
CALL PLOT (XLONG,1.9,3)
CALL PLOT (0.,1.9,2)
CALL SYMBOL(4.,9.,14,PLANE,0.,4C)
CALL SYMBOL(4.,8.,14,SITE,0.,40)
XLONG2=XLONG/2.
CALL PLOT(0.,1.5,-3)
CALL AXIS(0.,-1.,3*HCGA,3,2.0,90.,CGACC(NN+1),CGACC(NN+2),-1)
CALL NUMBER(0.4,-.4.,105,-.4,00.0,4*HF4.1)
CALL NUMBER(0.5,+.4.,105,+.4,00.0,4*HF4.1)
CALL PLOT(0.,-1.0,-3)
CALL LINE(TIME,CGACC,NN,1,0,74)
CALL PLOT (XLONG,3.1,3)
CALL PLOT (0.,3.1,2)
CALL PLOT(0.,3.5,-3)
CALL AXIS(0.,-1.,3*HPSA,3,2.0,90.,PSACC(LL+1),PSACC(LL+2),-1)
CALL PLOT(0.,0.,3)
CALL PLOT(XLONG,0.,2)
CALL PLOT (XLONG,.4,3)
CALL PLCT (-.1.,4,2)
CALL NUMBER(0.5,.4.,105,+.4,00.0,4*HF4.1)
CALL NUMBER(0.4,-.5.,105,-.4,00.0,4*HF4.1)
CALL PLOT(0.,-1.0,-3)
CALL LINE(TIME,PSACC,LL,1,0,0)
CALL PLOT(0.,-3.0,-3)
CALL AXIS(-1.5,0.,15*ELEVATION (IN.),15,10.0,90.0,PROF(NN+1),
1PROF(NN+2),-1)
CALL PLOT(0.,0.,-3)
XPROF=.25+ABS(PROF(NN+1))/PROF(NN+2)
CALL SYMBOL (2.,XPROF,.14,15*NOSE GEAR TRACK,0.,15)
CALL LINE(TIME,PROF,NN,1,0,0)
XSTOP=XLONG+5.
CALL PLOT (XSTOP,0.,-3)
WRITE(6,290)
CALL PLOT(0.,0.,40)
C CALL PLOT
285 STOP
290 FORMAT(*S*)
END

```

```

SUBROUTINE TAYLOR(T,TD,TDD)
COMMON/FLEX1/SIMAIN1(15),SIMAIN2(15),SINOS(15),SICG(15)
1,SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GM(15),OMEGA(15)
COMMON/FLEX3/Q(15),QD(15),QDD(15)
COMMON/X1/W,WM,WN,MCG,MH,MN,A,B,C,MHI
COMMON/X2/PACH,VON,AAM,AHM,OAM
COMMON/X3/PACN,VON,AAN,AHN,OAN
COMMON/X6/Z,REACTH1,REACTN,REACTH2,DX,NTRUN,SPEED
COMMON/X5/CL,CD,AREA,THRUST
COMMON/X4/SXP,SN,SLP,SLN,TSM,TSN
COMMON/X7/AH,BH,CH,DH,AN,BN,CN,DN,AMA,BMA,CMA,DMA
COMMON/X8/STROKP(20),PINDN(20),STROKN(20),PINDN(20),NSCN,NSCN
COMMON/X9/FSF1,FSH2,FSN,FTM1,FTM2,FTN,XMAIN1,XPAIN2,XNOSE,
1VELM1,VELM2,VELN
COMMON/X10/ZPH,ZPHA,ZPN
DIMENSION T(18), TD(18), TDD(18)
REAL MCG,MH,MN,MHI
*****
C THIS THE TAYLOR SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
*****
1 Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
  ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
  ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
  ZPHA=APA+BP*Z+CPA*Z**2+DPA*Z**3
  QTN=0.
  QTM1=0.0
  CTM2=0.0
  CTON=0.
  CTOM1=0.0
  CTOM2=0.0
  DO 10 I=1,NFM
    QTN=QTN+Q(I)*SINOS(I)
    QTM1=QTM1+Q(I)*SIMAIN1(I)
    CTM2=CTM2+Q(I)*SIMAIN2(I)
    CTOM1=CTOM1+QD(I)*SIMAIN1(I)
    CTOM2=CTOM2+QD(I)*SIMAIN2(I)
10 QTON=QTN+QD(I)*SINOS(I)
  XNOSE=(T(2)-B*T(8)-T(6))+QTM
  XMAIN1=(T(2)+A*T(8)-T(4))+QTM1
  XMAIN2=(T(2)-C*T(8)-T(12))+QTM2
  VELN=TC(2)-B*TD(8)-TD(6)+QTON
  VELM1=TD(2)+A*TD(8)-TD(4)+QTM1
  VELM2=TD(2)-C*TD(8)-TD(12)+QTM2
C
C CALCULATE SPRING AND DAMPING COEFFICIENTS
C
  IF(XNOSE.GT.0.) XNOSE=-.001
  IF(XMAIN1.GT.0.) XMAIN1=-.001
  IF(XMAIN2.GT.0.) XMAIN2=-.001
  IF(VELN.EQ.0.) VELN=.001
  IF(VELM1.EQ.0.) VELM1=.001
  IF(VELM2.EQ.0.) VELM2=.001
  VELN=VELN-TD(14)
  VELM1=VELM1-TD(18)
  VELM2=VELM2-TD(16)
  XNLK=ABS(XNOSE)
  XMLK1=ABS(XMAIN1)

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```

XMLK2 = ABS(XMAIN2)
CALL TLOCK(XMLK, SLOPEN, YCEPN, STRCKN, PINDN, NSCN)
CALL TLOCK(XPLK1, SLOPEM1, YCEPM1, STROKM, PINDM, NSCM)
CALL TLOCK(XMLK2, SLOPEM2, YCEPM2, STROKM, PINDM, NSCM)
AON = SLOPEN*XNLK + YCEPN
AOM1 = SLOPEP1*XMLK1 + YCEPM1
AOM2 = SLOPEP2*XMLK2 + YCEPM2
CON = (.00008*(AHN**3.)) / (2.*(1.9*ON)**2)
COM1 = (.00008*(AHM**3.)) / (2.*(1.9*AOM1)**2)
COM2 = (.00008*(AHM**3.)) / (2.*(1.9*AOM2)**2)
SSN = (PAON*VON) / (((VON/AAN) - XNLK))
SSM1 = (PAOM1*VOM) / (((VOM/AAM) - XMLK1))
SSM2 = (PAOM2*VOM) / (((VOM/AAM) - XMLK2))
FTN = SXN* TSA * (T(6) - ZPN)
FTM1 = (SXM/2.)*TSM*(T(4)-ZPM)
FTM2 = (SXM/2.)*TSM*(T(12)-ZPHA)
IF(FTN.GT.0.)FTN=0.
IF(FTM1.GT.0.)FTM1=0.0
IF(FTM2.GT.0.)FTM2=0.0
IF(T(14).LT.0.000)SSN = (2937242.)/(329.38)-XNLK)
IF(T(16).LT.0.000)SSM2 = (5124326.59)/(37.893)-XMLK2)
IF(T(18).LT.0.000)SSM1 = (5124326.96)/(37.89)-XMLK1)
FSN = SXN*(-SSN+CON*VELN*ABS(VELN))
FSM1 = (SXM/2.)*(-SSM1 + COM1*VELM1*ABS(VELM1))
FSM2 = (SXM/2.)*(-SSM2 + COM2*VELM2*ABS(VELM2))
VLIFT = .001189*CL*AREA*(TD(10)*TD(10))
ORAGA = VLIFT*CO/CL
CRAGT = ABS(.025*FTM1 + .025*FTM2 + .025*FTN)
IF(NTRUN .EQ. 1) GO TO 125
IF(TD(10) .LT. SPEED) GO TO 125
THRUST = ORAGA + CRAGT

```

C SECONDARY PISTON CALCULATIONS

```

125 CON = .5
COM1 = .5
COM2 = .5
IF(TD(14).GT.0.0)CON = 5.0
IF(TD(16).GT.0.0)COM2 = 5.0
IF(TD(18).GT.0.0)COM1 = 5.0
F2N = 2733218. / (18.43 - ABS(T(14))) - 20.*TD(14) - CON*TD(14)*ABS(
1TD(14))
F2M2 = 4E43757. / (26.21 - ABS(T(16))) - 20.*TD(16) - COM2*TD(16)*ABS(
1TD(16))
F2M1 = 4E43757. / (26.21 - ABS(T(18))) - 20.*TD(18) - COM1*TD(18)*ABS(
1TD(18))
FSTN = FSN* .803 + F2N
FST1 = (FSM1/2.)*.798 + F2M1
FST2 = (FSM2/2.)*.798 + F2M2
TDD(2) = (-FSN-FSM1-FST2-MCG*386.+VLIFT)/MCG
TDD(4) = (FSP1-FTH1-MM*772.)/(MM*2.)
TDD(6) = (FSN-FTN-MM*386.)/MM
TDD(8) = (-FSP1*A -FSM2*C -FSN*B -ORAGT*(SLM+XMAIN1))/MMI
TDD(10) = (THRUST-ORAGA-CRAGT)/(MCG+MM+MM)*12.)
TDD(12) = (FSP2-FTH2-MM*772.)/(MM*2.)
TDD(14) = FSTN/.259

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```

TDD(16) = FST2/.259
TDD(18) = FST1/.259
CO 20 I=1,NFM
20 QDD(I) = -(SINAIN1(I)*(FSM1-REACTH1) + SINAIN2(I)*(FSM2-REACTH2)
1+(FSN-REACTN)*SINOS(I) + .2*OMEGA(I)*GN(I)*QD(I) + CMGA(I)**2*2*
2GN(I)*Q(I))/GN(I)
DX = .001
IF(FSTN.LT.8000..OR.T(14).LT.0.0) DX = .00005
IF(FST1.LT.8000..OR.T(16).LT.0.0) DX = .00005
IF(FST2.LT.8000..OR.T(18).LT.0.0) DX = .00005
IF(ABS(TC(14)).GT..001) DX = .00005
IF(ABS(TC(16)).GT..001) DX = .00005
IF(ABS(TC(18)).GT..001) DX = .00005
CO 30 I=2,18,2
T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.
30 TD(I) = TD(I) + TOD(I)*DX
IF(T(14).GE.-.0001.AND.TC(14).GE.0.000) T(14)=TD(14)=TDD(14)=0.0
IF(T(16).GE.-.0001.AND.TC(16).GE.0.000) T(16)=TD(16)=TDD(16)=0.0
IF(T(18).GE.-.0001.AND.TC(18).GE.0.000) T(18)=TD(18)=TDD(18)=0.0
CO 40 I=1,NFM
C(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
40 QD(I)=QD(I)+QDD(I)*DX
RETURN
END

```

```

SUBROUTINE IC(ZCGI,ZMI1,ZMI2,ZNI,THETAI)
COMMON/X1/W,MH,MN,MCG,MH,MA,A,B,C,MHI
COMMON/X2/PACH,VCH,AAM,AHM,OAM
COMMON/X3/PAGN,VON,AAN,APN,OAN
COMMON/X4/SXZ,SXN,SLM,SLR,TSM,TSN
COMMON/X6/Z,REACTM1,REACTN,REACTM2,DX,NTRUN
COMMON/X9/FSH1,FSH2,FSN,FTM1,FTM2,FTN,XMAIN1,XMAIN2,XNOSE,
1VELM1,VELM2,VELN
*****
C THIS IS THE IC SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
*****
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR TAXI
C FOR SXN MAIN AND SXN NOSE GEAR
C ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C ZCGI= CG DEFLECTION
C THETAI= PITCH ANGLE
C XMAIN= MAIN LANDING GEAR STATIC STROKE
C XNOSE= NOSE GEAR STATIC STROKE
*****
1 RM1 = 80000.
10 RM1=RM1 +50.
RM2 = (RP1*(A+B) - W*B)/(C-B)
RN = W-RP1 -RM2
RM1T = RM1/2.
RM2T = RP2/2.
ZNI= -RN/TSN
ZMI1 = -RM1T/TSM
ZMI2 = -RM2T/TSM
RM1T = RP1T - WM
RM2T = RP2T-WM
RN=RN-WN
XNOSE=PAGN*VCH/RN - VON/AAN
XMAIN1=PAOM*VCH/RM1T-VCH/AAM
IF(RM1T.GT.252000.) XMAIN1 = 5223296./RM1T - 37.89
IF(RM2T.GT.252000.) XMAIN2 = 5223296./RM2T - 37.89
THETAI=((XMAIN1+ZMI1)-(XNOSE+ZNI))/(B+A)
XMAIN2T = XMAIN1-THETAI*(A+C) -ZMI2 +ZMI1
ZCGI = XMAIN1-A*THETAI+ ZMI1
IF(RM1.GT.450000.) GO TO 20
IF(ABS(XMAIN2-XMAIN2T).LT..006) GO TO 30
GO TO 10
20 WRITE(6,*)
40 FORMAT(1X,*NO INITIAL CONDITIONS HAVE BEEN FOUND*)
30 IF(ZNI.GT.0.0) GO TO 10
RETURN
END

```

```

SUBROUTINE CCEFF (Y, A,B,C,D)
DIMENSION Y(4)
*****
C THIS IS THE COEFF SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
*****
1  A=Y(2)
   B=Y(1)
   C=(95.*Y(1)+56.*Y(2)-64.*Y(3)+8.*Y(4))/(-128.)
   D=(-16.*Y(1)-12.*Y(2)+16.*Y(3)-4.*Y(4))/(-128.)
RETURN
END

```

```

      SUBROUTINE TLOOK (X,SLOPE,YCEPT,S,P,N)
      DIMENSION S(30),P(30)
      *****
C   THIS IS THE TLOOK SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
      *****
C
C   THIS IS A 2 DIMENSIONAL TABLE LOOK UP ROUTINE
C   WITH LINEAR INTERPOLATION
C
C   X IS THE CURRENT VALUE OF STROKE
C   SLOPE AND YCEPT ARE CALCULATED AND RETURNED
C   S AND P MAKE UP THE TABLE
C   N IS THE NUMBER OF VALUES IN THE TABLE
      DO 1 I=1,N
      IF(X.GE.S(I).AND.X.LT.S(I+1))GO TO 2
1      CONTINUE
2      SLOPE=(P(I+1)-P(I))/(S(I+1)-S(I)+.01)
      YCEPT=P(I)-SLOPE*S(I)
      RETURN
      END

```

```

SUBROUTINE TAYLOR(T,TD,TCO)
*****
C THIS IS THE TAYLOR SUBROUTINE FOR F-4 AIRCRAFT SIMULATION
*****
COMMON/FLEX1/SIPAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GP(15),CMGA(15)
COMMON/FLEX3/Q(15),QD(15),QDD(15)
COMMON/X1/W,MN,MN,MCG,MH,MN,A,B,PMI
COMMON/X2/PACH,VON,AAM,AHM,OAM
COMMON/X3/PACN,VON,AAN,AHN,OAN
COMMON/X4/SAP,SAN,SLP,SLN,TSM,TSN
COMMON/X5/CL,CD,AREA,THRUST
COMMON/X6/Z,REACTH,REACTN,CX,NTRLN,SPEED
COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
COMMON/X8/STROKX(20),PINCH(20),STROKN(20),PINDN(20),NSCH,NSCN
COMMON/X9/FSF,FSN,FTP,FTN,XMAIN,XNOSE,V,VELN
COMMON/X10/ZPH,ZPN
DIMENSION T(12),TD(12),TCO(12)
REAL MCG,MH,MN,PMI
1 Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
QTN=0.
CTM=0.
GTCN=0.
GTCM=0.
DO 10 I=1,NFM
QTN=QTN+Q(I)*SINOSE(I)
CTM=CTM+C(I)*SIPAIN(I)
GTCM=GTCM+QC(I)*SIPAIN(I)
10 QTCN=QTCN+QC(I)*SINOSE(I)
XNOSE = (T(2) - B * T(8) - T(6)) + QTN
XMAIN = (T(2) + A * T(8) - T(4)) + QTM
VELM = TC(2) + A * TD(8) - TD(4) + QTCM
VELN = TC(2) - B * TD(8) - TD(6) + QTCN
IF(XMAIN.GE.0.) XMAIN=-.1
IF(XNOSE.GE.0.) XNOSE=-.1
IF(VELM.EQ.0.) VELM=-.1
IF(VELN.EQ.0.) VELN=-.1
XMLK=ABS(XMAIN)
XNLK=ABS(XNOSE)
C NOSE AND MAIN DAMPING COEFF
CALL TLOCK(XMLK,SLOPEM,YCEPM,STROCKM,PINDM,NSCM)
CALL TLOCK(XNLK,SLOPEN,YCEPN,STROCKN,PINDN,NSCN)
AOM = SLOPEM*ABS(XPAIN) + YCEPM
AON = SLOPEN*ABS(XNOSE) + YCEPN
IF(ABS(XPAIN).GT.13.86.AND.VELM.LT.0.0) AOM = AOM + .04906
IF(VELN.GT.0.0) AON = .8552-AON
IF(VELM.GT.0.0) AOM = .855 - AOM + .4536
CON=(.00008*(AMN**3.))/(2.*(1.9*AGN)**2)
COM=(.00008*(AHN**3.))/(2.*(1.9*ACH)**2)
IF(VELN.GT.0.0.AND.ABS(XPAIN).GT.13.86) COM = COM + 18.72
C NOSE AND MAIN STRUT PNEUMATIC FORCES
IF(ABS(XPAIN).GT.13.90) SSM = 19531.73/(2.2925-ABS(XMAIN+13.86))
IF(ABS(XPAIN).LT.13.86) SSM = (PACH*VON)/(((VON/AAM)-ABS(XMAIN)))
IF(ABS(XPAIN).GE.13.86.AND.ABS(XPAIN).LE.13.90) SSM = (1865.
1+ 171000.*(ABS(XMAIN)-13.86))
SSN=(PAON*VON)/(((VON/AAN)-XNLK))

```

```

FTM = SXP * TSM * (T(4) - ZPH)
FTN = SXN * TSM * (T(6) - ZFN)
IF (FTM.GT.0.)FTM=0.
IF (FTN.GT.0.)FTN=0.
FSN=SXN*(-SSA+CON*VELN*ABS(VELN) )
FSM=SXM*(-SSM+COM*VELM*ABS(VELM) )
IF (ABS(XPAIN).GE.15.88) FSM = FSM +10000000.*(XPAIN + 15.88)
IF (FSM.GT.0.0) FSM = 0.0
IF (FSN.GT.0.0) FSM = 0.0
VLIFT =.001169*CL*AREA*(TD(10)*TD(10))
DRAGA=VLIFT*CD/CL
CRAGT =AES(.025*FTM+.025 *FTN
TC(NTRUN.EQ.1) GO TO 20
IF (TD(10) .LT. SPEED) GO TO 20
THRUST=DRAGA+DRAGT
20  TOD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG
TOD(4)=(FSN-FTN-386.*SXM*MM)/(MM*SXM)
TOD(6)=(FSN-FTN-MM*386.*SXN)/(MM*SXN)
TOD(8) = -(FSN*A -FSN*B -CRAGT *(SLM+XMAIN))/MMI
TOD(10) = (THRUST-DRAGA-CRAGT)/((MCG*12.))
CO 30  I=1,NFM
30  QOD(I)=- (SIPAIN(I)*(FSM REACTM)+SINOS(I)*(FSN-REACTN)
1+.10*OMEGA(I)*QD(I)*GH(I)+CMEGA(I)**2*GH(I)*Q(I))/GH(I)
CX=.301
IF (ABS(XPAIN).GE.13.85.AND.ABS(XPAIN).LE.13.91) CX = .0001
CO 40  I = 2,10,2
T(I) = T(I) + TD(I)*DX + (TOD(I)*DX**2)/2.
40  TH(I) = TD(I) + TOD(I)*DX
CO 50  I=1,NFM
C(I)=Q(I)+QD(I)*CX+(QOD(I)*DX**2)/2.
50  CD(I)=QD(I)+QOD(I)*DX
RETURN
END

```

```

SUBROUTINE IC( ZCGI,ZHI,ZNI,THETA)
COMMON/FLEX1/SIMAIN(15),SINOSE(15),SLCG(15),SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GM(15),CMGA(15)
COMMON/FLEX3/Q(15),QD(15),QDD(15)
COMMON/X1/W,hM,MN,MCL,MM,MN,A,B,PMI
COMMON/X2/PACH,VOM,AAM,AHM,OAM
COMMON/X3/PAON,VON,AAN,AFN,OAN
COMMON/X4/SXP,SN,SLN,SLN,TSM,TSN
COMMON/X5/FSP,FSN,FT,FT,MAIN,XNOSE,VELN,VELN
*****
C THIS IS THE IC SUBROUTINE FOR A F-4 AIRCRAFT SIMULATION
*****
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR TAXI
C FOR SXM MAIN AND SXN NOSE GEAR
C ZHI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C ZCGI= CG DEFLECTION
C THETA= PITCH ANGLE
C XMAIN= MAIN LANDING GEAR STATIC STROKE
C XNOSE= NOSE GEAR STATIC STROKE
*****
1  RM=W/(1.+A/B)
   RN=W-RM
   RM=RM/SXP
   RN=RN/SXN
   ZHI=-RM/TSM
   ZNI=-RN/TSM
   RSH=RM-WM
   RSN=RN-WN
   XNOSE=+PAON*VON/RSN-VON/AAN
   XMAIN=+PACH*VOM/RSH-VOM/AAM
   IF (ABS(XPAIN).LT.13.88) GO TO 10
   XMAIN = 0.
20  XMAIN = XPAIN - .001
   RSMT = (PACH*VOM)/(((VOM/AAM)-ABS(XMAIN)))
   IF (ABS(XPAIN).GE.13.88) RSMT = + (19546.)/
1  (((2.298) -ABS(XPAIN + 13.88)))
   IF (ABS(RSH - RSMT).LT.50.0) GO TO 10
   GO TO 20
10  THETA=- (XNOSE+ZNI-(XMAIN+ZHI))/(B+A)
   ZCGI=XPAIN-A*THETA+ZM
   DO 30 I=1,NFM
   QD(I)=0.
30  C(I)=0.
   RETURN
END

```

```

SUBROUTINE TAYLOR(T,TD,TDD)
COMMON/FLX1/SIPAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
COMMON/FLX2/NFM,GM(15),CHEGA(15)
COMMON/FLX3/Q(15),QC(15),QDD(15)
COMMON/X1/W,BH,MN,PCG,MM,MN,A,B,PMI
COMMON/X2/PACH,VOM,AAM,AFM,OAM
COMMON/X3/PACN,VON,AAN,AFN,OAN
COMMON/X4/SXP, SXN,SLM,SLN,TSM ,TSN
COMMON/X5/CL,CD,AREA,THFLST
COMMON/X6/Z,REACTH,REACTA,CX,NTRLN
COMMON/X7/AM,BH,CM,DM,AN,BN,CN,ON
COMMON/X8/STROK(20),PINOM(20),STROKN(20),PINON(20),NSCH,NSCN
COMMON/X9/FSF,FSN,FTP,FTN,XMAIN,XNOSE,VELM,VELN
COMMON/X10/ZPM,ZPN
COMMON/X11/SSM,OTDM,CTM
DIMENSION T(12), TD(12), TDD(12)
REAL MCG,MM,MN,PMI
C F-111 TAYLOR SUBROUTINE
1 Z=Z+TD(1)*DX+TDD(1)*DX**2/2.
120 ZPM=AM+B*Z+C*Z**2+DM*Z**3
ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
OTN=0.
CTM=0.
OTDM=0.
OTDN=0.
DO 130 I=1,NFM
OTN=OTN+Q(I)*SINOSE(I)
CTM=CTM+C(I)*SIPAIN(I)
OTDM=OTDM+QD(I)*SIPAIN(I)
130 OTDN=OTDN+QC(I)*SINCSE(I)
XNOSE = (T(2) - 9 * T(8) - T(6)) +OTN
XMAIN = ((T(2) + A * T(8) - T(4)) +OTM )*.66
VELM = (TC(2) + A * TD(8) - TD(4) +OTDM)*.66
VELN = TC(2) - B * TD(8) - TD(6) +OTDN
IF(XMAIN.GE.0.) XMAIN=-.1
IF(XNOSE.GE.0.) XNOSE=-.1
IF(VELM.EQ.0.) VELM=-.1
IF(VELN.EQ.0.) VELN=-.1
XMLK=ABS(XMAIN)
XNLK=ABS(XNOSE)
C NOSE AND MAIN DAMPING COEFF
CALL TLOCK(XPLK,SLOPEM,YCEPM,STROKM,PINOM,NSC4)
CALL TLOCK(XNLK,SLOPEN,YCEPN,STROKN,PINON,NSCN)
AOM = (SLOPEM*XMLK+YCEPM)
AON = (SLOPEN*XNLK+ YCEPN)
CON=(.00008*(AOM**3.))/(2.*(1.9*ACN)**2)
CGM=(.00008*(AON**3.))/(2.*(1.9*ACM)**2)
C NOSE AND MAIN STRUT PNEUMATIC FORCES
SSM=(PACH*VOM)/(((VOM/AAP)-(XMLK-14.475)))
SSN=(PACN*VON)/(((VON/AAN)-XNLK))
IF(XMLK.GT.0..AND.XMLK.LT.14.275)SSM=4790.+201.7*XMLK
IF(XNLK.GT.14.275.AND.XNLK.LE.14.475)SSN=7669.+109440.
1*(XPLK-14.275)
FTM = SXP * TSM * (T(4) - ZPM)
FTN = SXN * TSN * (T(6) - ZPN)

```

```

IF (FTM.GT.0.)FTM=0.
IF (FTN.GT.0.)FTN=0.
FSN=SN* (-SSA+CON*VELN*ABS(VELN) )
FSM=SN* (-SSP +COM*VELM*ABS(VELM) )*.66
VLIFT =.001189*CL*AREA*(TD(1))*TC(10)
DRAGA=VLIFT*CO/CL
CRAGT =AES(.025*FTM+.025*FTN)
IF (NTRUN.EQ.1) GO TO 125
THRUST=DRAGA+DRAGT
125  TOD(2) = (-FSN-FSM-MCG*300.+VLIFT)/MCG
    TOD(4)=(FSM-FTM-386.*SN*MM)/(MM*SN)
    TOD(6)=(FSN-FTN-MM*386.*SN)/(MM*SN)
    TOD(8) = -(FSM*A -FSN*B -CRAGT *(SLH+XMAIN))/MMI
    TOD(10) = (THRUST-DRAGA-CRAGT)/((PCG*12.))
    DO 200 I=1,NFM
200  QOD(I)=-(SIPAIN(I)*(FSM-REACTM)+SINCSE(I)*(FSN-REACTN)
    1+.10*OMEGA(I)*QD(I)*GM(I)+CMEGA(I)**2*GM(I)*Q(I))/GM(I)
    DX=.001
    IF (XPLK.GE.14.275.AND.XMLK.LT.14.475) DX=.0001
    DO 1001 I = 2,10,2
    T(I) = T(I) + TD(I)*DX + (TOD(I)*DX**2)/2.
1001 TD(I) = TD(I) + TOD(I)*DX
    DO 1002 I=1,NFM
    C(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
1002 QD(I)=QD(I)+QDD(I)*DX
    RETURN
    END

```

```

SUBROUTINE IC( ZCGI,ZMI,ZNI,THETAI)
COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
COMMON/FLEX2/NFM,GM(15),CHEGA(15)
COMMON/FLEX3/Q(15),QO(15),QOD(15)
COMMON/X1/W,WM,WN,PCG,MM,MN,A,B,PMI
COMMON/X2/PACH,VON,AAN,A+H,OAH
COMMON/X3/PACH,VON,AAN,A+H,OAH
COMMON/X4/SXP,SN,SLM,SLA,TSM ,TSN
COMMON/X5/FSP,FSA,FTP,FTN,XMAIN,XNOSE,VELM,VELN
*****
C F-111 IC SUBROUTINE
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR TAXI
C FOR LAM MAIN AND SXN NOSE GEAR
C ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C ZCGI= CG DEFLECTION
C THETAI= PITCH ANGLE
C XMAIN= MAIN LANDING GEAR STATIC STROKE
C XNOSE= NOSE GEAR STATIC STROKE
*****
RM=W/(1.+A/B)
RN=W-RM
RM=RM/SXP
RN=RN/SXA
ZMI=-RM/TSM
ZNI=-RN/TSN
RSM = (RM -WP)/.66
RSN=RN-WN
XNOSE=+PAON*VON/RSN-VON/AAN
XMAIN=(+PAOM*VOM/RSM-VOM/AAM-14.375 )
IF (RSM.GE.7669..AND.RSN.LT.45557.) XMAIN = -(RSM+2696587.)/189440.
XMA66=XMAIN/.66
THETAI=-(XNOSE+ZNI-(XMA66+ZMI))/(9+A)
ZCGI=XMA66-A*THETAI+ZMI
DO 10 I=1,NFM
QO(I)=0.
10 C(I)=0.
RETURN
END

```

APPENDIX II

FORTRAN SYMBOL DEFINITIONS

This appendix contains an alphabetical listing of the Fortran variables used in the program TAXI categorized by the subroutine in which they are defined. In cases where a variable is defined in two or more subroutines, it is listed under the subroutine in which it is used most often. Some symbols used in the C-5A computer code are not listed. These variables are those which have been formed by adding a 1 or 2 to a variable name which is contained in the basic TAXI computer code. The 1 refers to the rear set of main gear and the 2 refers to the front set of main gear of the C-5A aircraft. Thus, a variable such as FSM1 in the C-5A code may be found by looking for the variable FSM in the listing of symbols and associating the definition of the variable with the rear set of main gear of the aircraft. Some variables denoted (C-5A simulation only) are those contained in the C-5A computer code exclusively.

APPENDIX II

FORTRAN SYMBOL DEFINITIONS

TAXI

<u>SYMBOL</u>	<u>DEFINITION</u>
A	Distance from CG to rear main gear
AAM	Pneumatic area, main gear
AAN	Pneumatic area, nose gear
AHM	Hydraulic area, main gear
AHN	Hydraulic area, nose gear
AM	Coefficient of polynomial fit to runway profile segment, rear main gear
AMA	Coefficient of polynomial fit to runway profile segment, front main gear(C-5A simulation only)
AN	Coefficient of polynomial fit to runway profile segment, nose gear
AREA	Aircraft wing area
B	Distance from CG to nose gear
BM	Coefficient of polynomial fit to runway profile segment, rear main gear
BMA	Coefficient of polynomial fit to runway profile segment, front main gear (C-5A simulation only)
BN	Coefficient of polynomial fit to runway profile segment, nose gear
C	Distance from CG to front main gear (C-5A simulation only)
CD	Coefficient of drag
CGACC	Array containing CG accelerations for Calcomp plot
CGOUT	Total CG acceleration
CL	Coefficient of lift

<u>SYMBOL</u>	<u>DEFINITION</u>
CM	Coefficient of polynomial fit to runway profile segment, rear main gear
CMA	Coefficient of polynomial fit to runway profile segment, front main gear (C-5A simulation only)
CN	Coefficient of polynomial fit to runway profile segment, nose gear
DDPLOT	Array containing aircraft distance down the runway for Calcomp plot
DISTAN	Distance down the runway used in removing overall slope from runway profile
DM	Coefficient of polynomial fit to runway profile segment, rear main gear
DMA	Coefficient of polynomial fit to runway profile segment, front main gear (C-5A simulation only)
DN	Coefficient of polynomial fit to runway profile segment, nose gear
DX	Time step for integration
DZ	Variable which compensates for the overlap of two adjacent runway segments
ELEV	Array containing runway profile elevations
ELEV1	Elevation of first runway profile point
ENDRUN	Length of runway
GM	Array containing generalized masses for each flexible mode of vibration
HDR	Counter for printing header on printed output
I	Index variable
IFPLOT	Variable which contains decision to produce plotted output or not
II	Subscript variable for runway markers on Calcomp plot

<u>SYMBOL</u>	<u>DEFINITION</u>
ITT	Index variable
IVAL	Integer truncation of distance between nose and rear main gear
IV'IA	Integer truncation of distance between rear main gear and front main gear (C-5A simulation only)
IXLONG	Integer truncation of length of time axis on Calcomp plot
J	Subscript variable for runway profile
LD	Counting variable for runway profile input
LDI	Counting variable for runway profile output listing
LL	Subscript variable for storage of pilot station acceleration time history
LLL	Subscript variable for storage of aircraft speed and distance for Calcomp plot
LPRIN	Runway distance for runway profile listing
LSD	Counting variable for runway profile input
LSDI	Counting variable for runway profile listing
M	Counting variable for printing out output header first time
MCG	Mass of entire aircraft
MGM	Integer truncation of total simulation time
MM	Mass of unsprung portion of one main landing gear
MMI	Pitching moment of inertia about aircraft center of gravity
MN	Mass of the unsprung portion of the nose landing gear
MRM	Length of runway divided by 1000 feet
NFM	Number of flexible modes
NN	Subscript variable for CG acceleration time history

<u>SYMBOL</u>	<u>DEFINITION</u>
NPTSS	Number of runway profile points
NSCM	Number of slope or area changes on main strut metering pin
NSCN	Number of slope or area changes on nose strut metering pin
NTRUN	Defines run as taxi or takeoff
NiO	Index variable for normalization of runway profile
OAM	Area of orifice hole, main gear
OAN	Area of orifice hole, nose gear
OMEGA	Array of flexible mode frequencies
PAOM	Preload pressure of main gear strut
PAON	Preload pressure of nose gear strut
PINDM	Array containing main gear metering pin diameters for conventional aircraft and net orifice areas for aircraft with metering tubes or fluted metering pins
PINDN	Array containing nose gear metering pin diameters for conventional aircraft and net orifice areas for aircraft with metering tubes or fluted metering pins
PLANE	Aircraft being simulated
PP	Counting variable for storage of distance and speed for Calcomp plot
PROF	Runway profile time history elevations
PROF10	PROF (NN+2)X10
PSA	Pilot station acceleration
PSACC	Array containing pilot station acceleration time history
PSARM	Distance from pilot station to CG
Q	Array of non-dimensional time dependent coordinates which weight the amount of motion due to each flexible mode in the total motion of the aircraft

<u>SYMBOL</u>	<u>DEFINITION</u>
QD	Time derivative of Q
QDD	Time derivative of QD
QDDCG	CG acceleration due to flexible motion
QDDIS	Pilot station acceleration due to flexible motion
QDDTAL	Tail station acceleration due to flexible motion
REACTM	Static, total force at main gear
REACTN	Static, total force at nose gear
RM	Incremented variable for determining position of runway markers
RMARK	Array containing runway markers positions
SICC	Mode shape deflection of CG
SIMAIN	Mode shape deflection at main landing gear
SINOSE	Mode shape deflection at nose landing gear
SIPS	Mode shape deflection at pilot station
SITAIL	Mode shape deflection at tail station
SITE	Location of runway
SLM	Distance from CL of main gear axle to CG of aircraft with strut fully extended
SLN	Distance from CL of nose gear axle to CG of aircraft with strut fully extended
SLP	Overall slope of runway profile
SPEED	Initial speed of aircraft
SSPLOT	Array of velocity of aircraft for Calcomp plot
STORE1	Temporary storage space for CG accelerations

<u>SYMBOL</u>	<u>DEFINITIONS</u>
STORE2	Temporary storage space for CG accelerations
STORE3	Temporary storage space for pilot station accelerations
STORE4	Temporary storage space for pilot station accelerations
STROKM	Array of strut stroke values corresponding to metering pin values (PINDM), main gear
STROKN	Array of strut stroke values corresponding to metering pin values (PINDN), nose gear
STN	Number of main gear struts
STN	Number of nose gear struts
TAILAC	Acceleration at tail station
TAILRM	Distance from tail station to CG
TAKOFF	Rotation velocity of aircraft
THRUST	Total thrust of aircraft
TIME	Array of simulation times at which CG acceleration time history points are stored
TIMEX	Counter variable for printed output
TIME1	Array of simulation times at which pilot station time history are stored
TSM	Tire spring constant, main gear
TSN	Tire spring constant, nose gear
TYPRUN	Defines simulation as takeoff or taxi
VAL	Distance between nose and rear main gear
VALA	Distance between rear main gear and front main gear (C-5A simulation only)
VOM	Main gear strut fully extended volume

<u>SYMBOL</u>	<u>DEFINITION</u>
VON	Nose gear strut fully extended volume
W	Weight of aircraft
WM	Main gear unsprung weight
WN	Nose gear unsprung weight
X	Simulation time
XLONG	Length of time axis for Calcomp plot
XLONG2	XLONG/2
XPROF	Location for printing of "NOSE GEAR TRACK" on Calcomp plot
XSTOP	XLONG+5
YP	Array containing runway segment elevation points and slope from end of previous segment, rear main gear
YPA	Array containing runway segment elevation points and slope from end of previous segment, front main gear (C-5A simulation only)
YPN	Array containing runway segment elevation points and slope from end of previous segment, nose gear
ZADOT	Slope of runway segment at end point, front main gear (C-5A simulation only)
ZNDOT	Slope of runway segment at end point, nose gear

TAYLOR

AOM	Net orifice area, main gear (OAM-metering pin area)
AON	Net orifice area, nose gear (OAN-metering pin area)
COM	Damping coefficient, main gear
CON	Damping coefficient, nose gear
DRAGA	Aerodynamic drag

<u>SYMBOL</u>	<u>DEFINITION</u>
DRAGT	Rolling Drag
FSM	Total force in all main gear struts
FSN	Total force in all nose gear struts
FSTN	Net force on secondary piston, nose gear (C-5A Simulation only)
FST1	Net force on secondary piston, rear main gear (C-5A Simulation only)
FST2	Net force on secondary piston, front main gear (C-5A Simulation only)
FTM	Force in tires, main gear
FTN	Force in tires, nose gear
F2M1	Total force in secondary chamber, rear main gear (C-5A simulation only)
F2M2	Total force in secondary chamber, front main gear (C-5A simulation only)
F2N	Total force in secondary chamber, nose gear (C-5A simulation only)
QTDM	Total velocity due to flexible modes at main gear
QTDN	Total velocity due to flexible modes at nose gear
QTM	Total deflection due to flexible modes at main gear
QTN	Total deflection due to flexible modes at nose gear
SLOPEM	Slope of line drawn through two metering pin points, main gear
SLOPEN	Slope line drawn through two metering pin points, nose gear
SSM	Pneumatic force, main gear
SSN	Pneumatic force, nose gear
T(2)	CG vertical displacement
T(4)	Unsprung mass vertical displacement, front main gear
T(6)	Unsprung mass vertical displacement, nose gear

<u>SYMBOL</u>	<u>DEFINITION</u>
T(8)	Rigid body pitch angle of aircraft
T(10)	Horizontal distance of aircraft
T(12)	Unsprung mass vertical displacement, front main gear (C-5A simulation only)
T(14)	Vertical displacement of secondary piston, nose gear (C-5A simulation only)
T(16)	Vertical displacement of secondary piston, front main gear (C-5A simulation only)
T(18)	Vertical displacement of secondary piston, rear main gear (C-5A simulation only)
TD(2)	Time derivative of T(2)
TD(4)	Time derivative of T(4)
TD(6)	Time derivative of T(6)
TD(8)	Time derivative of T(8)
TD(10)	Time derivative of T(10)
TD(12)	Time derivative of T(12) (C-5A simulation only)
TD(14)	Time derivative of T(14) (C-5A simulation only)
TD(16)	Time derivative of T(16) (C-5A simulation only)
TD(18)	Time derivative of T(18) (C-5A simulation only)
TDD(2)	Time derivative of TD(2)
TDD(4)	Time derivative of TD(4)
TDD(6)	Time derivative of TD(6)
TDD(8)	Time derivative of TD(8)
TDD(10)	Time derivative of TD(10)
TDD(12)	Time derivative of TD(12) (C-5A simulation only)
TDD(14)	Time derivative of TD(14) (C-5A simulation only)
TDD(16)	Time derivative of TD(16) (C-5A simulation only)

<u>SYMBOL</u>	<u>DEFINITION</u>
TDD(18)	Time derivative of TD(18) (C-5A simulation only)
VELM	Total strut velocity, main gear
VELN	Total strut velocity, nose gear
VLIFT	Aerodynamic lift force
XMAIN	Strut stroke, main gear
XMLK	Absolute value of XMAIN
XNLK	Absolute value of XNOSE
XNOSE	Strut stroke, nose gear
YCEPM	Y intercept of line drawn through metering pin points, main gear
YCEPN	Y intercept of line drawn through two metering pin points, nose gear
Z	Distance of aircraft from beginning of a 4 ft runway segment
ZPM	Runway elevation, rear main gear
ZPMA	Runway elevation, front main gear (C-5A simulation only)
ZPN	Runway elevation, nose gear (C-5A simulation only)

IC

RM	Static reaction force at main gear
RM1I	Static reaction force at rear main gear (C-5A simulation only)
RM2I	Static reaction force at front main gear (C-5A simulation only)
RN	Static reaction force at nose gear
RSM	RM - WM
RSN	RN - WN
THETAI	Rigid body initial pitch angle
XMAIN2T	Test variable for rigid body initial conditions (C-5A simulation only)

<u>SYMBOL</u>	<u>DEFINITION</u>
ZCGI	Initial CG vertical displacement
ZMI	Initial tire deflection, main gear
ZNI	Initial tire deflection, nose gear
<u>COEFF</u>	
A	Coefficient of polynomial fit to runway profile segment
B	Coefficient of polynomial fit to runway profile segment
C	Coefficient of polynomial fit to runway profile segment
D	Coefficient of polynomial fit to runway profile segment
Y	Runway profile elevation values
<u>LOOK</u>	
I	Index variable
N	Number of values in metering pin - stroke table
P	Metering pin diameter or net orifice area for aircraft with metering tubes or fluted metering pins
S	Strut stroke in metering pin table
SLOPE	Slope of line drawn between two metering pin points
YCEPT	Y intercept of line drawn between two metering pin points