GASP- GENERAL AVIATION SYNTHESIS PROGRAM

NASA-CR-152303

VOLUME I - MAIN PROGRAM

PART 1 - THEORETICAL DEVELOPMENT

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FOREWORD

The General Aviation Synthesis Program (GASP) was initially developed by engineers in the Mission Analysis Division at the National Aeronautics and Space Administration's Ames Research Center, Moffett Field, CA. Improvements continue to be implemented by individuals in the V/STOL Systems Technology Branch at Ames. Those people providing the major development contributions are:

T. L. Galloway

E. T. Schairer

J. V. Bowles

M. H. Waters

This documentation was prepared by the staff of Aerophysics Research Corporation, Bellevue, WA., under NASA contract NAS 2-9352. In addition to the contributions from the NASA personnel, Aerophysics people contributing to the documentation are:

D. S. Hague

J. F. MacRae

A. W. Merz

N. W. Woodbury

A. M. Hague

The NASA technical monitor for the documentation was Mr. T. L. Galloway. The Aerophysics Research Corporation project leader was Mr. D. S. Hague. The GASP program has been used by a number of companies and universities through NASA contracted studies and is under continuing development. Prospective users should consult NASA's Ames Research Center regarding the latest details of the computer code.

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I.1 INTRODUCTION

Over the past several years, NASA's Ames Research Center has developed the General Aviation Synthesis Program, GASP. This computer program performs tasks generally associated with aircraft preliminary design and allows an analyst the capability of performing parametric studies in a rapid manner. GASP emphasizes small fixed-wing aircraft employing propulsion systems varying from a single piston engine with fixed pitch propeller through twin turboprop/turbofan powered business or transport type aircraft. The program may be operated from a computer terminal in either the "batch" or "interactive graphics" mode.

The program is comprised of modules representing the various technical disciplines integrated into a computational flow which ensures that the interacting effects of design variables are continuously accounted for in the aircraft sizing procedure. The model is a useful tool for comparing configurations, assessing aircraft performance and economics, performing tradeoff and sensitivity studies, and assessing the impact of advanced technologies on aircraft performance and economics. By utilizing the computer model the impact of various aircraft requirements and design factors may be studied in a systematic manner with benefits measured in terms of overall aircraft performance and economics.

The GASP program has as its purpose the numerical specification of many aircraft design characteristics. Input quantities are general indicators of aircraft type, size, and performance, and the synthesis is extended to the point at which all of the important aircraft characteristics have been analyzed quantitatively. The synthesis model and procedure together develop the aircraft configurations in a manner useful in parametric analysis and also provide a useful step toward more detailed analytical and experimental studies.

The synthesis program consists of a control module and several technology submodules which perform the various independent studies required in the design of general aviation or small transport type aircraft. Each of the six technology modules shown in Figure I.1.1 is composed of one or more computer subroutines, and the input to each module may be either the output of another module, or it may be input directly to the module. The integrated approach ensures that results contain the effects of design interactions among the various modules. For example, a change in wing loading affects wing area, tail size, lift, drag, propulsion system size, cruise attitude, structural weight, range and other parameters. Any particular net effect may be large or small; nevertheless it is determined numerically regardless of its magnitude.

I.1.1 Discussion

This section provides a brief description of the engineering methods used in the synthesis program. The descriptions are in the order shown in Figure I.1.1.

I.1.1.1 Geometry. In this module, the dimensions of the aircraft components are calculated. Typical input parameters are the number of passengers, aspect ratio, taper ratio, sweep angles and thicknesses of wing and tail surfaces. The cabin is assumed to be of circular cross section, and tail surfaces are sized using trend equations derived for existing aircraft. Output of this module provides areas, lengths, angles, etc., which may be needed by other modules.

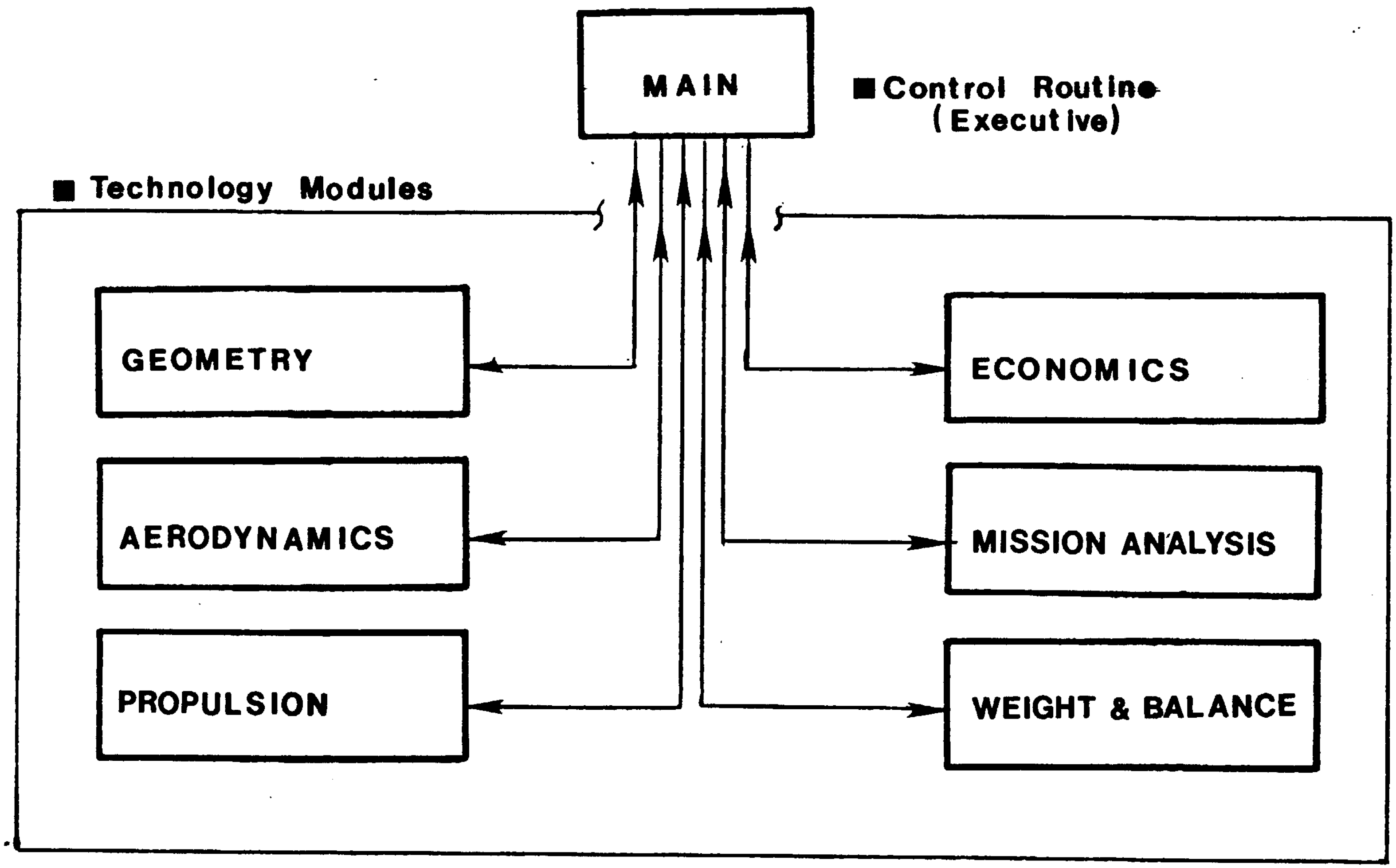

FIGURE I.1.1 - GASP PROGRAM STRUCTURE

I.1.1.2 Aerodynamics. Lift coefficient is determined as the sum of a term proportional to angle of attack, and a term due to high lift devices such as slots, flaps, etc. Lift curve slope computation includes ground effect and the effects of aspect ratio, Mach number and sweepback. Drag coefficient is the sum of profile drag, increments due to high lift devices, landing gear and compressibility, and the induced drag due to lift, including ground effect. Configuration geometry, flight conditions and type of high lift devices are input, while drag polars are output for the cruise, takeoff, and landing flight condition.

I.1.1.3 Propulsion. Currently, turbojet, turbofan, turboprop, and reciprocating or rotating combustion engines can be simulated. Both engine size and performance are determined. Both cruise and take-off requirements of the aircraft may be specified. The results also provide engine thrust and fuel flow at any flight condition using performance data for the specific engine of interest.

I.1.1.4 Weight and Balance. Gross weight and payload are input, together with details regarding aircraft geometry and weight trend coefficients. The program has options for sizing tip tanks and locating the wing such that the aircraft is in balance for the center of gravity travel of the aircraft. An acceptable value of static margin is input for this purpose.

I.1.1.5 Mission Performance. The taxi, take-off, climb, cruise and landing segments of a mission are analyzed, and total range is computed. Options are available for calculating engine out and accelerate/stop distance, best rate of climb, high speed climb and other operating characteristics. When a specific range is required, the aircraft size is determined which provides this range within a specified tolerance.

I.1.1.6 Economics. Both flyaway and operating costs are determined in this module. Flyaway cost is found by summing estimates of labor costs, material costs, and purchased equipment costs including overhead, tooling, sales, and profit for manufacturer and dealer. Operating costs include fuel, oil, inspection, maintenance, storage, insurance, depreciation, and taxes, and the variable and fixed costs are combined to determine total operating costs as a function of annual utilization rates.

A typical computational flow through the GASP program is illustrated in Figure I.1.2.

I.1.2 Documentation

The six major submodules of the GASP program, as listed in Figure I.1.1 are of quite different lengths and levels of complexity. In addition, many subroutines are called by more than one other subroutine, so that it may be unclear, for example, whether it is a "propulsion" or a "performance" subroutine. The choice is usually made arbitrarily, for the sake of convenience alone.

The seven volumes of the report are organized as shown in Figure I.1.3. The GASP program is composed of 65 computer subroutines, 48 of which are documented in detail. Utility subroutines are listed in Figure I.1.3 for completeness; however, they were not documented in detail but are described in Section I.3.

Each of the subsequent volumes is organized by first defining the "major" and "minor" subroutines of that section. The discussion is then directed at explaining how the subroutines interact, and how the computer logic is related to the purpose of each subprogram. Each significant equation of the subroutine is defined and discussed, and this discussion may include comment as to the

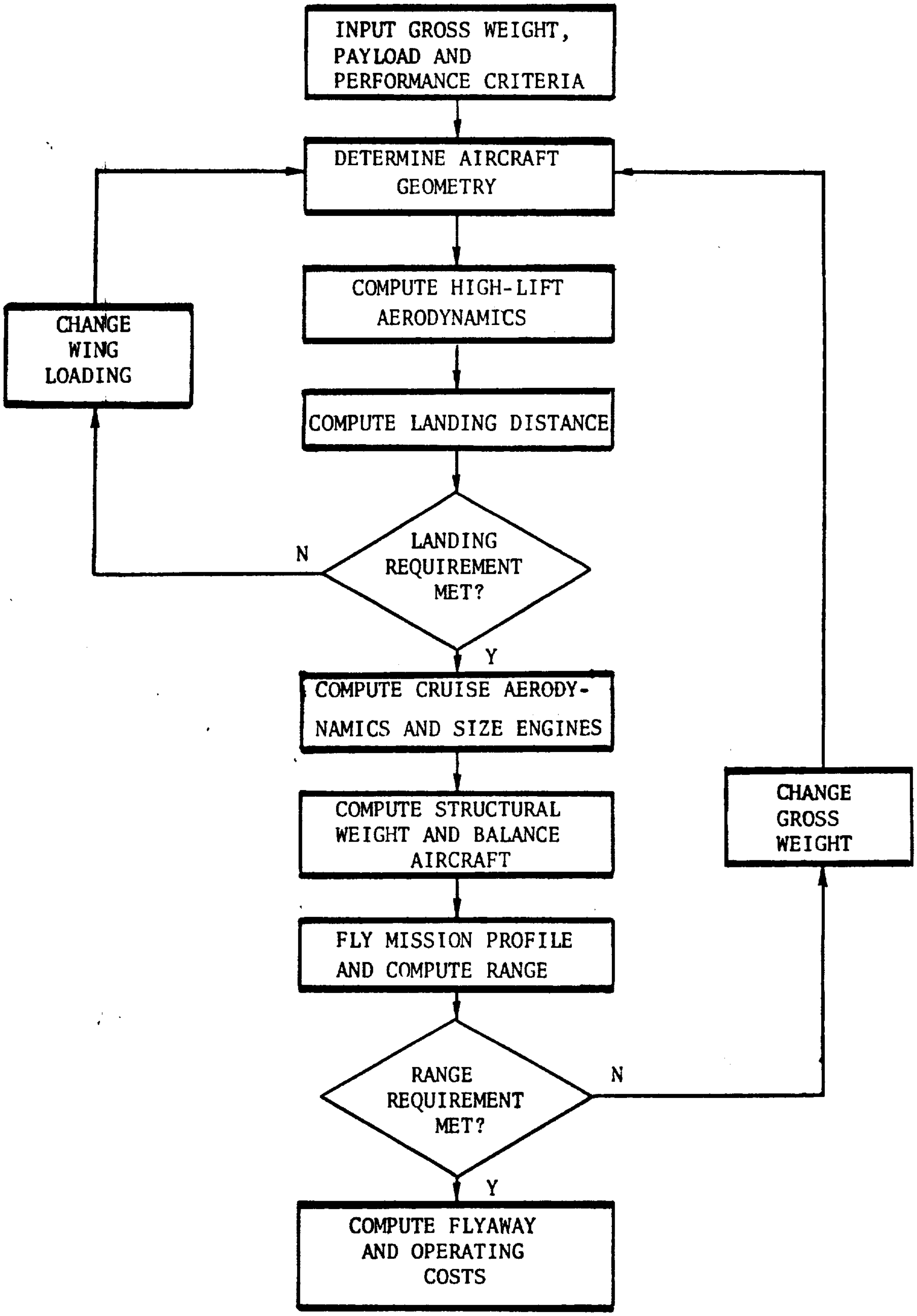

FIGURE I.1.2 TYPICAL GASP COMPUTATIONAL SEQUENCE

Volume 1 - Control and Utility Programs

MAIN Program
Utility Subroutines:

Propeller or Turbofan		(Propeller Only)	(Tabular Turbofan Data)	
OUTPUT	INTS	BILINE	MAPS	DTABX
ITRLN	MAXMHW	UNINT	STORE3	BISC
BIV	ITRMHW	BIQUAD	TTABX	
TPALT		MAXBND	TABX	

Volume 2 - Geometry Program

SIZE

Volume 3 - Aerodynamics Programs

AERO	CTAER	APPFLP
AEROUT	DRAG	
CLIFT	FLAPS	

Volume 4 - Propulsion Programs

(Turbofan)		(Propeller)		
ENGDTT	ENGSZ	ENGDAT	HOPWSZ	RCWSZ
ENGDT1-7	NACDG	ENGINE	PERFM	TURBEG
ENGINE		ENGSZ	PNOYS	ZNENG
		GEARBX	PWRPLT	ZNOISE

Volume 5 - Weight and Balance Programs

DLOAD	TAIL	WAIT (Propeller Weight)
ENGWGT	WGHT	

Volume 6 - Performance Programs

ACCEL	DLAND	TAXI
ASPEED	PERFRM	TURN
CLIMB	RGBAL	XRANGE
DERIV	TAKOFF	

Volume 7 - Economics Programs

GACOST COST (Propeller Cost)

FIGURE I.1.3 - GASP DOCUMENTATION AND MAJOR SUBROUTINE LAYOUT assumptions needed for its derivation, or other relevant detail. Part 2 of each volume is the user's manual in which the input and output parameters of each subroutine are tabulated and defined alphabetically, including the units in which each is measured. A sample problem is also represented in terms of its numerical input and output. Finally, Part 3 of each volume is a programmer's manual showing detailed flow charts for all subroutines in the volume.

I.1.3 Utility Subroutines

The GASP system includes a number of subroutines which can be termed "utility" subroutines. These are relatively brief programs which may be called by several other subroutines, and which typically perform a numerical function such as tabular lookup. These utility programs are listed alphabetically below, and are described very briefly in terms of their significant input and output quantities.

The utility programs that will be used by the GASP system depends on the propulsion option being exercised. The utility programs may be catalogued by propulsion option as follows:

1. Turbofan or propeller option uses the following:

BIV	MAXMHW
INTS	OUTPUT
ITRLN	TPALT
ITRMHW	

2. If the turbofan engine data is input in tabular form, then the following are used in addition to those in (1) above:

BISC	STORES
DTABX	TABX
MAPS	TTABX

3. If a propeller type of propulsion system is used, then the following are used in addition to those mentioned in (1) above:

BILINE	MAXBND
BIQUAD	UNINT

I.1.3.1 BILINE (T, I, XI, YI, Z, K) - Linear Interpolation, One Independent Variable.— Tabular interpolation generates a numerical value for Z, corresponding to input values of XI and YI. The tabular data T(I) specifies the table number; T(I + 1) = 0, 1 or 3 denotes the order of the interpolation; T(I + 2) is the number of X values; T(I + 3) is the number of Y values; and T(I + 4) are the values of X in ascending order. Output K denotes the number of interpolations performed.

I.1.3.2 BIQUAD (T, I, XI, YI, Z, K) - Quadratic Interpolation, One Independent Variable.— This subroutine performs an interpolation over a four point interval, to maintain slope continuity. Table number T(I), T(I + 1) is the number of X values; T(I + 2) is the number of Y values, and T(I + 3) are the values of X in ascending order. Output K measures the number of interpolations.

I.1.3.3 BISC (Y, X, N, IL, IH, J).— This subroutine determines the "low" and "high" integers IL and IH specifying the output values Y(IL) and Y(IH) which bracket the input number X. The dimension of Y is N, and output J is 0, 1, or 2 according to whether $Y(1) \leq X \leq Y(N)$, $X < Y(1)$ or $X > Y(N)$ respectively.

I.1.3.4 BIV(Z, X, Y, AX, AY, AZ1, NX, NY, NERR) - Linear Interpolation, Two Independent Variables.— If input data X and Y fall in the tabular range AX(NX) and AY(NY), respectively, then NERR = 1. The input data AZ1 is given at NX * NY points, and the output is Z unless X or Y fall outside the associated tabular range (X < AX(1), etc.) in which case NERR = 2.

I.1.3.5 DTABX(XTAB, YTAB, ZTAB, X, Z, L).— This is a *function* which calls subroutines BISC and TABX, and which is itself called by TTABX. Independent variables X, Z define the dependent variable DTABX, according to principles of Lagrange interpolation.

I.1.3.6 INTS(T, M, L, E, B, C, HMA, HMI, BET, DERIV).— A finite difference integrator, performed in double precision, of a system of M simultaneous first-order differential equations, which are defined in external subroutine DERIV. The non-zero components of T(100) are related to the state variables in DERIV. The other parameters in the calling sequence are input, and are associated with the numerical aspects of integration (error magnitudes, step sizes, etc.).

I.1.3.7 ITRLN (AX, AY, X, Y, N).— This subroutine returns a value for Y corresponding to an input quantity X. The input parameters for the N pairs AX(IP and AY(I), and AX(I) must increase nonotonically. If X is less than AX(1) or greater than AX(N), the subroutine extrapolates for Y(X).

I.1.3.8 ITRMHW(ERROR, ERRM1, DRIVER, F, FF, JC, JX), Newton-Rapshon Method in GASP.— This subroutine determines a zero to a function defined externally. Inputs are ERROR, the current (non-zero) value of the dependent variable; DRIVER, the current value of the independent variable; and F, a multiplier near unity. Outputs are ERRM1 and DRIVER, the augmented values of the dependent and independent variables, and JC, the counter. FF and JX are not used.

I.1.3.9 MAPS.— This program is called by program MAIN, and it calls subroutine STORE3 three times to develop tables for thrust, fuel flow and airflow in the cruise configuration. The independent variables are altitude, Mach number and turbine inlet temperature ratio.

I.1.3.10 MAXBND(PARAM, PRMM1, DRIVER, DMIN, DMAX, F, FF, KC, KX).— Determines the maximum values of the dependent variable PARAM, and the associated independent variable DRIVER, subject to DMIN $\leq$ DRIVER $\leq$ DMAX. F and FF are input multipliers near unity in magnitude, and KC and KX are output counters; KX is initially zero, and is set to 1 when the maximum is determined.

I.1.3.11 MAXMHW(PARAM, PRMM1, DRIVER, F, FF, KC, KX).— This subroutine determines the maximum of an input function Y(X) = PARAM(DRIVER), which is defined externally. F and FF are input multipliers near unity, and KC is an output interaction counter, while KX changes from 0 to 1 when the maximum is determined. The previous value of Y(X) is PRMM1, and DRIVER is both input and output value of X. MAXBND is similar to MAXMHW except limits are placed on DRIVER.

I.1.3.12 OUTPUT.— This subroutine begins with thirteen common block statements, and it includes 34 FORMAT statements. The subroutine is called by MAIN for the purpose of printing over 100 input and output figures related to geometry, weights, aerodynamics of the aircraft.

I.1.3.13 STORE3(NMAPS, NPTS, NLINE, AMAP, Z, X, Y, IREAD, IPRINT, ITAPE).— This is called by MAPS, and it stores the dependent variable Y(144, NMAPS) and the two independent variables X(12, NMAPS) and Z(12, NMAPS). Other input quantities are NMAPS the number of maps, NPTS, the number of points on a line of constant Z; NLINE, the number of lines of constant Z, and AMAP, the identifying parameter of a map. The last three integers are also input, and at least one must be nonzero for the program to read or write data.

I.1.3.14 TABX(XTAB, YTAB, O, L).— This *function* is called by TTABX, and it acts as an interpolation subroutine. In effect, TABX is the value of the independent variable XTAB(2) for which Y is zero, and this function calls subroutine BISC, which *brackets* the X-value 0 satisfying XTAB(I) $\leq$ 0 $\leq$ XTAB(J).

I.1.3.15 TPALT(ALTZ, ALT, PO, FKALT, TO GO, XKV).— This subroutine relates static pressure, temperature and gravity, kinematic viscosity (PO, TO, GO, XKV) to the altitude. ALTZ is geometric altitude, ft. and ALT is potential altitude, ft, while PO is measured in lb per sq in., TO in deg R, and GO in ft per sec per sec. XLV is returned in ft^2 per sec units. If PO is input, ALTZ and ALT are output, and vice versa. FKALT determines whether geometric or geopotential altitude is used.

I.1.3.16 TTABX(NMAPS, NPTS, NLINE, Z, X, Y, ZPR, XPR, WPR, ZVAL), Interpolation, Three Independent Variables.— This is another *function* which is a four-dimensional interpolator, where NPTS are the number of points on a line, NLINE the number of lines on a map, and NMAPS the number of maps. For a choice of map value WPR, X-value XPR and Z-value ZPR, the function takes the value TTABX. The dimensions are X(12, J), Z(12, J) and Y(144, J), where Y is the dependent variable and J is the map number. Typical inputs are values of temperature ratio, Mach number and altitude, and output might be thrust, fuel flow or airflow.

I.1.3.17 UNINT(N, XA, YA, X, Y, C).— This subroutine performs a four-point interpolation to generate a smooth curve with continuous slope between adjacent intervals. The number of input pairs is N, and YA(I) is monotonic from I to N. No such restriction applies to YA(I). If the input X is less than XA(1), then let Y = YA(1); if X is greater than XA(N) then L = 2 and Y = YA(N). Otherwise, L = 0 and Y is calculated by interpolation.

I.1.4 External Subroutines

The GASP program is composed of over 60 subroutines some of which call as many as 8 or 10 other subroutines. The alphabetic listing of these subroutines is given in Figure I.1.4 where the programs indicated parenthetically may be called by the indicated subroutine. The volume in which each subroutine can be found is also indicated in this tabulation.

The contents of each volume of the documentation are listed symbolically in Figure I.1.5, where the parenthetic numbers correspond to the subroutines listed in Figure I.1.4.

FIGURE I.1.4

PROGRAMS AND THEIR SUBROUTINES

PROGRAM	VOLUME
MAIN (AEROUT, CTAER, DLAND, ENGSZ, ENGWGT, FLAPS, GACOST, MAPS, OUTPUT, PERFRM, PNOYS, RGBAL, SIZE, WGHT)	I
SUBROUTINES - TURBOFAN AND PROPELLER OPTIONS	
1. ACCEL (DRAG, ENGINE, TPALT)	VI
2. AERO	III
3. AEROUT (CLIFT, DRAG)	III
4. APPFLP (FLAPS, ITRMHW)	IV
5. ASPEED (CTAER, ENGINE, ITRMHW, TPALT)	VI
6. BISC	I
7. BIV	I
8. CLIFT	III
9. CLIMB (CLIFT, DRAG, ENGINE, TPALT)	VI
10. CTAER (AERO, CLIFT, DRAG, TPALT)	III
11. DERIV (CLIFT, DRAG)	VI
12. DLAND (AERO, CLIFT, DRAG, ENGINE, TPALT)	VI
13. DLOAD	V
14. DRAG (ITRLN)	III
15. DTABX (BISC, TABX)	I
16. ENGDTT (TTABX)	IV
17-23 ENGDT1-7 (ITRLN, BIV)	IV
24. ENGINE (ENGDTT, ENGDT1-7, WACDG, ITRMHW)	IV
25. ENGSZ (APPFLP, DRAG, ENGINE, ENGWGT, PERFRM, TPALT, TURN)	IV
26. ENGWGT (ENGINE, HOPWSZ, RCWSZ)	V

FIGURE I.1.4 PROGRAMS AND THEIR SUBROUTINES

SUBROUTINES - TURBOFAN AND PROPELLER OPTIONS (Continued)

27. FLAPS (ITRLN, ITRMHW, TPALT) III
28. GACOST (ASPEED, ENGINE, TPALT) VII
29. INTS (DERIV) I
30. ITRLN I
31. ITRMHW I
32. MAPS I
33. MAXMHW I
34. NACDG IV
35. OUTPUT (CLIFT, TPALT). I
36. PERFRM (ACCEL, CLIMB, DLAND, TAKOFF, TAXI, TURN, XRANGE) VI
37. RGBAL (AEROUT, CTAER, ENGSZ, ENGWGT, FLAPS, OUTPUT, PERFRM,
SIZE, WGHT) VI
38. SIZE (TPALT) II
39. STORE3 I
40. TABX I
41. TAIL (BIV, CLIFT, ENGINE, ITRLN, TPALT). V
42. TAKOFF (CLIFT, DERIV, DRAG, ENGINE, INTS, TPALT) VI
43. TAXI (ENGINE, TPALT) VI
44. TPALT. I
45. TTABX. I
46. TURN (DRAG, ENGINE, TPALT) VI
47. WGHT (DLOAD, ENGSZ, ENGWGT, TAIL) V
48. XRANGE (ASPEED, CTAER, ENGINE, ITRMHW, TPALT) VI

FIGURE I.1.4 PROGRAMS AND THEIR SUBROUTINES

ADDITIONAL AND REPLACEMENT SUBROUTINES - USED BY PROPELLER OPTIONS

	PROGRAM	VOLUME
49.	BILINE	I
50.	BIQUAD	I
51.	COST	IV
52.	ENGDAT (COST, GEARBX, PERFM, WAIT, ZNOISE)	IV
53.	ENGINE (MAXBND, MAXMHW, PWRPLT, TPALT, TURBEG)	IV
54.	ENGSZ (APPFLP, DRAG, ENGINE, ENGWGT, ITRMHW, PERFRM, TPALT)	IV
55.	GEARBX	IV
56.	HOPWSZ (ITRLN)	IV
57.	MAXBND	IV
58.	PERFM (BIQUAD, UNINT)	IV
59.	PNOYS (ASPEED, ENGINE, GEARBX, TPALT, ZNENG)	IV
60.	PWRPLT (ITRLN)	IV
61.	TCWSZ (BIV, ITRLN)	IV
62.	TURBEG (BIV, ITRLN, ITRMHW)	IV
63.	UNINT	IV
64.	WAIT	IV
65.	ZNENG (UNINT)	IV
66.	ZNOISE (BILINE)	IV

FIGURE I.1.5 CONTENTS OF EACH VOLUME

VOLUME	CONTENTS
I	Introduction *(MAIN, 6, 7, 15, 29-33, 35, 39, 40, 44, 45, 49, 50, 63)
II	Geometry *(38)
III	Aerodynamics *(2, 3, 4, 8, 10, 14, 27)
IV	Propulsion *(16-25, 34, 52-62, 65, 66)
V	Weight and Balance *(13, 26, 41, 47, 64)
VI	Performance *(1, 5, 9, 11, 12, 36, 37, 42, 43, 46, 48)
VII	Economics *(28, 51)

* Parenthetic numbers refer to subroutine numbers of Figure I.1.4

GASP - GENERAL AVIATION SYNTHESIS PROGRAM

VOLUME I - MAIN PROGRAM

PART 2 - USER'S MANUAL

JANUARY 1978

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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Moffett Field, California

Under

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AEROPHYSICS RESEARCH CORPORATION

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I.2 MAIN PROGRAM USER'S MANUAL

Program MAIN acts as the control program in the computer synthesis of general aviation aircraft. By calling 14 principal subroutines, MAIN effectively controls all the 66 subroutines which make up the GASP package, and it is the input to MAIN which specifies the aircraft being designed. The GASP computer program is intended to apply to a broad spectrum of aircraft types, and each aircraft design is specified by over 200 aircraft input parameters and about 60 propeller input parameters, as tabulated under namelists INGASP and INPROP in the following pages.

Many different vehicle sizing and performance options are available in GASP. The user may select certain options and bypass others according to his needs by inputting appropriate values for several indicator variables. For example, economic and/or noise calculations will be performed or bypassed according to the values input for TBO and KNOYS, respectively. Likewise, mission performance calculations may be terminated at the end of any segment according to the value of IFLY. Thus, one of the important functions of Program MAIN is to control the sequence in which the various subroutines are called.

It is obviously required that the input data be physically consistent, and for this reason the units of each input parameter should be carefully noted. Errors in input data will often be apparent in the numerical results. More troublesome, however, are those errors which have smaller, but still significant effects on the resulting design, since these errors may not be suspected.

Many of the input parameters are given default values, and these are indicated parenthetically following the definition of the parameter. All other parameters must be input before the program will run. Many variables are used only when certain program options are selected, and thus they need not be input when these options are not used. For example, 24 variables are used only when the tail is sized in TAIL (stability and control analysis, LCWING=2). Likewise, some input variables are required only when noise and cost options are exercised. A typical input stream to GASP is presented in Figure I.2.1. The data input begins with a Title Card assigned by the analyst which also contains the integer IENGSC. Data input basically follows the format: (1) Title Card; (2) Additional data read by MAPS and STORE3, if IENGSC is negative on the title card; (3) NAMELIST INGASP; and (4) NAMELIST INPROP.

The variables for these data blocks are presented in alphabetical order in Figures I.2.2 to I.2.4. Breakdowns of the Namelist INGASP and INPROP inputs arranged by categories are presented in Figures I.2.5 and I.2.6. Format of the Title card is

TITLE CARD

COL 2-72	used for title
COL 75-76	Engine cycle indicator (IENGSZ)
	= 0, propeller aircraft (default value)
	= 1, General Electric CJ-610
	= 2, Garrett TFE 731
	= 3, UACL JT-15D
	= 4, AFCO/Lycoming ALF 502
	= 5, General Electric CF-34
	= 6, General Electric TF-34
	= 7, General Electric T700/F1-QCGAT
	= -1,engine data input in tabular form

If engine data input in tabular form, engine data follows the title card and is set up as described in section headed Engine Table , Figure I.2.7.

A typical input stream to the GASP program has the appearance

```
SAMPLE TURBOPROP SPECIFIED ENGINE SIZE
 $INGASP
 WG=12500., WGS=45.045, ENP=2., NTYE=6, EMCRU=.4000, HNCRU=10000.,
 KWRITE=2,
 SAB=2 , VS=18., AS=1., WAS=18., PAX=19., PS=40.865,
 AR=7 71, TCR=.15, TCT=.15, DLMC4=.9, SLM=.400, YP=.324,
 ARHT=3 35, ARVT=1 544, TCVT=.09, TCHT=.09, SLMV=.35, SLMH=.40,
 YMG=.324, EYEW=.5, ELRW=0., DELP=7., CATD=0., ALPHLO=-2.,
 VMLFSL=357 , KNAC=1, SAH=.299,
 ELOON=2 216, ELOOT=2 515, HCK=1 80, ELPC=4.73,
 VBARVX=.123, VBARHX=1.165, COELTH=.235, BOELTV=1.639,
 DELCD=.00159,KWCD=12,
 ACLS=-.66,-.32,-.10,0.,.10,.20,.30,.40,.575,.70,.90,1.13,
 ACDCDR=1 8,1 175,1 05,1 025,1.009,1.0,1.009,1.025,1.10,1.225,1.55,2.25,
 CFOC=.27, BTEOB=.55, RCLMAX=1 280, JFLTYP=4,
 DCLMTE = .56, DFLPTO=.0., DFLPLD=36., DCDOTE=.125,
 DELTT=.1500, HTMAX=500.,
 JENGSZ=3, IPART=3, RCCRU=0., XLODE=3.6,
 UWNAC=2 0,
 SKFW=.35, SKFS=.0256, SKPEI=.3575, SKLG=.04984, DWPQCH=30.,
 SKWF=.4250, SKB=98 5,SKY=.243,SKZ=.356,UWPAX=181.,
 SKWW=155 1,
 WFEX=1749., WFUL=686., WPLX=2300.,
 LCWING=0,
 NFAIL=0         , ICRUS=1,
 RWCRTX=.992, DVI=9.0, DVR=0., XLFMAX=1.250, HUB=.350,
 DELTVR=1.0,
 RSMX=600 , XLFMX=1 10, TDELAY=2., TIDLE=300., HTG=3.4,
 NCADE=1,TBO=3000., CMV=0., CCRW=0., SRPM=.150.,
 CMF=0 , FCSF=.70, OHR=40., CLIAB=1000.,
 UCSENG=100 , ALR=5.0,
  DVI=8 0, DVR=7.0, DELTVR=2.5,
  ICLM=3, VCLMB=140.,
 KNAC=2, WENG=358 , WNAC=204 5, DBARN=2.91,ELN=11.04,
 KNAC=1, XLODE=3 80, UWNAC=2.037, SWSLS=.3143, SKPEI=.3575, FPYL=0.,
  CRMACH=.35, CRALT=10000.,
 $END
 $INPROP
 NTYP=15,
 WPROP1=151.5,
 BL=3 ,AF=114., CLI=.55,            DIST=1000., IDATE=1970,
 CLI=.5,
 XNMAX=41730 , GR=.04792,
 KODECR=4, DPROP=8.5, TSPDMX=1000., KODETH=6,
 FT=-1 0,
 KODECR=7, HPMSLS=840.,
 JSIZE=2, ANCQHP=.12,
 WKPFAC=.863,
 KNOYS=1, HNOYS=1000., DIST=1000.,
 $END
```

FIGURE I.2.1

TYPICAL INPUT STREAM

ORIGINAL PAGE IS OF POOR QUALITY

This is card image of input deck: for propeller configurations both namelist "ingasp" and "inprop" are required; for turbofan configurations only namelist "ingasp" is required.

Three examples illustrating use of the GASP program are presented in Appendices A, B, and C as follows: Appendix A - Turboprop Powered Design, Fixed Engine Size; Appendix B - Two-Place Trainer with Fixed Pitch Propeller, and Appendix C - Turbofan Design Using Scaled TFE-731 Engine.

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
ACDCDR	normalized wing profile drag values in drag table (if KWCD ≠ 0)
ACLS	array of C_L values in wing profile drag table (if KWCD ≠ 0)
ALPHLO	zero lift angle of attack, deg
ALTFLP	altitude during takeoff and landing for Reynold's number calculation, ft (0.)
ALTLND	altitude of landing field, ft (0.)
ALR	manhour labor rate $ per hr (3.40)
AR	wing aspect ratio
ARHT	aspect ratio of horizontal tail
ARVT	aspect ratio of vertical tail
ARVTE	effective aspect ratio of vertical tail (numerical function of ARVT and SAH), if LCWING = 2 .
AS	number of aisles
ATMXQC	maximum tip tank length/wing tip chord (3.16 if KTIPX = 1)
BENGOB	fraction of flap-free wing span due to engines (0.)
BMLOD	length to diameter ratio of tail boom (14.5 if KCONFG=1)
BOELTV	wing span/vertical tail moment arm (if VBARVX input)
BTEOB	flap span to wing span ratio (.75)
CATD	0, normal design structural category, FAR Part 23 1, utility design structural category, FAR Part 23 2, aerobatic design structural category FAR Part 23 3, transport design structural category FAR Part 25
CCRW	annual cost of crew, $(0.)
CFOC	flap chord to wing chord ratio (.3)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
CHALF	two-dimensional variation with angle of attack of elevator hinge moment coefficient (function of RH) if LCWING = 2
CHDEL	two-dimensional variation with elevator deflection of elevator hinge moment coefficient (function of RH) if LCWING = 2
CINP	cost of annual inspection, $ (1500.)
CKF	fuselage form factor (numerical function of fuselage fineness ratio)
CKHT	horizontal tail form factor (numerical function of TCHT and SAH)
CKN	nacelle form factor (numerical function of nacelle fineness ratio)
CKTP	tip tank form factor (numerical function of tip tank fineness ratio)
CKVT	vertical tail form factor (numerical function of TCVT)
CKW	wing form factor (numerical function of TCR and TCT)
CLEOC	leading edge device chord/wing chord (0.)
CLIAB	cost of liability insurance, $ (215.)
CLTLMT	limiting C_L in turn, if JTRSZ = 1 (1.0)
CMF	increment to fixed annual cost, $ (0.)
CMFLPL	wing C_M about cg, landing flaps (function of DFLPLD) if LCWING = 2
CMFLPT	wing C_M about cg, takeoff flaps (function of DFLPTO) if LCWING = 2
CMPLD	pitching moment coefficient of all engines about cg at landing (0.) if LCWING = 2

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
CMV	increment to hourly operating cost, $ (0.)
CNPAC	required directional stability of aircraft, per deg., if LCWING = 2.
COELTH	wing chord/horizontal tail moment arm (if VBARHX input)
CP	aircraft price, $ (default program calculations)
CPMRGN	wing cg relative to quarter chord mac, fraction mac (.10) if LCWING $\neq$ 0
CRALT	mission cruise altitude, ft (HNCRU)
CRMACH	mission cruise Mach number (EMCRU)
CRWOH	crew overhead rate (.50)
CXA	distance main wheel contact point aft of mac leading edge, fraction mac., if LCWING = 2
DBARN	nacelle mean diameter, KNAC = 2, ft
DCDOTE	drag coefficient increment due to optimally deflected trailing edge default flaps (function of JFLAP)
DCLMLE	lift coefficient increment due to optimally deflected leading edge slat (.93)
DCLMTE	lift coefficient increment due to optimally deflected trailing edge flaps (default function of JFLAP)
DCMCLP	one engine propulsion stability term if LCWING = 2
DELCD	increment in CD (.0015)
DELFE	increment in equivalent flap plate area of fuselage sq ft (.25)
DELH	altitude increment during climb, ft (1000.)
DELLED	deflection of leading edge device, deg (0.)
DELLEO	optimal deflection for leading edge device, deg (45.)
DELP	fuselage pressure differential, psi

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
DELTEO	optimum trailing edge flap deflection angle, deg. (default function of JFLAP)
DELTT	time spent taxiing before takeoff and after landing, hrs.
DELWFC	incremental control group weight, lb. (0.)
DELTVR	estimate of time required to rotate aircraft during takeoff, sec (3.5)
DELWST	incremental structural weight, lb. (0.)
DEMAX	maximum up elevator deflection, deg (-25.), if LCWING=2
DFLPTO	takeoff flap deflection, deg
DFLPLD	landing flap deflection, deg
DLMC4	sweep of wing quarter chord, deg
DLSWSW	increment in wetted area/wing area (0.)
DRMAX	maximum rudder deflection, deg (25.0) if LCWING = 2
DV1	increment of engine failure decision speed above stall, kts (5.)
DVR	increment of takeoff rotation speed above engine failure decision speed, kts (5.)
DWPQCH	horizontal tail quarter chord sweep, deg, if LCWING≠0
DWPQCV	vertical tail quarter chord sweep, deg, if LCWING≠0
DYR	aircraft depreciation period, year (8.)
EGMRGN	engine cg relative to leading edge of mac, for wing-mounted engines; fraction mac, positive aft (0.), if LCWING≠0
ELINC	distance from leading edge of vertical tail to leading edge horizontal tail on line of intersection of vertical tail and horizontal tail, ft, if LCWING ≠ 0
ELN	nacelle length, KNAC = 2, ft
ELODN	length to diameter ratio of nose cone of fuselage (2.0)

VARIABLE	DESCRIPTION
ELODT	length to diameter ratio of tail cone of fuselage (3.2)
ELPC	length of pilot compartment, ft (4.44)
ELRW	length of pylon attachment, for fuselage mounted engines
EMCRU	design cruise Mach number
EMTURN	turn Mach number, if JTRSZ = 1
ENP	number of engines
EYET	horizontal tail incidence angle, deg (0.) if LCWING = 2
EYEW	wing incidence to fuselage horizontal reference deg.
FACW1	change in gross weight to start range iteration (default function of gross weight and range)
FCSF	fuel cost, $ per gal (.51)
FLAPN	number of flap segments per wing panel (1.)
FPYL	factor for turbofan engine pylon weight (.7) if NTYE=7 and KNAC≠2
FRESF	required reserve fuel; <10, fraction of 45 min; >10, lb fuel (1.0)
GRFE	landing gear flat plate area, sq ft; (function of gross weight)
HAPP	landing obstacle height, ft (50.)
HBTP	turbofan engine face hub/tip ratio, if NTYE=7 and KNAC ≠2
HCK	mean fuselage cabin diameter minus mean fuselage nose diameter, ft (2.47)
HIR	hull insurance rate; insurance cost/aircraft price (.02)
HNCRU	design cruise altitude, ft
HOO	altitude at start of mission, ft (0.)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
HPORT	takeoff altitude, when JENGSZ=1 or 2, ft (0.)
HRI	hours between annual inspection (100.)
HTG	wing height above ground during ground run, ft (3.)
HTMAX	terminal altitude for takeoff segment, ft.(500.)
HTURN	altitude of turn, ft, if JTRSZ = 1
HWING	0, low wing position on fuselage if LCWING = 2 1, high wing position on fuselage if LCWING = 2
ICLM	1, climb at maximum rate of climb (default) 2, climb at maximum allowable operating speed 3, climb at input EAS
ICRUS	0, cruise at EMCRU (default) for cost and range calculation 1, cruise at normal power for cost and range calculation 2, cruise for best specific range for cost and range calculation
IFLY	1, compute full mission (default) 2, compute mission through takeoff segment only 3, compute mission through climb segment only 4, compute landing performance only
IGEAR	type of landing gear: 0, retractable (default) 1, fixed gear
IPART	1, FAR Part 25 Turbine (default) propulsion sizing requirements 3, FAR, Part 23, General Aviation propulsion sizing requirements
ISWING	0, keep wing loading fixed during range balance (default) 1, keep wing area fixed during range balance
IWLD	0, landing weight = gross weight (default) 1, landing weight = weight at end of mission 2, landing weight = fraction of gross weight

VARIABLE	DESCRIPTION
JENGSZ	0, size engine for cruise only 1, size for cruise and takeoff 2, size for cruise and takeoff and climb requirement 3, size for cruise and climb requirement 4, engine thrust specified; input KNAC = 2, ELN, DBARN, WENG, WNAC , if NTYE = 7, only
JFLTYP	1, plain flap 2, split flap 3, single slotted flap (default) 4, double slotted flap 5, triple slotted flap 6, Fowler flap 7, double slotted Fowler flap
JTRSZ	0, no turn (default) (available only if NTYE=7) 1, turn sizing option (available only if NTYE=7)
KCONFG	type of fuselage tail cone: 0, conventional cone (default) 1, tail boom support
KNAC	0, nacelle drag computed as penalty to engine performance (turbofans only) 1, nacelle drag part of aircraft drag; nacelle sized by engine 2, same as 1, except nacelle size input DRARN, ELN
KODETO *	engine power setting during takeoff segment if NTYE=7
KODECL *	engine power setting during climb segment if NTYE=7
KODETR *	engine power setting during turn segment if NTYE = 7
KODEAC *	engine power setting during acceleration segment if NTYE = 7
	* These variable are set to 5, 6, 7 where 5 = maximum power (default) 6 = maximum continuous power 7 = maximum climb power
KPLOT	0, no plotting (default) 1, aerodynamic data plotted

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
KTIPX	tip tank indicator: 0, no tip tanks (default) 1, allows tip tanks
KWCD	number of points in wing profile drag table if input (0.)
KWRITE	0, no print 1, all write statements are printed 2, selected summary statements are printed (normal option) -1, selected summary statements are printed (abbreviated option) 9, additional write of propulsion performance (debugging)
LCWING	0, do not locate wing to balance aircraft 1, balance aircraft 2, compute cg limits and size horizontal and vertical tail for stability
LDCKMX	maximum fineness ratio of tip tank (8.0), if KTIPX = 1
MUB	coefficient of braking friction (.4)
NCADE	0, no additional equipment cost (default) 1, additional equipment cost a function of base cost
NFAIL	0, computes engine out and accelerate/stop distance 1, computes only all engine performance (default)
NTYE	1, reciprocating engine with carburetor 2, reciprocating engine with fuel injection 3, reciprocating engine with fuel injection and geared 4, rotary combustion engine 5, turboshaft engine 6, turboprop engine 7, turbojet or turbofan engine 11, 12, 13; same as 1, 2, 3 except HOPWSZ computes geometry and weight 14, same as 4 except RCWSZ computes geometry and weight
OHR	overhaul cost of one engine, $ per lb thrust or $per HP (5.5)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
PAX	number of passengers, excluding pilot
PR	inlet pressure recovery factor (1.) if NTYE = 7
PRV	aircraft residual value/original value (.20)
PS	seat pitch, in
RCCRU	required rate of climb at cruise sizing condition, fpm (0.)
RCLMAX	CLMAX reference value of basic wing reference condition aspect ratio = 12 taper ratio = 1. t/c = 0.10 $\Lambda_c/4 = 0^{\circ}$ Reynolds number = 6×10^6
RCRRQ	0, no range or endurance requirement (default) < 24, design endurance, hrs > 24, design range, nm
RELP	engine cg fraction of fuselage length, for fuselage-mounted engines (0.) if LCWING ≠ 0
RELR	cg of fuselage and contents, fraction fuselage length (.4) if LCWING ≠ 0
RH	elevator chord/horizontal tail chord (.4) if LCWING = 2
RI	loan interest rate; yearly interest/loan (0.)
RSMX	maximum allowable rate of sink during landing approach, ft per min (1000.)
RV	rudder chord/vertical tail chord (.4) if LCWING = 2
RVMCS	ratio of minimum control speed to stall speed in takeoff configuration (1.0) , if LCWING = 2
RWCRTX	ratio of cruise weight to gross weight for porpulsion sizing (1.0)
SAB	seats abreast in fuselage

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
SAH	horizontal tail location on vertical tail: 0, low tail 1, T-tail
SCFAC	shift in divergence Mach number due to supercritical design (0.)
SINKTD	landing touchdown sink rate, ft per sec (3.0)
SKB	weight trend coefficient of fuselage (136.)
SKCC	weight trend coefficient of cockpit controls (11.)
SKFS	weight trend coefficient for fuel system (.0195)
SKFT	fraction of total theoretical tip tank volume used for fuel (.979)
SKFW	weight trend coefficient of fixed wing controls (.404)
SKLG	weight trend coefficient of landing gear, fraction gross weight (.0318)
SKMG	weight trend coefficient main gear, fraction of landing gear (.80)
SKPEI	weight trend coefficient of engine installation, fraction dry engine (.135)
SKPES	weight trend coefficient of engine nacelle, fraction dry engine (.338) if KNAC $\neq$ 2
SKSAS	weight of stability augmentation system, lb (0.)
SKTL	factor on tail weight for arresting hook (1.)
SKWF	fraction of total theoretical wing volume used for wing fuel (.430)
SKWTP	tip tank weight trend coefficient, lb per sq ft (1.89)
SKWW	weight trend coefficient of wing without high lift devices (133.4)
SKY	weight trend coefficient horizontal tail (.18)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
SKZ	weight trend coefficient vertical tail (.22)
SLM	wing taper ratio
SLMH	taper ratio of horizontal tail
SLMV	taper ratio of vertical tail
SM1D	engine face Mach number sea level static if NTYE = 7 and KNAC ≠ 2
SRPM	storage or tie down rate, $/mo
STATIC	aircraft static margin, fraction mac (.03) if LCWING = 2
STMRGN	aircraft cg relative to quarter chord of mac, fraction mac, positive aft (0.), if LCWING ≠ 0.
STRUT	wing strut attachment point, fraction semispan (0.)
SWSLS	engine specific weight lb/lb thrust or lb/HP for recip/turboprop if KNAC ≠ 2
TAUH	elevator effectiveness if LCWING = 2., (default function of RH)
TAUV	rudder effectiveness if LCWING = 2 (default function of RV)
TBO	time between overhauls, hr (0. default which deletes cost computations)
TCHT	horizontal tail root thickness to chord ratio
TCR	wing root thickness to chord ratio
TCT	wing tip thickness to chord ratio
TCVT	vertical tail root thickness to chord ratio
TDELAY	delay for brake and reverse thrust application during landing, sec (1.0)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
TDELLD	temperature increment above standard during landing, deg. F, (0.)
TDELTO	takeoff temperature above standard during engine sizing, JENGSZ=1 or 2 (0.)
TDELTX	takeoff temperature above standard during mission, deg. F (0.)
THEMAX	maximum allowable fuselage floor angle, deg (15.)
THIN	input thrust for one engine, lb., if JENGSZ=4 and NTYE=7
TIDLE	idle thrust for propeller configurations, lb., if NTYE≠7 (0.)
TP	vertical position of thrust line relative to cg, positive for thrust below cg, ft (0.), if LCWING = 2
TR	property tax rate; tax/value (0.)
TROTID	ratio of reverse thrust to idle thrust during landing (0.)
UCSENG	unit cost of engine, \$ per lb thrust or \$ per HP (default program calculates)
UM	coefficient of rolling friction (.02)
UWNAC	nacelle weight/nacelle surface area; lb per sq ft,if KNAC≠2
UWPAX	weight per passenger, including baggage, lb (200.)
VBARHX	horizontal tail volume coefficient (default function of fuselage length and diameter)
VBARVX	vertical tail volume coefficient (default function of fuselage length and diameter)
VCLMB	climb speed, EAS, kts (input only if ICLM=3)
VMLFSL	maximum structural design flight speed, mi per hr.
VRAT	ratio of allowable lift off speed to stall speed (1.1)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
VRATT	ratio of landing approach speed to stall speed (1.3)
VTDRAT	ratio of touchdown speed to stall speed (1.15)
WAS	aisle width, in.
WCFLAP	weight trend coefficient in flap weight equation (default function of JFLTYP)
WENG	dry weight of one engine, lb if KNAC = 2
WFEX	fixed equipment weight, lb (default function of PAX)
WFUL	fixed useful load weight, lb
WG	initial gross weight, lb
WGS	wing loading, lb per sq ft
WLPCT	ratio of landing weight to gross weight, if IWLD=2
WNAC	weight of one nacelle, lb if KNAC = 2
WPLX	design payload, lb (default function of PAX)
WPYLON	weight of one pylon, lb, if KNAC=2 and TYPE=7
WS	seat width, in
WTMISN	aircraft weight at start of mission, lb (default gross weight)
WTRFAC	weight during turn, % of gross, if JTRSZ = 1 (1.0)
XLDGRQ	required landing distance, ft (99999.)
XLFMAX	maximum load factor during takeoff rotation (1.1)
XLFMX	landing flare load factor if < 4 or landing flare initiation height, ft if > 4. (1.2)
XLFTRN	sustained turn load factor, if JTRSZ=1
XLQDE	nacelle length to diameter ratio, KNAC=0 or 1
XTORQ	required takeoff distance to clear 35 ft, input if JENGSZ=1 or 2 (99999.)

FIGURE I.2.2 INPUT - PROGRAM MAIN (INGASP)

VARIABLE	DESCRIPTION
YMG	location of main gear on wing: 0, on fuselage 1, at tip
YP	location of engines on wing: 0, on fuselage 1, at tip
ZCG	height above runway of cg at nose wheel lift off, ft, (function of HWING) if LCWING = 2

FIGURE I.2.3 INPUT - PROGRAM MAIN (INPROP)

VARIABLE	DESCRIPTION
AF	propeller or Q-FAN blade activity factor per blade
ANCQHP	nacelle area per horsepower (.12)
BL	number of propeller or Q-FAN blades
BLANG	propeller blade angle at 3/4 rad., deg., only if specifying blade angle when NTYP = 1
BMEP	brake mean effective pressure, psi (0.) if NTYE > 10.
CAMT	initial production quantity of propellers to be used for costing (default function of propeller type)
CLI	propeller blade integrated design lift coefficient
CTI	initial estimate of propeller thrust coefficient (.2)
DIST	slant distance to observer for propeller noise, ft (1000.)
DPROP	propeller diameter, ft
EMNOYS	aircraft Mach number for noise calculation if KNOYS=0
FT	fraction of total propulsor thrust which is lost due to installation (0.)
GR	gear ratio, propeller rpm/engine rpm (1.)
HCRIT	critical altitude for turbocharger engines, ft (16000).
HNOYS	aircraft altitude for noise calculation, ft (1000.) if KNOYS 0 or 1
HPMSLS	maximum sea level static horsepower (0.) if KODECR=7
HPQAB	horsepower/bore area, piston engines, HP per sq in (2.6) if NTYE > 10.
IDATE	propeller weight technology level; 1970 or 1980, if NTYP > 10

VARIABLE	DESCRIPTION
JSIZE	1, increase HP with constant propeller diameter 2, increase both HP and diameter, keep disk loading constant (default)
KNOYS	-1, no prop noise calculation (default) 0, compute prop noise for aircraft at HNOYS and EMNOYS 1, compute prop noise for aircraft at HNOYS at maximum level speed
KODECR	used during engine sizing for piston engines: = 1, size engine and prop diameter at specified flight condition to maximize prop efficiency; engine operating point (PCRCR, PCPCR) specified for turboprop engines: = 1, engine being sized at a given flight condition; PCNCCR is input. T4 may be input T4STCR, otherwise T4/T2 = f(PCNCCR) for either piston or turboprop: = 2, size prop diameter at specified flight condition to maximize prop efficiency - engine size and operating point are fixed = 3, 4, size engine at specified flight condition - percent max engine power and prop size are fixed; KODECR = 3, prop RPM not specified (iterate to max prop eff); KODECR = 4, prop RPM is specified (no iteration involved). = 7, for horsepower and prop diameter input
KODETH	used during mission calculations = 5 or 6, find engine operating point (per cent max power) at specified flight condition for a fixed engine and prop size = 5, prop RPM not specified (iterate to minimize fuel flow) = 6, prop RPM specified (no iteration involved)
KSPCHG	0, no turbocharger (naturally aspirated) (0) 1, turbocharged engine

VARIABLE	DESCRIPTION
NCYL	number of cylinders, piston engines (4) if NTYE > 10
NTYP	1, fixed pitch propeller 2, constant speed propeller 3, constant speed full feathering propeller 4, constant speed, full feathering, deicing propeller 5, constant speed, full feathering, deicing propeller with reverse 6, Q-FAN propulsor 11 to 16, same as 1 to 6, except Hamilton-Standard routines are used for estimating weight, cost, and noise
PCNCCL	per cent corrected rotor speed at climb for turboprop (1.0)if NTYE = 5 or 6
PCNCCR	per cent corrected rotor speed at cruise for turboprop (.96), if NTYE = 5 or 6
PCNCTO	per cent corrected rotor speed at takeoff for turboprop (1.0), if NTYE = 5 or 6
PCPCL	per cent maximum power in climb for reciprocating engines (1.0), if NTYE < 5
PCPCR	per cent maximum power in cruise for reciprocating engines (.75) if NTYE < 5
PCPTO	per cent maximum power at takeoff for reciprocating engines (1.), if NTYE < 5

VARIABLE	DESCRIPTION
PCRCL	per cent maximum rpm in climb for reciprocating engines (1.) , if NTYE < 5
PCRCR	per cent maximum rpm in cruise for reciprocating engines (.907) , if NTYE < 5
PCRTO	per cent maximum rpm at takeoff for reciprocating engines (1.) , if NTYE < 5
ROTN	number of rotors, rotating combustion engines (2.) if NTYE = 14
RWH	ratio of width to height of piston engine (1.3) if NTYE > 10
SKDIM	dimension trend coefficient - engine cross-section (1.0)
SKWGT	weight trend coefficient - bare engine (1.0)
T4STCL	turboprop turbine inlet temperature at climb, deg R (Garrett TPE331 engine), if NTYE = 5 or 6
T4STCR	turboprop turbine inlet temperature at cruise, deg R (Garrett TYE331 engine) , if NTYE = 5 or 6.
T4STTO	turboprop turbine inlet temperature at takeoff, deg R (Garrett TPE331 engine) , if NTYE = 5 or 6
TSPDMX	maximum allowable propeller tip speed, ft per sec (900.)
UCSPP	unit cost of propulsor, $ per lb (default program calculates)
WKPFAC	propeller weight adjustment factor (1.0)
WPROP1	weight of one propeller, lb., if KNAC = 2
XCLF	propeller learning curve factor in costing for 1000 units (1.02)
XCLF1	learning curve factor for single unit for propeller cost (3.2178)
XCK70	single unit propeller cost 1970 technology, $ per lb., (default function of NTYP)
XCK80	single unit propeller cost 1980 technology, $ per lb., (function of NTYP)

VARIABLE	DESCRIPTION
XCW	propeller counterweight factor (function of NTYP)
XK1	coefficient in propeller or Q-FAN weight equation (function of NTYP)
XK2	coefficient in Q-FAN shroud weight equation (function of NTYP)
XK3	coefficient in gearbox weight equation (function of NTYP)
XNMAX	maximum engine speed, rpm

FIGURE I.2.4 OPTIONAL INPUT TO SUBROUTINES MAPS AND STORE3

VARIABLE	DESCRIPTION
AMAP	value of altitude
IPRINT	0, do not print input data 1, print input data
IREAD	0, no data input 1, read data from cards 2, read data from Tape 11
ITITL	table title
NLINE	number of T4/T2 points
NMAPS	number of altitudes
NPTS	number of Mach number points
SFNIDL	idle specific thrust, lb per lb per sec
T4MAX	maximum turbine inlet temperature, deg R
T4MC	cruise turbine inlet temperature, deg R
T4MCL	maximum continuous or climb turbine inlet temperature, deg R
WAMAP	SLS airflow of engine, lb per sec
X(L, M)	Mach number values
Y(L, M)	table values (thrust, fuel flow or corrected airflow) at altitude M
Z(L, M)	T4/T2 values at altitude M

FIGURE I.2.5 FUNCTIONAL LISTING OF
INGASP INPUT DATA

GENERAL CONFIGURATION DATA	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	WG	-	Gross Weight (lb)
	WGS	-	Wing Loading (psf)
	PAX	-	Number of Passengers (excluding pilot)
	ENP	-	Number of Engines
	IGEAR	0	= 0 - Retractable Gear; = 1 - Fixed Gear
	KCONFG	0	= 0 - Conventional Tail Cone = 1 - Boom Type Tail Support
	KTIPX	0	Tip Tank Indicator = 0 - No Tip Tanks; = 1 - Allows Tip Tanks
	NTYE*	-	Type of Engine Indicator
	KWRITE**	-	Print Control Parameter
	EMCRU	-	Design Cruise Mach Number
	HNCRU	-	Design Cruise Altitude

*NTYE = 1 indicates reciprocating engine with carburetor.
= 2 indicates reciprocating engine with fuel injection.
= 3 indicates reciprocating engine geared with fuel injection.
= 4 indicates rotary combustion engine.
= 5 indicates turboshaft engine.
= 6 indicates turboprop engine.
= 7 indicates turbojet or turbofan engine.
= 11, 12, 13 same as 1, 2, 3 except routine HOPWSZ used to compute engine geometry and weight.
= 14 same as 4 except routine RCWSZ used to compute engine geometry and weight.
= 0 no propulsor.

**KWRITE = 0 no print.
= 1 all write statements are printed.
= 2 selected summary write statements printed (normal output option).
= -1 selected summary write statements printed (abbreviated output option).
= 9 additional write of propulsion performance (use for debugging).

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

GEOMETRY	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
FUSELAGE	SAB	-	Seats abreast in fuselage
	WS	-	Seat width (inches)
	AS	-	Number of aisles
	WAS	-	Aisle width (inches)
	PS	-	Seat pitch (inches)
	ELPC	4.44	Length of pilot compartment (ft)
	HCK	2.47	Mean dia. cabin minus mean dia. nose (ft)
	ELODN	2.	Length/dia. ratio of fuselage nose section
	ELODT	3.2	Length/dia. ratio of tail cone
	BMLOD	14.5	Length/dia. ratio of boom (KCONFG =1)
NACELLE	KNAC*	-	Nacelle drag indicator
	ELN	f(eng size)	Nacelle length (KNAC=2), ft
	DBARN	f(eng size)	Nacelle mean diameter (KNAC=2), ft
	ELRW	-	Length of pylon attachment for fuselage mounted engines (ft)
WING	AR	-	Wing aspect ratio
	TCR	-	Wing root thickness/chord ratio
	TCT	-	Wing tip thickness/chord ratio
	SLM	-	Wing taper ratio
	DLMC4	-	Sweep of wing 1/4 chord (deg)
	EYEW	-	Wing incidence to horiz. reference (deg)

*KNAC = 0 - nacelle drag accounted for in engine performance (only used with turbofans).
= 1 - nacelle drag accounted for as an aerodynamic force; nacelle sized in engine routine.
= 2 - same as 1 except nacelle dimensions input in SIZE routine.

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

HORIZ TAIL	VBARHX	f(geom)	Horizontal tail volume coefficient
	TCHT	-	Horizontal tail root thickness/chord ratio
	ARHT	-	Aspect ratio of horizontal tail
	SLMH	-	Taper ratio of horizontal tail
	DWPQCH	-	Horizontal quarter chord sweep, deg
	COELTH	f(geom)	Wing chord/horizontal tail arm
	SAH	-	Location of horizontal on vertical = 0. - low tail; = 1 - T tail
VERT TAIL	VBARVX	f(geom)	Vertical tail volume coefficient
	TCVT	-	Vertical tail root thickness/chord
	ARVT	-	Aspect ratio of vertical tail
	SLMV	-	Taper ratio of vertical tail
	DWPQCV	-	Vertical tail quarter chord sweep, deg
	BOELTV	f(geom)	Wing span/vertical tail arm

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA

AERO-DYNAMICS	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	CKW	*	Wing form factor
	CKF	*	Fuselage form factor
	CKN	*	Nacelle form factor
	CKVT	*	Vertical tail form factor
	CKHT	*	Horizontal tail form factor
	CKTP	*	Tip tank form factor
	ALPHLO	-	Angle of attack at $C_L = 0$
	DLSWSW	0.	Increment in wetted area/wing area
	DELCD	.0015	Increment in C_D
	DELFE	.25	Increment in equiv. flat plate area of fuselage
	SCFAC	0.	0 - conventional drag divergence; >0 - shift in M_D due to supercritical
	GRFE	0.	0 - correlated on gross weight; >0 - landing gear flat plate area (ft^2)
	KWCD	0	Number of points in wing profile drag table
	ACLS	-	C_L values in wing profile drag table
	ACDCDR	-	Normalized wing profile drag values in wing profile drag table.

*Form factor defaults

$$CKW = 1.03\ [2 + 4(t/c)_w + 240(t/c)_w^4]$$

$$CKVT = 2 + 4(t/c)_{VT} + 240(t/c)_{VT}^4$$

$$CKHT = [1 + .10(1-SAH)][2 + 4(t/c)_{HT} + 240(t/c)_{HT}^4]$$

$$CKF = 1.35\ [1 + \frac{60}{(1/d)_F^3} + .0025(1/d)_F]$$

$$CKN = 1.50\ [1 + \frac{.35}{(1/d)_N}]$$

$$CKTP = 1 + \frac{60}{(1/d)_{TP}^3} + .0025(1/d)_{TP}$$

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

HIGH LIFT DEVICES	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	RCLMAX*		$C_{L_{MAX}}$ of basic wing at reference conditions
	ALTFLP	0.	Altitude for Reynolds number calc, ft
FLAPS	FLAPN	1.	Number of flap segments per wing panel
	WCFLAP	f(JFLTYP)	Coefficient in flap weight equation
	BENGOB	0.	Fraction of wing span without flaps due to wign mounted engines (0. - fuselage mounted)
	JFLTYP**	3	Flap type indicator
	DFLPTO		Takeoff flap deflection, deg
	DFLPLD		Landing flap deflection, deg
	CFOC	.30	Flap chord to wing chord ratio
	BTEOB	.75	Ratio of flap span/wing span
	DCLMTE	f(JFLTYP)	$\Delta C_{L_{MAX}}$ of ref. wing due to flaps at opt deflec.
	DCDOTE	f(JFLTYP)	ΔC_D of ref. wing due to flaps at opt. deflec.
	DELTEO	f(JFLTYP)	Optimum flap deflection angle
L.E. DEVICES	CLEOC	0.	L.E. device chord/wing chord ratio
	DELLED	0.	Deflection of leading edge device
	DCLMLE	.93	$\Delta C_{L_{MAX}}$ of ref wing due to L.E. device at opt
	DELLEO	45.	Opt deflection angle for L.E. device (deg)

* Reference conditions: Aspect ratio = 12; taper ratio = 1.0; thickness ratio = 0.10; c/4 sweepback = 0^o. Reynolds No. = 6×10^6

** Type of trailing edge devices:

JFLTYP = 1, plain
= 2, split
= 3, single slotted
= 4, double slotted
JFLTYP = 5, triple slotted
= 6, Fowler
= 7, double slotted Fowler

This FLAPS routine is based on the methodology in the following reference: Sanders, Karl L.: "High Lift Devices, A Weight and Performance Tradeoff Methodology," Tech. Paper No. 761, The Society of Aeronautical Weight Engineers, Inc. May 1969.

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

PROPULSION	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	JENGSZ*	-	Engine sizing options
	IPART	1	1 - Part 25 turbine, 3 - Part 23 Gen Aviation
	PR	1.	Inlet pressure recovery factor
	THIN	-	Input thrust for one engine (lbs) (Input only if JENGSZ = 4)
	XTORQ	99999.	Required takeoff distance to 35 ft (input only if JENGSZ = 1 or 2)
	RWCRTX	1.0	Ratio of cruise wt/gross wt (used for eng. siz)
	RCCRU	-	Required rate of climb @ cruise conditions
	HPORT	0.	Takeoff altitude (ft) } Used only for engine sizing when JENGSZ = 1 or 2
	TDELTO	0.	Takeoff temp above std, (°F) } Used only for engine sizing when JENGSZ = 1 or 2
	SM1D	-	Engine face Mach no. S.L. static } Input only if KNAC=0 or 1
	HBTP	-	Engine face hub/tip ratio } Input only if KNAC=0 or 1
	XLQDE	-	Nacelle length/diameter ratio } Input only if KNAC=0 or 1
	JTRSZ	0	0 = no turn, 1 = turn sizing option
	XLFTRN**	-	Turn load factor
	CLTLMT**	1.0	C_L limit in turn } Input only if JTRSZ=1
	HTURN**	-	Altitude of turn } Input only if JTRSZ=1
	EMTURN**	-	Turn Mach number } Input only if JTRSZ=1
	WTRFAC	1.0	weight during turn (% gross) or service ceiling weight
	ROCREQ	50.0	Engine out service ceiling rate of climb
	HSCREQ	0.	Engine out service ceiling required

*JENGSZ = 0, size for cruise only
= 1, size for cruise and takeoff
= 2, size for cruise and takeoff and climb required
= 3, size for cruise and climb req.
= 4, engine thrust specified for turbofan aircraft (must use KNAC=2). Must also input ELN, DBARN, WENG, WNAC

** If turning performance is desired in mission profile, these variables must be input. Turning performance will be computed after climb segment.

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

PROPU-SION	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
Turbofan Version Only	KODETO***	5	Takeoff power indicator
	KODECL***	5	Climb power indicator
	KODETR***	5	Turn power indicator
	KODEAC***	5	Acceleration power indicator

*** If value = 5, maximum power
= 6, maximum continuous power
= 7, maximum climb power

WEIGHTS	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	SKPEI	.135	Wt coef engine instal (fraction of dry eng)
	SKLG	.0318	Wt coef landing gear (fraction of gross wt)
	SKMG	.80	Wt coef main gear (fraction of landing gear)
	SKPES*	.338	Wt coef eng nacelle (fraction of dry engine) 0 for buried in fuselage
	SKY	.180	Wt coef horizontal tail
	SKZ	.220	Wt coef vertical tail
	SKTL	1.0	Factor on tail wt for arresting hook
	SKWW	133.4	Wt coef wing (excluding high lift devices)
	SKB	136.	Wt coef fuselage
	SKCC	11.	Wt coef cockpit controls
	SKFW	.404	Wt coef fixed wing controls
	SKSAS	0.	Wt of stability augmentor system
	SKFS	.0195	Wt coef for fuel system
	SKWF	.430	Fraction of wing volume for wing fuel
	SKFT	.979	Fraction of theoretical tip tank volume for fuel
	SKWTP	1.890	Tip tank wt coef (lb/surface area, ft^2)
	LCWING	0	= 0 - will not locate wing and balance aircraft; = 1 - balance aircraft = 2 - compute fwd and aft c.g. limits. Size tail based on stability and control.
	RELP	0.	Engine c.g. fraction of fuselage length (for fuselage mounted engines)
	EGMRGN**	0.	Engine c.g. in relation to L.E. of MAC (fraction of MAC) for wing mounted engines
	CPMRGN**	.10	Wing c.g. with respect to c/4 MAC (fraction of MAC)

FIGURE I.2.5 . FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

WEIGHTS	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	STMRGN**	0.	Aircraft c.g. with respect to c/4 MAC (fraction of MAC)
	RELR	.4	c.g. of fuselage and contents (fraction of fuselage length)
	UWPAX	200.	Weight per passenger (UWPAX times PAX used maximum payload case)
	ATMXQC	3.16	Max tip tank length/wing tip chord
	LDCKMX	8.	Max l/d of tip tank
	ELINC	0.	Distance between L.E. of V.T. and L.E. of H.T. on line of intersection of V.T. and H. T. (ft)
	WPLX	f(PAX)	Design payload (LB)
	WFEX	f(PAX)	Fixed equipment weight (lbx)
	WFUL	-	Fixed useful load (includes crew), lbs
	UWPAX	200.	Weight per passenger (UWPAX times PAX is used for maximum payload case), lbs
	STRUT	0.	Wing strut attachment point, fraction of semi-span (= 0, cantilever)
	VMLFSL	-	Maximum operating design flight speed (mph)
	CATD***	-	Design category (structure)
	DELP****	-	Fuselage pressure differential (psi)
	YP	-	Location of engines on Wing. 0., on fuselage 1., at tip
	YMG		Location of main gear on wing,0.- on fuselage and 1. - at tip

* Comes from ENGWGT routine if engine geometry computed there, otherwise default value

** Positive direction is aft; negative direction is forward.

*** CATD = 0, normal (FAR 23)
= 1, utility (FAR 23)
= 2, aerobatic (FAR 23)
= 3, transport (FAR 25)

Used to determine allowable load factors and design speeds

**** If input DELP is not adequate to maintain an 8000 ft. cabin at cruise altitude the proper DELP will be computed in the program. If DELP is input as zero, it is assumed that the cabin is not pressurized.

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

WEIGHTS	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
ENGINE	WENG*	f(eng size)	Dry weight of one engine, lb (includes gearbox if geared)
	WNAC*	f(eng size)	Wt of one nacelle, lb
	WPYLON*	f(eng size)	Wt of one pylon, lb
	SWSLS**		Engine specific wt = lb/lb thrust for turbofan/jet = lb/HP for recip and turboprop
	UWNAC**		Nacelle wt/nacelle surface area (lb/ft^2)
	FPYL**	0.7	Factor for pylon weight

*Must be input if KNAC=2 (for non-zero weights); may be input for KNAC=0 or 1 (no call to ENGWGT).

**Input only if KNAC=0 or KNAC=1.

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

PERFORMANCE	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	HOO	0.	Altitude at start of mission, ft
	IFLY*	1	Partial mission indicator
	WTMISN	WG	Aircraft wt at start of mission, lb
	THEMAX	15.	Max allowable fuselage angle, deg
	UM	.02	Coefficient of rolling friction
	MUB	.4	Coefficient of braking friction
	HTG	3.0	Wing height above ground during ground run
TAXI	DELTT	-	Time spent to taxi before takeoff (hrs)
TAKEOFF	XLFMAX	1.10	Max load factor during takeoff rotation
	DELTVR	3.5	Guess on time required to rotate, sec
	DV1	5.0	Increment of decision speed above stall (kts)
	DVR	5.0	Increment of rotation speed above decision speed (kts)
	VRAT	1.10	Ratio of allowable lift-off speed to stall
	TDELTX	0	Increment in ambient temperature above standard day (°F)
	HTMAX	500.	Terminal altitude for takeoff segment, ft AGI
	NFAIL	1	= 0 - computes engine out and accel/stop dist = 1 - computes only all engine performance
CLIMB	ICLM	1	= 1 - max rate of climb = 2 - climb at max allowable speed = 3 - climb at input EAS (VCLMB)
	VCLMB	0.	Climb speed, EAS, kts (input only if ICLM=3)
	DELH	1000.	Altitude increment during climb

*IFLY = 1 compute full mission
= 2 compute mission through takeoff
= 3 compute mission through climb
= 4 compute landing performance only

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

PERFOR-MANCE	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
CRUISE	CRMACH	EMCRU	Cruise Mach number
	CRALT	HNCRU	Cruise altitude, ft
	ICRUS*	0	Cruise speed indicator
	FRESF	1.	Required reserve fuel < 10 = fraction of 45 min > 10 = lbs fuel
	RCRRQ	0.	Required range or endurance = 0, no requirement < 24, design endurance, hrs. > 24, design range, n.mi.
	FACWI	**	Change in gross weight to start range iteration
	ISWING	0.	= 0, hold wing loading fixed during range balance = 1, hold wing area fixed during range balance
LANDING	XLDGRQ	99999.	Required landing distance (ft)
	ALTLND	0.	Altitude of landing field (ft)
	VRATT	1.3	Ratio of approach speed to stall speed
	RSMX	1000.	Maximum allowable rate of sink (fpm)
	TROTID	0.	Ratio of reverse thrust to idle thrust
	HAPP	50.	Obstacle height (ft)
	SINKTD	3.	Touchdown sink rate (fps)
	XLFMX	1.20	Flare load factor (XLFMX<4); flare initiation height, ft (XLFMX ≥ 4)
	TDELAY	1.0	Delay for brake and reverse thrust application (seconds)
	IWLD	0	0, landing weight = gross weight 1, landing weight = weight at end of mission 2, landing weight = fraction of gross weight
	WLPCT	-	WLPCT, landing weight/gross weight ratio (IWLD = 2)

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

PERFOR-MANCE	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	TDELLD	0.	Temperature increment above std. (^{o}F)
	VTDRAT	1.15	Ratio of touchdown speed to stall speed

* ICRUS = 0, cruise flown at input speed (EMCRU)

= 1, Cruise flown at speed at normal cruise power

= 2, Cruise flown at speed for best specific range

** For gross weights below 5000 lbs or design ranges less than 800 n. mi., FACW1 = 0.95. Otherwise FACW1 = 0.75.

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

CØST	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	NCADE	0	= 0 no additional equipment cost = 1 add equip cost a function of base cost
	CMV	0.	Increment to hourly operating cost($)
	CCRW	0.	Cost of crew ($)
	CMF	0.	Increment to fixed annual cost ($)
	HIR	.02	Hull insurance rate (%/100)
	CLIAB	215.	Cost of liability insurance ($)
	PRV	.20	Aircraft residual value (%/100)
	DYR	8.	Years for depreciation (years)
	RI	0.	Loan interest rate (%/100)
	TR	0.	Property tax rate (%/100)
	CRWØH	.50	Crew overhead rate (%/100)
	CINP	1500.	Cost of annual inspection ($)
	HRI	100.	Hours between annual inspection (hrs)
	ØHR	5.5	One engine overhaul cost ($/#T; $/HP)
	UCSENG	f(NTYE)	Unit cost of engine ($/#T; $/HP)
	UCSPP	f(NTYP)	Unit cost of propulsor ($/#) (NTYP < 10)
	TBØ	-	Time between overhaul (hrs)
	SRPM	-	Storage or tie-down rate ($/month)
	CP	Routine Computes	Aircraft price - if not input routine computes
	ALR	3.40	Manhour labor rate ($/hr)
	FCSF	.51	Fuel cost ($/gal)

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

STABILITY AND CONTROL TAIL SIZING	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
LONGITUDINAL	CMFLPL	$f(\delta_F)$	Wing pitching moment coefficient about aircraft (landing flaps)
	CMFLPT	$f(\delta_F)$	Wing pitching moment coefficient about aircraft (takeoff flaps)
	CMPLD	0.	Pitching moment coefficient about center of gravity due to all engines during landing
	STATIC	.03	Aircraft static margin, fraction of MAC
	CHALF	f(RH)	2-D variation of elevator hinge moment coefficient with angle of attack
	CHDEL	f(RH)	2-D variation of elevator hinge moment coefficient with elevator deflection,
	RH	0.40	Elevator chord/horizontal tail chord
	DEMAX	-25.	Maximum trailing-edge-up elevator deflection, deg (<0 for T.E. up)
	EYET	0.	Horizontal tail incidence angle relative to horizontal reference, deg
	ZCG	ZAC=f(HWING)	Height of center of gravity above runway a nose wheel liftoff, ft
	TP	0.	Vertical position of thrust line relative center of gravity, ft (> 0 for thrust below center of gravity)
	CXA		Distance of main wheel contact point aft of MAC leading edge, fraction of MAC
	DCMCLP	0 for Jets $f(T_C, DPROP)$	Propulsion stability term $(d\ C_m/d\ C_L)$ power, one engine
	HWING		Position of wing on fuselage = 0, low wing = 1, high wing

FIGURE I.2.5 FUNCTIONAL LISTING OF INGASP INPUT DATA (Continued)

STABILITY AND CONTROL TAIL SIZING	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
LONGITUDINAL	TAUH	f(RH)	Elevator effectiveness
DIRECTIONAL	CNPAC	f(WG, B)	Required directional stability of aircraft C_{N_ψ}, per deg
	ARVTE	f(ARVT, SAH)	Vertical tail effective aspect ratio
	RV	0.40	Rudder chord/vertical tail chord
	RVMCS	1.0	$\frac{\text{Minimum control speed}}{\text{Stall speed (takeoff configuration)}}$
	DRMAX	25.	Maximum rudder deflection, deg
	TAUV	f(RV)	Rudder effectiveness $d\,\alpha_{VT}/d\,\delta_{Rudder}$

FIGURE I.2.6 FUNCTIONAL LISTING OF INPROP INPUT DATA

ENGINES	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	KODECR*	-	Recip/turboprop engine cruise sizing option
	KODETH*	-	Recip/turboprop eng throttling options
	XNMAX	-	Max engine speed, rpm
	GR	1.	Gear ratio = propeller spd/eng spd
	HPMSLS	0.	Max SLS horsepower; input if KODECR=7
	ANCQHP	.12	Nacelle area/horsepower (for NTYE 10)
	JSIZE	2	Engine sizing indicator, takeoff and climb: = 1 increase HP with no inc in prop diam; = 2 increase both power and prop diam but hold disk loading const (HPMSLS/ADISK)

* KODECR - used during engine sizing

For piston engines:
KODECR = 1, size engine and prop diameter at specified flight condition to maximize prop efficiency; engine operating point (PCRCR, PCPCR) specified.

For turboprop engines:
KODECR = 1, engine being sized at a given flight condition; PCNCCR is input. T4 may be input T4STCR, otherwise T4/T2 = f(PCNCCR).

For either piston or turboprop:
KODECR = 2, size prop diameter at specified flight condition to maximize prop efficiency - engine size and operating point are fixed.
=3, 4 size engine at specified flight condition - per cent max engine power and prop size are fixed; KODECR = 3, prop RPM not specified (iterate to max prop eff); KODECR = 4, prop RPM is specified (no iteration involved).
= 7, for horsepower and prop diameter input.

* KODETH - used during mission calculations
KODETH = 5, 6 find engine operating point (% max power) at specified flight condition for a fixed engine and prop size; KODETH = 5 prop RPM not specified (iterate to minimize fuel flow; KODETH = 6, prop RPM specified (no iteration involved).

FIGURE I.2.6 FUNCTIONAL LISTING OF INPROP INPUT DATA

ENGINES	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
RECIP	PCPTO	1.	% power @ takeoff for recip engine (= POWER/HPMSL)
	PCRTO	1.	% RPM @ takeoff for recip engine (= RPM takeoff/XNMAX)
	PCPCL	1.	% power @ climb for recip engine (= $POWER_{CL}$/HPMSLS)
	PCRCL	1.	% RPM @ climb for recip engine (= RPM_{CL}/XNMAX)
	PCPCR	.75	% power @ cruise for recip engines (= $POWER_{CR}$/HPMSLS)
	PCRCR	.907	% RPM @ cruise for recip engine (=RPM_{CR}/ XNMAX)
	KSPCHG	0	Supercharger indicator: = 0, naturally aspirated engine = 1, supercharged engine
	BMEP	0.	Brake mean effective pressure, psi
	HCRIT	16000.	Cricital altitude, ft (KSPCHG=1)
TURBOPROP	PCNCCR	0.961	% corrected rotor speed at cruise (turboshaft/prop)
	PCNCCL	1.0	% corrected rotor speed at climb (turbo-shaft/prop)
	PCNCTO	1.0	% corrected rotor speed at takeoff (turboshaft/prop)
	T4STCR	0.	Turbine inlet temperature at cruise, ^{O}R (turboshaft or turboprop)
	T4STCL**	0.	Turbine inlet temperature at climb, ^{O}R (turboshaft or turboprop)
	T4STTO**	0.	Turbine inlet temperature at takeoff, ^{O}R (turboshaft or turboprop)

** If the default values (zero) are used, the program uses the limits specified in routine TURBEG for the Garrett TPE 331 turboprop.

FIGURE I.2.6 FUNCTIONAL LISTING OF INPROP INPUT DATA

PROPELLER	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
	NTYP*	-	Type of propulsor indicator
	AF	-	Propeller blade activity factor/blade
	DPROP	-	Propulsor diameter, ft
	BL	-	Number of propeller blades
	CLI**	-	Prop blade integrated design lift coefficient
	BLANG	-	Propeller blade angle @ r/R=.75 (deg) (this is only input if blade angle is specified for fixed pitch)
	IDATE	-	Propeller tech level, 1970 or 1980
	TSPDMX	900.	Max propeller tip speed, ft/sec
	FT	0.	Thrust loss factor (fraction of total thrust: $T = (1 - FT)\ T_{FT=0}$. FT =-1.0, Program computes FT.
	CTI	.2	Initial guess on thrust coefficient (propeller)
	PCLER	0.058	Propeller tip - fuselage clearance, fraction of propeller diameter

* NTYP = 1, fixed pitch propeller
= 2, constant speed propeller
= 3, constant speed, full feathering propeller
= 4, constant speed, full feathering, de-ice propeller
= 5, constant speed, full feathering, de-ice propeller, with reverse
= 6, QFAN propulsor
= 11, 12, 13, 14, 15, 16 - same as 1, 2, 3, 4, 5, 6, except Hamilton Standard routines used for propulsor weight, cost and noise.

** Recommended value: CLI = .5

FIGURE I.2.6 FUNCTIONAL LISTING OF INPROP INPUT DATA

	INPUT VARIABLE NAME	VALUE OF DEFAULT	DESCRIPTION
WEIGHTS (input only if KNAC=1)	XK1	f(NTYP)	Coefficient in propulsor wt equation
	XK2	f(NTYP)	Coefficient in propulsor shroud wt
	XK3	f(NTYP)	Coefficient in gearbox wt
	XCW	f(NTYP)	Accounts for propeller counterweights
	BNUM	-	Number of blades for propulsor (QFAN)
	AFTØT	-	Total activity factor of QFAN
	SKWGT	1.0	Wt coefficient - bare engine wt
	SKDIM*	1.0	Dimension coef - eng crosssectional dimension
	RWH	1.3	Ratio of width/height of piston engines
	NCYL	4	Number of cylinders - piston engines
	RØTN	2.	Number of rotors - R/C engines
	HPQAB	2.6	HP/bore area - piston eng (HP/in^2)
	WKPFAC	1.0	Propeller wt adjustment factor
	WPRØP1	-	Wt of one propeller, lb (KNAC=2 only) (includes gearbox, if geared)
COST	SCLF1**	3.2178	Learning curve factor for single unit
	XCLF**	1.02	Learning curve factor for 1000 units
	XCK70**	Computed	Single unit O.E.M. prop cost 1970, $/lb
	SCK80**	Computed	Single unit O.E.M. prop cost 1980, $/lb
	CAMT**	Computed	Initial quantity to be used
NOISE	KNØYS***	-1	Propeller noise indicator
	DIST	1000.	Slant distance to observer, ft
	HNØYS	1000.	Aircraft altitude for noise calc., ft
	EMNØYS	-	Aircraft Mach no. for noise calc. (KNØYS=0)

*Diameter for rotary combustion engines; width for piston engines

**Default values for these parameters are taken from NASA CR-2066, "Computer Program User's Manual for Advanced General Aviation Propeller Study," May 1975

*** KNØYS = -1 No noise calculation
= 0 Compute noise for aircraft flying at HNØYS and EMNØYS
= 1 Comput noise for aircraft flying at max level speed at HNØYS

FIGURE I.2.7 -

INPUT FORMAT FOR ENGINE TABLE (IF IENGSZ = -1)
TURBOFAN VERSION ONLY

Card 1

IREAD	Col.	1-5	right justified
IPRINT	Col.	6-10	right justified
WAMAP	Col.	21-30	left justified
T4MAX	Col.	31-40	left justified
T4MCL	Col.	41-50	left justified
T4MC	Col.	51-60	left justified
SFNIDL	Col.	61-70	left justified

IREAD = 0 No data input
= 1 Read data from cards
= 2 Read data from Tape 11

IPRINT = 0 Do not print input data
= 1 Print input data

WAMAP = SLS Airflow of engine (lb/sec)

T4MAX = Maximum turbine inlet temperature (°R)

T4MCL = Maximum cont. or climb TIT (°R)

T4MC = Cruise TIT (°R)

SFNIDL = Idle specific thrust (lb/lb/sec)

Card 2

ITITL - Table Title

Card 3

NMAPS - Number of altitudes

Card 4

Blank Card.

Card 5

NPTS - Number of Mach number points

NLINE - Number of T4/T2 points

AMAP - Value of Altitude

Card 6

X(1, 1) ----------- X(NPTS, 1) - Mach no. values

Card 7

Z(1, 1), Y(L, 1) ---------- Y(NPTS, 1)
.
.
.
.
Z(NLINE, 1), Y(NLINE, 1) -------

Z = T4/T2 values   Y = Table values
(thrust, fuel flow, or airflow)

Group for each Altitude

APPENDIX A

TURBOPROP POWERED DESIGN, FIXED ENGINE SIZE

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SAMPLE TURBOPROP SPECIFIED ENGINE SIZE
 $INGASP
 WG=12500., WGS=45.045, ENP=2., NTYE=6, EMCRU=.4000, HMCRU=10000.,
 KWRITE=2,
 SAB=2., WS=18., AS=1., WAS=18., PAX=19., PS=40.865,
 AR=7.71, TCR=.15, TCT=.15, DLMC4=.9, SLM=.400, YP=.324,
 ARHT=3.35, ARVT=1.544, TCVT=.09, TCHT=.09, SLMV=.35, SLMH=.40,
 YMG=.324, EYEV=.5, ELRW=0., DELP=7., CATD=0., ALPHLO=-2.,
 VMLFSL=357., KNAC=1, SAH=.299,
 ELODN=2.216, ELODT=2.515, HCK=1.80, ELPC=4.73,
 VBARVX=.123, VBARHX=1.165, COELTH=.235, BOELTV=1.639,
 DELCD=.00159,KWCD=12,
 ACLS=-.66,-.32,-.10,0.,.10,.20,.30,.40,.575,.70,.90,1.13,
 ACDCDR=1.8,1.175,1.05,1.025,1.009,1.0,1.009,1.025,1.10,1.225,1.55,2.25,
 CFOC=.27, BTEOB=.55, RCLMAX=1.280, JFLTYP=4,
 DCLMTE = .56, DFLPTO= 0., DFLPLD=36., DCDOTE=.125,
 DELTT=.1500, HTMAX=500.,
 JENGSZ=3, IPART=3, RCCRU=0., XLQDE=3.6,
 UWNAC=2.0,
 SKFW=.35, SKFS=.0256, SKPEI=.3575, SKLG=.04984, DWPQCH=30.,
 SKWF=.4250, SKB=98.5,SKY=.243,SKZ=.356,UWPAX=181.,
 SKWW=155.1,
 WFEX=1749., WFUL=686., WPLX=2300.,
 LCWING=0,
 NFAIL=0         , ICRUS=1,
 RWCRTX=.992, DVI=9.0, DVR=0.,  XLFMAX=1.250, MUB=.350,
 DELTVR=1.0,
 RSMX=600.,  XLFMX=1.10,  TDELAY=2.,  TIDLE=300.,   HTG=3.4,
 NCADE=1,TBO=3000., CMV=0., CCRW=0., SRPM= 150.,
 CMF=0., FCSF=.70,  OHR=40.,  CLIAB=1000.,
 UCSENG=100., ALR=5.0,
  DVI=8.0,  DVR=7.0,  DELTVR=2.5,
  ICLM=3,  VCLMB=140.,
 KNAC=2, WENG=358., WNAC=204.5, DBARN=2.91,ELN=11.04,
 KNAC=1, XLQDE=3.80, UWNAC=2.037, SWSLS=.3143, SKPEI=.3575, FPYL=0.,
  CRMACH=.35,  CRALT=10000.,
 $END
 $INPROP
 NTYP=15,
 WPROP1=151.5,
 BL=3.,AF=114., CLI=.55,          DIST=1000., IDATE=1970,
 CLI=.5,
 XNMAX=41730., CR=.04732,
 KODECR=4, DPROP=8.5, TSPDMX=1000., KODETH=6,
 FT=-1.0,
 KODECR=7, HPMSLS=840.,
 JSIZE=2, ANCQHP=.12,
 WKPFAC=.863,
 KNOYS=1, HNOYS=1000., DIST=1000.,
 $END
```

This is card image of input deck: for propeller configurations both namelist "ingasp" and "inprop" are required; for turbofan configurations only namelist "ingasp" is required

ORIGINAL PAGE IS
OF POOR QUALITY

SAMPLE TURBOPROP SPECIFIED ENGINE SIZE

THIS IS A PROPELLER AIRCRAFT
INPUT DATA FOLLOW

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******************

                         *****GEOMETRY*****

CONFIG VG     =  12500.      KWRITE =      2    FUSEL SAB    =     2.              ELODN  =  2.216
       WGS    =  45.045      IGEAR  =      0          VS     = 18.000              ELODT  =  2.515
       PAX    =     19.      KCONFG =      0          AS     =     1.              BMLOO  = 14.500
       EMCRU  =    .400      KTIPX  =      0          VAS    = 18.000      NACELLE KNAC   =      1
       HMCRU  =  10000.      ENP    =     2.          PS     =   40.9              ELN    = 11.040
                             NTYE   =      6          ELPC   =  4.730              DBARN  =  2.910
                             KPLOT  =      0          HCK    =  1.800              ELRW   =  0.000

  WING TCT    =    .150 HORIZ VBARHX =  1.1650 VERT  VBARVX =   .1230
       TCR    =    .150 TAIL  TCHT   =    .090 TAIL  TCVT   =    .090
       AR     =   7.710       ARHT   =   3.350       ARVT   =  1.544
       SLM    =    .400       SLMH   =    .400       SLMV   =   .350
       DLMC4  =    .900       DWPQCH =  30.000       DWPQCV = 35.000
       EYEW   =    .500       COELTH =    .235       BOELTV =  1.639
                              SAH    =    .299

                         ***AERODYNAMICS***

       CKW    =  -1.000       CKHT   =  -1.000       GRFE   =  0.000
       CKF    =  -1.000       CKTP   =  -1.000       SCFAC  =  0.000
       CKN    =  -1.000       DELCD  =  .00159       DLSWSW = -0.000
       CKVT   =  -1.000       DELFE  =    .250       ALPHLO = -2.000

       KWCD   =      12
       ACLS   =   -.660  -.320  -.100  0.000   .100   .200   .300   .400   .575   .700   .900  1.130
       ACDCOR =   1.800  1.175  1.050  1.025  1.009  1.000  1.009  1.025  1.100  1.225  1.550  2.250

                         *HIGH LIFT DEVICES*

       RCLMAX =   1.280 FLAPS JFLTYP =       4 LED   CLEOC  =  0.000
       ALTFLP =      0.       DFLPTO =   0.000       DELLED =  0.000
       FLAPN  =      1.       DFLPLD =  36.000       DCLMLE =   .930
       WCFLAP =  -1.000       CFOC   =    .270       DELLEO = 45.000
       BENGOB =   0.000       BTEOB  =    .550
                              DCLMTE =    .560
                              DCDOTE =    .125
                              DELTEO =   0.000

                         ****PROPULSION****

       JENGSZ =       3       HPORT  =      0.       RCCRU  =  0.000           RWCRTX =   .992
       IPART  =       3       TDELTO =      0.       XTORQ  =     -1           HSCREQ =     0.
       KODECR =       7       XNMAX  =  41730.       HPMSLS =  840.0
       KODETH =       6       GR     =  .04792       ANCQHP =   .120
       JSIZE  =       2
       T4STTO =      0.       T4STCL =      0.       T4STCR =     0.
       PCNCTO =   1.000       PCNCCL =   1.000       PCNCCR =   .961

  PROP NTYP   =      15       DPROP  =   8.500       IDATE  =   1970           CANT   =  0.000
       BL     =      3.       AF     = 114.000       XCLF1  =  0.000           WKPFAC =   .863
       TSPDMX =  1000.0       CLI    =    .500       XCLF   =  0.000           PCLER  =  .0580
       FT     =  -1.000       BLANG  =   0.000       XCK70  =     0.           CTI    =   .200
                              XCK80  =       0
 NOISE KNOYS  =       1       DIST   =   1000.       HNOYS  =   1000           EMNOYS =  0.000

                         *****WEIGHTS*****
```

	SKPEI	.3575		SKY	.2430	SKB	98.500	SKFS	.0256
	SKLG	.0498		SKZ	.3560	SKCC	11.000	SKWF	.4250
	SKMG	.8000		SKTL	1.0000	SKFW	.3500	SKFT	.9790
	SKFES	.3380		SKWW	155.100	SKSAS	0.000	SKWTP	1.8900
	WPLX	2300.0		YMG	.3240	EGMRGN	0.0000	LCWING	0
	WFEX	1749.0		RELP	0.0000	CPMRGN	.1000	ELINC	0.000
	WFUL	686.0		RELR	.4000	STMRGN	0.0000	LOCKMX	8.000
	UWPAX	181.0		CATD	0.	DELP	7.000	ATMXQC	3.160
	STRUT	0.0000		VMLFSL	357.0	YP	.3240	DELWST	0.0
	DELWFC	0.0							
ENGINE	WENG	358.0		WNAC	204.5	WPYLON	0.0		
	SVSLS	.314		UWNAC	2.037	FPYL	0.000	XLQDE	3.800
	WPROP1	151.5							
				PERFORMANCE					
TAXI TO	DELTT	.150		XLFMAX	1.250	DVR	7.000	TDELTX	0.000
	IFLY	1		DELTVR	2.500	UM	.020	HTMAX	500.000
	THFMAX	15.000		DVI	8.000	MUB	.350	NFAIL	0
	HOL	0.		VRAT	1.10	WTMISN	0.		
CLIMB	ICLM	3	CRUISE	CRMACH	.350	FRESF	1.000	FACWI	.950
	DELH	1000.		CRALT	10000.	RCRRQ	0.0	ISWING	0
	VCLMB	140.0		ICRUS	1	OFALT	0.	OFEM	-1
LAND	IWLD	0		XLDGRQ	99999.	VRATT	1.300	HAPP	50.
	TDELLD	0.0		ALTLND	0.	RSMX	600.	SINKTD	3.0
	TDELAY	2.0		WLPCT	0.0000	TROTID	0.000	XLFMX	1.100
	HTG	3.4		TIDLE	300.0	VTDRAT	9999.0		
				******COST******					
	NCADE	1		HIR	.020	RI	0.000	CMV	0.000
	CLIAB	1000.0		TR	0.000	OHR	40.000	CCRW	0.
	HRI	100.0		PRV	.200	CRWOH	500	UCSENG	100.000
	LMF	0.0		DYR	8.0	CINP	1500	UCSPP	0.000
	TBO	3000.0		SRPM	150.0	CP	0.	ALR	5.000
	FC'F	.700							

This is the formatted repeat of the input data

```
************************************************************************************

              FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)
              CLMAX    VSTALL,KTS  FLAP ANGLE   LE ANGLE   DELTA CL   DELTA CD

FLAPS UP      1.3763     98.6         0.0         0.0      0.0000     0.0000
T.O. CONFIG   1.3763     98.6         0.0         0.0      0.0000     0.0000
LDG. CONFIG   1.7583     87.0        36.0         0.0       .3954      .0352

               DOUBLE SLOTTED FLAPS
               OPT ANGLE   DELCL AT OPT   DELCD AT OPT   AREA(FT2)   WEIGHT(LB)

FLAPS            55.0         .5600          .1250          40.4        118.6

************************************************************************************

************************************************************************************

        TEMP.=  518. DEG.STD.= 0.
  LANDING ELEVATION=     0. FT.
  LANDING WING LOADING=  45.05 PSF.
  LANDING WEIGHT =    12500. LBS.

  LANDING DISTANCE FROM 50. FT.=   2944. FT.

  F.A.R. FACTORED FIELD LENGTH =   4906. FT.

               APPROACH           TRANSITION          DELAY              ROLL

          DIST=      952.    DIST=      145.    DIST=     337.    DIST=      1510.
          R/S=       600.    XLFMX=    1.100    TDELAY=   2.00    MUB=       .3500
          VAPEAS=  112.76    SINKTD=   3.000    TIDLE=    300     TR/TIDLE= 0.0000
          VAPTAS=  112.84    VSTEAS=   86.74    VTDTAS=  99.82    ABAR(G)=   .2926
          THETA=     3.01    CLMX=    1.7651
          THRUST=    836.    HFLAR=     14.2

************************************************************************************

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
  ANGLE OF ATTACK(DEGREES)=  1.029  LIFT= 12400.0  L/D=  10.440  ALTITUDE= 10000.0  MACH=  .4000
```

Results of computation for flap characteristics

Landing performance

Results of design cruise aerodynamic calculations

(6?)

```
                       ENGINE SIZING DATA FOLLOW
                       *************************
TURBOPROP ENGINE INFO. (RHP= 1.1560)

*MACH NO. =    .4000   T2 =  498.48   RTHET2 =    .9803
*   TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =   567.08
*       XN     = 39314.      HPSLRF = 726.6
*       XNCR   = 40103.      XNCREF = 41730.
*       PCNR   =   .9421     PCNCMX = 1.0780
*       PCNCR  =   .9610     T4QT2M = 4.2192
*       T4QT2  = 4.2192      T4T2RF = 4.3803
MAX AVAIL HP  AT THIS FLT.COND.(HPM) =   661.79
RATED SLS HORSEPOWER(HPMSLS) =   840.00
HPM,HPMSLS,HPWR,HPAVLB,=      661.8     840.0     567.1     567.1
PCPOWR,PCRPM,=                 .675      .942
BSFC,WF,=                      .551     312.5
THPROP,FT,EFFPI,EFFP,=        654.8      .032      .917      .887
XNMAX,GR,DPROP,=            41730.0      .048     8.500
TIPSPD=                       838.5
XJ,CP,CT,=                    1.584      .129      .072
BL,AF,COD,BLANG=                 3.     114.0        -1     35.40
JET THRUST=                    17.9
KODE,TSFC=                        7      .465
```

Performance of one engine at design cruise for specified engine

```
TURBOPROP ENGINE INFO. (RHP= 1.1560)

*MACH NO  =    .2114   T2 =  505.32   RTHET2 =    .9870
*   TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =   729.84
*       XN     = 41189.      HPSLRF = 726.6
*       XNCR   = 41730.      XNCREF = 41730.
*       PCNR   =   .9870     PCNCMX = 1.0780
*       PCNCR  = 1.0000      T4QT2M = 4.4741
*       T4QT2  = 4.4741      T4T2RF = 4.4741
MAX AVAIL HP  AT THIS FLT.COND.(HPM) =   729.84
RATED SLS HORSEPOWER(HPMSLS) =   840.00
HPM,HPMSLS,HPWR,HPAVLB,=      729.8     840.0     729.8     729.8
PCPOWR,PCRPM,=                 .869      .987
BSFC,WF,=                      .571     416.4
THPROP,FT,EFFPI,EFFP,=       1362.7      .023      .790      .772
XNMAX,GR,DPROP,=            41730.0      .048     8.500
TIPSPD=                       878.5
XJ,CP,CT,=                     .813      .124      .118
BL,AF,COD,BLANG=                 3.     114.0        -1     25.82
JET THRUST=                    63.3
KODE,TSFC=                        7      .292
```

Performance of one engine at T.O. flaps - one engine out climb condition

```
TURBOPROP ENGINE INFO. (RHP= 1.1560)

*MACH NO  =    .1929   T2 =  522.53   RTHET2 =  1.0037
*   TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =   862.71
*       XN     = 41730.      HPSLRF = 726.6
*       XNCR   = 41576.      XNCREF = 41730.
*       PCNR   = 1.0000      PCNCMX = 1.0780
*       PCNCR  =   .9963     T4QT2M = 4.4438
*       T4QT2  = 4.4438      T4T2RF = 4.4438
MAX AVAIL HP  AT THIS FLT COND (HPM) =   868.39
RATED SLS HORSEPOWER(HPMSLS) =   840.00
HPM,HPMSLS,HPWR,HPAVLB,=      868.4     840.0     862.7     862.7
```

Performance of one engine at T.O. flaps - all engine climb condition

```
PCPOWR,PCRPM,=              1.027      1.000
BSFC,WF,=                    .575      496.4
THPROP,FT,EFFPI,EFFP,=     1684.6       .022       .767      .750
XNMAX,GR,DPROP,=          41730.0       .048      8.500
TIPSPD=                     890.0
XJ,CP,CT,=                   .745       .122       .122
BL,AF,COD,BLANG=               3.      114.0         -1     24.92
JET THRUST=                  77.9
KODE,TSFC=                      7       .282


TURBOPROP ENGINE INFO. (RHP= 1.1560)

*MACH NO  =   .1708    T2 =  521.69    RTHET2 =  1.0029
*   TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =   859.89
*        XN     = 41730.       HPSLRF = 726.6
*        XNCR   = 41609.       XNCREF = 41730.
*        PCNR   = 1.0000       PCNCMX = 1.0780
*        PCNCR  =  .9971       T4QT2M = 4.4509
*        T4QT2  = 4.4509       T4T2RF = 4.4509
MAX AVAIL HP  AT THIS FLT COND (HPM) =    864.46
RATED SLS HORSEPOWER(HPMSLS) =    840.00
HPM,HPMSLS,HPWR,HPAVLB,=    864.5      840.0      859.9     859.9
PCPOWR,PCRPM,=              1.024      1.000
BSFC,WF,=                    .576      495.3
THPROP,FT,EFFPI,EFFP,=     1795.8       .021       .725      .709
XNMAX,GR,DPROP,=          41730.0       .048      8.500
TIPSPD=                     890.0
XJ,CP,CT,=                   .660       .121       .130
BL,AF,COD,BLANG=               3.      114.0         -1     24.05
JET THRUST=                  82.8
KODE,TSFC=                      7       .264
```

Performance of one engine at landing flaps + LD gear ext. - all engine climb condition

```
TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 23
  AIRPORT ALTITUDE=     0. FT.   AMBIENT TEMP ABOVE STD. DAY=    0.0 DEG F
```

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
T.O. FLAPS - ONE ENG OUT	5000.	137.7	532.70	237.18	.82	13.18
T.O. FLAPS - ALL ENGINES	0.	127.9	2671.84	1078.35	.81	13.19
LANDING FLAPS+LD GEAR EXT - ALL ENGINES	0.	113.1	2083.79	381.62	1.04	8.43

```
*** ENGINE-OUT SERVICE CEILING = 13366.0 FT.
    BEST RATE OF CLIMB SPEED   =   154.6 KTAS
    ENGINE-OUT RATE OF CLIMB   =    50.0 FPM
    WEIGHT AT ALTITUDE         = 12000.0 LBS

RESIZE ENGINES AT CRUISE TO ACCOUNT FOR RESIZED NACELLES

TURBOPROP ENGINE INFO. (RHP= 1.1560)

*MACH NO  =   .4000    T2 =  498.48    RTHET2 =   .9803
*   TPE-331 CYCLE
*HP AVLB AT THIS PWR SET AND FLT COND (HPAVLB) =   567.08
*        XN     = 39314.       HPSLRF = 726.6
*        XNCR   = 40103.       XNCREF = 41730.
```

The previous series is repeated for properly sized nacelle since the KNAC=1 option was specified and nacelle size was determined during engine sizing

```
*      PCNR   =  .9421       PCNCMX = 1.0780
*      PCNCR  =  .9610       T4QT2M = 4.2192
*      T4QT2  = 4.2192       T4T2RF = 4.3803
MAX.AVAIL.HP  AT THIS FLT.COND.(HPM) =    661.79
RATED SLS HORSEPOWER(HPMSLS) =    840.00
HPM,HPMSLS,HPWR,HPAVLB,=      661.8      840.0      567.1      567.1
PCPOWR,PCRPM,=                 .675       .942
BSFC,WF,=                      .551      312.5
THPROP,FT,EFFPI,EFFP,=        652.5       .043       .917       .878
XNMAX,GR,DPROP,=            41730.0       .048      8.500
TIPSPD=                       838.5
XJ,CP,CT,=                    1.571       .129       .072
BL,AF,COD,BLANG=                 3.      114.0        -1       35.25
JET THRUST=                    17.9
KODE,TSFC-                        7       .466
```

TURBOPROP ENGINE INFO. (RHP= 1.1560)

```
*MACH NO. =    .2114    T2 =  505.32    RTHET2 =    .9870
*    TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =    729.84
*      XN     = 41189.       HPSLRF =  726.6
*      XNCR   = 41730.       XNCREF = 41730.
*      PCNR   =  .9870       PCNCMX = 1.0780
*      PCNCR  = 1.0000       T4QT2M = 4.4741
*      T4QT2  = 4.4741       T4T2RF = 4.4741
MAX.AVAIL.HP. AT THIS FLT.COND.(HPM) =    729.84
RAtED SLS HORSEPOWER(HPMSLS) =    840.00
HPM,HPMSLS,HPWR,HPAVLB,=      729.8      840.0      729.8      729.8
PCPOWR,PCRPM,=                 .869       .987
BSFC,WF,=                      .571      416.4
THPROP,FT,EFFPI,EFFP,=       1359.9       .030       .788       .764
XNMAX,GR,DPROP,=            41730.0       .048      8.500
TIPSPD=                       878.5
XJ,CP,CT,=                     .807       .124       .118
BL,AF,COD,BLANG=                 3.      114.0        -1       25.75
JET THRUST=                    63.3
KODE,TSFC=                        7       .293
```

TURBOPROP ENGINE INFO. (RHP= 1.1560)

```
*MACH NO. =    .1929    T2 =  522.53    RTHET2 =   1.0037
*    TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =    862.71
*      XN     = 41730.       HPSLRF =  726.6
*      XNCR   = 41576.       XNCREF = 41730.
*      PCNR   = 1.0000       PCNCMX = 1.0780
*      PCNCR  =  .9963       T4QT2M = 4.4438
*      T4QT2  = 4.4438       T4T2RF = 4.4438
MAX.AVAIL.HP. AT THIS FLT.COND.(HPM) =    868.39
RATED SLS HORSEPOWER(HPMSLS) =    840.00
HPM,HPMSLS,HPWR,HPAVLB,=      868.4      840.0      862.7      862.7
PCPOWR,PCRPM,=                1.027      1.000
BSFC,WF,=                      .575      496.4
THPROP,FT,EFFPI,EFFP,=       1680.8       .029       .764       .742
XNMAX,GR,DPROP,=            41730.0       .048      8.500
TIPSPD=                       890.0
XJ,CP,CT,=                     .740       .122       .122
BL,AF,COD,BLANG=                 3.      114.0        -1       24.86
JET THRUST=                    77.9
KODE,TSFC=                        7       .282
```

```
TURBOPROP ENGINE INFO. (RHP= 1.1560)

*MACH NO. =   .1706   T2 =  521.69   RTHET2 =  1.0029
*   TPE-331 CYCLE
*HP AVLB AT THIS PWR SET.AND FLT.COND.(HPAVLB) =    859.89
*        XN     = 41730.        HPSLRF =  726.6
*        XNCR   = 41609.        XNCREF = 41730.
*        PCNR   = 1.0000        PCNCMX = 1.0780
*        PCNCR  =  .9971        T4QT2M = 4.4509
*        T4QT2  = 4.4509        T4T2RF = 4.4509
MAX.AVAIL.HP. AT THIS FLT.COND.(HPM) =    864.46
RATED SLS HORSEPOWER(HPMSLS) =   840.00
HPM,HPMSLS,HPWR,HPAVLB,=        864.5      840.0      859.9      859.9
PCPOWR,PCRPM,=                  1.024      1.000
BSFC,WF,=                        .576      495.3
THPROP,FT,EFFPI,EFFP,=         1790.8       .027       .722       .702
XNMAX,GR,DPROP,=              41730.0       .048      8.500
TIPSPD=                         890.0
XJ,CP,CT,=                       .654       .121       .130
BL,AF,COD,BLANG=                   3.      114.0        -1       24.00
JET THRUST=                      82.8
KODE,TSFC=                          7       .264


TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 23
  AIRPORT ALTITUDE=      0. FT.   AMBIENT TEMP ABOVE STD. DAY=    0.0 DEG F

  CONFIGURATION                               ALT (FT)   V (KTAS)  R/C (FPM)  R/C REQ (FPM)  CL REQ    L/D

  T.O. FLAPS - ONE ENG OUT                      5000.      137.7     517.49      237.18        .82     13.03
  T.O. FLAPS - ALL ENGINES                         0.      127.9    2652.63     1078.35        .81     13.04
  LANDING FLAPS-LD GEAR EXT - ALL ENGINES          0.      113.1    2066.88      381.62       1.04      8.38


   *** ENGINE-OUT SERVICE CEILING = 13134.4 FT.
       BEST RATE OF CLIMB SPEED   =   152.4 KTAS
       ENGINE-OUT RATE OF CLIMB   =    50.0 FPM
       WEIGHT AT ALTITUDE         = 12000.0 LBS

ENGINE SIZED TO MATCH CRUISE DRAG
  PROP DIAMETER=    8.50 FT. S.L. HORSEPOWER=    840.

ENGINE SIZE MEETS RATE OF CLIMB REQUIREMENTS
  RATE OF CLIMB= 2066.9 FPM.   RATE OF CLIMB REQ=  381.6 FPM

MAXIMUM S.L.S. ENGINE PERFORMANCE
  POWER       =  840.00
  THRUST/WT   =   .4357
  PROP RPM    =  1999.7
  PROP DIAM   =    8.50
  PROP TIPSPD =   890.0

MOUNT AND GEAR BOX ASSEMBLY WEIGHT
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Summary of engine sizing

Summary of Propulsion Weights

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TWO-STAGE = 94. POUNDS

 MOUNT AND GEAR BOX = 94. POUNDS
 AFTERBODY =  0. POUNDS

PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE              264.0
  NACELLE WEIGHT/ENGINE             205.3
  PYLON WEIGHT/ENGINE                 0.0
  PROPULSOR WEIGHT/ENGINE           151.5
```

SAMPLE TURBOPROP SPECIFIED ENGINE SIZE

GROSS WEIGHT = 12500. PASSENGERS = 19. PLUS CREW OF 1

FUSELAGE	LENGTH	(ELF)	57.41	FT
	WIDTH	(SWF)	5.50	FT
	WETTED AREA	(SF)	867.	SQFT
	DELTA P	(DELP)	7.00	PSI
WING	ASPECT RATIO	(AR)	7.71	
	AREA	(SW)	277.5	SQFT
	SPAN	(B)	46.3	FT
	GEOM. MEAN CHORD	(CBARW)	6.37	FT
	QUARTER CHORD SWEEP	(DLMC4)	.9	DEG
	TAPER RATIO	(SLM)	.400	
	ROOT THICKNESS	(TCR)	.150	
	TIP THICKNESS	(TCT)	.150	
	WING LOADING	(WGS)	45.0	PSF
	WING FUEL VOLUME	(VFW)	648.1	GAL
HOR. TAIL	ASPECT RATIO	(ARHT)	3.35	
	AREA	(SHT)	76.0	SQFT
	SPAN	(BHT)	15.95	FT
	MEAN CHORD	(CBARHT)	5.05	FT
	THICKNESS/CHORD	(TCHT)	.090	
	MOMENT ARM	(ELTH)	27.1	FT
	VOLUME COEFF.	(VBARH)	1.165	
VERT. TAIL	ASPECT RATIO	(ARVT)	1.54	
	AREA	(SVT)	55.9	SQFT
	SPAN	(BVT)	9.29	FT
	MEAN CHORD	(CBARVT)	6.48	FT
	THICKNESS/CHORD	(TCVT)	.090	
	MOMENT ARM	(ELTV)	28.2	FT
	VOLUME COEFF.	(VBARV)	.123	
ENG. NACELLES	LENGTH	(ELN)	11.04	FT
	MEAN DIAMETER	(DBARN)	2.91	FT
	NUMBER ENGINES	(ENP)	2.0	
	WETTED AREA	(SN)	201.60	SQFT
	LOCATION	7.5 FT. FROM A/C CENTERLINE		

VDIVE = 310. KTS   VMO = 264. KTS   MMO = .543
ULT. LF = 5.70   MAN. LF = 3.80   GUST LF = 2.96

PROPULSION GROUP			
PRIMARY ENGINES	(WEP)	528.	
PRIMARY ENGINE INSTL.	(WPEI)	256.	
FUEL SYSTEM	(WFSS)	52.	
PROPULSOR WEIGHT	(WPROP)	303.	
GEAR BOX WEIGHT	(WTGB)	188.	
TOTAL PROP. GROUP WT.	(WP)	1327.	
STRUCTURES GROUP			
WING	(WW)	1367.	
HOR. TAIL	(WHT)	216.	
VERT. TAIL	(WVT)	159.	
FUSELAGE	(WB)	1445.	
LANDING GEAR	(WLG)	623.	
PRIMARY ENG. SECTION	(WPES)	411.	
GROUP WEIGHT INC.	(DELWST)	0.	
TOTAL STRUC. GROUP WT.	(WST)	4220.	
FLIGHT CONTROLS GROUP			
COCKPIT CONTROLS	(WCC)	31.	
FIXED WING CONTROLS	(WCFW)	144.	
SAS	(WSAS)	0.	
GROUP WEIGHT INC.	(DELWFC)	0.	
TOTAL CONTROL WT.	(WFC)	175.	
WT. OF FIXED EQUIPMENT	(WFE)	1749.	
WEIGHT EMPTY	(WE)	7471.	
FIXED USEFUL LOAD	(WFUL)	686.	(INC. CREW)
OPERATING WEIGHT EMPTY	(OWE)	8157.	
PAYLOAD	(WPL)	2300.	(PAX. VOL. = 19. DESIGN PAX= 12.)
FUEL	(WFA)	2043.	(WFW= 2043.) (WFTP= 0.)
GROSS WEIGHT	(WG)	12500.	

SAMPLE TURBOPROP SPECIFIED ENGINE SIZE

CRUISE MACH = .400 CRUISE ALTITUDE = 10000. CRUISE Q (PSF) =163.26

CRUISE RE.NUM. PER FT. = 2.144E+06 FLATPLATE CF AT RE=10EX7 IS .00287

AERODYNAMIC DATA

DRAG BREAKDOWN	FLATPLATE AREA(SQFT)	CDO	WETTED AREA(SQFT)
WING	2.1213	.00764	464.09
FUSELAGE	2.7335	.00985	866.85
VERT. TAIL	.3614	.00130	111.89
HOR. TAIL	.5465	.00197	151.95
ENGINE NAC.	.8266	.00298	201.60
TIP TANKS	0.0000	0.00000	0.00
INCREMENTAL	.4412	.00159	0.00
TOTAL	7.0305	.02534	1796.37

MEAN SKIN FRICTION COEF. = .003914

AERODYNAMIC COEFF.

A1		.7166	
A2		-.1163	
A3		.0631	
A4=.75X(T/C)		.1125	
A5=CDO--		.0147	
A6		2.6682	
A7=1/(PI.SEE.AR)		.0512	
3-D LIFT SLOPE AT CRUISE MACH	(CLALPH)	5.1839	PER RADIAN
OSWALD FACTOR	(SEE)	.8064	

CRUISE CD = .0253 + .0512 *CL**2 (ASSUMES MINIMUM WING PROFILE DRAG)

RETRACTABLE LANDING GEAR CD INC. = .02185

LOW SPEED LIFT/DRAG-GR.UP(IF RIO.G.E.

	FLAPS UP			TAKEOFF			LANDING		
ALPHA	CL	CD	L/D	CL	CD	L/D	CL	CD	L/D
-2.00000	0.00000	.02553	0.00000	0.00000	.02553	0.00000	.39544	.06232	6.34532
0.00000	.17112	.02685	6.37232	.17198	.02687	6.40074	.56742	.06758	8.39676
2.00000	.34225	.03145	10.88134	.34396	.03151	10.91416	.73940	.07657	9.65599
4.00000	.51337	.03939	13.03264	.51594	.03953	13.05020	.91138	.08958	10.17353
6.00000	.68450	.05093	13.44120	.68792	.05119	13.43804	1.08336	.10701	10.12368
8.00000	.85562	.06647	12.87218	.85990	.06690	12.85360	1.25534	.12934	9.70559
10.00000	1.02674	.08646	11.87499	1.03188	.08712	11.84389	1.42732	.15547	9.18045
12.00000	1.19787	.10993	10.89617	1.20386	.11081	10.86410	1.59930	.18500	8.64475

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MISSION PERFORMANCE DATA FOLLOWS
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TAXI AT IDLE THRUST

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	FUEL FLOW (LB/HR)
0.000	0.	0.	12500.	0.	371.
.150	0.	56.	12444.	0.	371.

VSTLKT= 97.8 KTS EAS VRAT= 1.100 CLTO= 1.1431
VEND = 140.0 KNOTS EAS

(TEMP.= 519. DEG.STD.+ 0.)

TAKEOFF (ELEVATION= 0. FT)

TIME (SEC)	DIST. (FEET)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	ACCEL (FPS2)	CL	CD	ALPHA (DEG)	GAMMA (DEG)	ROC (FPM)	LOAD FACT	THRUST (LBS)	FUEL FLOW (LB/HR)	FUS. ANGLE (DEG)
0.0	0.0	55.7	12444.	0.0	0.0	0.0	0.000	13.43	.2314	.0485	.50	0.00	0.0	0.00	5446.	978.	0.00
1.0	6.7	55.9	12444.	0.0	7.9	7.9	.012	13.13	.2314	.0485	.50	0.00	0.0	0.00	5331.	979.	0.00
2.0	26.6	56.2	12444.	0.0	15.6	15.6	.024	12.81	.2315	.0485	.50	0.00	0.0	0.00	5214.	980.	0.00
3.0	59.3	56.5	12444.	0.0	23.1	23.1	.035	12.48	.2315	.0485	.50	0.00	0.0	0.00	5101.	980.	0.00
4.0	104.6	56.8	12443.	0.0	30.5	30.5	.046	12.16	.2316	.0485	.50	0.00	0.0	0.00	4990.	981.	0.00
5.0	162.1	57.0	12443.	0.0	37.6	37.6	.057	11.83	.2317	.0485	.50	0.00	0.0	0.00	4883.	981.	0.00
6.0	231.5	57.3	12443.	0.0	44.5	44.6	.067	11.50	.2318	.0485	.50	0.00	0.0	0.00	4778.	982.	0.00
7.0	312.4	57.6	12442.	0.0	51.3	51.3	.077	11.16	.2319	.0485	.50	0.00	0.0	0.00	4677.	983.	0.00
8.0	404.6	57.8	12442.	0.0	57.8	57.9	.087	10.83	.2321	.0485	.50	0.00	0.0	0.00	4579.	983.	0.00
9.0	507.7	58.1	12442.	0.0	64.2	64.2	.097	10.50	.2322	.0485	.50	0.00	0.0	0.00	4483.	984.	0.00
10.0	621.4	58.4	12442.	0.0	70.4	70.4	.106	10.18	.2324	.0485	.50	0.00	0.0	0.00	439..	985.	0.00
11.0	745.3	58.7	12441.	0.0	76.3	76.4	.115	9.85	.2326	.0485	.50	0.00	0.0	0.00	4301.	985.	0.00
12.0	879.1	58.9	12441.	0.0	82.1	82.1	.124	9.53	.2327	.0485	.50	0.00	0.0	0.00	4214.	986.	0.00
13.0	1022.5	59.2	12441.	0.0	87.7	87.7	.132	9.21	.2329	.0485	.50	0.00	0.0	0.00	4131.	987.	0.00
14.0	1175.2	59.5	12441.	0.0	93.1	93.1	.141	8.91	.2331	.0485	.50	0.00	0.0	0.00	4052.	988.	0.00
15.0	1336.9	59.8	12440.	0.0	98.3	98.3	.148	8.60	.2333	.0485	.50	0.00	0.0	0.00	3974.	988.	0.00
16.0	1507.2	60.0	12440.	0.0	103.3	103.4	.156	8.29	.2335	.0485	.50	0.00	0.0	0.00	3897.	989.	0.00
17.0	1685.9	60.3	12440.	0.0	108.2	108.2	.163	7.99	.2337	.0486	.50	0.00	0.0	0.00	3822.	990.	0.00
18.0	1872.6	60.6	12439.	0.0	112.9	112.9	.170	7.69	.2340	.0486	.50	0.00	0.0	0.00	3749.	991.	0.00
ROTATION (TIME= 18.0 AND TAS= 112.8 EAS= 112.8)																	
19.0	2067.1	60.9	12439.	0.0	117.4	117.4	.177	7.38	.5344	.0548	3.71	0.00	0.0	.57	3678.	991.	3.21
LIFTOFF (TIME= 19.8 DIST= 2228.0 TAS= 120.8 EAS= 120.8)																	
20.0	2269.0	61.1	12439.	0.0	121.6	121.7	.184	6.67	.9075	.0718	7.68	.02	4.0	1.04	3612.	992.	7.20
21.0	2477.5	61.4	12439.	1.6	125.3	125.3	.189	5.43	.9943	.0806	8.68	1.09	242.3	1.21	3555.	992.	9.27
22.0	2691.4	61.7	12438.	9.5	128.0	128.0	.193	3.66	.9764	.0898	8.88	3.15	713.3	1.24	3512.	993.	11.53
23.0	2908.5	62.0	12438.	25.4	129.7	129.7	.196	2.14	.9483	.0949	8.88	5.22	1195.0	1.25	3485.	993.	13.60
DISTANCE TO 35 FT.= 3005.0 TAS= 130.2 EAS= 130.1 V35/VS= 1.3308																	
24.0	3127.1	62.2	12438.	49.3	130.6	130.5	.197	1.06	.8919	.0920	8.30	7.20	1658.3	1.19	3470.	992.	15.00
GEAR RETRACTION STARTED AT 24.0 SEC,COMPLETE AT 31.0 SEC																	
25.0	3346.1	62.5	12437.	79.3	131.2	131.0	.198	.92	.7995	.0798	7.24	8.26	1910.0	1.08	3459.	992.	15.00
26.0	3565.6	62.8	12437.	112.2	131.7	131.5	.199	.90	.7605	.0731	6.79	8.71	2022.0	1.04	3449.	991.	15.00
27.0	3785.9	63.1	12437.	146.4	132.3	132.0	.200	.94	.7422	.0684	6.57	8.93	2079.6	1.02	3438.	991.	15.00
28.0	4007.0	63.3	12437.	181.4	132.8	132.5	.201	.99	.7319	.0643	6.45	9.05	2116.8	1.01	3427.	990.	15.00
29.0	4229.1	63.6	12436.	216.9	133.5	133.1	.202	1.05	.7244	.0606	6.37	9.13	2147.1	1.01	3416.	989.	15.00
30.0	4452.2	63.9	12436.	253.0	134.1	133.7	.203	1.11	.7179	.0569	6.29	9.21	2175.7	1.01	3404.	989.	15.00
31.0	4676.4	64.2	12436.	289.5	134.8	134.3	.204	1.18	.7115	.0532	6.21	9.29	2204.6	1.01	3391.	988.	15.00
32.0	4901.7	64.4	12436.	326.4	135.5	134.9	.205	1.11	.7051	.0526	6.14	9.36	2234.0	1.01	3378.	987.	'5.00
33.0	5128.0	64.7	12435.	363.9	136.2	135.5	.206	1.04	.6988	.0521	6.07	9.43	2262.3	1.01	3366.	987.	15.00
34.0	5355.4	65.0	12435.	401.8	136.8	136.0	.207	.98	.6929	.0516	6.00	9.50	2289.1	1.01	3355.	986.	15.00
35.0	5583.8	65.3	12435.	440.2	137.4	136.6	.208	.92	.6860	.0513	5.95	9.55	2308.8	1.01	3344.	985.	15.00
36.0	5813.1	65.5	12434.	478.8	137.9	137.0	.209	.87	.6819	.0510	5.91	9.59	2329.9	1.01	3334.	985.	15.00

VSTLKT= 97.8 KTS EAS   VRAT= 1.100 CLTO= 1.1431

ENGINE OUT PERFORMANCE FOLLOWS
VEND = 140.0 KNOTS EAS

(TEMP.= 519. DEG-STD.= 3.)

TAKEOFF (ELEVATION= 0. FT)

TIME (SEC)	DIST. (FEET)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	ACCEL (FPS2)	CL	CD	ALPHA (DEG)	GAMMA (DEG)	ROC (FPM)	LOAD FACT	THRUST (LBS)	FUEL FLOW (LB/HR)	FUS. ANGLE (DEG)
0.0	0.0	55.7	12444.	0.0	0.0	0.0	0.000	13.43	.2314	.0485	.50	0.00	0.0	0.00	5446.	978.	0.00
1.0	6.7	55.9	12444.	0.0	7.9	7.9	.012	13.13	.2314	.0485	.50	0.00	0.0	0.00	5331.	979.	0.00
2.0	26.6	56.2	12444.	0.0	15.6	15.6	.024	12.81	.2315	.0485	.50	0.00	0.0	0.00	5214.	980.	0.00
3.0	59.3	56.5	12444.	0.0	23.1	23.1	.035	12.48	.2315	.0485	.50	0.00	0.0	0.00	5101.	980.	0.00
4.0	104.6	56.8	12443.	0.0	30.5	30.5	.046	12.16	.2316	.0485	.50	0.00	0.0	0.00	4990.	981.	0.00
5.0	162.1	57.0	12443.	0.0	37.6	37.6	.057	11.83	.2317	.0485	.50	0.00	0.0	0.00	4883.	981.	0.00
6.0	231.5	57.3	12443.	0.0	44.5	44.6	.067	11.50	.2318	.0485	.50	0.00	0.0	0.00	4778.	982.	0.00
7.0	312.4	57.6	12442.	0.0	51.3	51.3	.077	11.16	.2319	.0485	.50	0.00	0.0	0.00	4677.	983.	0.00
8.0	404.6	57.8	12442.	0.0	57.8	57.9	.087	10.83	.2321	.0485	.50	0.00	0.0	0.00	4579.	983.	0.00
9.0	507.7	58.1	12442.	0.0	64.2	64.2	.097	10.50	.2322	.0485	.50	0.00	0.0	0.00	4483.	984.	0.00
10.0	621.4	58.4	12442.	0.0	70.4	70.4	.106	10.18	.2324	.0485	.50	0.00	0.0	0.00	4391.	985.	0.00
11.0	745.3	58.7	12441.	0.0	76.3	76.4	.115	9.85	.2326	.0485	.50	0.00	0.0	0.00	4301.	985.	0.00
12.0	879.1	58.9	12441.	0.0	82.1	82.1	.124	9.53	.2327	.0485	.50	0.00	0.0	0.00	4214.	986.	0.00
13.0	1022.5	59.2	12441.	0.0	87.7	87.7	.132	9.21	.2329	.0485	.50	0.00	0.0	0.00	4131.	987.	0.00
14.0	1175.2	59.5	12441.	0.0	93.1	93.1	.141	8.91	.2331	.0485	.50	0.00	0.0	0.00	4052.	988.	0.00
15.0	1336.9	59.8	12440.	0.0	98.3	98.3	.148	8.60	.2333	.0485	.50	0.00	0.0	0.00	3974.	988.	0.00
16.0	1507.2	60.0	12440.	0.0	103.3	103.4	.156	8.29	.2335	.0485	.50	0.00	0.0	0.00	3897.	989.	0.00
ENGINE FAILURE (TIME= 16.5 AND TAS= 105.8 EAS= 105.8)																	
17.0	1685.9	60.3	12440.	0.0	108.0	108.0	.163	3.06	.2337	.0486	.50	0.00	0.0	0.00	1913.	495.	0.00
18.0	1869.6	60.4	12440.	0.0	109.7	109.7	.166	2.98	.2338	.0486	.50	0.00	0.0	0.00	1899.	495.	0.00
19.0	2056.4	60.5	12439.	0.0	111.5	111.5	.168	2.90	.2339	.0486	.50	0.00	0.0	0.00	1886.	495.	0.00
ROTATION (TIME= 19.8 AND TAS= 112.8 EAS= 112.8)																	
20.0	2246.1	60.7	12439.	0.0	113.2	113.2	.171	2.83	.2490	.0487	.66	0.00	0.0	.24	1872.	495.	.18
21.0	2438.7	60.8	12439.	0.0	114.8	114.9	.173	2.71	.6126	.0575	4.54	0.00	0.0	.62	1859.	495.	4.04
LIFTOFF (TIME= 21.8 DIST= 2594.6 TAS= 116.0 EAS= 116.1)																	
22.0	2633.9	60.9	12439.	0.0	116.3	116.4	.176	2.18	.9856	.0773	8.52	.01	2.2	1.03	1848.	496.	8.03
23.0	2831.3	61.1	12439.	1.0	117.4	117.5	.177	1.40	1.0740	.0859	9.52	.77	159.1	1.14	1839.	496.	9.79
24.0	3030.0	61.2	12439.	6.4	117.8	117.9	.178	.02	1.0982	.0986	10.12	2.40	500.5	1.18	1835.	496.	12.03
25.0	3228.8	61.4	12439.	16.1	117.8	117.8	.178	.01	.9329	.0903	8.62	2.93	609.5	1.00	1835.	495.	11.05
26.0	3427.6	61.5	12439.	26.1	117.8	117.8	.178	.02	.9132	.0917	8.52	2.81	585.4	.98	1835.	495.	10.83
DISTANCE TO 35 FT.= 3613.7 TAS= 117.9 EAS= 117.8 V35/VS= 1.2050																	
27.0	3626.4	61.6	12438.	35.6	117.9	117.8	.178	.01	.9185	.0944	8.62	2.67	555.7	.99	1834.	495.	10.79
28.0	3825.3	61.8	12438.	44.7	117.9	117.8	.178	.02	.9260	.0959	8.72	2.57	535.0	.99	1834.	495.	10.79

ACCELERATE - STOP DISTANCE = 3789.8 FEET.

ENGINE OUT DISTANCE TO 35 FT.= 3613.7 FEET

ALL ENGINE DISTANCE TO 35 FT. (L) = 3005.0 FEET
FAR 25 T.O. DISTANCE (1.15XL) = 3455.8 FEET
ALL ENGINE DISTANCE TO 50 FT. = 3132.8 FEET

AT END OF TAKEOFF PHASE
TIME= .160 HRS   FUEL USED= 66. LBS   WEIGHT= 12434. LBS   ALT.= 500. FT.

ACCELERATE TO MACH NO. = .213

77

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.160	0.00	65.7	12434.	500.	138.	137.	.209	.635	3328	984
.160	.04	66.0	12434.	500.	141.	140.	.213	.637	3300	985

END OF ACCELERATION SEGMENT
TIME= .160 HRS FUEL USED= 66.0 LBS WEIGHT= 12434. LBS RANGE= 0. NM

CLIMB TO 10000. FT. AT SPECIFIED EAS (140.000 KTS)

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	CL	CD	ALPHA (DEG)	GAMMA (DEG)	FUS. ANGLE (DEG)	R/C (FPM)	THRUST (LBS)	FUEL FLOW (LB/HR)
.160	0.	66.	12434.	500.	141.	140.	.213	.639	.6650	.0494	5 70	9 52	14.73	2364.	2969.	908.
.164	1.	69.	12431.	1000.	142.	140.	.215	.639	.6656	.0495	5.71	9 10	14 31	2275.	2929.	898.
.171	2.	76.	12424.	2000.	144.	140.	.219	.639	.6650	.0494	5 70	9 24	14 43	2344.	2959.	905.
.178	3.	82.	12418.	3000.	146.	140.	.223	.639	.6659	.0495	5 70	8 60	13 80	2216.	2820.	870.
.186	4.	89.	12411.	4000.	148.	140.	.227	.639	.6665	.0495	5 70	7 98	13 19	2090.	2687.	837.
.194	5.	95.	12405.	5000.	151.	140.	.232	.639	.6671	.0496	5 70	7 39	12 60	1966.	2558.	805.
.202	6.	102.	12398.	6000.	153.	140.	.236	.639	.6676	.0496	5 70	6 83	12 03	1844.	2435.	774.
.211	7.	109.	12391.	7000.	155.	140.	.241	.639	.6679	.0496	5 70	6 29	11 49	1725.	2317.	744.
.221	9.	116.	12384.	8000.	158.	140.	.245	.639	.6682	.0497	5 70	5 77	10 97	1609.	2203.	715.
.231	11.	124.	12376.	9000.	160.	140.	.250	.639	.6683	.0497	5 69	5 28	10 47	1495.	2095.	687.
.243	12.	131.	12369.	10000.	163.	140.	.255	.639	.6684	.0497	5 68	4 83	10.01	1388.	1995.	659.

END OF CLIMB TO 10000. FT
TIME= .243 HRS FUEL USED= 131. LBS WEIGHT= 12369. LBS RANGE= 12. NM

ALTITUDE= 10000. FT TAS= 257.44 KTS MACH NO= .4029

Max. speed at normal rated cruise power for specified cruise altitude

ACCELERATE TO MACH NO. = .350

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688
.254	14.77	140 0	12360.	10000.	223.	192.	.350	.675	1800.	719

END OF ACCELERATION SEGMENT
TIME= .254 HRS FUEL USED= 140.0 LBS WEIGHT= 12360. LBS RANGE= 15. NM

Acceleration from end of climb to start of cruise at specified speed - maximum payload

ACCELERATE TO MACH NO. = .403

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688
.267	17.86	149.2	12351.	10000.	257.	221.	.403	.685	1654.	742

END OF ACCELERATION SEGMENT
TIME= .267 HRS FUEL USED= 149.2 LBS WEIGHT= 12351. LBS RANGE= 18. NM

Acceleration from end of climb to start of cruise at max. speed - maximum payload

ACCELERATE TO MACH NO. = .365

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.257	15.33	141.7	12358.	10000.	233.	201.	.365	.678	1761.	726.

END OF ACCELERATION SEGMENT
TIME= .257 HRS FUEL USED= 141.7 LBS WEIGHT= 12358. LBS RANGE= 15. NM

Acceleration from end of climb to start of cruise at speed for best specific range - maximum payload

CRUISE PERFORMANCE SUMMARY
FOR
**** MAXIMUM PAYLOAD *****
FUEL AVAILABLE= 904.

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC. RANGE START CRUISE	AT BEST SPEC. RANGE END CRUISE
TIME	HRS.	.254	.936	.267	.712	.257	.875
RANGE	N.MI	15.	167.	18.	132.	15	160.
FUEL USED	LBS.	140.	503.	149.	430.	142.	485.
WEIGHT	LBS.	12360.	11997.	12351.	12070.	12358	12015
ALTITUDE	FT.	10000.	10000.	10000.	10000.	10000	10000
TAS	KTS.	223.6	223.6	257.4	257.4	233.4	233.4
EAS	KTS.	192.2	192.2	221.2	221.2	200.6	200.6
MACH NO.		.3500	.3500	.4029	.4029	.3654	.3654
DIV. MACH		.6751	.6763	.6853	.6860	.6785	.6795
ANGLE ATTACK	.EG.	2.007	1.890	.971	.903	1.660	1.559
FUSE. ANGLE	DEG.	1.507	1.390	.471	.403	1.160	1.059
CL		.3568	.3464	.2691	.2630	.3274	.3183
L/D		10.963	10.771	9.259	9.102	10.455	10.267
FUEL FLOW	LB/HR	534.5	531.1	632.0	629.4	557.8	554.7
BREG. FACTOR	N.MI	5175.	5055.	5034.	4940.	5176	5059.
SPEC. RANGE	NM/LB	.41839	.42109	.40735	.40903	.41852	.42081
RESERVE FUEL(LBS) (45.0 MIN.)		401.		474.		418.	

****

ACCELERATE TO MACH NO. = .350

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.254	14.77	140.0	12360.	10000.	223.	192.	.350	.675	1800.	719.

END OF ACCELERATION SEGMENT
TIME= .254 HRS FUEL USED= 140.0 LBS WEIGHT= 12360. LBS RANGE= 15. NM

ACCELERATE TO MACH NO. = .403

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.267	17.86	149.2	12351.	10000.	257.	221.	.403	.685	1654.	742.

END OF ACCELERATION SEGMENT
TIME= .267 HRS FUEL USED= 149.2 LBS WEIGHT= 12351. LBS RANGE= 18. NM

ACCELERATE TO MACH NO. = .365

FUEL FUEL

Similar acceleration segments for maximum fuel

TIME (HRS)	RANGE (NM)	USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.257	15.33	141.7	12358.	10000.	233.	201.	.365	.678	1761.	726.

END OF ACCELERATION SEGMENT
TIME= .257 HRS FUEL USED= 141.7 LBS WEIGHT= 12358. LBS RANGE= 15. NM

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
****** MAXIMUM FUEL ******
FUEL AVAILABLE= 4334.

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC. RANGE START CRUISE	AT BEST SPEC. RANGE END CRUISE
TIME	HRS.	.254	7.612	.267	6.314	.257	7.251
RANGE	N.MI	15.	1660.	18.	1575.	15.	1648.
FUEL USED	LBS.	140.	3933.	149	3860.	142.	3916.
WEIGHT	LBS.	12360.	8567.	12351.	8640.	12358.	8584.
ALTITUDE	FT.	10000.	10000.	10000.	10000.	10000.	10000.
TAS	KTS.	223.6	223.6	257.4	257.4	233.4	233.4
EAS	KTS.	192.2	192.2	221.2	221.2	200.6	200.6
MACH NO.		.3500	.3500	.4029	.4029	.3654	.3654
DIV. MACH		.6751	.6878	.6853	.6947	.6785	.6901
ANGLE ATTACK	DEG.	2.007	.778	.971	.078	1.660	.543
FUSE. ANGLE	DEG.	1.507	.278	.471	-.422	1.160	.043
CL		.3568	.2473	.2691	.1882	.3274	.2275
L/D		10.963	8.517	9.259	6.938	10.455	8.013
FUEL FLOW	LB/HR	534.5	504.0	632.0	604.9	557.8	529.6
BREG. FACTOR	N.MI.	5175.	3804.	5034.	3680.	5176.	3787.
SPEC. RANGE	NM/LB	.41839	.44369	.40735	.42560	.41852	.44081

RESERVE FUEL(LBS) (45.0 MIN.) 401. 474. 418.

****

ACCELERATE TO MACH NO. = .350

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.254	14.77	140.0	12360.	10000.	223.	192.	.350	.675	1800.	719.

END OF ACCELERATION SEGMENT
TIME= .254 HRS FUEL USED= 140.0 LBS WEIGHT= 12360. LBS RANGE= 15. NM

ACCELERATE TO MACH NO. = .403

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.267	17.86	149.2	12351.	10000.	257.	221.	.403	.685	1654.	742.

END OF ACCELERATION SEGMENT
TIME= .267 HRS FUEL USED= 149.2 LBS WEIGHT= 12351. LBS RANGE= 18. NM

ACCELERATE TO MACH NO. = .365

FUEL FUEL

Similar acceleration segments for design payload

TIME (HRS)	RANGE (NM)	USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FLOW (LB/HR)
.243	12.38	131.5	12369.	10000.	163.	140.	.255	.638	2107.	688.
.257	15.33	141.7	12358.	10000.	233.	201.	.365	.678	1761.	725.

END OF ACCELERATION SEGMENT
TIME= .257 HRS FUEL USED= 141.7 LBS WEIGHT= 12358. LBS RANGE= 15. NM

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
FUEL AVAILABLE• 2043.

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC. RANGE START CRUISE	AT BEST SPEC. RANGE END CRUISE
TIME	HRS.	.254	3.104	.267	2.538	.257	2.948
RANGE	N.MI	15.	652.	18.	603.	15.	644.
FUEL USED	LBS.	140.	1642.	149.	1569.	142.	1624.
WEIGHT	LBS.	12360.	10858.	12351.	10931.	12358.	10876.
ALTITUDE	FT.	10000.	10000.	10000.	10000.	10000.	10000.
TAS	KTS.	223.6	223.6	257.4	257.4	233.4	233.4
EAS	KTS.	192.2	192.2	221.2	221.2	200.6	200.6
MACH NO.		.3500	.3500	.4029	.4029	.3654	.3654
DIV. MACH		.6751	.6801	.6853	.6889	.6785	.6830
ANGLE ATTACK	DEG.	2.007	1.521	.971	.629	1.660	1.221
FUSE. ANGLE	DEG.	1.507	1.021	.471	.129	1.160	.721
CL		.3568	.3135	.2691	.2381	.3274	.2882
L/D		10.963	10.112	9.259	8.434	10.455	9.594
FUEL FLOW	LB/HR	534.5	521.0	632.0	619.3	557.8	545.4
BREG. FACTOR	N.MI.	5175.	4664.	5034.	4547.	5176.	4658.
SPEC. RANGE	NM/LB	.41839	.42924	.40735	.41567	.41852	.42803

RESERVE FUEL(LBS) (45.0 MIN.) 401. 474. 418.

****

RANGE = 603. BLOCK TIME• 2.538 USED FOR DESIGN RANGE AND COST

****

Design range results: if range or endurance had been specified iteration on gross weight would follow until required value was satisfied

****

TEMP.= 518. DEG.STD.+ 0.
LANDING ELEVATION• 0. FT.
LANDING WING LOADING• 45.05 PSF.
LANDING WEIGHT = 12500. LBS.

LANDING DISTANCE FROM 50. FT.= 2938. FT.

F.A.R. FACTORED FIELD LENGTH = 4896. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST•	952.	DIST•	145.	DIST•	337.	DIST•	1504.
R/S•	600.	XLFMX•	1.100	TDELAY•	2.00	MUB•	.3500
VAPEAS•	112.76	SINKTD•	3.000	TIDLE•	300.	TR/TIDLE•	0.0000
VAPTAS•	112.84	VSTEAS•	86.74	VTDTAS•	99.82	ABAR(G)•	.2937
THETA•	3.01	CLMX•	1.7651				
THRUST•	872.	HFLAR•	14.2				

****

ALTITUDE• 10000. FT TAS• 258.75 KTS MACH NO• .4050

MOUNT AND GEAR BOX ASSEMBLY WEIGHT

TWO-STAGE = 94. POUNDS

MOUNT AND GEAR BOX = 94. POUNDS
AFTERBODY = 0. POUNDS

GEAR BOX COST = 6323. DOLLARS

--- COST DATA ---

AIRCRAFT PRICING

ENGINES NUMBER = 2. TYPE= 6

EMPTY WEIGHT= 7471. LBS MAX CRUISE SPEED= 259. KNOTS

CONSUMER PRICE= 950177. DOL. BASIC PRICE= 766192. DOL
ADD. EQUIPMENT COST= 183985. DOL.

DIRECT LABOR (9180 MHRS.)	45898.	
LABOR OVERHEAD(147 PCT)	67269.	
AIRFRAME MATERIALS	11212.	
PURCHASED EQUIP.	241743.	
($/ENG = 84000.)		
($/PROP= 1813.)		
($/GRBX= 6323.)		
(OTHER = 57470.)		
	366123.	SUB-TOTAL
ENG.TL.SALES.G-A(36.PCT)	133351.	
	499473.	MANUFACTURING COST
FACTORY PROFIT(18.PCT)	89905.	
	589379.	DEALER COST
DEALER-DIST. MARKUP(30.PCT)	176814.	
	766192.	BASIC PRICE

••

DESIGN MISSION

OPERATING COST FOR NOR.RATED POWER AND 10000. ALTITUDE

SEATS= 19. FUEL COST= .700 $/GAL

RANGE= 603. N.M. BLOCK FUEL= 1569 LBS BLOCK TIME= 2.538 HRS.

FUEL RATE= 92.2 GPH. TBO= 3000. HRS. HOURS/INSP.= 100. HRS.

VARIABLE COST	(DOL/HR)	FIXED COST	(DOL/YR)	
FUEL+OIL	64.83	STORAGE	1800.	
INSP.+MAIN.	15.00	INSURANCE	20004	(HULL 2.0PCT)
OVERHAUL RES.	22.40	DEPRECIATION	95018	(8 YR-20 PCT)
OTHER	0.00	OTHER	0	
		CREW	0	(OVERHEAD 50.PCT)
		FAA TAX	463	
	102.23 TOTAL		117284.	TOTAL

UTILIZATION(HRS/YR)	100.	200.	300.	400.	500.	800.
TOTAL OPR COST(DOL/HR)	1275.07	688.65	493.17	395.44	336.80	248.83
TOTAL OPR COST(DOL/NM)	5.37	2.90	2.08	1.67	1.42	1.05
TOTAL OPR COST(C/ASNM)	28.26	15.27	10.93	8.77	7.47	5.52

••

SPEED LIMITED BY MMO OR VMO------ MACH NO.= .4059 FNAV= 2176.67 FNRQ= 1724.67

•••• WARNING HELICAL TIP MACH NUMBER GREATER THAN .9

Far field propeller noise estimate

PROPELLER NOISE FOR 2. ENGINES AT 268.0 KTAS AND AT 1000.0 FEET
REF LEVEL= 93.97 DIA AND BLADE CORR.= 4.33 DIST.CORR.= -6.02 NO.ENGINE CORR.= 3.01 PNL ADJUST= 5.60

TOTAL= 100.89 PNDB OR 88.89 DB(A)

APPENDIX B

TWO PLACED TRAINER WITH FIXED PITCH PROPELLER

GASP SAMPLE. 2 PLACE TRAINER WITH FIXED PITCH PROP

THIS IS A PROPELLER AIRCRAFT
INPUT DATA FOLLOW
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                             *****GEOMETRY*****

CONFIG  WG     .    1600          KWRITE  .      2 -----FUSEL  SAB    .      2                 ELODN   .   1.000
        WGS    .  10.200          IGEAR   .      1             WS     .  14.000                ELODT   .   4.090
        PAX    .      1.          KCONFG  .      0             AS     .      0                 BMLOD   .  14.500
        EMCRU  .    .162          KTIPX   .      0             WAS    .  0.000      NACELLE    KNAC    .       1
        HMCRU  .   7500.          ENP     .     1              PS     .    0.0                 ELN     .   0.000
                                  NTYE    .      1             ELPC   .  4.440                 DBARN   .   0.000
                                  KPLOT   .      0             HCK    .  1.100                 ELRW    .   0.000

  WING  TCT    .    .120   HORIZ  VBARHX  .   .4720     VERT  VBARVX .   .0370
        TCR    .    .120   TAIL   TCHT    .    .090     TAIL  TCVT   .    .090
        AR     .   6.820          ARHT    .   3.500           ARVT   .  1.500
        SLM    .    .700          SLMH    .    .562           SLMV   .   .500
        DLMC4  .   0.000          DWPQCH  .   3.000           DWPQCV .  35.000
        EYEW   .   1.500          COELTH  .    .380           BOELTV .  2.420
                                  SAH     .   0.000

                             ***AERODYNAMICS***

        CKW    .  -1.000          CKHT    .  -1.000           GRFE   .  0.000
        CKF    .  -1.000          CKTP    .  -1.000           SCFAC  .  0.000
        CKN    .   0.000          DELCD   .  .01116           DLSWSW .  0.000
        CKVT   .  -1.000          DELFE   .    .250           ALPHLO . -2.000

                             *HIGH LIFT DEVICES*

        RCLMAX .   1.456   FLAPS  JFLTYP  .       3     LED   CLEDC  .  0.000
        ALTFLP .       0          DFLPTO  .   0.000           DELLED .  0.000
        FLAPN  .      1.          DFLPLD  .  40.000           DCLMLE .   .930
        WCFLAP .   1.598          CFOC    .    .290           DELLEO . 45.000
        BENGOB .   0.000          BTEOB   .    .450
                                  DCLMTE  .    .892
                                  DCDOTE  .    .098
                                  DELTEO  .   0.000

                             ****PROPULSION****

        JENGSZ .       3          HPORT   .       0           RCCRU  .  0.000          RWCRTX  .   1.000
        IPART  .       3          TDELTO  .       0.          XTORQ  .     -1          HSCREQ  .      0.
        KODECR .       3          XNMAX   .    2750           HPMSLS .    0.0
        KODETH .       5          GR      . 1.00000           ANCQHP .   .350
        JSIZE  .       1
        PCPTO  .   1.000          PCPCL   .   1.000           PCPCR  .   .740
        PCRTO  .   1.000          PCRCL   .   1.000           PCRCR  .   .982
        KSPCHG .       0          HCRIT   .  16000.           BMEP   . 143.300

  PROP  NTYP   .      11          DPROP   .   5.750           IDATE  .   1970          CAMT    .   0.000
        BL     .       2          AF      .  80.000           XCLFI  .  0.000          WKPFAC  .    .845
        TSPDMX .  1000.0          CLI     .    .500           XCLF   .  0.000          PCLER   .   .0580
        FT     .   0.000          BLANG   .   0.000           XCK70  .      0          CTI     .    .200
                                  XCK80   .       0
 NOISE  KNOYS  .       1          DIST    .    1000           HNOYS  .   1000          EHNOYS  .   0.000

                             *****WEIGHTS*****

        SKPEI  .   .1650          SKY     .    2040           SKB    . 130.000         SKFS    .   .1190
        SKLG   .   .0710          SKZ     .    2270           SKCC   .  11.500         SKWF    .   .0762
        SKMG   .   .8000          SKTL    .  1.0000           SKFW   .   .4850         SKFT    .   .9790
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        SKPES  =   .0520        SKWW    = 137.860       SKSAS  =  0.000      SKWTP  =  1.8900
        WPLX   =  251.8         YMG     =  0.0000       EGMRGN = 0.0000      LCWING =       1
        WFEX   =  104.3         RELP    =   .0570       CPMRGN =   .1000     ELINC  =    .600
        WFUL   =  211.3         RELR    =   .2780       STMRGN = 0.0000      LOCKMX =   8.000
        UWPAX  =  200.0         CATD    =       1       DELP   =  0.000      ATMXQC =   3.160
        STRUT  =   .4040        VMLFSL  =   123.0       YP     = 0.0000      DELWST =     0.0
        DELWFC =    0.0

ENGINE  WENG   =    0.0         WNAC    =     0.0       WPYLON =    0.0
        SWSLS  =  1.963         UWNAC   =    .292       FPYL   =  0.000      XLQDE  =   3.500
        NCYL   =      4         HPQAB   =   2.600       SKDIM  =  1.000      XK1    =   0.000
                                ROTN    =      2.       RWH    =  1.300      XK2    =   0.000
        XCW    =  0.000                                 SKWGT  =  1.000      XK3    =   0.000
        WPROP1 =    0.0

                                ***PERFORMANCE***

TAXI    DELTT  =   .083         XLFMAX  =   1.100       DVR    =  0.000      TDELTX =   0.000
  TO    IFLY   =      1         DELTVR  =   3.500       UM     =   .020      HTMAX  = 200.000
        THEMAX = 13.000         DVI     =   0.000       MUB    =   .400      NFAIL  =       1
        HOO    =     0.         VRAT    =    1.10       WTMISN =     0.

CLIMB   ICLM   =      1  CRUISE CRMACH  =   0.000       FRESF  =  1.000      FACWI  =    .950
        DELH   =  1000.         CRALT   =       0       RCRRQ  =    0.0      ISWING =       0
        VCLMB  =    0.0         ICRUS   =       0       OFALT  =      0      OFEM   =      -1

LAND    IWLD   =      0         XLDGRQ  =   99999       VRATT  =  1.300      HAPP   =     50.
        TDELLD =    0.0         ALTLND  =       0       RSMX   =   1000      SINKTD =     3.0
        TDELAY =    1.0         WLPCT   =  0.0000       TROTID =  0.000      XLFMX  =   1.200
        HTG    =    3.0         TIDLE   =     0.0       VTDRAT = 9999.0

                               ******COST******

        NCADE  =      0         HIR     =    .020       RI     =  0.000      CMV    =   0.000
        CLIAB  =  215.0         TR      =   0.000       OHR    = 12.500      CCRW   =      0.
        HRI    =  100.0         PRV     =    .200       CRWOH  =    .500     UCSENG =   0.000
        CMF    =    0.0         DYR     =     8.0       CINP   =    200.     UCSPP  =   0.000
        TBO    = 2000.0         SRPM    =    25.0       CP     =      0      ALR    =   3.400
        FCSF   =   .700
```

FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)

	CLMAX	VSTALL,KTS	FLAP ANGLE	LE ANGLE	DELTA CL	DELTA CD
FLAPS UP	1.2784	48.6	0.0	0.0	0.0000	0.0000
T.O. CONFIG	1.2784	48.6	0.0	0.0	0.0000	0.0000
LDG. CONFIG	1.6417	42.9	40.0	0.0	.3870	.0438

SINGLE SLOTTED FLAPS

	OPT ANGLE	DELCL AT OPT	DELCD AT OPT	AREA(FT2)	WEIGHT(LB)
FLAPS	40.0	.8923	.0982	18.6	17.7

TEMP. = 518. DEG-STD. = 0.
LANDING ELEVATION= 0. FT.
LANDING WING LOADING= 10.20 PSF.
LANDING WEIGHT = 1600. LBS.

LANDING DISTANCE FROM 50. FT. = 824. FT.

F.A.R. FACTORED FIELD LENGTH = 1374. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	406.	DIST=	46.	DIST=	83	DIST=	290
R/S=	689.	XLFMX=	1.200	TDELAY=	1.00	MUB=	.4000
VAPEAS=	55.53	SINKTD=	3.000	TIDLE=	0	TR/TIDLE=	0.0000
VAPTAS=	55.57	VSTEAS=	42.72	VTDTAS=	49.16	ABAR(G)=	.3700
THETA=	7.02	CLMX=	1.6480				
THRUST=	0.	HFLAR=	9.6				

IDLE THRUST LIMITING RATE OF SINK

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
ANGLE OF ATTACK(DEGREES)= 2.179 LIFT= 1600.0 L/D= 8.092 ALTITUDE= 7500.0 MACH= .1620

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ENGINE SIZING DATA FOLLOW
****

HPM.HPMSLS.HPWR.HPAVLB.=	78.1	101.4	75 0	75.0
PCPOWR.PCRPM.=	.740	.947		
BSFC.WF.=	.436	32.7		
THPROP.FT.EFFPI.EFFP.=	197.7	0 000	853	.853
XNMAX.GR.DPROP.=	2750.0	1.000	5.750	
TIPSPD=	784.2			
XJ.CP.CT.=	.708	.042	.051	
BL.AF.COD.BLANG=	2.	80 0	-1	20.16
JET THRUST=	0.0			
KODE.TSFC=	3	.165		

HPM.HPMSLS.HPWR.HPAVLB.=	101 4	101.4	88.9	88 9
PCPOWR.PCRPM.=	.877	.849		
BSFC.WF.=	.594	52 8		
THPROP.FT.EFFPI.EFFP.=	315.7	0 000	688	.688
XNMAX.GR.DPROP.=	2750.0	1.000	5.750	
TIPSPD=	702.9			
XJ.CP.CT.=	.477	.056	.080	
BL.AF.COD.BLANG=	2.	80 0	-1	20.16
JET THRUST=	0.0			
KODE.TSFC=	8	.167		

HPM.HPMSLS.HPWR.HPAVLB.=	101.4	101 4	87 3	87.3
PCPOWR.PCRPM.=	.861	.833		
BSFC.WF.=	.597	52 1		
THPROP.FT.EFFPI.EFFP.=	324.4	0.000	.635	.635
XNMAX.GR.DPROP.=	2750.0	1.000	5.750	
TIPSPD=	689 5			
XJ.CP.CT.=	.429	.058	.086	
BL.AF.COD.BLANG=	2.	80 0	-1	20.16
JET THRUST=	0.0			
KODE.TSFC=	8	.161		

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 23
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
T.O. FLAPS - ALL ENGINES	0.	63 1	675 68	558 49	.76	10.88
LANDING FLAPS-LD GEAR EXT - ALL ENGINES	0.	55 7	459 10	246 42	.97	8.23

ENGINE SIZED TO MATCH CRUISE DRAG
PROP DIAMETER= 5 75 FT. S L. HORSEPOWER= 101.

ENGINE SIZE MEETS RATE OF CLIMB REQUIREMENTS
RATE OF CLIMB= 459 1 FPM. RATE OF CLIMB REQ= 246 4 FPM

MAXIMUM S L S ENGINE PERFORMANCE
POWER = 101 40
THRUST/WT = 2461
PROP RPM = 2110 0
PROP DIAM = 5 75
PROP TIPSPD = 635 2

PROPULSION SYSTEM WEIGHTS

ENGINE WEIGHT/ENGINE	199.1
NACELLE WEIGHT/ENGINE	10.4
PYLON WEIGHT/ENGINE	0.0
PROPULSOR WEIGHT/ENGINE	20.6

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE

ANGLE OF ATTACK(DEGREES)= 2.179 LIFT= 1600.0 L/D= 8.089 ALTITUDE= 7500.0 MACH= .1620

WING LOCATION INFO

FUSELAGE LENGTH =	20.31	H-TAIL VOL. ARM =	12.62	C.G LOCATION OF PROPULSION=	1.16
WING 1/4C LOC ON C.L.=	5.39	H-TAIL C.G LOCATION =	18.22	C.G OF REMAINING WEIGHT =	5.65
MAC 1/4C LOCATION =	5.35	H-TAIL MAC FROM C.L. =	2.25		
MAC DIST FROM C.L. =	7.70	H-TAIL LOCAT ON VERT =	0.00		
WING C.G LOCATION =	5.83	V-TAIL VOL. ARM =	13.56		
TIP TANKS C.G LOCATE =	0.00	V-TAIL C.G LOCATION =	19.16		

AIRCRAFT C.G. LOCATION = 5.35 FT. OR .250 OF MAC

	WING	H-TAIL	V-TAIL
AREA	156.863	28.437	14.006
SPAN	32.708	9.976	4.584
ASPECT RATIO	6.820	3.500	1.500
TAPER RATIO	.700	.562	.500
1/4C SWEEP	0.000	3.000	35.000
L.E. SWEEP	1.482	7.549	42.689
C.L. CHORD	5.642	3.650	4.074
MEAN CHORD	4.846	2.925	3.169
TIP CHORD	3.950	2.051	2.037

GASP SAMPLE· 2 PLACE TRAINER WITH FIXED PITCH PROP

GROSS WEIGHT = 1600. PASSENGERS = 1. PLUS CREW OF 1

FUSELAGE	LENGTH	(ELF)	20 31	FT
	WIDTH	(SWF)	3 33	FT
	WETTED AREA	(SF)	151	SQFT
	DELTA P	(DELP)	0.00	PSI
WING	ASPECT RATIO	(AR)	6 82	
	AREA	(SW)	156 9	SQFT
	SPAN	(B)	32 7	FT
	GEOM MEAN CHORD	(CBARW)	4 85	FT
	QUARTER CHORD SWEEP	(DLMC4)	0 0	DEG
	TAPER RATIO	(SLM)	700	
	ROOT THICKNESS	(TCR)	120	
	T:P THICKNESS	(TCT)	.120	
	WING LOADING	(WGS)	10 2	PSF
	WING FUEL VOLUME	(VFW)	38 0	GAL
HOR. TAIL	ASPECT RATIO	(ARHT)	3.50	
	AREA	(SHT)	28 4	SQFT
	SPAN	(BHT)	9 98	FT
	MEAN CHORD	(CBARHT)	2 93	FT
	THICKNESS/CHORD	(TCHT)	090	
	MOMENT ARM	(ELTH)	12 6	FT
	VOLUME COEFF.	(VBARH)	472	
VERT. TAIL	ASPECT RATIO	(ARVT)	1 50	
	AREA	(SVT)	14 0	SQFT
	SPAN	(BVT)	4 58	FT
	MEAN CHORD	(CBARVT)	3 17	FT
	THICKNESS/CHORD	(TCVT)	.090	
	MOMENT ARM	(ELTV)	13 6	FT
	VOLUME COEFF.	(VBARV)	037	
ENG.NACELLES	LENGTH	(ELN)	6 29	FT
	MEAN DIAMETER	(DBARN)	1 80	FT
	NUMBER ENGINES	(ENP)	1 0	
	WETTED AREA	(SN)	35 49	SQFT
	LOCATION		ON FUSELAGE	

GASP SAMPLE. 2 PLACE TRAINER WITH FIXED PITCH PROP

VDIVE = 144. KTS   VMO = 123. KTS   MMO = 252
ULT. LF = 6.60   MAN. LF = 4.40   GUST LF = 4.02

PROPULSION GROUP			
PRIMARY ENGINES	(WEP)	199	
PRIMARY ENGINE INSTL.	(WPEI)	33	
FUEL SYSTEM	(WFSS)	21	
PROPULSOR WEIGHT	(WPROP)	21.	
TOTAL PROP GROUP WT.	(WP)	273.	
STRUCTURES GROUP			
WING	(WW)	206.	
HOR. TAIL	(WHT)	34.	
VERT. TAIL	(WVT)	18.	
FUSELAGE	(WB)	185.	
LANDING GEAR	(WLG)	114.	
PRIMARY ENG. SECTION	(WPES)	10.	
GROUP WEIGHT INC.	(DELWST)	0.	
TOTAL STRUC. GROUP WT.	(WST)	567.	
FLIGHT CONTROLS GROUP			
COCKPIT CONTROLS	(WCC)	14.	
FIXED WING CONTROLS	(WCFW)	23.	
SAS	(WSAS)	0.	
GROUP WEIGHT INC.	(DELWFC)	0.	
TOTAL CONTROL WT.	(WFC)	37.	
WT. OF FIXED EQUIPMENT	(WFE)	104.	
WEIGHT EMPTY	(WE)	982.	
FIXED USEFUL LOAD	(WFUL)	211.	(INC. CREW)
OPERATING WEIGHT EMPTY	(OWE)	1193.	
PAYLOAD	(WPL)	252.	(PAX.VOL.= 1. DESIGN PAX= 1.)
FUEL	(WFA)	155.	(WFW= 155.) (WFTP= 0.)
GROSS WEIGHT	(WG)	1600.	

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GASP SAMPLE. 2 PLACE TRAINER WITH FIXED PITCH PROP

CRUISE MACH = .162 CRUISE ALTITUDE = 7500. CRUISE Q (PSF) = 29 48

CRUISE RE NUM. PER FT. = 9.336E+05 FLATPLATE CF AT RE=10EX7 IS .00292

AERODYNAMIC DATA

DRAG BREAKDOWN	FLATPLATE AREA(SQFT)	CDO	WETTED AREA(SQFT)
WING	1.3592	.00867	276 69
FUSELAGE	.9383	.00598	151 04
VERT. TAIL	.1190	.00076	28 01
HOR. TAIL	.2696	.00172	56 87
ENGINE NAC.	0.0000	0 00000	0 00
TIP TANKS	0 0000	0 00000	0 00
INCREMENTAL	1.7512	.01116	0 00
FIXED GEAR	1.1707	.00746	NOT INCL.
TOTAL	5 6081	.03575	512 62

MEAN SKIN FRICTION COEF.= .010940

AERODYNAMIC COEFF.

A1		.7547	
A2		-.1157	
A3		.0438	
A4=.75X(T/C)		.0900	
A5=CDO--		.0271	
A6		2.9721	
A7=1/(PI SEE AR)		.0590	
3-D LIFT SLOPE AT CRUISE MACH	(CLALPH)	4 7503	PER RADIAN
OSWALD FACTOR	(SEE)	.7908	

CRUISE CD = .0358 + .0590 CL2 (ASSUMES MINIMUM WING PROFILE DRAG)

LOW SPEED LIFT/DRAG-GR UP(IF RIO G E.

	FLAPS UP			TAKEOFF			LANDING		
ALPHA	CL	CD	L/D	CL	CD	L/D	CL	CD	L/D
-2 00000	0 00000	.03575	0 00000	0 00000	.03575	0 00000	.38696	.08136	4 75600
0 00000	.16559	.03737	4 43106	.16642	.03739	4 45129	.55337	.08701	6 36005
2 00000	.33118	.04223	7 84315	.33283	.04229	7 87027	.71979	.09648	7 46074
4 00000	.49677	.05032	9 87276	.49925	.05046	9 89341	.88621	.10977	8 07330
6 00000	.66236	.06165	10 74460	.66567	.06191	10 75304	1 05262	.12689	8 29577
8 00000	.82794	.07621	10 86389	.83208	.07662	10 86040	1 21904	.14783	8 24640
10 00000	.99353	.09401	10 56808	.99850	.09460	10 55534	1 38546	.17259	8 02741
12 00000	1.15912	.11505	10 07482	1 16492	.11585	10 05571	1 55187	.20118	7 71392

MISSION PERFORMANCE DATA FOLLOWS
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TAXI AT IDLE THRUST

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	FUEL FLOW (LB/HR)
0.000	0.	0.	1600.	0.	20.
.083	0.	2.	1598.	0.	20.

VSTLKT= 48.4 KTS EAS VRAT= 1.100 CLTO= 1.0618
VEND = 73.9 KNOTS EAS

(TEMP.= 519. DEG.STD.= 0.)

TAKEOFF (ELEVATION= 0. FT)

TIME (SEC)	DIST. (FEET)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO	ACCEL (FPS2)	CL	CD	ALPHA (DEG)	GAMMA (DEG)	ROC (FPM)	LOAD FACT	THRUST (LBS)	FUEL FLOW (LB/HR)	FUS. ANGLE (DEG)
0.0	0.0	1.7	1598.	0.0	0.0	0.0	0.000	7.28	3200	0390	1.50	0.00	0.0	0.00	394.	49.	0.00
1.0	3.6	1.7	1598.	0.0	4.3	4.3	.006	7.16	3200	0390	1.50	0.00	0.0	0.00	388	49	0.00
2.0	14.4	1.7	1598	0.0	8.5	8.5	.013	7.02	3201	0390	1.50	0.00	0.0	0.00	382	49.	0.00
3.0	32.3	1.7	1598.	0.0	12.6	12.6	.019	6.89	3201	0390	1.50	0.00	0.0	0.00	377.	49.	0.00
4.0	57.1	1.7	1598.	0.0	16.7	16.7	.025	6.73	3201	0390	1.50	0.00	0.0	0.00	371.	49.	0.00
5.0	88.6	1.8	1598.	0.0	20.6	20.7	.031	6.58	3201	0390	1.50	0.00	0.0	0.00	366.	50	0.00
6.0	126.7	1.8	1598.	0.0	24.5	24.5	.037	6.43	3202	0390	1.50	0.00	0.0	0.00	362.	50.	0.00
7.0	171.4	1.8	1598	0.0	28.3	28.3	.043	6.27	3202	0390	1.50	0.00	0.0	0.00	357.	50.	0.00
8.0	222.3	1.8	1598	0.0	32.0	32.0	.048	6.11	3203	0390	1.50	0.00	0.0	0.00	353	50	0.00
9.0	279.3	1.8	1598	0.0	35.6	35.6	.054	5.95	3204	0390	1.50	0.00	0.0	0.00	349	51.	0.00
10.0	342.3	1.8	1598.	0.0	39.0	39.1	.059	5.77	3204	0390	1.50	0.00	0.0	0.00	345.	51.	0.00
11.0	411.1	1.8	1598.	0.0	42.4	42.4	.064	5.58	3205	0390	1.50	0.00	0.0	0.00	341.	51.	0.00
12.0	485.6	1.9	1598	0.0	45.7	45.7	.069	5.40	3206	0390	1.50	0.00	0.0	0.00	337	51	0.00
13.0	565.6	1.9	1598	0.0	48.9	48.9	.074	5.22	3208	0390	1.50	0.00	0.0	0.00	333	52.	0.00
ROTATION (TIME= 12.8 AND TAS= 48.3 EAS= 48.4)																	
14.0	650.6	1.9	1598	0.0	51.9	51.9	.078	5.00	5253	0444	3.73	0.00	0.0	.47	329.	52.	2.23
15.0	740.8	1.9	1598.	0.0	54.8	54.8	.083	4.67	7371	0527	6.04	0.00	0.0	.74	325.	52.	4.54
LIFTOFF (TIME= 15.8 DIST= 816.3 TAS= 57.0 EAS= 57.0)																	
16.0	835.6	1.9	1598	0.0	57.5	57.5	.087	4.12	9580	0644	8.45	.07	7.1	1.06	322.	52.	7.02
17.0	934.5	1.9	1598	1.6	59.6	59.6	.090	2.88	9169	0655	8.15	1.81	191.0	1.09	320.	52.	8.46
18.0	1036.3	1.9	1598	6.4	60.9	60.9	.092	1.59	8713	0702	8.05	3.52	379.1	1.09	318	53.	10.07
19.0	1139.5	2.0	1598	14.2	61.5	61.5	.093	.44	8529	0742	8.15	5.16	560.3	1.10	317.	53.	11.81
20.0	1242.9	2.0	1598	24.9	61.6	61.6	.093	.14	7431	0677	6.95	6.15	668.9	.96	317.	53.	11.60
DISTANCE TO 35 FT.= 1339.4 TAS= 61.7 EAS= 61.6 V35/VS= 1.2745																	
21.0	1346.4	2.0	1598	35.8	61.7	61.6	.093	.02	7744	0711	7.35	6.11	664.7	1.01	317.	53	11.98
22.0	1450.0	2.0	1598.	46.8	61.7	61.6	.093	-.01	7741	0711	7.35	6.14	669.0	1.00	317.	53	11.99
23.0	1553.6	2.0	1598	58.0	61.7	61.6	.093	-.01	7740	0711	7.35	6.14	669.0	1.00	317.	53	11.99
24.0	1657.1	2.0	1598	69.1	61.7	61.7	.093	.04	7657	0704	7.25	6.10	664.9	.99	317.	53	11.85
25.0	1760.8	2.0	1598	80.2	61.7	61.7	.093	.05	7740	0711	7.35	6.02	656.5	1.01	316.	53	11.87
26.0	1864.5	2.1	1598	91.1	61.8	61.7	.093	.09	7657	0704	7.25	5.99	653.8	1.00	316.	53.	11.74
27.0	1968.4	2.1	1598	101.9	61.9	61.8	.093	.10	7740	0711	7.35	5.90	644.4	1.01	316.	53	11.75
28.0	2072.4	2.1	1598.	112.8	61.9	61.8	.094	.15	7492	0689	7.05	5.97	652.6	.98	316	53	11.52
29.0	2176.5	2.1	1598	123.7	62.0	61.9	.094	.02	7740	0711	7.35	6.03	659.3	1.01	316.	53	11.87
30.0	2280.6	2.1	1598	134.6	62.0	61.9	.094	.08	7658	0704	7.25	5.94	650.9	1.00	315	53	11.69
31.0	2384.9	2.1	1598	145.4	62.1	62.0	.094	.10	7658	0704	7.25	5.90	647.4	1.00	315	53	11.65
32.0	2489.2	2.1	1598	156.3	62.1	62.0	.094	.10	7492	0689	7.05	5.99	657.5	.98	315.	53	11.54
33.0	2593.7	2.2	1598	167.1	62.2	62.1	.094	.01	7823	0719	7.45	5.92	650.7	1.03	315	53	11.87
34.0	2698.3	2.2	1598	178.0	62.3	62.1	.094	.12	7575	0696	7.15	5.87	645.4	1.00	315	53	11.52
35.0	2803.0	2.2	1598	188.9	62.3	62.2	.094	.04	7658	0704	7.25	5.94	654.2	1.01	314.	53.	11.69
36.0	2907.7	2.2	1598	199.7	62.4	62.2	.094	.04	7658	0704	7.25	5.93	653.6	1.01	314.	52.	11.69

ALL ENGINE DISTANCE TO 35 FT. (L) = 1339 4 FEET
FAR 25 T O DISTANCE (1 15XL) = 1540.3 FEET
ALL ENGINE DISTANCE TO 50 FT. = 1479.2 FEET

AT END OF TAKEOFF PHASE
TIME= 093 HRS FUEL USED= 2. LBS WEIGHT= 1598. LBS ALT.= 200. FT.

ACCELERATE TO MACH NO. = .112

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
093	0.00	2.2	1598.	200.	62.	62.	094	665	314.	52
095	.12	2 3	1598.	200.	74.	74.	.112	.690	305.	54.

END OF ACCELERATION SEGMENT
TIME= 095 HRS FUEL USED= 2.3 LBS WEIGHT= 1598. LBS RANGE= 0 NM

CLIMB TO 7500. FT. AT MAXIMUM RATE OF CLIMB

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	CL	CD	ALPHA (DEG)	GAMMA (DEG)	FUS. ANGLE (DEG)	R/C (FPM)	THRUST (LBS)	FUEL FLOW (LB/HR)
095	0.	2	1598	200	74	73	111	690	5552	0539	4 73	5 40	8 63	702	305.	54.
114	2	3	1597.	1000.	74	73	112	689	5664	0547	4 87	5 14	8 50	669.	297.	53.
.139	3.	5.	1595	2000	74	72	112	688	5806	0556	5 04	4 82	8 36	629	287.	51.
.166	5	6.	1594	3000	74.	71.	113	686	5951	0567	5 21	4 51	8 22	590.	277.	50.
.194	7.	7.	1593.	4000	74	70	114	684	6099	0577	5 39	4 20	8 09	551	267.	49.
224	10.	9	1591.	5000	74	69	114	682	6248	0588	5 57	3 90	7 97	513	258.	47.
256	12.	10	1590.	6000	75.	68	115	681	6399	0599	5 76	3 61	7 86	476	249.	46.
292	15.	12.	1588	7000	75	67	116	679	6552	0611	5 94	3 32	7 76	439	240.	45.
.311	16.	13.	1587.	7500	75.	67	116	678	6629	0617	6 03	3 17	7 71	421.	235.	45.

END OF CLIMB TO 7500 FT
TIME= 311 HRS FUEL USED= 13. LBS WEIGHT= 1587 LBS RANGE= 16 NM

ACCELERATE TO MACH NO. = .162

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.311	16 07	12 9	1587.	7500.	75.	67.	116	678	235	45
.324	17.34	13 5	1586.	7500.	104.	93.	162	714	215	47.

END OF ACCELERATION SEGMENT
TIME= 324 HRS FUEL USED= 13.5 LBS WEIGHT= 1586 LBS RANGE= 17 NM

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
****** MAXIMUM FUEL ******
FIXED PITCH PROPELLER
FUEL AVAILABLE= 228.

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC RANGE START CRUISE	AT BEST SPEC RANGE END CRUISE
TIME	HRS.	0 000	0 000	.324	6 732	0 000	0 000
RANGE	N MI	0.	0	17.	691.	0	0
FUEL USED	LBS.	0.	0.	14.	205	0	0
WEIGHT	LBS.	0	0.	1586	1395.	0	0
ALTITUDE	FT.	0.	0.	7500	7500	0.	0
TAS	KTS.	0.0	0.0	104 7	105 3	0 0	0 0
EAS	KTS.	0 0	0 0	93 6	94 3	0 0	0 0
MACH NO.		0 0000	0.0000	.1624	.1636	0 0000	0 0000
DIV MACH		0 0000	0.0000	.7169	.7205	0 0000	0 0000
ANGLE ATTACK	DEG.	0 000	0.000	1 949	1 571	0 000	0 000
FUSE. ANGLE	DEG.	0 000	0 000	.449	.071	0 000	0 000
CL		0 0000	0 0000	.3274	.2962	0 0000	0 0000
L/D		0 000	0 000	7 782	7 241	0 000	0 000
FUEL FLOW	LB/HR	0.0	0 0	30 1	29 8	0 0	0 0
BREG. FACTOR	N MI.	0	0	5518	4939	0	0
SPEC. RANGE	NM/LB	0.00000	0.00000	3.47581	3 53864	0 00000	0.00000
RESERVE FUEL(LBS) (45 0 MIN.)			0.		23.		0.

****

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
**** MAXIMUM PAYLOAD *****
FIXED PITCH PROPELLER
FUEL AVAILABLE= 155

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC RANGE START CRUISE	AT BEST SPEC RANGE END CRUISE
TIME	HRS	0 000	0 000	324	4 261	0 000	0 000
RANGE	N MI	0.	0	17	430	0	0
FUEL USED	LBS	0	0	14	132	0	0
WEIGHT	LBS	0	0	1586	1468	0	0
ALTITUDE	FT	0	0	7500	7500	0	0
TAS	KTS.	0 0	0 0	104 3	105 1	0 0	0 0
EAS	KTS.	0 0	0.0	93 2	93 9	0 0	0 0
MACH NO		0 0000	0 0000	.1618	.1630	0 0000	0 0000
DIV MACH		0 0000	0 0000	.7149	.7184	0 0000	0 0000
ANGLE ATTACK	DEG	0 000	0 000	2 155	1 788	0 000	0 000
FUSE ANGLE	DEG	0 000	0 000	655	288	0 000	0 000
CL		0 0000	0 0000	3444	.3141	0 0000	0 0000
L/D		0 000	0 000	8 056	7 559	0 000	0 000
FUEL FLOW	LB/HR	0 0	0 0	30 3	30 0	0 0	0 0
BREG FACTOR	N MI	0	0	8463	8147	0	0
SPEC RANGE	NM/LB	0 00000	0 00000	3 44134	3 50408	0 00000	0 00000

RESERVE FUEL(LBS) 0. 23. 0
(45 0 MIN.)

****

RANGE = 430 BLOCK TIME= 4 261 USED FOR DESIGN RANGE AND COST

****

****

TEMP = 518 DEG STD + 0
LANDING ELEVATION= 0 FT
LANDING WING LOADING= 10 20 PSF
LANDING WEIGHT = 1600 LBS

LANDING DISTANCE FROM 50 FT = 824 FT

F A R FACTORED FIELD LENGTH = 1373 FT

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	406	DIST=	46	DIST=	83	DIST=	290
R/S=	689	XLFMX=	1 200	TDELAY=	1 00	MUB=	4000
VAPEAS=	55 53	SINKTD=	3 000	TIDLE=	0	TR/TIDLE=	0 0000
VAPTAS=	55 57	VSTEAS=	42 72	VTDTAS=	49 16	ABAR(G)=	3700
THETA=	7 03	CLMX=	1 6480				
THRUST=	0	HFLAR=	9 6				

IDLE THRUST LIMITING RATE OF SINK

****

```
                    --- COST DATA ---
AIRCRAFT PRICING

     ENGINES       NUMBER =     1.   TYPE=     1

     EMPTY WEIGHT=      982. LBS                 MAX CRUISE SPEED=   104. KNOTS

     CONSUMER PRICE=    9465. DOL.        BASIC PRICE=   9465  DOL
                                          ADD  EQUIPMENT COST=      0  DOL.

     DIRECT LABOR (  346.MHRS.)           1177.
     LABOR OVERHEAD(132.PCT)              1552
     AIRFRAME MATERIALS                    518
     PURCHASED EQUIP.                     1876.
        ($/ENG =  1337.)
        ($/PROP=   147.)
        (OTHER =   392.)
                                          5123.  SUB-TOTAL
     ENG.TL.SALES,G-A( 31.PCT)            1563
                                          6686   MANUFACTURING COST
     FACTORY PROFIT(  9.PCT)               594
                                          7280   DEALER COST
     DEALER-DIST. MARKUP( 30.PCT)         2184
                                          9465   BASIC PRICE
********************************************************************************

   DESIGN MISSION

      OPERATING COST FOR NOR.RATED POWER AND    7500. ALTITUDE

     SEATS=       2.          FUEL COST=       .700 $/GAL

     RANGE=     430. N.M.     BLOCK FUEL=      132  LBS     BLOCK TIME=  4 261 HRS.

     FUEL RATE=  5.2 GPH.     TBO= 2000  HRS     HOURS/INSP =  100  HRS.

     VARIABLE COST     (DOL/HR)              FIXED COST       (DOL/YR)
         FUEL-OIL          3.75                  STORAGE          300
         INSP -MAIN.       2.00                  INSURANCE        404  (HULL 2.0PCT)
         OVERHAUL RES.      .63                  DEPRECIATION     946  ( 8 YR-20 PCT)
         OTHER             0.00                  OTHER              0
                                                 CREW               0  (OVERHEAD 50 PCT)
                                                 FAA TAX           25
                          6.39 TOTAL                             1676.  TOTAL

     UTILIZATION(HRS/YR)        100.      200       300.      400.      500       800.
     TOTAL OPR COST(DOL/HR)    23.14     14 76     11 97     10 57      9 74      8 48
     TOTAL OPR COST(DOL/NM)      .23       15        12        10        10        08
     TOTAL OPR COST(C/ASNM)    11 48      7 32      5 94      5 24      4 83      4 21
********************************************************************************
ALTITUDE=      1000. FT   TAS=      112 86 KTS   MACH NO=       .1710

PROPELLER NOISE FOR  1. ENGINES AT  112.9 KTAS AND AT  1000 0 FEET
   REF LEVEL= 77 32  DIA AND BLADE CORR = 11 25  DIST CORR = -6 02  NO ENGINE CORR =  0 00  PNL ADJUST=  2.24

 TOTAL=  84 79 PNDB  OR   72.79 DB(A)
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APPENDIX C

TURBOFAN DESIGN USING SCALED TFE-731 ENGINE

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                              GASP TURBOFAN SAMPLE USING SCALED TFE-731

                          ENGINE CYCLE IS GARRETT TFE731-2
                             INPUT DATA FOLLOW
                             ******************

                              *****GEOMETRY*****

CONFIG VG     .    7500.           KWRITE .       2      FUSEL SAB    .       2              ELODN  .   2.000
       VGS    .  55.000            IGEAR  .       0            VS     .  20.000              ELODT  .   3.200
       PAX    .      5.            KCONFG .       0            AS     .       1              BHLOD  .  14.500
       EMCRU  .     .700           KTIPX  .       1            VAS    .   4.000    NACELLE   KNAC   .       1
       HNCRU  .  40000.            ENP    .       2.           PS     .   50.0               ELN    .   0.000
                                   NTYE   .       7            ELPC   .   4.440              DBARN  .      -1
                                   KPLOT  .       0            HCK    .   2.470              ELRW   .   5.000

  WING TCT    .    .100      HORIZ VBARHX .  0.0000     VERT  VBARVX .  0.0000
       TCR    .    .120      TAIL  TCHT   .    .080     TAIL  TCVT   .    .100
       AR     .   7.000            ARHT   .   4.250           ARVT   .   2.000
       SLM    .    .500            SLMH   .    .500           SLMV   .    .500
       DLMC4  .  15.000            CWPQCH .  25.000           DWPQCV .  35.000
       EYEW   .   1.000            COELTH .   0.000           BOELTV .   0.000
                                   SAH    .    .500

                              ***AERODYNAMICS***

       CKW    .  -1.000            CKHT   .  -1.000           GRFE   .   0.000
       CKF    .  -1.000            CKTP   .  -1.000           SCFAC  .   0.000
       CKN    .  -1.000            DELCD  .  .00150           DLSVSW .   0.000
       CKVT   .  -1.000            DELFE  .    .250           ALPHLO .  -1.200

       KWCD   .      12
       ACLS   .  -1.000   -.600   -.400   -.200   0.000    .100    .200    .400    .600    .800   1.000   1.200
       ACDCDR .   2.400   1.466   1.221   1.056   1.005   1.000   1.005   1.046   1.138   1.333   1.743   2.718

                              *HIGH LIFT DEVICES*

       RCLMAX .   1.400      FLAPS JFLTYP .       1     LED  CLEOC  .   0.000
       ALTFLP .      0.            DFLPTO .  15.000          DELLED .   0.000
       FLAPN  .      1.            DFLPLD .  40.000          DCLMLE .    .930
       WCFLAP .  -1.000            CFOC   .    .300          DELLEO .  45.000
       BENGOB .   0.000            BTEOB  .    .750
                                   DCLMTE .   0.000
                                   DCDOTE .   0.000
                                   DELTEO .   0.000

                              ****PROPULSION****

       JENGSZ .       2            HPORT  .      0.           RCCRU  .  30.000           RWCRTX .   1.000
       IPART  .       1            TDELTO .      0.           XTORQ  .   3100.           HSCREQ .      0.
       KODETO .       5            KODECL .       7           SMID   .    .500           THIN   .      0.
       KODETR .       5            KODEAC .       5           HBTP   .    .720           PR     .   1.000

                              *****WEIGHTS*****

       SKPEI  .   .1350            SKY    .   .1800           SKB    . 125.000           SKFS   .   .0232
       SKLG   .   .0400            SKZ    .   .2200           SKCC   .  11.000           SKWF   .   .4300
       SKMC   .   .8000            SKTL   .  1.0000           SKFW   .   .3550           SKFT   .   .8000
       SKPES  .   .3380            SKWW   . 133.400           SKSAS  .   0.000           SKWTP  .  1.8900
       WPLX   .   675.0            YMG    .   .2500           EGMRGN .  0.0000           LCWING .       2
       WFEX   .   860.0            RELP   .   .6500           CPMRGN .   .1000           ELINC  .   0.000
       WFUL   .   340.0            RELR   .   .4300           STMRGN .  0.0000           LDCKMX .   6.000
       UWPAX  .   200.0            CATO   .       3           DELP   .   4.200           ATMXQC .   3.160
       STRUT  .  0.0000            VMLFSL .   345.0           YP     .  0.0000           DELWST .     0.0
       DELWFC .     0.0
```

```
ENGINE  VENG    =    0 0          WNAC    =    0 0          WPYLON  =    0 0
        SWSLS   =   .222          UWNAC   =  2 287          FPYL    =   050          XLQDE   =  2.740

                              *STABILITY AND CONTROL*

                                  STATIC  =    030          ZCG     = 999 000        CNPAC   =  -.002
        CHFLPL  = 999.000         CHALF   = 999 000         TP      =    0 0         ARYTE   = -1.000
        CHFLPT  = 999 000         CHDEL   = 999 000         CYA     =    550         FV      =   .300
                                  RH      =    350          DCMCLP  =9999 000        TAUV    = 999 000
        CMPLD   =   0 000         DEMAX   =  -25 0          HWING   =      0         RVMCS   =    990
                                  EYET    =    0 0                                   DRMAX   =   25 0
                                  TAUH    = 999 000

                               ***PERFORMANCE***

TAXI    DELTT   =    .083         XLFMAX  =  1 100          DVR     =  5 000         TDELTX  =  0 000
 TO     IFLY    =      1          DELTVR  =  3 500          UM      =    020         HTMAX   = 500 000
        THEMAX  = 15.000          DVI     =  5 000          MUB     =    400         NFAIL   =      0
        HDO     =      0          VRAT    =   1 10          VTM'SN  =      0

CLIMB   ICLM    =      1   CRUISE CRMACH  =  0 000          FRESF   =  1 000         FACVI   =   .950
        DELH    =   1000          CRALT   =      0          RCFRQ   = 1200 0         ISWING  =      0
        VCLMB   =    0.0          ICRUS   =      1          OFALT   =  25000         OFEM    =   .500

LAND    IWLD    =      0          XLDGRQ  =   2300          VRATT   =  1 300         HAPP    =     50
        TDELLD  =    0 0          ALTLND  =      0          RSMX    =   1000         SINKTD  =    3 0
        TDELAY  =    1 0          WLPCT   = 0 0000          IROTID  =  0 000         XLFMX   =  1.150
        HTG     =    3.0          TIDLE   =    0 0          VTDRAT  = 9999 0

                               ******COST******

        NCADE   =      1          HIR     =    025          RI      =  0 000         CMV     =  0 000
        CLIAB   = 1000 0          TR      =  0 000          OHR     = 10 000         CCRV    =      0
        HRI     =  100 0          PRV     =    200          CRWOH   =    500         UCSENG  =  0 000
        CMF     =    0 0          DYR     =    8 0          CINP    =   2000         UCSPP   =  0 000
        TBO     = 2000 0          SRPM    =  100 0          CP      =      0         ALR     =  5 000
        FCSF    =   .750
```

FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)

	CLMAX	VSTALL,KTS	FLAP ANGLE	LE ANGLE	DELTA CL	DELTA CD
FLAPS UP	1.3609	109.6	0.0	0.0	0.0000	0.0000
T.O. CONFIG	1.5484	102.5	15.0	0.0	.1984	.0156
LDG. CONFIG	1.8013	95.2	40.0	0.0	.4627	.0482

PLAIN FLAPS

	OPT ANGLE	DELCL AT OPT	DELCD AT OPT	AREA(FT2)	WEIGHT(LB)
FLAPS	60.0	.9000	.1200	27.6	49.9

ITERATE ON WING AREA TO MEET REQ LDG FLD LGTH OF 2300. ,WING LOADING= 55.000 ,LDG FLD LGTH= 2378.

FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)

	CLMAX	VSTALL,KTS	FLAP ANGLE	LE ANGLE	DELTA CL	DELTA CD
FLAPS UP	1.3472	91.9	0.0	0.0	0.0000	0.0000
T.O. CONFIG	1.5353	86.1	15.0	0.0	.1989	.0159
LDG. CONFIG	1.7885	79.9	40.0	0.0	.4639	.0491

PLAIN FLAPS

	OPT ANGLE	DELCL AT OPT	DELCD AT OPT	AREA(FT2)	WEIGHT(LB)
FLAPS	60.0	.9000	.1200	40.7	51.9

ITERATE ON WING AREA TO MEET REQ LDG FLD LGTH OF 2300. ,WING LOADING= 38.500 ,LDG FLD LGTH= 1829.

FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)

	CLMAX	VSTALL,KTS	FLAP ANGLE	LE ANGLE	DELTA CL	DELTA CD
FLAPS UP	1.3589	107.0	0.0	0.0	0.0000	0.0000
T.O. CONFIG	1.5467	100.4	15.0	0.0	.1984	.0156
LDG. CONFIG	1.7997	93.2	40.0	0.0	.4629	.0483

PLAIN FLAPS

	OPT ANGLE	DELCL AT OPT	DELCD AT OPT	AREA(FT2)	WEIGHT(LB)
FLAPS	60.0	.9000	.1200	28.9	50.1

TEMP = 518. DEG STD + 0
LANDING ELEVATION= 0 FT
LANDING WING LOADING= 52.65 PSF
LANDING WEIGHT = 7500 LBS

LANDING DISTANCE FROM 50. FT.= 2303. FT.

F A R. FACTORED FIELD LENGTH = 3838. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	609.	DIST=	237.	DIST=	180	DIST=	1277.
R/S=	1000	XLFMX=	1.150	TDELAY=	1.00	MUB=	.4000
VAPEAS=	120.50	SINKTD=	3.000	TIDLE=	0	TR/TIDLE=	0.0000
VAPTAS=	120.58	VSTEAS=	92.70	VTDTAS=	106.67	ABAR(G)=	.3952
THETA=	4.69	CLMX=	1.8064				
THRUST=	420.	HFLAR=	27.9				

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
ANGLE OF ATTACK(DEGREES)= 2.717 LIFT= 7500.0 L/D= 11.654 ALTITUDE= 40000.0 MACH= .7000

ENGINE SIZING DATA FOLLOW
****

```
VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2839
    VEND =  228.4 KNOTS EAS

ROTATION (TIME=   17.5 AND TAS=   109.9 EAS=   110.01
LIFTOFF (TIME=   20.0 DIST=   2208.9 TAS=   122.4 EAS=   122.41
DISTANCE TO 35 FT =  3305.3   TAS=   139.4 EAS=   139.4 V35/VS=  1.3940

 ITERATION TO MATCH TAKEOFF DISTANCE
  XTO,XTORQ,WASLS  3305.  3100.   48.62


VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2839
    VEND =  240.3 KNOTS EAS

ROTATION (TIME=   15.2 AND TAS=   109.9 EAS=   110.01
LIFTOFF (TIME=   17.6 DIST=   1964.8 TAS=   124.2 EAS=   124.21
DISTANCE TO 35 FT.=  3067.6   TAS=   144.8 EAS=   144.7 V35/VS=  1.4477

 ITERATION TO MATCH TAKEOFF DISTANCE
  XTO,XTORQ,WASLS  3068.  3100.   55.27


VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2839
    VEND =  240.3 KNOTS EAS

ROTATION (TIME=   15.5 AND TAS=   109.9 EAS=   110.01
LIFTOFF (TIME=   17.8 DIST=   1972.6 TAS=   123.3 EAS=   123.31
DISTANCE TO 35 FT.=  3113.1   TAS=   144.3 EAS=   144.2 V35/VS=  1.4426

 ITERATION TO MATCH TAKEOFF DISTANCE
  XTO,XTORQ,WASLS  3113.  3100.   54.28
```

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE=   0. FT.   AMBIENT TEMP ABOVE STD. DAY=   0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T.O. FLAPS+LD GEAR EXT - ONE ENG OUT	0.	115.3	736.14	1.00	1.17	7.92
SEC SEG T.O. FLAPS - ONE ENGINE OUT	250	120.8	1093.72	293.41	1.08	10.29
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500.	137.3	1432.67	166.71	.87	12.18
APPROACH FLAPS - ONE ENG OUT	0	153.1	1388.09	325.38	.67	11.01
LANDING FLAPS - ALL ENGINES	0.	120.9	2924.90	391.48	1.07	7.28

APPROACH FLAP SETTING = 11.9 DEG.

```
*** ENGINE-OUT SERVICE CEILING = 31212.0 FT.
    BEST RATE OF CLIMB SPEED   =   256.0 KTAS
    ENGINE-OUT RATE OF CLIMB   =   100.0 FPM
    WEIGHT AT ALTITUDE         =  7200.0 LBS
```

ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW=   48.62

```
ENGINE SIZED TO MATCH T.O. DISTANCE OF  3100. FT (STD DAY,   0. DEG R.ALT=      0.) SLS AIRFLOW=     54.28

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE=   1681 2 LBS
****************************************************************************************************


PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE                   372 4
  NACELLE WEIGHT/ENGINE                   76 4
  PYLON WEIGHT/ENGINE                      4 5
     PROP OR OFAN              0.0
     GEARBOX                   0.0
     SHROUD                    0.0

ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)              1.97
  NACELLE LENGTH(FT)                    5.40


                        ****RESIZE ENGINES TO ACCOUNT FOR TIP TANKS****


SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
  ANGLE OF ATTACK(DEGREES)=   2.717   LIFT=  7500.0   L/D=  11 293   ALTITUDE= 40000 0   MACH=   .7000
```

ENGINE SIZING DATA FOLLOW

VSTLKT= 100.0 KTS EAS VRAT= 1.100 CLTO= 1.2839
VEND = 228.4 KNOTS EAS

ROTATION (TIME= 15.5 AND TAS= 109.9 EAS= 110.0)
LIFTOFF (TIME= 18.0 DIST= 2011.9 TAS= 124.1 EAS= 124.1)
DISTANCE TO 35 FT.= 3102.3 TAS= 143.6 EAS= 143.6 V35/VS= 1.4363

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T.O. FLAPS+LD GEAR EXT - ONE ENG OUT	0.	115.3	715.43	1.00	1.17	7.81
SEC SEG. T.O. FLAPS - ONE ENGINE OUT	250.	120.8	1068.63	293.41	1.08	10.08
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500.	137.3	1394.48	166.71	.87	11.77
APPROACH FLAPS - ONE ENG OUT	0.	153.1	1327.52	325.38	.67	10.56
LANDING FLAPS - ALL ENGINES	0.	120.9	2897.63	391.48	1.07	7.17

APPROACH FLAP SETTING = 11.9 DEG.

*** ENGINE-OUT SERVICE CEILING = 30021.1 FT.
BEST RATE OF CLIMB SPEED = 241.5 KTAS
ENGINE-OUT RATE OF CLIMB = 99.9 FPM
WEIGHT AT ALTITUDE = 7200.0 LBS

****RESIZE ENGINES AT CRUISE TO ACCOUNT FOR RESIZED NACELLES****

PROPULSION SYSTEM WEIGHTS		
ENGINE WEIGHT/ENGINE		372.4
NACELLE WEIGHT/ENGINE		76.4
PYLON WEIGHT/ENGINE		4.5
PROP OR OFAN	0.0	
GEARBOX	0.0	
SHROUD	0.0	

ENGINE POD DIMENSIONS	
ENGINE FACE DIAMETER(FT)	1.97
NACELLE LENGTH(FT)	5.40

VSTLKT= 100.0 KTS EAS VRAT= 1.100 CLTO= 1.2839
VEND = 228.4 KNOTS EAS

ROTATION (TIME= 15.5 AND TAS= 109.9 EAS= 110.0)
LIFTOFF (TIME= 18.0 DIST= 2011.9 TAS= 124.1 EAS= 124.1)
DISTANCE TO 35 FT = 3102.3 TAS= 143.6 EAS= 143.6 V35/VS= 1.4363

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D

1ST SEG T.O. FLAPS+LD GEAR EXT - ONE ENG OUT	0.	115 3	715 43	1 00	1 17	7.81
SEC SEG. T O FLAPS - ONE ENGINE OUT	250.	120 8	1068 63	293 41	1 08	10.08
FINAL T O. CRUISE CONFIG - ONE ENG OUT	1500.	137 3	1394 48	166 71	87	11.77
APPROACH FLAPS - ONE ENG OUT	0.	153 1	1327 52	325 38	67	10 56
LANDING FLAPS - ALL ENGINES	0.	120 9	2897 63	391 48	1 07	7.17

APPROACH FLAP SETTING = 11.9 DEG.

*** ENGINE-OUT SERVICE CEILING = 30021.1 FT.
BEST RATE OF CLIMB SPEED = 241.5 KTAS
ENGINE-OUT RATE OF CLIMB = 99.9 FPM
WEIGHT AT ALTITUDE = 7200.0 LBS

ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW= 52.47

ENGINE SIZED TO MATCH T.O. DISTANCE OF 3100. FT (STD DAY+ 0. DEG R.ALT= 0.1 SLS AIRFLOW= 54.28

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE= 1681.2 LBS
****

PROPULSION SYSTEM WEIGHTS
ENGINE WEIGHT/ENGINE 372.4
NACELLE WEIGHT/ENGINE 76.4
PYLON WEIGHT/ENGINE 4.5
PROP OR OFAN 0.0
GEARBOX 0.0
SHROUD 0.0

ENGINE POD DIMENSIONS
ENGINE FACE DIAMETER(FT) 1.97
NACELLE LENGTH(FT) 5.40

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---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD		MOST AFT LOAD		DESIGN LOAD	
	WT	CG	WT	CG	WT	CG
A/C OWE	4539 11	16.82	4539 11	16.82	4539.11	16.82
PAX	510 00		0 00		510 00	
BAGGAGE	0 00	17.73	165 00	17.73	165 00	17.73
WING FUEL	0 00	15.63	242 63	15 63	1213 15	15 63
TIP FUEL	242 63	15 39	0 00	15.39	561 42	15 39
FUS FUEL	0 00	15 63	0 00	15 63	511 32	15.63
TOTAL	5291.74	16.14	4946.74	16.79	7500.00	16.02

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FU:cLAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT	
CRUISE	2 7170	0997	.0759	.9500		.3904	.2689		0066			0 0000			-1
LIFTOFF	1 0000	0811	.0659	.9500	2041	.3958	.3304	0 0000	.0066	0 0000	-.1031		0 0000		-1
LANDING	13 6894	0812	.0660	.9500	2.7940	1.7997	.3301	3401	.0066	.0068	-.2000		0 0000		

ELEVATOR PARAMETERS

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CHALPHA(FLOATING TENDENCY)   =  -.00511          WING DE/DALPHA =    40819
CHDELTA(RESTORING TENDENCY)  =  -.01204
CMDELTA(CONTROL POWER)       =  -.02766
TAUH(EFFECTIVENESS)          =   .48250

                          FRACTION    STATION     HORIZONTAL TAIL SIZES
                             MAC     (DATUM NOSE)
NEUTRAL POINT               .2881      16 783        STATIC STABILITY AND TRIM     38 6869
STATIC MARGIN               .0300                    STABILITY AND LIFTOFF         38 4625
AFT CG LIMIT(STABILITY)     .2581      16 642        LIFTOFF                       38 4130
CG RANGE(LOADING)           .1405                    REQUIRED TAIL SIZE            38 4625
FWD CG LIMIT(CONTROL)       .1176      15 985        TAIL ARM(ELTH)                15 8459

VERTICAL TAIL AREA =   18 0603 FOR DIRECTIONAL STABILITY OF    - 00200

VERTICAL TAIL AREA=   17.9142 FOR MINIMUM CONTROL SPEED =    99 18 KTS

REQUIRED VERTICAL TAIL AREA =    18.0603   TAIL ARM(ELTV) =    14 3004

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                ---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

           MOST FWD LOAD          MOST AFT LOAD          DESIGN LOAD
            WT        CG           WT        CG           WT        CG

A/C OWE   4497 10    16 98       4497 10    16 98       4497 10    16 98
PAX        850 00                   0 00                 510 00
BAGGAGE      0 00    17 73        165 00    17 73        165 00    17 73
WING FUEL  242 63    16 84       1213 15    16 84       1213 15    16 84
TIP FUEL     0 00    16 89        561 42    16 89        561 42    16 89
FUS FUEL     0 00    16 84          0 00    16 84        553 32    16 84
TOTAL     5589 73    16 30       6436 68    16.96       7500 00    16 51


                ---TAIL SIZING SUMMARY---

                   WING   TAIL   TAIL   DOWN    WING --FUSELAGE--  ---NACELLE--   FLAP  ------POWER-------
CONDITION  ALPHA   CLA    CLA    EFF    WASH    CL    DCM    CM     DCM    CM     CM     DCM    CM    CT
 CRUISE   2 7170   0997   0759   9500           3904  2824          0049                 0 0000           -1
 LIFTOFF  1 0000   0811   0659   9500   2127    3958  3471 0 0000   0049 0 0000 - 1031         0 0000     -1
 LANDING 13 6894   0812   0660   9500 2 9111 1 7997   3467   3572   0049   0050 - 2000         0 0000

  ELEVATOR PARAMETERS
     CHALPHA(FLOATING TENDENCY)   =  -.00511          WING DE/DALPHA =    42531
     CHDELTA(RESTORING TENDENCY)  =  - 01204
     CMDELTA(CONTROL POWER)       =  - 02794
     TAUH(EFFECTIVENESS)          =    48250

                          FRACTION    STATION     HORIZONTAL TAIL SIZES
                             MAC     (DATUM NOSE)
NEUTRAL POINT               2694       17 006        STATIC STABILITY AND TRIM     38 2419
STATIC MARGIN               0300                     STABILITY AND LIFTOFF         39 3239
AFT CG LIMIT(STABILITY)     2394       16 866        LIFTOFF                       39 2955
CG RANGE(LOADING)           .1423                    REQUIRED TAIL SIZE            39 3239
FWD CG LIMIT(CONTROL)       .0971      16 200        TAIL ARM(ELTH)                15 6578

VERTICAL TAIL AREA =   18.2258 FOR DIRECTIONAL STABILITY OF    - 00200

VERTICAL TAIL AREA=   17 8874 FOR MINIMUM CONTROL SPEED =    99 18 KTS

REQUIRED VERTICAL TAIL AREA =    18 2258   TAIL ARM(ELTV) =    14 3218

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---AIRCRAFT C G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	MOST FWD LOAD CG	MOST AFT LOAD WT	MOST AFT LOAD CG	DESIGN LOAD WT	DESIGN LOAD CG
A/C OWE	4499 70	17 05	4499 70	17 08	4499 70	17 08
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17.15	1213.15	17.15	1213 15	17 15
TIP FUEL	242 63	16 86	0 00	16 86	561 42	16 86
FUS FUEL	0 00	17 15	0 00	17 15	550 72	17 15
TOTAL	5592 33	16 36	5877 85	17 09	7500 00	16 62

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	.0759	.9500		.3904	2894		0040			0 0000		-1
LIFTOFF	1 0000	.0811	.0659	9500	2133	3958	3556	0 0000	0040	0 0000	- 1031		0 0000	-1
LANDING	13 6894	.0812	0660	9500	2 9205	1.7997	3552	3660	0040	0042	- 2000		0 0000	

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY) = - 00511

CHDELTA(RESTORING TENDENCY) = - 01204

CHDELTA(CONTROL POWER) = - 02846

TAUH(EFFECTIVENESS) = 48250

WING DE/DALPHA = 42668

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	.2669	17.154
STATIC MARGIN	.0300	
AFT CG LIMIT(STABILITY)	.2369	17 014
CG RANGE(LOADING)	.1566	
FWD CG LIMIT(CONTROL)	.0803	16 281

HORIZONTAL TAIL SIZES

STATIC STABILITY AND TRIM	40 4049
STABILITY AND LIFTOFF	40 0681
LIFTOFF	40 0109
REQUIRED TAIL SIZE	40 4049
TAIL ARM(ELTH)	15 5210

VERTICAL TAIL AREA = 18 5201 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 18.0788 FOR MINIMUM CONTROL SPEED = 99 18 KTS

REQUIRED VERTICAL TAIL AREA = 18.5201 TAIL ARM(ELTV) = 14 1702

---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	MOST FWD LOAD CG	MOST AFT LOAD WT	MOST AFT LOAD CG	DESIGN LOAD WT	DESIGN LOAD CG
A/C OWE	4503.21	17.10	4503 21	17 10	4503 21	17 10
PAX	850 00		0.00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17 31	1213 15	17 31	1213 15	17 31
TIP FUEL	242 63	17 01	0.00	17 01	561 42	17 01
FUS FUEL	0 00	17 31	0 00	17 31	547 21	17 31
TOTAL	5595 85	16.41	5881 37	17.16	7500 00	16 70

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT

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CRUISE	2.7170	.0997	.0759	.9500		.3904	.2948		.0034			0.0000			
LIFTOFF	1.0000	.0811	.0659	.9500	.2138	.3958	.3623	0.0000	.0034	0.0000	-.1031		0.0000		-1
LANDING	13.6894	.0812	.0660	.9500	2.9262	1.7997	.3619	.3729	.0034	.0035	-.2000		0.0000		-1

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY)	= -.00511	WING DE/DALPHA =	.42751
CHDELTA(RESTORING TENDENCY)	= -.01204		
CHDELTA(CONTROL POWER)	= -.02896		
TAUH(EFFECTIVENESS)	= .48250		

	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	.2671	17.281	STATIC STABILITY AND TRIM	41.4229
STATIC MARGIN	.0300		STABILITY AND LIFTOFF	40.5663
AFT CG LIMIT(STABILITY)	.2371	17.140	LIFTOFF	40.4210
CG RANGE(LOADING)	.1618		REQUIRED TAIL SIZE	41.4229
FWD CG LIMIT(CONTROL)	.0753	16.384	TAIL ARM(ELTH)	15.4053

VERTICAL TAIL AREA = 18.7765 FOR DIRECTIONAL STABILITY OF -.00200

VERTICAL TAIL AREA= 18.2515 FOR MINIMUM CONTROL SPEED = 99.18 KTS

REQUIRED VERTICAL TAIL AREA = 18.7765 TAIL ARM(ELTV) = 14.0361

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---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	4506.41	17.15	4506.41	17.15	4506.41	17.15
PAY	850.00		0.00		510.00	
BAGGAGE	0.00	17.73	165.00	17.73	165.00	17.73
WING FUEL	0.00	17.43	1213.15	17.43	1213.15	17.43
TIP FUEL	242.63	17.13	0.00	17.13	561.42	17.13
FUS FUEL	0.00	17.43	0.00	17.43	544.01	17.43
TOTAL	5599.04	16.45	5884.56	17.22	7500.00	16.77

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE--- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT	
CRUISE	2.7170	.0997	.0759	.9500		.3904	.2976		.0030			0.0000			
LIFTOFF	1.0000	.0811	.0659	.9500	.2139	.3958	.3656	0.0000	.0030	0.0000	-.1031		0.0000		-1
LANDING	13.6894	.0812	.0660	.9500	2.9276	1.7997	.3652	.3763	.0030	.0031	-.2000		0.0000		-1

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY)	= -.00511	WING DE/DALPHA =	.42772
CHDELTA(RESTORING TENDENCY)	= -.01204		
CHDELTA(CONTROL POWER)	= -.02930		
TAUH(EFFECTIVENESS)	= .48250		

	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	.2683	17.349	STATIC STABILITY AND TRIM	42.0738
STATIC MARGIN	.0300		STABILITY AND LIFTOFF	40.8421
AFT CG LIMIT(STABILITY)	.2383	17.209	LIFTOFF	40.6334
CG RANGE(LOADING)	.1657		REQUIRED TAIL SIZE	42.0738
FWD CG LIMIT(CONTROL)	.0726	16.434	TAIL ARM(ELTH)	15.3474

VERTICAL TAIL AREA = 18.9172 FOR DIRECTIONAL STABILITY OF -.00200

ORIGINAL PAGE IS OF POOR QUALITY

VERTICAL TAIL AREA= 18.3496 FOR MINIMUM CONTROL SPEED = 99 18 KTS

REQUIRED VERTICAL TAIL AREA = 18.9172 TAIL ARM(ELTV) = 13 9611

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---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD		MOST AFT LOAD		DESIGN LOAD	
	WT	CG	WT	CG	WT	CG
A/C OWE	4508 32	17.17	4508.32	17.17	4508 32	17.17
PAX	850.00		0.00		510 00	
BAGGAGE	0 00	17.73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17.50	1213 15	17 50	1213 15	17 50
TIP FUEL	242 63	17.21	0 00	17 21	561 42	17 21
FUS FUEL	0 00	17 50	0 00	17 50	542 11	17 50
TOTAL	5600 95	16 47	5886.47	17.25	7500 00	16 80

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF.	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	.0997	.0759	.9500		.3904	.2990		.0029			0 0000		-1
LIFTOFF	1.0000	.0811	.0659	.9500	.2139	.3958	3674	0 0000	0029	0 0000	- 1031		0 0000	-1
LANDING	13 6894	.0812	.0660	.9500	2.9282	1.7997	3670	3782	0029	.0029	- 2000		0 0000	

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY) = - 00511

CHDELTA(RESTORING TENDENCY) = - 01204

CMDELTA(CONTROL POWER) = - 02947

TAUH(EFFECTIVENESS) = .48250

WING DE/DALPHA = 42781

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	.2688	17 385
STATIC MARGIN	0300	
AFT CG LIMIT(STABILITY)	2388	17 245
CG RANGE(LOADING)	.1675	
FWD CG LIMIT(CONTROL)	0713	16 461

HORIZONTAL TAIL SIZES

STATIC STABILITY AND TRIM	42 3920
STABILITY AND LIFTOFF	40 9798
LIFTOFF	40 7403
REQUIRED TAIL SIZE	42 3920
TAIL ARM(ELTH)	15 3187

VERTICAL TAIL AREA = 18 9923 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 18.4016 FOR MINIMUM CONTROL SPEED = 99 18 KTS

REQUIRED VERTICAL TAIL AREA = 18 9923 TAIL ARM(ELTV) = 13 9216

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SUMMARY OF CRUISE LIFT-WEIGHT BALANCE

ANGLE OF ATTACK(DEGREES)= 2.717 LIFT= 7500.0 L/D= 10 875 ALTITUDE= 40000 0 MACH= .7300

WING LOCATION INFO.

FUSELAGE LENGTH =	32 10	H-TAIL VOL ARM =	15 32	C G LOCATION OF PROPULSION=	20 87
WING 1/4C LOC ON C L =	15 42	H-TAIL C G LOCATION =	32 82	C G OF REMAINING WEIGHT =	13.80
MAC 1/4C LOCATION =	17 30	H-TAIL MAC FROM C L =	2 97		
MAC DIST FROM C L =	7 02	H-TAIL LOCAT ON VERT =	50		
WING C G LOCATION =	17 77	V-TAIL VOL ARM =	13 92		
TIP TANKS C G LOCATE =	17 21	V-TAIL C G LOCATION =	31 42		

	VING	H-TAIL	V-TAIL
AREA	142.461	42.392	18.992
SPAN	31.579	13.423	6.163
ASPECT RATIO	7.000	4.250	2.000
TAPER RATIO	.500	.500	.500
1/4C. SWEEP	15.000	25.000	35.000
L.E. SWEEP	17.514	28.578	40.921
C.L. CHORD	6.015	4.211	4.109
MEAN CHORD	4.678	3.275	3.196
TIP CHORD	3.008	2.106	2.054

GASP TURBOFAN SAMPLE USING SCALED TFE-731

GROSS WEIGHT = 7500. PASSENGERS = 5. PLUS CREW OF 1

FUSELAGE	LENGTH	(ELF)	32.10	FT
	WIDTH	(SWF)	4.67	FT
	WETTED AREA	(SF)	372.	SQFT
	DELTA P	(DELP)	8.19	PSI
WING	ASPECT RATIO	(AR)	7.00	
	AREA	(SW)	142.5	SQFT
	SPAN	(B)	31.6	FT
	GEOM. MEAN CHORD	(CBARW)	4.68	FT
	QUARTER CHORD SWEEP	(DLMC4)	15.0	DEG
	TAPER RATIO	(SLM)	.500	
	ROOT THICKNESS	(TCR)	.120	
	TIP THICKNESS	(TCT)	.100	
	WING LOADING	(WGS)	52.6	PSF
	WING FUEL VOLUME	(VFW)	181.4	GAL
HOR. TAIL	ASPECT RATIO	(ARHT)	4.25	
	AREA	(SHT)	42.4	SQFT
	SPAN	(BHT)	13.42	FT
	MEAN CHORD	(CBARHT)	3.28	FT
	THICKNESS/CHORD	(TCHT)	.080	
	MOMENT ARM	(ELTH)	15.3	FT
	VOLUME COEFF.	(VBARH)	.974	
VERT. TAIL	ASPECT RATIO	(ARVT)	2.00	
	AREA	(SVT)	19.0	SQFT
	SPAN	(BVT)	6.16	FT
	MEAN CHORD	(CBARVT)	3.20	FT
	THICKNESS/CHORD	(TCVT)	.100	
	MOMENT ARM	(ELTV)	13.9	FT
	VOLUME COEFF.	(VBARV)	.059	
ENG.NACELLES	LENGTH	(ELN)	5.40	FT
	MEAN DIAMETER	(DBARN)	1.97	FT
	NUMBER ENGINES	(ENP)	2.0	
	WETTED AREA	(SN)	66.82	SQFT
	LOCATION		ON FUSELAGE	
TIP TANKS	VOLUME	(VFTP)	5.61	CUFT
	DIAMETER	(BXIS)	1.19	FT
	LENGTH	(AXIS)	9.50	FT
	WETTED AREA	(STIP)	54.66	SQFT

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GASP TURBOFAN SAMPLE USING SCALED TFE-731

VDIVE =  360. KTS   VMO =  300. KTS   MMO =  .806
ULT. LF =  5.59   MAN. LF =  2.50   GUST LF =  3.73

PROPULSION GROUP
   PRIMARY ENGINES           (WEP)       745.
   PRIMARY ENGINE INSTL.     (WPEI)      101.
   FUEL SYSTEM               (WFSS)       54.
   TOTAL PROP GROUP WT.      (WP)        899.

STRUCTURES GROUP
   WING                      (WW)        690.
   HOR. TAIL                 (WHT)       131.
   VERT. TAIL                (WVT)        78.
   FUSELAGE                  (WB)        830.
   LANDING GEAR              (WLG)       300.
   PRIMARY ENG. SECTION      (WPES)      162.
   TIP TANKS                 (WTIP)      103.
   GROUP WEIGHT INC.         (DELWST)      0.
   TOTAL STRUC.GROUP WT.     (WST)      2293.

FLIGHT CONTROLS GROUP
   COCKPIT CONTROLS          (WCC)        25.
   FIXED WING CONTROLS       (WCFW)       91.
   SAS                       (WSAS)        0.
   GROUP WEIGHT INC.         (DELWFC)      0.
   TOTAL CONTROL WT.         (WFC)       116.

WT. OF FIXED EQUIPMENT       (WFE)       860.

WEIGHT EMPTY                 (WE)       4168.

FIXED USEFUL LOAD            (WFUL)      340. (INC. CREW )

OPERATING WEIGHT EMPTY       (OWE)      4508.

PAYLOAD                      (WPL)       675. (PAX.VOL.=  5.    DESIGN PAX=  3.)

FUEL                         (WFA)      2317. (WFW= 1213.) (WFTP=  561.)

GROSS WEIGHT                 (WG)       7500.
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GASP TURBOFAN SAMPLE USING SCALED TFE-731

CRUISE MACH =  .700          CRUISE ALTITUDE =  40000.          CRUISE Q (PSF) =135 04

CRUISE RE.NUM. PER FT.    = 1.343E+06    FLATPLATE CF AT RE=10EX7 IS  .00277

AERODYNAMIC DATA

                       FLATPLATE                 WETTED
DRAG BREAKDOWN         AREA(SQFT)      CDO      AREA(SQFT)

     WING                1.0892      .00765       230 88
     FUSELAGE            1.5835      .01112       371.51
     VERT TAIL            .1469      .00103        37 98
     HOR  TAIL            .3295      .00231        84 78
     ENGINE NAC.          .3303      .00232        66 82
     TIP TANKS            .1658      .00116        54 66
     INCREMENTAL          .2137      .00150         0.00

         TOTAL           3.8588      .02709       846 62

         MEAN SKIN FRICTION COEF.=  .004558

AERODYNAMIC COEFF.
    A1                                             8081
    A2                                           - 1216
    A3                                             0343
    A4= .75X(T/C)                                  0833
    A5=CDO--                                       0171
    A6                                           2 7588
    A7=1/(PI SEE AR)                               0556
    3-D LIFT SLOPE AT CRUISE MACH    (CLALPH)    5 7109    PER RADIAN
    OSWALD FACTOR                    (SEE)         8026

CRUISE CD =  .0271 +   .0556 CL2  (ASSUMES MINIMUM WING PROFILE DRAG)

RETRACTABLE LANDING GEAR CD INC.=  .02828
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MISSION PERFORMANCE DATA FOLLOWS
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TAXI AT IDLE THRUST

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	FUEL FLOW (LB/HR)
0.000	0	0	7500	0.	244.
.083	0.	20.	7480.	0.	244.

VSTLKT= 99.8 KTS EAS VRAT= 1.100 CLTO= 1.2839
VEND = 231.2 KNOTS EAS

(TEMP.= 519. DEG.STD.= 0.)

TAKEOFF (ELEVATION= 0. FT)

TIME (SEC)	DIST. (FEET)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	ACCEL (FPS2)	CL	CD	ALPHA (DEG)	GAMMA (DEG)	ROC (FPM)	LOAD FACT	THRUST (LBS)	FUEL FLOW (LB/HR)	FUS. ANGLE (DEG)
0.0	0.0	20.3	7480.	0.0	0.0	0.0	0.000	13.81	.3946	.0743	1.00	0.00	0.0	0.00	3362.	1657.	0.00
1.0	6.9	20.8	7479.	0.0	8.1	8.1	.012	13.61	.3946	.0743	1.00	0.00	0.0	0.00	3318.	1656.	0.00
2.0	27.4	21.2	7479	0.0	16.2	16.2	.024	13.40	.3947	.0743	1.00	0.00	0.0	0.00	3274.	1655.	0.00
3.0	61.4	21.7	7478.	0.0	24.1	24.1	.036	13.18	.3947	.0743	1.00	0.00	0.0	0.00	3233.	1655.	0.00
4.0	108.6	22.1	7478	0.0	31.8	31.8	.048	12.94	.3948	.0743	1.00	0.00	0.0	0.00	3192.	1655.	0.00
5.0	168.8	22.6	7477.	0.0	39.4	39.5	.060	12.70	.3949	.0743	1.00	0.00	0.0	0.00	3153.	1655.	0.00
6.0	241.7	23.1	7477.	0.0	46.9	46.9	.071	12.45	.3949	.0744	1.00	0.00	0.0	0.00	3115.	1656.	0.00
7.0	327.2	23.5	7476	0.0	54.2	54.3	.082	12.19	.3951	.0744	1.00	0.00	0.0	0.00	3078.	1657.	0.00
8.0	424.9	24.0	7476.	0.0	61.4	61.4	.093	11.93	.3952	.0744	1.00	0.00	0.0	0.00	3043.	1658.	0.00
9.0	534.5	24.4	7476.	0.0	68.4	68.4	.103	11.66	.3953	.0744	1.00	0.00	0.0	0.00	3011.	1659.	0.00
10.0	655.9	24.9	7475.	0.0	75.3	75.3	.114	11.41	.3955	.0744	1.00	0.00	0.0	0.00	2985.	1659.	0.00
11.0	788.8	25.4	7475	0.0	82.0	82.0	.124	11.16	.3956	.0744	1.00	0.00	0.0	0.00	2960	1659.	0.00
12.0	932.8	25.8	7474	0.0	88.6	88.6	.134	10.90	.3958	.0744	1.00	0.00	0.0	0.00	2935	1659.	0.00
13.0	1087.9	26.3	7474.	0.0	95.0	95.0	.143	10.64	.3960	.0744	1.00	0.00	0.0	0.00	2912.	1659.	0.00
14.0	1253.6	26.7	7473.	0.0	101.2	101.3	.153	10.38	.3962	.0744	1.00	0.00	0.0	0.00	2890.	1660.	0.00
15.0	1429.7	27.2	7473.	0.0	107.3	107.4	.162	10.11	.3964	.0744	1.00	0.00	0.0	0.00	2868.	1661.	0.00
ROTATION (TIME= 15.4 AND TAS= 109.8 EAS= 109.8)																	
16.0	1616.0	27.7	7472	0.0	113.3	113.3	.171	9.83	.4939	.0768	2.08	0.00	0.0	.41	2848.	1662.	1.08
17.0	1812.2	28.1	7472	0.0	119.0	119.0	.180	9.41	.7475	.0864	4.89	0.00	0.0	.70	2828.	166[illegible].	3.89
LIFTOFF (TIME= 17.8 DIST= 1975.9 TAS= 123.4 EAS= 123.4)																	
18.0	2017.8	28.6	7471.	0.0	124.4	124.5	.189	8.70	1.0100	.1024	7.79	.02	4.3	1.04	2810.	1664.	6.81
19.0	2232.2	29.1	7471	1.3	129.4	129.4	.195	7.93	.9835	.1032	7.59	.74	170.1	1.09	2793.	1665.	7.34
20.0	2454.5	29.5	7470.	5.8	133.9	133.9	.202	7.09	.9206	.1052	7.19	1.53	362.2	1.09	2777.	1666.	7.72
21.0	2684.0	30.0	7470.	13.4	137.9	137.9	.208	6.36	.8657	.1052	6.79	2.28	557.0	1.09	2761.	1666.	8.08
22.0	2919.7	30.4	7470	24.4	141.5	141.5	.214	5.68	.8253	.1046	6.39	3.04	760.0	1.09	2746.	1665.	8.43
DISTANCE TO 35 FT.= 3103.2 TAS= 144.0 EAS= 144.0 V35/VS= 1.4420																	
23.0	3161.0	30.9	7469	38.7	144.8	144.7	.219	5.14	.7913	.1021	5.99	3.75	959.2	1.10	2733.	1664.	8.74
GEAR RETRACTION STARTED AT 23.7 SEC.COMPLETE AT 30.7 SEC																	
24.0	3407.4	31.4	7469	56.3	147.7	147.6	.223	4.71	.7586	.0979	5.59	4.44	1159.4	1.09	2720.	1664.	9.03
25.0	3658.4	31.8	7468	77.3	150.5	150.3	.227	4.40	.7342	.0918	5.29	5.12	1360.1	1.10	2708.	1663.	9.41
26.0	3913.5	32.3	7468	101.7	153.0	152.8	.231	4.12	.7098	.0858	4.99	5.79	1565.4	1.10	2696.	1662.	9.79
27.0	4172.5	32.8	7467.	129.5	155.4	155.2	.235	3.87	.6653	.0798	4.69	6.46	1772.0	1.09	2685.	1660.	10.15
28.0	4435.1	33.2	7467	160.8	157.7	157.4	.238	3.62	.6691	.0746	4.49	7.11	1977.2	1.10	2674.	1659.	10.60
29.0	4701.1	33.7	7466	195.4	159.8	159.4	.242	3.39	.6528	.0694	4.29	7.73	2179.9	1.10	2663	1657.	11.03
30.0	4970.0	34.1	7466	233.5	161.8	161.3	.245	3.20	.6365	.0642	4.09	8.36	2383.3	1.10	2652	1656.	11.45
31.0	5241.9	34.6	7465	274.9	163.7	163.1	.248	2.94	.6201	.0605	3.89	8.97	2587.8	1.09	2642	1654.	11.86
32.0	5516.2	35.1	7465	319.7	165.4	164.7	.250	2.55	.6038	.0594	3.69	9.59	2793.1	1.09	2632	1651	12.28
33.0	5792.6	35.5	7464	367.9	166.8	166.0	.252	2.15	.5956	.0589	3.59	10.19	2991.3	1.09	2622.	1649.	12.78
FLAP RETRACTION STARTED AT 33.6 SEC.COMPLETE AT 38.1 SEC																	
34.0	6070.7	36.0	7464	419.5	168.1	167.1	.254	1.79	.5876	.0581	3.69	10.78	3185.0	1.09	2614	1646.	13.47
35.0	6350.1	36.4	7464	474.2	169.1	167.9	.256	1.44	.5804	.0571	4.14	11.39	3383.9	1.10	2605.	1644.	14.53

VSTLKT= 99.8 KTS EAS   VRAT= 1.100 CLTO= 1.2839

ENGINE OUT PERFORMANCE FOLLOWS
VENO = 231.2 KNOTS EAS

(TEMP. = 519. DEG STD. + 0.)

TAKEOFF (ELEVATION= 0. FT)

TIME (SEC)	DIST (FEET)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO	ACCEL (FPS2)	CL	CD	ALPHA (DEG)	GAMMA (DEG)	ROC (FPM)	LOAD FACT	THRUST (LBS)	FUEL FLOW (LB/HR)	FUS ANGLE (DEG)
0.0	0.0	20.3	7480.	0.0	0.0	0.0	0.000	13.81	.3946	.0743	1.00	0.00	0.0	0.00	3362.	1657.	0.00
1.0	6.9	20.8	7479.	0.0	8.1	8.1	.012	13.61	.3946	.0743	1.00	0.00	0.0	0.00	3318.	1656.	0.00
2.0	27.4	21.2	7479.	0.0	16.2	16.2	.024	13.40	.3947	.0743	1.00	0.00	0.0	0.00	3274.	1655.	0.00
3.0	61.4	21.7	7478.	0.0	24.1	24.1	.036	13.18	.3947	.0743	1.00	0.00	0.0	0.00	3233.	1655.	0.00
4.0	108.6	22.1	7478.	0.0	31.8	31.8	.048	12.94	.3948	.0743	1.00	0.00	0.0	0.00	3192.	1655.	0.00
5.0	168.8	22.6	7477.	0.0	39.4	39.5	.060	12.70	.3949	.0743	1.00	0.00	0.0	0.00	3153.	1655.	0.00
6.0	241.7	23.1	7477.	0.0	46.9	46.9	.071	12.45	.3949	.0744	1.00	0.00	0.0	0.00	3115.	1656.	0.00
7.0	327.2	23.5	7476.	0.0	54.2	54.3	.082	12.19	.3951	.0744	1.00	0.00	0.0	0.00	3078.	1657.	0.00
8.0	424.9	24.0	7476.	0.0	61.4	61.4	.093	11.93	.3952	.0744	1.00	0.00	0.0	0.00	3043.	1658.	0.00
9.0	534.5	24.4	7476.	0.0	68.4	68.4	.103	11.66	.3953	.0744	1.00	0.00	0.0	0.00	3011.	1659.	0.00
10.0	655.9	24.9	7475.	0.0	75.3	75.3	.114	11.41	.3955	.0744	1.00	0.00	0.0	0.00	2985.	1659.	0.00
11.0	788.8	25.4	7475.	0.0	82.0	82.0	.124	11.16	.3956	.0744	1.00	0.00	0.0	0.00	2960.	1659.	0.00
12.0	932.8	25.8	7474.	0.0	88.6	88.6	.134	10.90	.3958	.0744	1.00	0.00	0.0	0.00	2935.	1659.	0.00
13.0	1087.9	26.3	7474.	0.0	95.0	95.0	.143	10.64	.3960	.0744	1.00	0.00	0.0	0.00	2912.	1659.	0.00
14.0	1253.6	26.7	7473.	0.0	101.2	101.3	.153	10.38	.3962	.0744	1.00	0.00	0.0	0.00	2890.	1660.	0.00
ENGINE FAILURE (TIME= 14.6 AND TAS= 104.8 EAS= 104.8)																	
15.0	1429.7	27.1	7473.	0.0	107.0	107.1	.162	3.95	.3964	.0744	1.00	0.00	0.0	0.00	1435.	830.	0.00
16.0	1612.3	27.3	7473.	0.0	109.3	109.3	.165	3.86	.3966	.0744	1.00	0.00	0.0	0.00	1431.	831.	0.00
ROTATION (TIME= 16.2 AND TAS= 109.8 EAS= 109.8)																	
17.0	1798.8	27.6	7472.	0.0	111.6	111.6	.168	3.75	.5408	.0782	2.60	0.00	0.0	.44	1427.	831.	1.60
18.0	1989.0	27.8	7472.	0.0	113.7	113.8	.172	3.51	.7944	.0888	5.42	0.00	0.0	.67	1423.	831.	4.42
19.0	2182.8	28.0	7472.	0.0	115.7	115.7	.175	3.09	1.0479	.1052	8.23	0.00	0.0	.93	1420.	831.	7.23
LIFTOFF (TIME= 19.2 DIST= 2222.0 TAS= 116.1 EAS= 116.1)																	
20.0	2379.7	28.3	7472.	.4	117.3	117.4	.177	2.34	1.2011	.1210	9.95	.40	83.0	1.09	1417.	831.	9.35
21.0	2578.8	28.5	7471.	3.3	118.5	118.5	.179	1.56	1.1818	.1283	10.05	1.29	269.8	1.10	1415.	831.	10.34
22.0	2779.5	28.7	7471.	9.4	119.2	119.2	.180	.78	1.1625	.1363	10.25	2.16	455.2	1.10	1413.	831.	11.41
23.0	2980.9	29.0	7471.	18.6	119.4	119.4	.180	.11	1.1516	.1416	10.35	3.04	642.2	1.09	1412.	831.	12.39
24.0	3182.3	29.2	7471.	30.4	119.5	119.4	.180	.03	1.0806	.1343	9.55	3.56	752.5	1.03	1412.	831.	12.11
DISTANCE TO 35 FT = 3255.9 TAS= 119.5 EAS= 119.4 V35/VS= 1.1961																	
25.0	3383.6	29.4	7471.	43.2	119.5	119.4	.180	.01	1.0634	.1320	9.35	3.72	785.4	1.01	1411.	830.	12.07

ACCELERATE - STOP DISTANCE = 3406.5 FEET

ENGINE OUT DISTANCE TO 35 FT. = 3255.9 FEET

ALL ENGINE DISTANCE TO 35 FT (L) = 3103.2 FEET
FAR 25 T.O. DISTANCE (1.15XL) = 3568.6 FEET
ALL ENGINE DISTANCE TO 50 FT = 3323.3 FEET

AT END OF TAKEOFF PHASE
TIME= .093 HRS FUEL USED= 37. LBS WEIGHT= 7463 LBS ALT.= 500 FT.

ACCELERATE TO MACH NO = .353

TIME	RANGE	FUEL USED	WEIGHT	ALT.	TAS	EAS	MACH	MACH	THRUST	FUEL FLOW

ORIGINAL PAGE IS OF POOR QUALITY

(HRS)	(NM)	(LBS)	(LBS)	(FT)	(KTS)	(KTS)	NO.	DIV	(LBS)	(LB/HR)
.093	0.00	36.6	7463.	500.	169.	168.	.257	742	2601.	1642
.097	.78	42.9	7457.	500.	233.	231.	.353	.772	2431.	1653.

END OF ACCELERATION SEGMENT
TIME= .097 HRS FUEL USED= 42 9 LBS WEIGHT= 7457. LBS RANGE= 1 NM

CLIMB TO 40000. FT. AT MAXIMUM RATE OF CLIMB

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO	MACH DIV	CL	CD	ALPHA (DEG)	GAMMA (DEG)	FUS ANGLE (DEG)	R/C (FPM)	THRUST (LBS)	FUEL FLOW (LB/HR)
097	1.	43.	7457.	500.	233.	231	352	774	2814	0317	2 14	12 90	14 03	5268.	2482.	1688.
099	1.	46.	7454.	1000.	235.	231.	356	774	.2823	0317	2 14	12 05	13 19	4962.	2484.	1688.
.102	2.	51.	7449.	2000.	238.	231.	362	774	2821	.0316	2 14	12 04	13 18	5034.	2486.	1688.
.105	3.	57.	7443.	3000.	242.	231.	.369	774	2819	.0316	2 13	11 99	13 12	5088.	2482.	1685.
.108	3.	62.	7438.	4000.	245.	231.	376	774	2819	.0316	2 12	11 82	12 94	5091.	2461.	1677.
.112	4.	68.	7432.	5000.	244.	227.	375	773	2927	.0320	2 25	11 98	13 23	5138.	2302.	1558.
.115	5.	73.	7427.	6000.	246.	225.	379	772	2988	0322	2 32	11 05	12 37	4773.	2257.	1529.
.118	6.	78.	7422.	7000.	247.	223.	383	.771	.3043	0324	2 38	10 79	12 17	4689.	2212.	1499.
.122	7.	84.	7416.	8000.	249.	221.	386	770	.3101	0326	2 44	10 52	11 96	4602.	2167.	1469.
.126	8.	89.	7411.	9000.	250.	219.	390	770	3160	0328	2 51	10 25	11 76	4514	2122.	1439.
.129	9.	94.	7406.	10000.	252	217.	.394	769	3220	0331	2 57	9 98	11 56	4424.	2077.	1410.
.133	9.	100.	7400.	11000.	253.	214.	.398	768	3279	0333	2 64	10 06	11 70	4485.	2033.	1380.
.137	10.	105.	7395.	12000.	255.	212.	402	767	.3347	0336	2 71	9 45	11 16	4242.	1989.	1351.
.141	11.	110.	7390.	13000.	256.	210	406	767	3413	0338	2 78	9 19	10 97	4149	1945.	1321.
.145	12.	115.	7385.	14000.	258	208	.410	766	3481	0341	2 86	8 92	10 78	4055.	1901.	1292.
.149	13.	121.	7379.	15000.	260.	206	414	765	.3551	0344	2 93	8 65	10 59	3960.	1858.	1263.
.153	15.	126.	7374.	16000.	261.	204	418	764	3623	0347	3 01	8 39	10 40	3864	1815.	1234.
.157	16.	131.	7369.	17000.	263.	202.	.423	763	.3697	0350	3 09	8 13	10 22	3767.	1772.	1206.
.162	17.	137.	7363.	18000.	265	200.	427	762	3773	0353	3 17	7 86	10 04	3669.	1729.	1177.
.166	18.	142.	7358.	19000.	266.	198	431	761	3851	0357	3 26	7 60	9 86	3570.	1687.	1149.
.171	19.	147.	7353.	20000.	273.	199	443	.762	3810	0354	3 19	6 50	8 70	3129.	1638.	1123.
.176	21.	153.	7347.	21000.	274.	197	.448	761	3889	0358	3 28	6 92	9 19	3345.	1591.	1094.
.181	22.	159.	7341.	22000.	277.	195	453	760	3955	0361	3 34	6 48	8 82	3164.	1544.	1067.
.187	23.	164.	7336.	23000.	279.	194	.460	759	.4010	0364	3 39	6 11	8 50	3014.	1498.	1040.
.192	25.	170.	7330.	24000.	282.	192	.466	.759	4077	0367	3 46	5 88	8 34	2925.	1453.	1013.
.198	27.	176.	7324.	25000.	284.	191	471	758	4155	0371	3 54	5 63	8 17	2826.	1410	986.
.204	28.	182.	7318.	26000.	286.	189	477	.757	4244	0375	3 63	5 40	8 03	2728.	1367.	959.
.210	30.	188.	7312.	27000.	288.	187	482	755	4335	0380	3 72	5 13	7 85	2609	1326.	933.
.216	32.	193.	7307.	28000.	290.	185.	488	.754	4427	0385	3 82	4 86	7 68	2492.	1285.	908.
.223	34.	200.	7300.	29000.	292.	183.	.493	753	4521	0390	3 91	4 60	7 51	2375	1245.	882.
.230	36.	206.	7294.	30000.	295.	181	499	752	4616	0395	4 01	4 34	7 35	2260.	1207.	857.
.237	38.	212.	7288.	31000.	297.	179.	505	751	4713	0400	4 10	4 09	7 19	2146.	1169.	833.
.245	40.	219.	7281.	32000.	301.	178	516	751	4740	0402	4 11	3 61	6 71	1922.	1131.	810.
.254	43.	226.	7274.	33000.	310.	180	533	752	4647	0397	3 96	2 98	5 94	1633.	1088.	788.
.264	46.	234.	7266.	34000.	313.	178.	539	750	4744	0402	4 05	3 20	6 25	1767.	1048.	764.
.273	49.	241.	7259.	35000.	315	176	546	749	4843	0408	4 15	2 93	6 08	1635	1009.	739.
.284	52.	248.	7252.	36000.	318.	174	554	748	4943	0414	4 24	2 68	5 92	1507.	971.	716.
.295	56.	256.	7244.	37000.	320.	171.	558	746	5103	0423	4 40	2 44	5 84	1380.	927.	685.
.307	60.	265.	7235.	38000.	322.	168.	.562	.744	5275	0434	4 58	2 16	5 73	1230.	884.	654.
.320	64.	273.	7227.	39000.	325.	166.	566	.742	5448	0444	4 75	1 88	5 64	1080.	842.	624.
.336	69.	283.	7217.	40000.	327.	163.	.570	.740	5622	0456	4 93	1 62	5 55	935.	803.	598.

END OF CLIMB TO 40000 FT
TIME= .336 HRS FUEL USED= 283. LBS WEIGHT= 7217. LBS RANGE= 69 NM

ALTITUDE= 40000. FT TAS= 438.79 KTS MACH NO= .7643

ACCELERATE TO MACH NO. = .700

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.336	68.99	283.0	7217.	40000.	327.	163.	.570	.739	823	621
.375	83.94	309.0	7191.	40000.	402.	200.	.700	.762	838	664

END OF ACCELERATION SEGMENT
TIME= .375 HRS FUEL USED= 309.0 LBS WEIGHT= 7191. LBS RANGE= 84 NM

ACCELERATE TO MACH NO. = .764

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.336	68.99	283.0	7217.	40000.	327.	163.	.570	.739	823	621
.402	96.07	328.2	7172.	40000.	439.	218.	.764	.770	848	689

END OF ACCELERATION SEGMENT
TIME= .402 HRS FUEL USED= 328.2 LBS WEIGHT= 7172 LBS RANGE= 96. NM

ACCELERATE TO MACH NO. = .642

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.336	68.99	283.0	7217.	40000.	327.	163.	.570	.739	823	621
.354	75.52	294.8	7205.	40000.	369.	184.	.642	.753	829	643

END OF ACCELERATION SEGMENT
TIME= .354 HRS FUEL USED= 294.8 LBS WEIGHT= 7205 LBS RANGE= 76 NM

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
**** MAXIMUM PAYLOAD *****
FUEL AVAILABLE= 1992

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC. RANGE START CRUISE	AT BEST SPEC. RANGE END CRUISE
TIME	HRS.	.375	3 008	402	2 557	354	3 413
RANGE	N.MI	84.	1142.	96.	1041.	76	1204.
FUEL USED	LBS.	309.	1607	328	1552	295	1643.
WEIGHT	LBS.	7191.	5893.	7172	5948	7205	5857.
ALTITUDE	FT.	40000	40000	40000.	40000	40000	40000
TAS	KTS.	401 9	401 9	438 8	438 8	368 8	368 8
EAS	KTS.	199 8	199 8	218.1	218 1	183 3	183.3
MACH NO.		.7000	.7000	.7643	.7643	6424	5424
DIV. MACH		.7626	.7708	.7701	.7766	7540	7641
ANGLE ATTACK	DEG.	2 556	1 978	1.770	1.264	3 456	2 585
FUSE. ANGLE	DEG.	1 556	878	.770	.264	2 456	1 585
CL		.3743	.3068	3132	2597	4454	3620
L/D		10 637	9 432	9 700	8 514	11 388	10 305
FUEL FLOW	LB/HR	513 0	474 3	586 4	551 5	464 5	418 4
BREG FACTOR	N MI.	5637	4997.	5370	4736	5724	5166.
SPEC RANGE	NM/LB	.78342	.84735	.74834	.79565	.79394	88144
RESERVE FUEL(LBS) (45.0 MIN.)		385.		440.		348	

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ACCELERATE TO MACH NO. = .700

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.336	68 99	283.0	7217.	40000.	327.	163.	.570	.739	823	621.
.375	83 96	309.1	7191.	40000.	402.	200.	.700	.762	838	664

END OF ACCELERATION SEGMENT
TIME= .375 HRS FUEL USED= 309.1 LBS WEIGHT= 7191. LBS RANGE= 84. NM

ACCELERATE TO MACH NO. = .764

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FUEL FLOW (LB/HR)
.336	68 99	283.0	7217.	40000	327.	163.	.570	.739	823	621.
.402	96 07	328 2	7172.	40000.	439	218.	.764	.770	848	689

END OF ACCELERATION SEGMENT
TIME= 402 HRS FUEL USED= 328 2 LBS WEIGHT= 7172 LBS RANGE= 96. NM

ACCELERATE TO MACH NO. = .642

FUEL FUEL

TIME (HRS)	RANGE (NM)	USED (LBS)	WEIGHT (LBS)	ALT. (FT)	TAS (KTS)	EAS (KTS)	MACH NO.	MACH DIV	THRUST (LBS)	FLOW (LB/HR)
.336	68.99	283.0	7217.	40000.	327.	163.	.570	.739	823	621.
.354	75.52	294.8	7205.	40000.	369.	184.	.642	.753	829	643.

END OF ACCELERATION SEGMENT
TIME= .354 HRS FUEL USED= 294.8 LBS WEIGHT= 7205. LBS RANGE= 76. NM

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
****** MAXIMUM FUEL ******
FUEL AVAILABLE= 2317

		AT SPECIFIED SPEED START CRUISE	END CRUISE	AT NORMAL POWER START CRUISE	END CRUISE	AT BEST SPEC RANGE START CRUISE	END CRUISE
TIME	HRS.	.375.	3 698	.402	3 148	.354	4 194
RANGE	N MI	84.	1420	96	1301	76	1492
FUEL USED	LBS.	309.	1932	328	1877	295	1968
WEIGHT	LBS.	7191	5568	7172	5623	7205	5532
ALTITUDE	FT	40000	40000	40000	40000	40000	40000
TAS	KTS	401 9	401 9	438 8	438 8	368 8	368 8
EAS	KTS.	199 8	199 8	218 1	218 1	183 3	193 3
MACH NO		.7000	.7000	.7643	.7643	.6424	.6424
DIV MACH		.7626	.7729	.7701	.7783	.7540	.7666
ANGLE ATTACK	DEG.	2 556	1 708	1 770	1 129	3 456	2 375
FUSE ANGLE	DEG.	1 556	.708	.770	.129	2 456	1 375
CL		.3743	.2899	.3132	.2455	.4454	.3419
L/D		10 637	9 076	9 700	8 161	11 388	9 966
FUEL FLOW	LB/HR	513 0	465 8	586 4	544 4	464 5	408 9
BREG FACTOR	N MI	5637	4807.	5370	4535	5724	4993
SPEC RANGE	NM/LB	.78342	.86272	.74834	.80603	.79394	.90199

RESERVE FUEL(LBS) 385. 440. 348
(45 0 MIN.)

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RANGE = 1301. BLOCK TIME= 3 148 USED FOR DESIGN RANGE AND COST

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TEMP = 518 DEG STD = 0
LANDING ELEVATION= C. FT
LANDING WING LOADING= 52 65 PSF.
LANDING WEIGHT = 7500 LBS.

LANDING DISTANCE FROM 50 FT = 2459. FT.

F A R FACTORED FIELD LENGTH = 4098. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	609	DIST=	237	DIST=	180	DIST=	1433
R/S=	1000	XLFMX=	1 150	TDELAY=	1 00	MUB=	.4000
VAPEAS=	120 50	SINKTD=	3 000	TIDLE=	.165	TR/TIDLE=	0 0000
VAPTAS=	120 58	VSTEAS=	92 70	VTDTAS=	106 67	ABARIG(=	.3521
THETA=	4 69	CLMX=	1 8064				
THRUST=	433	HFLAR=	27 9				

****
ITERATION TO BALANCE RANGE
RANGE ERROR, RANG. ERROR MINUS 1 .0841 1 0000
GROSS WGT, GROSS WGT MINUS1 5625 0 7500 0

144

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FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)

	CLMAX	VSTALL,KTS	FLAP ANGLE	LE ANGLE	DELTA CL	DELTA CD
FLAPS UP	1.3486	107.4	0.0	0.0	0.0000	0.0000
T.O. CONFIG	1.5344	100.8	15.0	0.0	.1949	.0153
LDG. CONFIG	1.7847	93.5	40.0	0.0	.4551	.0474

	PLAIN FLAPS OPT ANGLE	DELCL AT OPT	DELCD AT OPT	AREA(FT2)	WEIGHT(LB)
FLAPS	60.0	.9000	.1200	21.0	36.8

****

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
ANGLE OF ATTACK(DEGREES)= 2.717 LIFT= 5625.0 L/D= 9.857 ALTITUDE= 40000.0 MACH= .7000

VSTLKT= 100.4 KTS EAS VRAT= 1.100 CLTO= 1.2736
VEND = 223.5 KNOTS EAS

ROTATION (TIME= 14.7 AND TAS= 110.3 EAS= 110.4)
LIFTOFF (TIME= 17.2 DIST= 1938.7 TAS= 125.0 EAS= 125.0)
DISTANCE TO 35 FT.= 3039.5 TAS= 145.5 EAS= 145.5 V35/VS= 1.4491

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T.O. FLAPS-LD GEAR EXT - ONE ENG OUT	0	115.7	757.49	1.00	1.17	7.41
SEC SEG. T.O. FLAPS - ONE ENGINE OUT	250	121.3	1132.80	294.59	1.07	9.58
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500	137.7	1457.35	167.26	.86	11.02
APPROACH FLAPS - ONE ENG OUT	0	154.2	1400.51	327.66	.66	9.99
LANDING FLAPS - ALL ENGINES	0	121.4	3080.26	393.12	1.06	6.86

APPROACH FLAP SETTING = 11.0 DEG.

*** ENGINE-OUT SERVICE CEILING = 29548.9 FT.
BEST RATE OF CLIMB SPEED = 234.0 KTAS
ENGINE-OUT RATE OF CLIMB = 99.8 FPM
WEIGHT AT ALTITUDE = 5400.0 LBS

****RESIZE ENGINES AT CRUISE TO ACCOUNT FOR RESIZED NACELLES****

PROPULSION SYSTEM WEIGHTS

ENGINE WEIGHT/ENGINE		294.4
NACELLE WEIGHT/ENGINE		60.4
PYLON WEIGHT/ENGINE		3.8
PROP OR OFAN	0.0	
GEARBOX	0.0	
SHROUD	0.0	

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ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)        1.75
  NACELLE LENGTH(FT)              4.80

VSTLKT= 100.4 KTS EAS   VRAT= 1.100 CLTO= 1.2736
     VEND =  223.0 KNOTS EAS

ROTATION (TIME=   14.0 AND TAS=   110.3 EAS=   110.4)
LIFTOFF (TIME:   16.4 DIST=   1847.6 TAS=   125.0 EAS=   125.1)
DISTANCE TO 35 FT.=  2979.5   TAS=   147.4 EAS=   147.4 V35/VS=  1.4684

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
  AIRPORT ALTITUDE=      0. FT.   AMBIENT TEMP ABOVE STD. DAY=.    0.0 DEG F
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CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG.T.O. FLAPS&LD GEAR EXT - ONE ENG OUT	0	115.7	844.27	1.00	1.17	7.33
SEC SEG. T.O. FLAPS - ONE ENGINE OUT	250	121.3	1220.38	294.59	1.07	9.43
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500	137.7	1550.15	167.26	.86	10.77
APPROACH FLAPS - ONE ENG OUT	0	154.2	1490.32	327.66	.66	9.72
LANDING FLAPS - ALL ENGINES	0.	121.4	3278.23	393.12	1.06	6.78

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APPROACH FLAP SETTING = 11.0 DEG.

*** ENGINE-OUT SERVICE CEILING = 30002.8 FT.
    BEST RATE OF CLIMB SPEED    =   234.5 KTAS
    ENGINE-OUT RATE OF CLIMB    =    99.6 FPM
    WEIGHT AT ALTITUDE          =  5400.0 LBS
ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW=     44.84

ENGINE SIZED TO MATCH T.O. DISTANCE OF   3100  FT (STD DAY=   0. DEG R.ALT=     0.) SLS AIRFLOW=    44.84

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE=    1389.0 LBS
*****************************************************************************************

PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE            307.7
  NACELLE WEIGHT/ENGINE            60.4
  PYLON WEIGHT/ENGINE               3.9
     PROP OR OFAN          0.0
     GEARBOX               0.0
     SHROUD                0.0

ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)        1.75
  NACELLE LENGTH(FT)              4.80

VSTLKT= 100.4 KTS EAS   VRAT= 1.100 CLTO= 1.2736
     VEND =  223.0 KNOTS EAS
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ROTATION (TIME= 13.8 AND TAS= 110.3 EAS= 110.4)
LIFTOFF (TIME= 16.2 DIST= 1835.0 TAS= 125.7 EAS= 125.7)
DISTANCE TO 35 FT.= 2956.0 TAS= 148.2 EAS= 148.2 V35/VS= 1.4763

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T.O. FLAPS-LD GEAR EXT - ONE ENG OUT	0.	115.7	886.51	1.00	1.17	7.33
SEC SEG T.O. FLAPS - ONE ENGINE OUT	250.	121.3	1262.40	294.59	1.07	9.41
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500.	137.7	1594.09	167.26	.86	10.72
APPROACH FLAPS - ONE ENG OUT	0.	154.2	1530.41	327.66	.66	9.63
LANDING FLAPS - ALL ENGINES	0.	121.4	3363.32	393.12	1.06	6.76

APPROACH FLAP SETTING = 11.0 DEG.

*** ENGINE-OUT SERVICE CEILING = 30270.2 FT.
BEST RATE OF CLIMB SPEED = 233.1 KTAS
ENGINE-OUT RATE OF CLIMB = 99.6 FPM
WEIGHT AT ALTITUDE = 5400.0 LBS

****RESIZE ENGINES AT CRUISE TO ACCOUNT FOR RESIZED NACELLES****

PROPULSION SYSTEM WEIGHTS
ENGINE WEIGHT/ENGINE 313.1
NACELLE WEIGHT/ENGINE 64.2
PYLON WEIGHT/ENGINE 3.9
PROP OR OFAN 0.0
GEARBOX 0.0
SHROUD 0.0

ENGINE POD DIMENSIONS
ENGINE FACE DIAMETER(FT) 1.81
NACELLE LENGTH(FT) 4.95

VSTLKT= 100.4 KTS EAS VRAT= 1.100 CLTO= 1.2736
VEND = 223.0 KNOTS EAS

ROTATION (TIME= 13.7 AND TAS= 110.3 EAS= 110.4)
LIFTOFF (TIME= 16.0 DIST= 1798.4 TAS= 124.8 EAS= 124.9)
DISTANCE TO 35 FT.= 2957.7 TAS= 148.5 EAS= 148.5 V35/VS= 1.4790

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T.O. FLAPS-LD GEAR EXT - ONE ENG OUT	0	115.7	893.35	1.00	1.17	7.32
SEC SEG T.O. FLAPS - ONE ENGINE OUT	250.	121.3	1269.30	294.59	1.07	9.40
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500.	137.7	1601.40	167.26	.86	10.70
APPROACH FLAPS - ONE ENG OUT	0	154.2	1537.49	327.66	.66	9.61

LANDING FLAPS - ALL ENGINES 0. 121.4 3378 92 393 12 1.06 6.76

APPROACH FLAP SETTING = 11.0 DEG.

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*** ENGINE-OUT SERVICE CEILING = 30304.5 FT.
    BEST RATE OF CLIMB SPEED   =   232.9 KTAS
    ENGINE-OUT RATE OF CLIMB   =    99.6 FPM
    WEIGHT AT ALTITUDE         =  5400.0 LBS
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ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW= 45.78

ENGINE SIZED TO MATCH T.O. DISTANCE OF 3100. FT (STD DAY+ 0. DEG R.ALT= 0.1 SLS AIRFLOW= 45.78

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE= 1418 1 LBS

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PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE              314.1
  NACELLE WEIGHT/ENGINE              64 2
  PYLON WEIGHT/ENGINE                 3.9
     PROP OR QFAN            0.0
     GEARBOX                 0.0
     SHROUD                  0.0

ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)          1.81
  NACELLE LENGTH(FT)                4.95
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---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	3959.92	17.13	3959.92	17.13	3959 92	17.13
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	157.11	17.58	785 53	17.58	785 53	17 58
TIP FUEL	0 00	18 16	204 56	18 16	204 56	18 16
FUS FUEL	0 00	17 58	0 00	17 58	0 00	17 58
TOTAL	4967 02	16.36	5115 00	17 26	5625 00	16 64

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	.0759	9500		3904	4634		0058			0 0000		
LIFTOFF	1 0000	0811	0659	9500	1875	3909	5694	0 0000	0058	0 0000	- 1031		0 0000	-1
LANDING	13 7080	.0812	0660	9500	2 5708	1 7847	5688	5870	0058	.0060	- 2000		0.0000	-1

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ELEVATOR PARAMETERS
    CHALPHA(FLOATING TENDENCY)    =  - 00511        WING DE/DALPHA =   37507
    CHDELTA(RESTORING TENDENCY)   =  - 01204
    CMDELTA(CONTROL POWER)        =  -.03551
    TAUH(EFFECTIVENESS)           =   .48250
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	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	.2027	16 896	STATIC STABILITY AND TRIM	32 4725
STATIC MARGIN	.0300		STABILITY AND LIFTOFF	28 3656
AFT CG LIMIT(STABILITY)	.1727	16 774	LIFTOFF	27 6133
CG RANGE(LOADING)	.2223		REQUIRED TAIL SIZE	32 4725
FWD CG LIMIT(CONTROL)	-.0496	15 874	TAIL ARM(ELTH)	15 6501

VERTICAL TAIL AREA = 16.1853 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 14.8489 FOR MINIMUM CONTROL SPEED = 99 58 KTS

REQUIRED VERTICAL TAIL AREA = 16.1853 TAIL ARM(ELTV) = 14 0734

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---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	MOST FWD LOAD CG	MOST AFT LOAD WT	MOST AFT LOAD CG	DESIGN LOAD WT	DESIGN LOAD CG
A/C OWE	3892 97	16 80	3892.97	16 80	3892 97	16 80
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17.73	165 00	17.73	165 00	17 73
WING FUEL	157 11	17 29	785 53	17 29	785 53	17 29
TIP FUEL	0 00	17.65	271 50	17 65	271 50	17 65
FUS FUEL	0 00	17 29	0 00	17 29	00	17 29
TOTAL	4900 08	16 08	5115 00	16.95	5625 00	16 35

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT	
CRUISE	2 7170	0997	0759	9500		3904	4784		0046			0 0000			-1
LIFTOFF	1 0000	0811	0659	9500	2008	3909	5879	0 0000	0046	0 0000	- 1031		0 0000		-1
LANDING	13 7080	.0812	.0660	.9500	2.7520	1.7847	5872	6060	0046	0047	- 2000		0 0000		

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY)	=	- 00511
CHDELTA(RESTORING TENDENCY)	=	- 01204
CMDELTA(CONTROL POWER)	=	- 03604
TAUH(EFFECTIVENESS)	=	.48250

WING DE/DALPHA = 40151

	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	.1772	16 995	STATIC STABILITY AND TRIM	33 0877
STATIC MARGIN	.0300		STABILITY AND LIFTOFF	28 7188
AFT CG LIMIT(STABILITY)	.1472	16 874	LIFTOFF	27 9531
CG RANGE(LOADING)	.2155		REQUIRED TAIL SIZE	33 0877
FWD CG LIMIT(CONTROL)	-.0683	16 001	TAIL ARM(ELTH)	15 5908

VERTICAL TAIL AREA = 15.9840 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 14.5496 FOR MINIMUM CONTROL SPEED = 99 58 KTS

REQUIRED VERTICAL TAIL AREA = 15.9840 TAIL ARM(ELTV) = 14 3629

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---AIRCRAFT C G SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	3893.27	16.83	3893.27	16.83	3893.27	16.83
PAX	850.00		0.00		510.00	
BAGGAGE	0.00	17.73	165.00	17.73	165.00	17.73
WING FUEL	0.00	17.49	785.53	17.49	785.53	17.49
TIP FUEL	157.11	17.37	271.21	17.37	271.21	17.37
FUS FUEL	0.00	17.49	0.00	17.49	0.00	17.49
TOTAL	4900.37	16.11	5115.00	16.99	5625.00	16.39

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2.7170	.0997	.0759	.9500		.3904	.4862		.0040			0.0000		
LIFTOFF	1.0000	.0811	.0659	.9500	.2014	.3909	.5974	0.0000	.0040	0.0000	-.1031		0.0000	-1
LANDING	13.7080	.0812	.0660	.9500	2.7607	1.7847	.5968	.6158	.0040	.0042	-.2000		0.0000	-1

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY) = -.00511

CHDELTA(RESTORING TENDENCY) = -.01204

CHDELTA(CONTROL POWER) = -.03645

TAUH(EFFECTIVENESS) = .48250

WING DE/DALPHA = .40279

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	.1737	17.086
STATIC MARGIN	.0300	
AFT CG LIMIT(STABILITY)	.1437	16.965
CG RANGE(LOADING)	.2186	
FWD CG LIMIT(CONTROL)	-.0749	16.079

HORIZONTAL TAIL SIZES	
STATIC STABILITY AND TRIM	33.6191
STABILITY AND LIFTOFF	28.9883
LIFTOFF	28.1786
REQUIRED TAIL SIZE	33.6191
TAIL ARM(ELTH)	15.5167

VERTICAL TAIL AREA = 16.1450 FOR DIRECTIONAL STABILITY OF -.00200

VERTICAL TAIL AREA= 14.6367 FOR MINIMUM CONTROL SPEED = 99.58 KTS

REQUIRED VERTICAL TAIL AREA = 16.1450 TAIL ARM(ELTV) = 14.2774

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---AIRCRAFT C.G. SUMMARY (DATUM-NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	3898.42	16.86	3898.42	16.86	3898.42	16.86
PAX	850.00		0.00		510.00	
BAGGAGE	0.00	17.73	165.00	17.73	165.00	17.73
WING FUEL	0.00	17.60	785.53	17.60	785.53	17.60
TIP FUEL	157.11	17.45	266.05	17.45	266.05	17.45
FUS FUEL	0.00	17.60	0.00	17.60	.00	17.60
TOTAL	4905.53	16.13	5115.00	17.03	5625.00	16.43

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2.7170	.0997	.0759	.9500		.3904	.4898		.0038			0.0000		
LIFTOFF	1.0000	.0811	.0659	.9500	.2015	.3909	.6019	0.0000	.0038	0.0000	-.1031		0.0000	-1
LANDING	13.7080	.0812	.0660	.9500	2.7620	1.7847	.6012	.6204	.0038	.0039	-.2000		0.0000	-1

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ELEVATOR PARAMETERS
    CHALPHA(FLOATING TENDENCY)   =  -.00511        WING DE/DALPHA =   .40297
    CHDELTA(RESTORING TENDENCY)  =  -.01204
    CMDELTA(CONTROL POWER)       =  -.03680
    TAUH(EFFECTIVENESS)          =   .48250

                          FRACTION   STATION     HORIZONTAL TAIL SIZES
                            MAC     (DATUM NOSE)
NEUTRAL POINT              .1742     17 137         STATIC STABILITY AND TRIM     34 0460
STATIC MARGIN               0300                    STABILITY AND LIFTOFF         29 1627
AFT CG LIMIT(STABILITY)     1442     17 016         LIFTOFF                       28 3090
CG RANGE(LOADING)          .2224                    REQUIRED TAIL SIZE            34 0460
FWD CG LIMIT(CONTROL)     -.0782     16 114         TAIL ARM(ELTH)                15 4712

VERTICAL TAIL AREA =   16.2383 FOR DIRECTIONAL STABILITY OF    -.00200

VERTICAL TAIL AREA=   14.6937 FOR MINIMUM CONTROL SPEED =   . 99 58 KTS

REQUIRED VERTICAL TAIL AREA =   16 2383  TAIL ARM(ELTV) =   14 2220

**************************************************************************************

 WING LOCATION INFO.
FUSELAGE LENGTH       =   32 10      H-TAIL VOL  ARM        =   15 47      C G LOCATION OF PROPULSION=   20.87
WING 1/4C LOC ON C L.=    15 82      H-TAIL C G LOCATION    =   32 72      C G OF REMAINING WEIGHT   =   13.80
MAC 1/4C LOCATION     =   17 44      H-TAIL MAC FROM C L    =    2 66
MAC DIST FROM C L     =    6 08      H-TAIL LOCAT ON VERT   =     50
WING C G LOCATION     =   17 85      V-TAIL VOL  ARM        =   14 22
TIP TANKS C G LOCATE  =   17 45      V-TAIL C G LOCATION    =   31 47

                        WING        H-TAIL       V-TAIL

  AREA                106 846       34 046       16 238
  SPAN                 27 348       12 029        5 699
  ASPECT RATIO          7 000        4 250        2 000
  TAPER RATIO             500          500          500
  1/4C  SWEEP          15 000       25 000       35 000
  L E  SWEEP           17 514       28 578       40 921
  C L  CHORD            5 209        3 774        3 799
  MEAN CHORD            4 052        2 935        2 955
  TIP CHORD             2.605        1.887        1 900

  TAXI AT IDLE THRUST

                  FUEL                         FUEL
 TIME   RANGE     USED    WEIGHT    ALT        FLOW
 (HRS)  (NM)     (LBS)    (LBS)     (FT)     (LB/HR)

 0 000     0.       0.    5625.       0.       206.
  .083     0.      17.    5608.       0.       206.

VSTLKT= 100 2 KTS EAS    VRAT= 1.100 CLTO= 1.2736
     VEND =  228 7 KNOTS EAS


ROTATION (TIME=    13 6 AND TAS=   110 2 EAS=    110 2)
LIFTOFF (TIME=    16 0 DIST=    1805 1 TAS=    125 4 EAS=    125 4)
DISTANCE TO 35 FT =  2934 0    TAS=   148 6 EAS=    148 6 V35/VS=  1.4827
GEAR RETRACTION STARTED AT    21 8 SEC.COMPLETE AT    28 8 SEC
FLAP RETRACTION STARTED AT    31 7 SEC.COMPLETE AT    36 2 SEC

VSTLKT= 100 2 KTS EAS    VRAT= 1.100 CLTO= 1.2736
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ENGINE OUT PERFORMANCE FOLLOWS
    VENO =  228 7 KNOTS EAS
ENGINE FAILURE (TIME=   12 9 AND TAS=   105 2 EAS=   105 21

ROTATION (TIME=   14 2 AND TAS=   110 2 EAS=   110 21
LIFTOFF (TIME=   17 0 DIST=   1976 4 TAS=   117 1 EAS=   117 1)
DISTANCE TO 35 FT =  3046 0   TAS=   122 1 EAS=   122 1 V35/VS=  1 2181

   ACCELERATE - STOP DISTANCE =     3276 1 FEET.

  ENGINE OUT DISTANCE TO 35 FT.=     3046 0 FEET

ALL ENGINE DISTANCE TO 35 FT. (L) =     2934 0 FEET
FAR 25 T O  DISTANCE (1 15XL) =     3374 1 FEET
ALL ENGINE DISTANCE TO 50 FT. =     3162 5 FEET

   AT END OF TAKEOFF PHASE
TIME=   093 HRS   FUEL USED=     30. LBS   WEIGHT=   5595 LBS   ALT.=     500. FT.

  ACCELERATE TO MACH NO. = .349

END OF ACCELERATION SEGMENT
TIME=  .095 HRS   FUEL USED=   33 8 LBS   WEIGHT=   5591. LBS   RANGE=    1. NM
   END OF CLIMB TO   40000  FT
TIME=  .305 HRS   FUEL USED=    212. LBS   WEIGHT=   5413. LBS   RANGE=    59  NM

ALTITUDE=    40000. FT   TAS=    434.91 KTS   MACH NO=     .7576

  ACCELERATE TO MACH NO. = .700

END OF ACCELERATION SEGMENT
TIME=   343 HRS   FUEL USED=  233.3 LBS   WEIGHT=   5392. LBS   RANGE=   74. NM

  ACCELERATE TO MACH NO. = .758

END OF ACCELERATION SEGMENT
TIME=   363 HRS   FUEL USED=  245 0 LBS   WEIGHT=   5380 LBS   RANGE=   82  NM

  ACCELERATE TO MACH NO. = .625

END OF ACCELERATION SEGMENT
TIME=   320 HRS   FUEL USED=  220 0 LBS   WEIGHT=   5405 LBS   RANGE=   64. NM
```

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
**** MAXIMUM PAYLOAD *****
FUEL AVAILABLE= 727

		AT SPECIFIED SPEED START CRUISE	END CRUISE	AT NORMAL POWER START CRUISE	END CRUISE	AT BEST SPEC RANGE START CRUISE	END CRUISE
TIME	HRS.	.343	.729	.363	.591	.320	.909
RANGE	N MI	74	229	82	182	64	276
FUEL USED	LBS.	233	400	245	357	220	441
WEIGHT	LBS.	5392	5225	5380	5268	5405	5184
ALTITUDE	FT	40000	40000	40000	40000	40000	40000
TAS	KTS	401 9	401 9	434 9	434 9	358 9	358 9
EAS	KTS.	199 8	199 8	216 2	216 2	178 4	178 4
MACH NO		.7000	.7000	.7576	.7576	.6252	.6252
DIV MACH		.7631	.7646	.7699	.7707	.7515	.7538
ANGLE ATTACK	DEG.	2 555	2 438	1 844	1 781	3 771	3 567
FUSE. ANGLE	DEG.	1 555	1 438	.844	.781	2 771	2 567
CL		.3742	.3626	.3188	.3122	.4703	.4511
L/D		9 401	9 227	8 610	8 488	10 341	10 161
FUEL FLOW	LB/HR	435 2	429 7	492 7	488 6	380 2	371 3
BREG FACTOR	N MI	4982	4890	4752	4692	5106	5014
SPEC RANGE	NM/LB	.92338	.93527	.88273	.89013	.94404	.96668

RESERVE FUEL(LBS) 326 370 285
(45 0 MIN.)

****

ACCELERATE TO MACH NO. = .700

END OF ACCELERATION SEGMENT
TIME= .343 HRS FUEL USED= 233.4 LBS WEIGHT= 5392. LBS RANGE= 74 NM

ACCELERATE TO MACH NO. = .758

END OF ACCELERATION SEGMENT
TIME= .363 HRS FUEL USED= 245.0 LBS WEIGHT= 5380. LBS RANGE= 82 NM

ACCELERATE TO MACH NO. = .625

END OF ACCELERATION SEGMENT
TIME= .320 HRS FUEL USED= 220.0 LBS WEIGHT= 5405 LBS RANGE= 64 NM

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DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
****** MAXIMUM FUEL ******
FUEL AVAILABLE= 1052.

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC. RANGE START CRUISE	AT BEST SPEC. RANGE END CRUISE
TIME	HRS.	.343	1 495	363	1 265	320	1 800
RANGE	N MI	74.	537.	82	475	64	596
FUEL USED	LBS.	233.	725	245	682	220	766
WEIGHT	LBS.	5392	4900.	5380	4943	5405	4859
ALTITUDE	FT.	40000.	40000.	40000	40000	40000	40000
TAS	KTS.	401 9	401 9	434 9	434 9	358 9	358 9
EAS	KTS.	199 8	199 8	216 2	216 2	178 4	178 4
MACH NO		.7000	.7000	.7576	.7576	.6252	6252
DIV MACH		.7631	.7673	.7699	7730	.7515	.7572
ANGLE ATTACK	DEG.	2 554	2 212	1 844	1 597	3 771	3 268
FUSE. ANGLE	DEG.	1 554	1 212	.844	.597	2 771	2 268
CL		.3742	.3401	.3188	2929	4703	4228
L/D		9 401	8 866	8 610	8 117	10 341	9 862
FUEL FLOW	LB/HR	435 2	419 4	492 7	477 2	380 2	358 8
BREG FACTOR	N MI.	4982	4698	4752	4508	5106	4863
SPEC. RANGE	NM/LB	.92338	.95817	.88273	91141	94404	1 00021
RESERVE FUEL(LBS) (45.0 MIN.)		326.		370		285	

****

RANGE = 475. BLOCK TIME= 1 265 USED FOR DESIGN RANGE AND COST

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TEMP = 518. DEG STD.= 0.
LANDING ELEVATION= 0. FT.
LANDING WING LOADING= 52 65 PSF.
LANDING WEIGHT = 5625. LBS.

LANDING DISTANCE FROM 50. FT.= 2488. FT.

F.A.R. FACTORED FIELD LENGTH = 4147. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	612.	DIST=	238	DIST=	181.	DIST=	1458.
R/S=	1000.	XLFMX=	1.150	TDELAY=	1 00	MUB=	.4000
VAPEAS=	121.01	SINKTD=	3 000	TIDLE=	139.	TR/TIDLE=	0 0000
VAPTAS=	121 09	VSTEAS=	93 08	VTDTAS=	107 12	ABARIGI=	3489
THETA=	4 67	CLMX=	1.7913				
THRUST=	366	HFLAR=	27 9				

****

ITERATION TO BALANCE RANGE
RANGE ERROR, RANGE ERROR MINUS 1 - 6044 .0841
GROSS WGT, GROSS WGT MINUS1 7270 9 5625 0

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*****************************************************************************************

                    FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)
                 CLMAX     VSTALL,KTS  FLAP ANGLE   LE ANGLE    DELTA CL    DELTA CD

FLAPS UP         1.3576      107.1         0.0         0.0       0.0000      0.0000
T.O. CONFIG      1.5452      100.4        15.0         0.0        .1980       .0156
LDG. CONFIG      1.7979       93.2        40.0         0.0        .4620       .0482

                  PLAIN FLAPS
                  OPT ANGLE    DELCL AT OPT   DELCD AT OPT    AREA(FT2)     WEIGHT(LB)

FLAPS               60.0           .9000          .1200          28.0           48.5
*****************************************************************************************

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
  ANGLE OF ATTACK(DEGREES)=   2.717   LIFT=  7270.9   L/D=  11.469   ALTITUDE= 40000.0   MACH=   .7000

VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2826
     VEND =  228.5 KNOTS EAS

ROTATION (TIME=   17.2 AND TAS=   110.0 EAS=   110.0)
LIFTOFF (TIME=   19.6 DIST=   2158.1 TAS=   122.1 EAS=   122.1)
DISTANCE TO 35 FT.=  3296.1   TAS=  140.3 EAS=   140.3 V35/VS=  1.4021

 ITERATION TO MATCH TAKEOFF DISTANCE
  XTO,XTORQ,WASLS  3296.  3100.   47.87


VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2826
     VEND =  240.3 KNOTS EAS

ROTATION (TIME=   15.0 AND TAS=   110.0 EAS=   110.0)
LIFTOFF (TIME=   17.4 DIST=   1940.9 TAS=   124.1 EAS=   124.1)
DISTANCE TO 35 FT.=  3062.6   TAS=  145.3 EAS=   145.3 V35/VS=  1.4524

 ITERATION TO MATCH TAKEOFF DISTANCE
  XTO,XTORQ,WASLS  3063.  3100.   54.12


VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2826
     VEND =  236.8 KNOTS EAS

ROTATION (TIME=   15.3 AND TAS=   110.0 EAS=   110.0)
LIFTOFF (TIME=   17.8 DIST=   1986.6 TAS=   124.1 EAS=   124.1)
DISTANCE TO 35 FT.=  3087.9   TAS=  144.2 EAS=   144.2 V35/VS=  1.4418

 ITERATION TO MATCH TAKEOFF DISTANCE
  XTO,XTORQ,WASLS  3088.  3100.   53.03


TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
  AIRPORT ALTITUDE=      0. FT.   AMBIENT TEMP ABOVE STD. DAY=    0.0 DEG F
```

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG.T.O. FLAPS-LD GEAR EXT - ONE ENG OUT	0	115.4	744.46	1.00	1.17	7.87
SEC SEG. T.O. FLAPS - ONE ENGINE OUT	250	120.9	1104.32	293.56	1.08	10.23
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500.	137.3	1442.77	166.78	.87	12.05
APPROACH FLAPS - ONE ENG OUT	0.	153.2	1396.93	325.54	.67	10.91
LANDING FLAPS - ALL ENGINES	0.	121.0	2952.27	591.68	1.07	7.24

APPROACH FLAP SETTING = 11.9 DEG.

*** ENGINE-OUT SERVICE CEILING = 31121.7 FT.
BEST RATE OF CLIMB SPEED = 254.3 KTAS
ENGINE-OUT RATE OF CLIMB = 100.0 FPM
WEIGHT AT ALTITUDE = 6980.0 LBS

PROPULSION SYSTEM WEIGHTS		
ENGINE WEIGHT/ENGINE		363.8
NACELLE WEIGHT/ENGINE		74.7
PYLON WEIGHT/ENGINE		4.4
PROP OR OFAN	0.0	
GEARBOX	0.0	
SHROUD	0.0	

ENGINE POD DIMENSIONS
ENGINE FACE DIAMETER(FT) 1.95
NACELLE LENGTH(FT) 5.34

ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW= 47.87

ENGINE SIZED TO MATCH T.O. DISTANCE OF 3100. FT (STD DAY, 0. DEG R.ALT, 0.) SLS AIRFLOW= 53.03

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE= 1642.5 LBS
****

PROPULSION SYSTEM WEIGHTS		
ENGINE WEIGHT/ENGINE		363.8
NACELLE WEIGHT/ENGINE		74.7
PYLON WEIGHT/ENGINE		4.4
PROP OR OFAN	0.0	
GEARBOX	0.0	
SHROUD	0.0	

ENGINE POD DIMENSIONS
ENGINE FACE DIAMETER(FT) 1.95
NACELLE LENGTH(FT) 5.34

VSTLKT= 100.0 KTS EAS VRAT= 1.100 CLTO= 1.2826
VEND = 228.5 KNOTS EAS

ROTATION (TIME= 15.4 AND TAS= 110.0 EAS= 110.0)
LIFTOFF (TIME= 17.8 DIST= 1979.2 TAS= 123.5 EAS= 123.5)

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DISTANCE TO 35 FT.= 3105.0 TAS= 143.9 EAS= 143.9 V35/VS= 1.4388

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG.T.O. FLAPS+LD GEAR EXT - ONE ENG.OUT	0.	115.4	717.69	1.00	1.17	7.76
SEC SEG. T.O. FLAPS - ONE ENGINE OUT	250.	120.9	1072.93	293.56	1.08	10.01
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500.	137.3	1397.38	166.78	.87	11.66
APPROACH FLAPS - ONE ENG OUT	0.	153.2	1328.37	325.54	.67	10.46
LANDING FLAPS - ALL ENGINES	0.	121.0	2912.57	391.68	1.07	7.13

APPROACH FLAP SETTING = 11.9 DEG.

*** ENGINE-OUT SERVICE CEILING = 29877.9 FT.
BEST RATE OF CLIMB SPEED = 239.5 KTAS
ENGINE-OUT RATE OF CLIMB = 99.8 FPM
WEIGHT AT ALTITUDE = 6980.0 LBS

****RESIZE ENGINES AT CRUISE TO ACCOUNT FOR RESIZED NACELLES****

PROPULSION SYSTEM WEIGHTS
ENGINE WEIGHT/ENGINE 362.9
NACELLE WEIGHT/ENGINE 74.5
PYLON WEIGHT/ENGINE 4.4
PROP OR OFAN 0.0
GEARBOX 0.0
SHROUD 0.0

ENGINE POD DIMENSIONS
ENGINE FACE DIAMETER(FT) 1.95
NACELLE LENGTH(FT) 5.33

VSTLKT= 100.0 KTS EAS VRAT= 1.100 CLTO= 1.2826
VEND = 228.5 KNOTS EAS

ROTATION (TIME= 15.4 AND TAS= 110.0 EAS= 110.0)
LIFTOFF (TIME= 17.8 DIST= 1979.2 TAS= 123.5 EAS= 123.5)
DISTANCE TO 35 FT.= 3105.3 TAS= 144.0 EAS= 143.9 V35/VS= 1.4388

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD. DAY= 0.0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG.T.O. FLAPS+LD GEAR EXT - ONE ENG OUT	0	115.4	717.71	1.00	1.17	7.76
SEC SEG. T.O. FLAPS - ONE ENGINE OUT	250.	120.9	1072.97	293.56	1.08	10.01
FINAL T.O. CRUISE CONFIG - ONE ENG OUT	1500	137.3	1397.43	166.78	.87	11.66
APPROACH FLAPS - ONE ENG OUT	0	153.2	1328.46	325.54	.67	10.46
LANDING FLAPS - ALL ENGINES	0.	121.0	2912.56	391.68	1.07	7.13

APPROACH FLAP SETTING = 11.9 DEG.

*** ENGINE-OUT SERVICE CEILING = ~~29879 9 FT~~
BEST RATE OF CLIMB SPEED = 239 5 KTAS
ENGINE-OUT RATE OF CLIMB = 99 8 FPM
WEIGHT AT ALTITUDE = 6980 0 LBS

ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW= 51 63

ENGINE SIZED TO MATCH T.O. DISTANCE OF 3100 FT (STD DAY= 0. DEG R.ALT= 0) SLS AIRFLOW= 52.89

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE= 1638 2 LBS

PROPULSION SYSTEM WEIGHTS
ENGINE WEIGHT/ENGINE 362 9
NACELLE WEIGHT/ENGINE 74 5
PYLON WEIGHT/ENGINE 4.4
PROP OR OFAN 0.0
GEARBOX 0.0
SHROUD 0.0

ENGINE POD DIMENSIONS
ENGINE FACE DIAMETER(FT) 1.95
NACELLE LENGTH(FT) 5.33

---AIRCRAFT C.G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD		MOST AFT LOAD		DESIGN LOAD	
	WT	CG	WT	CG	WT	CG
A/C OWE	4460 61	16 86	4460 61	16 86	4460 61	16 86
PAX	510 00		340 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	15 87	1157 62	15 87	1157 62	15 87
TIP FUEL	231 52	15 64	535 89	15 64	535 89	15 64
FUS FUEL	0 00	15 87	0 00	15 87	441 74	15 87
TOTAL	5202.13	16 18	6659 12	16 56	7270 86	16 12

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	--NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	0759	9500		3904	3343		0010					
LIFTOFF	1 0000	0811	0659	9500	2081	3952	4108	0 0000	0010	0 0000	- 1031	0 0000	0 0000	-1
LANDING	13 6894	0812	0660	9500	2 8493	1 7979	4104	4228	0010	0010	- 2000		0 0000	-1

ELEVATOR PARAMETERS
CHALPHA(FLOATING TENDENCY) = - 00511
CHDELTA(RESTORING TENDENCY) = - 01204
CMDELTA(CONTROL POWER) = - 02773
TAU(EFFECTIVENESS) = 48250

WING DE/DALPHA = 41628

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	2302	17 596

HORIZONTAL TAIL SIZES
STATIC STABILITY AND TRIM 32 6490

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STATIC MARGIN	.0300		STABILITY AND LIFTOFF	38 7906
AFT CG LIMIT(STABILITY)	.2002	17 458	LIFTOFF	38 6230
CG RANGE(LOADING)	.0832		REQUIRED TAIL SIZE	38 7906
FWD CG LIMIT(CONTROL)	.1170	17 075	TAIL ARM(ELTH)	15 0381

VERTICAL TAIL AREA = 19.5243 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 18.4173 FOR MINIMUM CONTROL SPEED = 99 23 KTS

REQUIRED VERTICAL TAIL AREA = 19 5243 TAIL ARM(ELTV) = 13 4881

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---AIRCRAFT C G SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	MOST FWD LOAD CG	MOST AFT LOAD WT	MOST AFT LOAD CG	DESIGN LOAD WT	DESIGN LOAD CG
A/C OWE	4426 13	17.23	4426 13	17 23	4426 13	17 23
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17 92	1157 62	17 92	1157 62	17 92
TIP FUEL	231 52	17 66	535 89	17 66	535 89	17 66
FUS FUEL	0 00	17 92	0 00	17 92	476 22	17 92
TOTAL	5507 66	16 52	6284 64	17 41	7270 86	16 95

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	0759	9500		3904	3072		0039			0 0000		-1
LIFTOFF	1 0000	0811	0659	9500	2112	3952	3775	0 0000	0039	0 0000	- 1031		0 0000	-1
LANDING	13 6894	0812	0660	9500	2 8915	1 7979	3771	3886	0039	0040	- 2000		0 0000	

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY)	= - 00511	WING DE/DALPHA = 42244
CHDELTA(RESTORING TENDENCY)	= - 01204	
CHDELTA(CONTROL POWER)	= - 03130	
TAUH(EFFECTIVENESS)	= 48250	

	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	2826	17 286	STATIC STABILITY AND TRIM	42 9003
STATIC MARGIN	0300		STABILITY AND LIFTOFF	39 5947
AFT CG LIMIT(STABILITY)	.2526	17 148	LIFTOFF	39 0300
CG RANGE(LOADING)	1915		REQUIRED TAIL SIZE	42 9003
FWD CG LIMIT(CONTROL)	0612	16 266	TAIL ARM(ELTH)	15 3457

VERTICAL TAIL AREA = 18 4570 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 17.7395 FOR MINIMUM CONTROL SPEED = 99 23 KTS

REQUIRED VERTICAL TAIL AREA = 18 4570 TAIL ARM(ELTV) = 14 0035

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---AIRCRAFT C G SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	MOST FWD LOAD CG	MOST AFT LOAD WT	MOST AFT LOAD CG	DESIGN LOAD WT	DESIGN LOAD CG
A/C OWE	4428 72	17 11	4428 72	17 11	4428 72	17 11

PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17 37	1157 62	17 37	1157 62	17 37
TIP FUEL	231 52	17 17	535 89	17 17	535 89	17 17
FUS FUEL	0 00	17 37	0 00	17 37	473 63	17 37
TOTAL	5510 24	16 41	6287 23	17 18	7270 86	16 72

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	.0997	.0759	9500		3904	3128		0031			0 0000		
LIFTOFF	1 0000	.0811	.0659	9500	2123	3952	3856	0 0000	0031	0 0000	- 1031		0 0000	-1
LANDING	13 6894	.0812	.0660	9500	2 9058	1.7979	3852	3969	0031	0032	- 2000		0 0000	-1

ELEVATOR PARAMETERS
CHALPHA(FLOATING TENDENCY) = - 00511
CHDELTA(RESTORING TENDENCY) = - 01204
CMDELTA(CONTROL POWER) = - 02969
TAUH(EFFECTIVENESS) = 48250

WING DE/DALPHA = .42454

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	2580	17 316
STATIC MARGIN	0300	
AFT CG LIMIT(STABILITY)	2280	17 178
CG RANGE(LOADING)	1673	
FWD CG LIMIT(CONTROL)	.0607	16 408

HORIZONTAL TAIL SIZES

STATIC STABILITY AND TRIM	40 5209
STABILITY AND LIFTOFF	39 1125
LIFTOFF	38 8727
REQUIRED TAIL SIZE	40 5209
TAIL ARM(ELTH)	15 4103

VERTICAL TAIL AREA = 18.5529 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 17.7442 FOR MINIMUM CONTROL SPEED = 99 23 KTS

REQUIRED VERTICAL TAIL AREA = 18 5529 TAIL ARM(ELTV) = 13 9998

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---AIRCRAFT C G SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	4424 41	17 13	4424 41	17.13	4424 41	17.13
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17.51	1157 62	17 51	1157 62	17 51
TIP FUEL	231 52	17 18	0 00	17 18	535 89	17 18
FUS FUEL	0 00	17.51	0 00	17 51	477 93	17 51
TOTAL	5505 94	16 42	5747 03	17 22	7270 86	16 76

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	.0997	0759	9500		3904	3145		0031			0 0000		
LIFTOFF	1 0000	.0811	0659	9500	2125	3952	3864	0 0000	0031	0 0000	- 1031		0 0000	-1
LANDING	13 6894	0812	.0660	9500	2.9090	1 7979	3860	3977	0031	0031	- 2000		0 0000	-1

ELEVATOR PARAMETERS
CHALPHA(FLOATING TENDENCY) = - 00511
CHDELTA(RESTORING TENDENCY) = - 01204
CMDELTA(CONTROL POWER) = - 03018

WING DE/DALPHA = .42500

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TAUH(EFFECTIVENESS) = .48250

	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	2626	17 350	STATIC STABILITY AND TRIM	41 4021
STATIC MARGIN	.0300		STABILITY AND LIFTOFF	39 4373
AFT CG LIMIT(STABILITY)	.2326	17 212	LIFTOFF	39 1032
CG RANGE(LOADING)	.1737		REQUIRED TAIL SIZE	41 4021
FWD CG LIMIT(CONTROL)	.0589	16 412	TAIL ARM(ELTH)	15 3346

VERTICAL TAIL AREA = 18 6094 FOR DIRECTIONAL STABILITY OF - .00200

VERTICAL TAIL AREA= 17.7905 FOR MINIMUM CONTROL SPEED = 99 23 KTS

REQUIRED VERTICAL TAIL AREA = 18.6094 TAIL ARM(ELTV) = 13 9634

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---AIRCRAFT C G SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	4426 52	17.14	4426 52	17 14	4426 52	17 14
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17 52	1157 62	17 52	1157 62	17 52
TIP FUEL	231 52	17 21	0 00	17 21	535 89	17 21
FUS FUEL	0 00	17 52	0 00	17 52	475 83	17 52
TOTAL	5508 04	16 43	5749 14	17 23	7270 86	16 77

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	0759	9500		3904	3154		0030			0 0000		-1
LIFTOFF	1 0000	0811	0659	9500	2125	3952	3876	0 0000	0030	0 0000	- 1031		0 0000	-1
LANDING	13 6894	0812	0660	.9500	2 9089	1 7979	3872	3989	0030	0030	- 2000		0 0000	

ELEVATOR PARAMETERS
- CHALPHA(FLOATING TENDENCY) = - .00511
- CHDELTA(RESTORING TENDENCY) = - .01204
- CMDELTA(CONTROL POWER) = - .03021
- TAUH(EFFECTIVENESS) = .48250

WING DE/DALPHA = .42498

	FRACTION MAC	STATION (DATUM NOSE)	HORIZONTAL TAIL SIZES	
NEUTRAL POINT	.2620	17 367	STATIC STABILITY AND TRIM	41 4451
STATIC MARGIN	.0300		STABILITY AND LIFTOFF	39 4635
AFT CG LIMIT(STABILITY)	.2320	17 229	LIFTOFF	39 1264
CG RANGE(LOADING)	1738		REQUIRED TAIL SIZE	41 4451
FWD CG LIMIT(CONTROL)	0582	16 428	TAIL ARM(ELTH)	15 3312

VERTICAL TAIL AREA = 18 6459 FOR DIRECTIONAL STABILITY OF - .00200

VERTICAL TAIL AREA= 17.8136 FOR MINIMUM CONTROL SPEED = 99 23 KTS

REQUIRED VERTICAL TAIL AREA = 18 6459 TAIL ARM(ELTV) = 13 9453

****

WING LOCATION INFO.
FUSELAGE LENGTH = 32.10 H-TAIL VOL ARM = 15 33 C G LOCATION OF PROPULSION= 20.87

WING 1/4C LOC ON C.L. =	15 46	H-TAIL C G LOCATION =	32 81	C G OF REMAINING WEIGHT =	13.80
MAC 1/4C LOCATION =	17 31	H-TAIL MAC FROM C L =	2 95		
MAC DIST FROM C L =	6 91	H-TAIL LOCAT ON VERT =	50		
WING C G LOCATION =	17 77	V-TAIL VOL ARM =	13 95		
TIP TANKS C G LOCATE =	17 21	V-TAIL C G LOCATION =	31 43		

	WING	H-TAIL	V-TAIL
AREA	138 109	41 445	18 646
SPAN	31 093	13 272	6 107
ASPECT RATIO	7 000	4 250	2 000
TAPER RATIO	500	500	500
1/4C SWEEP	15 000	25 000	35 000
L E SWEEP	17 514	28 578	40 921
C L CHORD	5 922	4 164	4 071
MEAN CHORD	4 606	3 238	3 166
TIP CHORD	2 961	2 082	2 036

TAXI AT IDLE THRUST

TIME (HRS)	RANGE (NM)	FUEL USED (LBS)	WEIGHT (LBS)	ALT (FT)	FUEL FLOW (LB/HR)
0 000	0	0.	7271.	0	237.
083	0.	20	7251.	0.	237

VSTLKT= 99 9 KTS EAS VRAT= 1.100 CLTO= 1 2826
VEND = 230 1 KNOTS EAS

ROTATION (TIME= 15 3 AND TAS= 109 9 EAS= 109 9)
LIFTOFF (TIME= 17 8 DIST= 1985 1 TAS= 123 9 EAS= 123 9)
DISTANCE TO 35 FT = 3087 3 TAS= 144 0 EAS= 143 9 V35/VS= 1.4410
GEAR RETRACTION STARTED AT 23 5 SEC.COMPLETE AT 30 5 SEC
FLAP RETRACTION STARTED AT 33 5 SEC.COMPLETE AT 38 0 SEC

VSTLKT= 99 9 KTS EAS VRAT= 1 100 CLTO= 1.2826

ENGINE OUT PERFORMANCE FOLLOWS
VEND = 230 1 KNOTS EAS
ENGINE FAILURE (TIME= 14 5 AND TAS= 104.9 EAS= 104 9)

ROTATION (TIME= 16 0 AND TAS= 109 9 EAS= 109 9)
LIFTOFF (TIME= 19 0 DIST= 2192 8 TAS= 116 1 EAS= 116 1)
DISTANCE TO 35 FT = 3231 8 TAS= 119 5 EAS= 119 5 V35/VS= 1.1965

ACCELERATE - STOP DISTANCE = 3401 5 FEET.

ENGINE OUT DISTANCE TO 35 FT. = 3231 8 FEET

ALL ENGINE DISTANCE TO 35 FT (L) = 3087 3 FEET
FAR 25 T O DISTANCE (1 15XL) = 3550 4 FEET
ALL ENGINE DISTANCE TO 50 FT = 3307 8 FEET

AT END OF TAKEOFF PHASE
TIME= 093 HRS FUEL USED= 36 LBS WEIGHT= 7235 LBS ALT = 500 FT

ACCELERATE TO MACH NO. = .351

```
END OF ACCELERATION SEGMENT
 TIME=  .097 HRS   FUEL USED=    41.6 LBS   WEIGHT=   7229. LBS   RANGE=    1. NM
   END OF CLIMB TO   40000  FT
TIME=   .336 HRS   FUEL USED=    276. LBS   WEIGHT=   6995. LBS   RANGE=    69  NM

ALTITUDE=     40000. FT   TAS=    435.66 KTS   MACH NO=      .7589

 ACCELERATE TO MACH NO. = .700

END OF ACCELERATION SEGMENT
 TIME=  .376 HRS   FUEL USED=   301.6 LBS   WEIGHT=   6969. LBS   RANGE=   84. NM

 ACCELERATE TO MACH NO. = .759

END OF ACCELERATION SEGMENT
TIME=  .402 HRS   FUEL USED=   319.1 LBS   WEIGHT=   6952. LBS   RANGE=   95  NM

 ACCELERATE TO MACH NO. = .640

END OF ACCELERATION SEGMENT
TIME=  .354 HRS   FUEL USED=   287.3 LBS   WEIGHT=   6984. LBS   RANGE=   75  NM
```

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
**** MAXIMUM PAYLOAD *****
FUEL AVAILABLE= 1844.

		AT SPECIFIED SPEED		AT NORMAL POWER		AT BEST SPEC. RANGE	
		START CRUISE	END CRUISE	START CRUISE	END CRUISE	START CRUISE	END CRUISE
TIME	HRS.	376	2.775	.402	2.391	354	3.187
RANGE	N MI	84	1048.	95.	962	75	1110
FUEL USED	LBS.	302.	1467.	319.	1418	287.	1504.
WEIGHT	LBS.	6969	5804.	6952.	5853	6984.	5767
ALTITUDE	FT.	40000	40000.	40000.	40000	40000	40000.
TAS	KTS	401.9	401.9	435.7	435.7	367.7	367.7
EAS	KTS.	199.8	199.8	216.6	216.6	182.8	182.8
MACH NO.		.7000	.7000	.7589	7589	6404	6404
DIV MACH		7627	.7703	.7696	7757	7537	.7632
ANGLE ATTACK	DEG.	2.555	1.927	1.829	1.350	3.490	2.673
FUSE. ANGLE	DEG.	1.555	.927	829	.350	2.490	1.673
CL		3742	3117	.3176	2674	4480	3700
L/D		10.501	9.403	9.648	8.568	11.275	10.293
FUEL FLOW	LB/HR	503.8	468.5	568.6	537.8	454.2	411.9
BREG FACTOR	N MI.	5563.	4982.	5330	4745	5657	5152
SPEC RANGE	NM/LB	.79773	.85774	.76618	81013	80945	.89268

	AT SPECIFIED SPEED	AT NORMAL POWER	AT BEST SPEC. RANGE
RESERVE FUEL(LBS) (45.0 MIN.)	378.	426	341

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ACCELERATE TO MACH NO. = .700

END OF ACCELERATION SEGMENT
TIME= .376 HRS FUEL USED= 301.6 LBS WEIGHT= 6969 LBS RANGE= 84. NM

ACCELERATE TO MACH NO. = .759

END OF ACCELERATION SEGMENT
TIME= .402 HRS FUEL USED= 319.1 LBS WEIGHT= 6952. LBS RANGE= 95. NM

ACCELERATE TO MACH NO. = .640

END OF ACCELERATION SEGMENT
TIME= 354 HRS FUEL USED= 287.3 LBS WEIGHT= 6984 LBS RANGE= 75. NM

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DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
****** MAXIMUM FUEL ******
FUEL AVAILABLE= 2169

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC RANGE START CRUISE	AT BEST SPEC RANGE END CRUISE
TIME	HRS.	.376	3.475	.402	2.998	.354	3.961
RANGE	N MI	84.	1329	95	1227	75	1402
FUEL USED	LBS	302	1792	319	1743	287	1829
WEIGHT	LBS.	6969	5479	6952	5528	6984	5442
ALTITUDE	FT	40000	40000	40000	40000	40000	40000
TAS	KTS	401.9	401.9	435.7	435.7	367.7	367.7
EAS	KTS	199.8	199.8	216.6	216.6	182.8	192.8
MACH NO		.7000	.7000	.7589	.7589	.6404	.6404
DIV MACH		.7627	.7724	.7696	.7775	.7537	.7657
ANGLE ATTACK	DEG.	2.554	1.752	1.829	1.208	3.490	2.455
FUSE ANGLE	DEG	1.554	.752	.829	.208	2.490	1.455
CL		.3742	.2942	.3176	.2526	.4480	.3492
L/D		10.501	9.045	9.648	8.211	11.275	9.955
FUEL FLOW	LB/HR	503.8	459.8	568.6	530.5	454.2	402.1
BREG FACTOR	N MI	5563	4792	5330	4543	5657	4979
SPEC RANGE	NM/LB	.79774	.87394	.76618	.82126	.80945	.91431

RESERVE FUEL(LBS) 378 426 341
(45.0 MIN.)

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RANGE = 1227. BLOCK TIME= 2.998 USED FOR DESIGN RANGE AND COST

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TEMP = 518 DEG.STD.+ 0.
LANDING ELEVATION= 0 FT.
LANDING WING LOADING= 52.65 PSF.
LANDING WEIGHT = 7271. LBS.

LANDING DISTANCE FROM 50 FT = 2481. FT.

F A R FACTORED FIELD LENGTH = 4101. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	609.	DIST=	237	DIST=	189	DIST=	1434.
R/S=	1000	XLFMX=	1.150	TDELAY=	1.00	MUB=	.4000
VAPEAS=	120.56	SINKTD=	3.000	TIDLE=	160	TR/TIDLE=	0.0000
VAPTAS=	120.64	VSTEAS=	92.74	VTDTAS=	105.72	ASAR(G)=	.3521
THETA=	4.69	CLMX=	1.8045				
THRUST=	425	HFLAR=	27.9				

****
****
ITERATION TO BALANCE RANGE
RANGE ERROR. RANGE ERROR MINUS 1 .0222 -.6044
GROSS WGT. GROSS WGT MINUS1 7212.5 7270.9

FLAP PERFORMANCE SUMMARY (OUT OF GROUND EFFECT)

	CLMAX	VSTALL.KTS	FLAP ANGLE	LE ANGLE	DELTA CL	DELTA CD
FLAPS UP	1 3573	107 1	0 0	0 0	0 0000	0 0000
T.O. CONFIG	1 5448	100 4	15 0	0 0	1979	0156
LDG. CONFIG	1.7974	93 2	40 0	0 0	4617	0482

PLAIN FLAPS

	OPT ANGLE	DELCL AT OPT	DELCD AT OPT	AREA(FT2)	WEIGHT(LB)
FLAPS	60 0	9000	1200	27 7	48 1

SUMMARY OF CRUISE LIFT-WEIGHT BALANCE
ANGLE OF ATTACK(DEGREES)= 2 717 LIFT= 7212 5 L/D= 11 421 ALTITUDE= 40000 0 MACH= .7000

VSTLKT= 100 0 KTS EAS VRAT= 1 100 CLTO= 1 2823
VEND = 228 5 KNOTS EAS

ROTATION (TIME= 17.1 AND TAS= 110 0 EAS= 110 01
LIFTOFF (TIME= 19 6 DIST= 2166 4 TAS= 122 5 EAS= 122 61
DISTANCE TO 35 FT.= 3273.2 TAS= 140 1 EAS= 140 1 V35/VS= 1.4006

ITERATION TO MATCH TAKEOFF DISTANCE
XTO,XTORQ,WASLS 3273 3100 47 68

VSTLKT= 100 0 KTS EAS VRAT= 1.100 CLTO= 1.2823
VEND = 240.3 KNOTS EAS

ROTATION (TIME= 15 2 AND TAS= 110 0 EAS= 110 01
LIFTOFF (TIME= 17 6 DIST= 1964 4 TAS= 124 1 EAS= 124 11
DISTANCE TO 35 FT = 3078 8 TAS= 144 8 EAS= 144 8 V35/VS= 1.4474

ITERATION TO MATCH TAKEOFF DISTANCE
XTO,XTORQ,WASLS 3079 3100 53 18

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
AIRPORT ALTITUDE= 0. FT. AMBIENT TEMP ABOVE STD DAY= 0 0 DEG F

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T O FLAPS-LD GEAR EXT - ONE ENG OUT	0	115 4	765 64	1 00	1 17	7 86
SEC SEG T O FLAPS - ONE ENGINE OUT	250	120 9	1126 70	293 59	1 08	10 21
FINAL T O CRUISE CONFIG - ONE ENG OUT	1500	137 4	1467 53	166 79	87	12 03
APPROACH FLAPS - ONE ENG OUT	0	153 2	1423 26	325 58	67	10 88
LANDING FLAPS - ALL ENGINES	0	121 0	2999 05	391 73	1 07	7 23

APPROACH FLAP SETTING = 11 8 DEG.

```
*** ENGINE-OUT SERVICE CEILING = 31312.7 FT
    BEST RATE OF CLIMB SPEED   =   254 8 KTAS
    ENGINE-OUT RATE OF CLIMB   =   100 0 FPM
    WEIGHT AT ALTITUDE         =  6924.0 LBS

PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE             364.7
  NACELLE WEIGHT/ENGINE             74.8
  PYLON WEIGHT/ENGINE                4.4
     PROP OR OFAN           0.0
     GEARBOX                0.0
     SHROUD                 0.0

ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)        1.95
  NACELLE LENGTH(FT)              5.34

ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW=    47.68

ENGINE SIZED TO MATCH T.O. DISTANCE OF  3100. FT (STD DAY=   0. DEG R.ALT=     0.1 SLS AIRFLOW=    53.16

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS

RATED SEA LEVEL STATIC THRUST PER ENGINE=   1646 5 LBS
****************************************************************************************************

PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE             364.7
  NACELLE WEIGHT/ENGINE             74 8
  PYLON WEIGHT/ENGINE                4.4
     PROP OR OFAN           0.0
     GEARBOX                0.0
     SHROUD                 0.0

ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)        1 95
  NACELLE LENGTH(FT)              5.34

VSTLKT= 100.0 KTS EAS   VRAT= 1.100 CLTO= 1.2823
    VEND =  228 5 KNOTS EAS

ROTATION (TIME=   15 3 AND TAS=   110 0 EAS=   110 0)
LIFTOFF (TIME=   17 6 DIST=   1956 0 TAS=   123 5 EAS=   123 5)
DISTANCE TO 35 FT =  3101.1   TAS=   144 6 EAS=   144 6 V35/VS=  1.4451

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
  AIRPORT ALTITUDE=      0. FT.   AMBIENT TEMP ABOVE STD  DAY=     0 0 DEG F
```

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T O FLAPS-LD GEAR EXT - ONE ENG OUT	0	115 4	.37 23	1 00	1.17	7.74
SEC SEG T O FLAPS - ONE ENGINE OUT	250	120 9	1093 60	293 59	1 08	10 00
FINAL T O CRUISE CONFIG - ONE ENG OUT	1500	137 4	1420 12	166 79	.87	11 63
APPROACH FLAPS - ONE ENG OUT	0	153 2	1352 34	325 58	.67	10 43
LANDING FLAPS - ALL ENGINES	0	121 0	2956 16	391 73	1.07	7.12

```
APPROACH FLAP SETTING = 11.8 DEG.


*** ENGINE-OUT SERVICE CEILING = 30094 2 FT
    BEST RATE OF CLIMB SPEED    =   240 4 KTAS
    ENGINE-OUT RATE OF CLIMB    =    99 9 FPM
    WEIGHT AT ALTITUDE          =  6924 0 LBS

              ****RESIZE ENGINES AT CRUISE TO ACCOUNT FOR RESIZED NACELLES****

PROPULSION SYSTEM WEIGHTS
  ENGINE WEIGHT/ENGINE             363 5
  NACELLE WEIGHT/ENGINE             74 6
  PYLON WEIGHT/ENGINE                4 4
     PROP OR OFAN          0.0
     GEARBOX               0.0
     SHROUD                0 0

ENGINE POD DIMENSIONS
  ENGINE FACE DIAMETER(FT)       1.95
  NACELLE LENGTH(FT)             5.33


VSTLKT= 100 0 KTS EAS   VRAT= 1.100 CLTO= 1.2823
     VEND =  228 5 KNOTS EAS


ROTATION (TIME=   15 3 AND TAS=   110 0 EAS=   110 0)
LIFTOFF (TIME=   17 6 DIST=   1955 9 TAS=   123 5 EAS=   123 5)
DISTANCE TO 35 FT.=  3101.5   TAS=   144 6 EAS=   144 6 V35/VS=  1.4452

TAKE OFF RATE OF CLIMB REQUIREMENTS - FAR PART 25
  AIRPORT ALTITUDE=      0  FT.   AMBIENT TEMP ABOVE STD  DAY=    0 0 DEG F
```

CONFIGURATION	ALT (FT)	V (KTAS)	R/C (FPM)	R/C REQ (FPM)	CL REQ	L/D
1ST SEG T O FLAPS-LD GEAR EXT - ONE ENG OUT	0	115 4	737 26	1 00	1 17	7 75
SEC SEG T O FLAPS - ONE ENGINE OUT	250	120 9	1093 64	293 59	1.08	10 00
FINAL T O CRUISE CONFIG - ONE ENG OUT	1500	137 4	1420 19	166 79	.87	11 63
APPROACH FLAPS - ONE ENG OUT	0	153 2	1352 46	325 58	.67	10 43
LANDING FLAPS - ALL ENGINES	0	121 0	2956 16	391 73	1 07	7 12

```
  APPROACH FLAP SETTING = 11 8 DEG.


  *** ENGINE-OUT SERVICE CEILING = 30056 8 FT
      BEST RATE OF CLIMB SPEED    =   240 4 KTAS
      ENGINE-OUT RATE OF CLIMB    =    99 9 FPM
      WEIGHT AT ALTITUDE          =  6924 0 LBS
ENGINE SIZED TO MATCH CRUISE DRAG - SLS AIRFLOW=     51 44

ENGINE SIZED TO MATCH T O  DISTANCE OF  3100  FT (STD DAY=  0  DEG R.ALT=     0 ) SLS AIRFLOW=    52.99

ENGINE SIZE MEETS ALL RATE OF CLIMB REQUIREMENTS
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RATED SEA LEVEL STATIC THRUST PER ENGINE= 1641 2 LBS

PROPULSION SYSTEM WEIGHTS

ENGINE WEIGHT/ENGINE		363 5
NACELLE WEIGHT/ENGINE		74 6
PYLON WEIGHT/ENGINE		4 4
PROP OR OFAN	0 0	
GEARBOX	0 0	
SHROUD	0 0	

ENGINE POD DIMENSIONS

ENGINE FACE DIAMETER(FT)	1 95
NACELLE LENGTH(FT)	5 33

---AIRCRAFT C G SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	MOST FWD LOAD CG	MOST AFT LOAD WT	MOST AFT LOAD CG	DESIGN LOAD WT	DESIGN LOAD CG
A/C OWE	4449 78	16 88	4448 78	16 88	4448 78	16 88
PAX	510 00		340 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	15 93	1143 62	15 93	1143 62	15 93
TIP FUEL	228 72	15 70	529 45	15 70	529 45	15 70
FUS FUEL	0 00	15 93	0 00	15 93	415 66	15 93
TOTAL	5187 50	16 19	6626 84	16 59	7212 50	16 15

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	0759	9500		390?	.084		0044			0 0000		-1
LIFTOFF	1 0000	0811	0659	9500	2044	39?	3790	0 0000	0044	0 0000	- 1031		0 0000	-1
LANDING	13 6895	0812	0660	9500	2 7976	1 7?	3785	3900	0044	0045	- 2000		0 0000	

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY)	=	- 0051
CHDELTA(RESTORING TENDENCY)	=	- 01204
CMDELTA(CONTROL POWER)	=	- 02743
TAU(EFFECTIVENESS)	=	48250

WING DE/DALPHA = 40872

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	2537	17 089
STATIC MARGIN	0300	
AFT CG LIMIT(STABILITY)	2237	16 952
CG RANGE(LOADING)	0863	
FWD CG LIMIT(CONTROL)	1374	16 556

HORIZONTAL TAIL SIZES

STATIC STABILITY AND TRIM	30 7065
STABILITY AND LIFTOFF	36 6633
LIFTOFF	36 4960
REQUIRED TAIL SIZE	36 6633
TAIL ARM(ELTH)	15 5467

VERTICAL TAIL AREA = 18 3461 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 17 7826 FOR MINIMUM CONTROL SPEED = 99 24 KTS

REQUIRED VERTICAL TAIL AREA = 18 3461 TAIL ARM(ELTV) = 13 9956

---AIRCRAFT C G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	4404 24	17 05	4404 24	17 05	4404 24	17 05
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17 30	1143 62	17 30	1143 62	17 30
TIP FUEL	228 72	17 19	529 45	17 19	529 45	17 19
FUS FUEL	0 00	17 30	0 00	17 30	460 19	17 30
TOTAL	5482 97	16 36	6242 31	17 13	7212 50	16 66

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT
CRUISE	2 7170	0997	0759	9500		3904	2993		0053			0 0000		-1
LIFTOFF	1 0000	0811	0659	9500	2103	3951	3677	0 0000	C053	0 0000	- 1031		0 0000	-1
LANDING	13 6895	0812	0660	9500	2 8784	1 7974	3673	3785	0053	0055	- 2000		0 0000	

ELEVATOR PARAMETERS

CHALPHA(FLOATING TENDENCY) = - 00511 WING DE/DALPHA = 42053

CHDELTA(RESTORING TENDENCY) = - 01204

CMDELTA(CONTROL POWER) = - 02936

TAUH(EFFECTIVENESS) = 48250

	FRACTION MAC	STATION (DATUM NOSE)
NEUTRAL POINT	2689	16 961
STATIC MARGIN	0300	
AFT CG LIMIT(STABILITY)	2389	16 824
CG RANGE(LOADING)	.1675	
FWD CG LIMIT(CONTROL)	0714	16 055

HORIZONTAL TAIL SIZES	
STATIC STABILITY AND TRIM	38 9527
STABILITY AND LIFTOFF	37 7730
LIFTOFF	37 5708
REQUIRED TAIL SIZE	38 9527
TAIL ARM(ELTH)	15 6618

VERTICAL TAIL AREA = 17.7621 FOR DIRECTIONAL STABILITY OF - 00200

VERTICAL TAIL AREA= 17.3349 FOR MINIMUM CONTROL SPEED = 99 24 KTS

REQUIRED VERTICAL TAIL AREA = 17 7621 TAIL ARM(ELTV) = 14 3670

---AIRCRAFT C G. SUMMARY (DATUM=NOSE)---

	MOST FWD LOAD WT	CG	MOST AFT LOAD WT	CG	DESIGN LOAD WT	CG
A/C OWE	4405 92	17 01	4405 92	17 01	4405 92	17 01
PAX	850 00		0 00		510 00	
BAGGAGE	0 00	17 73	165 00	17 73	165 00	17 73
WING FUEL	0 00	17 10	1143 62	17 10	1143 62	17 10
TIP FUEL	228 72	16 84	529 45	16 84	529 45	16 84
FUS FUEL	0 00	17 10	0 00	17 10	458 51	17 10
TOTAL	5484 65	16 31	6243 99	17 03	7212 50	16 57

---TAIL SIZING SUMMARY---

CONDITION	ALPHA	WING CLA	TAIL CLA	TAIL EFF	DOWN WASH	WING CL	--FUSELAGE-- DCM	CM	---NACELLE-- DCM	CM	FLAP CM	------POWER------- DCM	CM	CT

/50

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CRUISE   2.7170  .0997  .0759  .9500           .3904   .3110          .0040                       0 0000          -1
LIFTOFF  1.0000  .0811  .0659  .9500  .2118   .3951   .3822 0 0000   .0040 0 0000 - .1031             0 0000   -1
LANDING 13.6895  .0812  .0660  .9500 2 8992 1 7974   .3817   .3933   .0040   .0041 - .2000            0 0000

    ELEVATOR PARAMETERS
        CHALPHA(FLOATING TENDENCY)    =  -.00511         WING DE/DALPHA =    .42357
        CHDELTA(RESTORING TENDENCY)   =  -.01204
        CMDELTA(CONTROL POWER)        =  -.02888
        TAUH(EFFECTIVENESS)           =   .48250

                              FRACTION    STATION      HORIZONTAL TAIL SIZES
                                 MAC    (DATUM NOSE)
    NEUTRAL POINT               .2516      17.137         STATIC STABILITY AND TRIM      38 6240
    STATIC MARGIN               .0300                     STABILITY AND LIFTOFF          38 0938
    AFT CG LIMIT(STABILITY)     .2216      16.999         LIFTOFF                        38 0034
    CG RANGE(LOADING)           .1572                     REQUIRED TAIL SIZE             38 6240
    FWD CG LIMIT(CONTROL)       .0645      16 278         TAIL ARM(ELTH)                 15 5408

    VERTICAL TAIL AREA =   18.1218 FOR DIRECTIONAL STABILITY OF     -.00200

    VERTICAL TAIL AREA=   17.5310 FOR MINIMUM CONTROL SPEED =     99 24 KTS

    REQUIRED VERTICAL TAIL AREA =   18 1218  TAIL ARM(ELTV) =   14 1965

*************************************************************************************************

 WING LOCATION INFO.
FUSELAGE LENGTH        =  32 10      H-TAIL VOL  ARM        =  15 54     C G LOCATION OF PROPULSION=  20 87
WING 1/4C LOC ON C L.=  15 29      H-TAIL C G LOCATION    =  32 79     C G OF REMAINING WEIGHT    =  13.80
MAC 1/4C LOCATION      =  17 13      H-TAIL MAC FROM C L.   =   2 86
MAC DIST FROM C L.     =   6 88      H-TAIL LOCAT ON VERT   =     50
WING C G LOCATION      =  17 59      V-TAIL VOL  ARM        =  14 20
TIP TANKS C.G LOCATE   =  16 84      V-TAIL C G LOCATION    =  31 44

                        WING       H-TAIL      V-TAIL

  AREA               137.000      38 624      18 122
  SPAN                30 968      12 812       6 020
  ASPECT RATIO         7 000       4 250       2 000
  TAPER RATIO           .500        .500        .500
  1/4C  SWEEP         15 000      25 000      35 000
  L E  SWEEP          17 514      28 5?8      40 921
  C L  CHORD           5 899       4 020       4 014
  MEAN CHORD           4 588       3 126       3 122
  TIP CHORD            2.949       2 010       2 007

   TAXI AT IDLE THRUST

                  FUEL                        FUEL
 TIME    RANGE    USED    WEIGHT    ALT.      FLOW
 (HRS)   (NM)     (LBS)   (LBS)     (FT)    (LB/HR)

 0 000     0.       0      7213.      0.      238.
  .083     0.      20.     7193.      0       238.

VSTLKT=  99 9 KTS EAS   VRAT= 1.100 CLTO= 1.2823
    VEND =  231.3 KNOTS EAS

ROTATION (TIME=   15 2 AND TAS=   109 9 EAS=   109 9)
LIFTOFF (TIME=   17 6 DIST=   1962 0 TAS=   123 9 EAS=   123 9)
DISTANCE TO 35 FT =  3070 2   TAS=   144 4 EAS=   144 4 V35/VS=  1.4451
GEAR RETRACTION STARTED AT   23 4 SEC.COMPLETE AT   30 4 SEC
FLAP RETRACTION STARTED AT   33 3 SEC.COMPLETE AT   37 8 SEC
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VSTLKT=  99 9 KTS EAS   VRAT= 1.100 CLTO= 1 2823

 ENGINE OUT PERFORMANCE FOLLOWS
     VEND =  231 3 KNOTS EAS
ENGINE FAILURE (TIME=   14 4 AND TAS=   104 9 EAS=   104 9)

ROTATION (TIME=   15 9 AND TAS=   109 9 EAS=   109 9)
LIFTOFF (TIME=   18 8 DIST=   2169 2 TAS=   116 1 EAS=   116 1)
DISTANCE TO 35 FT =  3240 2   TAS=   119 9 EAS=   119 9 V35/VS=  1 2004

    ACCELERATE - STOP DISTANCE =     3389 5 FEET.

  ENGINE OUT DISTANCE TO 35 FT =.    3240 2 FEET

ALL ENGINE DISTANCE TO 35 FT  (L) =     3070 2 FEET
FAR 25 T O  DISTANCE (1 15XL) =     3530 7 FEET
ALL ENGINE DISTANCE TO 50 FT  =     3291 2 FEET

  AT END OF TAKEOFF PHASE
TIME=    093 HRS   FUEL USED=     36  LBS   WEIGHT=   7177  LBS   ALT =    500. FT

 ACCELERATE TO MACH NO  =  353

 END OF ACCELERATION SEGMENT
 TIME=  .097 HRS   FUEL USED=    41 5 LBS   WEIGHT=   7171. LBS   RANGE=   1  NM
   END OF CLIMB TO   40000  FT
TIME=   .331 HRS   FUEL USED=    271  LBS   WEIGHT=   6941  LBS   RANGE=    68  NM

ALTITUDE=     40000  FT   TAS=    439 69 KTS   MACH NO=      7659

 ACCELERATE TO MACH NO  =  700

END OF ACCELERATION SEGMENT
TIME=  .369 HRS   FUEL USED=   296 3 LBS   WEIGHT=   6916  LBS   RANGE=   82  NM

 ACCELERATE TO MACH NO  =  766

END OF ACCELERATION SEGMENT
TIME=  396 HRS   FUEL USED=   314 9 LBS   WEIGHT=   6898  LBS   RANGE=   94  NM

 ACCELERATE TO MACH NO. =  .640

END OF ACCELERATION SEGMENT
TIME=   348 HRS   FUEL USED=   282 5 LBS   WEIGHT=   6930  LBS   RANGE=   74  NM
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DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
**** MAXIMUM PAYLOAD *****
FUEL AVAILABLE= 1807

		AT SPECIFIED SPEED		AT NORMAL POWER		AT BEST SPEC RANGE	
		START CRUISE	END CRUISE	START CRUISE	END CRUISE	START CRUISE	END CRUISE
TIME	HRS.	369	2 728	396	2 308	348	3 112
RANGE	N MI	82	1030	94	935	74	1090
FUEL USED	LBS.	296	1432	315	1377	282	1469
WEIGHT	LBS	6916	5780	6898	5836	6930	5744
ALTITUDE	FT	40000	40000	40000	40000	40000	40000
TAS	KTS	401 9	401 9	439 7	439 7	367 7	367 7
EAS	KTS.	199 8	199 8	218 6	218 6	182 8	182 8
MACH NO		7000	7000	7659	7659	6404	5404
DIV MACH		7627	7702	7703	7761	7537	7630
ANGLE ATTACK	DEG	2 556	1 939	1 754	1 299	3 491	2 688
FUSE ANGLE	DEG.	1 556	939	754	299	2 491	1 688
CL		3744	3129	3119	2639	4481	3714
L/D		10 512	9 435	9 557	8 505	11 284	10 324
FUEL FLOW	LB/HR	499 3	465 0	573 2	539 2	450 4	409 1
BREG FACTOR	N MI	5571	4999	5294	4762	5661	5166
SPEC RANGE	NM/LB	80491	86419	76705	81549	81630	89881

RESERVE FUEL(LBS) 374 430 338
(45 0 MIN.)

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ACCELERATE TO MACH NO. = .700

END OF ACCELERATION SEGMENT
TIME= .369 HRS FUEL USED= 296 3 LBS WEIGHT= 6916 LBS RANGE= 82 NM

ACCELERATE TO MACH NO. = .766

END OF ACCELERATION SEGMENT
TIME= .396 HRS FUEL USED= 314 9 LBS WEIGHT= 6898 LBS RANGE= 94 NM

ACCELERATE TO MACH NO = 640

END OF ACCELERATION SEGMENT
TIME= 348 HRS FUEL USED= 282 5 LBS WEIGHT= 6930 LBS RANGE= 74 NM

DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
****** MAXIMUM FUEL ******
FUEL AVAILABLE= 2132

		AT SPECIFIED SPEED START CRUISE	END CRUISE	AT NORMAL POWER START CRUISE	END CRUISE	AT BEST SPEC RANGE START CRUISE	END CRUISE
TIME	HRS.	.369	3.432	.396	2.905	.348	3.912
RANGE	N MI	82	1313	94	1197	74	1384
FUEL USED	LBS.	296	1757	315	1702	282	1794
WEIGHT	LBS.	6916	5455	6898	5511	6930	5419
ALTITUDE	FT	40000	40000	40000	40000	40000	40000
TAS	KTS.	401.9	401.9	439.7	439.7	367.7	367.7
EAS	KTS.	199.8	199.8	218.6	218.6	182.8	192.8
MACH NO		.7000	.7000	.7659	.7659	.6404	.6404
DIV MACH		.7627	.7723	.7703	.7779	.7537	.7656
ANGLE ATTACK	DEG.	2.556	1.763	1.754	1.160	3.491	2.468
FUSE ANGLE	DEG.	1.556	.763	.754	.160	2.491	1.468
CL		.3744	.2953	.3119	.2492	.4481	.3504
L/D		10.512	9.075	9.557	8.147	11.284	9.984
FUEL FLOW	LB/HR	499.3	456.4	573.2	534.6	450.4	399.3
BREG FACTOR	N MI	5570	4807	5294	4535	5661	4993
SPEC RANGE	NM/LB	.80491	.88060	.76705	.82242	.81630	.92083

RESERVE FUEL(LBS) 374. 430 338
(45.0 MIN.)

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RANGE = 1197. BLOCK TIME= 2.905 USED FOR DESIGN RANGE AND COST

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TEMP = 518. DEG.STD.+ 0.
LANDING ELEVATION= 0. FT
LANDING WING LOADING= 52.65 PSF.
LANDING WEIGHT = 7213. LBS.

LANDING DISTANCE FROM 50. FT.= 2463. FT.

F A R FACTORED FIELD LENGTH = 4105. FT.

APPROACH		TRANSITION		DELAY		ROLL	
DIST=	609.	DIST=	237.	DIST=	180.	DIST=	1436.
R/S=	1000.	XLFMX=	1.150	TDELAY=	1.00	MUB=	.4000
VAPEAS=	120.58	SINKTD=	3.000	TIDLE=	.161	TR/TIDLE=	0.0000
VAPTAS=	120.66	VSTEAS=	92.75	VTDTAS=	106.74	ABAR(G)=	.3517
THETA=	4.69	CLMX=	1.8041				
THRUST=	422.	HFLAR=	27.9				

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RANGE OR ENDURANCE ITERATION SUMMARY

ITERATION	GROSS WEIGHT(LB)	RANGE(NMI) OR ENDURANCE(HR)

154

0	7500 00	1300 979
1	5625 00	474 687
2	7270 86	1226 664
3	7212 50	1197 334
REQUIRED RG OR END. •		1200 000

GASP TURBOFAN SAMPLE USING SCALED TFE-731

GROSS WEIGHT = 7213. PASSENGERS = 5 PLUS CREW OF 1

FUSELAGE	LENGTH	(ELF)	32 10	FT
	WIDTH	(SWF)	4 67	FT
	WETTED AREA	(SF)	372	SQFT
	DELTA P	(DELP)	8 19	PSI
WING	ASPECT RATIO	(AR)	7 00	
	AREA	(SW)	137 0	SQFT
	SPAN	(B)	31 0	FT
	GEOM MEAN CHORD	(CBARW)	4 59	FT
	QUARTER CHORD SWEEP	(DLMC4)	15 0	DEG
	TAPER RATIO	(SLM)	500	
	ROOT THICKNESS	(TCR)	120	
	TIP THICKNESS	(TCT)	100	
	WING LOADING	(WGS)	52 6	PSF
	WING FUEL VOLUME	(VFW)	171 0	GAL
HOR. TAIL	ASPECT RATIO	(ARHT)	4 25	
	AREA	(SHT)	38 6	SQFT
	SPAN	(BHT)	12 81	FT
	MEAN CHORD	(CBARHT)	3 13	FT
	THICKNESS/CHORD	(TCHT)	080	
	MOMENT ARM	(ELTH)	15 5	FT
	VOLUME COEFF.	(VBARH)	955	
VERT. TAIL	ASPECT RATIO	(ARVT)	2 00	
	AREA	(SVT)	18 1	SQFT
	SPAN	(BVT)	6 02	FT
	MEAN CHORD	(CBARVT)	3 12	FT
	THICKNESS/CHORD	(TCVT)	100	
	MOMENT ARM	(ELTV)	14 2	FT
	VOLUME COEFF.	(VBARV)	061	
ENG NACELLES	LENGTH	(ELN)	5 33	FT
	MEAN DIAMETER	(DBARN)	1 95	FT
	NUMBER ENGINES	(ENP)	2 0	
	WETTED AREA	(SN)	65 23	SQFT
	LOCATION		ON FUSELAGE	
TIP TANKS	VOLUME	(VFTP)	5 29	CUFT
	DIAMETER	(BXIS)	1 16	FT
	LENGTH	(AXIS)	9 32	FT
	WETTED AREA	(STIP)	52 56	SQFT

GASP TURBOFAN SAMPLE USING SCALED TFE-731

VDIVE = 360 KTS VMO = 300 KTS MMO = .806
ULT. LF = 5.60 MAN. LF = 2.50 GUST LF = 3.73

PROPULSION GROUP			
PRIMARY ENGINES	(WEP)	727	
PRIMARY ENGINE INSTL	(WPEI)	98	
FUEL SYSTEM	(WFSS)	49.	
TOTAL PROP GROUP WT.	(WP)	875.	
STRUCTURES GROUP			
WING	(WW)	659.	
HOR TAIL	(WHT)	121.	
VERT TAIL	(WVT)	72.	
FUSELAGE	(WB)	821.	
LANDING GEAR	(WLG)	289.	
PRIMARY ENG. SECTION	(WPES)	158.	
TIP TANKS	(WTIP)	99.	
GROUP WEIGHT INC.	(DELWST)	0.	
TOTAL STRUC GROUP WT.	(WST)	2219.	
FLIGHT CONTROLS GROUP			
COCKPIT CONTROLS	(WCC)	25.	
FIXED WING CONTROLS	(WCFW)	87.	
SAS	(WSAS)	0	
GROUP WEIGHT INC.	(DELWFC)	0.	
TOTAL CONTROL WT.	(WFC)	112.	
WT. OF FIXED EQUIPMENT	(WFE)	860.	
WEIGHT EMPTY	(WE)	4066.	
FIXED USEFUL LOAD	(WFUL)	340.	(INC. CREW)
OPERATING WEIGHT EMPTY	(OWE)	4406.	
PAYLOAD	(WPL)	675.	(PAX VOL = 5. DESIGN PAX= 3.)
FUEL	(WFA)	2132.	(WFV= 1144.) (WFTP= 529.)
GROSS WEIGHT	(WG)	7213.	

GASP TURBOFAN SAMPLE USING SCALED TFE-731

CRUISE MACH = .700 CRUISE ALTITUDE = 40000 CRUISE Q (PSF) =135 04

CRUISE RE NUM. PER FT. = 1.343E+06 FLATPLATE CF AT RE=10EX7 IS .00277

AERODYNAMIC DATA

DRAG BREAKDOWN	FLATPLATE AREA(SQFT)	CDO	WETTED AREA(SQFT)
WING	1 0508	.00767	221 02
FUSFLAGE	1 5835	.01156	371 51
VERT. TAIL	.1407	.00103	36 24
HOR TAIL	.3026	.00221	77 25
ENGINE NAC.	.3231	.00236	65 23
TIP TANKS	.1599	.00117	52 56
INCREMENTAL	.2055	.00150	0 00
TOTAL	3.7662	.02749	823 82

MEAN SKIN FRICTION COEF = .004572

AERODYNAMIC COEFF.

A1	.8082	
A2	-.1216	
A3	.0342	
A4= .75X(T/C)	.0833	
A5=CDO--	.0175	
A6	2 7678	
A7=1/(PI SEE AR)	.0557	
3-D LIFT SLOPE AT CRUISE MACH (CLALPH)	5 7109	PER RADIAN
OSWALD FACTOR (SEE)	.8007	

CRUISE CD = .0275 + .0557 CL2 (ASSUMES MINIMUM WING PROFILE DRAG)

RETRACTABLE LANDING GEAR CD INC.= .02850

CRUISE DRAG

CL= .1000

MACH	CD	L/D	CLALPH	ALPHA
.50000	.02805	3 5654	5 0827	-.0727
.55000	.02805	3 5654	5 2006	-.0983
.60000	.02805	3 5654	5 3408	-.1272
.65000	.02805	3 5654	5 5085	-.1599
.70000	.02805	3 5654	5 7109	-.1967
.75000	.02805	3 5654	5 9569	-.2385
.80000	.02805	3 5652	6 2692	-.2861
.85000	.03206	3.1193	6 6690	-.3409

CL= .2000

MACH	CD	L/D	CLALPH	ALPHA
.50000	.02976	6 7208	5 0827	1 0545
.55000	.02976	6 7208	5 2006	1 0034
.60000	.02976	6 7208	5 3408	.9456
.65000	.02976	6 7208	5 5085	.8803
.70000	.02976	6 7208	5 7109	.8065
.75000	.02976	6 7208	5 9589	.7230
.80000	.02987	6 6968	6 2692	.6279
.85000	.03714	5 3851	6 6690	.5183

CL= .3000

MACH	CD	L/D	CLALPH	ALPHA
.50000	.03270	9 1736	5 0827	2 1818

.55000	.03270	9.1736	5 2006	2 1051
.60000	.03270	9.1736	5 3408	2.0184
.65000	.03270	9.1736	5 5085	1 9204
.70000	.03270	9 1736	5 7109	1 8098
.75000	03270	9 1736	5 9589	1 6845
.80000	03328	9 0145	6 2692	1 5418
85000	.04495	6.6736	6 6690	1.3774

CL= .4000

MACH	CD	L/D	CLALPH	ALPHA
50000	03676	10 8808	5 0827	3 3091
.55000	03676	10 8808	5 2006	3 2068
60000	.03676	10 8808	5 3408	3 0911
.65000	.03676	10 8808	5 5085	2 9608
.70000	.03676	10 8808	5 7109	2 8131
.75000	03676	10 8808	5 9589	2 6460
.80000	03845	10 4030	6 2692	2 4557
.85000	05566	7 1870	6 6690	2 2365

CL= .5000

MACH	CD	L/D	CLALPH	ALPHA
50000	.04213	11 8675	5 0827	4 4363
.55000	04213	11 8675	5 2006	4 3085
.60000	04213	11 8675	5 3408	4 1639
.65000	.04213	11 8675	5 5085	4 0007
70000	04213	11 8675	5 7109	3 8163
75000	04213	11 8674	5 9589	3 6075
80000	04585	10 9056	6 2692	3 3696
85000	06972	7 1717	6 6690	3 0957

LOW SPEED LIFT/DRAG-GR UP(IF RIO G E.

	FLAPS UP			TAKEOFF			LANDING	
ALPHA	CL	CD	L/D	CL	CD	L/D	CL	CD	L/D
-2 00000	- 06503	02792	-2 32932	13259	04329	3 06311	39639	07678	5 16219
0 00000	09754	02802	3 48088	29596	04594	6 44176	55377	08143	6 87425
2 00000	26010	03139	8 28508	45934	05184	8 86057	72114	08975	8 05690
4 00000	42267	03788	11 15765	62272	06106	10 19771	88452	10185	8 70457
6 00000	58523	04759	12 29773	78610	07380	10 65232	1 04990	11799	8 89832
8 00000	74780	06083	12 29402	94948	09039	10 50448	1 21328	13881	8 74046
10 00000	91036	07798	11 67458	1 11285	11158	9 97362	1 37666	16562	8 31206
12 00000	1 07293	10009	10 71992	1 27623	13851	9 21391	1 54003	19709	7 81373
14 00000	1 23549	.12709	9 72178	1 43961	16848	8 54470	1 70341	23205	7 34084

ALTITUDE= 40000 FT TAS= 441 99 KTS MACH NO= 7699

15 5

```
                    --- COST DATA ---
AIRCRAFT PRICING

     ENGINES       NUMBER =    2   TYPE=     7

     EMPTY WEIGHT=    4066  LBS                 MAX CRUISE SPEED=   442. KNOTS

     CONSUMER PRICE= 582132. DOL.         BASIC PRICE= 470077  DOL
                                          ADD  EQUIPMENT COST= 112055  DOL.

     DIRECT LABOR ( 6832 MHRS )       34162
     LABOR OVERHEAD(145 PCT)          49695
     AIRFRAME MATERIALS                7647
     PURCHASED EQUIP                 140052
        ($/ENG = 44641.)
        (OTHER = 50770.)
                                     231555   SUB-TOTAL
     ENG.TL.SALES.G-A( 35 PCT)        79969
                                     311524   MANUFACTURING COST
     FACTORY PROFIT( 16 PCT)          50073
                                     361597   DEALER COST
     DEALER-DIST. MARKUP( 30 PCT)    108479
                                     470077   BASIC PRICE
```

```
***************************************************************************************

   DESIGN MISSION

      OPERATING COST FOR NOR RATED POWER AND  40000  ALTITUDE

        SEATS=       6.          FUEL COST=      .750 $/GAL

        RANGE=    1197. N.M.     BLOCK FUEL=    1702  LBS     BLOCK TIME=  2.905 HRS.

        FUEL RATE= 87.4 GPH.     TBO= 2000  HRS     HOURS/INSP. =  100  HRS.

        VARIABLE COST    (DOL/HR)               FIXED COST      (DOL/YR)
            FUEL+OIL        65 84                   STORAGE         1200
            INSP +MAIN.     20 00                   INSURANCE      15553  (HULL 2 5PCT)
            OVERHAUL RES.   16 41                   DEPRECIATION   58213  ( 8 YR-20 PCT)
            OTHER            0 00                   OTHER              0
                                                    CREW               0  (OVERHEAD 50 PCT)
                                                    FAA TAX          277
                        102 25 TOTAL                               75244. TOTAL

        UTILIZATION(HRS/YR)        100.     200      300      400      500      800.
        TOTAL OPR COST(DOL/HR)   854 69   478 47   353 06   290 36   252 74   196 30
        TOTAL OPR COST(DOL/NM)     2 07     1 16      86       70       61       48
        TOTAL OPR COST(C/ASNM)    34 56    19 35    14 28    11 74    10 22     7 94

SPEED LIMITED BY MMO OR VMO------ MACH NO =   .7434 FNAV=     1135 75 FNRQ=     1123 79
```

OFF DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
**** MAXIMUM PAYLOAD *****
FUEL AVAILABLE= 1807.

		AT SPECIFIED SPEED		AT NORMAL POWER		AT BEST SPEC. RANGE	
		START CRUISE	END CRUISE	START CRUISE	END CRUISE	START CRUISE	END CRUISE
TIME	HRS.	.198	3 051	233	1 229	197	3 231
RANGE	N MI	27.	866	41.	487	26	906
FUEL USED	LBS.	171.	1457.	210	1117	170	1473
WEIGHT	LBS.	7041.	5755	7003	6095	7043	5739
ALTITUDE	FT.	25000.	25000.	25000	25000	25000	25000
TAS	KTS.	301 3	301 3	447 9	447 9	289 9	289 9
EAS	KTS.	201 8	201 8	300 0	300 0	194 2	194 2
MACH NO.		.5000	.5000	7433	7433	4812	4812
DIV. MACH		.7628	.7711	7878	7904	7592	.7682
ANGLE ATTACK	DEG.	3.010	2 241	426	215	3 383	2 534
FUSE. ANGLE	DEG.	2 010	1 241	- 574	- 785	2 383	1 534
CL		.3735	3053	.1681	.1463	4034	.3287
L/D		10 592	9 371	6 237	5 507	10 964	9 776
FUEL FLOW	LB/HR	465 9	437 1	918 8	905 8	444 3	416 4
BREG. FACTOR	N MI.	4557.	3969	3416	3016	4599	3999
SPEC. RANGE	NM/LB	.64674	.68924	.48749	.49447	.65259	.69634
RESERVE FUEL(LBS) (45.0 MIN.)		349.		689.		333.	

****

OFF DESIGN CASE
CRUISE PERFORMANCE SUMMARY
FOR
***** DESIGN PAYLOAD *****
****** MAXIMUM FUEL ******
FUEL AVAILABLE= 2132.

		AT SPECIFIED SPEED START CRUISE	AT SPECIFIED SPEED END CRUISE	AT NORMAL POWER START CRUISE	AT NORMAL POWER END CRUISE	AT BEST SPEC. RANGE START CRUISE	AT BEST SPEC. RANGE END CRUISE
TIME	HRS.	.198	3.799	233	1 591	197	4 018
RANGE	N.MI	27.	1112.	41	649	26	1134.
FUEL USED	LBS.	171.	1782.	210	1442	170	1798
WEIGHT	LBS.	7041.	5430.	7003	5770	7043	5414.
ALTITUDE	FT.	25000.	25000.	25000	25000	25000	25000.
TAS	KTS.	301.3	301.3	447 9	447 9	289 9	289 9
EAS	KTS.	201 8	201.8	300 0	300 0	194 2	194 2
MACH NO.		.5000	.5000	.7433	.7433	.4812	.4812
DIV MACH		.7628	.7732	.7878	7914	.7592	.7705
ANGLE ATTACK	DEG.	3 010	2 047	426	140	3 383	2 323
FUSE. ANGLE	DEG.	2 010	1 047	-.574	-.860	2 383	1 323
CL		.3735	.2880	.1681	.1385	4034	.3101
L/D		10 592	9 006	6 237	5 238	10 964	9 416
FUEL FLOW	LB/HR	465.9	431 3	918 8	901 6	444 3	410 3
BREG FACTOR	N MI.	4557.	3796.	3416	2868	4599	3829
SPEC. RANGE	NM/LB	.64674	.69860	.48749	49679	65259	70674

RESERVE FUEL(LBS) 349. 689 333
(45.0 MIN.)

****

RANGE = 649. BLOCK TIME= 1.591 USED FOR OFF DESIGN RANGE AND COST

****

ALTITUDE= 40000. FT TAS= 441.99 KTS MACH NO= .7699

****

OFF DESIGN MISSION

OPERATING COST FOR NOR.RATED POWER AND 25000 ALTITUDE

SEATS= 6. FUEL COST= 750 $/GAL

RANGE= 649. N M. BLOCK FUEL= 1442 LBS BLOCK TIME= 1.591 HRS.

FUEL RATE=135 3 GPH. TBO= 2000 HRS HOURS/INSP.= 100. HRS.

VARIABLE COST	(DOL/HR)	FIXED COST	(DOL/YR)	
FUEL-OIL	101.75	STORAGE	1200	
INSP.+MAIN.	20.00	INSURANCE	15553	(HULL 2 5PCT)
OVERHAUL RES.	16 41	DEPRECIATION	58213	(8 YR-20 PCT)
OTHER	0 00	OTHER	0	
		CREW	0	(OVERHEAD 50 PCT)
		FAA TAX	277	
	138.17 TOTAL		75244	TOTAL

UTILIZATION(HRS/YR)	100	200	300	400	500.	800.
TOTAL OPR COST(DOL/HR)	890 60	514 38	388 98	326 27	288 65	232 22
TOTAL OPR COST(DOL/NM)	2 18	1 26	95	80	71	.57
TOTAL OPR COST(C/ASNM)	36 38	21 01	15 89	13 33	11 79	9 49

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GASP - GENERAL AVIATION SYNTHESIS PROGRAM

VOLUME I - MAIN PROGRAM

PART 3 - PROGRAMMER'S MANUAL

JANUARY 1978

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Ames Research Center
Moffett Field, California

Under

CONTRACT NAS 2-9352

AEROPHYSICS RESEARCH CORPORATION

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I.3 PROGRAMMERS MANUAL FOR MAIN PROGRAM AND UTILITY SUBROUTINES

This volume presents a description of the GASP Executive Program and the Utility Subroutines of GASP.

I.3.1 MAIN Program

The principal purposes of the MAIN program are the reading of input data required for the aircraft design, and the calling of the subroutines which carry out this design. The input data is read as a title card, NAMELIST/ INGASP/ and NAMELIST/INPROP/ , and tabular input if that propulsion option is selected which total about 220 and 50 parameters respectively. Many of these are given default values in the event that no numerical value is assigned in the NAMELIST format. These parameters vary from the fundamental (gross weight, cruise Mach number, etc.) to the detailed (takeoff rotation rate, seat width, etc.), and are listed alphabetically in Section 1.5. The subroutine structure of MAIN down to the first level arrayed by technology is presented in Figure I.3.1.

The main program calls one minor data reading subroutine (MAPS) and thirteen major subroutines which are normally called in the following order. Each subroutine may call other subroutines as indicated parenthetically:

SIZE

FLAPS

DLAND (AERO, CLIFT, DRAG, ENGINE)

CTAER (AERO, CLIFT, DRAG)

ENGSZ (APPFLP, DRAG, ENGINE, ENGWGT, PERFRM, TURN)

ENGWGT (ENGINE, HOPWSZ, RCWSZ

WGHT (LOAD, ENGSZ, ENGWGT, TAIL)

OUTPUT (CLIFT)

AEROUT (CLIFT, DRAG)

PERFRM (ACCEL, CLIMB, DLAND, TAKOFF, TAXI, TURN, XRANGE)

RGBAL (AEROUT, CTAER, ENGSZ, ENGWGT, FLAPS, OUTPUT, PERFORM,
SIZE, WGHT)

GACOST (ASPEED, ENGINE)

PNOYS (ASPEED, ENGINE, GEARBX, ZNENG)

It may be noted, for example, that subroutine PERFRM is also called by ENGSZ and RGBAL, and that ENGSZ is called by WGHT. That is, there exists a very strong and complex connection between the various subroutines and the final effect of changing a parametric value is usually impossible to predict *a priori*. A detailed flow chart for the MAIN program is presented in Figure I.3.2.

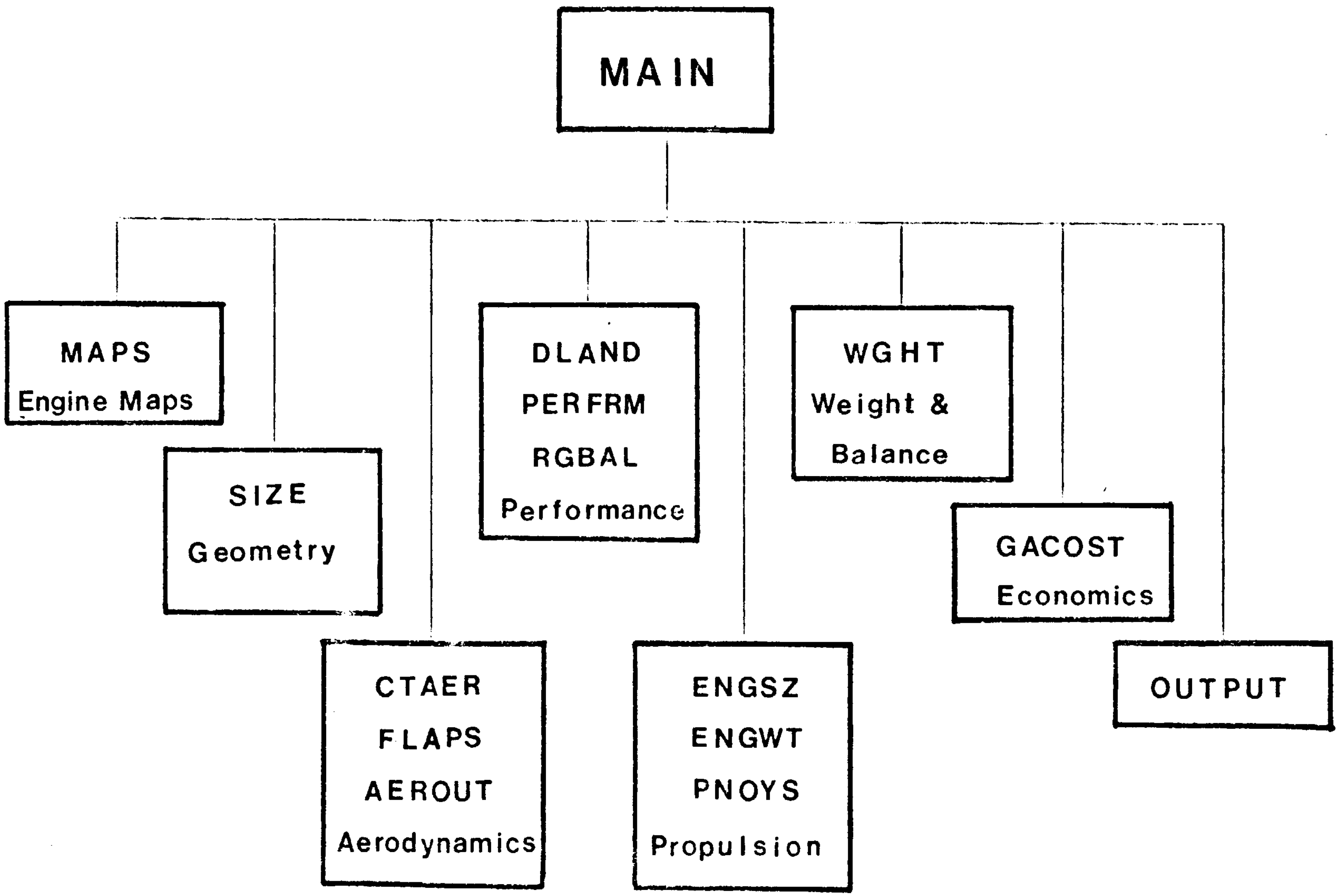

FIGURE I.3.1 - MAIN PROGRAM & SUBROUTINE STRUCTURE

FIGURE I.3.2 PROGRAM MAIN

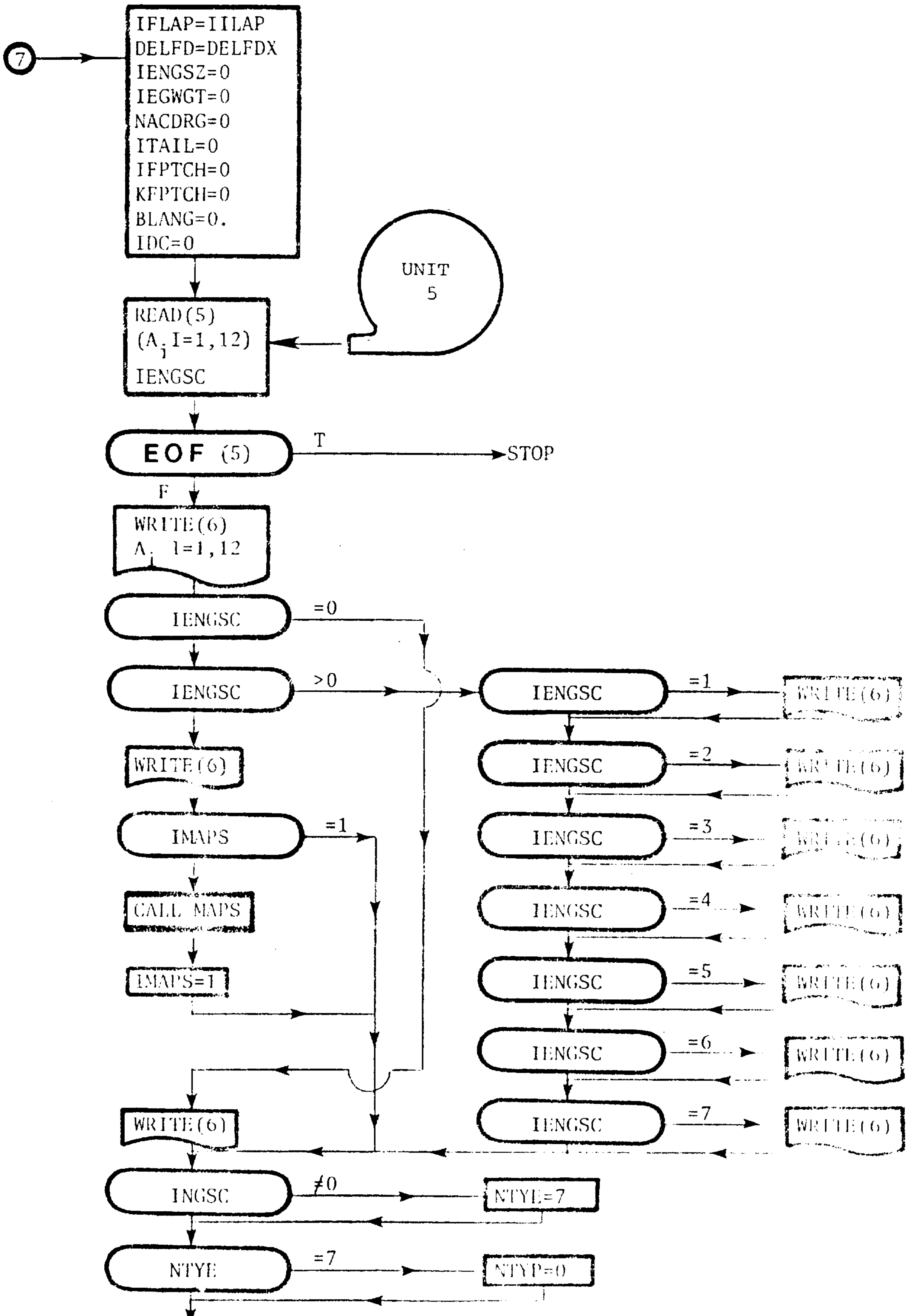

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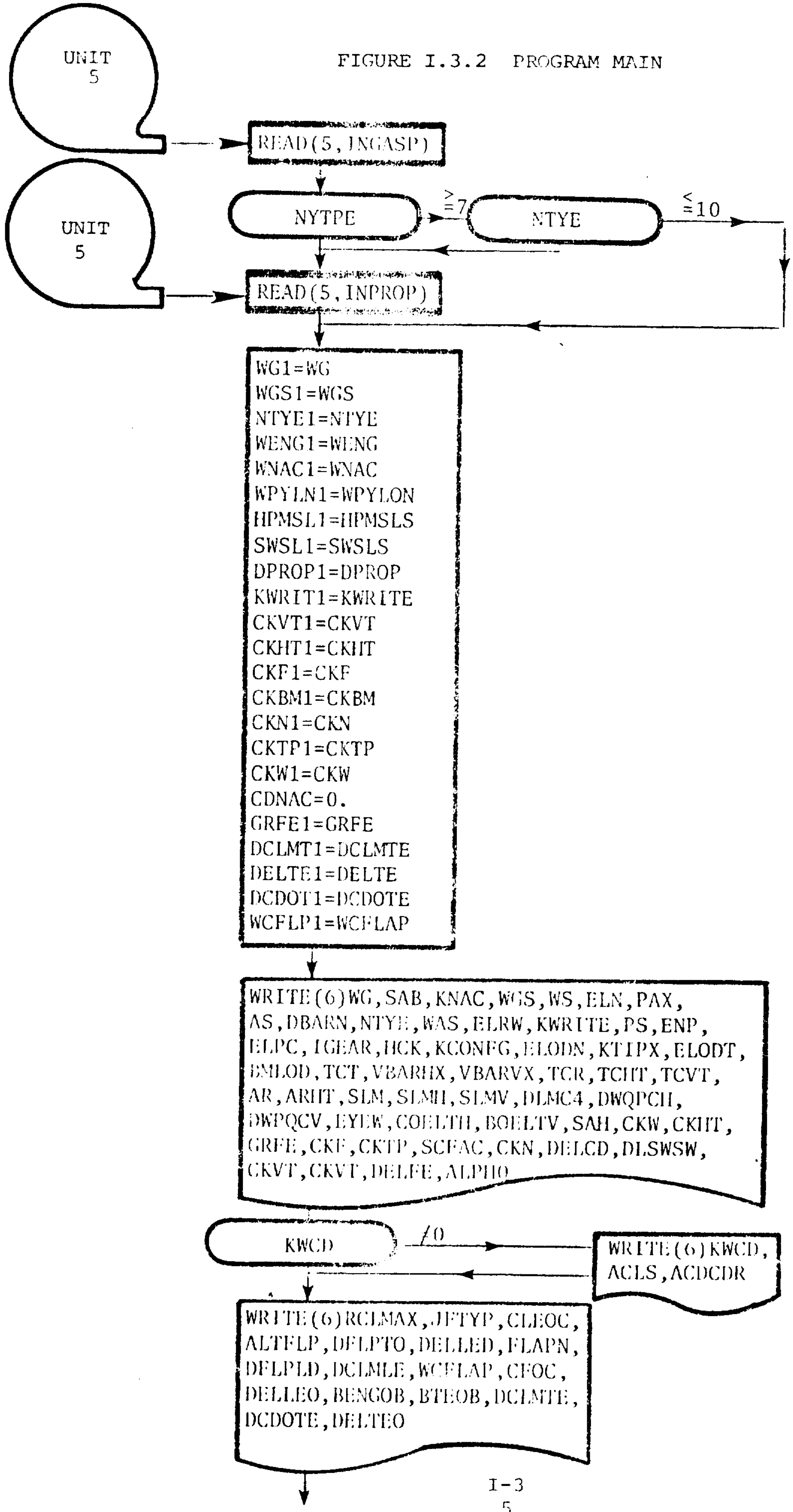
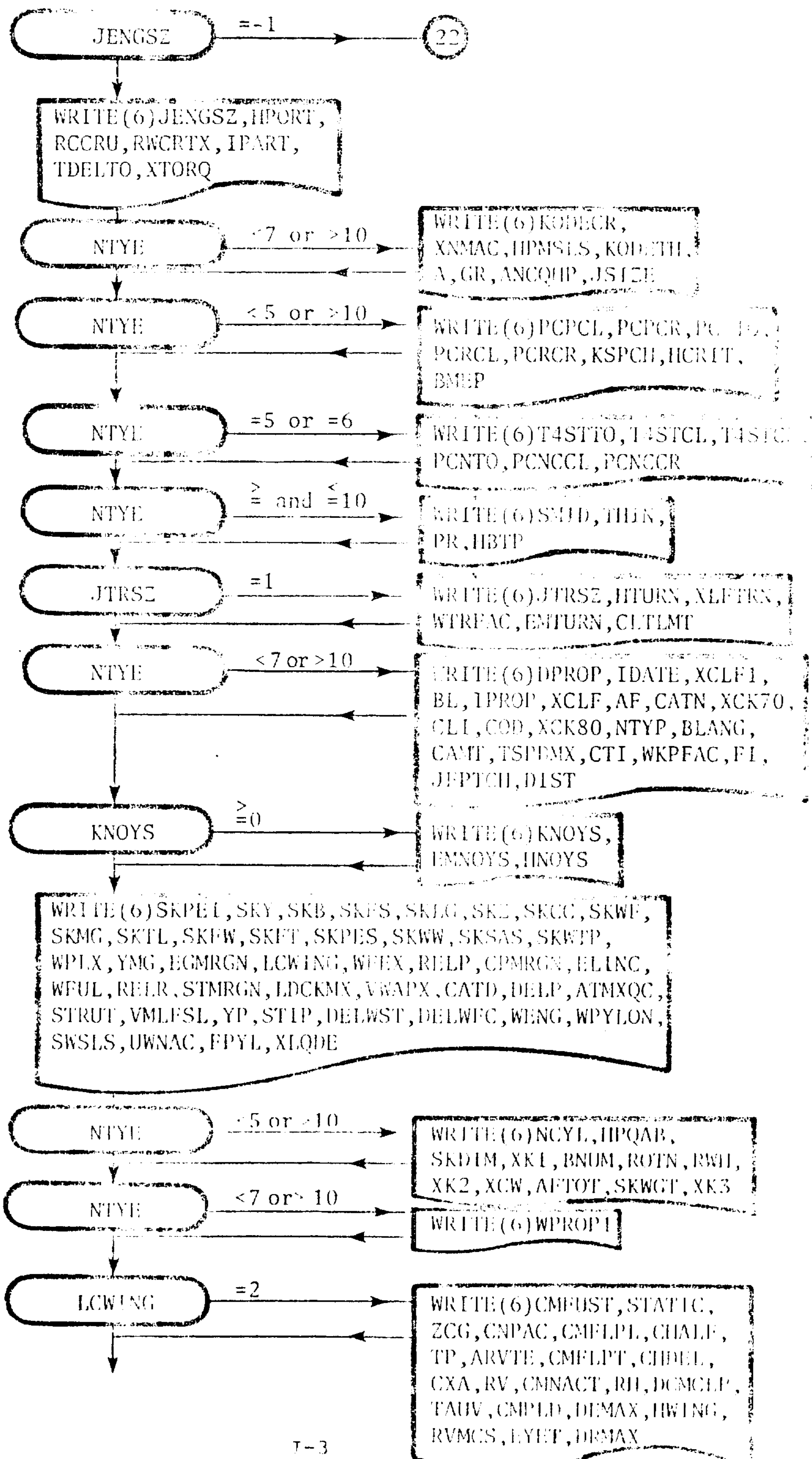
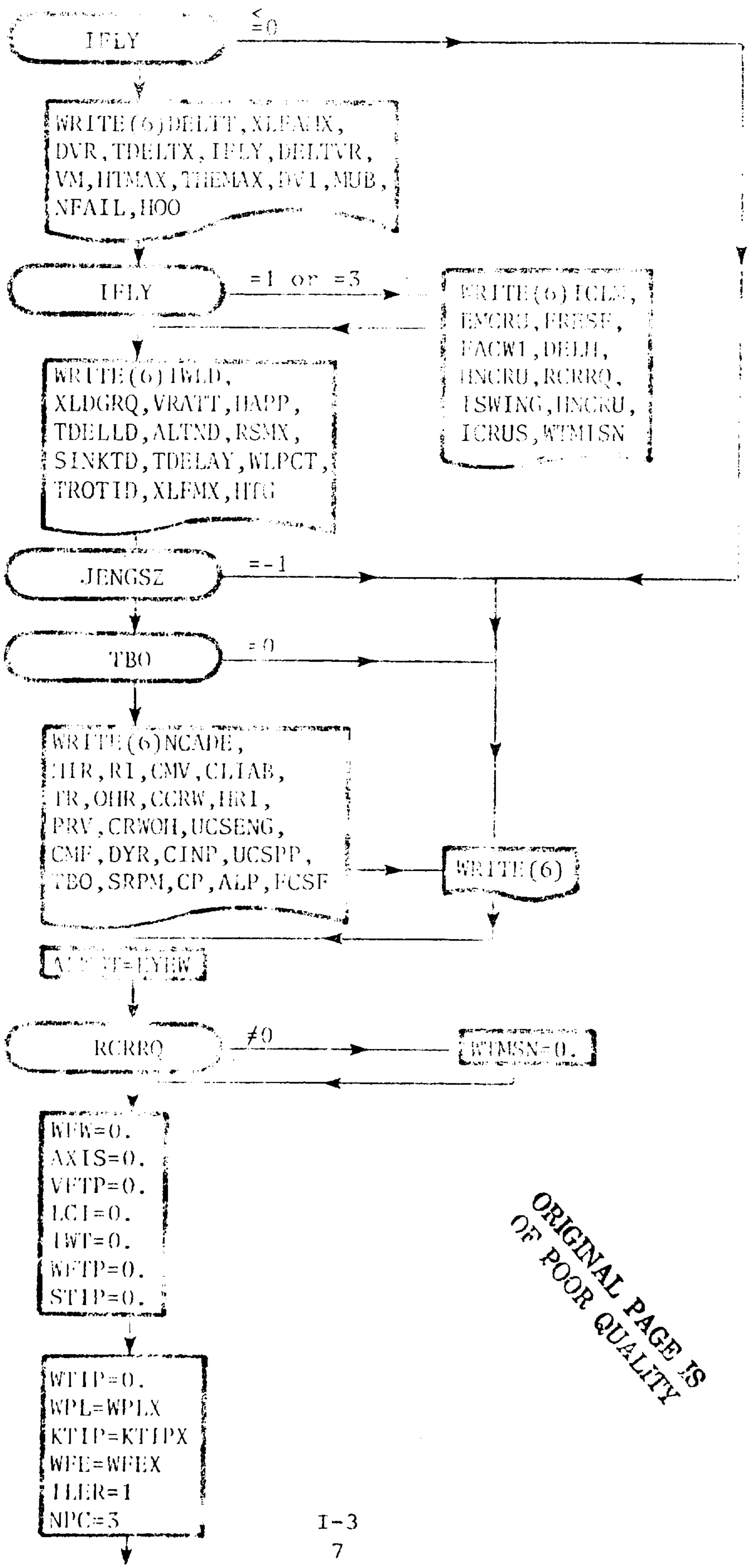
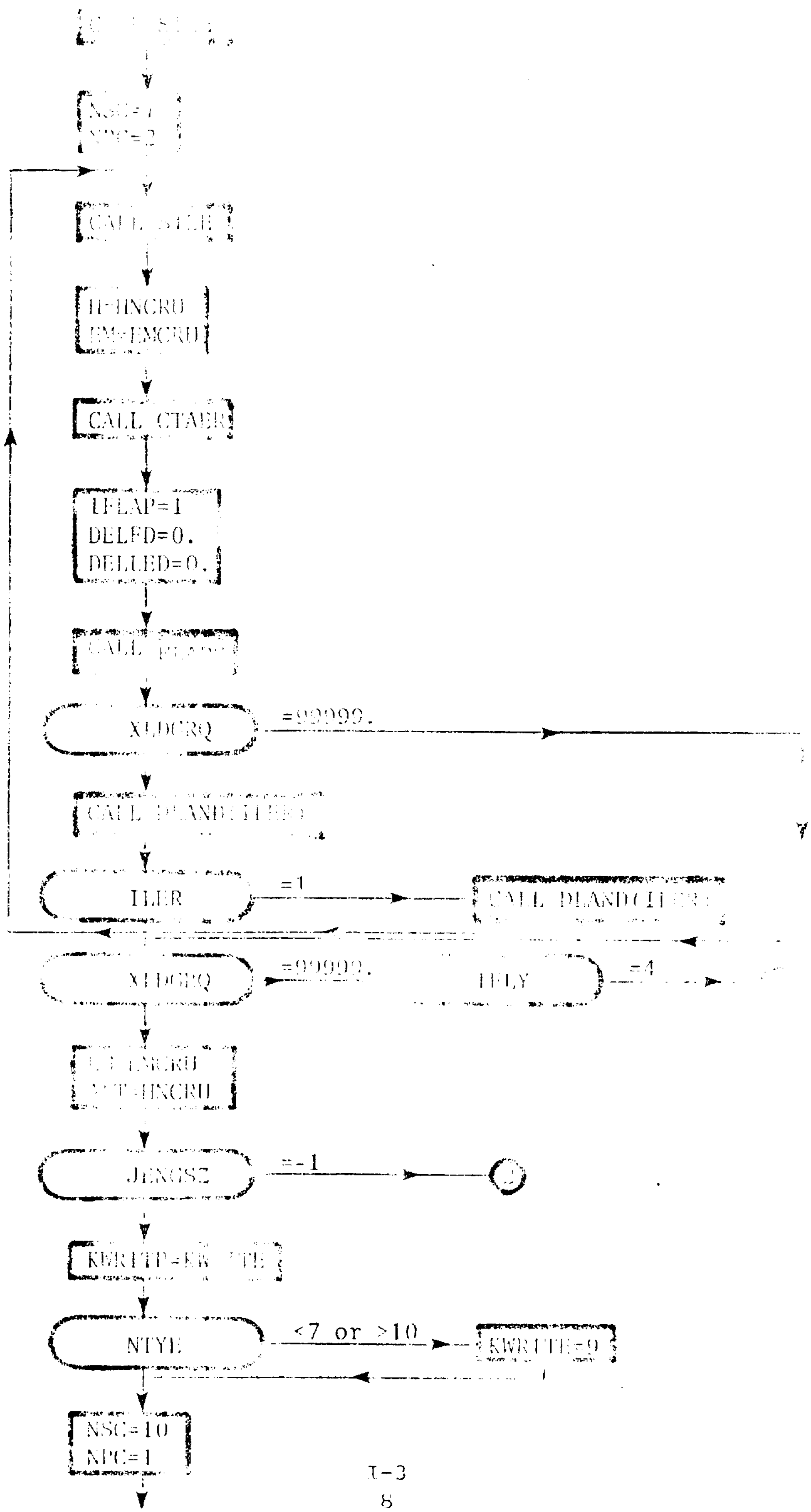
FIGURE I.3.2 PROGRAM MAIN




JENGSZ
=-1
22
WRITE(6)JENGSZ,HPORT,
RCCRU,RWCRTX,IPART,
TDELTO,XTORQ
NTYE
<7 or >10
WRITE(6)KODECR,
XNMAC,HPMSLS,KODETH,
A,GR,ANCQHP,JSIZE
NTYE
<5 or >10
WRITE(6)PCPCL,PCPCR,
PCRCL,PCRCR,KSPCH,HCRIT,
BMEP
NTYE
=5 or =6
WRITE(6)T4STTO,T4STCL,
PCNTO,PCNCCL,PCNCCR
NTYE
≥ and ≤10
WRITE(6)SHID,THIN,
PR,HBTP
JTRSZ
=1
WRITE(6)JTRSZ,HTURN,XLFTRN,
WTRFAC,EMTURN,CLTLMT
NTYE
<7 or >10
WRITE(6)DPROP,IDATE,XCLF1,
BL,IPROP,XCLF,AF,CATN,XCK70,
CLI,COD,XCK80,NTYP,BLANG,
CAMT,TSPDMX,CTI,WKPFAC,FI,
JFPTCH,DIST
KNOYS
≥0
WRITE(6)KNOYS,
EMNOYS,HNOYS
WRITE(6)SKPEI,SKY,SKB,SKFS,SKLG,SKZ,SKCC,SKWF,
SKMG,SKTL,SKFW,SKFT,SKPES,SKWW,SKSAS,SKWTP,
WPLX,YMG,EGMRGN,LCWING,WFEX,RELP,CPMRGN,ELINC,
WFUL,RELR,STMRGN,LDCKMX,VWAPX,CATD,DELP,ATMXQC,
STRUT,VMLFSL,YP,STIP,DELWST,DELWFC,WENG,WPYLON,
SWSLS,UWNAC,FPYL,XLQDE
NTYE
<5 or >10
WRITE(6)NCYL,HPQAB,
SKDIM,XKI,BNUM,ROTN,RWH,
XK2,XCW,AFTOT,SKWGT,XK3
NTYE
<7 or >10
WRITE(6)WPROP1
LCWING
=2
WRITE(6)CMFUST,STATIC,
ZCG,CNPAC,CMFLPL,CHALF,
TP,ARVTE,CMFLPT,CHDEL,
CXA,RV,CMNACT,RH,DCMCLP,
TAUV,CMPLD,DEMAX,HWING,
RVMCS,LYET,DRMAX


IFLY
≤0
WRITE(6)DELTT,XLFAMX,
DVR,TDELTX,IFLY,DELTVR,
VM,HTMAX,THEMAX,DV1,MUB,
NFAIL,HOO
IFLY
=1 or =3
EMCRU,FRESF,
FACW1,DELH,
HNCRU,RCRRQ,
ISWING,HNCRU,
ICRUS,WTMISN
WRITE(6)IWLD,
XLDGRQ,VRATT,HAPP,
TDELLD,ALTND,RSMX,
SINKTD,TDELAY,WLPCT,
TROTID,XLFMX,HTG
JENGSZ
=-1
TBO
=0
WRITE(6)NCADE,
PRV,CRWOH,UCSENG,
CMF,DYR,CINP,UCSPP,
TBO,SRPM,CP,ALP,FCSF
WRITE(6)
RCRRQ
≠0
WFW=0.
AXIS=0.
VFTP=0.
LCI=0.
IWT=0.
WFTP=0.
STIP=0.
WTIP=0.
WPL=WPLX
KTIP=KTIPX
WFE=WFEX
ILER=1
NPC=3


CALL STEP
NSC=7
NPC=2
CALL
II=IINCRU
EM=EMCRU
CALL CTABR
IFLAP=1
DELFD=0.
DELLED=0.
CALL
XLDCRQ
=99999.
CALL
ILER
=1
CALL
XLDGRQ
=99999.
IFLY
=4
JENGSZ
=-1
NTYE
<7 or >10
KWRITE=9
NSC=10
NPC=1

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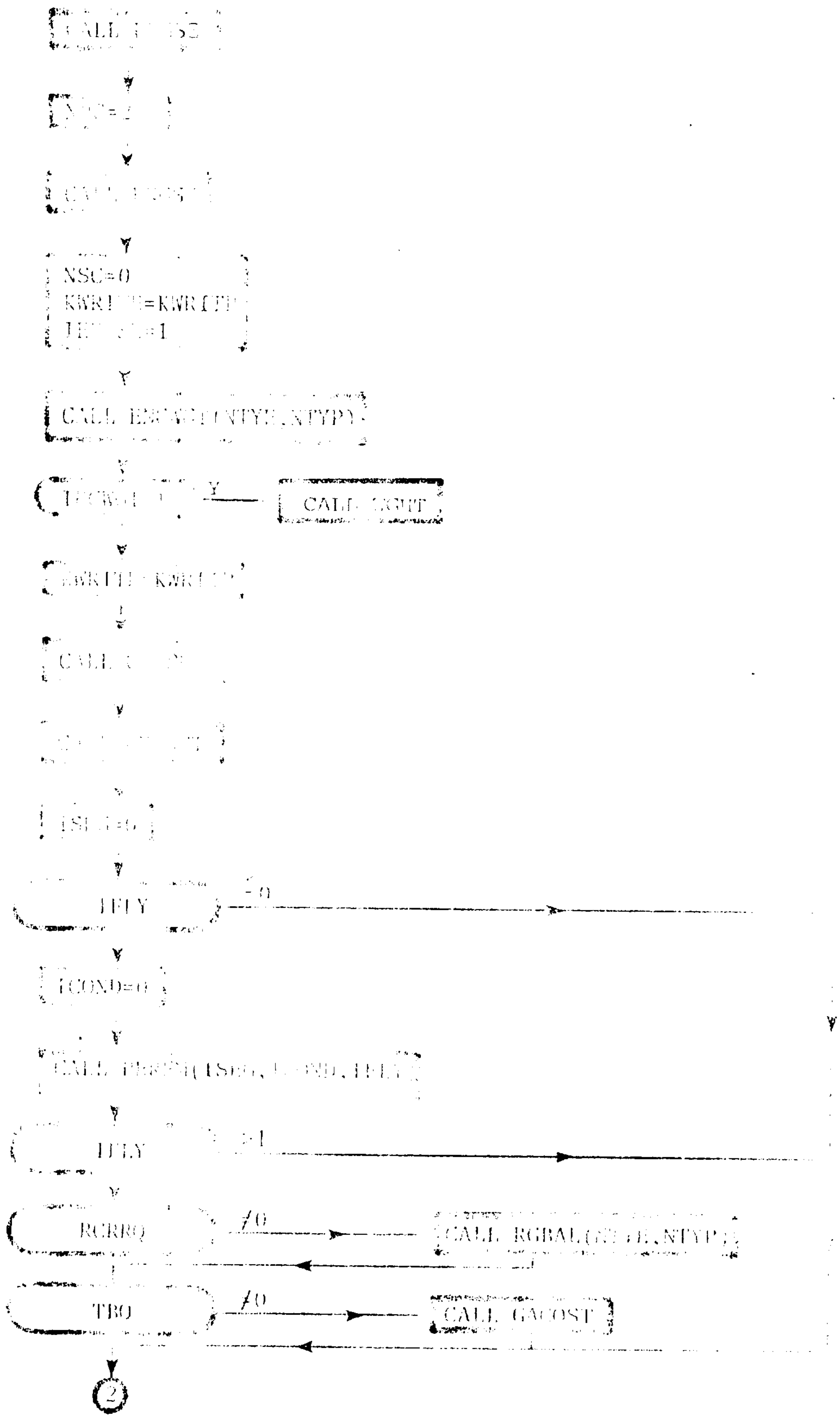
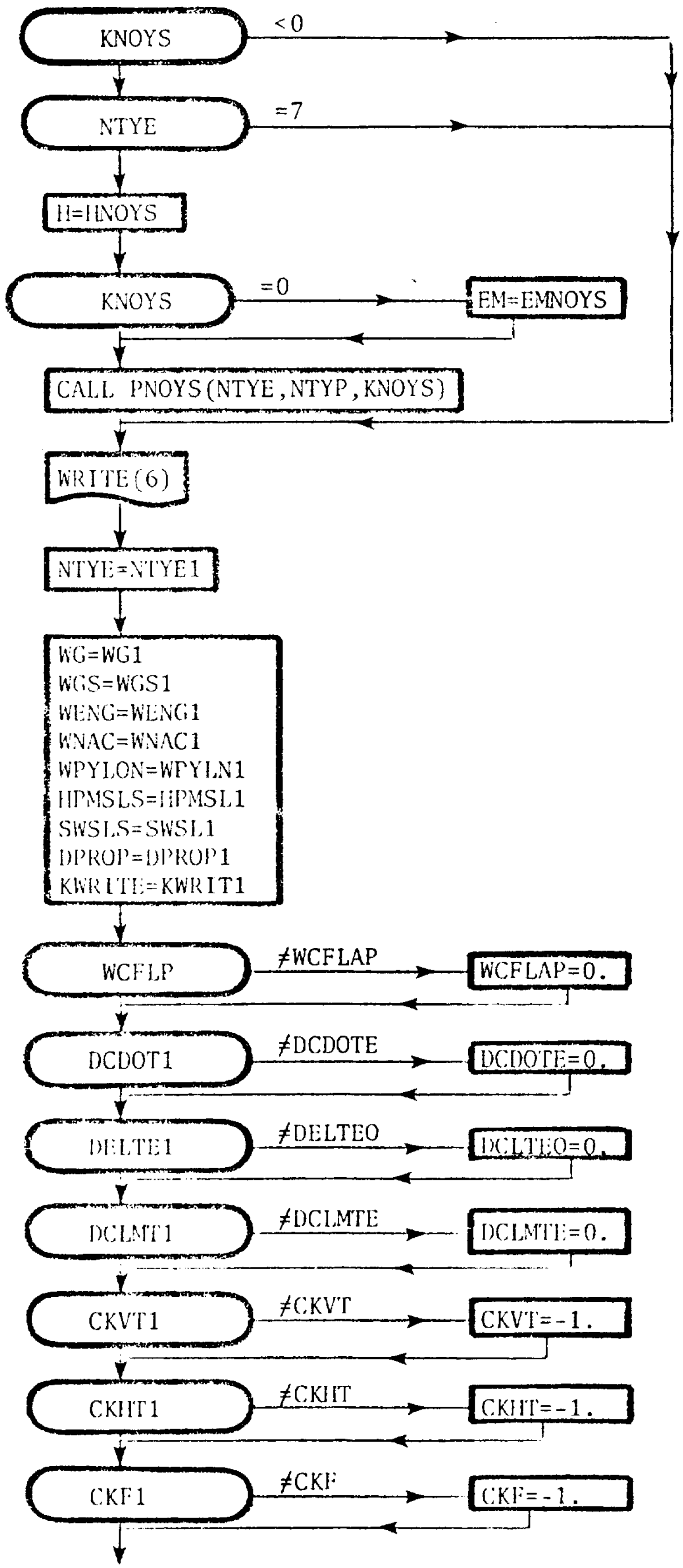
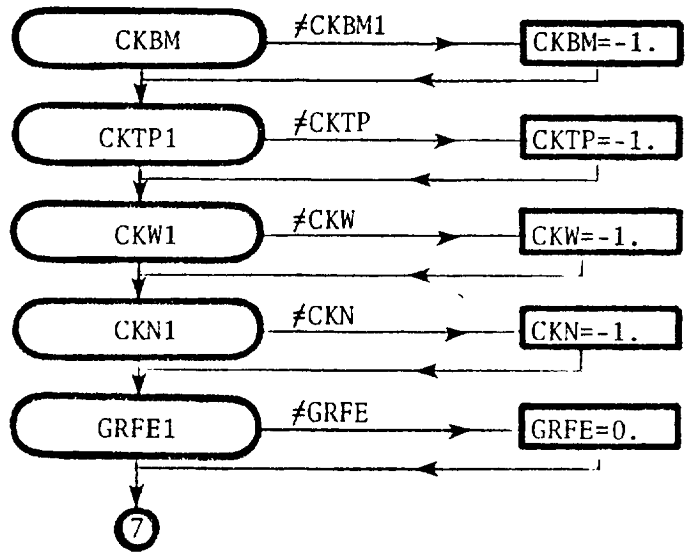

NSC=0
CALL
IFLY
ICOND=0
IFLY
=1
RCRRQ
≠0
CALL RGBAL
TBO
≠0
CALL GACOST
2

FIGURE I.3.2 PROGRAM MAIN




CKBM
≠CKBM1
CKBM=-1.
CKTP1
≠CKTP
CKTP=-1.
CKW1
≠CKW
CKW=-1.
CKN1
≠CKN
CKN=-1.
GRFE1
≠GRFE
GRFE=0.
7

I.3.2 Subroutine BIV - Linear Interpolation in Two Independent Variables

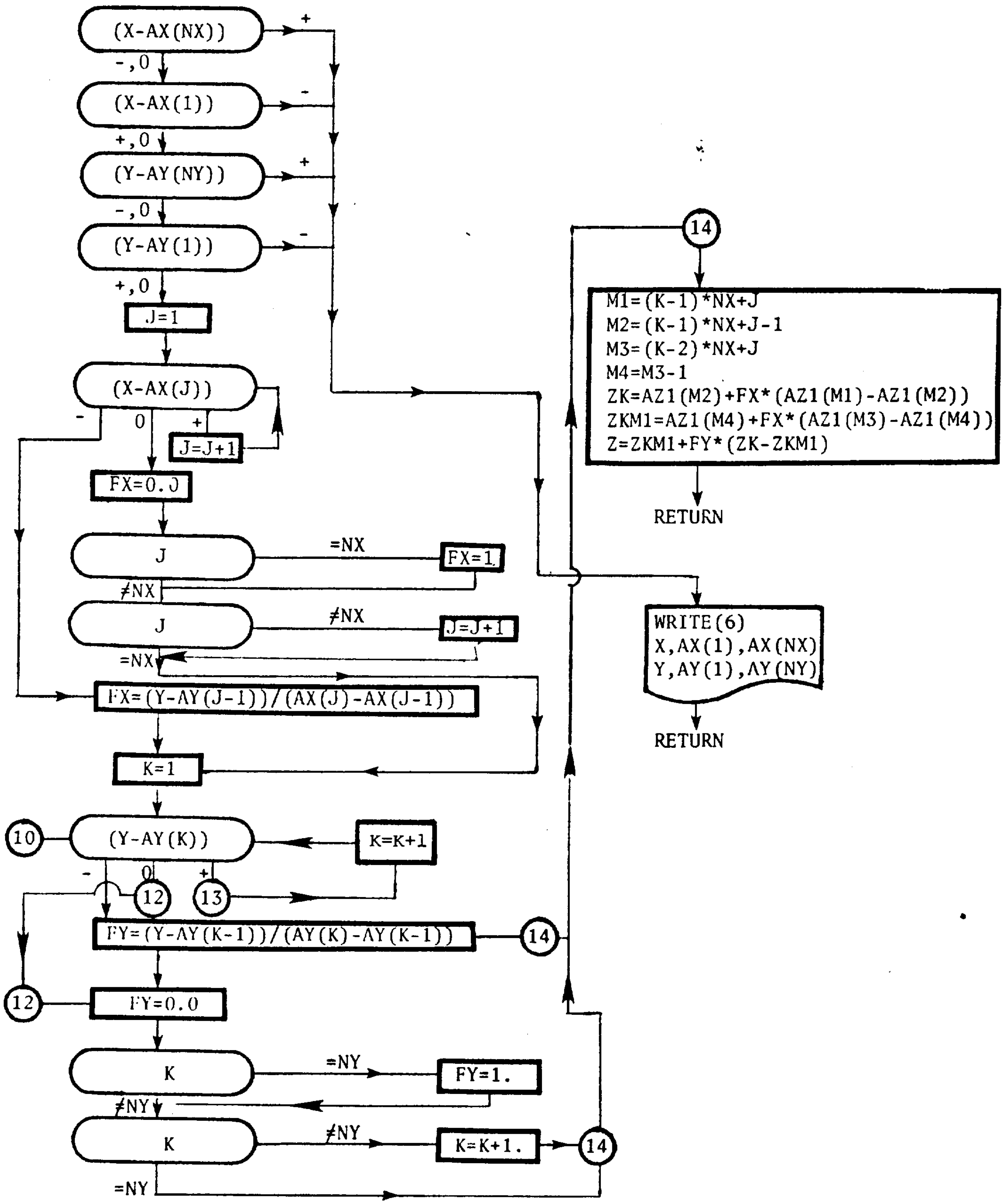
A utility routine performing a linear interpolation in stored data of the form

$$Z_{jk} = Z_{jk}(X_j, Y_k) \qquad i = 1, 2, \ldots, N_i$$
$$j = 1, 2, \ldots, N_j$$

Interpolation only is permitted. If an independent variable value falls outside the stored range, an error exit is made and the independent variable values being employed together with their boundary values are printed out.

Figure I.3.3 presents a detailed flow chart for this subroutine.

FIGURE I.3.3 SUBROUTINE BIV



I.3.3 Subroutine INTS - Double Precision Finite Difference Integrator

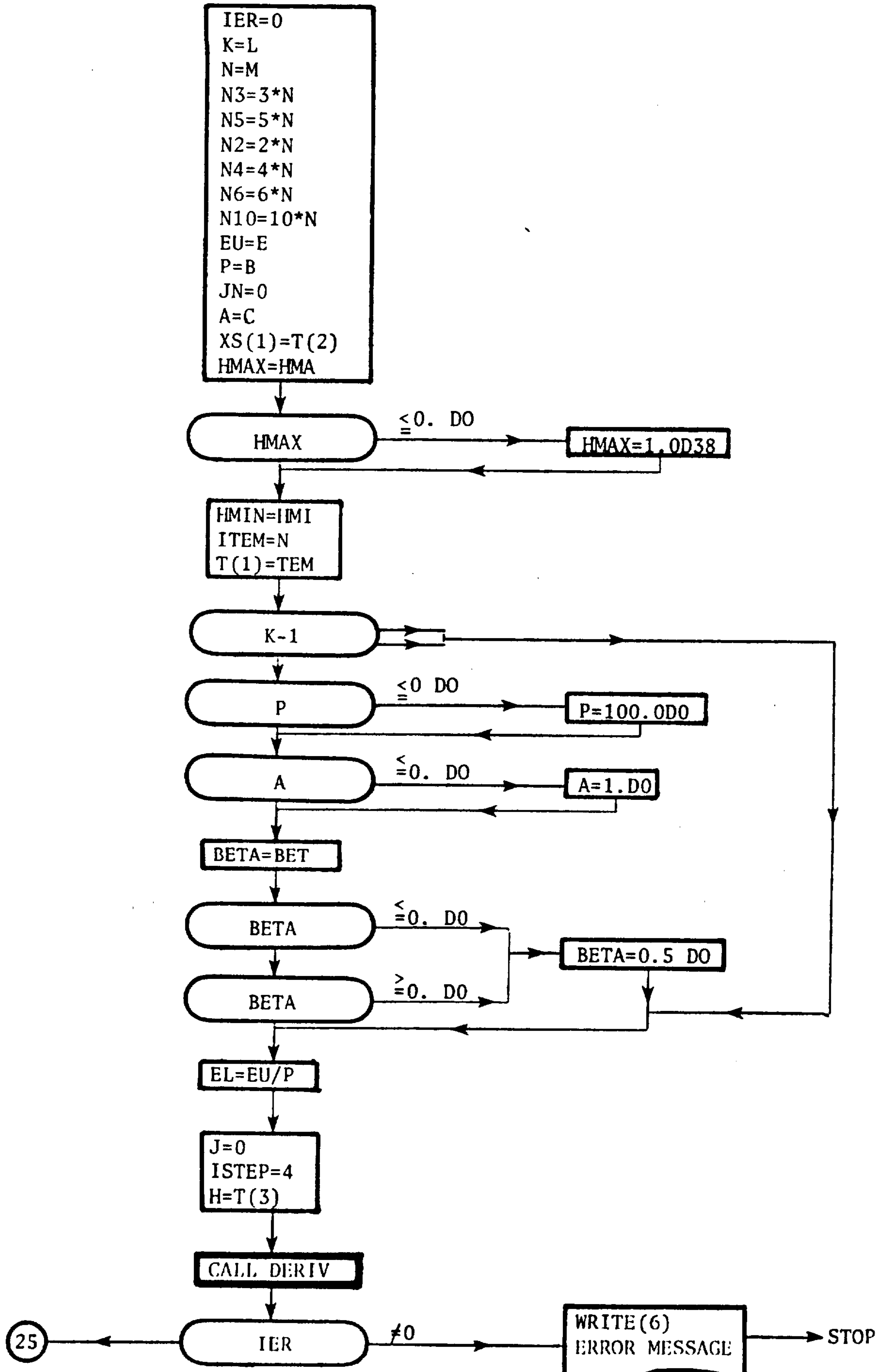
The calling sequence is

CALL INTS(T, M, L, E, B, C, HMA, HMI, BET, DERIV)

This utility routine is a finite difference integrator, performed in double precision, of a system of M simultaneous first-order differential equations which are defined in external subroutine DERIV. The non-zero components of T(100) are related to the state variables in DERIV. The other parameters in the calling sequence are input and are associated with the numerical aspects of integration (error magnitudes, step sizes, etc.).

A detailed flow chart for INTS is provided in Figure I.3.4.

FIGURE I.3.4 SUBROUTINE INTS



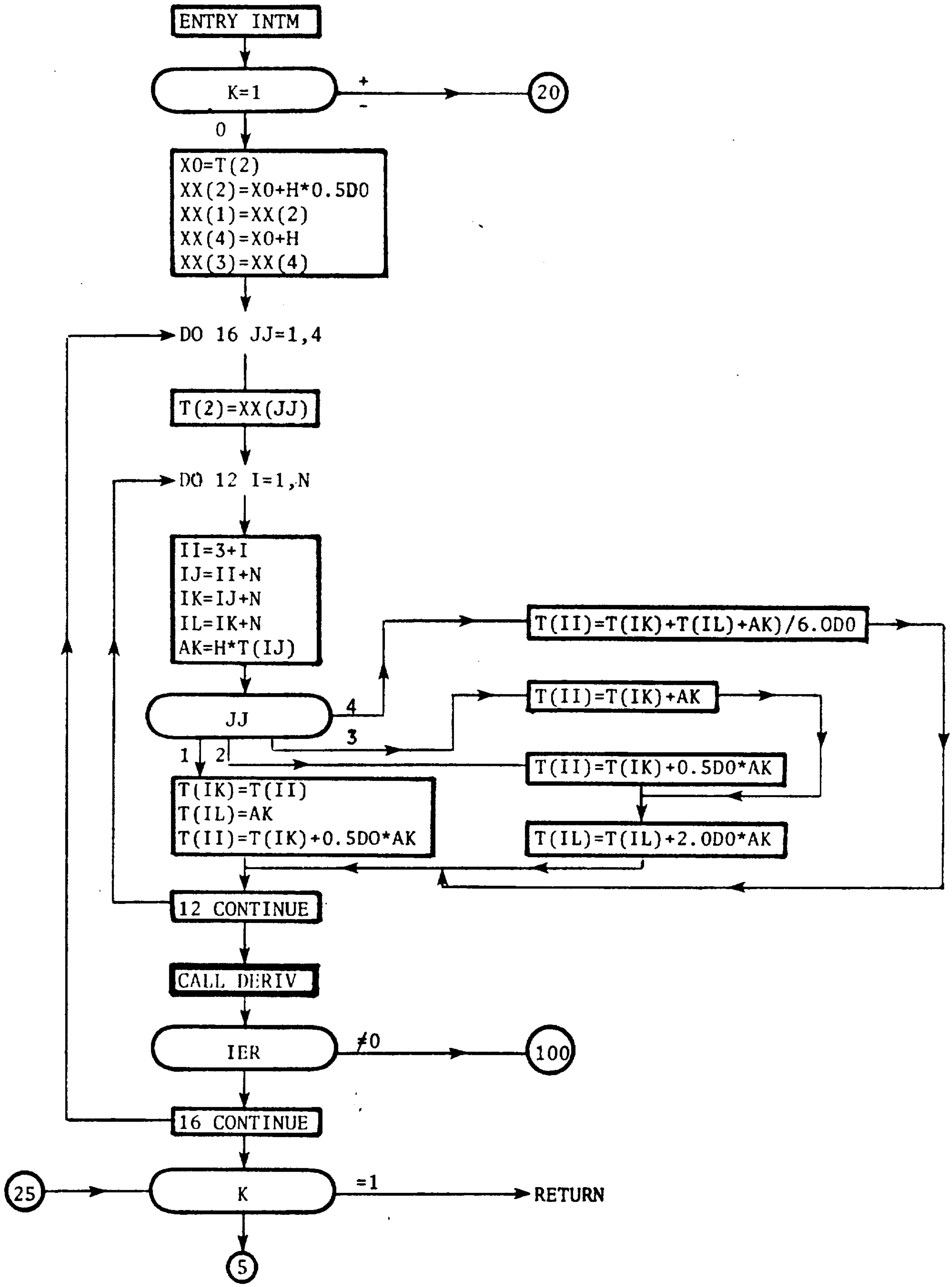

ENTRY INTM
K=1
+
-
0
20
XO=T(2)
XX(2)=XO+H*0.5D0
XX(1)=XX(2)
XX(4)=XO+H
XX(3)=XX(4)
DO 16 JJ=1,4
T(2)=XX(JJ)
DO 12 I=1,N
II=3+I
IJ=II+N
IK=IJ+N
IL=IK+N
AK=H*T(IJ)
JJ
4
3
1
2
T(II)=T(IK)+T(IL)+AK)/6.0D0
T(II)=T(IK)+AK
T(II)=T(IK)+0.5D0*AK
T(IL)=T(IL)+2.0D0*AK
T(IK)=T(II)
T(IL)=AK
T(II)=T(IK)+0.5D0*AK
12 CONTINUE
CALL DERIV
IER
≠0
100
16 CONTINUE
K
=1
RETURN
25
5

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FIGURE I.3.4 SUBROUTINE INTS

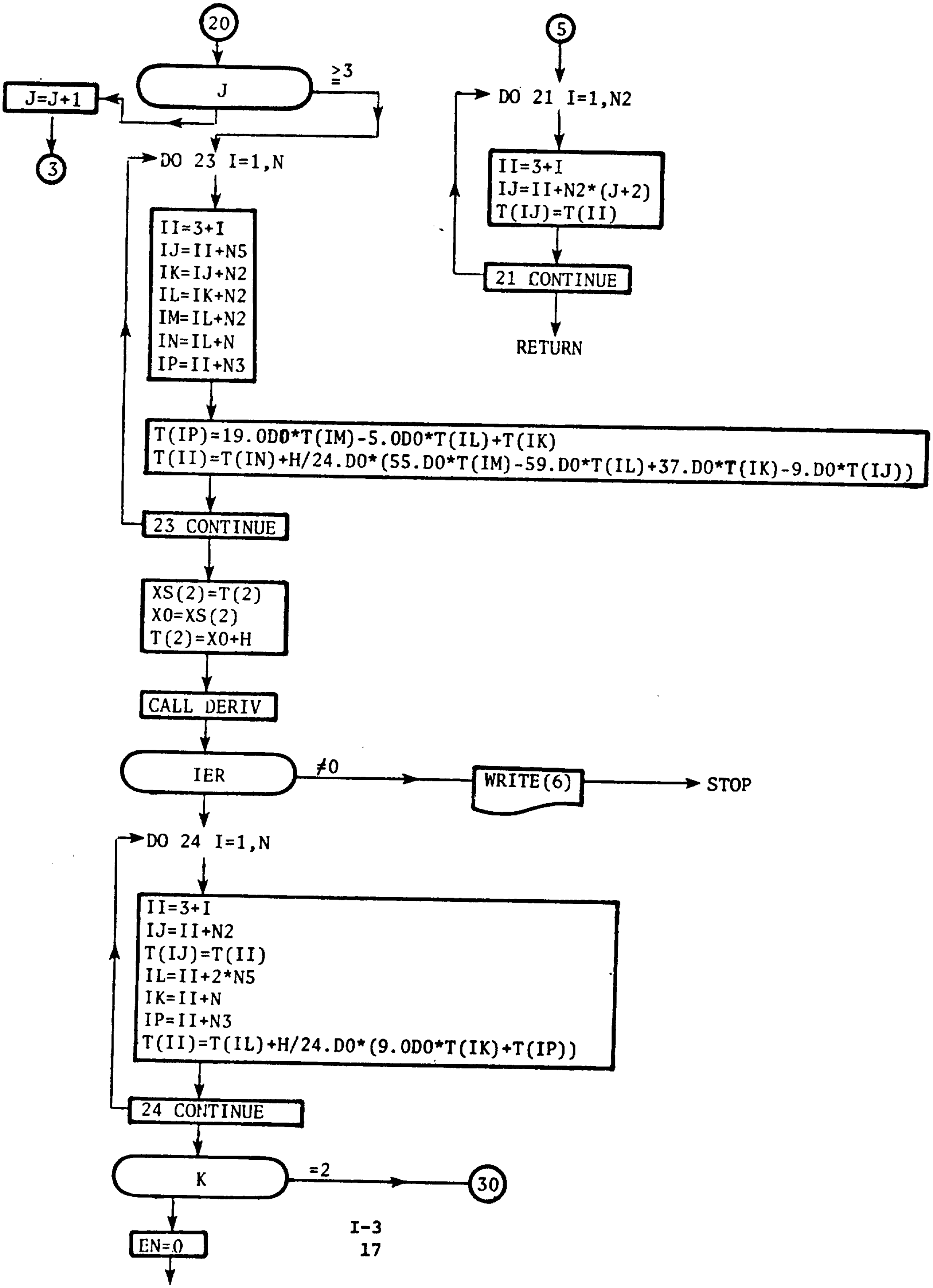
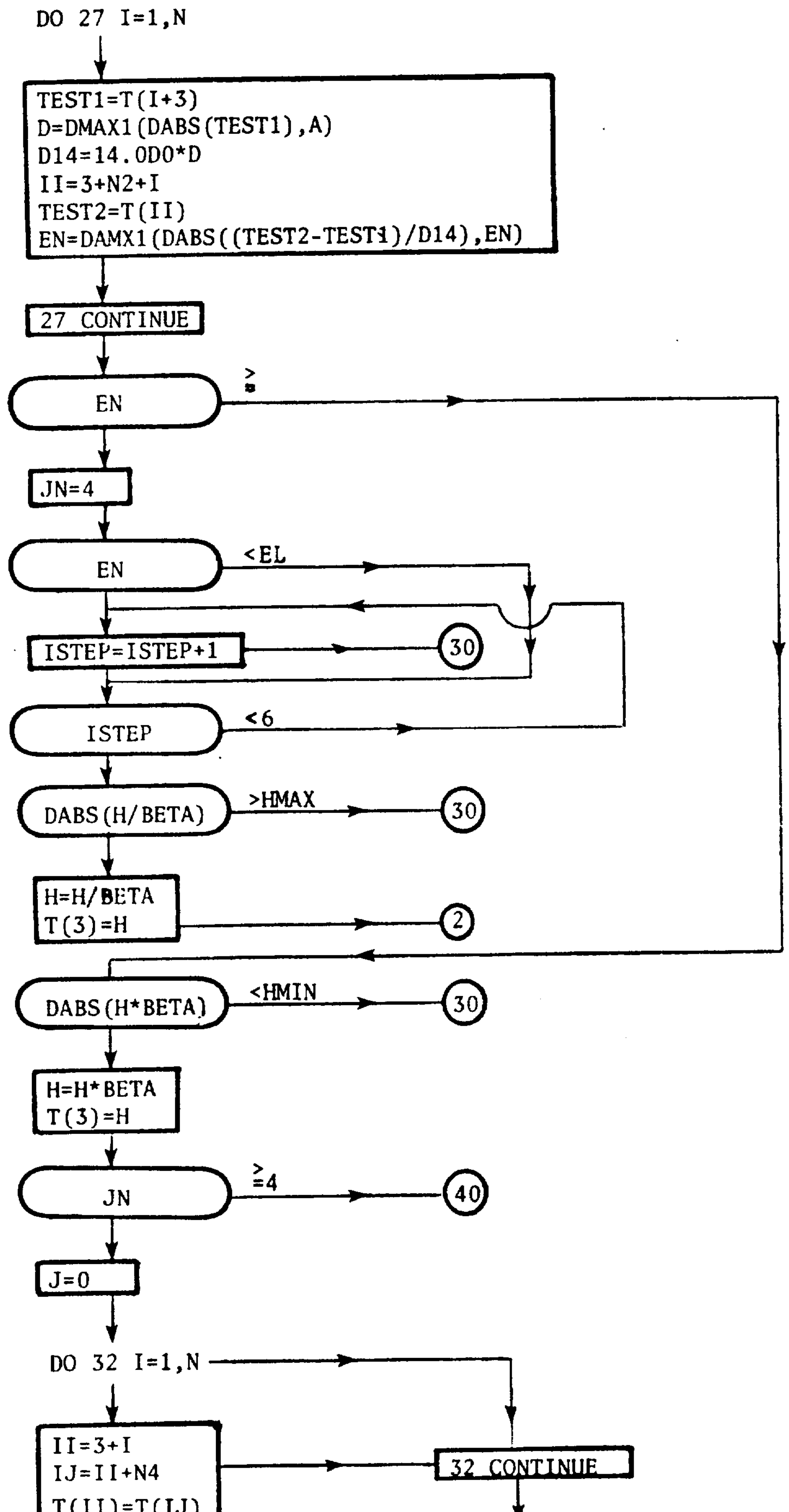
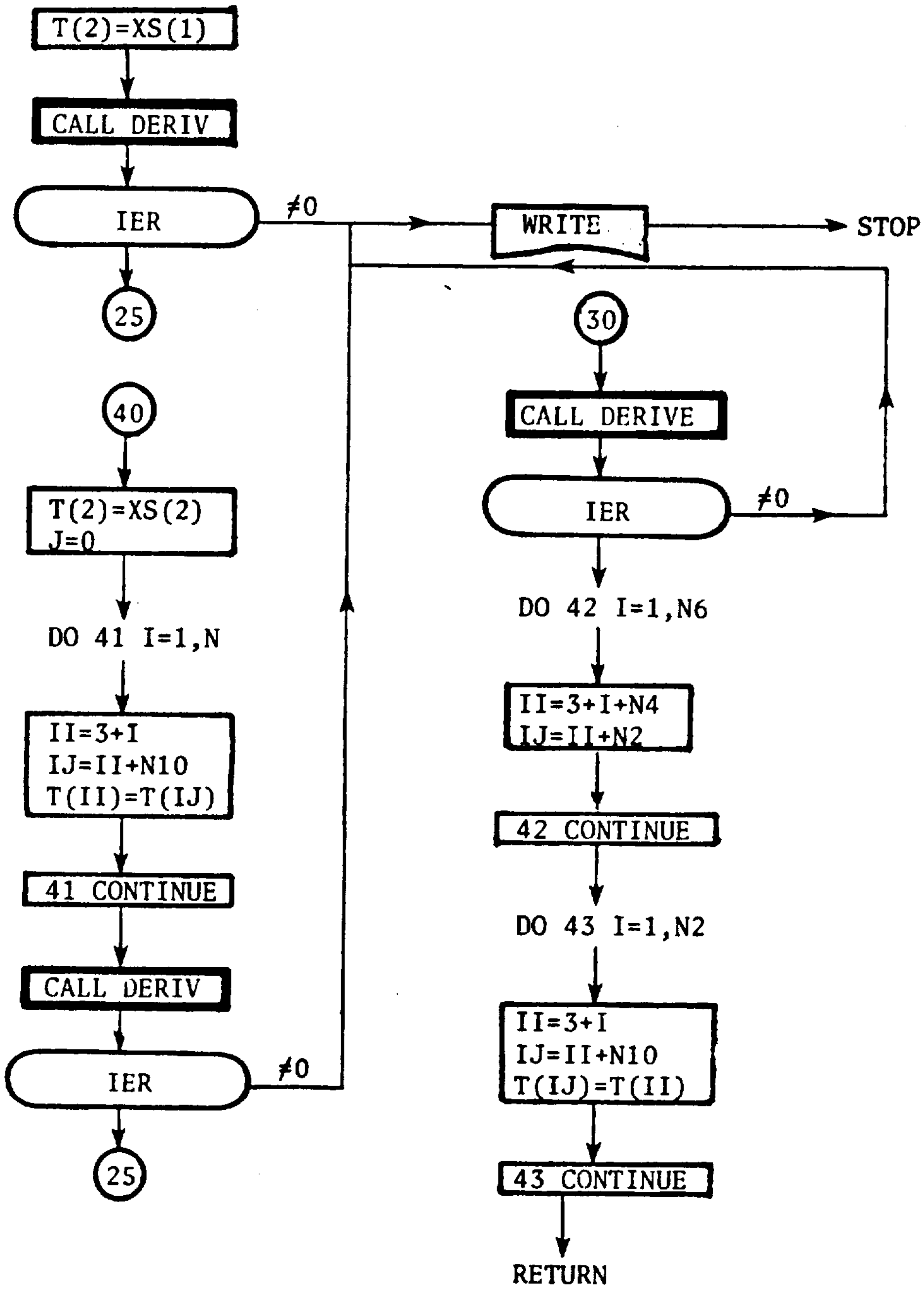


FIGURE I.3.4 SUBROUTINE INTS




T(2)=XS(1)
CALL DERIV
IER
≠0
WRITE
STOP
25
40
T(2)=XS(2)
J=0
DO 41 I=1,N
II=3+I
IJ=II+N10
T(II)=T(IJ)
41 CONTINUE
CALL DERIV
IER
≠0
25
30
CALL DERIVE
IER
≠0
DO 42 I=1,N6
II=3+I+N4
IJ=II+N2
42 CONTINUE
DO 43 I=1,N2
II=3+I
IJ=II+N10
T(IJ)=T(II)
43 CONTINUE
RETURN

I.3.4 Subroutine ITRLN - Linear Interpolation in One Independent Variable

This routine performs a linear interpolation in stored data of the form

$$Y_i = Y_i(X_i) \qquad i = 1, 2, \ldots, N$$

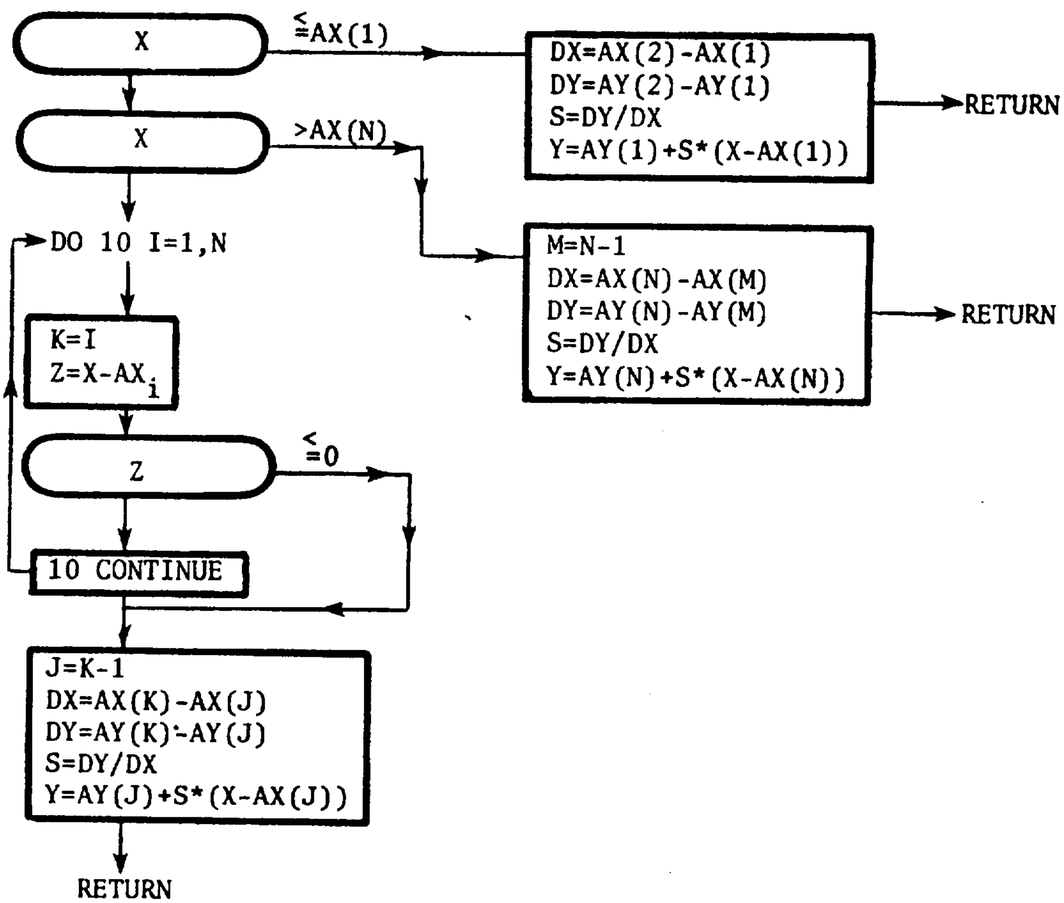
The calling sequence is

```
CALL ITRLN(AX, AY, X, Y, N)
```

This subroutine returns a value for Y corresponding to an input quantity X. The input parameters are the N pairs AX(I) and AY(I), and AXOIP must increase monotonically. If X is less than AX(1) or greater than AX(N), the subroutine extrapolates for Y(X).

A deailed flow chart for ITRLN is presented in Figure I.3.5.

FIGURE I.3.5 SUBROUTINE ITRLN



I.3.5 Subroutine ITRMHW - Location of Root by Newton-Raphson Method

This utility routine finds a zero of the function

$$E = f(D)$$

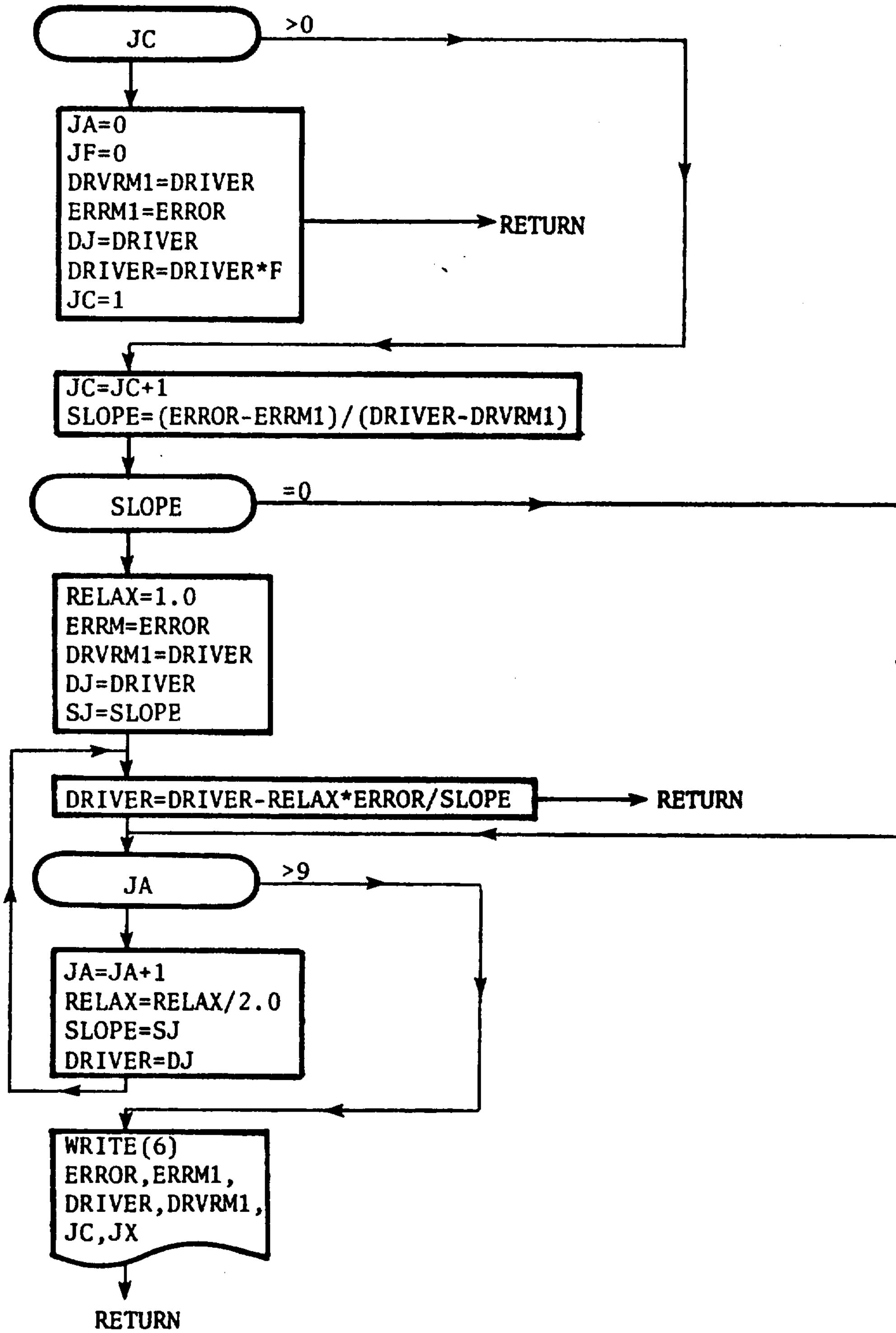
The calling sequence is

```
CALL ITRMHW(ERROR, ERRM1, DRIVER, F, FF, JC, JX)
```

This subroutine determines a zero to a function defined externally. Inputs are ERROR, the current (non-zero) value of the dependent variable; DRIVER, the current value of the independent variable; and F, a multiplier near unity. Outputs are ERRM1 and DRIVER, the augmented values of the dependent and independent variables, and JC, the counter. FF and JX are not used.

A detailed flow chart for ITRMHW is presented in Figure I.3.6.

FIGURE I.3.6 SUBROUTINE ITRMHW



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I.3.6 Subroutine MAXMHW - Maximum of a Function of One Independent Variable

This utility routine determines a local maximum of the function

$$Y = f(D)$$

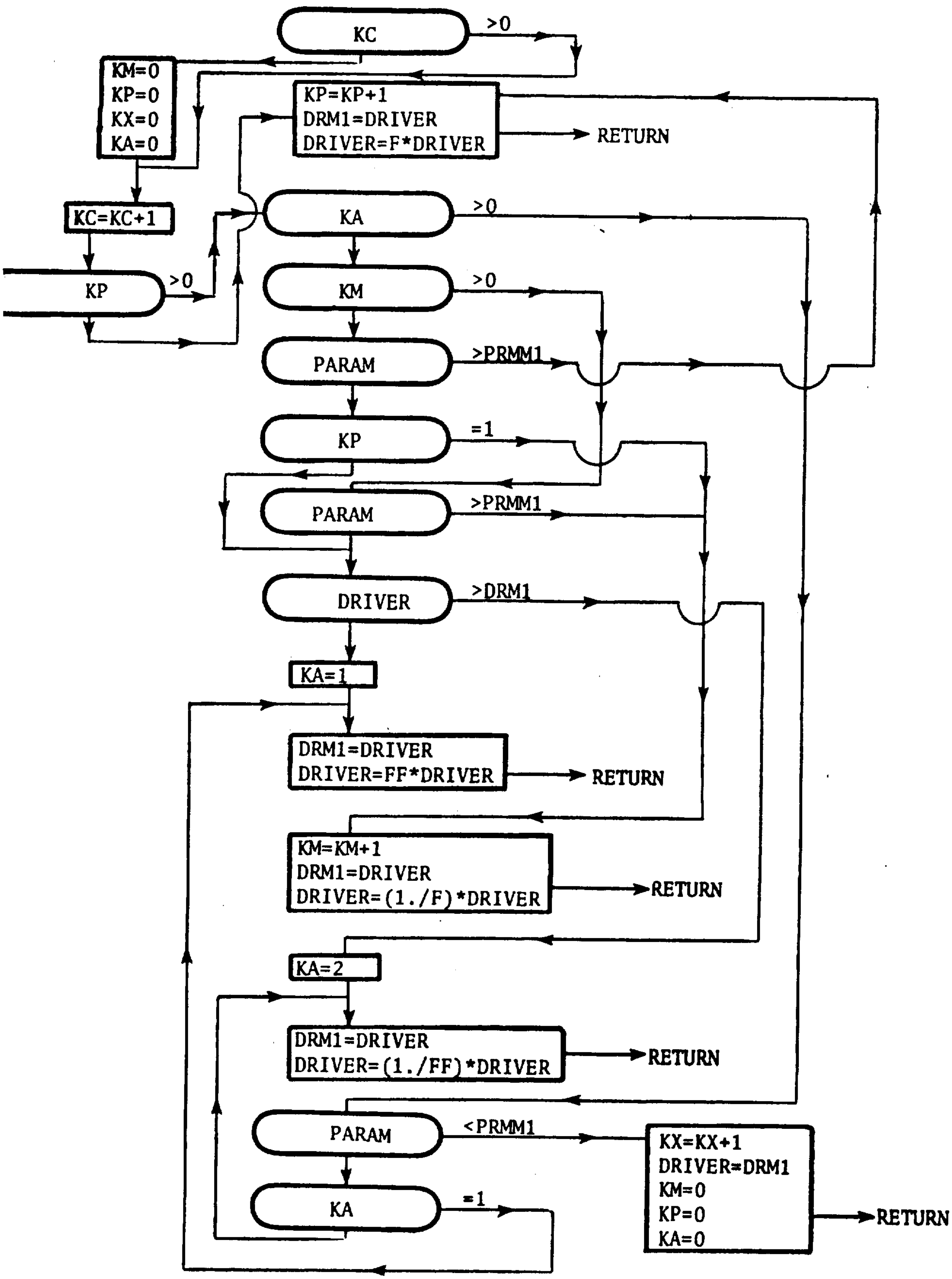
The calling sequence is

CALL MAXMHW(PARAM, PRMM1, DRIVER, F, FF, KC, KX)

This subroutine determines the maximum of an input function Y(X)=PARAM(DRIVER, which is defined externally. F and FF are input multipliers near unity, and KC is an output interaction counter, while KX changes from 0 to 1 when the maximum is determined. The previous value of Y(X) is PRMM1, and DRIVER is both input and output value of X.

A detailed flow chart for MAXMHW is presented in Figure I.3.7.

FIGURE I.3.7 SUBROUTINE MAXMHW



I.3.7 Subroutine OUTPUT - Program Print Output Routine

This routine provides print output of the aircraft characteristics. Calling sequence is

CALL OUTPUT

This subroutine begins with thirteen common block statements, and it includes 34 FORMAT statements. The subroutine is called by MAIN for the purpose of printing over 100 input and output figures related to geometry, weights, aerodynamics or the aircraft design.

A detailed flow chart for subroutine OUTPUT is presented in Figure I.3.8.

FIGURE I.3.8 SUBROUTINE OUTPUT

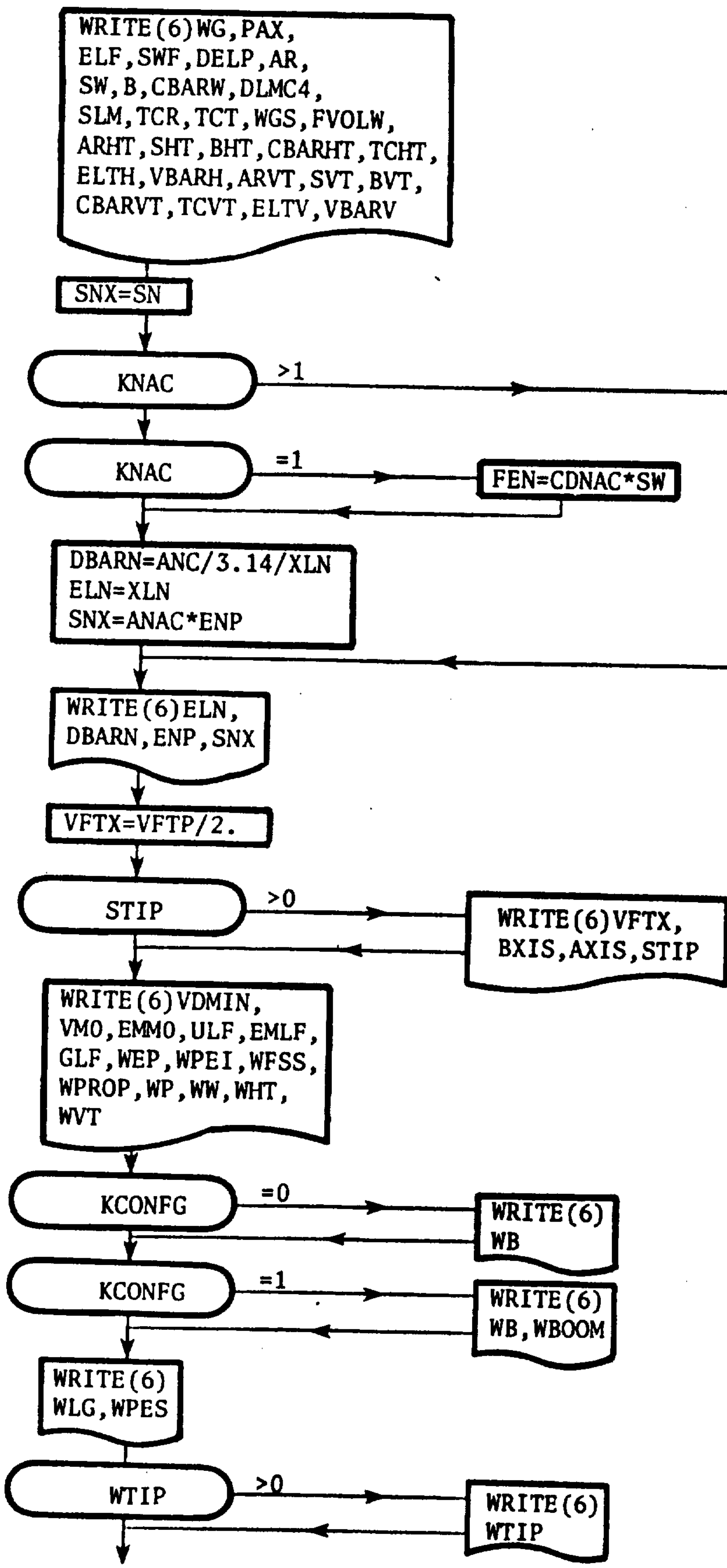


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FIGURE I.3.8 SUBROUTINE OUTPUT

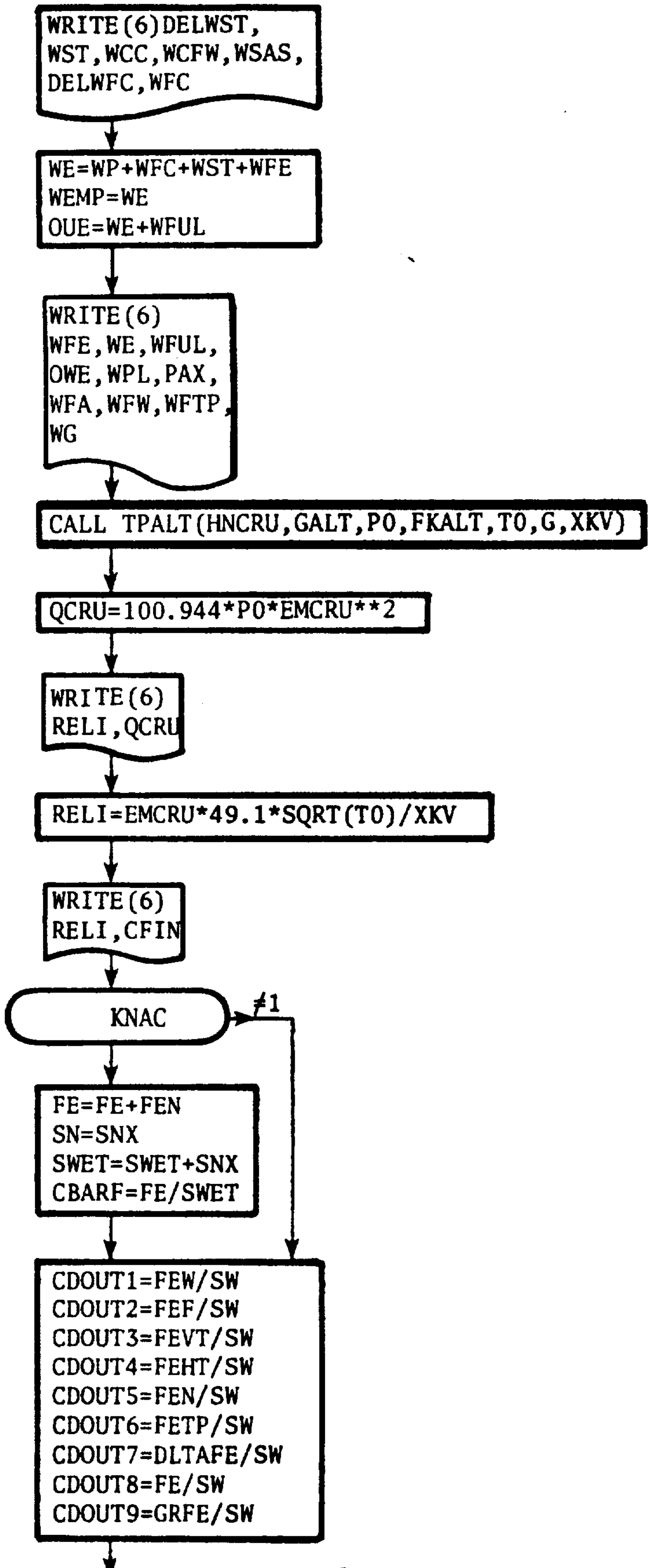
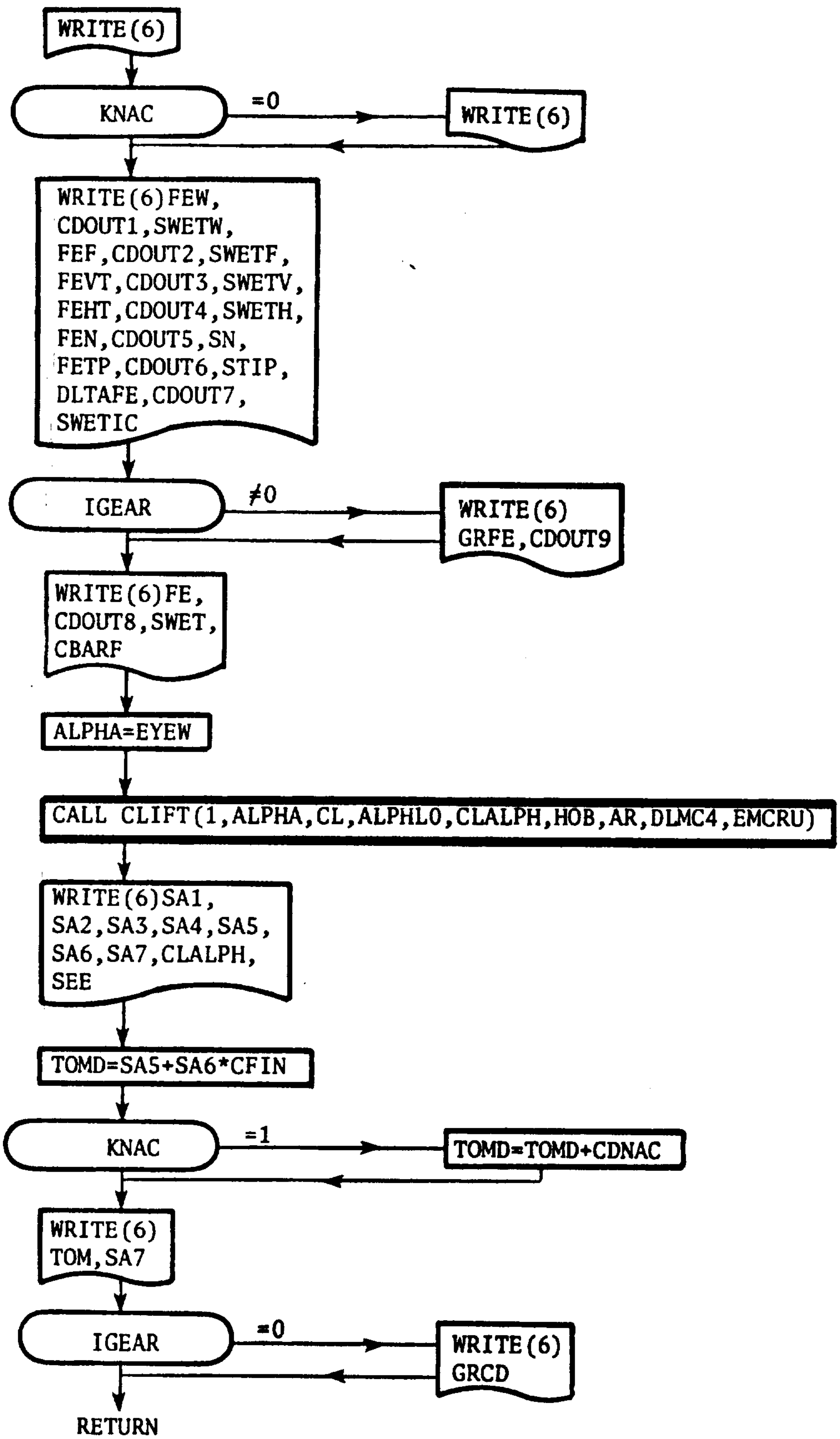


FIGURE I.3.8 SUBROUTINE OUTPUT



I.3.8 Subroutine TPALT - Atmospheric Properties Routine

This routine provides characteristics as a function of altitude. The calling sequence is

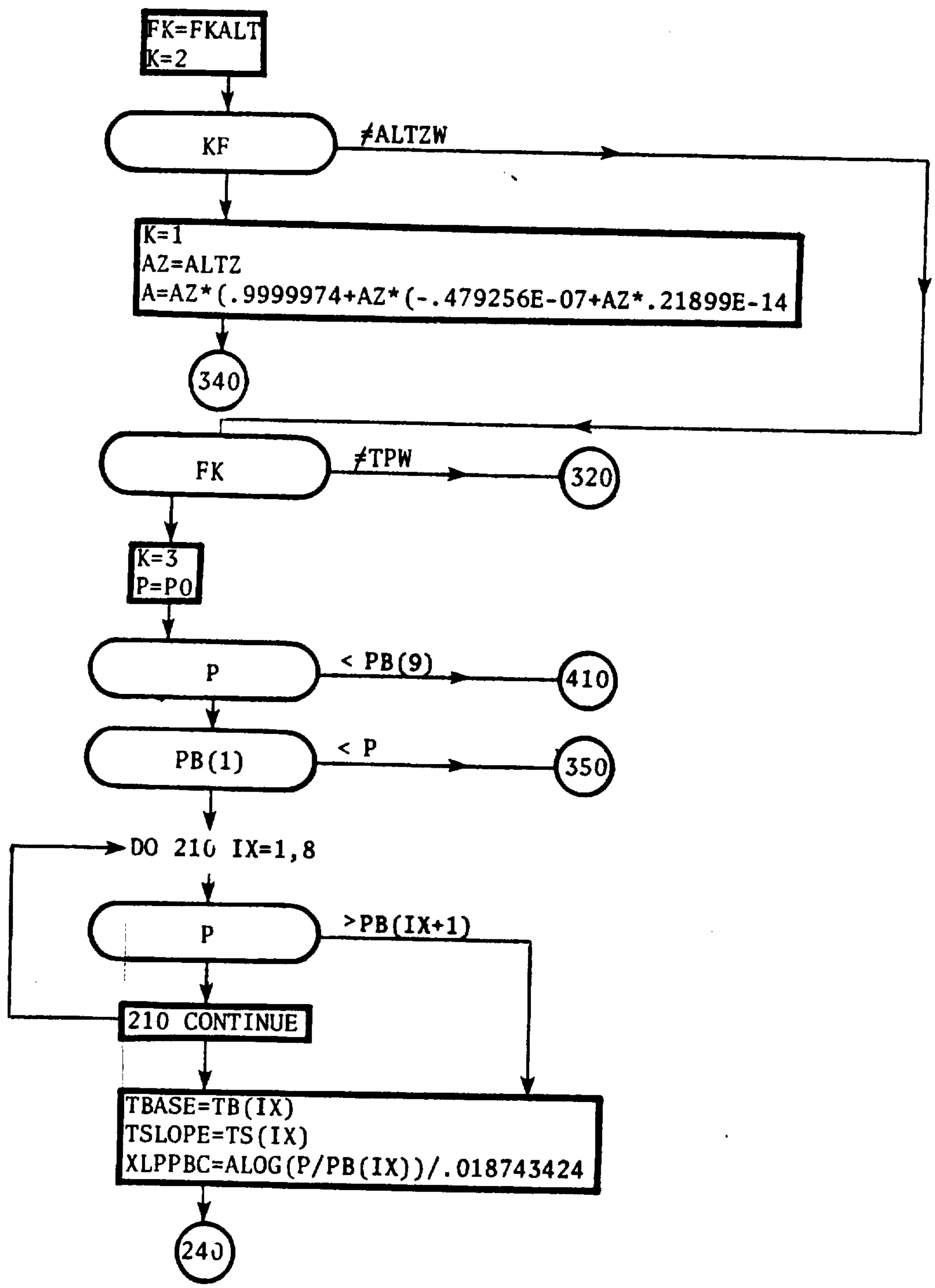
CALL TPALT(ALTZ, ALT, PO, FKALT, TO GO, XKV)

This subroutine relates static pressure, temperature and gravity, and kinematic viscosity in ft^2/sec, (PO, TO, GO, XKV) to the altitude. ALTZ is geometric altitude, ft., and ALT is potential altitude, ft., while PO is measured in lb per sq in., TO in deg R, and GO in ft per sec per sec.
If PO is in input, ALTZ and ALT are output, and vice versa. FKALT determines whether geometric or geopotential altitude is used.

A detailed flow chart for TPALT is presented in Figure I.3.9.

FIGURE I.3.9 SUBROUTINE TPALT

Subroutine TPALT(ALTZ,ALT,PO,FKALT,TO,GO,XKV)



194

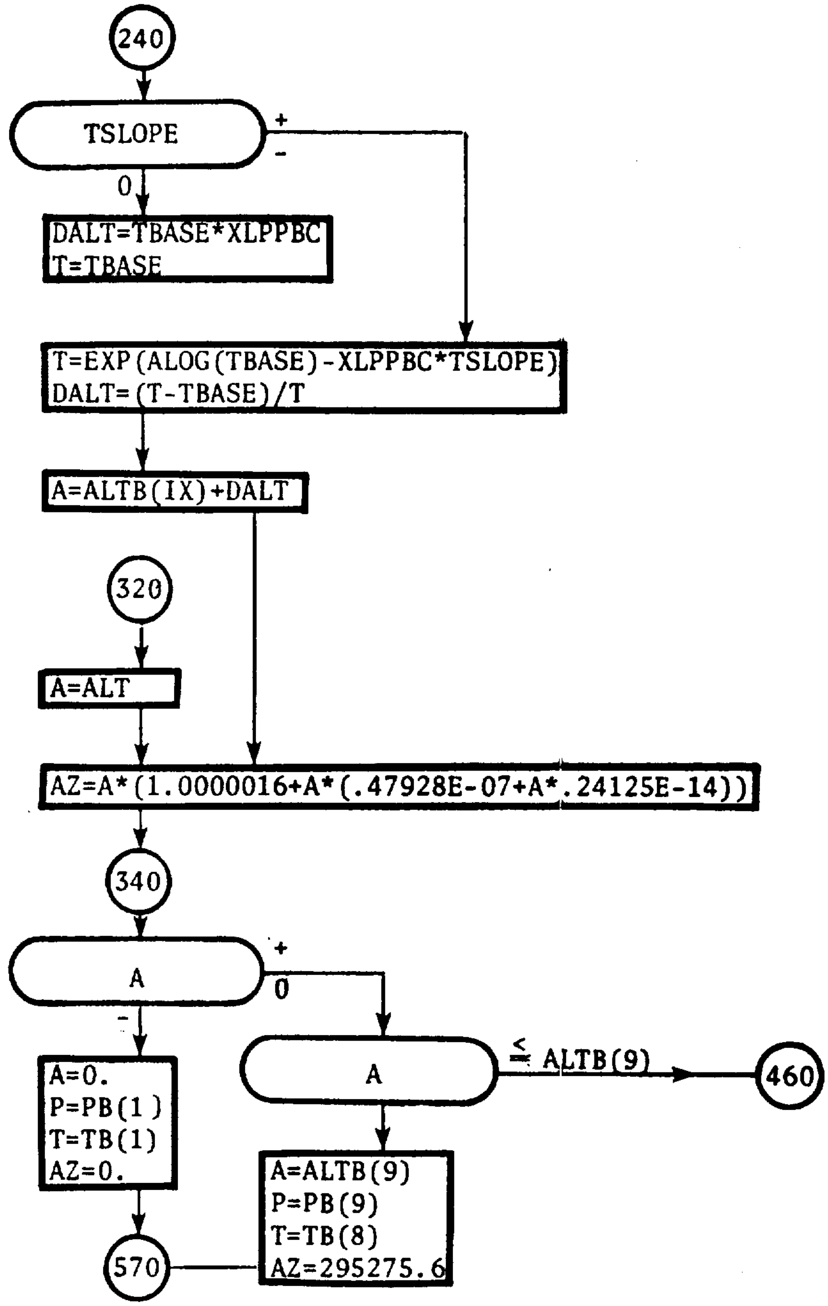
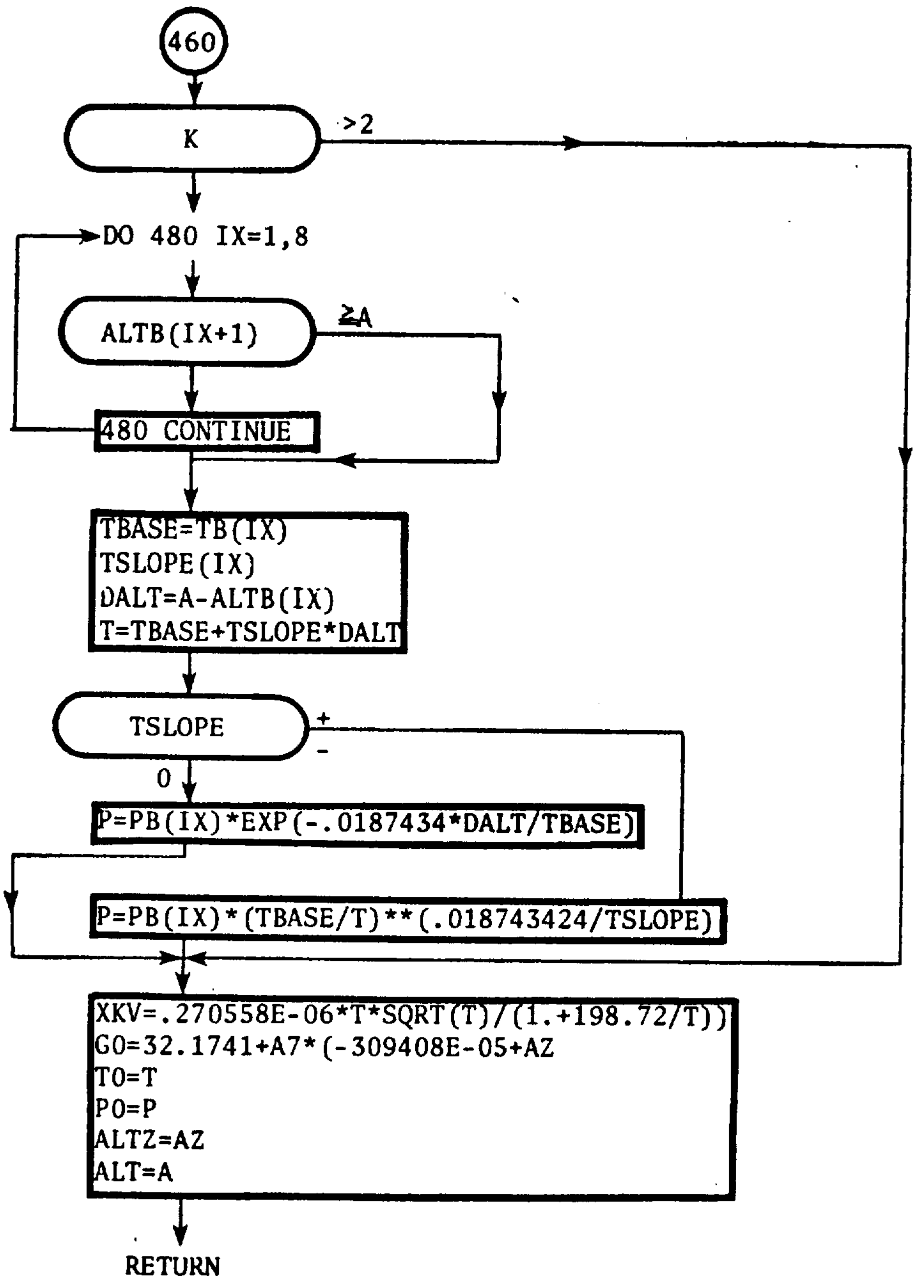

240
TSLOPE
+
-
0
DALT=TBASE*XLPPBC
T=TBASE
T=EXP(ALOG(TBASE)-XLPPBC*TSLOPE)
DALT=(T-TBASE)/T
A=ALTB(IX)+DALT
320
A=ALT
AZ=A*(1.0000016+A*(.47928E-07+A*.24125E-14))
340
A
+
0
-
A
≤ ALTB(9)
460
A=0.
P=PB(1)
T=TB(1)
AZ=0.
A=ALTB(9)
P=PB(9)
T=TB(8)
AZ=295275.6
570

FIGURE I.3.9 SUBROUTINE TPALT 3



I.3.9 Subroutine BILINE -

Linear Interpolation, One Independent Variable

This is a utility routine performing linear interpolation in stored data of the form

$$Z_i = Z_i(X_i); \quad i = 1, 2, \ldots N$$

A detailed flow chart for this routine is provided in Figure I.3.10.

BILINE

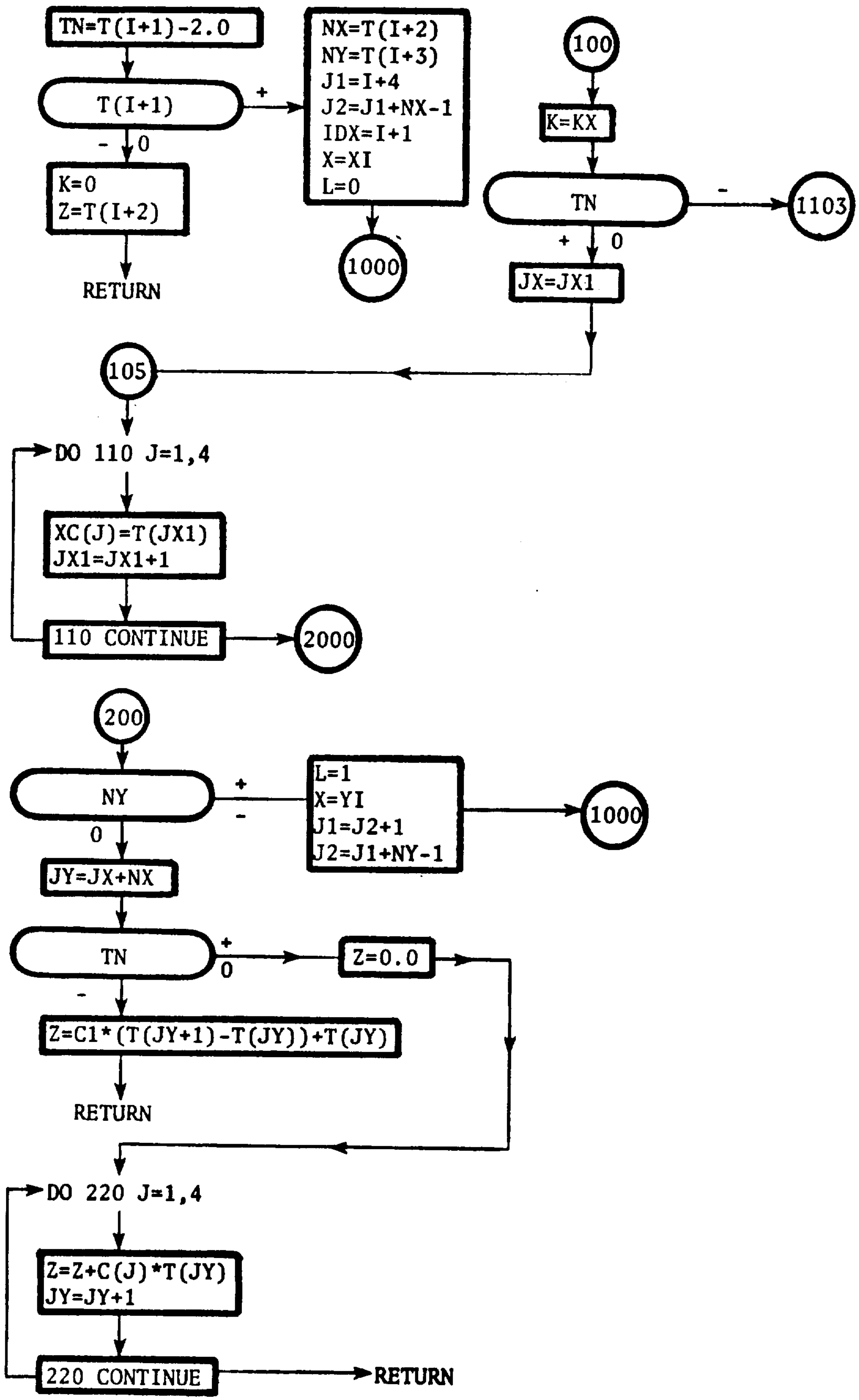
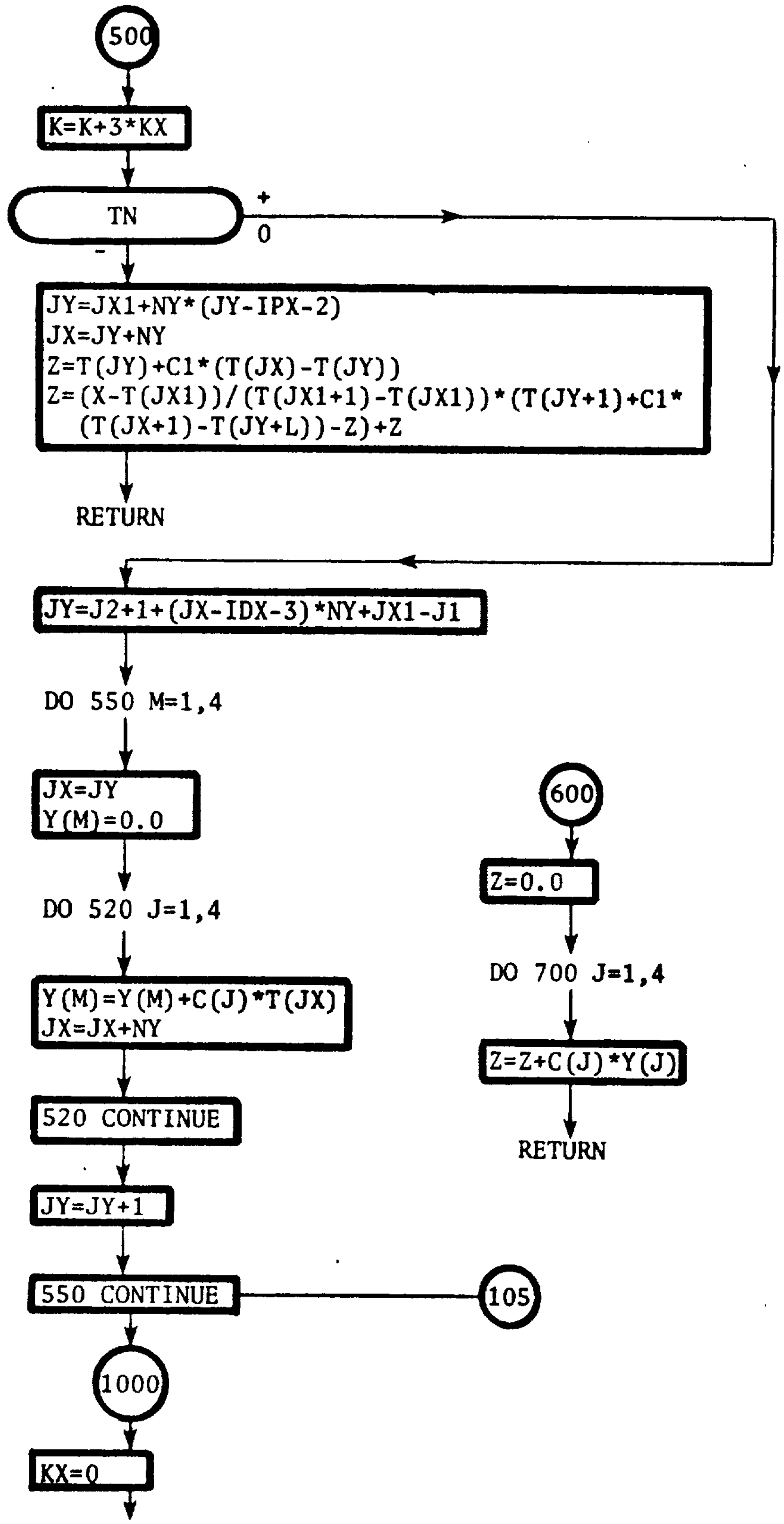
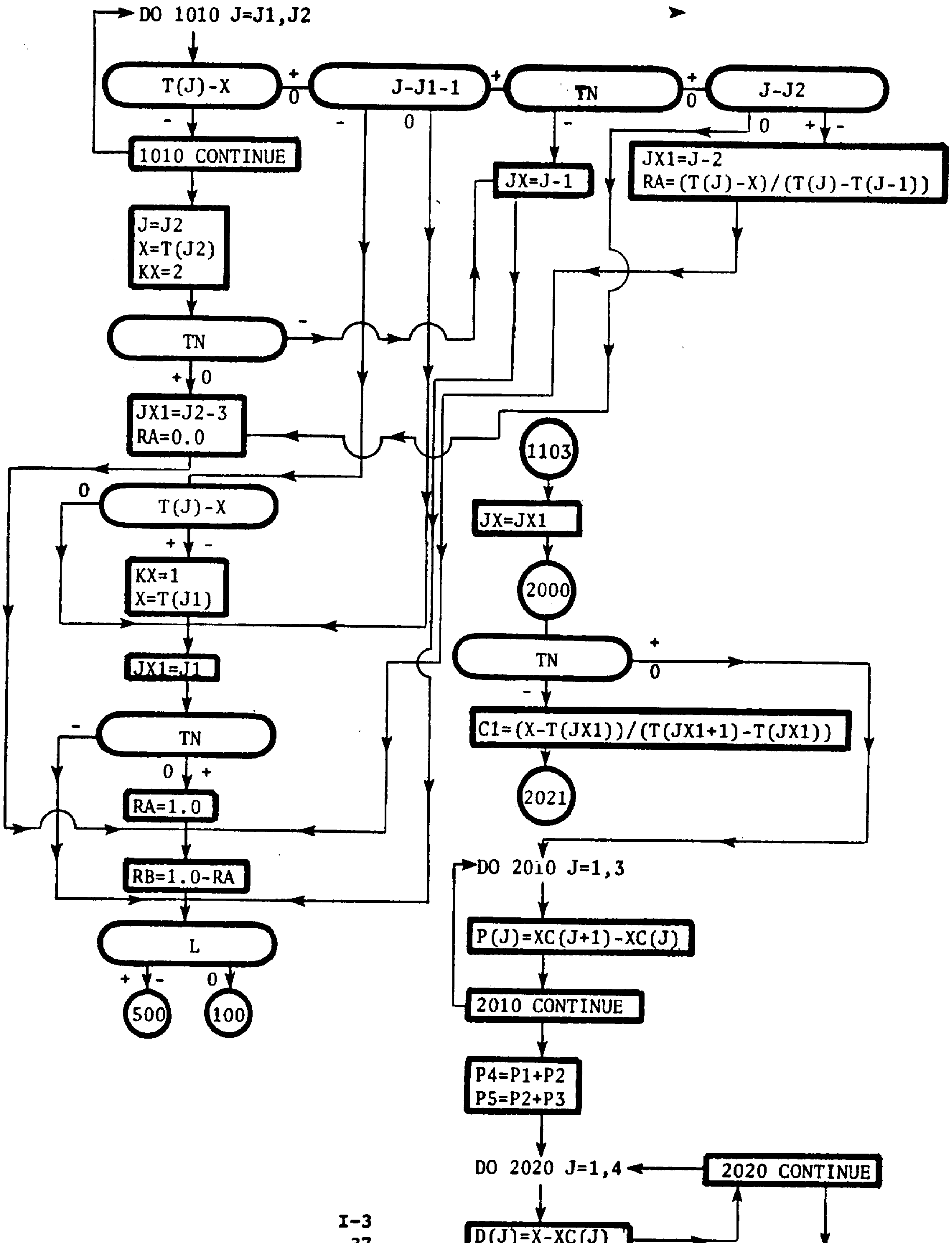
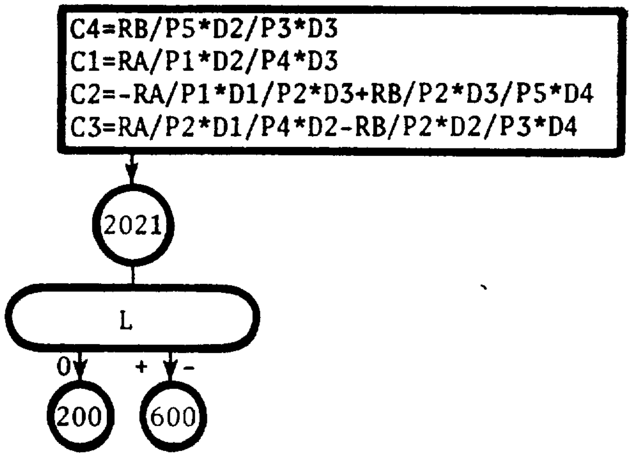


FIGURE I.3.10 - SUBROUTINE BILINE


500
K=K+3*KX
TN
+
0
-
JY=JX1+NY*(JY-IPX-2)
JX=JY+NY
Z=T(JY)+C1*(T(JX)-T(JY))
Z=(X-T(JX1))/(T(JX1+1)-T(JX1))*(T(JY+1)+C1*
(T(JX+1)-T(JY+L))-Z)+Z
RETURN
JY=J2+1+(JX-IDX-3)*NY+JX1-J1
DO 550 M=1,4
JX=JY
Y(M)=0.0
DO 520 J=1,4
Y(M)=Y(M)+C(J)*T(JX)
JX=JX+NY
520 CONTINUE
JY=JY+1
550 CONTINUE
105
1000
KX=0
600
Z=0.0
DO 700 J=1,4
Z=Z+C(J)*Y(J)
RETURN


DO 1010 J=J1,J2
T(J)-X
J-J1-1
TN
J-J2
1010 CONTINUE
JX=J-1
JX1=J-2
RA=(T(J)-X)/(T(J)-T(J-1))
J=J2
X=T(J2)
KX=2
TN
JX1=J2-3
RA=0.0
1103
T(J)-X
JX=JX1
KX=1
X=T(J1)
2000
TN
JX1=J1
C1=(X-T(JX1))/(T(JX1+1)-T(JX1))
TN
2021
RA=1.0
DO 2010 J=1,3
RB=1.0-RA
P(J)=XC(J+1)-XC(J)
L
2010 CONTINUE
500
100
P4=P1+P2
P5=P2+P3
DO 2020 J=1,4
2020 CONTINUE
D(J)=X-XC(J)

200


C4=RB/P5*D2/P3*D3
C1=RA/P1*D2/P4*D3
C2=-RA/P1*D1/P2*D3+RB/P2*D3/P5*D4
C3=RA/P2*D1/P4*D2-RB/P2*D2/P3*D4
2021
L
0
+
-
200
600

I.3.10 Subroutine BIQUAD -

Quadratic Interpolation, One Independent Variable

This is a utility routine performing quadratic interpolation in one independent variable using data stored in the form

$$Z_i = Z_i(X_i);\ i = 1, 2, \ldots N$$

A detailed flow chart for subroutine BIQUAD is presented in Figure I.3.11.

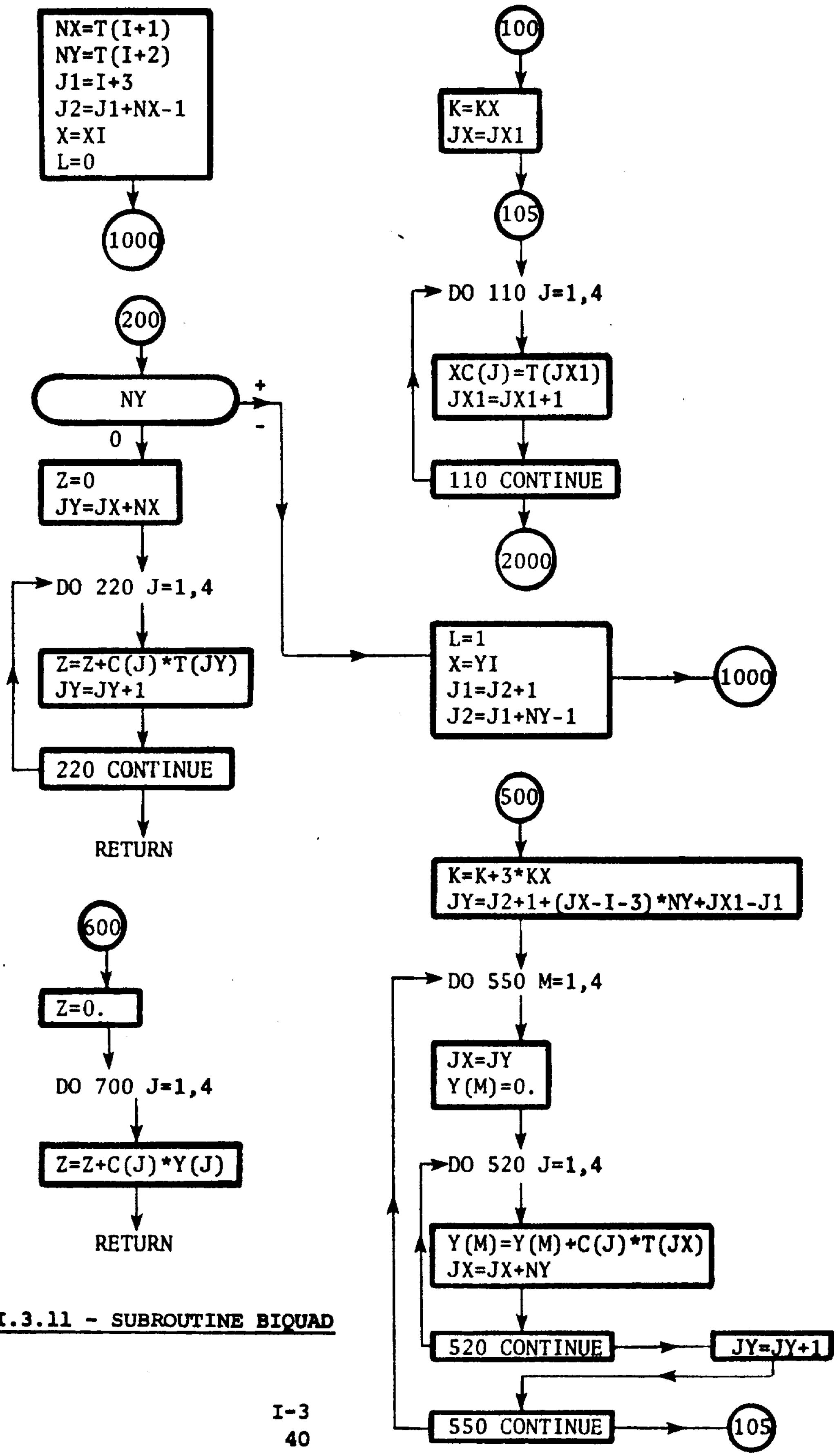
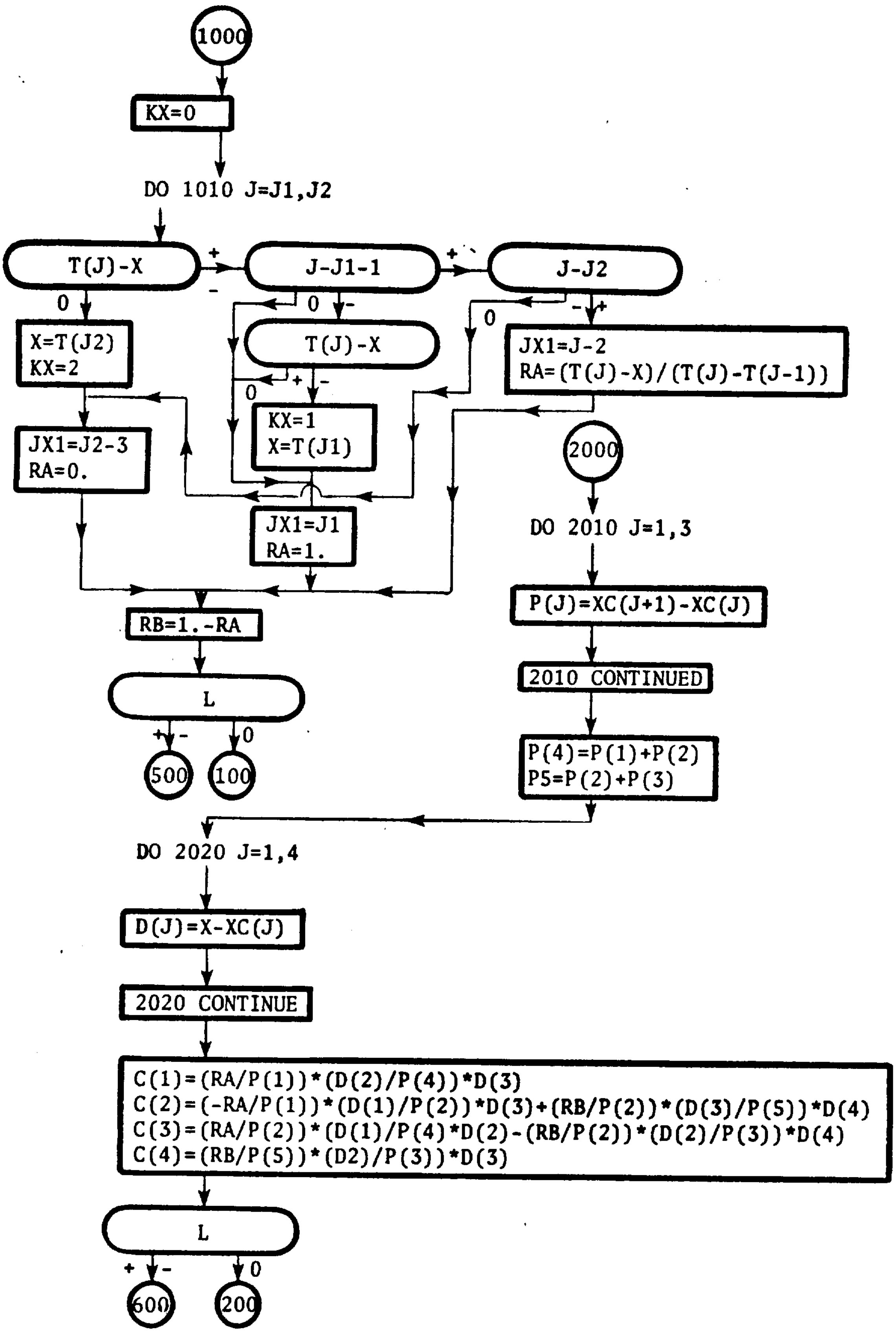


FIGURE I.3.11 - SUBROUTINE BIQUAD


1000
KX=0
DO 1010 J=J1,J2
T(J)-X
J-J1-1
J-J2
X=T(J2)
KX=2
T(J)-X
JX1=J-2
RA=(T(J)-X)/(T(J)-T(J-1))
KX=1
X=T(J1)
JX1=J2-3
RA=0.
2000
JX1=J1
RA=1.
DO 2010 J=1,3
P(J)=XC(J+1)-XC(J)
RB=1.-RA
2010 CONTINUED
L
P(4)=P(1)+P(2)
P5=P(2)+P(3)
500
100
DO 2020 J=1,4
D(J)=X-XC(J)
2020 CONTINUE
C(1)=(RA/P(1))*(D(2)/P(4))*D(3)
C(2)=(-RA/P(1))*(D(1)/P(2))*D(3)+(RB/P(2))*(D(3)/P(5))*D(4)
C(3)=(RA/P(2))*(D(1)/P(4)*D(2)-(RB/P(2))*(D(2)/P(3))*D(4)
C(4)=(RB/P(5))*(D2)/P(3))*D(3)
L
600
200

I.3.11 Subroutine MAXBND -

Maximum Value of a Variable

This is a utility routine which determines the maximum value of a variable in the interval DMIN to DMAX. A detailed flow chart for MAXBND is presented in Figure I.3.12.

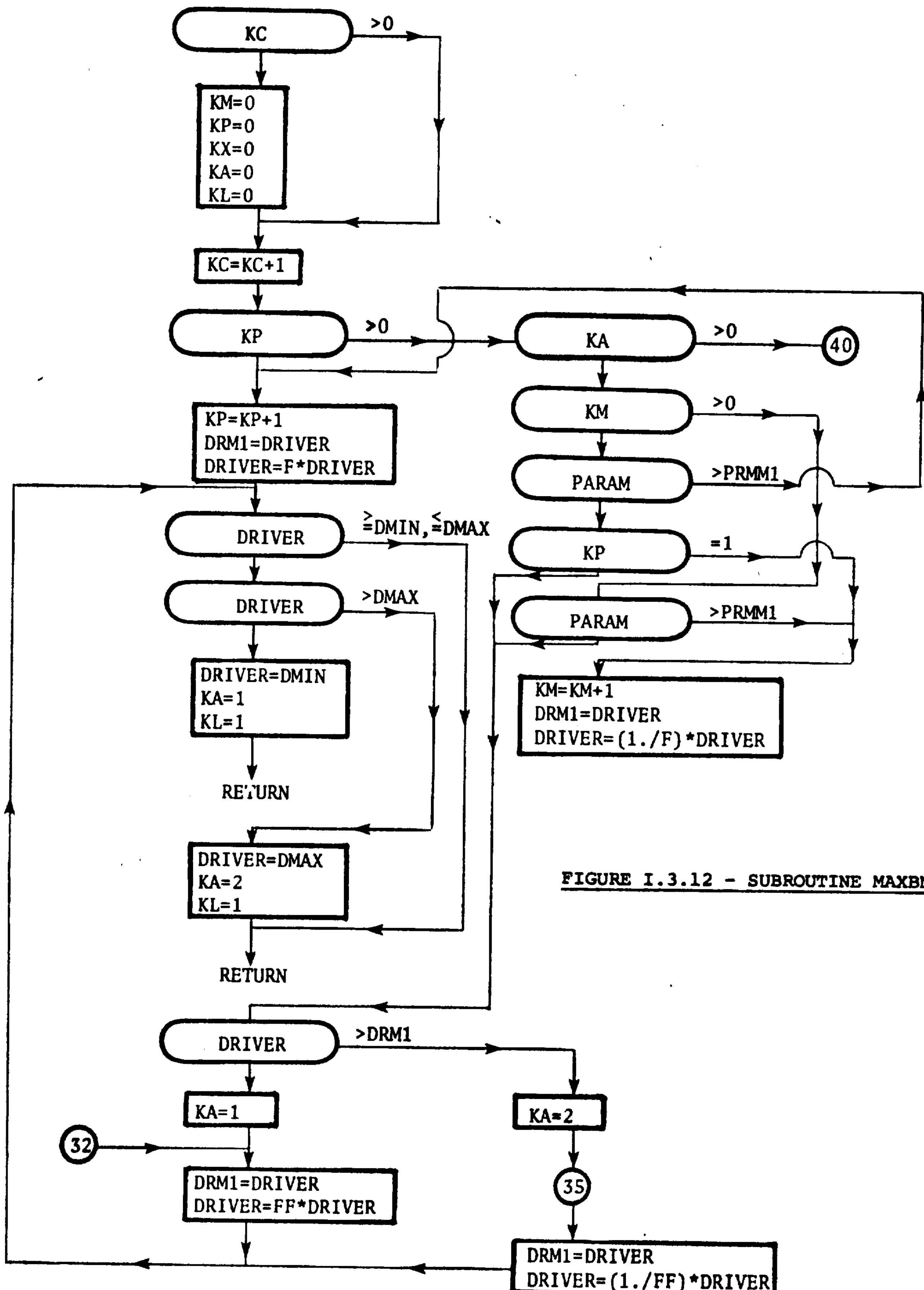
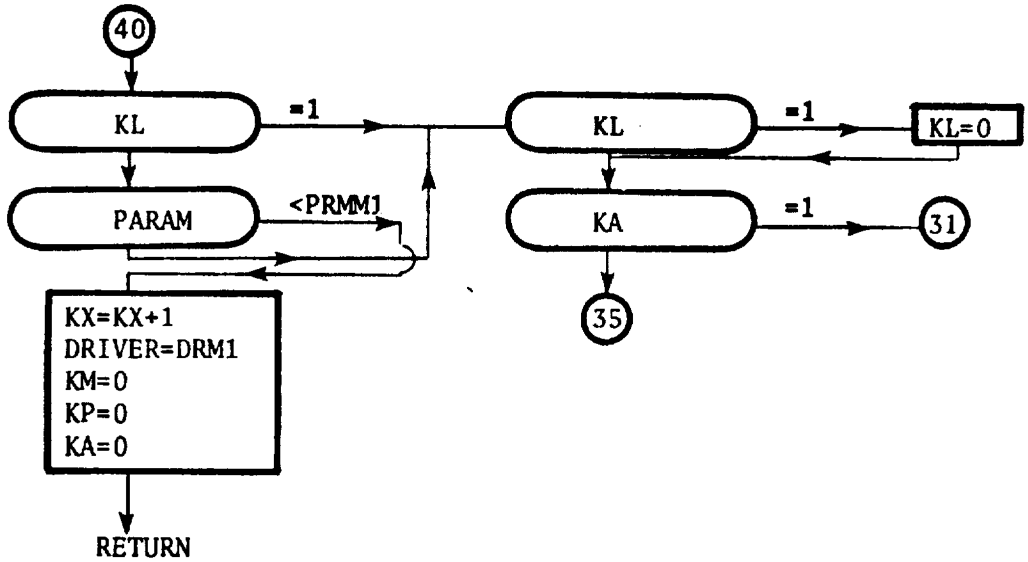


FIGURE I.3.12 - SUBROUTINE MAXBND


40
KL
=1
PARAM
<PRMM1
KX=KX+1
DRIVER=DRM1
KM=0
KP=0
KA=0
RETURN
KL
=1
KL=0
KA
=1
31
35

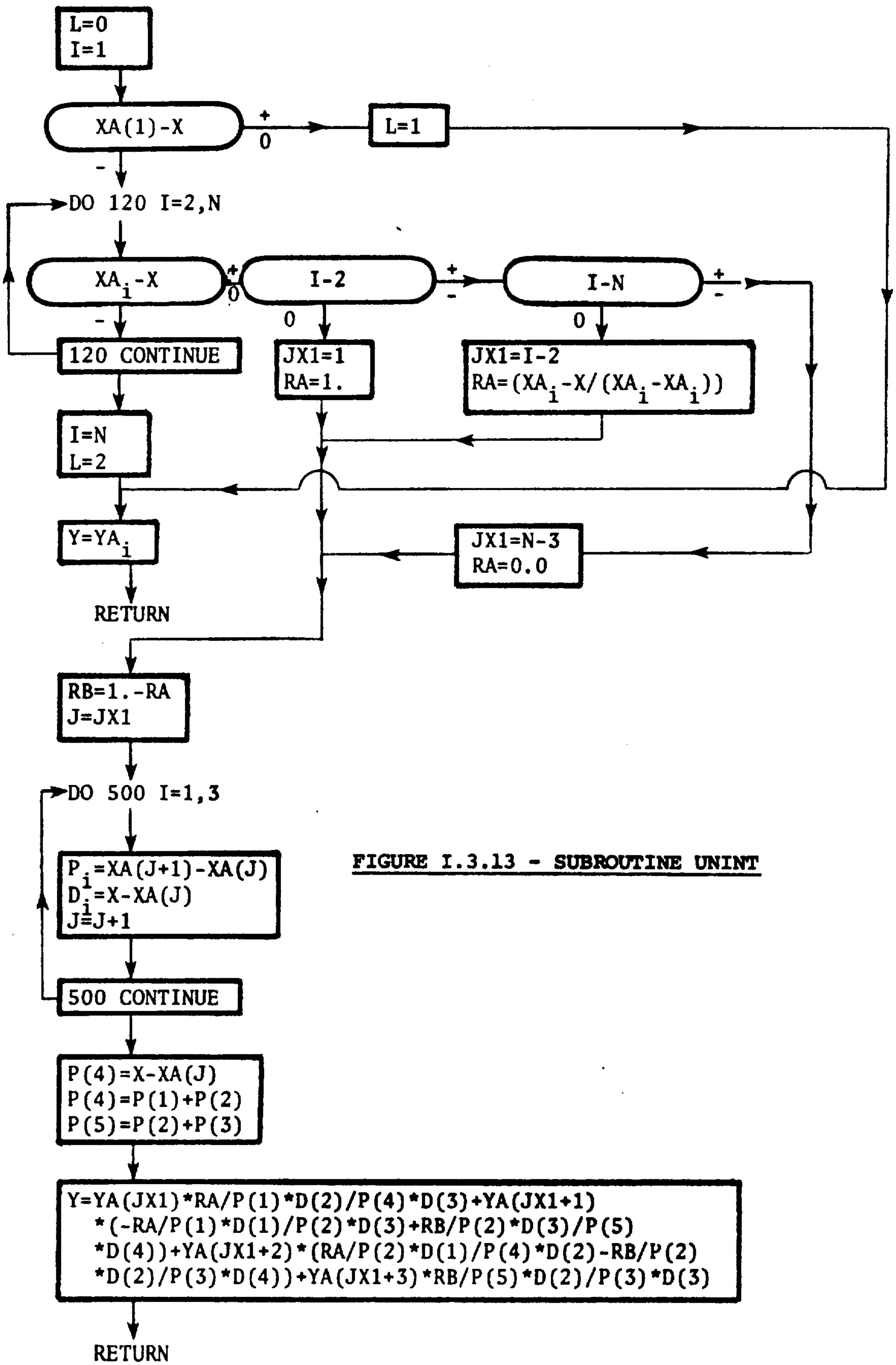
I.3.12 Subroutine UNINT -

Four Point Smooth Interpolation

This is a utility routine which performs a smooth four point interpolation in stored tabular data of the form

$$U_i = Y_i(X_i); \; i = 1, 2, \ldots N$$

A detailed flow chart for UNINT is provided in Figure I.3.13.



<u>**FIGURE I.3.13 - SUBROUTINE UNINT**</u>